# AIPCP Programmatic Biological Assessment

## Supplemental Materials Binder

October 2017

United States Department of Agriculture

Agricultural Research Service

# Table of Contents

**1. NPDES General Permit No. CAG 990005**

**2. Herbicide and Adjuvant/Dye Labels and Material Safety Data Sheets**

Herbicides

- 2,4-D – Weedar 64
- Carfentrazone-ethyl – Stingray
- Diquat – Reward
- Endothall (dipotassium salt) – Aquathol
- Florpyrauxifen-benzyl – Procellacor *[No label available to date]*
- Flumioxazin – Clipper
- Fluridone – Sonar
- Glyphosate – RoundUp
- Imazamox – Clearcast
- Imazapyr – Habitat
- Penoxsulam – Galleon

Adjuvants and Dyes

- Agridex
- Break-Thru SP 133
- Competitor
- Cygnet Plus
- Bright Dyes
- ColorFast
- Rhodamine WT

**3. UC Davis Toxicity Study Results**

A. Acute and Chronic Toxicity Testing of New Herbicides and Adjuvants on Delta Smelt
B. The Effects and Interactions of Penoxsulam, Imazamox and Agridex on Early Life Stages of Delta Smelt
C. The Effects of Penoxsulam, Imazamox and Agridex on survival, health indices and histopathology of Early Life Stages of Delta Smelt
D. Sublethal Effects of Herbicides Penoxsulam, Imazamox, Fluridone and Glyphoste on Delta Smelt
E. 2017 Toxicity Study – Draft Final Report to the Department of Parks and Recreation, Division of Boating and Waterways

**4. Draft Collaboration Guidelines**

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Section 1

# NPDES General Permit No. CAG 990005

CORRECTION – 7/27/2016
Typographical Error – Changed Order Number From 2016-0074-EXEC to 2016-0073-EXEC

STATE WATER RESOURCES CONTROL BOARD
ORDER 2016-0073-EXEC

AMENDING

WATER QUALITY ORDER 2013-0002-DWQ
GENERAL PERMIT NO. CAG 990005
(AS AMENDED BY ORDERS 2014-0078-DWQ AND 2015-0029-DWQ)

STATEWIDE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES
TO WATERS OF THE UNITED STATES FROM ALGAE AND
AQUATIC WEED CONTROL APPLICATIONS

The State of California, Water Resources Control Board (hereafter State Water Board) finds:

1. The State Water Board is authorized to prescribe statewide general National Pollutant Discharge Elimination System (NPDES) permits for categories of discharges that involve the same or similar operations and the same or similar types of waste pursuant to the California Water Code section 13263(i).

2. On September 22, 1989, the U.S. Environmental Protection Agency (U.S. EPA) granted the State of California, through the State Water Board and the Regional Water Quality Control Boards, the authority to issue general NPDES permits pursuant to title 40 Code of Federal Regulations (C.F.R.) parts 122 and 123.

3. Section 122.28 of 40 C.F.R. provides for issuance of general permits to regulate a category of point sources if the sources involve the same or substantially similar types of operations; discharge the same type of waste; require the same type of effluent limitations or operating conditions; require similar monitoring; and are more appropriately regulated under a general order rather than individual permits.

4. On March 5, 2013, the State Water Board adopted Water Quality Order 2013-0002-DWQ (later amended by Orders 2014-0078-DWQ on May 20, 2014 and 2015-0029-DWQ on March 3, 2015), Statewide NPDES Permits for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications (hereafter Weed Control Permit). The State Water Board amended Order 2013-0002-DWQ through Order 2014-0078-DWQ on May 20, 2014 and Order 2015-0029-DWQ on March 3, 2015. The Weed Control Permit covers the point source discharge of residual pesticides resulting from pesticide applications for aquatic weed control. The Weed Control Permit covers only pesticides that are approved for aquatic use by U.S. EPA and registered by the California Department of Pesticide Regulation (DPR) for aquatic applications in accordance with specific application rates.

5. Section III.B of the Weed Control Permit provides delegation authority from the State Water Board to the Executive Director for the following actions:

a. Amend the permit to add new active ingredients currently registered by DPR for the control of aquatic weeds; and

b. Add Dischargers to the list of public agencies in permit Attachment G that have satisfactorily completed the California Environmental Quality Act (CEQA) process and been granted an exception from meeting receiving water limitations for pesticide active ingredients that are priority pollutants in accordance with section 5.3 of the State Water Board Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP).

6. The discharge of residual aquatic pesticides with the following active ingredients is permitted with coverage under the Weed Control Permit: 2,4-D, acrolein, calcium hypochlorite, copper, diquat, endothall, fluridone, glyphosate, imazamox, imazapyr, penoxsulam, sodium carbonate peroxyhydrate, sodium hypochlorite, and triclopyr-based algaecides and aquatic herbicides, and adjuvants containing ingredients represented by the surrogate nonylphenol.

7. The State Water Board granted exceptions to public agencies and mutual water companies that met the criteria stated in SIP section 5.3 for short-term or seasonal exceptions from meeting the receiving water limitations for priority pollutants of acrolein and copper.

8. This item proposes the following amendments to the Weed Control Permit:

   a. Add the City of Sacramento, City of Poway, Helix Water District, San Diego County Water Authority, Santa Fe Irrigation District, and Sweetwater Authority to Attachment G which lists dischargers excepted from meeting receiving water limitations for acrolein or copper in accordance with SIP section 5.3. These agencies have satisfactorily completed the required CEQA process for exceptions to copper receiving water limits.

   b. Modify the SIP exception for Byron-Bethany Irrigation District (District) in Attachment G to add a SIP exception for copper to the District's current SIP exception for acrolein. Attachment G lists dischargers receiving exceptions to meeting receiving water limitations for acrolein or copper in accordance with SIP section 5.3. The District has satisfactorily completed the required CEQA process.

   c. Add the pesticide active ingredient flumioxazin. DPR approved the use of pesticide products containing this active ingredient for aquatic use in the state in 2014.

   d. Add the pesticide active ingredients hydrogen peroxide and peroxyacetic acid. DPR approved the use of pesticide products containing these active ingredients for aquatic use in the state in 2002.

9. Interested parties were invited to comment on the proposed permit amendments in response to the 30 day public notice of the amended permit issued on February 23, 2016. The Executive Director considered all comments received during the public notice period, and, where necessary, revised the proposed permit amendment accordingly prior to authorizing the amendments.

**IT IS HEREBY ORDERED THAT:**

Pursuant to the authority delegated by Water Code section 13267(f), Resolution 2002-0104, and Order 2015-0029-DWQ, Order 2013-0002-DWQ is hereby amended as shown in Attachment A.

6/30/16
Dated

Thomas Howard
Executive Director

**ATTACHMENT A**

**STATE WATER RESOURCES CONTROL BOARD**

**1001 I Street, Sacramento, California 95814**
http://www.waterboards.ca.gov/water_issues/programs/npdes/aquatic.shtml

**WATER QUALITY ORDER 2013-0002-DWQ**
**(AS AMENDED BY ORDERS 2014-0078-DWQ, 2015-0029-DWQ, AND 2016-0073-EXEC)**

**GENERAL PERMIT NO. CAG990005**

# STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

The following Dischargers may apply for coverage under this General Permit in compliance with the waste discharge requirements as set forth in this General Permit:

**Table 1. Discharger Information**

| | |
|---|---|
| **Dischargers** | Any entity that discharges residual algaecides and aquatic herbicide and their degradation byproducts to waters of the United States* from algae and aquatic weed control applications. |

**Table 2. Administrative Information**

| | |
|---|---|
| This General Permit was adopted by the State Water Resources Control Board (hereinafter State Water Board) on: | **March 5, 2013** |
| This General Permit shall become effective on: | **December 1, 2013** |
| This General Permit shall expire on: | **November 30, 2018** |
| The U.S. Environmental Protection Agency (U.S. EPA) and the State Water Board have classified this discharge as a **minor** discharge. | |

I, Jeanine Townsend, Clerk to the Board, do hereby certify that this General Permit with all attachments is a full, true, and correct copy of the General Permit adopted by the State Water Board on March 5, 2013.

AYE:

NAY:

ABSENT:

ABSTAIN:

Jeanine Townsend
Clerk to the Board

## Table of Contents

I. Discharge Information ..... 3
II. Permit Coverage and Application Requirements ..... 3
A. General Permit Coverage ..... 3
B. Discharger ..... 4
C. General Permit Application ..... 4
D. Fees ..... 5
E. Terminating Coverage ..... 5
III. Findings ..... 6
IV. Discharge Prohibitions ..... 6
V. Effluent Limitations ..... 6
VI. Receiving Water Limitations ..... 7
VII. Receiving Water Monitoring Triggers ..... 8
VIII. Aquatic Pesticide Use Requirements ..... 9
A. Application Schedule ..... 9
B. Public Notice Requirements ..... 9
C. Aquatic Pesticides Application Plan (APAP) ..... 9
D. APAP Processing, Approval, and Modifications ..... 11
E. Algaecide and Aquatic Herbicide Application Log ..... 12
IX. Provisions ..... 12
A. Standard Provisions ..... 12
B. Monitoring and Reporting Program Requirements ..... 14
C. Special Provisions ..... 14
X. Compliance Determination ..... 18

## List of Tables

Table 1. Discharger Information ..... 1
Table 2. Administrative Information ..... 1
Table 3. Receiving Water Limitations ..... 7
Table 4. Receiving Water Monitoring Triggers ..... 9

## List of Attachments

Attachment A – Definitions ..... A-1
Attachment B – Standard Provisions ..... B-1
Attachment C – Monitoring and Reporting Program ..... C-1
Attachment D – Fact Sheet ..... D-1
Attachment E – Notice of Intent ..... E-1
Attachment F – Notice of Termination ..... F-1
Attachment G – Exception List ..... G-1

## I. DISCHARGE INFORMATION

Pesticide formulations may include "active ingredients"* and "inert ingredients."* Adjuvants* or surfactants may be added to the ingredients in the application equipment used in delivery of the pesticide. As part of the registration process of pesticides for use in California, U.S. EPA and the California Department of Pesticide Regulation (DPR) evaluate data submitted by registrants to ensure that a product used according to label instructions will cause no harm or adverse impact on non-target organisms that cannot be reduced or mitigated with protective measures or use restrictions. The Clean Water Act (CWA) section 301(a) broadly prohibits the discharge of any pollutant to waters of the United States, except in compliance with an NPDES permit. Residual pesticides* discharged into surface waters constitute pollutants within the meaning of the CWA even if the discharge is in compliance with the registration requirements of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Therefore, coverage under an NPDES permit is required.

The discharge of algaecides and aquatic herbicides and their residues to surface waters for algae and aquatic weed control throughout the State of California may pose a threat to existing and potential beneficial uses of waters of the United States if not properly controlled and regulated.

This General Permit regulates the discharge of aquatic pesticides* (algaecides and aquatic herbicides) used for algae and aquatic weed control to waters of the United States. These are algaecides and aquatic herbicides with registration labels that explicitly allow direct application to water bodies.

## II. PERMIT COVERAGE AND APPLICATION REQUIREMENTS

### A. General Permit Coverage

Except for discharges on tribal lands that are regulated by a federal permit, this General Permit covers the point source* discharge to waters of the United States of residues resulting from pesticide applications using products containing 2,4-D, acrolein, calcium hypochlorite, copper, diquat, endothall, flumioxazin, fluridone, glyphosate, hydrogen peroxide, imazamox, imazapyr, penoxsulam, peroxyacetic acid, sodium carbonate peroxyhydrate, sodium hypochlorite, and triclopyr-based algaecides and aquatic herbicides, and adjuvants containing ingredients represented by the surrogate nonylphenol. This General Permit covers only discharges of algaecides, and aquatic herbicides that are currently registered for use in California, or that become registered for use and contain the above-listed active ingredients and ingredients represented by the surrogate of nonylphenol.

* An asterisk means the term is defined in Attachment A. This applies to all sections of this General permit.

This General Permit does not cover agricultural storm water discharges or return flows from irrigated agriculture because these discharges are not defined as "point sources" and do not require coverage under an NPDES permit. This General Permit also does not cover other indirect or nonpoint source discharges from applications of algaecides and aquatic herbicides, including discharges of pesticides to land that may be conveyed in storm water or irrigation runoff.

As shown in Table 1, this General Permit becomes effective on December 1, 2013. To obtain coverage under this General Permit on or after that date, Dischargers must submit their application for coverage as set forth in Section II.C below, at least 90 days prior to their first pesticide application.

B. **Discharger**

A Discharger under this General Permit includes any entity involved in the application of algaecides and aquatic herbicides that results in a discharge of algaecides and aquatic herbicides and their residues and degradation byproducts to waters of the United States, and meets either or both of the following two criteria:

The entity has control over the financing for or the decision to perform algaecide and aquatic herbicide applications that result in discharges, including the ability to modify those decisions; or

The entity has day-to-day control of algaecide and aquatic herbicide applications or performs activities that are necessary to ensure compliance with this General Permit. For example, the entity is authorized to direct workers to carry out activities required by this General Permit or perform such activities themselves.

C. **General Permit Application**

To obtain authorization under this General Permit, Dischargers must submit to the State Water Board a complete application that consists of the following:

1. A Notice of Intent (NOI) shown as Attachment E, signed in accordance with the signatory requirements of the Standard Provisions in Attachment B;
2. An application fee. A fee is required only for new Dischargers. Dischargersenrolled under Order No. 2004-0009-DWQ and applying for coverage under this Permit will be billed during the regular billing cycle; and
3. An Aquatic Pesticide* Application Plan (APAP).

A Discharger proposing to apply algaecides and aquatic herbicides in multiple Water Board regions shall submit one NOI, one APAP, and one filing fee. The Discharger shall indicate in the NOI all the Water Board regions where applications are planned. The Discharger shall address all required elements of the APAP for all areas in the state where discharges are proposed.

Within 90 days of receipt of an application, the State Water Board's Deputy Director of the Division of Water Quality (Deputy Director) will either issue a Notice of Applicability (NOA) or deny the application. The NOA will specify the permitted algaecide and aquatic herbicide active ingredients that may be used, and any region-specific conditions and requirements not stated in this General Permit. Any such region-specific conditions and requirements shall be enforceable. The Discharger is authorized to discharge starting on the date of the NOA.

Alternatively, the Deputy Director or a Regional Water Board Executive Officer may issue a Notice of Exclusion (NOE),[1] which either terminates the permit coverage or requires submittal of an application for an individual permit or alternative general permit.

D. **Fees**

The fee for enrollment under this General Permit shall be based on section 2200(b)(9) category 3 of title 23, California Code of Regulations, which is available at http://www.waterboards.ca.gov/resources/fees/docs/fy1112fee_schdl_npdes_prmt.pdf and is payable to the State Water Board.

E. **Terminating Coverage**

To terminate permit coverage, a Discharger must submit a complete and accurate Notice of Termination (NOT) provided in Attachment F. The Discharger's authorization to discharge under this General Permit terminates on the day of the coverage termination letter issued by the Deputy Director. Prior to the termination effective date, the Discharger is subject to the terms and conditions of this General Permit and is responsible for submitting the annual fee and all reports associated with this General Permit.

A Discharger must submit an NOT when one of the following conditions occurs:

1. A new operator has taken over responsibility of the Discharger's algae or aquatic weed control activities covered under an existing NOA;
2. The Discharger has ceased all discharges from the application of algaecides and aquatic herbicide for which it obtained General Permit coverage and does not expect to discharge during the remainder of this General Permit term; or

[1] An NOE is a one-page notice that indicates and justifies why the Discharger or proposed Discharger is not eligible for coverage under this General Permit and states the reason why. This justification can include, but is not limited to, necessity to comply with a total maximum daily load or to protect sensitive water bodies. The NOE can also indicate that the coverage is denied if feasible alternatives to the selected pesticide application project are not analyzed.

3. The Discharger has obtained coverage under an individual permit or an alternative general permit for all discharges required to be covered by an NPDES permit.

## III. FINDINGS

The Fact Sheet (Attachment D), which contains the background information and rationale for the requirements in this General Permit, is hereby incorporated into this General Permit and constitutes its findings. All other attachments (A, B, C, and E through G) are also incorporated into this General Permit.

THEREFORE, IT IS HEREBY ORDERED that this General Permit supersedes Order No. 2004-0009-DWQ except for enforcement purposes, and in order to meet the provisions contained in division 7 of the Water Code (commencing with § 13000) and regulations adopted thereunder, and the provisions of the CWA and regulations and guidelines adopted thereunder:

A. The Discharger shall comply with the requirements in this Order.

B. The Executive Director is authorized to amend this Order to add active ingredients that are registered by DPR for the control of aquatic weeds, and to grant exceptions pursuant to section 5.3 of the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (SIP).

## IV. DISCHARGE PROHIBITIONS

A. The discharge of residual algaecides and aquatic herbicides in a manner different from that described in this General Permit is prohibited.

B. The discharge of residual algaecides and aquatic herbicides shall not create a nuisance as defined in section 13050 of the California Water Code.

C. The discharge shall not cause, have a reasonable potential to cause, or contribute to an in-stream excursion above any applicable standard or criterion promulgated by U.S. EPA pursuant to section 303 of the CWA, or water quality objective adopted by the State or Regional Water Boards.

D. All pesticides are prohibited from the waters of the Lahontan Region (Region 6). The use of this permit is invalid in the Lahontan Region unless the discharger has requested a prohibition exemption from the Lahontan Water Board and the Lahontan Water Board has granted an exemption for the use of algaecides or aquatic herbicides.

## V. EFFLUENT LIMITATIONS

A. The discharge of residual algaecides and aquatic herbicides must meet applicable water quality standards; and

B. Dischargers shall implement Best Management Practices (BMPs) when applying aquatic algaecides and aquatic herbicides. The BMPs must be provided in the APAP which is described in Section VIII.C below.

## VI. RECEIVING WATER LIMITATIONS

The discharge shall not result in any of the following:

A. The discharge of residual algaecides and aquatic herbicides shall not cause or contribute to an exceedance of the following limitations in the receiving water:

**Table 3. Receiving Water Limitations**

| Constituent/ Parameter | BENEFICIAL USE[1] | | | | Basis |
|---|---|---|---|---|---|
| | MUN, µg/L | WARM or COLD, µg/L | Other than MUN, WARM, or COLD, µg/L | All Designations | |
| 2,4-D | 70 | | | | U.S. EPA MCL |
| Acrolein[2] | 320 | 21 | 780 | | U.S. EPA Water Quality Criteria, 1986. |
| Chlorine | | Freshwater Acute Criterion = 20 µg/L | | | U.S. EPA's Ambient Water Quality Criteria for Freshwater Aquatic Life Protection |
| | | Saltwater Acute Criterion = < 10 µg/L | | | California Ocean Plan |
| Copper[2] | | | | Dissolved Freshwater[3] Copper Chronic = 0.960exp{0.8545 [ln(hardness[4])] – 1.702}[5, 6]<br><br>Dissolved Saltwater[3] Copper Chronic = 3.1 µg/L [5,6] | California Toxics Rule |
| Diquat | 20 | | | | U.S. EPA MCL |
| Endothall | 100 | | | | U.S. EPA MCL |
| Fluridone | 560 | | | | U.S. EPA Integrated Risk Information System |
| Glyphosate | 700 | | | | U.S. EPA MCL |
| Nonylphenol | | | | Freshwater Chronic Criterion = 6.6 µg/L<br><br>Saltwater Chronic Criterion = 1.7 µg/L | U.S. EPA National Recommended Ambient Water Quality Criteria |
| Toxicity | Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s). | | | | Regional Water Boards' Basin Plans |

Notes:
1. See Regional Water Boards' Water Quality Control Plans (Basin Plans) for beneficial use definitions.
2. Public entities and mutual water companies* listed in Attachment G are not required to meet these limitations in receiving waters during the exception period described in the APAP and Section VIII.C.10 below.
3. For waters in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the freshwater criteria apply. For waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, saltwater criteria apply. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable criteria are the more stringent of the freshwater or saltwater criteria.
4. For freshwater aquatic life criteria, waters with a hardness 400 mg/L or less as calcium carbonate, the actual ambient hardness of surface water shall be used. For waters with a hardness of over 400 mg/L as calcium carbonate, a hardness of 400 mg/L as calcium carbonate shall be used with a default Water-Effect Ratio of 1.
5. Values should be rounded to two significant figures.
6. This limitation does not apply to the Sacramento River and its tributaries above the State Highway 32 Bridge at Hamilton City. See Table III-1 of the Basin Plan for the Sacramento and San Joaquin River Basins for copper limitation.

B. **Dissolved Oxygen.** Dissolved oxygen to be below the Regional Water Board Basin Plans' dissolved oxygen objectives for the receiving water.

C. **Floating Material.** Floating material to be present in the amounts that cause nuisance or adversely affect beneficial uses.

D. **Settleable Substances.** Settleable substances to be present in concentrations that result in the deposition of material that causes nuisance or adversely affects beneficial uses.

E. **Suspended Material.** Suspended material to be present in concentrations that cause nuisance or adversely affect beneficial uses.

F. **Taste and Odors.** Taste- or odor-producing substances to be present in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses or domestic or municipal water supplies.

G. **Toxic Pollutants.** Toxic pollutants to be present in the water column, sediments, or biota in concentrations that adversely affect beneficial uses; that produce detrimental response in human, plant, animal, or aquatic life; or that bioaccumulate in aquatic resources at levels which are harmful to human health.

H. **Color.** Esthetically undesirable discoloration.

I. **Aquatic Communities.** Aquatic communities and populations, including vertebrates, invertebrates, and non-target plant species to be degraded.

## VII. RECEIVING WATER MONITORING TRIGGERS

In the absence of Receiving Water Limitations, the Receiving Water Monitoring Triggers shown in Table 4 below will be used to assess compliance with the narrative receiving water toxicity limitation. However, exceeding the monitoring trigger does not constitute a violation of this General Permit as long as the Discharger performs the following actions: (1) initiates additional investigations for the cause of the exceedance; (2) implements

additional BMPs to reduce the algaecide and aquatic herbicide residue concentration to be below the monitoring triggers in future applications; and (3) evaluates the appropriateness of using alternative products.

**Table 4. Receiving Water Monitoring Triggers**

| Ingredient | Unit | Instantaneous Maximum Monitoring Trigger | Basis |
|---|---|---|---|
| Imazapyr | mg/L | 11.2 | U.S. EPA Office of Pesticides *Ecotoxicity Database* |
| Triclopyr Triethylamine | mg/L | 13.0 | U.S. EPA Office of Pesticides *Ecotoxicity Database* |
| Flumioxazin | mg/l | 0.23 | U.S. EPA Office of Pesticides *Ecotoxicity Database* |

## VIII. AQUATIC PESTICIDE USE REQUIREMENTS

### A. Application Schedule

The Discharger shall provide a phone number or other specific contact information to all persons who request the Discharger's application schedule. The Discharger shall provide the requester with the most current application schedule and inform the requester if the schedule is subject to change. Information may be made available by electronic means, including posting prominently on a well-known website.

### B. Public Notice Requirements

Every calendar year, at least 15 days prior to the first application of algaecide or aquatic herbicide, the Discharger shall notify potentially affected public agencies. The Discharger shall post the notification on its website if available. The notification shall include the following information:

1. A statement of the discharger's intent to apply algaecide or aquatic herbicide(s);
2. Name of algaecide and aquatic herbicide(s);
3. Purpose of use;
4. General time period and locations of expected use;
5. Any water use restrictions or precautions during treatment; and
6. A phone number that interested persons may call to obtain additional information from the Discharger.

### C. Aquatic Pesticides Application Plan (APAP)

Dischargers shall submit an APAP at least 90 days before the expected day of permit coverage. The APAP shall contain, but not be limited to, the following elements sufficient to address each proposed treatment area:*

1. Description of the water system to which algaecides and aquatic herbicides are being applied;
2. Description of the treatment area in the water system;
3. Description of types of weed(s) and algae that are being controlled and why;
4. Algaecide and aquatic herbicide products or types of algaecides and aquatic herbicides expected to be used and if known their degradation byproducts, the method in which they are applied, and if applicable, the adjuvants and surfactants used;
5. Discussion of the factors influencing the decision to select algaecide and aquatic herbicide applications for algae and weed control;
6. If applicable, list the gates or control structures to be used to control the extent of receiving waters potentially affected by algaecide and aquatic herbicide application and provide an inspection schedule of those gates or control structures to ensure they are not leaking;
7. If the Discharger has been granted a short-term or seasonal exception under State Water Board *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays,* and Estuaries of California* (Policy) section 5.3 from meeting acrolein and copper receiving water limitations, provide the beginning and ending dates of the exception period, and justification for the needed time for the exception. If algaecide and aquatic herbicide applications occur outside of the exception period, describe plans to ensure that receiving water criteria are not exceeded because the Dischargers must comply with the acrolein and copper receiving water limitations for all applications that occur outside of the exception period;
8. Description of monitoring program;
9. Description of procedures used to prevent sample contamination from persons, equipment, and vehicles associated with algaecide and aquatic herbicide application;
10. Description of the BMPs to be implemented. The BMPs shall include, at the minimum:
    a. Measures to prevent algaecide and aquatic herbicide spill and for spill containment during the event of a spill;
    b. Measures to ensure that only an appropriate rate of application consistent with product label requirements is applied for the targeted weeds or algae;
    c. The Discharger's plan in educating its staff and algaecide and aquatic herbicide applicators on how to avoid any potential adverse effects* from the algaecide and aquatic herbicide applications;
    d. Discussion on planning and coordination with nearby farmers and agencies with water rights diversion so that beneficial uses of the water (irrigation,

drinking water supply, domestic stock water, etc.) are not impacted during the treatment period; and

e. A description of measures that will be used for preventing fish kill when algaecides and aquatic herbicides will be used for algae and aquatic weed controls.

11. Examination of Possible Alternatives. Dischargers should examine the alternatives to algaecide and aquatic herbicide use to reduce the need for applying algaecides and herbicides. Such methods include:

    a. Evaluating the following management options, in which the impact to water quality, impact to non-target organisms including plants, algaecide and aquatic herbicide resistance, feasibility, and cost effectiveness should be considered:

        i. No action;

        ii. Prevention;

        iii. Mechanical or physical methods;

        iv. Cultural methods;

        v. Biological control agents; and

        vi. Algaecides and aquatic herbicides;

        If there are no alternatives to algaecides and aquatic herbicides, Dischargers shall use the minimum amount of algaecides and aquatic herbicides that is necessary to have an effective control program and is consistent with the algaecide and aquatic herbicide product label requirements.

    b. Using the least intrusive method of algaecide and aquatic herbicide application; and

    c. Applying a decision matrix concept to the choice of the most appropriate formulation.

D. **APAP Processing, Approval, and Modifications**

Upon receipt of an APAP, staff will post it on the State Water Board's website for a 30-day public comment period[2] and will distribute a notice via the State Water Board's Lyris list that an APAP has been posted. Staff will coordinate with Regional Water Board staff in reviewing the application package for completeness and applicability to this General Permit. If no comments are received and State and Regional Water Board staff deem the APAP complete, the Deputy Director will issue an NOA within five (5) working days of closure of the comment period. If comments are received, staff will work with Regional Water Board staff and the Discharger to address the

[2] See Waterkeeper Alliance, Inc. v. EPA, 399 F.3d 486 (2nd Cir. 2005).

comments to allow the Deputy Director to issue an NOA as expeditiously as possible. Permit coverage will begin when the Discharger receives the NOA.

Major changes to the APAP shall be submitted to the Deputy Director for approval. Examples of major changes include using a different product other than what is specified in the APAP, changing an application method that may result in different amounts of pesticides being applied, or adding or deleting BMPs.

### E. Algaecide and Aquatic Herbicide Application Log

The Discharger shall maintain a log for each algaecide and aquatic herbicide application. The application log shall contain, at a minimum, the following information:

1. Date of application;
2. Location of application;
3. Name of applicator;
4. Type and amount of algaecide and aquatic herbicide used;
5. Application details, such as flow and level of water body, time application started and stopped, algaecide and aquatic herbicide application rate and concentration;
6. Visual monitoring assessment; and
7. Certification that applicator(s) followed the APAP.

## IX. PROVISIONS

### A. Standard Provisions

1. All Dischargers authorized to discharge under this General Permit shall comply with the Federal Standard Provisions included in Attachment B of this General Permit.
2. This General Permit does not authorize the discharge of residual algaecides and aquatic herbicides or their degradation byproducts to waters of the United States that are impaired by the active ingredient of the algaecides and herbicides used. Impaired waters are those waters not meeting water quality standards pursuant to section 303(d) of the CWA. California impaired waters are listed on: http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/2010_combo303d.xls.
3. This General Permit does not authorize any take of endangered species. The discharge is prohibited from adversely impacting biologically sensitive or critical habitats, including, but not limited to, habitat of species listed under federal or state endangered species laws. To ensure that endangered species issues are raised to the responsible agencies, the State Water Board has notified the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the California Department of Fish and Wildlife of this General Permit.

4. The State Water Board may use this General Permit to regulate the discharge of algaecides and aquatic herbicides and their residues to a surface water classified as Outstanding National Resource Waters or as a water body impaired by unknown toxicity only after the following conditions are satisfied: (1) the proposed project will comply with the limitations and discharge requirements specified in the General Permit; and (2) if required, the proposed algaecide and aquatic herbicide application qualifies for and has been granted a Basin Plan prohibition exception prior to discharge. The two bodies of water that are classified as Outstanding National Resource Waters in California are Lake Tahoe and Mono Lake.
5. The Discharger must follow all FIFRA pesticide label instructions and any Restricted Material Use Permits issued by a County Agricultural Commissioner.
6. All adjuvants used with the algaecides and aquatic herbicides must be labeled for aquatic use.
7. The Discharger must comply with effluent and receiving water limitations and must develop and implement an APAP.
8. To reduce the potential impacts to water quality, Dischargers shall implement the feasible alternatives to algaecide and aquatic herbicide use that are identified in the APAP.
9. All Dischargers authorized to discharge under this General Permit shall comply with discharge prohibitions and other requirements contained in Basin Plans, as implemented by the State and the nine Regional Water Boards.
10. All Dischargers authorized to discharge under this General Permit shall comply with the following provisions:
    a. After notice and opportunity for a hearing, this General Permit may be terminated or modified for cause, including, but not limited to:
        i. Violation of any term or condition contained in this General Permit;
        ii. Obtaining this General Permit by misrepresentation or by failing to disclose fully all relevant facts;
        iii. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge; and
        iv. A material change in the character, location, or volume of discharge (if applicable).
    b. The provisions of this General Permit are severable. If any provision of this General Permit is found invalid, the remainder of this General Permit shall not be affected.
    c. The Discharger shall maintain a copy of this General Permit and make it available at all times to operating personnel. Key operating personnel shall be familiar with its content.

d. Laboratories that perform sample analyses must be identified in all monitoring reports submitted to the State and Regional Water Boards.

e. All monitoring and analysis instruments and devices used by the Discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated based on manufacturer's recommendations to ensure their continued accuracy.

f. Each Discharger shall file with the State Water Board and the appropriate Regional Water Board technical reports on self monitoring* performed according to the detailed specifications contained in the Monitoring and Reporting Program attached to this General Permit.

g. The State and Regional Water Board are authorized to enforce the terms of this General Permit under provisions of the California Water Code, including, but not limited to, sections 13385, 13386, and 13387.

## B. Monitoring and Reporting Program Requirements

The Discharger shall comply with the Monitoring and Reporting Program, and future revisions thereto, in Attachment C of this General Permit.

## C. Special Provisions

### 1. Reopener Provisions

This General Permit may be reopened for modification and reissuance in accordance with the provisions contained in title 40 Code Federal Regulation (40 C.F.R.) section 122.62, and for the following reasons:

a. **Addition to the Public Entity List**. This General Permit may be reopened to modify Attachment G if any additional entity becomes qualified for a Policy section 5.3 exception.

b. **Addition of Aquatic Pesticide Active Ingredients**. This General Permit may be reopened to add additional algaecide and aquatic herbicide active ingredients if new active ingredients are registered by U.S. EPA and DPR.

c. **Acute and Chronic Toxicity.** If the State Water Board revises the Policy toxicity control provisions that would require new implementation procedures including the establishment of numeric chronic toxicity limitations, this General Permit may be reopened to include numeric acute and/or chronic toxicity receiving water limitations based on the new provisions.

d. **Receiving Water Limitations.** This General Permit may be reopened to add numeric Receiving Water Limitations for the residual algaecide and aquatic herbicides* exceeding the triggers if the additional investigation results show necessary.

e. **Endangered Species Act**. If U.S. EPA develops biological opinions regarding algaecides and aquatic herbicides included in this General Permit,

this General Permit may be re-opened to add or modify Receiving Water Limitations/Monitoring Triggers for aquatic herbicides and algaecides and their residues of concern, if necessary.

f. This General Permit covers the application of pesticides that are based on active ingredients that are currently registered by DPR for the control of algae and aquatic weeds. When DPR registers a new active ingredient for algae and aquatic weed control, this General Permit needs to be reopened to add the new active ingredient to the permit before Dischargers may begin using the active ingredient. In addition, when DPR registers a new active ingredient that is also a priority pollutant and has been added to this General Permit, this General Permit may also be reopened to allow Dischargers to obtain an exception from meeting receiving water limitations for the priority pollutant in accordance with SIP section 5.3. It is very resource intensive to have the State Water Board amend this General Permit on a frequent basis. Thus, this General Permit contains a delegation from the State Water Board to the Executive Director to amend this General Permit for these two purposes.

2. **Change of Discharger**

In the event of any change in the Discharger that has obtained coverage under this General Permit, the previous Discharger shall notify the new Discharger of the existence of this General Permit by letter. A copy of the letter shall be immediately forwarded to the Deputy Director. After receipt of the letter, the Deputy Director will terminate the permit coverage to the previous Discharger. The new Discharger shall complete and submit to the Deputy Director a revised NOI form (Attachment E), and any revisions to the APAP prepared by the previous control entity or a new APAP.

3. **Application Package**

Dischargers who seek coverage under this General Permit shall file a complete application package at least 90 days before the expected date of algaecide and aquatic herbicide application. The application package shall include an NOI, APAP, and application fee. Enrolled Dischargers will be billed annually thereafter.

4. **Special Studies, Technical Reports, and Additional Monitoring Requirements**

a. **Additional Investigation**

Each Discharger must conduct additional investigations when the chemical monitoring shows exceedance of any receiving water limitation or monitoring trigger. The additional investigations shall identify corrective actions to eliminate exceedance of receiving water limitations or monitoring triggers caused by the algaecide and aquatic herbicide application. The investigation shall include, but not be limited to evaluating the need to implement one or more of the following actions: revising and improving the existing BMPs,

revising the mode of application, using less toxic algaecide and aquatic herbicide products, or selecting alternative methods for algae and aquatic weed control.

b. **Qualified Biologist Certification Following Project Completion**

Upon completion of an algaecide and aquatic herbicide project, public entities and mutual water companies listed in Attachment G of this General Permit shall provide certification by a qualified biologist* that beneficial uses of receiving waters have been restored.

5. **Corrective Action**

a. **Exceedance of Receiving Water Limitations or Monitoring Triggers.**

If a Receiving Water Limitation in Table 3 or a Monitoring Trigger in Table 4 is exceeded in the Event or Post-Event sample, the Discharger shall perform the following actions: (1) initiate additional investigations for the cause of the exceedance, (2) implement appropriate BMPs to reduce the algaecide and aquatic herbicide concentration to be below the applicable receiving water limitation or monitoring triggers in future applications, and (3) evaluate the appropriateness of using alternative products.

b. **Revision of Control Measures.**

If any of the following situations occur, the Discharger must review and, as necessary, revise the evaluation and selection of the control measures to ensure that the situation is eliminated and will not be repeated in the future:

i. An unauthorized release or discharge associated with the application of algaecides and aquatic herbicides (e.g., spill, leak, or discharge not authorized by this or another NPDES permit) occurs;

ii. The Discharger becomes aware, or the State Water Board concludes, that the control measures are not adequate/sufficient for the discharge to meet applicable water quality standards;

iii. Any monitoring activities indicate that the Discharger failed to:

a) Follow the label instructions for the product used;

b) Use the minimum amount of algaecide and aquatic herbicide product per application and optimum frequency of algaecide and aquatic herbicide applications that are necessary for an effective control program consistent with reducing the potential for development of resistance and the algaecide and aquatic herbicide product label requirements;

c) Perform regular maintenance activities to reduce leaks, spills, or other unintended discharges of algaecides and aquatic herbicides

associated with the application of algaecides and aquatic herbicides covered under this General Permit; or

d) Maintain algaecide and aquatic herbicide application equipment in proper operating condition by adhering to any manufacturer's conditions and industry practices, and by calibrating, cleaning, and repairing such equipment on a regular basis to ensure effective algaecide and aquatic herbicide application and algae and aquatic weed control. The Discharger must ensure that the equipment's rate of algaecide and aquatic herbicide application is calibrated to deliver the minimum quantity of algaecides and aquatic herbicides that is needed to have an effective control program and is consistent with the algaecide and aquatic herbicide product label requirements.

c. **Corrective Action Deadlines**

If the Discharger determines that changes to the control measures are necessary to eliminate any situation identified above, the Discharger shall make such changes within 60 days. The Discharger shall take the corrective action before any further discharge of the algaecides and aquatic herbicides and their residues will be allowed.

d. **Effect of Corrective Action**

The occurrence of a situation identified in Section C.5.b above may constitute a violation of this General Permit. Correcting the situation according to Corrective Action Section C.5.c above does not absolve the Discharger of liability for any original violation. However, failure to comply with any Corrective Action as required by Section C.5.c above constitutes an additional permit violation. The State and Regional Water Boards will consider the appropriateness and promptness of corrective action in determining enforcement responses to permit violations.

The State Water Board and the appropriate Regional Water Boards may impose additional requirements and schedules of compliance, including requirements to submit additional information concerning the condition(s) triggering corrective action or schedules and requirements more stringent than specified in this General Permit. Those requirements and schedules will supersede those in the Corrective Action Section above if such requirements conflict.

6. **Adverse Incident to Threatened or Endangered Species or Critical Habitat**

If the Discharger becomes aware of an adverse incident* to a federally-listed threatened or endangered species or its federally-designated critical habitat, that may have resulted from the Discharger's algaecides and aquatic herbicides application, the Discharger must immediately notify the National Marine Fisheries Service (NMFS) Santa Rosa office by phone at (707) 575-6050 in the case of an anadromous or marine species, or the U.S. Fish and Wildlife Service (FWS) at (916) 414-6600 in the case of a terrestrial or freshwater species. This notification

must be made by telephone immediately when the Discharger becomes aware of the adverse incident and must include at least the following information:

a. The caller's name, telephone number, and e-mail address;

b. Applicator name and mailing address;

c. The name of the affected species;

d. How and when the Discharger became aware of the adverse incident;

e. Description of the location of the adverse incident;

f. Description of the adverse incident, including the U.S. EPA pesticide registration number for each product applied in the area of the adverse incident; and

g. Description of any steps that have been taken or will be taken to alleviate the adverse impact to the species.

Additional information on federally-listed threatened or endangered species and federally-designated critical habitat is available from NMFS (www.nmfs.noaa.gov) for anadromous or marine species or FWS (www.fws.gov) for terrestrial or freshwater species.

## X. COMPLIANCE DETERMINATION

Compliance with receiving water limitations and monitoring triggers shall be determined through event and post-event monitoring results.

# Attachment A – Definitions

**Active Ingredient**
Active ingredients are ingredients disclosed by manufacturers that yield toxic effects* on target organisms.

**Adjuvants**
Adjuvants are ingredients that are mixed with herbicides prior to an application event and are often trade secrets. These ingredients are chosen by the Discharger, based on site characteristics, and typically increase the effectiveness of pesticides on target organisms.

**Adverse Incident**
Adverse Incident means a situation where the Discharger observes upon inspection or becomes aware of in which**:**

- A person or non-target organism may have been exposed to an algaecide or aquatic herbicide residue; and
- The person or non-target organism suffered an adverse or toxic effect.

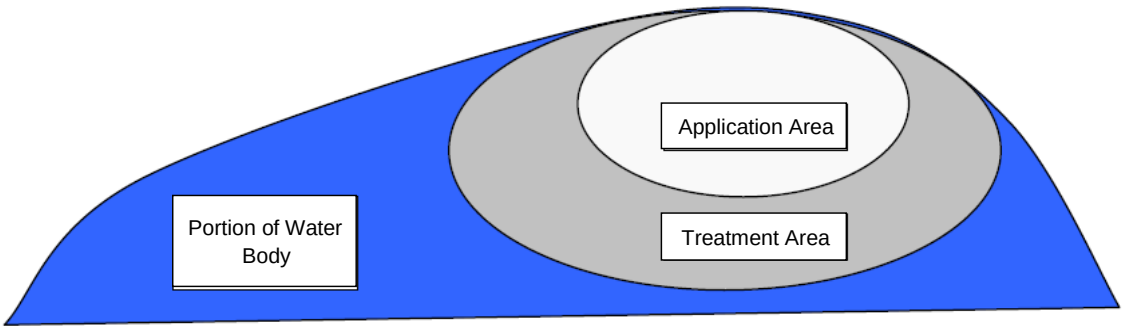
**Adverse or Toxic Effect**
An "adverse or toxic effect" includes any impact that occurs within waters of the United States on non-target organisms as a result of algaecide or aquatic herbicide residue discharge. Examples of these effects may include:

- Distressed or dead juvenile and small fishes
- Washed up or floating fish
- Fish swimming abnormally or erratically
- Fish lying lethargically at water surface or in shallow water
- Fish that are listless or nonresponsive to disturbance
- Stunting, wilting, or desiccation of non-target submerged or emergent aquatic plants
- Other dead or visibly distressed non-target aquatic organisms (amphibians, turtles, invertebrates, etc.)

An "adverse or toxic effect" also includes any adverse effects to humans (e.g., skin rashes) or domesticated animals that occur either directly or indirectly from a discharge to waters of the United States that are temporally and spatially related to exposure to an algaecide and aquatic herbicide residue (e.g., vomiting, lethargy).

**Algae Control**
Algae control means the treatment of filamentous algae, cyanobacteria (blue-green algae), or algal species that have the potential to affect human or environmental health.

**Application Area**
The application area is the area to which aquatic pesticides are directly applied.




**Application Event**
The application event is the time that introduction of the algaecide or aquatic herbicide to the treatment area takes place, not the length of time that the environment is exposed to the algaecide or aquatic herbicide.

**Aquatic Pesticides**
Aquatic pesticides in this General Permit are limited to algaecides and aquatic herbicides labeled for aquatic use to control aquatic weeds or algae.

**Beneficial Uses**
Beneficial uses of the waters of the state that may be protected against quality degradation include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves.

**Coalition**
Specifically refers to a monitoring coalition which is a collaborative monitoring partnership of dischargers to develop a monitoring plan that addresses the monitoring requirements of this General Permit. The Coalition's monitoring plan will be submitted for Coalition members in lieu of individual monitoring plans from each member.

~~**Contained, Non-Flowing Waters**~~
~~For the purposes of this permit, "contained, non-flowing waters" shall mean a water body that has no inflow or outflow immediately preceding and for a period of at least 48 hours following application of the pesticide active ingredients hydrogen peroxide, peroxyacetic acid, or sodium carbonate peroxyhydrate.~~

**Enclosed Bays**
Enclosed Bays means indentations along the coast that enclose an area of oceanic water within distinct headlands or harbor works. Enclosed bays include all bays where the narrowest distance between the headlands or outermost harbor works is less than 75 percent of the greatest dimension of the enclosed portion of the bay. Enclosed bays do not include inland surface waters or ocean waters.

**Estuaries**
Estuaries means waters, including coastal lagoons, located at the mouths of streams that serve as areas of mixing for fresh and ocean waters. Coastal lagoons and mouths of streams that are temporarily separated from the ocean by sandbars shall be considered estuaries. Estuarine waters shall be considered to extend from a bay or the open ocean to a point upstream where there is no significant mixing of freshwater and seawater. Estuaries do not include inland surface waters or ocean waters.

**Half-Life**
Half-life is the time required for half of the compound introduced into an ecosystem to be eliminated or disintegrated by natural processes.

**Inert Ingredients**
Inert ingredients are additional ingredients and are often trade secrets; therefore, they are not always disclosed by the manufacturer.

**Mutual Water Company**
A mutual water company is defined in the Public Utilities Code, section 2725 as “[a]ny private corporation or association organized for the purpose of delivering water to its stockholders and members at cost, including use of works for conserving, treating, and reclaiming water."

**Point Source**
Any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock concentrated animal feeding operation, landfill leachate collection system, or vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff.

**Priority Pollutants**
Priority pollutants are listed within the California Toxics Rule in 40 Code of Federal Regulations, section 131.38(b)(1). Criteria to protect aquatic life and human health are set for priority pollutants in the California Toxics Rule.

**Public Entity**
Public entity includes the federal government or a state, county, city and county, city, district, public authority, or public agency.

**Qualified Biologist**
A qualified biologist is a biologist who has the knowledge and experience in the ecosystem where the algaecide or aquatic herbicide is applied so that he or she can adequately evaluate whether the beneficial uses of the receiving waters have been protected and/or restored upon completion of the algaecide and aquatic herbicide application project.

**Receiving Waters**
Receiving waters are waters of the United States anywhere outside of the treatment area at anytime and anywhere inside the treatment area after completion of the treatment event.

**Representative Monitoring Location**
To be considered "representative," at a minimum, a location must be similar in hydrology, algaecide or aquatic herbicide use, and other factors that affect the residual discharge to the areas being represented in that environmental setting.

**Residual Algaecide and Aquatic Herbicide**
Residual algaecide and aquatic herbicide are those portions of the pesticides that remain in the water after the application and its intended purpose (injury or elimination of targeted pests) have been completed.

**Self Monitoring**
Sampling and analysis performed by the Discharger or Coalition to determine compliance with the Permit. All laboratory analyses must be conducted by a laboratory certified by the California Department of Public Health.

**Treatment Area**
The treatment area is the area being treated by the algaecide or aquatic herbicide for algae and aquatic weed control and, therefore, the area being targeted to receive an appropriate rate of application consistent with product label requirements of algaecide or aquatic herbicide. It is the responsibility of the Discharger to define the treatment area for each specific algaecide and aquatic herbicide application.

**Waters of the United States**
1. All waters which are currently used, were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;
2. All interstate waters, including interstate "wetlands;"
3. All other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sand flats, "wetlands," sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds the use, degradation, or destruction of which would affect or could affect interstate or foreign commerce including any such waters:
    a. Which are or could be used by interstate or foreign travelers for recreational or other purposes;
    b. From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or
    c. Which are used or could be used for industrial purposes by industries in interstate commerce.
4. All impoundments of waters otherwise defined as waters of the United States under this definition;
5. Tributaries of waters identified in items1 through 4 of this definition;

6. The territorial sea; and
7. "Wetlands" adjacent to waters (other than waters that are themselves wetlands) identified in paragraphs (1) through (6) of this definition. Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of CWA (other than cooling ponds as defined in 40 C.F.R. section 423.11(m) which also meet the criteria of this definition) are not waters of the United States. This exclusion applies only to manmade bodies of water which neither were originally created in waters of the United States (such as disposal area in wetlands) nor resulted from the impoundment of waters of the United States [See Note 1 of this Section.] Waters of the United States do not include prior converted cropland. Notwithstanding the determination of an area's status as prior converted cropland by any other federal agency, for the purposes of the Clean Water Act, the final authority regarding Clean Water Act jurisdiction remains with U.S. EPA.

# Attachment B – Standard Provisions

## I. STANDARD PROVISIONS – PERMIT COMPLIANCE (IF APPLICABLE)

### A. Duty to Comply

1. The Discharger must comply with all of the conditions of this General Permit. Any noncompliance constitutes a violation of the CWA and the California Water Code and is grounds for enforcement action, for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. (40 C.F.R. §122.41(a).)

2. The Discharger shall comply with effluent standards or prohibitions established under section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this General Permit has not yet been modified to incorporate the requirement. (40 C.F.R. §122.41(a)(1).)

### B. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a Discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this General Permit. (40 C.F.R. §122.41(c).)

### C. Duty to Mitigate

The Discharger shall take all reasonable steps to minimize or prevent any discharge in violation of this General Permit that has a reasonable likelihood of adversely affecting human health or the environment. (40 C.F.R. §122.41(d).)

### D. Proper Operation and Maintenance

The Discharger shall at all times properly operate and maintain all facilities and systems of control (and related appurtenances) which are installed or used by the Discharger to achieve compliance with the conditions of this General Permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. (40 C.F.R. §122.41(e).)

### E. Property Rights

1. This General Permit does not convey any property rights of any sort or any exclusive privileges. (40 C.F.R. §122.41(g).)

2. The issuance of this General Permit does not authorize any injury to persons or property or invasion of other private rights, or any infringement of state or local law or regulations. (40 C.F.R. §122.5(c).)

### F. Inspection and Entry

The Discharger shall allow the Regional Water Board, State Water Board, United States Environmental Protection Agency (U.S. EPA), and/or their authorized representatives (including an authorized contractor acting as their representative), upon the presentation of credentials and other documents, as may be required by law, (40 C.F.R. §122.41(i); Water Code, §13383) to:

1. Enter upon the Discharger's premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this General Permit;
2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this General Permit;
3. Inspect and photograph, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this General Permit; and
4. Sample or monitor, at reasonable times, for the purposes of assuring General Permit compliance or as otherwise authorized by the CWA or the Water Code, any substances or parameters at any location.

## II. STANDARD PROVISIONS – PERMIT ACTION

### A. General

This General Permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Discharger for modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any General Permit condition. (40 C.F.R. §122.41(f).)

### B. Duty to Reapply

If the Discharger wishes to continue an activity regulated by this General Permit after the expiration date of this General Permit, the Discharger must apply for and obtain authorization as required by the new permit. (40 C.F.R. §122.41(b).)

### C. Transfers

This General Permit is not transferable to any person except after notice to the State Water Board. The State Water Board may require modification or revocation and reissuance of the General Permit to change the name of the Discharger and incorporate such other requirements as may be necessary under the CWA and the Water Code. (40 C.F.R. §122.41(l)(3); §122.61.)

### D. Continuation of this Permit

If this permit is not reissued or replaced prior to the expiration date, it will be administratively continued in accordance with 40 C.F.R. section 122.6 and remain in full force and effect.

## III. STANDARD PROVISIONS – MONITORING

Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. (40 C.F.R. §122.41(j)(1).)

Monitoring results must be conducted according to test procedures under 40 C.F.R. part 136 unless other test procedures have been specified in this General Permit. (40 C.F.R. §122.41(j)(4); §122.44(i)(1)(iv).)

## IV. STANDARD PROVISIONS – RECORDS

### A. Records Retention

The Discharger shall retain records of all monitoring information, including all calibration and maintenance records, copies of all reports required by this General Permit, and records of all data used to complete the application for this General Permit, for a period of at least three (3) years from the date of the sample, measurement, report or application. This period may be extended by request of the the State Water Board's Deputy Director of the Division of Water Quality (Deputy Director) at any time. (40 C.F.R. §122.41(j)(2).)

### B. Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements (40 C.F.R. §122.41(j)(3)(i).);
2. The individual(s) who performed the sampling or measurements (40 C.F.R. §122.41(j)(3)(ii).);
3. The date(s) analyses were performed (40 C.F.R. §122.41(j)(3)(iii).);
4. The individual(s) who performed the analyses (40 C.F.R. §122.41(j)(3)(iv).);
5. The analytical techniques or methods used (40 C.F.R. §122.41(j)(3)(v).); and
6. The results of such analyses. (40 C.F.R. §122.41(j)(3)(vi).)

### C. Claims of confidentiality for the following information will be denied (40 C.F.R. §122.7(b).):

1. The name and address of any permit applicant or Discharger (40 C.F.R. §122.7(b)(1).); and
2. Permit applications and attachments, permits and effluent data. (40 C.F.R. §122.7(b)(2).)

## V. STANDARD PROVISIONS – REPORTING

### A. Duty to Provide Information

The Discharger shall furnish to the Regional Water Board, State Water Board, or U.S. EPA within a reasonable time, any information which the Regional Water Board, State Water Board, or U.S. EPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this General Permit or to determine compliance with this General Permit. Upon request, the Discharger shall also furnish

to the Regional Water Board, State Water Board, or U.S. EPA copies of records required to be kept by this General Permit. (40 C.F.R. §122.41(h); Wat. Code, §13267)

**B. Signatory and Certification Requirements**

1. All applications, reports, or information submitted to the Regional Water Board, State Water Board, and/or U.S. EPA shall be signed and certified in accordance with Standard Provisions – Reporting V.B.2, V.B.3, V.B.4, V.B.5, and V.B.6 below. (40 C.F.R. §122.41(k).)

2. **For a corporation.** By a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (i) A president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who perfoms similar policy- or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.

3. **For a partnership or sole proprietorship.** By a general partner or the proprietor, respectively;

4. **For a municipality, state, federal, or other public agency:** All permit applications shall be signed by either a principal executive officer or ranking elected official. For purposes of this provision, a principal executive officer of a federal agency includes: (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of U.S. EPA). (40 C.F.R. §122.22(a)(3).)

5. All reports required by this General Permit and other information requested by the Regional Water Board, State Water Board, or U.S. EPA shall be signed by a person described in Standard Provisions – Reporting V.B.1 above, or by a duly authorized representative of that person. A person is a duly authorized representative only if:

   a. The authorization is made in writing by a person described in Standard Provisions – Reporting V.B.1 above (40 C.F.R. §122.22(b)(1).);

   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity or an individual or a position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a

named individual or any individual occupying a named position.) (40 C.F.R. §122.22(b)(2).); and

c. The written authorization is submitted to the Regional Water Board and State Water Board. (40 C.F.R. §122.22(b)(3).)

6. If an authorization under Standard Provisions – Reporting V.B.1 above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Standard Provisions – Reporting V.B.1 above must be submitted to the Regional Water Board and State Water Board prior to or together with any reports, information, or applications, to be signed by an authorized representative. (40 C.F.R. §122.22(c).)

Any person signing a document under Standard Provisions – Reporting V.B.1 or V.B.3 above shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." (40 C.F.R. §122.22(d).)

## C. Monitoring Reports

1. Monitoring results shall be reported at the intervals specified in the Monitoring and Reporting Program (Attachment C) in this General Permit. (40 C.F.R. §122.22(l)(4).)

2. Monitoring results must be reported on a Self Monitoring* Report (SMR) form as agreed to by the Deputy Director and the Discharger.

3. If the Discharger monitors any pollutant more frequently than required by this General Permit using test procedures approved under 40 C.F.R part 136 or as specified in this General Permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the SMR or a reporting form specified by the State Water Board. (40 C.F.R. §122.41(l)(4)(ii).)

4. Calculations for all limitations, which require averaging of measurements, shall utilize an arithmetic mean unless otherwise specified in this General Permit. (40 C.F.R. §122.41(l)(4)(iii).)

## D. Compliance Schedules

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this General Permit, shall be submitted no later than 14 days following each schedule date. (40 C.F.R. §122.41(l)(5).)

### E. Planned Changes

The Discharger shall give notice to the State and the Regional Water Board as soon as possible of any planned physical alterations or additions to the permitted activity or discharge. Notice is required under this provision (40 C.F.R. §122.41(l)(1)) only when the alteration or addition could significantly change the nature or increase the quantity of pollutants discharged. This notification applies to pollutants that are subject neither to effluent limitations in this General Permit nor to notification requirements under 40 C.F.R. section 122.42(a)(1).

### F. Anticipated Noncompliance

The Discharger shall give advance notice to the State and Regional Water Boards of any planned changes in the permitted discharge or activity that may result in noncompliance with General Permit requirements. (40 C.F.R. §122.41(l)(2).)

### G. Other Noncompliance

The Discharger shall report all instances of noncompliance not reported under Standard Provisions – Reporting V.C, V.D, and V.E above at the time monitoring reports are submitted. The reports shall contain the information listed in Standard Provision – Reporting V.F above. (40 C.F.R. §122.41(l)(7).)

### H. Other Information

When the Discharger becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the State Water Board, Regional Water Board, or U.S. EPA, the Discharger shall promptly submit such facts or information. (40 C.F.R. §122.41(l)(8).)

## VI. STANDARD PROVISIONS – ENFORCEMENT

The State and the Regional Water Boards are authorized to enforce the terms of this General Permit under several provisions of the Water Code, including, but not limited to, sections 13385, 13386, and 13387.

# Attachment C – Monitoring and Reporting Program

## Table of Contents

I. General Monitoring Provisions....C-2
II. Monitoring Locations and Sample Types....C-3
A. Monitoring Locations....C-3
B. Sample Types....C-4
III. Receiving Water Monitoring Requirements – Surface Water....C-4
A. General Monitoring Requirements....C-4
B. Visual, Physical, and Chemical Monitoring Requirements....C-5
IV. Reporting Requirements....C-7
A. General Monitoring and Reporting Requirements....C-7
B. Annual Information Collection....C-7
C. Annual Report....C-8
D. Electronic Reporting....C-8
E. Reporting Protocols....C-9
F. Other Reporting Requirements....C-10

## List of Tables

Table C-1. Monitoring Requirements....C-6
Table C-2. Reporting Schedule....C-8

# ATTACHMENT C – MONITORING AND REPORTING PROGRAM

Section 122.48 of title 40 of the Code of Federal Regulations (40 C.F.R. §122.48) requires that all NPDES permits specify monitoring and reporting requirements. California Water Code sections 13267 and 13383 also authorize the State Water Resources Control Board (the State Water Board) and the Regional Water Quality Control Board (Regional Water Board) to require technical and monitoring reports. This Monitoring and Reporting Program (MRP) establishes monitoring and reporting requirements which implement federal and California State laws and regulations.

This MRP is designed to address the two key questions shown below. It also encourages Dischargers to form monitoring coalitions with others doing similar applications within a given watershed or doing applications of similar environmental settings (flowing water and non-flowing water). The Coalition or Discharger may select sites representing worst case scenarios or high-use areas for each active ingredient in each environmental setting. If the Discharger elects in its Aquatic Pesticide Application Plan (APAP) to undertake monitoring and reporting through a Coalition, then the Coalition will prepare and implement an MRP (pursuant to this Attachment C) and act on behalf of the Discharger with respect to monitoring and reporting. Otherwise, the Discharger will prepare and implement an individual MRP.

**Question No. 1:** Does the residual algaecides and aquatic herbicides discharge cause an exceedance of receiving water limitations?

**Question No. 2:** Does the discharge of residual algaecides and aquatic herbicides, including active ingredients, inert ingredients, and degradation byproducts, in any combination cause or contribute to an exceedance of the “no toxics in toxic amount” narrative toxicity objective?

If the Discharger elects in its APAP to undertake monitoring and reporting through a Coalition, the APAP should reference and attach the Coalition’s monitoring plan.

## I. GENERAL MONITORING PROVISIONS

A. Samples and measurements taken as required herein shall be representative of the nature of the monitored discharge. All samples shall be taken at the anticipated monitoring locations specified in the Discharger’s or Coalition’s APAP.

B. All laboratory analyses shall be conducted at a laboratory certified for such analyses by the California Department of Public Health in accordance with California Water Code section 13176. Laboratories that perform sample analyses shall be identified in all monitoring reports. The Discharger shall institute a Quality Assurance-Quality Control Program for any onsite field measurements such as electric conductivity, pH, turbidity, and temperature. A manual containing the steps followed in this program must be kept in the laboratory and shall be available for inspection by the State Water Board and the appropriate Regional Water Board staff. The Quality Assurance-Quality Control Program must conform to United States Environmental Protection Agency (U.S. EPA) guidelines or to procedures approved by the State Water Board and the appropriate Regional Water Board.

C. All analyses shall be conducted in accordance with the latest edition of "Guidelines Establishing Test Procedures for Analysis of Pollutants," promulgated by the U.S. EPA in title 40 Code Federal Regulation (40 C.F.R.) 136 or equivalent methods that are commercially and reasonably available and that provide quantification of sampling parameters and constituents sufficient to evaluate compliance with applicable effluent limits and to perform reasonable potential analysis. Equivalent methods must be more sensitive than those specified in 40 C.F.R. 136 if the method is available in the 40 C.F.R. 136, and must be approved for use by the Regional Water Board Executive Officer.

Any procedures to prevent the contamination of samples as described in the monitoring program in the APAP shall be implemented.

D. Records of monitoring information shall include the following:

1. The date, exact place, and time of sampling or measurements;
2. The individuals who performed the sampling or measurements;
3. The dates analysis were performed;
4. The individuals who performed the analyses;
5. The analytical techniques or methods used; and
6. Results of analyses.

E. All monitoring instruments and devices used to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their accuracy.

F. Monitoring results, including noncompliance, shall be reported at intervals and in a manner specified in this MRP.

## II. MONITORING LOCATIONS AND SAMPLE TYPES

### A. Monitoring Locations

Each Discharger or Coalition shall establish monitoring locations specified in the APAP to demonstrate compliance with the receiving water limitations, discharge specifications, and other requirements in this General Permit. The number and location of samples shall be selected to answer the two key questions. A Discharger or Coalition may use representative monitoring locations* to characterize water quality for all waters of the United States within the Discharger's or Coalition's boundaries for each environmental setting (flowing water and non-flowing water). However, the Discharger or Coalition must provide justification for the selection of the representative monitoring locations. To be considered "representative," at a minimum, a location must be similar in hydrology, algaecides and aquatic herbicides use, and other factors that affect the discharge of algaecides and aquatic herbicides and their residues to surface waters as a result of applications to the areas being represented in that environmental setting. Each Discharger or Coalition must provide technical justification and identify which areas are to be considered representative. Monitoring

location information shall include a description of the treatment area, GPS coordinates if feasible, and algaecides and aquatic herbicides being applied. The specific monitoring locations initially identified as representative monitoring locations may be changed based on surveillance of the Discharger or Coalition.

### B. Sample Types

The following monitoring is required for each sampling:

1. **Background Monitoring.** Background monitoring samples shall be collected upstream at the time of the application event* or in the application area* just prior to (up to 24 hours in advance of) the application event.
2. **Event Monitoring.** Event monitoring samples shall be collected immediately downstream of the treatment area in flowing waters or immediately outside of the treatment area in non-flowing waters, immediately after the application event, but after sufficient time has elapsed such that treated water would have exited the treatment area.
3. **Post-Event Monitoring.** Post-event monitoring samples shall be collected within the treatment area within one week after application or when treatment is complete.

## III. RECEIVING WATER MONITORING REQUIREMENTS – SURFACE WATER

### A. General Monitoring Requirements

The monitoring program described in the APAP shall be designed to answer the two key questions stated above. The monitoring program in the APAP shall describe the tasks and time schedules in which these two key questions will be addressed. Monitoring shall take place at locations that are being planned to be applied or may be applied as described in the Discharger's APAP.

The monitoring program described in the APAP must consider watershed specific attributes and waste constituents, based on the characteristics of applications within the Coalition's or Discharger's area, as well as the receiving water quality conditions. Developing the details of a monitoring design requires clearly defining several inputs to the design and then organizing these in a logical framework that supports effective decision making about indicators, monitoring locations, and monitoring frequency. The logical framework should describe:

1. The basic geographic and hydrographic features of the area, particularly application points and the pathways(s) of residue flows;
2. Algaecides and aquatic herbicides application practices and how they are distributed in space and time;
3. Relevant knowledge about the transport, fates, and effects of algaecides and aquatic herbicides, including best- and worst-case scenarios;

4. Description of the designated beneficial uses in each water body;
5. Relevant knowledge about the action of cumulative and indirect effects;
6. Mechanisms through which algaecides and aquatic herbicides applications could lead to designated use impacts, given the basic features of the area;
7. Known and potential impacts of algaecides and aquatic herbicides applications on water quality, ranked in terms of relative risk, based on factors such as magnitude, frequency and duration;
8. Sufficient number of sampling areas to assess the entire Discharger's or Coalition's area of influence; and
9. A description of sampling methods and a sampling schedule.

In conducting the receiving water sampling, a log shall be kept of the receiving water conditions throughout the reach bounded by the treatment area. Attention shall be given to the presence or absence of:

1. Floating or suspended matter;
2. Discoloration;
3. Bottom deposits;
4. Aquatic life;
5. Visible films, sheens, or coatings;
6. Fungi, slimes, or objectionable growths; and
7. Potential nuisance conditions.

Notes on receiving water conditions shall be summarized in the monitoring report.

## B. Visual, Physical, and Chemical Monitoring Requirements

Monitoring shall take place at locations that are described and scheduled in the Coalition's or Discharger's APAP. Monitoring for all active ingredients must include frequent and routine monitoring on a pre-determined schedule, as summarized in the Table C-1 below:

## Table C-1. Monitoring Requirements

| Sample Type | Constituent/Parameter | Units | Sample Method | Minimum Sampling Frequency | Sample Type Requirement | Required Analytical Test Method |
|---|---|---|---|---|---|---|
| Visual | 1. Monitoring area description (pond, lake, open waterway, channel, etc.)<br>2. Appearance of waterway (sheen, color, clarity, etc.)<br>3. Weather conditions (fog, rain, wind, etc.) | Not applicable | Visual Observation | [1] | Background, Event and Post-event Monitoring | Not applicable |
| Physical | 1. Temperature[2] | ºF | Grab[4] | [5] | Background, Event and Post-event Monitoring | [6] |
| | 2. pH[3] | Number | | | | |
| | 3. Turbidity[3] | NTU | | | | |
| | 4. Electric Conductivity[3] @ 25°C | µmhos/cm | | | | |
| Chemical | 1. Active Ingredient[7] | µg/L | Grab[4] | [5] | Background, Event and Post-event Monitoring | [6] |
| | 2. Nonylphenol[8] | µg/L | | | | |
| | 3. Hardness (if copper is monitored) | mg/L | | | | |
| | 4. Dissolved Oxygen[2] | mg/L | | | | |

[1] All applications at all sites.

[2] Field testing.

[3] Field or laboratory testing.

[4] Samples shall be collected at three feet below the surface of the water body or at mid water column depth if the depth is less than three feet.

[5] Collect samples from a minimum of six application events for each active ingredient in each environmental setting (flowing water and non-flowing water) per year, except for glyphosate. If there are less than six application events in a year, collect samples during each application event for each active ingredient in each environmental setting (flowing water and non-flowing water). If the results of monitoring from six consecutive application events show concentrations that are less than the receiving water limitation/trigger for an active ingredient in an environmental setting, sampling shall be reduced to one application event per year for that active ingredient in that environmental setting. To support a reduction in monitoring frequency, the six sampling events showing concentrations that are less than the receiving water limitation/trigger for an active ingredient must be consecutive and can span more than one year or application season. The reduction in monitoring frequency under this provision applies to all listed active ingredients including SIP listed active ingredients If the yearly sampling event shows exceedance of the receiving water limitation/trigger for an active ingredient in an environmental setting, then sampling shall return to six application events for that active ingredient in each environmental setting. For glyphosate, collect samples from one application event from each environmental setting (flowing water and non-flowing water) per year.

[6] Pollutants shall be analyzed using the analytical methods described in 40 C.F.R. part 136.

[7] 2,4-D, acrolein, chlorine, dissolved copper, diquat, endothall, flumioxazin, fluridone, glyphosate, imazamox, imazapyr, penoxsulam, and triclopyr.

[8] It is required only when a surfactant is used.

## IV. REPORTING REQUIREMENTS

### A. General Monitoring and Reporting Requirements

1. The Coalition or Discharger shall comply with all Standard Provisions (Attachment B) related to monitoring, reporting, and recordkeeping.
2. Upon written direction of the State Water Board or the Regional Water Board, the Coalition or Discharger shall submit information as specified.
3. The Coalition or Discharger shall report to the State Water Board and appropriate Regional Water Board any toxic chemical release data that are reported to the State Emergency Response Commission within 15 days of reporting the data to the Commission pursuant to section 313 of the "Emergency Planning and Community Right to Know Act" of 1986 (42 U.S.C. §11001 et. seq.).

### B. Annual Information Collection

The Coalition or Discharger shall complete and retain all information on the previous reporting year beginning January 1 and ending December 31. When requested by the Deputy Director or Executive Officer of the applicable Regional Water Board, the Coalition or Discharger shall submit the annual information which must include the following:

1. An executive summary discussing compliance or violation of this General Permit and the effectiveness of the APAP to reduce or prevent the discharge of pollutants associated with algaecide and aquatic herbicide applications;
2. A summary of monitoring data, including the identification of water quality improvements or degradation as a result of the algaecide or aquatic pesticide application, if appropriate, and recommendations for improvements to the APAP [including proposed best management practices (BMPs)] and monitoring program based on the monitoring results. All receiving water monitoring data shall be compared to receiving water limitations and receiving water monitoring triggers;
3. Identification of BMPs currently in use and a discussion of their effectiveness in meeting the requirements in this General Permit;
4. A discussion of BMP modifications addressing violations of this General Permit;
5. A map showing the location of each treatment area;
6. Types and amounts of algaecides and aquatic herbicides used at each application event;*
7. Information on surface area and/or volume of treatment areas and any other information used to calculate dosage, concentration, and quantity of each algaecide and aquatic herbicide used;
8. Sampling results shall indicate the name of the sampling agency or organization, detailed sampling location information (including latitude and longitude or township/range/section if available), detailed map or description of each sampling area (address, cross roads, etc.), collection date, name of constituent/parameter

and its concentration detected, minimum levels, method detection limits for each constituent analysis, name or description of water body sampled, and a comparison with applicable water quality standards, description of analytical QA/quality control plan. Sampling results shall be tabulated so that they are readily discernible; and

9. Summary of algaecide and aquatic herbicide application log.

## C. Annual Report

The Coalition or Discharger shall submit to the Deputy Director and the appropriate Regional Water Board Executive Officer an annual report consisting of a summary of the past year's activities, and certify compliance with all requirements of this General Permit. If there is no discharge of algaecides and aquatic herbicides, their residues, or their degradation byproducts, the Coalition or Discharger shall provide the Deputy Director and the appropriate Regional Water Board Executive Officer a certification that algaecide and aquatic herbicide application activities did not result in a discharge to any water body. The annual report shall contain the following information:

1. An executive summary discussing compliance or violation of this General Permit and the effectiveness of the APAP; and
2. A summary of monitoring data, including the identification of water quality improvements or degradation as a result of the algaecide or aquatic pesticide application,
3. Dischargers shall submit the annual report according to the following schedule:

**Table C-2. Reporting Schedule**

| Reporting Frequency | Reporting Period | Annual Report Due |
|---|---|---|
| Annual | January 1 through December 31 | March 1 |

## D. Electronic Reporting

At any time during the term of this General Permit, the State Water Board or the appropriate Regional Water Board may notify the Coalition or Discharger of the requirement to submit electronically Self Monitoring Reports (SMRs) using the State Water Board's California Integrated Water Quality System (CIWQS) Program (http://www.waterboards.ca.gov/ciwqs/index.html). Until such notification is given, the Coalition or Discharger shall submit hardcopy SMRs. The CIWQS website will provide additional directions for SMR submittal in the event there will be service interruption for electronic submittal.

The Coalition or Discharger shall report the results for all monitoring specified in this MRP in the SMR. The Coalition or Discharger shall submit annual SMRs including the results of all required monitoring using U.S. EPA-approved test methods or other test methods specified in this General Permit. If the Coalition or Discharger monitors any pollutant more frequently than required by this General Permit, the results of this

monitoring shall be included in the calculations and reporting of the data submitted in the SMR.

## E. Reporting Protocols

The Coalition or Discharger shall report with each sample result the applicable reported Minimum Level (ML) and the current Minimum Detection Limit, as determined by the procedure in 40 C.F.R. part 136.

The Coalition or Discharger shall report the results of analytical determinations for the presence of chemical constituents in a sample using the following reporting protocols:

1. Sample results greater than or equal to the reported ML shall be reported as measured by the laboratory (i.e., the measured chemical concentration in the sample).
2. Sample results less than the Report Limit, but greater than or equal to the laboratory's MDL, shall be reported as "Detected, but Not Quantified," or DNQ. The estimated chemical concentration of the sample shall also be reported.

   For the purposes of data collection, the laboratory shall write the estimated chemical concentration next to DNQ as well as the words "Estimated Concentration" (may be shortened to "Est. Conc."). The laboratory may, if such information is available, include numerical estimates of the data quality for the reported result. Numerical estimates of data quality may be percent accuracy (plus a percentage of the reported value), numerical ranges (low to high), or any other means considered appropriate by the laboratory.
3. Sample results less than the laboratory's MDL shall be reported as "<" followed by the MDL.
4. The Coalition or Discharger shall instruct laboratories to establish calibration standards so that the ML value (or its equivalent if there is differential treatment of samples relative to calibration standards) is the lowest calibration standard. At no time is the Coalition or Discharger to use analytical data derived from extrapolation beyond the lowest point of the calibration curve.
5. Multiple Sample Data: If two or more sample results are available, the Coalition or Discharger shall compute the arithmetic mean unless the data set contains one or more reported determinations of DNQ or "Not Detected" (ND). In those cases, the Coalition or Discharger shall compute the median in place of the arithmetic mean in accordance with the following procedure:

   a. The data set shall be ranked from low to high, ranking the reported ND determinations lowest, DNQ determinations next, followed by quantified values (if any). The order of the individual ND or DNQ determinations is unimportant.

   b. The median value of the data set shall be determined. If the data set has an odd number of data points, then the median is the middle value. If the data

set has an even number of data points, then the median is the average of the two values around the middle unless one or both of the points are ND or DNQ, in which case the median value shall be the lower of the two data points where DNQ is lower than a value and ND is lower than DNQ.

6. The annual report shall comply with the following requirements:

   a. The Coalition or Discharger shall arrange all reported data in a tabular format. The data shall be summarized to clearly illustrate whether the algaecide and aquatic herbicide applications are conducted in compliance with effluent and receiving water limitations. The Coalition or Discharger is not required to duplicate the submittal of data that are entered in a tabular format within CIWQS. When electronic submittal of data is required and CIWQS does not provide for entry into a tabular format within the system, the Coalition or Discharger shall submit electronically the data in a tabular format as an attachment.

   b. The Coalition or Discharger shall attach a cover letter to the annual report that clearly identifies violations of the permit; discusses corrective actions taken or planned; and provides a time schedule for corrective actions. Identified violations must include a description of the requirement that was violated and a description of the violation.

   c. The annual report must be submitted to the State Water Board and the appropriate Regional Water Board, signed and certified as required by the Standard Provisions (Attachment B).

## F. Other Reporting Requirements

### 1. Twenty-Four Hour Report

The Coalition or Discharger shall report to the State Water Board and appropriate Regional Water Board any noncompliance, including any unexpected or unintended effect of an algaecide or aquatic herbicide use that may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the Coalition or Discharger becomes aware of the circumstances and must include the following information:

a. The caller's name and telephone number;

b. Applicator name and mailing address;

c. Waste Discharge Identification (WDID) number;

d. The name and telephone number of a contact person;

e. How and when the Coalition or Discharger become aware of the noncompliance;

f. Description of the location of the noncompliance;

g. Description of the noncompliance identified and the U.S. EPA pesticide registration number for each product the Discharger applied in the area of the noncompliance; and

h. Description of any steps that the Coalition or Discharger has taken or will take to correct, repair, remedy, cleanup, or otherwise address any adverse effects.

If the Coalition or Discharger is unable to notify the State and the appropriate Regional Water Board within 24 hours, the Coalition or Discharger must do so as soon as possible and also provide the rationale for why the Discharger was unable to provide such notification within 24 hours.

2. **Five-Day Written Report**

The Coalition or Discharger shall also provide a written submission within five (5) days of the time the Discharger becomes aware of the noncompliance. The written submission shall contain the following information:

a. Date and time the Coalition or Discharger contacted the State Water Board and the appropriate Regional Water Board notifying of the noncompliance and any instructions received from the State and/or Regional Water Board; information required to be provided in Section D.1 (24-Hour Reporting);

b. A description of the noncompliance and its cause, including exact date and time and species affected, estimated number of individual and approximate size of dead or distressed organisms (other than the pests to be eliminated);

c. Location of incident, including the names of any waters affected and appearance of those waters (sheen, color, clarity, etc);

d. Magnitude and scope of the affected area (e.g. aquatic square area or total stream distance affected);

e. Algaecide and aquatic herbicide application rate, intended use site (e.g., banks, above, or direct to water), method of application, and name of algaecide and herbicide product, description of algaecide and herbicide ingredients, and U.S. EPA registration number;

f. Description of the habitat and the circumstances under which the noncompliance activity occurred (including any available ambient water data for aquatic algaecides and aquatic herbicides applied);

g. Laboratory tests performed, if any, and timing of tests. Provide a summary of the test results within five days after they become available;

h. If applicable, explain why the Coalition or Discharger believes the noncompliance could not have been caused by exposure to the algaecides or aquatic herbicides from the Coalition's or Discharger's application; and

i. Actions to be taken to prevent recurrence of adverse incidents.

The State Water Board staff or Regional Water Board staff may waive the above-required written report under this provision on a case-by-case basis if an oral report has been received within 24 hours.

# Attachment D – Fact Sheet

## Table of Contents

I. Permit Information ..... D-3
A. Background ..... D-3
B. General Criteria ..... D-7
II. Notification Requirements ..... D-8
A. General Permit Application ..... D-8
B. Fee ..... D-9
C. Public Notification ..... D-9
III. Discharge Description ..... D-9
A. Existing Discharge Description ..... D-9
B. Annual Report Review ..... D-10
C. Receiving Water Description ..... D-11
IV. Applicable Plans, Policies, and Regulations ..... D-11
A. Legal Authorities ..... D-11
B. California Environmental Quality Act (CEQA) ..... D-11
C. State and Federal Regulations, Policies, and Plans ..... D-12
V. Rationale For Effluent Limitations and Discharge Specifications ..... D-16
A. Discharge Prohibitions ..... D-17
B. Effluent Limitations ..... D-18
VI. Rationale for Receiving Water Limitations and Monitoring Triggers ..... D-22
A. Groundwater ..... D-22
B. Surface Water ..... D-22
VII. Rationale for Monitoring and Reporting Requirements ..... D-34
A. MRP Goals ..... D-34
B. Effluent Monitoring ..... D-34
C. Toxicity Testing Requirements ..... D-35
D. Receiving Water Monitoring ..... D-36
VIII. Rationale for Aquatic Pesticide Use Requirements ..... D-36
A. Application Schedule ..... D-36
B. Application Notification Requirements ..... D-36
C. APAP ..... D-37
D. APAP Processing, Approval, and Modifications ..... D-37
E. Aquatic Pesticide Application Log ..... D-37
IX. Rationale for Provisions ..... D-37
A. Standard Provisions ..... D-37
B. Special Provisions ..... D-38
X. Compliance Determination ..... D-39
XI. Public Participation ..... D-40
A. Notification of Interested Parties ..... D-40
B. Written Comments ..... D-40
C. Public Hearing and Meeting ..... D-40
D. Information and Copying ..... D-40
E. Register of Interested Persons ..... D-41

F. Additional Information ..... D-41

## List of Tables

Table D-1. Monitoring Data Summary, 2004-2008, Order No. 2004-0009-DWQ ..... D-10
Table D-2. Summary of Receiving Water Limitations ..... D-24
Table D-3. Toxicity Data Summary for Flumioxazin (CAS#103361-09-7) ..... D-27
Table D-4. Toxicity Data Summary for Imazamox (CAS# 114311-32-9) ..... D-28
Table D-5. Toxicity Data Summary for Imazapyr (CAS#81334-34-1) ..... D-29
Table D-6. Toxicity Data Summary for Imazapyr Isopropylamine Salt (CAS#81510-83-0) ... D-29
Table D-7. Toxicity Data Summary for Penoxsulam (CAS#219714-96-2) ..... D-30
Table D-8. Toxicity Data Summary for Hydrogen Peroxide ..... D-32
Table D-9. Toxicity Data Summary for Triclopyr TEA Salt (CAS#57213-69-1) ..... D-33
~~Table D-1. Monitoring Data Summary, 2004-2008, Order No. 2004-0009-DWQ ..... D-10~~
~~Table D-2. Summary of Receiving Water Limitations ..... D-23~~
~~Table D-3. Toxicity Data Summary for Imazamox (CAS# 114311-32-9) ..... D-25~~
~~Table D-4. Toxicity Data Summary for Imazapyr (CAS#81334-34-1) ..... D-27~~
~~Table D-5. Toxicity Data Summary for Imazapyr Isopropylamine Salt (CAS#81510-83-0) ... D-27~~
~~Table D-6. Toxicity Data Summary for Penoxsulam (CAS#219714-96-2) ..... D-28~~
~~Table D-7. Toxicity Data Summary for Triclopyr TEA Salt (CAS#57213-69-1) ..... D-29~~

# Attachment D – Fact Sheet

As described in Section III, Findings, of this General Permit, the State Water Resources Control Board (State Water Board) incorporates this Fact Sheet as findings of the State Water Board that support the issuance of this General Permit. This Fact Sheet includes the legal requirements and technical rationale that serve as the basis for the requirements of this General Permit.

This General Permit has been prepared under a standardized format to accommodate a broad range of discharge requirements for Dischargers in California.

## I. PERMIT INFORMATION

### A. Background

#### 1. The Regulatory Background

In 1972, the Federal Water Pollution Control Act (also referred to as the Clean Water Act or CWA) was amended to provide that the discharge of pollutants to waters of the United States from any point source is effectively prohibited unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) Permit.

On September 22, 1989, the U.S. Environmental Protection Agency (U.S. EPA) granted the State of California, through the State Water Resources Control Board (State Water Board) and the Regional Water Quality Control Boards (Regional Water Boards), the authority to issue general NPDES permits pursuant to title 40 Code of Federal Regulations (40 C.F.R.) 122 and 123.

Section 122.28 of 40 C.F.R. provides for issuance of general permits to regulate a category of point sources if the sources involve the same or substantially similar types of operations; discharge the same type of waste; require the same type of effluent limitations or operating conditions; require similar monitoring; and are more appropriately regulated under a general permit rather than individual permits.

On March 12, 2001, the Ninth Circuit Court of Appeals held that discharges of pollutants from the use of aquatic pesticides in waters of the United States require coverage under an NPDES permit. (*Headwaters, Inc. v. Talent Irrigation District).*[3] The *Talent* decision was issued just prior to the major season for applying aquatic pesticides.

Because of the serious public health, safety, and economic implications of delaying pesticide applications, in 2001 the State Water Board adopted Water

[3] 243 F.3d 526 (9th Cir., 2001).

Quality Order (Order) No. 2001-12-DWQ, Statewide General NPDES Permit for Discharges of Aquatic Pesticides to Waters of the United States on an emergency basis to provide immediate NPDES permit coverage for broad categories of aquatic pesticide use in California.

Order No. 2001-12-DWQ imposed requirements on any discharge of aquatic pesticides by public entities to waters of the United States in accordance with the Policy which establishes procedures for implementing water quality standards for priority pollutants* in NPDES permits.

Section 5.3 of the State Water Board Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Policy) allows for short-term or seasonal exceptions from its requirements for resource or pest management conducted by public entities or mutual water companies. In order to qualify for an exception from meeting priority pollutant standards, a public entity must fulfill the requirements listed in section 5.3 and the State Water Board must decide to grant the exception. Among other requirements, entities seeking an exception to complying with water quality standards for priority pollutants must submit documents in compliance with California Environmental Quality Act (CEQA).[4] Because of the emergency adoption of Order No. 2001-12-DWQ, the State Water Board invoked an exemption to the requirements of section 5.3 of the Policy and issued the permit incorporating a categorical exception to water quality standards for priority pollutants.

Order No. 2001-12-DWQ required that Dischargers develop a best management practices (BMPs) plan that minimizes adverse impacts to receiving waters and a monitoring and reporting plan that is representative of each type of aquatic pesticide application.

In August 2001, Waterkeepers Northern California (Waterkeepers) filed a lawsuit against the State Water Board challenging several aspects of Order No. 2001-12-DWQ. Major aspects of the challenge included the emergency adoption of the Order without compliance with CEQA and other exception requirements of the Policy; failure to address cumulative impacts; and failure to comply with the California Toxics Rule (CTR).[5]

In a settlement of the Waterkeepers' lawsuit, the State Water Board agreed to fund a comprehensive aquatic pesticide monitoring program that would assess receiving water toxicity caused by aquatic pesticides and alternatives for pesticide use. The State Water Board contracted with the San Francisco Estuary Institute (SFEI) to conduct the program. SFEI published the final report on February 5, 2004.

[4] Cal. Pub. Resources Code § 21000 et. seq.
[5] 40 C.F.R. Section 131.38.

In November 2002, the Ninth Circuit issued another opinion concerning the need for an NPDES permit for pesticide application. (*League of Wilderness Defenders v. Forsgren*.[6]) In this case, the court held that the USDA Forest Service must obtain an NPDES permit before it sprays insecticides* from an aircraft directly into or over rivers as part of silviculture activities. The court found that the insecticides are pollutants under the CWA. The court also defined the exemption for silvicultural pest control from the definition of "point source" in U.S. EPA's regulations to be limited to pest control activities from which there is natural runoff.

Also in 2002, the Second Circuit issued an unpublished decision regarding the need for an NPDES permit for application of pesticides for mosquito control in federal wetland areas. (*Altman v. Town of Amherst*.) The lower court had dismissed a citizens' suit, holding that pesticides, when used for their intended purpose, do not constitute a "pollutant" for purposes of the CWA, and are more appropriately regulated under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The appeals court vacated the trial court's decision and remanded the matter. In its unpublished decision, the Second Circuit expressed concern that: "[u]ntil the EPA articulates a clear interpretation of current law - among other things, whether properly used pesticides released into or over waters of the United States can trigger the requirements for NPDES permits - the question of whether properly used pesticides can become pollutants that violate the [Clean Water Act] will remain open."

Order No. 2001-12-DWQ expired on January 31, 2004. In 2004, it was replaced by two general permits: a vector control permit for larvicides (Order No. 2004-0008-DWQ) and a weed control permit (Order No. 2004-0009-DWQ). The State Water Board determined that adoption of these two permits was consistent with the Ninth Circuit decisions.

In 2005, the Ninth Circuit held that a pesticide that is applied consistent with FIFRA is not a "chemical waste" (*Fairhurst v. Hagener),*[7] but also stated that it would not change its decision in *Headwaters.* The court stated that whether an NPDES permit was required depends on whether there was any "residue or unintended effect" from application of the pesticide. In *Fairhurst*, the court found neither residue nor unintended effect was present. Therefore, the pesticide application at issue did not require an NPDES permit.

**U.S. EPA's Final Rule:** On November 20, 2006, U.S. EPA adopted a final regulation providing that NPDES permits are not required for pesticide applications as long as the Discharger follows FIFRA label instructions. According to the regulation, pesticides applied under the following two circumstances are not pollutants and, therefore, are not subject to NPDES permitting requirements:

[6] 309 F.3d 1181 (9th Cir., 2002).
[7] 422 F.3d 1146 (9th Cir., 2005).

a. The application of pesticides directly to waters of the United States in order to control pests. Examples of such applications include applications to control mosquito larvae, aquatic weeds, or other pests that are present in waters of the United States; and

b. The application of pesticides to control pests that are present over waters of the United States, including near such waters, where a portion of the pesticides will unavoidably be deposited to waters of the United States in order to target the pests effectively; for example, when insecticides are aerially applied to a forest canopy where waters of the United States may be present below the canopy or when pesticides are applied over or near water for control of adult mosquitoes or other pests.

**Lawsuits Against U.S. EPA's Final Rule:** After U.S. EPA's new regulation was adopted in 2006, lawsuits were filed by both the pesticide industry and environmental groups in 11 of the 13 Circuits, including the Ninth Circuit Court, challenging U.S. EPA's Final Rule.

***The National Cotton Council of America v. U.S. EPA:*** [8] The petitions for review were consolidated in the Sixth Circuit Court by an order of the Judicial Panel on Multidistrict Litigation.

On January 11, 2009, the Sixth Circuit Court of Appeals determined that U.S. EPA's Final Rule is not a reasonable interpretation of the CWA and vacated the Final Rule. U.S. EPA did not request reconsideration of the decision, but did file a motion for a two-year stay of the effect of the decision in order to provide agencies time to develop, propose, and issue NPDES general permits for pesticide applications covered by the ruling. On June 8, 2009, the Sixth Circuit granted the motion, such that the U.S. EPA exemption was to remain in place until April 9, 2011. Subsequently, U.S. EPA was granted an extension of the stay, which allowed the exemption to continue until October 31, 2011.

2. **Related Pesticide Regulation Information**

Pesticide formulations may include "active ingredients" and "inert ingredients." Adjuvants or surfactants may be added to the ingredients in the application equipment that is used in the delivery of the aquatic pesticide.

As part of the registration process of pesticides for use in California, U.S. EPA and the California Department of Pesticide Regulation (DPR) evaluate data submitted by registrants to ensure that a product used according to label instructions will cause no harm or adverse impact on non-target organisms that cannot be reduced or mitigated with protective measures or use restrictions. Registrants are required to submit data on the effects of pesticides on target pests (efficacy) as well as non-target effects. Data on non-target effects include plant effects (phytotoxicity), fish and wildlife hazards (ecotoxicity), impacts on

[8] 553 F.3d 927 (6th Cir., 2009).

endangered species, effects on the environment, environmental fate, degradation byproducts, leachability, and persistence. Requirements that are specific to use in California are included in many pesticide labels that are approved by U.S. EPA. Use must be reported to the County Agricultural Commissioner where required by law or by agreement with DPR.

The CWA, at section 301(a), broadly prohibits the discharge of any pollutant to waters of the United States, except in compliance with an NPDES permit. Since FIFRA is not necessarily as protective of water quality as the CWA, pesticides discharged into surface waters may constitute pollutants within the meaning of the CWA even if the discharge is in compliance with the registration requirements of FIFRA, thus, requiring coverage under a valid NPDES permit.

DPR and the County Agricultural Commissioners regulate the sale and use of pesticides in California. Pesticide applications subject to this General Permit must be consistent with permits issued by County Agricultural Commissioners and the pesticide label instructions approved by U.S. EPA under FIFRA. According to federal law, pesticide label language is under the sole jurisdiction of U.S. EPA. Label language and any changes thereto must be approved by U.S. EPA before the product can be sold in this country. DPR cannot require manufacturers to make changes on labels; however, DPR can refuse to register products unless manufacturers address unmitigated hazards by amending the pesticide label.

State regulations require that the County Agricultural Commissioners determine if a substantial adverse environmental impact will result from the proposed use of a restricted material. If the County Agricultural Commissioner determines that this is likely, the commissioner may deny the restricted pesticide use permit or may issue it under the condition that site-specific use practices be followed (beyond the label and applicable regulations) to mitigate potentially adverse effects. DPR conducts scientific evaluations of potential health and environmental impacts and provides commissioners with information in the form of suggested permit conditions. DPR's suggested permit conditions reflect minimum measures necessary to protect people and the environment. County Agricultural Commissioners use this information and its evaluation of local conditions to set site-specific limits in permits.

## B. General Criteria

1. This General Permit serves as a general NPDES Permit for the discharge of residual algaecides and aquatic herbicides to surface waters as a result of algaecides and aquatic herbicides applications for algae and aquatic weed controls.
2. Dischargers who submit a complete application under this General Permit are not required to submit an individual permit application. The State Water Board's Deputy Director of the Division of Water Quality (Deputy Director) may request additional information or determine that a Discharger is not eligible for coverage under this General Permit and would be better regulated under an individual permit or other general NPDES permit adopted by the appropriate Regional

Water Board. If the discharge becomes covered by an individual or another general permit, the applicability of this General Permit to the specified discharge will be immediately terminated on the effective date of the individual permit or coverage under the other general permit.

## II. NOTIFICATION REQUIREMENTS

### A. General Permit Application

To obtain authorization under this General Permit, Dischargers must submit to the State Water Board a complete application at least 90 days prior to their first application of the season. This is to allow posting of the Aquatic Pesticide Application Plan (APAP) for a 30-day comment period, staff to review APAP and respond to comments, and the Deputy Director to issue the Notice of Applicability (NOA). Following are the application information requirements:

1. A Notice of Intent (NOI shown as Attachment E) signed in accordance with the signatory requirements of the Standard Provisions in Attachment B;
2. An application fee. A fee is required only for new Dischargers. Dischargers that are enrolled under Order No. 2004-0009-DWQ and are applying for coverage under this Permit will be billed during the regular billing cycle; and
3. An APAP.

State Water Board staff will post the APAP on the State Water Board's website for 30 days for public review. In the meantime, the State and Regional Water Board staff will review the application package for completeness and applicability to this General Permit. After the application has been deemed complete, the Deputy Director will issue an NOA. The NOA will specify the permitted active ingredients of algaecides and aquatic herbicides that may be used, and any Regional Water Board specific conditions and requirements not stated in this General Permit. Any such region-specific conditions and requirements shall be enforceable. The Discharger is authorized to discharge starting on the date of the NOA. If comments are received, staff will immediately work to resolve them in order to issue an NOA within 90 days of receipt of the application.

This General Permit specifices an effective date of December 1, 2013. The effective date is delayed because, with the impending start of the 2013 application season, Dischargers may be unable to comply with the requirement to submit their applications 90 days prior to their first pesticide application.The delay will allow enrollees under Water Quality Order No. 2004-0009-DWQ to have continued permit coverage throughout the 2013 application season while preparing their new application for coverage under this General Permit; new enrollees to prepare and submit their applications as well; and Water Boards' staff to process the applications and issue NOAs.

Alternatively, the Deputy Director may issue a Notice of Exclusion**,** which either terminates permit coverage or requires submittal of an application for an individual permit or alternative general permit.

### B. Fee

The annual fee for enrollment under this General Permit, shall be based on Category 3 in section 2200(b)(9) of title 23, California Code of Regulations (Cal. Code Regs.). This category is appropriate because algaecide and aquatic herbicide applications incorporate BMPs to control potential impacts to beneficial uses, and this General Permit prohibits pollutant discharge associated with algaecide and aquatic herbicide applications from causing exceedance of CTR criteria or water quality objectives. Information concerning the applicable fees can be found at http://www.waterboards.ca.gov/resources/fees/docs/fy1112fee_schdl_npdes_prmt.pdf

A Discharger proposing to apply algaecides and aquatic herbicides in multiple Water Board regions shall submit one NOI, one APAP, and one filing fee. The Discharger shall indicate in the NOI all the Water Board regions where applications are planned. The Discharger shall address all required elements of the APAP for all areas in the state where discharges are proposed.

### C. Public Notification

The State Water Board has notified interested agencies and persons of its intent to prescribe waste discharge requirements in this General Permit and provided them with an opportunity to submit their written comments and recommendations.

## III. DISCHARGE DESCRIPTION

This General Permit covers the point source discharge to waters of the United States of pesticide residues resulting from applications using products containing 2,4-D, acrolein, calcium hypochlorite, copper, diquat, endothall, flumioxazin, fluridone, glyphosate, hydrogen peroxide, imazamox, imazapyr, penoxsulam, sodium carbonate peroxyhydrate, peroxyacetic acid, sodium hypochlorite, and triclopyr-based algaecides and aquatic herbicides, and adjuvants containing ingredients represented by the surrogate nonylphenol. This General Permit covers only discharges of algaecides, aquatic herbicides, and adjuvants that are currently registered for use in California, or that become registered for use and contain the above-listed active ingredients and ingredients represented by the surrogate of nonylphenol.

### A. Existing Discharge Description

As of January 11, 2013, there were 153 active enrollees under Water Quality Order No. 2004-0009-DWQ, Statewide General National Pollutant Discharge Elimination System Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States, General Permit No. CAG990005 (Order No. 2004-0009-DWQ). Most of the enrollees are local public agencies such as cities and irrigation,

flood control, or reclamation districts. The other enrollees include six state of California agencies: the Departments of Boating and Waterways, Fish and Wildlife, Food and Agriculture, Parks and Recreation, Transportation, and Water Resources; a federal agency, U.S. Department of Fish and Wildlife Service; and a few private entities such as home owner associations and mobile home park owners.

The State Water Board granted exceptions to public agencies and mutual water companies that met the criteria stated in section 5.3 of the Policy for short-term or seasonal exceptions from meeting the receiving water limitations for priority pollutants of acrolein and copper.

Order No. 2004-0009-DWQ permits the discharge of aquatic pesticides with the following active ingredients: 2,4-D, acrolein, copper, diquat, endothall, fluridone, glyphosate, and triclopyr. The State Water Board reopened Order No. 2004-0009-DWQ after its adoption to add two more active ingredients: (1) imazapyr, a non-selective herbicide, for control of cordgrass and broadleaf weeds and other emergent aquatic species; and (2) sodium carbonate peroxyhydrate as an alternative to copper for algae control.*

## B. Annual Report Review

State Water Board staff reviewed annual reports from 2004 through 2008[9] submitted under Order No. 2004-0009-DWQ. The data are summarized in Table D-1 below. As shown in Table D-1, all constituent concentrations from post-event application samples were below receiving water limitations except for the following: three exceedances each for acrolein and glyphosate and 82 exceedances for copper out of 288 monitoring events. For glyphosate, it is likely that the three exceedances were not the result of aquatic pesticide applications because the pre-application samples also showed exceedances and the remaining 151 sampling events showed no exceedance. For copper, 43 of the 82 exceedances were from public agencies or mutual water companies that were excepted from meeting priority pollutant limitations during the exception period. Thus, staff did not consider these exceedances as violations of the receiving water limitations. However, 39 of the exceedances were from entities that did not have a Policy exception. Therefore, staff considered these exceedances as true violations of the receiving water limitations.

**Table D-1. Monitoring Data Summary, 2004-2008, Order No. 2004-0009-DWQ**

| Pollutant | Number of Samples | Number of Exceedance |
|---|---|---|
| 2,4-D | 3 | 0 |
| Acrolein | 213 | 3 |

[9] The data are submitted to the Regional Water Boards per Order No. 2004-0009-DWQ. When State Water Board staff started collecting data from the Regional Water Boards, the data available covered only this period.

| Pollutant | Number of Samples | Number of Exceedance |
|---|---|---|
| Copper | 288 | 85 |
| Diquat | 17 | 0 |
| Endothall | 6 | 0 |
| Fluridone | 12 | 0 |
| Glyphosate | 154 | 3 |
| Nonylphenol | 53 | 0 |

Under Order No. 2004-0009-DWQ, the most commonly used aquatic pesticide products contained copper, acrolein, and glyphosate in descending order.

### C. Receiving Water Description

The annual reports showed that most algae and aquatic weed control applications were performed in fresh inland surface waters such as lakes, ponds, flood control and drainage channels, or canals. Some applications were performed in coastal waters, marina lagoons, and slough with brackish water.

## IV. APPLICABLE PLANS, POLICIES, AND REGULATIONS

The requirements contained in this General Permit are based on the applicable plans, policies, and regulations identified below.

### A. Legal Authorities

This General Permit is issued pursuant to section 402 of the federal Clean Water Act (CWA) and implementing regulations adopted by the U.S. Environmental Protection Agency (U.S. EPA) and chapter 5.5, division 7 of the California Water Code, commencing with section 13370. It shall serve as an NPDES permit for point source discharges of residual algaecides and aquatic herbicides to surface waters. This General Permit also serves as WDRs pursuant to article 4, chapter 4, division 7 of the California Water Code (commencing with §13260).

This General Permit shall serve as a General NPDES permit for point source discharges of residues from algaecides and aquatic herbicide applications for algae and aquatic weed control. This General Permit also serves as general Waste Discharge Requirements pursuant to article 4, chapter 4, and division 7 of the California Water Code (commencing with §13260).

### B. California Environmental Quality Act (CEQA)

Pursuant to California Water Code section 13389, State and Regional Water Boards are exempt from the requirement to comply with Chapter 3, Division 13 of the Public Resources Code when adopting NPDES permits.

## C. State and Federal Regulations, Policies, and Plans

### 1. Water Quality Control Plans (Basin Plans)

The Regional Water Boards have adopted Basin Plans that designate beneficial uses, establish water quality objectives, and contain implementation programs and policies to achieve those objectives for all waters addressed through the plans. In addition, the Basin Plans implement State Water Board Resolution No. 88-63, which established state policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply. The Basin Plans identify typical beneficial uses as follows: municipal and domestic supply, agricultural irrigation, stock watering, process supply, service supply, hydropower supply, water contact recreation, canoeing and rafting recreation, other non-contact water recreation,* warm freshwater aquatic habitat, cold freshwater habitat,* warm fish migration habitat, cold fish migration habitat, warm and cold spawning habitat, wildlife habitat, navigation, rare, threatened, or endangered species habitat, groundwater recharge,* and freshwater replenishment.

Requirements of this General Permit implement provisions contained in the applicable Basin Plans.

### 2. National Toxics Rule (NTR) and California Toxics Rule (CTR)

U.S. EPA adopted the NTR on December 22, 1992, and later amended it on May 4, 1995 and November 9, 1999. About 40 criteria in the NTR applied in California. On May 18, 2000, U.S. EPA adopted the CTR. The CTR promulgated new toxics criteria for California and, in addition, incorporated the previously adopted NTR criteria that were applicable in the state. The CTR was amended on February 13, 2001. These rules contain water quality criteria for priority pollutants.

### 3. State Implementation Policy (Policy)

On March 2, 2000, the State Water Board adopted the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (Policy). The Policy became effective on April 28, 2000 with respect to the priority pollutant criteria promulgated for California by U.S. EPA through the NTR and to the priority pollutant objectives established by the Regional Water Board in the Basin Plans. The Policy became effective on May 18, 2000 with respect to the priority pollutant criteria promulgated by U.S. EPA through the CTR. The State Water Board adopted amendments to the Policy on February 24, 2005 that became effective on July 13, 2005. The Policy establishes implementation provisions for priority pollutant criteria and objectives and provisions for chronic toxicity control. Requirements of this General Permit implement the Policy.

*Policy Exception*

The Policy provides categorical exceptions allowing short-term or seasonal exceptions from meeting the priority pollutant criteria/objectives if it is determined to be necessary to implement control measures for resource or pest management conducted by public entities or mutual water companies to fulfill statutory requirements. The Policy specifically refers to vector or weed control, pest eradication, or fishery management as the basis for categorical exceptions. The exceptions are only granted to public entities or mutual water companies that have adequately provided the following information as required by the Policy:

a. A detailed description of the proposed action which includes the proposed method of completing the action;

c. A time schedule;

d. A discharge and receiving water monitoring plan that specifies monitoring prior to application events,* during application events, and after completion with the appropriate quality control procedures;

e. CEQA documentation including notifying potentially affected public and government agencies; and

f. Any necessary contingency plans.

The public entities and mutual water companies listed in Attachment G have met the above requirements before the issuance or during the term of the Order No. 2004-0009-DWQ.

The final Negative Declaration or Mitigated Negative Declarations (ND/MND) prepared by the public entities or mutual water companies have determined that the water quality impacts identified in the environmental assessments of the ND/MND from algaecide and aquatic herbicide applications are less than significant, and would not have a significant effect on the environment. The boards of each public entity and mutual water company*, as the lead agencies under CEQA, approved the final ND/MND. Therefore, each public entity or mutual water company is not required to meet priority pollutant criteria during the exception period.

During the issuance of the Order No. 2004-0009-DWQ, as required in section 15096 of the CEQA Guidelines, the State Water Board, as a Responsible Agency under CEQA, considered the ND/MND approved by the board of each public entity or mutual water company. The State Water Board found that the projects will have less than significant water quality impact if the Dischargers meet the requirements in this General Permit. Accordingly, the Policy 5.3 exception granted previously will continue to be valid under this Order.

Any Discharger not listed in Attachment G is required to meet all applicable priority pollutant criteria for receiving waters.

4. **Antidegradation Policy**

Section 131.12 of 40 C.F.R. requires that the state water quality standards include an antidegradation policy consistent with the federal policy. The State

Water Board established California's antidegradation policy in State Water Board Resolution No. 68-16. Resolution No. 68-16 incorporates the federal antidegradation policy where the federal policy applies under federal law. Resolution No. 68-16 requires that existing water quality be maintained unless degradation is justified based on specific findings. The Basin Plans implement, and incorporate by reference, both the state and federal antidegradation policies.

The permitted discharge must be consistent with the antidegradation provision of 40 C.F.R. section 131.12 and Resolution No. 68-16. The conditions of this General Permit require residual algaecide and aquatic herbicide discharges to meet applicable water quality objectives. Specifically, the General Permit sets receiving water limitations for 2,4-D, acrolein, chlorine, copper, diquat, endothall, fluridone glyphosate, and nonylphenol. It also sets receiving water monitoring triggers for imazapyr and triclopyr triethylamine (TEA).

The BMPs and other controls required pursuant to the General Permit constitute Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT).

The General Permit requirements are protective of the broad range of beneficial uses set forth in basin plans throughout the state, constituting best control available consistent with the purposes of the algaecide and aquatic herbicide application in order to ensure that pollution or nuisance will not occur. The nature of pesticides is to be toxic in order to protect beneficial uses such as human health or long-term viability of aquatic life. For example, blue-green algae are bacteria that live in both fresh and marine waters. In California, certain forms of blue-green algae have been a particular problem in the Klamath River watershed and on the Central Coast. Blooms of these bacteria can poison livestock, wildlife, and humans; they can also damage drinking water sources. The use of an algaecide is one of the effective ways to control the harmful blooms of blue-green algae. Although algaecide application will temporarily degrade the water quality and result in short-term toxicity in the receiving water, it prevents the toxicities in the entire water body for a long period of time. While surface waters may be temporarily degraded; water quality standards and objectives will not be exceeded after project completion.

Another example of benefits of pesticide application is the control of aquatic weeds in flood control channels. Aquatic herbicides used to control emerging aquatic weeds in a flood control channel will effectively prevent full growth and bloom of aquatic weeds that may block the channel and cause flooding in the surrounding communities. Although the water quality is temporarily degraded while the herbicide is taking its effect in eliminating the weeds, the water quality will not be exceeded after the project is completed. In addition, the receiving water limitations and other requirements of this General Permit will ensure maintenance of the highest water quality consistent with maximum benefit to the people of the state.

Given the nature of a General Permit and the broad range of beneficial uses to be protected across the state, data analysis of specific water bodies is infeasible.

While surface waters may be temporarily degraded, water quality standards and objectives will not be exceeded. The nature of pesticides is to be toxic in order to protect human health and water resources. However, compliance with receiving water limitations is required. Therefore, this General Permit is consistent with state and federal antidegradation policies.

5. **Endangered Species Act**

This General Permit does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code §2050 et. seq) or the Federal Endangered Species Act (16 U.S.C.A. §1531 et. seq). This General Permit requires compliance with effluent limitations, receiving water limitations, and other requirements to protect the beneficial uses of waters of the state. The Discharger is responsible for meeting all requirements of the applicable Endangered Species Act.

6. **Impaired Water Bodies on CWA 303(d) List**

This General Permit does not authorize the discharge of residual algaecides and aquatic herbicides and their degradation byproducts to waters of the United States that are impaired by the same active ingredients and their degradation byproducts. The links to California's impaired waters bodies are provided at http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtm.

7. **Other Plans, Policies, and Regulations**

The State Water Board adopted the *Water Quality Control Policy for the Enclosed Bays and Estuaries of California*. The requirements within this General Permit are consistent with the policy.

8. **Delegation to Executive Director**

This General Permit covers the application of pesticides that are based on active ingredients that are currently registered by DPR for the control of algae and aquatic weeds. When DPR registers a new active ingredient for algae and aquatic weed control, this General Permit needs to be reopened to add the new active ingredient to the permit before Dischargers may begin using the active ingredient. In addition, when DPR registers a new active ingredient that is also a priority pollutant and has been added to this General Permit, this General Permit may also be reopened to allow Dischargers to obtain an exception from meeting receiving water limitations for the priority pollutant in accordance with SIP section 5.3. It is very resource intensive to have the State Water Board amend this General Permit on a frequent basis. Thus, this General Permit contains a delegation from the State Water Board to the Executive Director to amend this General Permit for these two purposes. In cases of significant public controversy, the Executive Director may determine that any permit amendment otherwise subject to this section will be considered by the State Water Board.

## V. RATIONALE FOR EFFLUENT LIMITATIONS AND DISCHARGE SPECIFICATIONS

Effluent limitations and toxic and pretreatment effluent standards established pursuant to sections 301 (Effluent Limitations), 302 (Water Quality Related Effluent Limitations), 304 (Information and Guidelines), and 307 (Toxic and Pretreatment Effluent Standards) of the CWA and amendments thereto are applicable to the discharge.

The control of pollutants discharged is established through effluent limitations and other requirements in NPDES permits. There are two principal bases for effluent limitations: (1) 40 C.F.R. section 122.44(a) requires that permits include applicable technology-based limitations and standards; and (2) 40 C.F.R. section 122.44(d) requires that permits include water quality-based effluent limitations to attain and maintain applicable numeric and narrative water quality criteria to protect the beneficial uses of the receiving water where numeric water quality objectives have not been established.

The CWA mandates the implementation of effluent limitations that are as stringent as necessary to meet water quality standards established pursuant to state or federal law (33 U.S.C., §1311(b)(1)(C); 40 C.F.R. §122.44(d)(1)). NPDES permits must incorporate discharge limits necessary to ensure that water quality standards are met. This requirement applies to narrative criteria as well as to numeric criteria specifying maximum amounts of particular pollutants. Pursuant to 40 C.F.R. section 122.44(d)(1)(i), NPDES permits must contain limits that control all pollutants that "*are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard, including state narrative criteria for water quality*." Section 122.44(d)(1)(vi) of 40 C.F.R. further provides that "[w]*here a state has not established a water quality criterion for a specific chemical pollutant that is present in an effluent at a concentration that causes, has the reasonable potential to cause, or contributes to an excursion above a narrative criterion within an applicable State water quality standard, the permitting authority must establish effluent limits.*"

The CWA requires point source dischargers to control the amount of conventional, non-conventional, and toxic pollutants that are discharged into the waters of the United States. The control of pollutants discharged is established through effluent limitations and other requirements in NPDES permits. There are two principal bases for effluent limitations: 40 C.F.R. section 122.44(a) requires that permits include applicable technology-based limitations and standards; and section 122.44(d) requires that permits include water quality-based effluent limitations to attain and maintain applicable numeric and narrative water quality criteria to protect the beneficial uses of the receiving water where numeric water quality objectives have not been established.

With respect to narrative objectives, the State Water Board must establish effluent limitations using one or more of three specified sources: (1) U.S. EPA's published water quality criteria; (2) a proposed state criterion (i.e., water quality objective) or an explicit state policy interpreting its narrative water quality criteria; or (3) an indicator parameter (i.e., 40 C.F.R. §122.44(d)(1)(vi)(A), (B) or (C)). Basin Plans contain a narrative objective requiring that: "*All waters shall be maintained free of toxic substances in concentrations*

*that produce detrimental physiological responses in human, plant, animal, or aquatic life.*" Basin Plans require the application of the most stringent objective necessary to ensure that surface water and groundwater do not contain chemical constituents, discoloration, toxic substances, radionuclides, or taste and odor producing substances that adversely affect beneficial uses. Basin Plans state that material and relevant information, including numeric criteria, and recommendations from other agencies and scientific literature will be utilized in evaluating compliance with the narrative toxicity objective. Basin Plans also limit chemical constituents in concentrations that adversely affect surface water beneficial uses. Basin Plans further state that, to protect all beneficial uses, the Regional Water Board may apply limits more stringent than MCLs.

## A. Discharge Prohibitions

1. The discharge of residual algaecides, residual aquatic herbicides, and their degradation byproducts in a manner different from that described in this General Permit is prohibited.

   This prohibition is based on 40 C.F.R. 122.21(a), "Duty to Apply," and California Water Code section 13260, which requires filing a Report of Waste Discharge before discharges can occur. Discharges not described in the NOI, and subsequently not discharged in the manner permitted by this General Permit, are prohibited.

2. The discharge of residual algaecides, residual aquatic herbicides, and their degradation byproducts shall not create a nuisance as defined in section 13050 of the California Water Code.

   This prohibition is based on California Water Code section 13050 for water quality control for achieving water quality objectives.

3. The discharge shall not cause, have a reasonable potential to cause, or contribute to an in-stream excursion above any applicable standard or criterion promulgated by U.S. EPA pursuant to section 303 of the CWA, or water quality objective adopted by the State or Regional Water Boards.

   This prohibition is based on CWA section 301 and California Water Code.

4. All pesticides are prohibited from the waters of the Lahontan Region (Region 6). The use of this permit is invalid in the Lahontan Region unless the discharger has requested a prohibition exemption from the Lahontan Water Board and the Lahontan Water Board has granted an exemption for the use of algaecides or aquatic herbicides.

   This prohibition is based on the Lahontan Water Board's region-wide waste discharge prohibition for pesticides in water with exemption criteria to allow certain uses of aquatic pesticides.

## B. Effluent Limitations

### 1. Technology-Based Effluent Limitations

The intent of technology-based effluent limitations in NPDES permits is to require a minimum level of treatment of pollutants based on available treatment technologies while allowing the Discharger to use any available control technique to meet the limitations. For industrial and other non-municipal facilities, technology-based effluent limitations are derived by using: (1) national effluent limitations guidelines and standards established by U.S. EPA; or best professional judgment on a case-by-case basis in the absence of national effluent limitations guidelines and standards. In the case of pesticide applications, U.S. EPA has not developed guidelines and standards other than the requirement to follow the labels when applying pesticides. At this point, it is not appropriate to establish technology-based effluent limitations other than following the label when applying algaecides and aquatic herbicides.

Therefore, the effluent limitations contained in this General Permit are narrative and include requirements to develop and implement an APAP that describes appropriate BMPs, including compliance with all algaecide and aquatic herbicide label instructions, and to comply with numeric receiving water limitations and actions required if monitoring triggers are exceeded.

The BMPs required herein constitute BAT and BCT and will be implemented to minimize the area and duration of impacts caused by the discharge of algaecides and aquatic herbicides in the treatment area and to allow for restoration of water quality and protection of beneficial uses of the receiving waters to pre-application quality following completion of an application event.* In addition, for those enrollees that have been granted an exception to meeting receiving water limitations for acrolein and copper, in accordance with the Policy, this General Permit requires that upon completion of a pesticide application project, the Discharger shall provide certification by a qualified biologist that the receiving water beneficial uses have been restored.

The development of BMPs provides the flexibility necessary to establish controls to minimize the area extent and duration of impacts caused by the discharge of algaecides and aquatic herbicides. This flexibility allows Dischargers to implement appropriate BMPs for different types of applications and different types of waters.

Much of the BMP development has been incorporated into the algaecide and aquatic herbicide regulation process by U.S. EPA, DPR, and County Agricultural Commissioners. The Dischargers must be licensed by DPR if such licensing is required for the algaecide and aquatic herbicide application project. The algaecide and aquatic herbicide use must be consistent with the algaecide and aquatic herbicide label instructions and any Restricted Material Use Permits issued by County Agricultural Commissioners.

U.S. EPA and DPR scientists review algaecide and aquatic herbicide labels to ensure that a product used according to label instructions will cause no harm (or "adverse impact") on non-target organisms that cannot be reduced (or "mitigated") with protective measures or use restrictions. Many of the label directions constitute BMPs to protect water quality and beneficial uses. Label directions may include: precautionary statements regarding toxicity and environmental hazards; directions for proper handling, dosage, application, and disposal practices; prohibited activities; spill prevention and response measures; and restrictions on type of water body and flow conditions.

A Restricted Material Use Permit issued by the County Agricultural Commissioner incorporates applicable suggested permit conditions from DPR and local site-specific conditions necessary to protect the environment. State regulations require that specific types of information be provided in an application to the County Agricultural Commissioners for a Restricted Material Use Permit. The County Agricultural Commissioners review the application to ensure that appropriate alternatives were considered and that any potential adverse effects are mitigated. The County Agricultural Commissioners also conduct pre-project inspections on at least five percent of projects.

This General Permit requires that Dischargers use BMPs when implementing control programs in order to mitigate effects to water quality resulting from algaecide and aquatic herbicide applications. Dischargers are required to consider alternative control measures to determine if there are feasible alternatives to the selected algaecide and aquatic herbicide application project that could reduce potential water quality impacts. If the Discharger identifies alternative control measures to the selected algaecide and aquatic herbicide application project that could reduce potential water quality impacts and that are also feasible, practicable, and cost-effective, the Discharger shall implement the identified alternative measures. The selection of control measures that use non-toxic and less toxic alternatives is an example of an effective BMP.

2. **Water Quality-Based Effluent Limitations (WQBELs)**

a. **Scope and Authority**

Section 122.44(d)(1)(i) of 40 C.F.R. mandates that permits include effluent limitations for all pollutants that are or may be discharged at levels that have the reasonable potential to cause or contribute to an exceedance of a water quality standard, including numeric and narrative objectives within a standard. Where reasonable potential has been established for a pollutant, but there is no numeric criterion or objective for the pollutant, WQBELs must be established using: (1) U.S. EPA criteria under CWA section 304(a), supplemented where necessary by other relevant information; (2) an indicator parameter for the pollutant of concern; or (3) a calculated numeric water quality criterion, such as a proposed state criterion or policy interpreting the state's narrative criterion, supplemented with other relevant information, as provided in 40 C.F.R. section 122.44(d)(1)(vi).

The process for determining reasonable potential and calculating WQBELs when necessary is intended to protect the designated uses of the receiving water as specified in the Basin Plans, and achieve applicable water quality objectives and criteria that are contained in other state plans and policies, or any applicable water quality criteria contained in the CTR and NTR.

Section 122.44(k)(3) of 40 C.F.R. allows the use of other requirements such as BMPs in lieu of numeric effluent limits if the latter are infeasible. It is infeasible for the State Water Board to establish numeric effluent limitations in this General Permit because:

i. The application of algaecides and aquatic herbicides is not necessarily considered a discharge of pollutants according to the *National Cotton Council of America v. U.S. EPA*[10] and other applicable case law. The Sixth Circuit Court of Appeals ruled that residual pesticides associated with the application of pesticides at, over, or near water constitute pollutants within the meaning of the CWA and that the discharge must be regulated under an NPDES permit;

ii. This General Permit regulates the discharge of residual algaecides and aquatic herbicides used for algae and aquatic weed control to waters of the United States. These are algaecides and herbicides with registration labels that explicitly allow direct application to water bodies. In algaecides and aquatic herbicides applications to control pests, any algaecides and aquatic herbicides residue or degradation byproduct that is deposited in waters of the United States is a pollutant. However, at what point the algaecides and aquatic herbicides become a residue is not precisely known and varies depending on the type of algaecides and aquatic herbicides, application method and quantity, water chemistry, etc. Therefore, in the application of algaecides and aquatic herbicides, the exact effluent is unknown;

iii. It would be impractical to provide effective treatment of the algaecides and aquatic herbicides residue to protect water quality, given typically, algaecides and aquatic herbicides applications consist of numerous short duration intermittent algaecides and aquatic herbicides residue releases to surface waters from many different locations; and

iv. Treatment may render the algaecides and aquatic herbicides useless for algae and aquatic weed control.

Therefore, as stated in Technology-Based Effluent Limitations, Section V.B.1 above, the effluent limitations contained in this General Permit are narrative and include requirements to develop and implement an APAP that describes appropriate BMPs, including compliance with all algaecides and aquatic

[10] 553 F.3d 927 (6th Cir., 2009)

herbicides label instructions, and to comply with narrative receiving water limitations and triggers.

b. **Receiving Water Beneficial Uses**

Algaecide and aquatic herbicide applications for algae and aquatic weed control may potentially deposit residual algaecides and aquatic herbicides to surface waters. Beneficial uses of receiving waters are as follows: municipal and domestic supply, agricultural irrigation, agricultural stock watering, process water supply, service water supply, and hydropower supply, water contact recreation, canoeing and rafting recreation, other non-contact water recreation, warm freshwater aquatic habitat, cold freshwater aquatic habitat, warm fish migration habitat, cold fish migration habitat, warm and cold spawning habitat, wildlife habitat, navigation, groundwater recharge, and freshwater replenishment. Requirements of this General Permit implement the applicable Basin Plans.

c. **Determining the Need for WQBELs**

Water quality standards include Regional Water Board Basin Plan beneficial uses and narrative and numeric water quality objectives, State Water Board-adopted standards, and federal standards, including the CTR and NTR, as well as antidegradation policies. The Basin Plans include numeric site-specific water quality objectives and narrative objectives for toxicity, chemical constituents, and tastes and odors. The narrative toxicity objective states: "*All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life*." With regard to the narrative chemical constituent objective, the Basin Plans state that waters shall not contain chemical constituents in concentrations that adversely affect beneficial uses. At minimum, "…*water designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the maximum contaminant levels (MCLs)" in title 22 of CCR.* The narrative tastes and odors objective states: *"Water shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses*."

Federal regulations require effluent limitations for all pollutants that are or may be discharged at a level that will cause or have the reasonable potential to cause, or contribute to an in-stream excursion above a narrative or numerical water quality standard.

d. **Antidegradation Policy**

The permitted discharge is consistent with the antidegradation provisions of 40 C.F.R. section 131.12 and State Water Board Resolution No. 68-16. Compliance with these requirements will result in the use of best practicable treatment or control of the discharge. Due to the low volume of discharge

expected from discharges regulated under this General Permit, the impact on existing water quality will be insignificant. Dischargers seeking authorization to discharge under this General Permit are required to demonstrate compliance with receiving water limitations during the application. If, however, the appropriate Regional Water Board, subsequent to review of any application, finds that the impact of a discharge will be significant, then authorization for coverage under this General Permit will be denied and coverage under an individual permit will be required (including preparation of an antidegradation analysis).

## VI. RATIONALE FOR RECEIVING WATER LIMITATIONS AND MONITORING TRIGGERS

### A. Groundwater

[Not Applicable]

### B. Surface Water

CWA section 303(a-c), requires states to adopt water quality standards, including criteria necessary to protect beneficial uses. Regional Water Boards adopted water quality criteria as water quality objectives in the Basin Plans. The Basin Plans state that "[t]*he numerical and narrative water quality objectives define the least stringent standards that the Regional Water Board will apply to regional waters in order to protect the beneficial uses.*" The Basin Plans include numeric and narrative water quality objectives for various beneficial uses and water bodies. This General Permit contains receiving water limitations based on the Basin Plans' numerical and narrative water quality objectives for bio-stimulatory substances, chemical constituents, color, temperature, floating material, settleable substances, suspended material, tastes and odors, and toxicity. This General Permit also requires compliance with any amendment or revision to the water quality objectives contained in the Basin Plans adopted by Regional Water Boards subsequent to adoption of this General Permit.

Once algaecides and aquatic herbicides have been applied to a treatment area, the algaecide and aquatic herbicide product can actively control pests within the treatment area. The discharge of algaecides and aquatic herbicides, their residues, and their degradation byproducts from the applications to surface water must meet applicable water quality criteria and objectives. The receiving water limitations ensure that an application event* does not result in an exceedance of a water quality standard in the receiving water.

To protect all designated beneficial uses of the receiving water, the most protective (lowest) and appropriate (to implement the CTR criteria and WQOs in the Basin Plans) criteria should be selected as the permit limitation for a particular water body and constituent. In many cases, water quality standards include narrative, rather than numerical, water quality objectives. In such cases, numeric water quality limits from the literature or publicly available information may be used to ascertain compliance with water quality criteria.

Algaecide and aquatic herbicide formulations contain disclosed "active" ingredients that yield toxic effects* on target organisms and may also have toxic effects on non-target organisms. Algaecide and aquatic herbicide active ingredients that do not contain pollutants for which there are applicable numeric CTR criteria may still have toxic effects on receiving water bodies. In addition, the inactive or "inert" ingredients of algaecides and aquatic herbicides, which are trade secrets and have not been publicly disclosed, may also contain toxic pollutants or pollutants that could affect water quality.

DPR is responsible for reviewing toxic effects of product formulations and determining whether an algaecide or aquatic herbicide is suitable for use in California's waters. In this General Permit, inert ingredients are also considered on a constituent-by-constituent basis. U.S. EPA regulates pesticide use through strict labeling requirements in order to mitigate negative impacts to human health and the environment, and DPR environmental and medical toxicologists review toxicity data on formulations and can deny registration or work with registrants or County Agricultural Commissioners to impose additional requirements in order to protect human health or the environment.

U.S. EPA and DPR require that pesticides undergo toxicity testing and meet specific toxicity requirements before registering the pesticide for application to surface waters. U.S. EPA has found that the application of properly registered pesticides pose a minimal threat to people and the environment. In addition, the effects of these pesticides on water quality will be mitigated through compliance with FIFRA label requirements, application of BMPs, and monitoring.

Basin Plan water quality objectives to protect the beneficial uses of surface water and groundwater include numeric objectives and narrative objectives, including objectives for chemical constituents, toxicity, and tastes and odors. The toxicity objective requires that surface water and groundwater be maintained free of toxic substances in concentrations that produce detrimental physiological responses in humans, plants, animals, or aquatic life. The chemical constituent objective requires that surface water and groundwater shall not contain chemical constituents in concentrations that adversely affect any beneficial use or that exceed the MCLs set forth in title 22, Cal. Code Regs. The tastes and odors objective states that surface water and groundwater shall not contain taste- or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses. The Basin Plans require the application of the most stringent objective necessary to ensure that surface water and groundwater do not contain chemical constituents, toxic substances, radionuclides, or taste and odor producing substances in concentrations that adversely affect domestic drinking water supply, agricultural supply, or any other beneficial use.

1. **Receiving Water Limitations**

   The instantaneous maximum receiving water limitations are based on promulgated water quality criteria such as those provided in the CTR, water quality objectives adopted by the State and Regional Water Boards in their Basin

Plans, water quality criteria adopted by the California Department of Fish and Wildlife, water quality standards such as drinking water standards adopted by U.S. EPA or the California Department of Public Health (CDPH), or U.S. EPA National Recommended Ambient Water Quality Criteria.

This General Permit provides receiving water limitations based on the lowest water quality criteria/objectives to protect all designated beneficial uses of the receiving water. The receiving water limitations in this General Permit are the same as those in Order No. 2004-0009-DWQ. The rationale for each limitation is summarized below.

**Table D-2. Summary of Receiving Water Limitations**

| Constituent/ Parameter | BENEFICIAL USE[1] | | | | Basis |
|---|---|---|---|---|---|
| | MUN, µg/L | WARM or COLD, µg/L | Other than MUN, WARM, or COLD, µg/L | All Designations | |
| 2,4,-D | 70 | | | | U.S. EPA MCL |
| Acrolein[2] | 320 | 21 | 780 | | U.S. EPA Water Quality Criteria, 1986. |
| Chlorine | | Freshwater[3] Acute Criterion = 20 µg/L | | | U.S. EPA's Ambient Water Quality Criteria for Freshwater Aquatic Life Protection |
| | | Saltwater[3] Acute Criterion = < 10 µg/L | | | California Ocean Plan |
| Copper[2] | | | | Dissolved Freshwater[3] Copper Chronic = 0.960exp{0.8545 [ln(hardness[4])] – 1.702}[5, 6]<br><br>Dissolved Saltwater[3] Copper Chronic = 3.1 µg/L [5,6] | California Toxics Rule |
| Diquat | 20 | | | | U.S. EPA MCL |
| Endothall | 100 | | | | U.S. EPA MCL |
| Fluridone | 560 | | | | U.S. EPA Integrated Risk Information System |
| Glyphosate | 700 | | | | U.S. EPA MCL |
| Nonylphenol | | | | Freshwater Chronic Criterion = 6.6 µg/L<br><br>Saltwater Chronic Criterion = 1.7 µg/L | U.S. EPA National Recommended Ambient Water Quality Criteria |
| Toxicity | Algaecide and aquatic herbicide applications shall not cause or contribute to toxicity in receiving water(s). | | | | Regional Water Boards' Basin Plans |

Notes

1. See Regional Water Boards' Water Quality Control Plans (Basin Plans) for beneficial use definitions.
2. Public entities and mutual water companies listed in Attachment G are not required to meet this receiving water limitation during the exception period described in Section VIII.C.10, Limitations and Discharge Requirements, Aquatic Pesticides Application Plan (APAP).
3. For waters in which the salinity is equal to or less than 1 part per thousand 95% or more of the time, the freshwater criteria apply. For waters in which the salinity is equal to or greater than 10 parts per thousand 95% or more of the time, saltwater criteria apply. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable criteria are the more stringent of the freshwater or saltwater criteria.
4. For freshwater aquatic life criteria, waters with a hardness 400 mg/L or less as calcium carbonate, the actual ambient hardness of surface water shall be used. For waters with a hardness of over 400 mg/L as calcium carbonate, a hardness of 400 mg/L as calcium carbonate shall be used with a default Water-Effect Ratio of 1.
5. Values should be rounded to two significant figures.
6. This limitation does not apply to the Sacramento River and its tributaries above the State Highway 32 Bridge at Hamilton City. See Table III-1 of the Basin Plan for the Sacramento and San Joaquin River Basins for copper limitation.

Sodium hypochlorite, also known as liquid bleach, came into widespread use about 1930 for laundry, household, and general disinfecting uses. It is commercially available at strengths of five to 15 percent but is typically 10 percent or 12.5 percent available chlorine. It is more widely used than its dry counter part, calcium hypochlorite, due to its lower cost for transport, and is more easily handled.[11]

Chlorine is the only toxicant that results from the use of calcium hypochlorite and sodium hypochlorite-based pesticide products that are used to control algae and aquatic weeds. To protect all designated beneficial uses of the receiving water from chlorine residual, the most protective (lowest) and appropriate limitation for chlorine should be selected as the water quality limitation for a particular water body. The U.S. EPA National Recommended Ambient Water Quality Criteria for freshwater aquatic life and the California Ocean Plan water quality objectives for chlorine are applicable. U.S. EPA has recommended ambient water quality criteria of 11 µg/l as a continuous concentration (four-day average) and 19 µg/l as the maximum concentration (one-hour average) for freshwater aquatic life protection for chlorine. The California Ocean Plan Water Quality Objectives, which protect human health and marine aquatic life from constituents in marine waters of California, list 2 µg/l as the six month median, 8 µg/l as the daily maximum, and 60 µg/l as the instantaneous maximum for chlorine.

However, because of the lack of precision with current chlorine residual measuring instruments, it would be more appropriate to set the freshwater chlorine receiving water limitations to 10 µg/l as a monthly average and 20 µg/l as a daily maximum; a daily maximum of nondetect or <10 µg/l is appropriate to protect marine aquatic life.

[11] 11 G. C. White, Handbook of Chlorination, 2nd ed. (New York: Van Nostrand Reinhol Company Inc, 1986) 63-70.

The copper limitation in Order No. 2004-0009-DWQ was based on the CTR's Criteria Continuous Concentration (CCC) expressed in total recoverable concentration. This General Permit also uses CCC from the CTR as the basis of the copper limitations; however, the copper limitation is now expressed in dissolved concentration. Since the copper criterion in the CTR is expressed in dissolved concentration, the receiving water limitation must also be expressed in dissolved rather than total concentration since it is the dissolved portion of copper that is bioavailable to aquatic life.

Based on Policy section 5.3, this General Permit grants public entities and mutual water companies listed in Attachment G a short-term or seasonal exception from meeting receiving water limitations for acrolein and copper during treatment. As a condition of the exception, this General Permit requires Dischargers to provide the length and justification of required exception periods in their APAPs. There is no discrete definition for short-term; but the intent is to allow the exception to apply during the treatment period. It is up to the Discharger to make this demonstration.

The receiving water dissolved oxygen limitation is based on the Regional Water Board Basin Plans' dissolved oxygen objectives.

2. **Receiving Water Monitoring Triggers**

In algaecide or aquatic herbicide applications, it is reasonable to conclude that some residual algaecides or aquatic herbicides will remain in the receiving waters. These residual algaecides or aquatic herbicides may cause toxicity to aquatic life. However, information regarding the specific amount of algaecide or aquatic herbicide residues (described below) in the receiving water as a result of direct applications for weed control is not adequate to develop receiving water limitations for these algaecides and aquatic herbicides. Therefore, this General Permit only contains Receiving Water Monitoring Triggers and/or monitoring requirements for these algaecides or aquatic herbicides. The monitoring triggers and monitoring data will be used to assess whether the discharges of these algaecide or aquatic herbicide residues have the reasonable potential to cause or contribute to an excursion of a water quality standard, including numeric and narrative objectives within a standard.

In the absence of adopted criteria, objectives, or standards, the State Water Board used U.S. EPA's Ambient Criteria for the Protection of Freshwater Aquatic Life (Ambient Water Quality Criteria) which are directly applicable as a regulatory level to implement narrative toxicity limitations included in all Regional Water Board Basin Plans. Where adopted criteria, objectives, standards, or Ambient Water Quality Criteria are unavailable, the State Water Board used data from U.S. EPA's *Ecotoxicity Database* to develop the Receiving Water Monitoring Triggers to protect all beneficial uses of the receiving water.

For constituents that do not have Ambient Water Quality Criteria, the Instantaneous Maximum Receiving Water Monitoring Trigger is based on one-tenth of the lowest 50 Percent Lethal Concentration (LC50) from U.S. EPA's

*Ecotoxicity Database*. Using one-tenth of the lowest LC50 as the receiving water monitoring trigger is consistent with the Central Valley Regional Water Board's Basin Plan approach when developing the Daily Maximum Limitation for algaecides or aquatic herbicides that do not have water quality criteria.

This General Permit may be re-opened to add receiving water limitations to the algaecides or aquatic herbicides listed below if the monitoring triggers are exceeded or the monitoring data indicate re-opening of the permit is appropriate. The following is a detailed discussion of toxicity data, applicable water quality criteria, and Receiving Water Monitoring Triggers, if applicable, for these algaecides or aquatic herbicides:

a. FlumioxazinFlumioxazin was first registered for aquatic use by U.S. EPA in 2010 and by DPR in 2014. Flumioxazin is a protoporphyrinogen oxidase (PPO) inhibitor which acts by initiating cell membrane disruption in algae (e.g., Filamentous, Blue-Green) and submersed (e.g., Eurasian watermilfoil, Curlyleaf pondweed) and floating (e.g., Watermeal, Duckweed) aquatic plants. Flumioxazin is a contact herbicide that quickly degrades in water and plants. Flumioxazin must come in contact with the plant for optimal efficacy and is applied via foliar or surface spray or submersed injection. Flumioxazin does not accumulate in sediment. Flumioxazin degrades via hydrolysis with a half-life of 3.4 - 5.1 days at pH 5, 21.4 - 24.6 hours at pH 7, 14.6 - 22 minutes at pH 9.

   Staff obtained toxicity data for flumioxazin from U.S. EPA's *Ecotoxicity Database* to assess its toxicity to freshwater aquatic life. Table D-3 summarizes the toxicity data for flumioxazin below.

**Table D-3. Toxicity Data Summary for Flumioxazin (CAS#103361-09-7)**

| Type of Organism | Study Length | Study Date | LC50 (mg/L) |
|---|---|---|---|
| Bluegill sunfish | 96 h | 1992 | 21 |
| Sheepshead minnow | 96 h | 1992 | 4.7 |
| Rainbow trout | 96 h | 1992 | 2.3 |
| | 21 d | 1992 | 2.4 |
| **Lowest LC50/10 > 0.23** | | | |

Ambient Water Quality Criteria are unavailable for flumioxazin. Table D-3 shows that one-tenth of the lowest LC50 to protect the most sensitive freshwater aquatic life for flumioxazin is greater than 0.23 mg/l.

Due to the absence of water quality criteria for flumioxazin and its toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, this General Permit does not have a receiving water monitoring trigger for flumioxazin. However, this General Permit requires receiving water monitoring for

flumioxazin to collect data, which will provide information on whether the use of flumioxazin has water quality impacts.

~~a.~~b. Imazamox

Imazamox is a derivative of the active ingredient, ammonium salt of imazamox for the aquatic herbicide Clearcast, which DPR registered for use in California in October 2012. It is labeled for application to water for the control of submerged aquatic plants species and some emergent and floating species.

Imazamox is an herbicide that inhibits an enzyme in aquatic plants that is essential for the synthesis of three-branched chain amino acids.

Staff obtained toxicity data for imazamox from U.S. EPA's *Ecotoxicity Database* to assess its toxicity to freshwater aquatic life. However, U.S. EPA's *Ecotoxicity Database* contains toxicity data only for imazamox, but not for its salt. Table D-~~3~~ 4 summarizes the toxicity data for imazamox below.

**Table D-~~3~~4. Toxicity Data Summary for Imazamox (CAS# 114311-32-9)**

| Type of Organism | Study Length | Study Date | LC50 (mg/L) |
|---|---|---|---|
| Mysid | 96 h | 1998 | > 100 |
| | | 1998 | > 94.3 |
| Bluegill sunfish | 96 h | 1994 | > 119 |
| Rainbow trout | 96 h | 1994 | > 122 |
| Sheephead mino | 96 h | 1998 | > 94.2 |
| | | 1998 | > 94.2 |
| **Lowest LC50/10 > 9.4 mg/L** | | | |

Ambient Water Quality Criteria are unavailable for imazamox and imazamox salt. Table D-3 shows that one-tenth of the lowest LC50 to protect the most sensitive freshwater aquatic life for imazamox is greater than 9.4 mg/l.

Due to the absence of water quality criteria for imazamox and its low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, this General Permit does not have a receiving water monitoring trigger for imazamox. However, this General Permit requires receiving water monitoring for imazamox to collect data, which will provide information on whether the use of imazamox has water quality impacts.

~~b.~~c. Imazapyr

The active ingredient imazapyr is marketed by the trade names Arsenal, Chopper, and Assault. Upon contact, imazapyr can interfere with DNA synthesis and cell growth of the plants. The target weed species are grasses, broad-leaves, vines, brambles, shrubs and trees, and riparian and emerged aquatics. The result of exposure is death of new leaves. It was first registered in the United States in 1984.

Imazapyr is a slow-acting amino acid synthesis inhibitor. It has an average water half-life* of four days with photodegradation as the primary form of degradation in water. Imazapyr acts more quickly and is less toxic than other low-volume herbicides. According to the San Francisco Estuary* Invasive Spartina Project's May 4, 2005 report titled *Use of Imazapyr Herbicide to Control Invasive Cordgrass (Spartina spp.) in the San Francisco Estuary*, imazapyr in water rapidly degrades via photolysis. The report further states that a number of field studies demonstrated that imazapyr rapidly dissipated from water within several days, and no detectable residues of imazapyr were found in either water or sediment within two months; in estuarine systems, dilution of imazapyr with the incoming tides contributes to its rapid dissipation, suggesting that imazapyr is not environmentally persistent in the estuarine environment and does not result in significant impacts to water quality. The report concludes that imazapyr herbicides can be a safe, highly effective treatment for control and eradication of non-native *Spartina* species in the San Francisco Estuary and offers an improved risk scenario over the existing treatment regime with glyphosate herbicides. On August 30, 2005, DPR registered imazapyr for aquatic application as an aquatic herbicide.

Toxicity data for imazapyr were obtained from U.S. EPA's *Ecotoxicity Database* to assess the toxicity of imazapyr to freshwater aquatic life. Tables D-~~4~~ 5 and D-~~5~~ 6 summarize the toxicity data for imazapyr and imazapyr salt.

**Table D-45. Toxicity Data Summary for Imazapyr (CAS#81334-34-1)**

| Type of Organism | Study Length | Study Date | LC50 (mg/L) |
|---|---|---|---|
| Pink shrimp | 96 h | 1988 | > 189 |
| Atlantic silverside | 96 h | 1988 | > 184 |
| Bluegill sunfish | 96 h | 1983 | > 100 |
| | | 1983 | > 100 |
| Channel catfish | 96 h | 1983 | > 100 |
| Rainbow trout | 96 h | 1983 | > 100 |
| | | 1995 | > 110 |
| **Lowest LC50/10 > 10** | | | |

**Table D-~~5~~6. Toxicity Data Summary for Imazapyr Isopropylamine Salt (CAS#81510-83-0)**

| Type of Organism | Study Length | Study Date | LC50 (mg/L) |
|---|---|---|---|
| Water flea | 48 h | 1984 | 350 |
| Rainbow trout | 96 h | 1984 | **112** |
| Bluegill sunfish | 96 h | 1984 | > 1000 |
| **Lowest LC50/10 = 11.2** | | | |

Ambient Water Quality Criteria are unavailable for imazapyr and imazapyr salt. Tables D-~~4~~ 5 and D-~~5~~ 6 show that the lowest one-tenth of LC50 to protect the most sensitive freshwater aquatic life for imazapyr is 11.2 mg/l.

Due to its safe use in the environment and low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, this General Permit does not have a receiving water limitation for imazapyr. However, this General Permit contains a monitoring trigger of 11.2 mg/l based on one-tenth of the lowest LC50 from U.S. EPA's *Ecotoxicity Database* and requires receiving water monitoring to collect data, which will provide information on whether imazapyr has water quality impacts.

~~c.~~d. Penoxsulam

Penoxsulam is the active ingredient for Galleon SC, a selective systemic aquatic herbicide for management of freshwater aquatic vegetation in ponds, lakes, reservoirs, marshes, wetlands, non-irrigation canals, slow-moving water bodies, etc. Penoxsulam is a post-emergence acetolactate synthase (ALS) inhibitor developed by Dow AgroSciences to be used as a foliar spray on dry-seeded rice crops. The mode of action is to inhibit the acetolactate synthases enzyme in the target weed.

The U.S. EPA Pesticide Fact Sheet states that penoxsulam is expected to be very mobile, but not very persistent, in either aqueous or terrestrial environments. Penoxsulam exists almost exclusively in a disassociated state at pH values normally found in rice paddy water (averaging about eight), but not in terrestrial environments where lower pH values may be found. Penoxsulam degrades by two different transformation mechanisms, producing 13 different identified transformation products, 11 of which meet the criteria to be classified as major degradation byproducts,[12] six of which reached peak concentrations at study termination, indicating a greater degree of persistence than penoxsulam and a potential to reach concentrations even greater than those reported at study termination. The results of the screening-level risk assessment suggest that penoxsulam will not pose a threat to aquatic or terrestrial animals, however, this conclusion must be tempered by the fact that testing has not been conducted on several major degradation byproducts.

Toxicity data for penoxsulam were obtained from U.S. EPA's *Ecotoxicity Database* to assess the toxicity of penoxsulam to freshwater aquatic life. Table D-~~6~~ 7 summarizes the toxicity data for penoxsulam.

**Table D-~~6~~7. Toxicity Data Summary for Penoxsulam (CAS#219714-96-2)**

[12] U.S. EPA defines major degradation byproducts to be BSA, 2-amino-TP, TPSA, BSTCA methyl, BSTCA, 2-amino-TCA,5-OH-penoxsulam, SFA, sulfonamide, 5,8-di-OH and 5-OH, 2 aminoTP.

| Type of Organism | Study Length | Study Date | LC50 (mg/L) |
|---|---|---|---|
| Bluegill sunfish | 96 h | 2000 | > 103 |
| Common carp fish | 96 h | 2001 | > **101** |
| Mysid | 96 h | 2000 | > 114 |
| Rainbow trout | 96 h | 2002 | > 147 |
| | | 2000 | > 102 |
| Scud | 96 h | 2000 | > 126 |
| **Lowest LC50/10 > 10.1** | | | |

Ambient Water Quality Criteria are unavailable for penoxsulam. Table D-~~6~~ 7 shows that the lowest one-tenth of LC50 to protect the most sensitive freshwater aquatic life for penoxsulam is greater than 10.1 mg/l.

Due to its safe use in the environment, low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, and lack of accurate toxicity value, this General Permit does not have a receiving water monitoring trigger. However, this General Permit requires receiving water monitoring to collect data, which will provide information on whether penoxsulam has water quality impacts.

e. ~~d.~~ Hydrogen Peroxide, Peroxyacetic Acid, and Sodium Carbonate Peroxyhydrate

Hydrogen peroxide, peroxyacetic acid, and sodium carbonate peroxyhydrate are contact herbicides that work by oxidizing critical cellular components of the target aquatic vegetation leading to death. When applied to water, peroxyacetic acid and sodium carbonate peroxyhydrate break down to hydrogen peroxide. The hydrogen peroxide subsequently breaks down into water and oxygen. Sodium carbonate peroxyhydrate has been registered for aquatic use since early 2006. Hydrogen peroxide and peroxyacetic acid have been registered for aquatic use since 2002.

Use of these active ingredients in the aquatic environment is limited to contained, non-flowing waters as noted on product labels containing these active ingredients. These active ingredients can be highly toxic to fish and aquatic invertebrates at the higher application rates indicated on labels for products containing these active ingredients.

There are no LC50 toxicity data for peroxyacetic acid and sodium carbonate peroxyhydrate in U.S. EPA's *Ecotoxicity Database*~~.~~. However, these active ingredients break down to hydrogen peroxide and their toxicity can be evaluated based on the toxicity of hydrogen peroxide. Staff obtained LC50 toxicity data for hydrogen peroxide from U.S. EPA's *Ecotoxicity Database* to

assess it's toxicity to freshwater aquatic life. Table D-8 summarizes the LC50 toxicity data for hydrogen peroxide.

**Table D-8. Toxicity Data Summary for Hydrogen Peroxide (CAS#7722-84-1)**

| Type of Organism | Study Length (hours) | Study Date | LC50 (mg/L) |
|---|---|---|---|
| Bluegill sunfish | 0.5 - 96 | 1997 | 103 - 7,250* |
| Rainbow trout | 0.5 - 96 | 1997 | 45 - >12,000* |
| | 96 | 1992 | 93 |
| | 0.5 - 2 | 1997 | 189 - 574 |
| **Lowest LC50/10 > 4.5** | | | |

* Toxicity is highly temperature dependent with higher toxicity at higher temperatures. Range of study temperatures = 7.35°C to 21.5°C.

Ambient Water Quality Criteria are unavailable for hydrogen peroxide, peroxyacetic acid, and sodium carbonate peroxyhydrate. Table D-8 shows that one-tenth of the lowest LC50 to protect the most sensitive freshwater aquatic life for hydrogen peroxide is greater than 4.5 mg/l.

Due to the absence of water quality criteria for hydrogen peroxide, peroxyacetic acid, and sodium carbonate peroxyhydrate and the relatively rapid breakdown of these compounds in water, this General Permit does not have receiving water monitoring triggers for these active ingredients.

~~Sodium carbonate hydroxyhydrate has been registered as an algaecide since early 2006. The most common brand names are PAK 27, Phycomycin, and Green Clean. It is an alternative to traditional copper based algaecides. It acts as an oxidizing agent and thus kills the target algae. When it is applied into water, the compound quickly breaks down into hydrogen peroxide ($H_2O_2$) and sodium carbonate. The hydrogen peroxide oxidizes and thus kills the target pests. After contact, the hydrogen peroxide breaks down into water and oxygen.~~

~~U.S. EPA has waived toxicity testing for freshwater fish and invertebrate during the registration process. According to the U.S. EPA fact sheet, when the pesticide is applied in accordance with directions on the label, no harm is expected to freshwater fish or freshwater invertebrates.~~

~~There are no toxicity data for sodium carbonate peroxyhydrate in U.S. EPA's *Ecotoxicity Database*. Therefore, this General Permit does not have a monitoring trigger or a monitoring requirement for sodium carbonate peroxyhydrate.~~

~~d.~~f. Triclopyr Triethylamine (TEA) Salt

Triclopyr TEA is a systemic herbicide used to control broad-leaf weeds and woody plants.

U.S. EPA concluded in its re-registration document that triclopyr TEA is practically non-toxic to freshwater fish and aquatic invertebrates on an acute basis and triclopyr TEA is slightly toxic to practically non-toxic to estuarine/marine fish and invertebrates on an acute basis.

Triclopyr produces the metabolite or degradate 3,5,6-trichloro-2-pyridinol (TCP). Based on its analysis, U.S. EPA concludes that the existing uses of triclopyr are unlikely to result in acute or chronic dietary risks from TCP. Based on limited available data and modeling estimates, with less certainty, the U.S. EPA concluded that existing uses of triclopyr are unlikely to result in acute or chronic drinking water risks from TCP.

Toxicity data for triclopyr TEA were obtained from U.S. EPA's *Ecotoxicity Database* to assess the toxicity of triclopyr TEA to freshwater aquatic life. Table D-~~7~~ 9 summarizes the toxicity data for Triclopyr TEA.

**Table D-~~7~~9. Toxicity Data Summary for Triclopyr TEA Salt (CAS#57213-69-1)**

| Type of Organism | Study Length | Study Date | LC50 (mg/L) |
|---|---|---|---|
| Bluegill sunfish | 96 h | 1978 | 891 |
| | 96 h | 1973 | 471 |
| Fathead minnow | 96 h | 1978 | 947 |
| | 96 h | 1983 | 546 |
| | 96 h | 1983 | 279 |
| Grass shrimp | 96 h | 1992 | 326 |
| Inland Silverside fish | 96 h | 1989 | **130** |
| Pink shrimp | 96 h | 1975 | 895 |
| Rainbow trout | 96 h | 1973 | 240 |
| | 96 h | 1978 | 552 |
| **Lowest LC50/10 = 13.0** | | | |

Ambient Water Quality Criteria are unavailable for triclopyr TEA. Table D-~~7~~ 9 shows that the lowest one-tenth of LC50 to protect the most sensitive freshwater aquatic life for triclopyr TEA is 13 mg/l.

Due to its safe use in the environment and low toxicity to aquatic life as indicated in U.S. EPA's *Ecotoxicity Database*, this General Permit does not have a receiving water limitation for triclopyr TEA. However, this General Permit contains a monitoring trigger of 13.0 mg/l based on one-tenth of the lowest LC50 from U.S. EPA's *Ecotoxicity Database* and requires receiving

water monitoring to collect data, which will provide information on whether triclopyr TEA has water quality impacts.

## VII. RATIONALE FOR MONITORING AND REPORTING REQUIREMENTS

### A. MRP Goals

Section 122.48 of 40 C.F.R. requires that all NPDES permits specify requirements for recording and reporting monitoring results. Water Code sections 13267 and 13383 authorize the State and Regional Water Boards to require technical and monitoring reports. The Monitoring and Reporting Program (MRP) in Attachment C of this General Permit establishes monitoring and reporting requirements to implement federal and state requirements.

The goals of the MRP are to:

1. Identify and characterize algaecide or aquatic herbicide application projects conducted by the Discharger;
2. Determine compliance with the receiving water limitations and other requirements specified in this General Permit;
3. Measure and improve the effectiveness of the APAP;
4. Support the development, implementation, and effectiveness of BMPs;
5. Assess the chemical, physical, and biological impacts on receiving waters resulting from algaecide or aquatic herbicide applications;
6. Assess the overall health and evaluate long-term trends in receiving water quality;
7. Demonstrate that water quality of the receiving waters following completion of resource or weed management projects are equivalent to pre-application conditions; and
8. Ensure that projects that are monitored are representative of all algaecide or aquatic herbicide and application methods used by the Discharger.

The MRP in the Attachment C of this General Permit is considered as baseline monitoring requirements. Monitoring plans proposed by Dischargers in their APAP must meet the minimum requirements prescribed in the MRP. Public entities and mutual water companies that have a Policy section 5.3 exception should comply with the MRP in this General Permit as well as monitoring plan proposed in their CEQA document where the two plans differ.

### B. Effluent Monitoring

Pursuant to the requirements of 40 C.F.R. section 122.44(i), effluent monitoring is required for all constituents with effluent limitations. Effluent monitoring is necessary to assess compliance with effluent limitations, assess the effectiveness of the

treatment process, and assess the impacts of the discharge on the receiving water and groundwater.

The application of pesticides for pest control is not necessarily considered a discharge of pollutants according to the *National Cotton Council of America v. U.S. EPA* decision and other applicable case law. The regulated discharge is the discharge of residual pesticides. At what point the pesticide becomes a residue is not precisely known. Therefore, in the application of pesticides, the exact effluent is unknown. Thus, the effluent monitoring requirement is not applicable for algaecide or aquatic herbicide applications.

## C. Toxicity Testing Requirements

The State Water Board, pursuant to the Porter-Cologne Act and the federal CWA, customarily requires the Discharger to conduct toxicity monitoring. In fact, both Acts anticipate Discharger self monitoring. However, this General Permit does not require toxicity testing based on the 2004 toxicity study funded by the State Water Board and data collected from 2004 to 2008. The toxicity study found the following: (1) There was no toxicity with the use of 2,4-D, glyphosate, and triclopyr; (2) Toxicity testing was difficult for acrolein due to its volatility; (3) Results were inconclusive for diquat and fluridone; and (4) Peak copper concentrations did not exceed toxicity values. The monitoring data collected under Order No. 2004-0009-DWQ from 2004 to 2008 showed that all constituent concentrations from post-event application samples were below receiving water limitations except for the following: three exceedances each for acrolein and glyphosate and 82 exceedances for copper out of 288 monitoring events. For glyphosate, it is likely that the three exceedances were not the result of aquatic herbicide applications because the pre-application samples also showed exceedances and the remaining 151 samples showed no exceedance. For copper, 43 of the 82 exceedances were from public agencies or mutual water companies that were excepted from meeting priority pollutant limitations during the exception period. The Policy allows the exception. Thus, staff did not consider these exceedances as violations of the receiving water limitations. However, 39 of the exceedances were from entities that did not have a Policy exception. Although staff considered these exceedances as true violations of the receiving water limitations, staff is not aware of any long-term impacts from these exceedances. Long-term impacts from exceedances are likely not going to occur for the following reasons: (1) water quality criteria, which are used directly as receiving water limitations in this General Permit, have built-in factors of safety; (2) as shown in the 2004 toxicity study, the actual peak concentrations after applications of copper did not exceed toxicity values; and (3) the applications are short-term in duration. All of the foregoing information indicates that widespread acute ecosystem impacts will not occur from algaecide or aquatic herbicides applied according to their label instructions and requirements of this General Permit. Therefore, toxicity monitoring requirements are not necessary.

### D. Receiving Water Monitoring

Receiving water monitoring is necessary to determine the impacts of the discharge on the receiving stream.

All forms of testing have some degree of uncertainty associated with them. The more limited the amount of test data available, the larger the uncertainty. The intent of this General Permit's sampling program is to select a number that will detect most events of noncompliance without requiring needless or burdensome monitoring.

Staff also used EPA's Technical Support Document for Water Quality-Based Toxics Control (TSD) to determine the appropriate number of samples that would be needed to characterize the impacts of the residual pesticide discharge from pesticide applications. Page 53 of the TSD recommends using a coefficient of variation (CV) 0.6 when the data set contains less than 10 samples. Table 3-1 of the TSD shows that with a CV of 0.6, the multiplying factors used to determine whether a discharge causes, has the reasonable potential to cause, or contributes to an excursion above a state water quality standard begin to stabilize when the sample number is six. Thus, this General Permit requires six samples per year for each active ingredient in each environmental setting (flowing water and non-flowing water) to characterize the effects of residual pesticide discharge from pesticide applications. However, after a Discharger or Coalition has provided results from six consecutive sampling events showing concentrations that are less than the receiving water limitation/trigger for an active ingredient in a specific environmental setting, sampling shall be reduced to one application event per year for that active ingredient in that environmental setting.

Similarly, this General Permit contains a reduced monitoring frequency of once per year (instead of six) at each environmental setting for glyphosate. The reduced monitoring frequency is based on staff's review of available data from 2004 to 2008 that showed no exceedance of the permit limitation for glyphosate under Order No. 2004-0009-DWQ.

## VIII. RATIONALE FOR AQUATIC PESTICIDE USE REQUIREMENTS

### A. Application Schedule

The Discharger shall provide a phone number or other specific contact information for all persons who request the Discharger's application schedule.

### B. Application Notification Requirements

The Policy section 5.3, Categorical Exception, requires public agencies and mutual water companies that have been granted the short-term or seasonal exception for compliance with priority pollutant limitations to notify potentially affected public and government agencies of algaecide or aquatic herbicide application.

### C. APAP

This General Permit contains narrative effluent limitations, which include implementing BMPs described in the APAP, which is a requirement of this General Permit. See Section VI, Rationale for Effluent Limitations and Discharge Specifications, for more detailed explanation of the need for an APAP.

### D. APAP Processing, Approval, and Modifications

Upon receipt of a new or an amended APAP, staff will post it on the State Water Board's website. Major changes to the APAP shall be submitted to the Deputy Director for approval. Examples of major changes include using a different product other than what is specified in the APAP, changing an application method that may result in different amounts of algaecide or aquatic herbicides being applied, or adding or deleting BMPs. Since the APAP shall include ALL (1) the water bodies or water body systems in which algaecide or aquatic herbicides are being planned to be applied or may be applied to control algae and aquatic weeds and (2) the application areas and the target areas in the system that are being planned to be applied or may be applied, changes in monitoring locations are not considered major changes. However, these changes need to be reported in the annual report.

In preparing for the reissuance of the General Permit, staff will evaluate review periods and comments received during the life of this permit and look for efficiencies. Based on this information, staff will propose revisions to the public comment process for APAPs.

### E. Aquatic Pesticide Application Log

An application log to record all algaecide or aquatic herbicide applications is necessary. This application log will help Dischargers and the Water Boards' staff to investigate any exceedance of receiving water limitations or receiving water monitoring triggers.

## IX. RATIONALE FOR PROVISIONS

### A. Standard Provisions

#### 1. Standard Provisions in Attachment B

Standard Provisions, which apply to all NPDES permits in accordance with 40 C.F.R. section 122.41, and additional conditions applicable to specified categories of permits in accordance with 40 C.F.R. section 122.42, are provided in Attachment B. The Discharger must comply with applicable standard provisions and with those additional conditions that are applicable under 40 C.F.R. section 122.42.

Sections 122.41(a)(1) and (b) through (n) of 40 C.F.R. establish conditions that apply to all state-issued NPDES permits. These conditions must be incorporated

into the permits either expressly or by reference. If incorporated by reference, a specific citation to the regulations must be included in the General Permit. Section 123.25(a)(12) of 40 C.F.R. allows the state to omit or modify conditions to impose more stringent requirements. In accordance with 40 C.F.R. Section 123.25, this General Permit omits federal conditions that address enforcement authority specified in 40 C.F.R. section 122.41(j)(5) and (k)(2) because the enforcement authority under the California Water Code is more stringent. In lieu of these conditions, this General Permit incorporates by reference California Water Code section 13387(e).

2. **Discharge to Impaired Water Bodies**

Impaired water bodies are water quality limited segments listed under CWA 303(d) listings. The water bodies on these lists do not meet water quality standards, even if the discharge itself meets water quality standards. The Basin Plans state that "*Additional treatment beyond minimum federal standards will be imposed on dischargers to Water Quality Limit Segments. Dischargers will be assigned or allocated a maximum allowable load of critical pollutants so that water quality objectives can be met in the segment.*" The allocated loads are Discharger and receiving water specific. It is infeasible to assign a uniform load in a statewide general permit. Therefore, this General Permit does not authorize the discharge of active ingredients of algaecides or aquatic herbicides, their residues, and their degradation byproducts to water bodies that are already impaired due to the same product active ingredients, their residues, and their degradation byproducts.

## B. Special Provisions

1. **Reopener Provisions**

The reopener provisions allow future modification to this General Permit in accordance with 40 C.F.R. section 122.62.

a. Addition to Policy Exception List in Attachment G

This General Permit may be reopened to add a public entity or a mutual water company which may not otherwise meet the receiving water limitations for acrolein and copper and meets the requirements for an exception from meeting those limitations, consistent with section 5.3 of the Policy.

b. Addition of Aquatic Pesticide Active Ingredients

This General Permit may be reopened to add newly registered algaecide or aquatic herbicide active ingredients so that Dischargers can be covered by this General Permit when they apply the algaecide or aquatic herbicide products with the new active ingredients.

c. Acute and Chronic Toxicity

When the State Water Board revises the Policy's toxicity control provisions that would require the establishment of numeric chronic toxicity limitations or

other actions, this General Permit may be reopened to comply with those requirements.

d. Receiving Water Limitations

If monitoring data for residual pesticides show exceedance of monitoring triggers, the Discharger or Coalition shall conduct additional investigations to determine the cause of exceedance. At a minimum, the Discharger or Coalition shall evaluate its application methods, BMPs, and the appropriateness of using alternative products. As a result of the evaluation, this General Permit may be re-opened to add numeric Receiving Water Limitations for the residual pesticides exceeding the triggers.

e. Endangered Species Act

If U.S. EPA develops biological opinions regarding pesticides included in this General Permit, this General Permit may be re-opened to add or modify Receiving Water Limitations/Monitoring Triggers for residual pesticides of concern, if necessary.

2. **Special Studies, Technical Reports, and Additional Monitoring Requirements**

a. Additional Investigation

This General Permit requires Dischargers to conduct additional investigations if the monitoring results exceed the receiving water monitoring limitations. These investigations are necessary in order to address the exceedance caused by the algaecide or aquatic herbicide application and meet the General Permit's limitations and requirements including Basin Plans' narrative water quality objective of no toxics in toxic amount.

b. Qualified Biologist Certification Following Project Completion

The requirement is retained from Order No. 2004-0009-DWQ and is based on Policy section 5.3 exception.

3. **Corrective Action**

When receiving water limitations or triggers are exceeded, Dischargers are expected to assess the cause of exceedance and take appropriate actions as necessary to prevent recurrence of the problem.

## X. COMPLIANCE DETERMINATION

This General Permit specifies that compliance be based on event and post-event sampling results. The event sample results will determine if exceedance occurred outside the Treatment Area* during treatment. Post-event samples will determine if exceedance occurred in the Application or Treatment Area after treatment. Since the minimum effective concentration and time needed to effectively kill or control target weeds or algae vary due to site specific conditions, such as flow, target species, water chemistry, and type of algaecides or aquatic herbicides, this General Permit allows Dischargers to determine when treatment is completed.

## XI. PUBLIC PARTICIPATION

The State Water Board is considering the issuance of WDRs that will serve as a general NPDES permit for algaecide or aquatic herbicide applications. As a step in the WDR adoption process, the State Water Board staff has developed tentative WDRs. The State Water Board encourages public participation in the WDR adoption process.

### A. Notification of Interested Parties

The State Water Board has notified interested agencies, parties, and persons of its intent to prescribe general WDRs for algaecide or aquatic herbicide applications and has provided them with an opportunity to submit their written comments and recommendations. Notification was provided to interested parties through specific mailings and publication in major newspapers throughout California. The State Water Board, in a public meeting, heard and considered all comments pertaining to discharges to be regulated by this General Permit. Details of the Public Hearing are provided in the Fact Sheet of this General Permit.

### B. Written Comments

Interested persons were invited to submit written comments concerning this tentative WDR. Comments were due at the State Water Board offices by 12:00 noon on **August 21, 2012**. Seven comment letters were received.

### C. Public Hearing and Meeting

The State Water Board held a public hearing on the tentative WDRs during its regular Board meeting on **August 7, 2012**. The State Water Board ~~will~~ considered adoption of the WDRs at a public meeting on the following date, time, and location:

| | |
|---|---|
| Date: | **~~May~~ March ~~20~~5, ~~2014~~2013** |
| Time: | 9:00 a.m. |
| Location: | State Water Resources Control Board<br>1001 I Street<br>Sacramento, CA 95814 |

Interested persons ~~are~~ were invited to attend. At the public meeting, the State Water Board ~~will~~ heard comments, if any, limited to changes on the draft General Permit.

Please be aware that dates and venues may change. The State Water Board's website address is www.waterboards.ca.gov where you can access the ~~current~~ agenda for changes in dates and locations.

### D. Information and Copying

The tentative effluent limitations, receiving water limitations, and special provisions, comments received, and other information are on file and may be inspected at the

address above at any time between 8:30 a.m. and 4:45 p.m., Monday through Friday. Copying of documents may be arranged through the State Water Board by calling (916) 379-9152.

## E. Register of Interested Persons

Any person interested in being placed on the mailing list for information regarding this general WDR and NPDES permit should contact the State Water Board, reference the general WDR and NPDES permit, and provide a name, address, and phone number.

## F. Additional Information

Requests for additional information or questions regarding this General Permit should be directed to NPDES_Wastewater@waterboards.ca.gov.

# Attachment E – Notice of Intent

## WATER QUALITY ORDER NO. 2013-0002-DWQ GENERAL PERMIT NO. CAG990005

## STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

### I. NOTICE OF INTENT STATUS (see Instructions)

| |
|---|
| Mark only one item A. New Applicator B. Change of Information: WDID# _____<br>C. ☐ Change of ownership or responsibility: WDID# _____ |

### II. DISCHARGER INFORMATION

| | | | |
|---|---|---|---|
| A. Name | | | |
| B. Mailing Address | | | |
| C. City | D. County | E. State | F. Zip |
| G. Contact Person | H. E-mail address | I. Title | J. Phone |

### III. BILLING ADDRESS (Enter Information ***only*** if different from Section II above)

| | | | |
|---|---|---|---|
| A. Name | | | |
| B. Mailing Address | | | |
| C. City | D. County | E. State | F. Zip |
| G. E-mail address | H. Title | I. Phone | |

**IV. RECEIVING WATER INFORMATION**

A. Algaecide and aquatic herbicides are used to treat (check all that apply):

1. ☐ Canals, ditches, or other constructed conveyance facilities owned and controlled by Discharger.
   Name of the conveyance system: _____
2. ☐ Canals, ditches, or other constructed conveyance facilities owned and controlled by an entity other than the Discharger.
   Owner's name:_____
   Name of the conveyance system: _____
3. Directly to river, lake, creek, stream, bay, ocean, etc.
   Name of water body: _____

B. Regional Water Quality Control Board(s) where treatment areas are located (REGION 1, 2, 3, 4, 5, 6, 7, 8, or 9): Region _____
(List all regions where algaecide and aquatic herbicide application is proposed.)

**V. ALGAECIDE AND AQUATIC HERBICIDE APPLICATION INFORMATION**

A. Target Organisms: ____

B. Algaecide and Aquatic Herbicide Used: List Name and Active ingredients

C. Period of Application: Start Date_____ End Date_____

D. Types of Adjuvants Used:

**VI. AQUATIC PESTICIDE APPLICATION PLAN**

Has an Aquatic Pesticide Application Plan been prepared and is the applicator familiar with its contents?
☐ Yes ☐ No

If not, when will it be prepared? _____

**VII. NOTIFICATION**

Have potentially affected public and governmental agencies been notified? ☐ Yes ☐ No

**VIII. FEE**

Have you included payment of the filing fee (for first-time enrollees only) with this submittal?

☐ YES ☐ NO ☐ NA

**IX. CERTIFICATION**

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. Additionally, I certify that the provisions of the General Permit, including developing and implementing a monitoring program, will be complied with."

**A. Printed Name:** _____

**B. Signature:** _____ **Date:** _____

**C. Title:** _____

**XI. FOR STATE WATER BOARD STAFF USE ONLY**

| | | |
|---|---|---|
| **WDID:** | **Date NOI Received:** | **Date NOI Processed:** |
| **Case Handler's Initial:** | **Fee Amount Received:** **$** | **Check #:** |
| ☐ **Lyris List Notification of Posting of APAP** | **Date** _____ | **Confirmation Sent** _____ |

# INSTRUCTIONS FOR COMPLETING NOI

## WATER QUALITY ORDER NO. 2013-0002-DWQ
## GENERAL PERMIT NO. CAG990005

## STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

These instructions are intended to help you, the Discharger, to complete the Notice of Intent (NOI) form for the Statewide General NPDES permit. **Please type or print clearly when completing the NOI form**. For any field, if more space is needed, submit a supplemental letter with the NOI.

Send the completed and signed form along with the filing fee and supporting documentation to the Division of Water Quality, State Water Resources Control Board. Please also send a copy of the form and supporting documentation to the appropriate Regional Water Quality Control Board (Regional Water Board).

### ***Section I – Notice of Intent Status***

Indicate whether this request is for the first time coverage under this General Permit or a change of information for the discharge already covered under this General Permit. Dischargers that are covered under Order No. 2004-0009-DWQ before effective date of this General Permit should check the box for change of information. For a change of information or ownership, please supply the eleven-digit Waste Discharge Identification (WDID) number for the discharge.

### ***Section II – Discharger Information***

Enter the name of the Discharger.
Enter the street number and street name where correspondence should be sent (P.O. Box is acceptable).
Enter the city that applies to the mailing address given.
Enter the county that applies to the mailing address given.
Enter the state that applies to the mailing address given.
Enter the zip code that applies to the mailing address given.
Enter the name (first and last) of the contact person.
Enter the e-mail address of the contact person.
Enter the contact person's title.
Enter the daytime telephone number of the contact person

### ***Section III – Billing Address***

Enter the information **only** if it is different from Section II above.

**A.** Enter the name (first and last) of the person who will be responsible for the billing.

**B.** Enter the street number and street name where the billing should be sent (P.O. Box is acceptable).
**C.** Enter the city that applies to the billing address.
**D.** Enter the county that applies to the billing address.
**E.** Enter the state that applies to the billing address.
**F.** Enter the zip code that applies to the billing address.
**G.** Enter the e-mail address of the person responsible for billing.
**H.** Enter the title of the person responsible for billing.
**I.** Enter the daytime telephone number of the person responsible for billing.

## ***Section IV – Receiving Water Information***

Please be reminded that this General Permit does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code §2050 et. seq) or the Federal Endangered Species Act (16 U.S.C.A. §1531 et. seq). This General Permit requires compliance with effluent limitations, receiving water limitations, and other requirements to protect the beneficial uses of waters of the state. The Discharger is responsible for meeting all requirements of the applicable Endangered Species Act.

Additional information on federally-listed threatened or endangered species and federally-designated critical habitat is available from NMFS (www.nmfs.noaa.gov) for anadromous or marine species or FWS (www.fws.gov) for terrestrial or freshwater species.

**A.** Check all boxes that apply. At least one box must be checked.
1. Check this box if the treatment area is a canal, ditch, or other constructed conveyance system owned and controlled by Discharger. Print the name of the conveyance system.
2. Check this box if the treatment area is a canal, ditch, or other constructed conveyance system owned and controlled by an entity other than the Discharger. Print the owner's name and names of the conveyance system.
3. Check this box if the treatment area is not a constructed conveyance system (including application to river, lake, creek, stream, bay, or ocean) and enter the name(s) of the water body(s).

**B.** List all Regional Water Board numbers where algaecide and aquatic herbicide application is proposed. Regional Water Board boundaries are defined in section 13200 of the California Water Code. The boundaries can also be found on our website at http://www.waterboards.ca.gov/waterboards_map.shtml

| Regional Water Board Numbers | Regional Water Board Names |
|---|---|
| 1 | North Coast |
| 2 | San Francisco Bay |

| Regional Water Board Numbers | Regional Water Board Names |
|---|---|
| 3 | Central Coast |
| 4 | Los Angeles |
| 5 | Central Valley (Includes Sacramento, Fresno, Redding Offices) |
| 6 | Lahontan (South Lake Tahoe, Victorville offices) |
| 7 | Colorado River Basin |
| 8 | Santa Ana |
| 9 | San Diego |

***Section V – Algaecide and Aquatic Herbicide Application Information***

- **A.** List the appropriate target organism(s).
- **B.** List the name and active ingredients of each algaecide and aquatic herbicide to be used.
- **C.** List the start and end date of proposed aquatic algaecide and aquatic herbicide application event.
- **D.** List the name(s) and type(s) of adjuvants that will be used.

The Discharger must submit a new NOI if any information stated in this section will be changed. If the Discharger plans to use an algaecide and aquatic herbicide product not currently covered under its Notice of Applicability (NOA), and the algaecide and aquatic herbicide product may be discharged to a water of the United States as a result of algaecide and aquatic herbicide application, the Discharger must receive a revised NOA from the State Water Board's Deputy Director of the Division of Water Quality before using that product.

***Section VI – Aquatic Pesticide Application Plan***

The Coalition or Discharger must prepare and complete an Aquatic Pesticide Application Plan (APAP). The minimum contents of APAP are specified in the permit under Section VIII.C, Limitations and Discharge Requirements, of the General Permit. The Discharger must ensure that its applicator is familiar with the APAP contents before algaecide and aquatic herbicide application.

If an APAP is not complete at the time of application, enter the date by which it will be completed.

***Section VII – Notification***

Indicate if you have notified potentially affected public and governmental agencies, as required under item VIII.B of the General Permit.

***Section VIII – Fee***

The amount of Annual fee shall be based on Category 3 discharge specified in section 2200(b)(9) of title 23, California Code of Regulations. Fee information can be found at http://www.waterboards.ca.gov/resources/fees/docs/fy1112fee_schdl_npdes_prmt.pdf.

Check the YES box if you have included payment of the annual fee. Check the NO box if you have not included this payment. **NOTE:** You will be billed annually and payment is required to continue coverage.

***Section IX– Certification***

- **A.** Print the name of the appropriate official. The person who signs the NOI must meet the signatory and certification requirements stated in Attachment B Standard Provisions item V.B.
- **B.** The person whose name is printed above must sign and date the NOI.
- **C.** Enter the title of the person signing the NOI.

## Attachment F – Notice of Termination

## WATER QUALITY ORDER NO. 2013-0002-DWQ GENERAL PERMIT NO. CAG990005

## STATEWIDE GENERAL NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) PERMIT FOR RESIDUAL AQUATIC PESTICIDE DISCHARGES TO WATERS OF THE UNITED STATES FROM ALGAE AND AQUATIC WEED CONTROL APPLICATIONS

### I. WDID

| |
|---|
| WDID# _____ |

### II. DISCHARGER INFORMATION

| | | | |
|---|---|---|---|
| A. Name | | | |
| B. Mailing Address | | | |
| C. City | D. County | E. State | F. Zip |
| G. Contact Person | H. E-mail address | I. Title | J. Phone |

### III. BASIS FOR TERMINATION

| |
|---|
| |

## IV. CERTIFICATION

"I certify under penalty of law that 1) I am not required to be permitted under this General Permit No.CAG990005, and 2) this document and all attachments were prepared under my direction and supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. Additionally, I understand that the submittal of this Notice of Termination does not release an algaecide or aquatic herbicide applicator from liability for any violations of the Clean Water Act."

**A. Printed Name:** _____

**B. Signature:** _____ **Date:** _____

**C. Title:** _____

## V. FOR STATE WATER BOARD USE ONLY

☐ **Approved for Termination** ☐ **Denied and Returned to the Discharger**

**A. Printed Name:** _____

**B. Signature:** _____

**C. Date:** _____

**NOT Effective Date: / /**

## Attachment G – Exception List

## LIST OF PUBLIC AGENCIES AND MUTAL WATER COMPANIES GRANTED AN EXCEPTION PURSUANT TO STATE WATER RESOURCES CONTROL BOARD POLICY FOR IMPLEMENTATION OF TOXICS STANDARDS FOR INLAND SURFACE WATERS, ENCLOSED BAYS, AND ESTUARIES OF CALIFORNIA (POLICY)

The public entities and mutual water companies listed herein have prepared Initial Studies, Negative Declarations (ND), or Mitigated Negative Declarations (MND), and Notices of Determination for the discharge of algaecides and aquatic herbicides in accordance with the California Environmental Quality Act (CEQA (Public Resources Code § 21000 et seq.)) to comply with the exception requirements of section 5.3 of the Policy. The boards of each public entity or mutual water company, as the lead agencies under CEQA, approved the Final ND/MND and determined that the discharge of algaecides and aquatic herbicides in their respective projects would not have a significant effect on the environment. These public entities and mutual water companies have determined that the water quality or related water quality impacts identified in the environmental assessments of the ND/MND are less than significant.

In addition to submitting the CEQA documentation, these public entities and mutual water companies have also complied with the other exception requirements of section 5.3 of the Policy.

As required in section 15096 of the CEQA Guidelines, the State Water Resources Control Board (State Water Board), as a Responsible Agency under CEQA, considered the ND/MND approved by the board of each public entity or mutual water company and finds that the projects will have less than significant water quality impact if the waste discharge requirements in this General Permit are followed. Accordingly, the public entities and mutual water companies listed herein are hereby granted an exception pursuant to section 5.3 of the Policy.

1. Byron-Bethany Irrigation District
2. City of Antioch Department of Public Works
3. City of Sacramento
4. City of Poway
3.5. Contra Costa Water District
4.6. Contra Costa County Flood Control and Water Conservation District
5.7. Department of Food and Agriculture
6.8. Department of Water Resources
7. 9. Fresno Irrigation District
8. 10. Friant Water Users Authority
9. 11. Glenn-Colusa Irrigation District
12. Helix Water District

~~10.~~ 13. James Irrigation District
~~11.~~ 14. Madera Irrigation District
~~12.~~ 15. Maine Prairie Water District
~~13.~~ 16. Marin Municipal Water District
~~14.~~ 17. Merced Irrigation District
~~15.~~ 18. Metropolitan Water District of Southern California
~~16.~~ 19. Modesto Irrigation District
~~17.~~ 20. Nevada Irrigation District
~~18.~~ 21. North Marin Water District
~~19.~~ 22. Oakdale Irrigation District
~~20.~~ 23. Placer County Water Agency
~~21.~~ 24. Potter Valley Irrigation District
~~22.~~ 25. Princeton-Cordora-Glenn Irrigation District
~~23.~~ 26. Provident Irrigation District
~~24.~~ 27. Reclamation District 108
~~25.~~ 28. Reclamation District 1000
~~26.~~ 29. Reclamation District 1004
30. San Diego County Water Authority
~~27.~~ 31. Santa Cruz Water Department
32. Santa Fe Irrigation District
~~28.~~ 33. Solano Irrigation District
~~29.~~ 34. South Feather Water and Power Agency
~~30.~~ 35. South Sutter Water District
36. Sweetwater Authority
~~31.~~ 37. Tehama Colusa Canal Authority
~~32.~~ 38. Turlock Irrigation District
~~33.~~ 39. Woodbridge Irrigation District
~~34.~~ 40. Yolo County Flood Control and Water Conservation District

# Response to Comments

# Draft Amendments to the Statewide General National Pollutant Discharge Elimination System (NPDES) Permit for Residual Aquatic Pesticide Discharges to Waters of the United States from Algae and Aquatic Weed Control Applications

**State Water Resources Control Board**
**April 20, 2016**

The State Water Board received seven comment letters on the draft amendments to the Aquatic Weed Control Permit. The public notice was published on February 23, 2016 with a comment deadline of March 25, 2016 with an extension granted to Michael Blankinship to April 2, 2016 per his request. The seven commenters are noted in Table 1 below.

**Table 1 – Draft Aquatic Weed Control Permit Amendments Commenters**

| Company | Representative |
|---|---|
| Association of California Water Agencies | Rebecca Franklin |
| BioSafe Systems, LLC | Jeff Kline |
| Blankinship & Associates, Inc. | Michael Blankinship |
| California Department of Water Resources | David Duval |
| Clean Lakes Inc. | Thomas McNabb |
| General Public | Terry McNabb |
| SePRO Corporation | Sarah Miller |

All comments from commenters addressed two permit amendments: 1) the definition of "contained, non-flowing waters" related to applications of the pesticide active ingredients hydrogen peroxide, peroxyacetic acid, or sodium carbonate peroxyhydrate added to Attachment A – Definitions of the draft permit amendments and 2) the additional use restrictions for products containing hydrogen peroxide, peroxyacetic acid and/or sodium carbonate peroxyhydrate added in section IX.C.7 of the draft permit amendments. The specific text of these draft permit amendments is shown below:

**1) Attachment A – Definitions**

***Contained, Non-Flowing Waters***
*For the purposes of this permit, "contained, non-flowing waters" shall mean a water body that has no inflow or outflow immediately preceding and for a period of at least 48 hours following application of the pesticide active ingredients hydrogen peroxide, peroxyacetic acid, or sodium carbonate peroxyhydrate.*

**2) Section IX.C.7**

***Additional Restrictions for Use of Products Containing Hydrogen Peroxide, Peroxyacetic Acid, and Sodium Carbonate Peroxyhydrate***
*In addition to FIFRA label requirements, products containing the active ingredients sodium carbonate peroxyhydrate, hydrogen peroxide, and/or peroxyacetic acid must be applied with the following additional use restrictions:*

a. *Apply products containing these active ingredients only to contained, nonflowing waters;*
b. *Do not apply products containing these active ingredients during prime fish feeding times (i.e., at dawn or dusk and when flying insects are visible over water surface) to protect resident fish species;*

c. *Do not apply products containing these active ingredients when juvenile fish and amphibians are present;*
d. *Apply products containing these active ingredients from the shallow margins of the water body out to deeper waters to allow mobile aquatic life to escape the treatment area; and*
e. *Only treat one-half of the contained water body at a time to minimize impacts to the aquatic system and, do not make subsequent treatments of the untreated area in the same water body within 48 hours of the initial water body treatment.*

Comments on these additions stressed that the proposed additional use restrictions on sodium carbonate peroxyhydrate, hydrogen peroxide, and peroxyacetic acid will:

1) result in reduced efficacy of these pesticide active ingredients;
2) result in increased incidence of nuisance algae and weeds;
3) result in pesticide applicators using pesticide active ingredients that are more toxic and persistent in the environment than these pesticide active ingredients; and
4) result in limiting the use of these pesticide active ingredients to small, isolated water bodies.

Commenters also noted that the proposed additional use restrictions are unwarranted, breakdown of these pesticide active ingredients is rapid and leaves no residuals, and product label restrictions mitigate any potential impacts to fish, amphibians, and other aquatic organisms.

In addition, the California Department of Pesticide Regulation has advised that the permit cannot establish requirements that contradict or go beyond what is on the pesticide product label.

Based on the public comments and the California Department of Pesticide Regulation feedback, the proposed addition of 1) the definition of “contained, non-flowing waters” in Attachment A and 2) Section IX.C.7 have been removed from the proposed permit amendments.

Section 2

# Herbicide and Adjuvant/Dye Labels and Material Safety Data Sheets

Product File
ID# 276986

GROUP 4 HERBICIDE

# Nufarm Weedar® 64

## Broadleaf Herbicide

**THE 2,4-D AMINE WEED KILLER**

**To Control Susceptible Broadleaf Weeds In Cereal Grains, Corn, Sorghum, Rice, Sugarcane, Soybeans (Preplant only), Turf, Non-Crop Areas, And Certain Aquatic Applications**

| | |
|---|---|
| **ACTIVE INGREDIENT:** | |
| 2,4-Dichlorophenoxyacetic acid, dimethylamine salt* | 46.8% |
| **OTHER INGREDIENTS:** | 53.2% |
| **TOTAL:** | 100.0% |

*2,4-Dichlorophenoxyacetic acid equivalent 38.9% by weight or 3.8 pounds per gallon.
Isomer specific by AOAC method No. 978.05

**KEEP OUT OF REACH OF CHILDREN**

**DANGER / PELIGRO**

PRECAUCION AL USUARIO: Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

**SEE INSIDE BOOKLET FOR FIRST AID AND ADDITIONAL PRECAUTIONARY STATEMENTS**

For Chemical Spill, Leak, Fire, or Exposure, Call CHEMTREC (800) 424-9300.
For Medical Emergencies Only, Call (877) 325-1840.

EPA REG. NO.71368-1
EPA EST. NO. 228-IL-001

**Net Contents**
**2.5 Gal. (9.46 L)**

Manufactured for
Nufarm Inc.
11901 S. Austin Avenue
Alsip, IL 60803

0 94922 00084 2

Nufarm Grow a better tomorrow.

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 10/17/16 Reviewer Darling
Reg. No. 71368-1-2C

## PRECAUTIONARY STATEMENTS
## HAZARDS TO HUMANS AND DOMESTIC ANIMALS
## DANGER / PELIGRO

Corrosive. Causes irreversible eye damage. Harmful if swallowed. Avoid breathing vapors or spray mist. Do not get in eyes, on skin or on clothing.

**PERSONAL PROTECTIVE EQUIPMENT (PPE):**

Some of the materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category A on an EPA chemical-resistance category selection chart.

**All mixers, loaders, applicators, and other handlers must wear:**
- long-sleeved shirt and long pants,
- shoes and socks, plus
- chemical-resistant gloves (except for applicators using ground boom equipment),
- chemical-resistant apron when mixing or loading, cleaning up spills or equipment, or otherwise exposed to the concentrate, and
- protective eyewear.

See engineering controls for additional requirements.

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

**ENGINEERING CONTROLS STATEMENTS:**
When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d) (4-6)], the handler PPE (personal protective equipment) may be reduced or modified as specified in the WPS. Pilots must use an enclosed cockpit that meets the requirements listed in the WPS for agricultural pesticides [40 CFR 1 70.240(d)(6)].

### USER SAFETY RECOMMENDATIONS

**Users Should:**
- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. If pesticide gets on skin, wash immediately with soap and water.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

### FIRST AID

| | |
|---|---|
| **IF IN EYES** | •Hold eye open and rinse slowly and gently with water for 15 to 20 minutes.<br>•Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.<br>•Call a poison control center or doctor for treatment advice. |
| **IF SWALLOWED** | •Call a poison control center or doctor immediately for treatment advice.<br>•Have person sip a glass of water if able to swallow.<br>•Do not induce vomiting unless told to do so by the poison control center or doctor.<br>•Do not give anything by mouth to an unconscious person. |
| **IF ON SKIN OR CLOTHING** | •Take off contaminated clothing.<br>•Rinse skin immediately with plenty of water for 15 to 20 minutes.<br>•Call a poison control center or doctor for treatment advice. |

### HOT LINE NUMBER

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-877-325-1840 for emergency medical treatment information.

### NOTE TO PHYSICIANS

This product contains a phenoxy herbicidal chemical. There is no specific antidote. All treatments should be based on observed signs and symptoms of distress in the patient. Probable mucosal damage may contraindicate the use of gastric lavage. Overexposure to materials other than this product may have occurred.

## ENVIRONMENTAL HAZARDS

This pesticide is toxic to fish and aquatic invertebrates. For Terrestrial Uses: Do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas. Do not contaminate water when disposing of equipment washwater or rinsate.

This product contains a chemical with properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination. Application around a cistern or well may result in contamination of drinking water or groundwater.

For Aquatic Uses: Fish breathe dissolved oxygen in the water and decaying weeds also use oxygen. When treating continuous, dense weed masses, it may be appropriate to treat only part of the infestation at a time. For example, apply the product in lanes separated by untreated strips that can be treated after vegetation in treated lanes has disintegrated. During the growing season, weeds decompose in a 2 to 3 week period following treatment. Begin treatment along the shore and proceed outwards in bands to allow fish to move into untreated areas. Waters having limited and less dense weed infestations may not require partial treatments.

Do not contaminate water used for irrigation or domestic purposes (except as specifically listed on this label) especially in areas where grapes, cotton, tomatoes or other susceptible plants are grown.

Do not treat irrigation ditches in areas where water will be used to overhead (sprinkler) irrigate susceptible crops especially grapes, tomatoes, tobacco, and cotton.

Do not apply this product directly to, or permit to drift onto cotton, okra, grapes, tomatoes, fruit trees, vegetables, flowers or other desirable crop or ornamental plants which are susceptible to 2,4-D herbicide. Do not apply near susceptible plants since very small quantities of the 2,4-D will cause severe injury during the growing or dormant periods. Crops contacted by this product sprays or spray drift may be killed or suffer significant stand loss with extensive quality and yield reduction.

**MIXING AND LOADING:** Most cases of ground water contamination involving phenoxy herbicides such as 2,4-D have been associated with mixing/loading and disposal sites. Caution should be exercised when handling 2,4-D pesticides at such sites to prevent contamination of ground water supplies. Use of closed systems for mixing or transferring this pesticide will reduce the probability of spills. Placement of the mixing/loading equipment on an impervious pad to contain spills will help prevent ground water contamination.

## DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Read entire label before using this product.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

### AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE) and restricted-entry intervals. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 48 hours.

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water is: coveralls, chemical-resistant gloves made of any water-proof material, shoes plus socks, protective eyewear.

### NON-AGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Do not enter or allow people (or pets) to enter the treated area until sprays have dried.

## USE RESTRICTIONS

Do not apply this product through any type of irrigation system. Do not use in or near a greenhouse. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application.

## PRODUCT INFORMATION

INJURY TO CROPS FROM THIS HERBICIDE MAY OCCUR, IF YOU ARE NOT PREPARED TO ACCEPT SOME DEGREE OF CROP INJURY DO NOT USE THIS PRODUCT.

Crop varieties vary in response to 2,4-D and some are easily injured. Apply this product only to varieties known to be tolerant to 2,4-D. If you are uncertain concerning tolerant varieties or local use situations that may affect crop tolerance to 2,4-D, consult your seed company, State Agricultural Extension Service or qualified crop consultant for advice.

Be sure that use of this product conforms to all applicable laws, rules and regulations. Certain states have restrictions pertaining to application distances from susceptible crops. The applicator should become familiar with these laws, rules or regulations and follow them exactly.

## WEED RESISTANCE

Any weed population may contain plants that are naturally resistant to 2,4-D, the active ingredient in this product, and to other herbicides with the same mode of action. ATTENTION: Those resistant weed biotypes will not be controlled by this product. Consult advisors such as your local agricultural extension service for agronomic management practices to minimize the occurrence of glyphosate resistance and considerations for supplemental control measures.

**Weed Management**

To minimize the occurrence of glyphosate-resistant biotypes, observe the following general weed management practices:

- Scout application site before and after herbicide applications.
- Start with a clean application site, using either a burndown herbicide application or tillage.
- Control weeds early when they are relatively small.

- Add other herbicides (e.g. a selective and/or a residual herbicide) and cultural practices (e.g. tillage or crop rotation) where appropriate.
- Utilize the specified label rate for the most difficult to control weed in your field. Avoid tank mixtures with other herbicides that reduce this product's efficacy (through antagonism), or tank mixture directions that encourage application rates of this product below the label directions.
- Control weed escapes and prevent weeds from setting seeds.
- Clean equipment before moving from field to field to minimize the spread of weed seed or plant parts.
- Report any incidence of repeated non-performance of this product on a particular weed to your Nufarm representative, local retailer, or county extension agent.

**Management of Glyphosate-Resistant Biotypes**
Since the occurrence of new glyphosate-resistant weeds cannot be determined until after product use and scientific confirmation, manufacturer is not responsible for any losses that may result from the failure of this product to control glyphosate-resistant weed biotypes.

The following good agronomic practices are recommended to reduce the spread of confirmed glyphosate-resistant biotypes:
- If a naturally occurring resistant biotype is present in your application site, this product should be tank-mixed or applied sequentially with an appropriately labeled herbicide with a different mode of action to achieve control.
- Cultural and mechanical control practices (e.g. crop rotation or tillage) may also be used as appropriate.
- Scout treated application site after herbicide applications and control escaping weeds including resistant biotypes before they set seed.
- Thoroughly clean equipment before leaving fields known to contain resistant biotypes.

## MIXING INSTRUCTIONS

Add about one-half the water to the mixing tank, then add this product with agitation and finally the rest of water with continuing agitation.

**NOTE:** Adding oil, wetting agent, or other surfactants to the spray may increase effectiveness on weeds but also may reduce selectivity to crops, resulting in crop damage.

## COMPATIBILITY

If this product is to be tank mixed with fertilizers or with other pesticides, compatibility should be tested prior to mixing. To test for compatibility, use a small container and mix a small amount (0.5 to 1 quart) of spray, combining all ingredients in the same ratio as the anticipated use. If any indications of physical incompatibility develop, do not use this mixture for spraying. Indications of incompatibility usually will appear within 5 to 15 minutes after mixing.

Read and follow all directions and precautions on this label and on the labels of any products for which a tank mixture is being considered.

## APPLICATION PROCEDURES

Apply by air or ground equipment in sufficient gallonage to obtain adequate coverage, except as otherwise directed on this label. Use 2 or more gallons of water per acre for aerial application and 10 or more gallons of water per acre for ground application.

## SPRAY DRIFT MANAGEMENT

A variety of factors including weather conditions (e.g., wind direction, wind speed, temperature, relative humidity) and method of application (e.g., ground, aerial, airblast) can influence pesticide drift. The applicator must evaluate all factors and make appropriate adjustments when applying this product.

**Droplet Size**
When applying sprays that contain 2,4-D as the sole active ingredient, or when applying sprays that contain 2,4-D mixed with active ingredients that require a Coarse or coarser spray, apply only as a Coarse or coarser spray (ASAE standard 572) or a volume mean diameter of 385 microns or greater for spinning atomizer nozzles.

When applying sprays that contain 2,4-D mixed with other active ingredients that require a Medium or more fine spray, apply only as a Medium or coarser spray (ASAE standard 572) or a volume mean diameter of 300 microns or greater for spinning atomizer nozzles.

**Wind Speed**
Do not apply at wind speeds greater than 15 mph. Only apply this product if the wind direction favors on-target deposition and there are not sensitive areas (including, but not limited to, residential areas, bodies of water, known habitat for nontarget species, nontarget crops) within 250 feet downwind. If applying a Medium spray, leave one swath unsprayed at the downwind edge of the treated field.

**Temperature Inversions**
If applying at wind speeds less than 3 mph, the applicator must determine if: a) conditions of temperature inversion exist, or b) stable atmospheric conditions exist at or below nozzle height. Do not make applications into areas of temperature inversions or stable atmospheric conditions.

**Susceptible Plants**
Do not apply under circumstances where spray drift may occur to food, forage, or other plantings that might be damaged or crops thereof rendered unfit for sale, use or consumption. Susceptible crops include, but are not limited to, cotton, okra, flowers, grapes (in growing stage), fruit trees (foliage), soybeans (vegetative stage), ornamentals, sunflowers, tomatoes, beans, and other vegetables, or tobacco. Small amounts of spray drift that might not be visible may injure susceptible broadleaf plants.

**Other State and Local Requirements**
Applicators must follow all state and local pesticide drift requirements regarding application of 2,4-D herbicides. Where states have more stringent regulations, they must be observed.

**Equipment**
All aerial and ground application equipment must be properly maintained and calibrated using appropriate carriers or surrogates.

*Additional requirements for aerial applications:*
The boom length must not exceed 75% of the wingspan or 90% of the rotor blade diameter.

Release spray at the lowest height consistent with efficacy and flight safety. Do not release spray at a height greater than 10 feet above the crop canopy unless a greater height is required for aircraft safety. This requirement does not apply to forestry or rights-of-way applications.

When applications are made with a crosswind, the swath will be displaced downwind. The applicator must compensate for this by adjusting the path of the aircraft upwind.

*Additional requirements for ground boom application:*
Do not apply with a nozzle height greater than 4 feet above the crop canopy.

## SMALL QUANTITY DILUTION TABLE

To spray small areas use the following dilution table.

| If Dosage on Label Shows Following Rate Per Acre | Use this Amount for each Gallon of Water Per 1,000 Square Feet |
|---|---|
| 2 pints (1 quart) | 0.72 ounces (4.3 teaspoons) |
| 3 pints (1-1/2 quarts) | 1.1 ounces (2 tablespoons) |
| 4 pints (2 quarts) | 1.4 ounces (2.8 tablespoons) |
| 6 pints (3 quarts) | 2.2 ounces (4.4 tablespoons) |

## GENERAL WEED LIST

**Annual and Biennial Weeds**

| | | |
|---|---|---|
| Beggarticks* | Mallow* (venice or little) | Russian thistle* |
| Bullthistle | Marshelder | Salsify (western or common) |
| Coffeeweed | Morningglory (common, ivy, woolly) | Smartweeds* (annual species) |
| Common cocklebur | Musk thistle* (***) | Sowthistle (annual or spiny) |
| Common burdock | Mustards (except blue mustard) | Sunflower |
| Common evening primrose | Pepper weeds (except perennial) | Vervains* |
| Common lambsquarters | Pigweeds** (Amaranthus spp.) | Vetches |
| Hairy galinsoga | Prickly lettuce | Wild carrot |
| Jimsonweed | Ragweed (common or giant) | Wild lettuce |
| Knotweed* | Rough fleabane | Wild parsnips |

## GENERAL WEED LIST

**Perennial Weeds**

| | | |
|---|---|---|
| Bindweed* (hedge, field, European) | Blue lettuce | Goldenrod* |
| Canada thistle* | | Healall |
| Catnip | | Ground Ivy* |
| Chicory | | Hoary cress* |
| Dandelion | | Ironweed* |
| Docks* | | Jerusalem artichoke |
| Dogbane* | | Many flowered aster |
| | | Nettles* (including stinging) |
| | | Orange hawkweed* |
| | | Plantains |
| | | Sowthistle (perennial) |
| | | Vervains* |
| | | Wild garlic* |
| | | Wild onion* |

*These species may require repeated applications and/or use of the higher rate recommended on this product label even under ideal conditions for application.
**Control of pigweeds in the High Plains area of Texas and Oklahoma may not be satisfactory with this product.
***Not registered for control of musk thistle in California.

## SPECIFIC USE DIRECTIONS

## APPLES, PEARS, STONE FRUIT AND NUT ORCHARDS (EXCEPT FILBERTS)

| WEEDS IN CROPS | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Annual broadleaf weeds** | 3 pints | For control of weeds on the orchard floor, apply using coarse sprays and low pressure in sufficient volume of water to obtain thorough wetting of weeds. Treat when weeds are small and actively growing. |

**RESTRICTIONS AND LIMITATIONS FOR USE IN APPLES, PEARS, STONE FRUIT AND NUT ORCHARDS (EXCEPT FILBERTS)**

- Do not apply to bare ground as injury may result.
- Do not apply immediately before irrigation and withhold irrigation for 2 days before and for 3 days after treatment.
- Do not allow spray to drift onto or contact foliage, fruit, stems, trunks of trees or exposed roots as injury may result.
- Do not apply to newly established or young orchards. Trees must be at least 1 year old and in vigorous condition.
- Do not apply during bloom.
- Do not graze or feed cover crops from treated orchards.
- Do not make more than 2 applications per crop cycle. Maximum of 4.2 pints (2.0 lbs. ae) per acre per application.
- **(PHI)** Do not harvest apples and pears within 14 days of application, stone fruit within 40 days of application and nuts within 60 days of application.
- For apples, pears and stone fruits, allow at least 75 days between applications.
- For tree nuts, allow at least 30 days between applications.
- Do not cut orchard floor forage for hay within 7 days of application.

## FILBERTS

| WEEDS IN CROPS | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Annual broadleaf weeds** | 2.1 pints | Apply a maximum of 2.1 pints (1.0 lb. ae) in 10 to 100 gallons of spray solution per acre. |

**RESTRICTIONS AND LIMITATIONS FOR USE IN FILBERTS**

- Do not apply to bare ground as injury may result.
- Do not use on light sandy soil.
- Do not apply immediately before irrigation and withhold irrigation for 2 days before and for 3 days after treatment.
- Do not allow spray to drift onto or contact foliage, fruit, stems, trunks of trees or exposed roots as injury may result.
- Do not apply to newly established or young orchards. Trees must be at least 1 year old and in vigorous condition.
- Do not apply during bloom.
- Do not graze or feed cover crops from treated orchards.
- Do not make more than 4 applications per crop cycle. Maximum of 2.1 pints (1.0 lbs. ae) per acre per application.
- **(PHI)** Do not harvest filberts with 45 days of application.
- Allow at least 30 days between applications.
- Do not cut orchard floor forage for hay within 7 days of application.

## CEREAL GRAINS

## (Wheat, Barley, Millet, Oats, Rye and Triticale)

| WEEDS IN CROP | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Not underseeded with legumes**<br>**Postemergence**<br>Annual and biennial broadleaf weeds<br>Perennial broadleaf weeds | <br><br>1/2 to 2 pints*<br>1 to 2 pints* | Apply after grain is well tillered (usually about 4 to 8 inches high). **Do not spray grain in the boot to dough stage.** |
| **Underseeded with legumes** | 1/4 to 1/2 pint* | Apply after grain is 8 inches tall. **Do not spray grain in boot to dough stage.** Do not spray alfalfa or sweet clover unless the infestation is severe and injury to these legumes can be tolerated. |
| **Emergency weed control in Triticale, Wheat**<br>Perennial broadleaf weeds | 2.6 pints | Apply when weeds are approaching bud stage, after the grain dough stage. **Do not spray during the boot to dough stage.** The 2.6 pints per acre application can produce injury to wheat. Balance the severity of your weed problem against the possibility of crop damage. Where perennial weeds are scattered, spot treatment is suggested to minimize the extent of crop injury. |

*Use the lower rate if small annual and biennial weeds are the major problem. Use the higher rate if perennial weeds or annual and biennial weeds are present which are in the hard-to-kill categories as determined by local experience. The higher rates increase the risk of grain injury and should be used only where the weed control problem justifies the grain damage risk. Do not apply this product to grain in the seedling stage.

**RESTRICTIONS AND LIMITATIONS FOR USE ON CEREAL GRAINS**

- For aerial application on grain, apply this product in 3 to 10 gallons of water per acre.
- For ground application a minimum of 10 to 15 gallons of water per acre is recommended for proper spray coverage.
- Do not permit dairy animals or meat animals being finished for slaughter to forage treated grain fields within 2 weeks after treatment.
- Do not feed treated straw to livestock if an emergency treatment as described above is applied.
- **(PHI)** Do not harvest within 14 days of application.
- Limit to one postemergence application per crop cycle.
- Limit to one preharvest application per crop cycle.
- **Postemergence:** Maximum of 2.6 pints (1.25 lbs. ae) per acre per application.
- **Preharvest:** Maximum of 1 pint (0.5 lb. ae) per acre per application.
- Limit to 3.6 pints product (1.75 lbs. ae) per acre per crop cycle.

## CORN AND SORGHUM

| WEEDS IN CROP | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **CORN (Field corn, popcorn and sweet corn)**<br>**Preplant** | 1 to 2 pints | To control emerged broadleaf weed seedlings or existing cover crops prior to planting corn, apply 7 to 14 days before planting. Do not use on light, sandy soil, or where soil moisture is inadequate for normal weed growth. Use high rate for less susceptible weeds or cover crops such as alfalfa. |
| **Preemergence** | 2 pints | Apply 3 to 5 days after planting but before corn emerges. Do not use on light, sandy soils or where soil moisture is low. |
| **Postemergence**<br>Annual broadleaf weeds<br>Perennial broadleaf weeds | 1/2 to 1 pint<br>1 pint | Apply when weeds are small and corn is less than 8 inches tall (to top of canopy). When corn is over 8 inches tall, use drop nozzles and keep spray off foliage. Treat perennial weeds when they are in the bud to bloom stage. **Do not spray corn in the tassel to dough stage.** Corn treated with 2,4-D may become temporarily brittle. Winds or cultivation may cause stalk breakage during the period of time when the corn is brittle. |
| **Grain Sorghum (Milo)**<br>Postemergence | 1 pint | Apply when sorghum is 6 to 15 inches tall. If sorghum is taller than 8 inches to top of the canopy, use drop nozzles and keep spray off the foliage. **Do not treat during the boot, flowering or dough stage.** |

**CORN (FIELD CORN, POPCORN AND SWEET CORN) AND SORGHUM RESTRICTIONS**

**Field Corn and Popcorn Restrictions**

- **(PHI)** Do not harvest within 7 days of application.
- **(PGI)** Do not use treated crop as fodder for 7 days following application.
- Limited to one Preplant, one Postemergence and one Preharvest application per crop cycle.
  - **Preplant or Preemergence:** Maximum of 2 pints (1.0 lb. ae) per acre.
  - **Postemergence:** Maximum of 1 pint (0.5 lb. ae) per acre.
  - **Preharvest:** Maximum of 3 pints (1.5 lbs. ae) per acre.
  - Maximum of 6 pints (3.0 lbs. ae) per acre per crop cycle.

**Sweet Corn Restrictions**

- **(PHI)** Do not harvest within 45 days of application.
- **(PGI)** Do not use treated crop as fodder for 7 days following application.
- Limited to one Preplant and one Postemergence application per crop cycle.
  - **Preplant or Preemergence:** Maximum of 2 pints (1.0 lb. ae) per acre.
  - **Postemergence:** Maximum of 1 pint (0.5 lb. ae) per acre.
  - Maximum of 3 pints (1.5 lbs. ae) per acre per crop cycle.
  - Minimum of 21 days between applications.

**Sorghum Restrictions**

- **(PHI)** Do not harvest within 30 days of application.
- Limited to one Postemergence application per crop cycle.
- **(PGI)** Do not permit meat or dairy animals to consume treated crop as fodder or forage for 30 days following application.
  - **Postemergence:** Maximum of 2 pints (1.0 lb. ae) per acre per crop cycle.

## HOPS (DO NOT USE IN CALIFORNIA.)

| WEEDS IN CROPS | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Annual broadleaf weeds** | 1 pint | Make directed applications to the row middles. Make up to 3 applications at 30-day intervals with the last application before harvest. |

**RESTRICTIONS AND LIMITATIONS FOR HOPS**

- Limited to 3 applications per crop cycle.
- Maximum of 1 pint (0.5 lb. ae) per acre per application.
- Maximum of 3 pints (1.5 lbs. ae) per acre per crop cycle.
- Minimum of 30 days between applications.
- **(PHI)** Do not harvest within 28 days of application.

## RICE (DO NOT USE IN CALIFORNIA.)

| WEEDS IN CROP | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Preplant** | 1 to 2 pints | Apply four or more weeks prior to planting rice. |
| **Postemergence** | 1 to 2-1/2 pints | Apply when rice is in the late tillering stage of development at the time of first joint development. Do not apply after panicle initiation, after rice internodes exceed one-half inch, at early seedling, early panicle, boot or heading stages. Consult local university or Agricultural Extension Service specialists for more specific information on rates and timing of application. |

**RESTRICTIONS AND LIMITATIONS FOR USE IN RICE**

- Do not apply more than a total of 2-1/2 pints per acre of this product to rice per growing season.
- Do not use on rice in California without an approved Supplemental Label allowing the use.
- **(PHI)** Do not harvest within 60 days of application.
- **Preplant:** Limited to 1 preplant application per crop cycle. Maximum of 2 pints (1.0 lb. ae) per acre per preplant application.
- **Postemergence:** Limited to 1 postemergence application per crop cycle. Maximum of 3 pints (1.5 lbs. ae) per acre per postemergence application.

## WILD RICE (For Use In Minnesota Only)

| WEEDS IN CROP | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Common water plantain** | 1/2 pint | Broadcast in 4 to 10 gallons total spray volume. Apply after water plantain has emerged from the water and when wild rice is in the 1 to 2 aerial leaf to early tillering stage. Do not spray after wild rice has reached the boot stage. |

**RESTRICTIONS AND LIMITATIONS FOR USE IN WILD RICE**

- For use only on wild rice grown in commercial paddies.
- Do not apply to wild rice growing in lakes, rivers or streams.
- Water that is drained out of wild rice paddies is not to be used to irrigate other crops. In order to protect federally listed endangered or threatened species, the Minnesota Department of Agriculture has a program to pre-notify landowners where pesticide applications may affect federally listed endangered or threatened species.
- Limited to 1 application per crop cycle.
- Do not apply more than 1/2 pint per acre of 2,4-D Amine 4 (0.25 lb. ae/A) per use season.
- **(PHI)** Do not harvest within 60 days of application.

## RED POTATOES*
## (Only for Use on Red Potatoes Intended for Fresh Market)

| APPLICATION TIMING | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| Postemergence | 2.35 fl. oz. | Red Potatoes: Properly timed applications of this product generally enhance red color, aid in storage retention of red color, improve skin appearance, increase tuber set, and improve tuber size uniformity (fewer jumbos). Crop response may vary depending on variety, stress factors, and local conditions. Varieties with naturally dark red color generally benefit less from treatment. |

**PRECAUTIONS FOR USE ON RED POTATOES**

- Make first application when potatoes are in the pre-bud stage (about 7 to 10 inches high) and make a second application about 10 to 14 days later.
- Consult with Agricultural Extension Service and other qualified crop advisors for local recommendations.

**RESTRICTIONS FOR USE ON RED POTATOES**

- The preharvest interval (PHI) is 45 days.
- Minimum of 10 days between applications.
- Postemergence
  - Limited to two postemergence application per crop cycle.
  - Maximum of 2.35 fluid ounces (0.07 lb 2,4-D ae) per acre per application.
- Apply 2.35 fluid ounces of this product per acre in 5 to 25 gallons of water using ground or aerial equipment. The specific spray volume selected should be sufficient for good coverage of plants.

***Not currently registered in California.**

## SOYBEANS* (Preplant Only)

| WEEDS IN CROP | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| Postemergence | 3/4 to 1 pint | Apply not less than 15 days prior to planting soybeans, when weeds are small and actively growing. Use the higher rate on larger weeds and when perennials are present. |
| | >1 to 2 pints | Apply not less than 30 days prior to planting soybeans, when weeds are actively growing. |
| In addition to those weeds found on the GENERAL WEED LIST, this product will suppress or control the following broadleaf weeds frequently encountered in reduced tillage soybean production systems: alfalfa*, bullnettle, smallflowered bittercress, Carolina geranium, smallflowered buttercup, common and rough cinquefoil, red clover*, horseweed or marestail, mousetail, wild mustard, field pennycress, cutleaf evening primrose, common purslane, speedwell, velvetleaf, and Virginia copperleaf. * These weeds are only partially controlled. | | |
| Apply no more than 2.0 pints of this product in one season prior to planting soybeans. After applying, plant soybean seed as deep as practical or at least 1-1/2 to 2 inches deep. Adjust the planter press wheel, if necessary, to ensure that planted seed is completely covered. | | |
| If desired, this product may be applied pre-plant to soybeans in tank mixtures with other herbicides such as Poast®, Poast Plus®, Roundup®, Roundup D-Pak®, Honcho®, Gramoxone Extra®, Prowl®, Pursuit Plus®, Scepter®, Scepter 70 DG, Squadron® and others that are registered for pre-plant soybean use. | | |
| **NOTE:** Unacceptable injury to soybeans planted in fields previously treated with this product may occur and the extent of injury will depend on weather and agronomic factors such as the amount of weed vegetation and previous crop residue present that may be in effect between the time of application and the emergence of the soybean plant. | | |

**RESTRICTIONS AND LIMITATIONS FOR USE IN SOYBEANS (PREPLANT)**

- Do not apply this product when weather conditions such as temperature, air inversions, or wind favor drift from treated areas to susceptible plants.
- Apply no more than 2.0 pints (1.0 lb. ae) of this product per acre in one season prior to planting soybeans.
- Only one application per growing season, regardless of the application rate used, is allowed.
- Do not apply this product prior to planting soybeans if you are not prepared to accept the results of soybean injury including possible loss of stand and yield.
- Do not replant fields treated with this product in the same growing season with crops other than those labeled for 2,4-D pre-plant use.
- Do not mow or cultivate weeds prior to treating with this product as poor control may result.
- Do not apply this product pre-plant to soybeans in fields having a coarse-textured soil where the percent organic matter is <1.0%.
- Only one application of this product may be made prior to planting soybeans per growing season.

***Not currently registered for use in California.**

## SUGARCANE (DO NOT USE IN CALIFORNIA.)

| WEEDS IN CROP | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Preemergence** | 4 pints | Apply before canes appear for control of emerged broadleaf weeds. |
| **Postemergence** | 1-1/2 to 4 pints | Apply after cane emerges and through lay-by. |

**RESTRICTIONS AND LIMITATIONS FOR USE IN SUGARCANE**

- Do not apply more than a total of 8 pints (4.0 lb. ae) of this product to sugarcane per acre per growing season.
- Do not harvest cane prior to crop maturity.
- **Preemergence:** Limited to 1 application per crop cycle. Maximum of 4 pints (2.0 lb. ae) per acre per application.
- **Postemergence:** Limited to 1 application per crop cycle. Maximum of 4 pints (2.0 lb. ae) per acre per application.

## CONSERVATION RESERVE PROGRAM AREAS

| WEEDS | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Annual broadleaf weeds**<br>In young grasses<br><br>In established grasses | <br>1/2 to 1 pint<br><br>1/2 to 2 pints | Apply to actively growing annual broadleaf weeds. Use 1/2 to 1 pint when weeds are small; use higher rates on older weeds. Do not apply to young grasses with fewer than 6 leaves or prior to tillering, as excessive injury may result. Do not apply more than 1 pint until grasses are well established as excessive injury may result. |
| **Biennial and perennial broadleaf weeds**<br>In established grasses | 2 to 4 pints | Treat when biennial weeds are in the seedling to rosette stage and before flower stalks become apparent. Treat perennial weeds in the bud to bloom stage. Apply to actively growing weeds. |

**RESTRICTIONS AND LIMITATIONS FOR USE ON CONSERVATION RESERVE PROGRAM AREAS**

- Use at least 2 gallons of water per acre by air and 5 gallons of water per acre by ground.
- Do not apply to grasses in the boot to dough stage if grass seed production is desired.
- Do not cut forage for hay within 7 days of application.
- **Postemergence:**
  - For susceptible annual and biennial broadleaf weeds, do not exceed 2 pints (1.0 lb. ae) per acre per application.
  - For moderately susceptible biennial and perennial broadleaf weeds and for difficult to control weeds and woody plants, do not exceed 4 pints (2.0 lbs. ae) per acre per application.
  - Spot treatments do not exceed 4 pints (2.0 lbs. ae) per acre.
  - Maximum of 2 applications per year.
  - Maximum of 8 pints (4.0 lbs. ae) per acre per year.
  - Minimum of 30 days between applications.
- If grass is to be cut for hay, Agricultural Use Requirements for the Worker Protection Standard are applicable.
- For program lands, such as Conservation Reserve Program, consult program rules to determine whether grass or hay may be used. The more restrictive requirements of the program rules or this label must be followed.

## ESTABLISHED GRASS PASTURES, RANGELAND AND GRASS CUT FOR HAY

| WEEDS | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Annual broadleaf weeds** | 2 pints | Apply when weeds are small and actively growing and prior to bud stage. Spray while musk thistles or other biennial species are in the seedling to rosette stage and before flower stalks become apparent. |
| **Biennial and perennial broadleaf weeds** | 2 to 4 pints | The lower rate can be used in the spring during rosette stage. Use the highest rate in the fall or after flower stalks have developed. Do not apply to newly seeded areas until grass is well established. Do not apply to grass in the early boot through milk stage if grass seed production is desired. Bentgrass and legumes may be injured by this treatment. |

**RESTRICTIONS AND LIMITATIONS FOR USE ON ESTABLISHED GRASS PASTURES, RANGELAND AND GRASS CUT FOR HAY**

- Do not cut forage for hay within 7 days of application.
- **Postemergence:**
  - For susceptible annual and biennial broadleaf weeds, do not exceed 2 pints (1.0 lb. ae) per acre per application.
  - For moderately susceptible biennial and perennial broadleaf weeds and for difficult to control weeds and woody plants, do not exceed 4 pints (2.0 lbs. ae) per acre per application.
  - Spot treatments do not exceed 4 pints (2.0 lbs. ae) per acre.
  - Maximum of 2 applications per year.

- Maximum of 8 pints (4.0 lbs. ae) per acre per year.
- Minimum of 30 days between applications.

• If grass is to be cut for hay, Agricultural Use Requirements for the Worker Protection Standard are applicable.

## FALLOWLAND AND CROP STUBBLE
### Idle Land, or Postharvest to Crops, or Between Crops

| WEEDS | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| Annual broadleaf weeds | 1 to 2 pints | Use the lower rate when weeds are small (2 to 3 inches tall) and actively growing. Use the higher rate on older and drought-stressed plants. |
| Biennial broadleaf weeds | 2 to 4 pints | Spray when musk thistles or other biennial species are in the seedling to rosette stage and before flower stalks become apparent. The lower rate can be used in the spring during rosette stage. Use the highest rate in the fall or after flower stalks have developed. |
| Perennial broadleaf weeds | 2 to 4 pints | Spray weed in the bud to bloom stage or while in good vegetative growth. Do not disturb treated areas for at least 2 weeks after treatment, or until tops are dead. |
| Wild garlic and onion in crop stubble | 4 pints | Apply to new regrowth of wild garlic or onion which occurs in the fall following harvest of small grains, corn or grain sorghum. |

**RESTRICTIONS AND LIMITATIONS FOR USE IN FALLOWLAND AND CROP STUBBLE**
- Limit to two applications per year.
- Maximum single rate application of 4 pints (2.0 lbs. ae) per acre.
- Maximum of 8 pints (4.0 lbs. ae) per acre per year.
- Plant only labeled crops within 29 days following application.
- Minimum of 30 days between applications.

## GRASSES FOR SEED PRODUCTION

| WEEDS IN CROP | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Annual and perennial broadleaf weeds** | 2 to 4 pints | Apply to established stands in spring from tiller to early boot stage. **Do not spray in boot stage.** New spring seedings may be treated with the lower rate after grass seedlings have at least 5 leaves. Perennial weed regrowth may be treated in the fall. |

**RESTRICTIONS AND LIMITATIONS FOR USE ON GRASSES FOR SEED PRODUCTION**
- Do not graze dairy animals or cut forage for hay within 7 days of application.
- Maximum of 4 pints (2.0 lbs. ae) per acre per application.
- Limited to 2 applications per year.
- Minimum of 21 days between applications.

## NON-CROPLAND
**(Fencerows, Hedgerows, Roadsides, Ditches, Right-of-Way, Utility Power Lines, Railroads and Industrial Sites)**

| WEEDS | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| **Annual broadleaf weeds** | 2 to 4 pints | Treat when weeds are young and actively growing. Perennial weeds should be near the bud stage, but not flowering at application. Do not use on susceptible southern grasses such as St. Augustine. Do not apply to newly seeded areas until grass is well established. Bentgrass, clover, legumes and dichondra may be injured by this treatment. |
| **Biennial and perennial broadleaf weeds** | 4 pints | |

**RESTRICTIONS AND LIMITATIONS FOR USE ON NON-CROPLAND**
- Applications to non-cropland areas are not applicable to treatment of commercial timber or other plants being grown for sale or other commercial use, or for commercial seed production, or for research purposes.
- **Postemergence (annual and perennial weeds):**
  - Limit 2 applications per year.
  - Maximum of 4 pints (2.0 lbs. ae) per acre per application.
  - Minimum 30 days between applications.
- **Postemergence (woody plants):**
- Limit 1 application per year.
- Maximum of 8 pints (4.0 lbs. ae) per acre per application.

## SPOT TREATMENT IN NON-CROP AREAS

Mix 2 to 3 fluid ounces of this product in 3 gallons of water. Wet all weeds and stems thoroughly. For best results, treat when weeds are actively growing.

## ORNAMENTAL TURF AREAS

**Golf Courses, Cemeteries, Parks, Turfgrass, and Other Grass Areas**

| WEEDS | AMOUNT OF WEEDAR® 64 PER ACRE | DIRECTIONS |
|---|---|---|
| Annual broadleaf weeds | 2 to 3 pints | Treat when weeds are young and actively growing. Perennial weeds should be near the bud stage, but not flowering at application. Do not use on susceptible southern grasses such as St. Augustine. Do not apply to newly seeded area until grass is well established. Bentgrass, clover, legumes and dichondra may be injured by this treatment. |
| Biennial and perennial broadleaf weeds | 3 pints | |

**RESTRICTIONS AND LIMITATIONS FOR USE ON ORNAMENTAL TURF AREAS**

- Use sufficient gallonage for thorough and uniform coverage.
- Do not apply more than 2 broadcast applications per year per treatment site. This does not exclude spot treatments.
- Maximum of 3 pints (1.5 lbs. ae) per acre per application.
- Maximum of 6 pints (3.0 lbs. ae) per acre per year, excluding spot treatments.

## POPLAR/COTTONWOOD TREES GROWN FOR PULP BROADLEAF WEED CONTROL

This product may be applied through wick applicators or conventional ground sprayers. (Excluding irrigation systems) Do not allow this product to contact leaves or green bark of the tree. Use 1/2 pint to 3 pints per acre in enough water to provide uniform coverage prior to or after planting of Poplar/Cottonwood trees. Application during warm weather is preferred. Apply when weeds are actively growing, preferably before bud stage. Repeat treatment may be necessary for less susceptible weeds; re-apply as needed. Accord® may be mixed with this product to increase weed control. Follow both labels to determine correct rates. Two quarts or more of a spreader - activator per 100 gallons of spray solution may be added to improve herbicide performance.

**RESTRICTIONS AND LIMITATIONS FOR USE ON POPLAR/COTTONWOOD TREES GROWN FOR PULP BROADLEAF WEED CONTROL**

- Limited to 1 broadcast application per year. Maximum of 6 pints (4.0 lbs. ae) per acre per broadcast application.

## BIOENERGY CROPS - TREES

## WEED CONTROL IN HYBRID POPLAR TREES, COTTONWOOD TREES AND WILLOW TREES GROWN AS BIOENERGY CROPS

**USE INSTRUCTIONS**

This product may be used in hybrid poplar trees, cottonwood trees and willow trees grown as bioenergy crops. Application during warm weather is preferred. Apply when weeds are actively growing, preferably before bud stage. Repeat treatment may be necessary for less susceptible weeds; re-apply as needed.

For hybrid poplar, cottonwood and willow make application prior to or after planting. For ground spray equipment, use 1/2 to 3 pints per acre. Apply 1 to 4 pints per acre using wick type applicators that treat weeds directly. Crop injury may result if the wick, wick solution or spray solution contact leaves or green bark of the crop trees.

**NOTE: Extreme care should be exercised to avoid contact of the spray solution, spray, drift, or mist with tree foliage, green bark of trucks, stems or exposed roots of the poplar, cottonwood and will trees. Contact of the spray solution to these parts can result in serious damage. Even when using extreme care in application of this product, injury to crops from this herbicide may occur. If you are not prepared to accept some degree of crop injury, do not use this product.**

**TANK MIXTURES**
This product may be tank mixed with Credit 41 Herbicide (EPA Reg. No. 71368-20) to provide broader spectrum of control.

**RESTRICTIONS AND LIMITATIONS**
- Limited to 1 broadcast applications per year.
- Maximum of 4 pints (2.0 lb. ae) per acre per application.
- Minimum of 30 days between applications.
- Use sufficient spray volume for thorough and uniform coverage, but a minimum of 10 gallons per acre for broadcast application.
- Do not apply this product by air for use of weed control in hybrid poplar tree, cottonwood trees and willow tress grown as bioenergy crops.
- Do not use this product in or near greenhouses, for use of weed control in hybrid poplar tree, cottonwood trees and willow tress grown as bioenergy crops.
- Do not spray immediately before irrigation and withhold above-ground irrigation for 3 days after application.
- Treated plantings not to be consumed by human or animal.

## FORESTRY - TREE INJECTION

**For Controlling Species Such as Alder, Aspen, Birch, Blackgum, Cherry, Oak, Sweetgum, and Tulip Poplar**

Make injections as near to the root collar as possible, using one injection per inch of trunk dbh (4-1/2 feet). For resistant species such as hickory, injections should overlap. For best results, injections should be made during the growing season, May 15th through October 15th.

**For Dilute Injection**
Mix 1 gallon of product in 19 gallons of water for dilute injections.

**For Concentrate Injections**
Use 1 to 2 ml of concentrate WEEDAR® 64 per injection. The injection bit must penetrate the inner bark.

**RESTRICTIONS AND LIMITATIONS FOR USE ON FORESTRY - TREE INJECTION**
- Limited to 1 injection application per year. Maximum of 2 ml of 4.0 lbs. ae formulation per injection site.

## WEEDS AND BRUSH ON IRRIGATION CANAL DITCHBANKS

**(Seventeen Western States: Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, Nevada, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming)**

**For Control of Annual and Perennial Broadleaf Weeds**
Apply 1 to 2 quarts of this product per acre in approximately 20 to 100 gallons per acre. Treat when weeds are young and actively growing before the bud or early bloom stage. For harder-to-control weeds, a repeat spray after 30 days using the same rates may be needed for maximum results. Apply no more than two treatments per season.

**For Woody Brush and Patches of Perennial Broadleaf Weeds**
Mix 1/2 gallon of product in 150 gallons of water. Wet foliage thoroughly using about 1 gallon of solution per square rod.

**Spraying Instructions**
Apply with low pressure (10 to 40 psi) power spray equipment mounted on a truck, tractor, or boat. Apply while traveling upstream to avoid accidental concentration of chemical into water. Spray when the air is fairly calm, 5 mph or less. Do not use on small canals (less than 10 cfs) where water will be used for drinking purposes.

Boom spraying onto water surface must be held to a minimum and no cross-stream spraying to opposite banks should be permitted. When spraying shoreline weeds, allow no more than 2 foot overspray onto water with an average of less than 1 foot overspray to prevent introduction of greater than negligible amounts of chemical into the water.

**RESTRICTIONS AND LIMITATIONS FOR USE ON IRRIGATION CANAL DITCHBANKS**
- Do not allow dairy animals to graze on treated areas for at least 7 days after spraying.
- Water within treated banks should not be fished.
- **Postemergence:** Limited to 2 applications per season. Maximum of 4 pints (2.0 lbs. ae) per acre per application. Minimum of 30 days between applications. Spot treatment permitted.

Do not use on small canals with a flow rate less than 10 cubic feet per second (CFS) where water will be used for drinking purposes. CFS may be estimated by using the formula below. The approximate velocity needed for the calculation can be determined by observing the length of time that it takes a floating object to travel a defined distance.

Divide the distance (ft.) by the time (sec.) to estimate velocity (ft. per sec.). Repeat 3 times and use the average to calculate CFS.

Average Width (ft.) x Average Depth (ft.) x Average Velocity (ft. per sec.) = CFS

**For ditchbank weeds:**
- Do not allow boom spray to be directed onto water surface.
- Do not spray across stream to opposite bank.

**For shoreline weeds:**
- Allow no more than 2 foot overspray onto water.

## AQUATIC WEED CONTROL

**For Use in Ponds, Lakes, Reservoirs, Marshes, Bayous, Drainage Ditches, Non-Irrigation Canals, Rivers and Streams that are Quiescent or Slow Moving.**

**NOTICE TO APPLICATORS**

**State and Local Coordination**

Before application, coordination and approval of local and state authorities may be required, either by letter of agreement or issuance of special permits for such use. **Wind Velocity - Ground or Surface Application:** Do not apply when wind speeds are at or above 10 mph. **Air Application:** Do not apply when wind speeds are at or above 5 mph. The restrictions do not apply to subsurface applications used in weed control programs.

## WATER HYACINTH (*Eichornia crasipe*) - Directions For Use

This product will control water hyacinth with surface and air applications.

**Amounts to Use:** 2 to 4 quarts (4 lb. acid equivalent per gallon) per acre. **Spray the weed mass only.** Use 4 quarts when plants are matured or when the weed mass is dense.

**When To Apply:** Spray when water hyacinth plants are actively growing. Repeat as necessary to kill regrowth and hyacinth plants missed in the previous operation.

**How To Use - Surface Application:** Use power sprayers operated with a boom or spray gun mounted on a boat, tractor or truck. Thorough wetting of foliage is essential for maximum control. Use 100 to 400 gal. per acre of spray mixture. Special precautions such as the use of low pressure, large nozzles and thickening agents should be taken to avoid spray drift in areas of sensitive crops. For DIRECTA-SPRA™ operation use this product with 1 pint of drift control agent in 50 to 100 gallons of water. For other applications, follow the drift control agent label for mixing directions.

**Air Application:** Use drift control spray equipment or thickening agents mixed into the spray solution. Apply 1.0 gallon per acre of this product through standard boom systems with a minimum of 5 gallons of spray mix per acre. For MICROFOIL® drift control spray systems, apply this product in 12 to 15 gallons spray mix per acre.

| | | | | | |
|---|---|---|---|---|---|
| 2,4-D Acid Equivalent | 1/2 pound | 1 pound | 2 pounds | 3 pounds | 4 pounds |
| WEEDAR® 64 | 1 pint | 2 pints | 2 quarts | 3 quarts | 4 quarts |

## RESTRICTIONS

**FLOATING AND EMERGENT WEEDS:**

- Maximum of 8 pints per surface acre per application.
- Limited to 2 applications per season.
- Minimum of 21 days between applications.
- Spot treatments are permitted.

Apply to emergent aquatic weeds in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, non-irrigation canals, rivers, and streams that are quiescent or slow moving. Coordination and approval of local and state authorities may be required, either by letter of agreement or issuance of special permits for aquatic applications.

**WATER USE**

1. Water for irrigation or sprays:
   - A. If treated water is intended to be used only for crops or non-crop areas that are labeled for direct treatment with 2,4-D such as pastures, turf, or cereal grains, the treated water may be used to irrigate and/or mix sprays for these sites at anytime after the 2,4-D aquatic application.
   - B. Due to potential phytotoxicity considerations, the following restrictions are applicable:

     If treated water is intended to be used to irrigate or mix sprays for plants grown in commercial nurseries and greenhouses; and other plants or crops that are not labeled for direct treatment with 2,4-D, the water must not be used unless one of the following restrictions has been observed:

     i. A setback distance from functional water intake(s) of greater than or equal to 600 ft. was used for the application, or,

     ii. A waiting period of 7 days from the time of application has elapsed, or,

     iii. An approved assay indicates that the 2,4-D concentration is 100 ppb (0.1 ppm) or less at the water intake. Wait at least 3 days after application before initial sampling at water intake.

2. Drinking water (potable water):
   - A. Consult with appropriate state or local water authorities before applying this product to public waters. State or local agencies may require permits. The potable water use restrictions on this label are to ensure that consumption of water by the public is allowed only when the concentration of 2,4-D in the water is less than the MCL (Maximum Contaminant Level) of 70 ppb. Applicators should consider the unique characteristics of the treated waters to assure that 2,4-D concentrations in potable water do not exceed 70 ppb at the time of consumption.
   - B. For floating and emergent weed applications, the drinking water setback distance from functioning potable water intakes is greater than or equal to 600 ft.
   - C. If no setback distance of greater than or equal to 600 ft. is used for application, applicators or the authorizing organization must provide a drinking water notification prior to a 2,4-D application to the party responsible for public water supply or to individual private water uses. Notification to the party responsible for a public water supply or to individual private water users must be done in a manner to assure that the party is aware of the water use restrictions when this product is applied to potable water. The following is an example of a notification via posting, but other methods of notification which convey the above restrictions may be used and may be required in some cases under State or local law or as a condition of a permit.

**Example:** Posting notification should be located every 250 feet including the shoreline of the treated area and up to 250 feet of shoreline past the application site to include immediate public access points. Posting must include the day and time of application. Posting may be removed if analysis of a sample collected at the intake 3 or more days following application shows that the concentration in the water is less than 70 ppb (100 ppb for irrigation or sprays), or after 7 days following application, whichever occurs first.

**Text of notification:** Wait 7 days before diverting functioning surface water intakes from the treated aquatic site to use as drinking water, irrigation, or sprays, unless water at functioning drinking water intakes is tested at least 3 days after application and is demonstrated by assay to contain not more than 70 ppb 2,4-D (100 ppb for irrigation or sprays).

Application Date: _____ Time: _____ .

D. Following each application of this product, treated water must not be used for drinking water unless one of the following restrictions has been observed:

i. A setback distance from functional water intake(s) of greater than or equal to 600 ft. was used for the application, or

ii. A waiting period of 7 days from the time of application has elapsed, or,

iii. An approved assay indicates that the 2,4-D concentration is 70 ppb (0.07 ppm) or less at the water intake. Sampling for drinking water analysis should occur no sooner than 3 days after 2,4-D application. Analysis of samples must be completed by a laboratory that is certified under the Safe Drinking Water Act to perform drinking water analysis using a currently approved version of analytical Method Number 515, 555, other methods for 2,4-D as may be listed in Title 40 CFR, Part 141.24, or Method Number 4015 (immunoassay of 2,4-D) from U.S. EPA Test Methods for Evaluating Solid Waste SW-846.

E. Note: Existing potable water intakes that are no longer in use, such as those replaced by a connection to a municipal water system or a potable water well, are not considered to be functioning potable water intakes.

F. Drinking water setback distances do not apply to terrestrial applications of 2,4-D adjacent to water bodies with potable water intakes.

3. Except as stated above, there are no restrictions on using water from treated areas for swimming, fishing, watering livestock or domestic purposes.

## WATER MILFOIL (*Myriophyllum spicatum*) - Directions For Use

This product will control water milfoil with surface, subsurface and air applications.

**How To Use:** To control water milfoil when less than 5 gallons of concentrate per acre is recommended, dilute the concentrate with water to apply a minimum of 5 gallons of spray mix per acre. Do not treat within 1/2 mile of potable water intakes. Shoreline areas should be treated by sub-surface injection applied by boat to avoid aerial drift. Do not apply when weather conditions favor drift from target area. Do not contaminate water by cleaning of equipment washwaters.

**Open Water Areas:** To reduce contamination and prevent undue exposure to fish and other aquatic organisms, do not treat water areas that are not infested with aquatic weeds.

**Amounts To Use:** Apply 2.5 to 2.75 gallons of this product per acre. The higher rate is used in areas of greater water exchange. These areas may require a repeat application.

**When To Apply:** For best results, apply in spring or early summer when milfoil starts to grow. This timing can be checked by sampling the lake bottom in areas heavily infested with weeds the year before.

**Subsurface Application:** Apply 2.5 to 2.75 gallons of this product per acre as a concentrate directly into the water through boat mounted distribution systems.

**Surface Application:** Apply 2.5 to 2.75 gallons of this product per acre in a minimum spray volume of 5 gallons mix per acre.

**Air Application:** Use drift control spray equipment or thickening agents mixed into the spray solution. Apply 2.5 to 2.75 gallons per acre of this product through standard boom systems with a minimum of 5 gallons of spray mix per acre. For MICROFOIL® drift control spray systems apply this product in 12 to 15 gallons spray mix per acre.

Do not apply within 21 days of previous application.

When treating moving bodies of water, applications must be made while traveling upstream to prevent concentration of 2,4-D downstream from the application.

## RESTRICTIONS

**SUBMERSED AQUATIC WEEDS:**

- Maximum of 22.7 pints (10.8 lbs. ae) per acre-foot per application.
- Limited to 2 applications per season.

Apply to aquatic weeds in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, non-irrigation canals, rivers, and streams that are quiescent or slow moving. Do not apply within 21 days of previous application. When treating moving bodies of water, applications must be made while traveling upstream to prevent concentration of 2,4-D downstream from the application. Coordination and approval of local and State authorities may be required, either by letter of agreement or issuance of special permits for such use.

| TABLE 1. AMOUNT OF 2,4-D TO APPLY FOR A TARGET SUBSURFACE CONCENTRATION | | | |
|---|---|---|---|
| **SURFACE AREA** | **Average Depth** | **For Typical Conditions 2 ppm 2,4-D ae/acre-foot** | **For Difficult Conditions* 4 ppm 2,4-D ae/acre-foot** |
| 1 Acre | 1 ft. | 5.4 lbs. (11.3 pts. product) | 10.8 lbs. (22.7 pts. product) |
| | 2 ft. | 10.8 lbs. (22.7 pts. product) | 21.6 lbs. (45.4 pts. product) |
| | 3 ft. | 16.2 lbs. (34.1 pts. product) | 32.4 lbs. (68.2 pts. product) |
| | 4 ft. | 21.6 lbs. (45.4 pts. product) | 43.2 lbs. (90.9 pts. product) |
| | 5 ft. | 27.0 lbs. (56.8 pts. product) | 54.0 lbs. (113.6 pts. product) |
| * Examples include spot treatment of pioneer colonies of Eurasian Water Milfoil and certain difficult to control aquatic species. | | | |

**WATER USE**

1 . Water for irrigation or sprays:

A. If treated water is intended to be used only for crops or non-crop areas that are labeled for direct treatment with 2,4-D such as pastures, turf, or cereal grains, the treated water may be used to irrigate and/or mix sprays for these sites at anytime after the 2,4-D aquatic application.

B. Due to potential phytotoxicity and/or residue considerations, the following restrictions are applicable:

If treated water is intended to be used to irrigate or mix sprays for unlabeled crops, noncrop areas or other plants not labeled for direct treatment with 2,4-D, the water must not be used unless one of the following restrictions has been observed:

i. A setback distance described in the Drinking Water Setback Table was used for the application, or,

ii. A waiting period of 21 days from the time of application has elapsed, or,

iii. An approved assay indicates that the 2,4-D concentration is 100 ppb (0.1 ppm) or less at the water intake. See Table 3 for the waiting period after application but before taking the initial sampling at water intake.

2. Drinking water (potable water):

A. Consult with appropriate state or local water authorities before applying this product to public waters. State or local agencies may require permits. The potable water use restrictions on this label are to ensure that consumption of water by the public is allowed only when the concentration of 2,4-D in the water is less than the MCL (Maximum Contaminant Level) of 70 ppb. Applicators should consider the unique characteristics of the treated waters to assure that 2,4-D concentrations in potable water do not exceed 70 ppb at the time of consumption.

B. For submersed weed applications, the drinking water setback distances from functioning potable water intakes are provided in Table 2. Drinking Water Setback Distance (below).

C. If no setback distance from the Drinking Water Setback Distance Table (Table 2) is to be used for the application, applicators or the authorizing organization must provide a drinking water notification and an advisory to shut off all potable water intakes prior to a 2,4-D application. Notification to the party responsible for a public water supply or to individual private water users must be done in a manner to assure that the party is aware of the water use restrictions when this product is applied to potable water. The following is an example of a notification via posting, but other methods of notification which convey the above restrictions may be used and may be required in some cases under State or local law or as a condition of a permit.

**Example:** Posting notification should be located every 250 feet including the shoreline of the treated area and up to 250 feet of shoreline past the application site to include immediate public access points. Posting should include the day and time of application. Posting may be removed if analysis of a sample collected at the intake no sooner than stated in Table 3 (below) shows that the concentration in the water is less than 70 ppb (100 ppb for irrigation or sprays), or after 21 days following application, whichever occurs first.

**Text of notification:** Wait 21 days before diverting functioning surface water intakes from the treated aquatic site to use as drinking water, irrigation, or sprays, unless water at functioning drinking water intakes is tested no sooner than (insert days from Table 3) and is demonstrated by assay to contain not more than 70 ppb 2,4-D (100 ppb for irrigation or sprays).

Application Date: _____ Time: _____ .

D. Following each application of this product, treated water must not be used for drinking water unless one of the following restrictions has been observed:

i. A setback distance described in the Drinking Water Setback Distance Table was used for the application, or

ii. A waiting period of at least 21 days from the time of application has elapsed, or,

iii. An approved assay indicates that the 2,4-D concentration is 70 ppb (0.07 ppm) or less at the water intake. Sampling for drinking water analysis should occur no sooner than stated in Table 3. Analysis of samples must be completed by a laboratory that is certified under the Safe Drinking Water Act to perform

drinking water analysis using a currently approved version of analytical Method Number 515, 555, other methods for 2,4-D as may be listed in Title 40 CFR, Part 141.24, or Method Number 4015 (immunoassay of 2,4-D) from U.S. EPA Test Methods for Evaluating Solid Waste SW-846.

E. Note: Existing potable water intakes that are no longer in use, such as those replaced by a connection to a municipal water system or a potable water well, are not considered to be functioning potable water intakes.

F. Drinking water setback distances do not apply to terrestrial applications of 2,4-D adjacent to water bodies with potable water intakes.

3. Except as stated above, there are no restrictions on using water from treated areas for swimming, fishing, watering livestock or domestic purposes.

**Table 2. Drinking Water Setback Distance for Submersed Weed Applications**

| APPLICATION RATE AND MINIMUM SETBACK DISTANCE (FEET) FROM FUNCTIONING POTABLE WATER INTAKE | | | |
|---|---|---|---|
| 1 ppm* | 2 ppm* | 3 ppm* | 4 ppm* |
| 600 | 1200 | 1800 | 2400 |
| * ppm acid equivalent target water concentration | | | |

**Table 3. Sampling for Drinking Water Analysis After 2,4-D Application for Submerged Weed Applications**

| MINIMUM DAYS AFTER APPLICATION BEFORE INITIAL WATER SAMPLING AT THE FUNCTIONING POTABLE WATER INTAKE | | | |
|---|---|---|---|
| 1 ppm* | 2 ppm* | 3 ppm* | 4 ppm* |
| 5 | 10 | 10 | 14 |
| * ppm acid equivalent target water concentration | | | |

Use of this product in certain portions of California, Oregon, and Washington is subject to the January 22, 2004 Order for injunctive relief in Washington Toxics Coalition, et al. v. EPA, C01 32C, (W.D. WA). For further information, please refer to EPA Web Site: http://www.epa.gov/espp.

## STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

**PESTICIDE STORAGE:** Store in original container in a dry, secured storage area. Keep container tightly closed when not in use. Store at temperature above 32°F. If allowed to freeze, warm to at least 40°F and remix before using. Freezing does not alter this product.

**PESTICIDE DISPOSAL:** Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law and may contaminate ground water. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

**CONTAINER HANDLING:**

**Nonrefillable Containers 5 Gallons or Less:** Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. **Triple rinse as follows:** Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by State and local authorities. Plastic containers are also disposable by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

## WARRANTY DISCLAIMER

**The directions for use of this product must be followed carefully. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, (1) THE GOODS DELIVERED TO YOU ARE FURNISHED "AS IS" BY MANUFACTURER OR SELLER AND (2) MANUFACTURER AND SELLER MAKE NO WARRANTIES, GUARANTEES, OR REPRESENTATIONS OF ANY KIND TO BUYER OR USER, EITHER EXPRESS OR IMPLIED, OR BY USAGE OF TRADE, STATUTORY OR OTHERWISE, WITH REGARD TO THE PRODUCT SOLD, INCLUDING, BUT NOT LIMITED TO MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, USE, OR ELIGIBILITY OF THE PRODUCT FOR ANY PARTICULAR TRADE USAGE.** UNINTENDED CONSEQUENCES, INCLUDING BUT NOT LIMITED TO INEFFECTIVENESS, MAY RESULT BECAUSE OF SUCH FACTORS AS THE PRESENCE OR ABSENCE OF OTHER MATERIALS USED IN COMBINATION WITH THE GOODS, OR THE MANNER OF USE OR APPLICATION, INCLUDING WEATHER, ALL OF WHICH ARE BEYOND THE CONTROL OF MANUFACTURER OR SELLER AND ASSUMED BY BUYER OR USER. THIS WRITING CONTAINS ALL OF THE REPRESENTATIONS AND AGREEMENTS BETWEEN BUYER, MANUFACTURER AND SELLER, AND NO PERSON OR AGENT OF MANUFACTURER OR SELLER HAS ANY AUTHORITY TO MAKE ANY REPRESENTATION OR WARRANTY OR AGREEMENT RELATING IN ANY WAY TO THESE GOODS.

## LIMITATION OF LIABILITY

TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, IN NO EVENT SHALL MANUFACTURER OR SELLER BE LIABLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, OR FOR DAMAGES IN THEIR NATURE OF PENALTIES RELATING TO THE GOODS SOLD, INCLUDING USE, APPLICATION, HANDLING, AND DISPOSAL. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, MANUFACTURER OR SELLER SHALL NOT BE LIABLE TO BUYER OR USER BY WAY OF INDEMNIFICATION TO BUYER OR TO CUSTOMERS OF BUYER, IF ANY, OR FOR ANY DAMAGES OR SUMS OF MONEY, CLAIMS OR DEMANDS WHATSOEVER, RESULTING FROM OR BY REASON OF, OR RISING OUT OF THE MISUSE, OR FAILURE TO FOLLOW LABEL WARNINGS OR INSTRUCTIONS FOR USE, OF THE GOODS SOLD BY MANUFACTURER OR SELLER TO BUYER. ALL SUCH RISKS SHALL BE ASSUMED BY THE BUYER, USER, OR ITS CUSTOMERS. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, BUYER'S OR USER'S EXCLUSIVE REMEDY, AND MANUFACTURER'S OR SELLER'S TOTAL LIABILITY SHALL BE FOR DAMAGES NOT EXCEEDING THE COST OF THE PRODUCT.

**If you do not agree with or do not accept any of directions for use, the warranty disclaimers, or limitations on liability, do not use the product, and return it unopened to the Seller, and the purchase price will be refunded.**

(RV031915)

## NOTICE TO BUYER

Purchase of this material does not confer any rights under patents governing this product or the use thereof in countries outside of the United States.

WEEDAR is a Registered Trademark of Nufarm, Inc.

All other trademarks are the property of their respective owners.

NOTES

NOTES

# Nufarm Weedar® 64

## Broadleaf Herbicide

| | |
|---|---|
| **ACTIVE INGREDIENT:** | |
| 2,4-Dichlorophenoxyacetic acid, dimethylamine salt* | 46.8% |
| **OTHER INGREDIENTS:** | 53.2% |
| **TOTAL** | 100.0% |

* 2,4-Dichlorophenoxyacetic acid equivalent 38.9% by weight or 3.8 pounds per gallon. Isomer specific by AOAC method No. 978.05

## KEEP OUT OF REACH OF CHILDREN

## DANGER / PELIGRO

PRECAUCION AL USUARIO: Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

**SEE INSIDE BOOKLET FOR FIRST AID AND ADDITIONAL PRECAUTIONARY STATEMENTS**

**For Chemical Spill, Leak, Fire, or Exposure, Call CHEMTREC (800) 424-9300. For Medical Emergencies Only, Call (877) 325-1840.**

### PRECAUTIONARY STATEMENTS
### HAZARDS TO HUMANS AND DOMESTIC ANIMALS
### DANGER / PELIGRO

Corrosive. Causes irreversible eye damage. Harmful if swallowed. Avoid breathing vapors or spray mist. Do not get in eyes, on skin or on clothing.

### FIRST AID

| | |
|---|---|
| **IF IN EYES:** | Hold eye open and rinse slowly and gently with water for 15 to 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice. |
| **IF SWALLOWED:** | Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person. |
| **IF ON SKIN OR CLOTHING:** | Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 to 20 minutes. Call a poison control center or doctor for treatment advice. |

**HOT LINE NUMBER**

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-877-325-1840 for emergency medical treatment information.

**NOTE TO PHYSICIANS**

This product contains a phenoxy herbicidal chemical. There is no specific antidote. All treatments should be based on observed signs and symptoms of distress in the patient. Probable mucosal damage may contraindicate the use of gastric lavage. Overexposure to materials other than this product may have occurred.

### ENVIRONMENTAL HAZARDS

This pesticide is toxic to fish and aquatic invertebrates. For Terrestrial Uses: Do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Drift and runoff may be hazardous to aquatic organisms in water adjacent to treated areas. Do not contaminate water when disposing of equipment washwater or rinsate.

This product contains a chemical with properties and characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination. Application around a cistern or well may result in contamination of drinking water or groundwater.

### STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

**PESTICIDE STORAGE:** Store in original container in a dry, secured storage area. Keep container tightly closed when not in use. Store at temperature above 32°F. If allowed to freeze, warm to at least 40°F and remix before using. Freezing does not alter this product.

**PESTICIDE DISPOSAL:** Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law and may contaminate ground water. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

**CONTAINER HANDLING:**

**Nonrefillable Containers 5 Gallons or Less:** Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. **Triple rinse as follows:** Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by State and local authorities. Plastic containers are also disposable by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

**EPA REG. NO.71368-1**
**EPA EST. NO. 228-IL-001**

**Net Contents: 2.5 Gal. (9.46 L)**

**Manufactured for**
**Nufarm Inc.**
**11901 S. Austin Avenue**
**Alsip, IL 60803**

PULL HERE TO OPEN
PRESS TO RESEAL

13169000 [3]

(RV031915)

## 1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

**Product Name:** **Nufarm Weedar® 64 Broadleaf Herbicide**
**EPA Reg. No.:** 71368-1
**Product Type:** Herbicide

**Company Name:** Nufarm Inc.
11901 S. Austin Avenue
Alsip, IL 60803
1-800-345-3330

**Telephone Numbers:** **For Chemical Emergency, Spill, Leak, Fire, Exposure, or Accident,**
**Call CHEMTREC Day or Night: 1-800-424-9300**
**For Medical Emergencies Only, Call 1-877-325-1840**

**This product is an EPA FIFRA registered pesticide. Some classifications on this SDS are not the same as the FIFRA label. Certain sections of this SDS are superseded by federal law governed by EPA for a registered pesticide. Please see Section 15. REGULATORY INFORMATION for explanation.**

## 2. HAZARDS IDENTIFICATION

**PHYSICAL HAZARDS:**
Not hazardous

**HEALTH HAZARDS:**

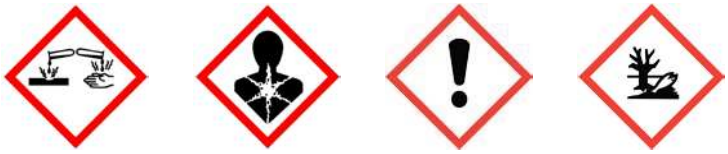
| | |
|---|---|
| Eye Damage/Irritation | Category 1 |
| Acute toxicity, oral | Category 4 |
| Specific target organ toxicity – Repeated exposure | Category 2 |

**ENVIRONMENTAL HAZARDS:**

| | |
|---|---|
| Acute aquatic toxicity | Category 2 |
| Chronic aquatic toxicity | Category 2 |

**SIGNAL WORD:**
DANGER

**HAZARD STATEMENTS**:
Causes serious eye damage. Harmful if swallowed. May cause damage to organs (liver, kidneys) through prolonged or repeated exposure. Toxic to aquatic life with long lasting effects.



**PRECAUTIONARY STATEMENTS**
Wear face shield, goggles or safety glasses with side protection. Wash hands thoroughly after handling. Do not eat, drink or smoke when using this product. Toxic to aquatic life with long lasting effects.

IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a poison control center or doctor for treatment advice.

IF SWALLOWED: Call a poison control center or doctor if you feel unwell. Rinse mouth. Dispose of contents and container in accordance with local and state regulations.

Avoid unintended release to the environment.

Collect spillage.

## 3. COMPOSITION / INFORMATION ON INGREDIENTS

| COMPONENT | CAS NO. | % BY WEIGHT |
|---|---|---|
| Dimethylamine Salt of 2,4-Dichlorophenoxyacetic Acid | 2008-39-1 | 45.4 – 48.2 |
| Other Ingredients | Trade Secret | Trade Secret |

**Synonyms:** 2,4-D DMA; 2,4-Dichlorophenoxyacetic acid, dimethylamine salt

Ingredients not precisely identified are proprietary or non-hazardous. Values are not products specifications.

## 4. FIRST AID MEASURES

**If in Eyes:** Hold eye open and rinse slowly and gently with water for 15 to 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
**If Swallowed:** Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.
**If on Skin or Clothing:** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 to 20 minutes. Call a poison control center or doctor for treatment advice.
**If Inhaled:** Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.
**Most Important symptoms/effects:** Eye irritation

**Indication of Immediate medical attention and special treatment if needed:** There is no specific antidote if this product is ingested. Treat symptomatically.

## 5. FIRE FIGHTING MEASURES

**Extinguishing Media:** Recommended for large fires: foam or water spray. Recommended for small fires: dry chemical or carbon dioxide.
**Special Fire Fighting Procedures:** Firefighters should wear NIOSH/MSHA approved self-contained breathing apparatus and full fire-fighting turn out gear. Dike area to prevent runoff and contamination of water sources. Dispose of fire control water later.
**Unusual Fire and Explosion Hazards:** Containers will burst from internal pressure under extreme fire conditions. If water is used to fight fire or cool containers, dike to prevent runoff contamination of municipal sewers and waterways.
**Hazardous Decomposition Materials (Under Fire Conditions):** May produce gases such as hydrogen chloride and oxides of carbon and nitrogen.

## 6. ACCIDENTAL RELEASE MEASURES

**Personal Precautions:** Wear appropriate protective gear for the situation. See Personal Protection information in Section 8.
**Environmental Precautions:** Prevent material from entering public sewer systems or any waterways. Do not flush to drain. Large spills to soil or similar surfaces may necessitate removal of topsoil. The affected area should be removed and placed in an appropriate container for disposal.
**Methods for Containment:** Dike spill using absorbent or impervious materials such as earth, sand or clay. Collect and contain contaminated absorbent and dike material for disposal.
**Methods for Cleanup and Disposal:** Pump any free liquid into an appropriate closed container. Collect washings for disposal. Decontaminate tools and equipment following cleanup. See Section 13: DISPOSAL CONSIDERATIONS for more information.
**Other Information:** Large spills may be reportable to the National Response Center (800-424-8802) and to state and/or local agencies.

## 7. HANDLING AND STORAGE

**HANDLING**:
Avoid breathing vapors or spray mist. Do not get in eyes, on skin or on clothing. Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet. Remove clothing/Personal Protective Equipment

(PPE) immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. If pesticide gets on skin, wash immediately with soap and water. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

**STORAGE:**
Store in original container in a dry, secured storage area. Keep container tightly closed when not in use. Store at temperatures above 32° F. If allowed to freeze, warm to at least 40° F and remix before using. Freezing does not alter the product. Do not contaminate water, food or feed by storage or disposal.

## 8. EXPOSURE CONTROLS / PERSONAL PROTECTION

**Engineering Controls:**
Where engineering controls are indicated by specific use conditions or a potential for excessive exposure, use local exhaust ventilation at the point of generation.

**Personal Protective Equipment:**
**Eye/Face Protection:** To avoid contact with eyes, wear chemical goggles or face shield. An emergency eyewash or water supply should be readily accessible to the work area.
**Skin Protection:** To avoid contact with skin, wear long pants, long-sleeved shirt, shoes and socks, and chemical-resistant gloves. For use according to product label, chemical-resistant gloves are not required for applicators using ground boom equipment. Wear a chemical-resistant apron when mixing or loading, cleaning up spills or equipment, or otherwise exposed to the concentrate. An emergency shower or water supply should be readily accessible to the work area.
**Respiratory Protection:** Not normally required. If vapors or mists exceed acceptable levels, wear NIOSH approved air-purifying respirator with cartridges/canisters approved for use against pesticides.
**General Hygiene Considerations:** Personal hygiene is an important work practice exposure control measure and the following general measures should be taken when working with or handling this material: 1) do not store, use and/or consume foods, beverages, tobacco products, or cosmetics in areas where this material is stored;
2) wash hands and face carefully before eating, drinking, using tobacco, applying cosmetics or using the toilet.

**Exposure Guidelines:**

| | OSHA | | ACGIH | | |
|---|---|---|---|---|---|
| **Component** | **TWA** | **STEL** | **TWA** | **STEL** | **Unit** |
| DMA Salt of 2,4-D | 10* | NE | 10* | NE | $mg/m^3$ |
| Other Ingredients | N/A | N/A | N/A | N/A | |

*Based on adopted limit for 2,4-D

NE= Not Established
N/A= Not Applicable

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| **Appearance:** | Clear, colorless to dark yellow liquid |
| **Odor:** | Mild phenolic amine |
| **Odor threshold:** | No data available |
| **pH:** | 6.9-9 |
| **Melting point/freezing point:** | No data available |
| **Initial boiling point and boiling range** | No data available |
| **Flash point:** | Not applicable due to aqueous formulation |
| **Evaporation rate:** | Not applicable |
| **Flammability (solid, gas):** | No data available |
| **Upper/lower flammability or explosive limits:** | No data available |
| **Vapor pressure:** | Not applicable |
| **Vapor density:** | Not applicable |
| **Relative density:** | 1.155 @ 20° C (9.64 lbs/gal) @21º C |
| **Solubility(ies):** | Soluble in water |
| **Partition coefficient: n-octanol/water:** | No data available |
| **Autoignition temperature:** | No data available |
| **Decomposition temperature:** | No data available |
| **Viscosity:** | 10.5 cPs @ 21º C |
| **VOC Emission Potential(%):** | 17.7 |

**Note:** Physical data are typical values, but may vary from sample to sample. A typical value should not be construed as a guaranteed analysis or as a specification.

## 10. STABILITY AND REACTIVITY

**Reactivity:** Not Reactive
**Chemical Stability:** This material is stable under normal handling and storage conditions.
**Possibility of Hazardous Reactions:** Will not occur.
**Conditions to Avoid:** Excessive heat. Do not store near heat or flame.
**Incompatible Materials:** Strong oxidizing agents: bases and acids.
**Hazardous Decomposition Products:** Under fire conditions may produce gases such as hydrogen chloride and oxides of carbon and nitrogen.

## 11. TOXICOLOGICAL INFORMATION

**Likely Routes of Exposure:** Eye contact, Skin contact
**Symptoms of Exposure:**
**Eye Contact:** Causes severe irritation.
**Skin Contact:** Causes slight irritation.
**Ingestion:** Harmful if ingested. May cause nausea, vomiting, abdominal pain, decreased blood pressure, muscle weakness, muscle spasms.
**Inhalation:** Low toxicity if inhaled. May cause upper respiratory tract irritation.
**Delayed, immediate and chronic effects of exposure:** None reported.

**Toxicological Data:**
Except as noted, data from laboratory studies conducted on this product are summarized below:
**Oral:** Rat $LD_{50}$: 1,030 mg/kg (female) (estimated based on mortalities for doses tested)
**Dermal:** Rabbit $LD_{50}$: >5,000 mg/kg (data on similar product)
**Inhalation:** Rat 4-hr $LC_{50}$: >2.06 mg/L (no animals died at this dose)
**Eye Irritation:** Rabbit: Corrosive/severely irritating (data on similar product)
**Skin Irritation:** Rabbit: Slightly irritating (data on similar product)
**Skin Sensitization:** Guinea Pig: Not a contact sensitizer

**Subchronic (Target Organ) Effects:** Repeated overexposure to phenoxy herbicides may cause effects to liver, kidneys, blood chemistry, and gross motor function. Rare cases of peripheral nerve damage have been reported, but extensive animal studies have failed to substantiate these observations, even at high doses for prolonged periods.
**Carcinogenicity / Chronic Health Effects:** Various animal cancer tests have shown no reliably positive association between 2,4-D exposure and cancer. Epidemiology studies on herbicide use have been both positive and negative with the majority being negative.
**Reproductive Toxicity:** No impairment of reproductive function attributable to 2,4-D has been noted in laboratory animal studies.
**Developmental Toxicity:** Studies in laboratory animals with 2,4-D have shown decreased fetal body weights and delayed development in the offspring at doses toxic to mother animals.
**Genotoxicity:** There have been some positive and some negative studies, but the weight of evidence is that 2,4-D is not mutagenic.
**Assessment Carcinogenicity:**
This product contains substances that are considered to be probable or suspected human carcinogens as follows:

| | Regulatory Agency Listing As Carcinogen | | | |
|---|---|---|---|---|
| **Component** | **ACGIH** | **IARC** | **NTP** | **OSHA** |
| Chlorophenoxy Herbicides | No | 2B | No | No |
| Other Ingredients | No | No | No | No |

## 12. ECOLOGICAL INFORMATION

**Ecotoxicity:**
Data on 2,4-D Dimethylamine Salt:

| | | | |
|---|---|---|---|
| 96-hour $LC_{50}$ Bluegill: | 524 mg/l | Bobwhite Quail Oral $LD_{50}$: | 500 mg/kg |
| 96-hour $LC_{50}$ Rainbow Trout: | 250 mg/l | Mallard Duck 8-day Dietary $LC_{50}$: | >5,620 ppm |
| 48-hour $EC_{50}$ Daphnia: | 184 mg/l | | |

**Environmental Fate:**
In laboratory and field studies, 2,4-D DMA salt rapidly dissociated to parent acid in the environment. The typical half-life of the resultant 2,4-D acid ranged from a few days to a few weeks.

## 13. DISPOSAL CONSIDERATIONS

**Waste Disposal Method:**
Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law and may contaminate ground water. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

**Container Handling and Disposal:**
**Nonrefillable Containers 5 Gallons or Less:** Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. **Triple rinse as follows:** Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by State and local authorities. Plastic containers are also disposable by incineration, or, if allowed by State and local authorities, by burning. If burned stay out of smoke.

**Nonrefillable containers larger than 5 gallons:** Nonrefillable container. Do not reuse or refill this container. Offer for recycling if available. Triple rinse or pressure rinse container (or equivalent) promptly after emptying. **Triple rinse as follows:** Empty the remaining contents into application equipment or a mix tank. Fill the container 1/4 full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. **Pressure rinse as follows:** Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 psi for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

**Refillable containers larger than 5 gallons:** Refillable container. Refill this container with pesticide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from this container into application equipment or a mix tank. Fill the container about 10% full with water and, if possible, spray all sides while adding water. Agitate vigorously or recirculate water with the pump for two minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times.

## 14. TRANSPORTATION INFORMATION

Follow the precautions indicated in Section 7: HANDLING AND STORAGE of this SDS.

**DOT:**

**<25 gallons per completed package**
Non Regulated

**≥ 25 gallons per completed package**
UN 3082, Environmentally hazardous substance, liquid, n.o.s. (2,4-D Salt), 9, III, RQ

**IMDG:**
Non Regulated

**IATA:**
Non Regulated

## 15. REGULATORY INFORMATION

**EPA FIFRA INFORMATION**

This chemical is a pesticide product registered by the United States Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets (SDS), and for workplace labels of non-pesticide chemicals. The hazard information required on the pesticide label is reproduced below. The pesticide label also includes other important information, including directions for use.

DANGER. Corrosive. Causes irreversible eye damage. Harmful if swallowed. Avoid breathing vapors or spray mist. Do not get in eyes, on skin, or on clothing.

### U.S. FEDERAL REGULATIONS

**TSCA Inventory:** This product is exempted from TSCA because it is solely for FIFRA regulated use.

**SARA Hazard Notification/Reporting:**
**Hazard Categories Under Criteria of SARA Title III Rules (40 CFR Part 370.66):**
Immediate and Delayed

**Section 313 Toxic Chemical(s):**
None Listed

**Reportable Quantity (RQ) under U.S. CERCLA:**
Acetic Acid, (2,4-Dichlorophenoxy)- (CAS No. 94-75-7) 100 pounds

**RCRA Waste Code:**
Under RCRA, it is the responsibility of the product user to determine at the time of disposal, whether a material containing the product or derived from the product should be classified as a hazardous waste.

**State Information:**
Other state regulations may apply. Check individual state requirements.

**California Proposition 65:** Not Listed.

## 16. OTHER INFORMATION

**National Fire Protection Association (NFPA) Hazard Rating:**
**Rating for this product: Health:** 3 **Flammability:** 1 **Reactivity:** 0
Hazards Scale: 0 = Minimal 1 = Slight 2 = Moderate 3 = Serious 4 = Severe

This Safety Data Sheet (SDS) serves different purposes than and DOES NOT REPLACE OR MODIFY THE EPA-ACCEPTED PRODUCT LABELING (attached to and accompanying the product container). This SDS provides important health, safety and environmental information for employers, employees, emergency responders and others handling large quantities of the product in activities generally other than product use, while the labeling provides that information specifically for product use in the ordinary course.

Use, storage and disposal of pesticide products are regulated by the EPA under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) through the product labeling, and all necessary and appropriate precautionary, use, storage, and disposal information is set forth on that labeling. It is a violation of Federal law to use a pesticide product in any manner not prescribed on the EPA-accepted label.

Although the information and recommendations set forth herein (hereinafter “Information”) are presented in good faith and believed to be correct as of the date hereof, Nufarm Americas Inc. makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Nufarm Americas Inc. be responsible for damages of any nature whatsoever resulting from the use of or reliance upon Information. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR THE PRODUCT TO WHICH INFORMATION REFERS AND ALL SUCH WARRANTIES ARE HEREBY SPECIFICALLY DISCLAIMED.

**Date of Issue:** June 21, 2016 **Supersedes:** May 14, 2015

Weedar is a registered trademark of Nufarm Americas Inc.

# Stingray®

## Aquatic Herbicide

SPECIMEN

SePRO

| | |
|---|---|
| **Active Ingredient** | |
| Carfentrazone-ethyl | 21.3% |
| **Other Ingredients** | 78.7% |
| **Total** | 100.0% |

This product contains 1.9 pounds active ingredient per gallon.

Contains Petroleum Distillates

**Keep Out of Reach of Children**

# CAUTION

EPA Reg. No. 279-3279-67690

FPL20140116

**See inside booklet for additional precautionary information.**

®Stingray is a registered trademark of FMC Corporation

**SePRO Corporation** 11550 North Meridian Street, Suite 600, Carmel, IN 46032 U.S.A.

## PRECAUTIONARY STATEMENTS

### HAZARDS TO HUMANS AND DOMESTIC ANIMALS

**CAUTION.** Harmful if swallowed, absorbed through the skin or inhaled. Causes moderate eye irritation. Avoid breathing spray mist. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after handling.

## KEEP OUT OF REACH OF CHILDREN

## CAUTION

| FIRST AID | |
|---|---|
| **If inhaled** | • Move person to fresh air.<br>• If person is not breathing, call 911 or an ambulance; then give artificial respiration, preferably mouth-to-mouth, if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| **If on skin or clothing** | • Take off contaminated clothing.<br>• Rinse skin immediately with plenty of water for 15 to 20 minutes.<br>• Call a poison control center or doctor for treatment advice. |
| **If in eyes** | • Hold eye open and rinse slowly and gently with water for 15 to 20 minutes.<br>• Remove contact lenses, if present, after the first 5 minutes; then continue rinsing eye.<br>• Call a poison control center or doctor for treatment advice. |
| **If swallowed** | • Immediately call a poison control center or doctor.<br>• Do not induce vomiting unless told to do so by a poison control center or doctor.<br>• Do not give any liquid to the person.<br>• Do not give anything by mouth to an unconscious person. |
| **HOTLINE NUMBER** | |
| Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact **INFOTRAC** at **1-800-535-5053** for emergency medical treatment information. | |

### Personal Protective Equipment (PPE)

Applicators and other handlers must wear: long-sleeved shirt and long pants, waterproof gloves, and shoes plus socks.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

### User Safety Recommendations:

Users should:

- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

**Note to Physician**: This product is expected to have low oral and dermal toxicity, and moderate inhalation toxicity. It is expected to be slightly irritating to the skin and minimally irritating to the eyes. Treatment is otherwise controlled removal of exposure followed by symptomatic and supportive care. This product may pose an aspiration pneumonia hazard.

### ENVIRONMENTAL HAZARDS

This product is very toxic to certain species of algae and moderately toxic to fish.

For aquatic uses, apply to water only as specified on this label.

## DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

### Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

**Re-entry Statement for aquatic uses**: Do not enter treated areas while treatments are in progress.

## GENERAL INFORMATION

STINGRAY Aquatic Herbicide is a liquid formulation which is emulsifiable in water. It is designed to be mixed with water and applied to aquatic areas for control of floating and emerged weeds.

Weed control is more effective on immature, actively growing weeds than on mature, less actively growing weeds. This product is a contact herbicide with little or no residual activity at recommended use rates.

This product is rapidly absorbed through the foliage of plants. The herbicide is rainfast within one hour after application. Within a few hours following application, the foliage of susceptible weeds may show signs of desiccation, and in subsequent weeks necrosis and death of the plant.

Extremes in environmental conditions (e.g. temperature and pH), may affect the activity of this product. Under warm conditions, herbicide symptoms may be accelerated.

Use of dirty or muddy water when preparing spray mixtures to apply this product may result in reduced herbicidal activity.

Applications made to moving bodies of water must be made while traveling upstream to prevent concentration of this herbicide in water. When making any bankside applications, do not overlap more than 1 foot into open water. Do not spray in bodies of water where weeds do not exist. Avoid applying under conditions of high wind or wave action. The maximum application rate of 13.5 fluid ounces per acre (0.2 lbs ai per acre) must not be exceeded in any single broadcast application that is being made over water.

**Tank Mix Recommendations**

This product may be tank mixed with other aquatic herbicides (e.g. 2,4-D, diquat, triclopyr, imazapyr and glyphosate) to control weeds not listed on this label. Refer to the companion herbicide label for use directions, precautions and restrictions on use. Stingray Aquatic Herbicide is believed to be compatible with most other aquatic herbicides. However, when preparing a new tank mix, always conduct a physical compatibility test by mixing proportional amounts of all spray ingredients in a test vessel (jar). Shake the mixture vigorously and allow it to stand for five to ten minutes. Rapid precipitation of the ingredients and failure to re-suspend when shaken indicates that the mixture is incompatible and should not be applied.

## AQUATIC USE DIRECTIONS

Necessary approval and/or permits should be obtained prior to application if required. Consult the responsible State Agencies (i.e., Fish and Game agencies or Department of Natural Resources).

For applications to aquatic sites such as, ponds, lakes, reservoirs, marshes, wetlands, bayous, drainage ditches, canals, streams, rivers, and other slow-moving or quiescent bodies of water for control of aquatic weeds. For use by:

1. Corps of Engineers.
2. Federal or State Public Agencies (i.e., Water Management District personnel, municipal officials).
3. Applicators and/or Licensees (Certified for aquatic pest control) that are authorized by the State or local government.

Treatment of dense weed areas may result in oxygen loss from decomposition of dead weeds. This loss of oxygen may cause fish suffocation. Therefore, treat up to a maximum of half of the water body area at one time. Wait a minimum of 14 days before retreatment or treatment of the remaining half of the water body.

Floating mats of vegetation may require retreatment. Avoid wash-off of sprayed foliage by spray boat or recreational boat backwash or by rainfall within 1 hour of application. Wait a minimum of 14 days between retreatment of the same body of water. Do not exceed 13.5 fluid ounces per acre (0.2 lb a.i per acre) in any single application.

For treatments after drawdown of water or in dry ditches, allow 7 or more days after treatment before reintroduction of water to achieve maximum weed control. Apply this product within 1 day after drawdown to ensure application to actively growing weeds.

Do not apply this product directly to water within 1/4 mile up-stream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/4 mile of an active potable water intake in a standing body of water such as a lake, pond or reservoir. To make aquatic applications around and within 1/4 mile of active potable water intakes, the water intake must be turned off prior to and for a minimum period of 24 hours after the application. The water intake may be turned on prior to 24 hours if the carfentrazone-ethyl and major degradate level in the intake water is below 0.2 parts per million as determined by analysis by SePRO approved laboratory. These aquatic applications may be made ONLY in those cases where there are alternative water sources or holding ponds which would permit the turning off of an active potable water intake for a minimum period of 24 hours after the applications. This restriction does NOT apply to intermittent inadvertent overspray of water in terrestrial use sites.

There is no restriction on the use of treated water for recreation or domestic purposes.

**Irrigation**

Irrigation from Stingray treated area may result in injury to the irrigated vegetation. Do not use treated water for irrigation in commercial nurseries or greenhouses. For crops, do not use treated water for irrigation purposes until 14 days after treatment where treatment is to 20% or more of the surface area, or until analysis by SePRO approved laboratory determines the carfentrazone-ethyl and major degradate level in intake water is less than 5 ppb.

Treated water may be used for irrigation by commercial turf farms and on residential turf and ornamentals without a holding restriction providing the application was made as a spot treatment to 20% or less of the water body surface area. If more than 20 % of the water body surface is treated, do not use the water for irrigation by commercial turf farms or on residential turf and ornamentals until 14 days after treatment, or until analysis by SePRO approved laboratory determines the carfentrazone-ethyl and major degradate level in intake water is less than 5 ppb.

The following table summarizes water holding periods prior to using treated water.

**Water Use Restrictions Following Applications with Stingray Aquatic Herbicide**

| Water Use | 20 % of the surface acre treated | 20- 50 % of the surface acre treated (spot treatment) |
|---|---|---|
| Drinking | 0 day | 1 day |
| Fishing and swimming | 0 day | 0 day |
| Livestock** consumption | 0 day | 1 day |
| Spray tank applications* and Irrigation to Commercial Turf Farms and Residential Turf and Ornamentals | 0 day | 14 days |
| Spray tank applications* and Irrigation to Food Crops | 0 day | 14 days |

* For preparing agricultural sprays for food crops, turf, or ornamentals (to prevent phytotoxicity), do not use water treated with Stingray Aquatic Herbicide before the specified time period.

** Treated water may not be used as a water source for livestock until the carfentrazone-ethyl and major degradate level has dropped to less than 0.2 ppm.

## ADJUVANTS

Applications of this product require the addition of a spray adjuvant. For best results, use methylated seed oils or nonionic surfactants at recommended manufacturers rates. Adjuvants that improve adherence to the leaf surface will also improve effectiveness.

Do not use with tank additives that alter the pH of the spray solution below pH 5 or above pH 8. Buffer solution to alter the pH range as appropriate.

## WEED CONTROL INFORMATION

Apply this product in accordance with the following table:

| WEED SPECIES | Pounds Active per Surface Acre | Stingray (fl. oz.) per Acre | Stingray (ml) per 1,000 sq. ft. |
|---|---|---|---|
| Water-lettuce *(Pistia stratiotes)* | 0.05 - 0.2 | 3.4 - 13.5 | 2 - 9 |
| Water-hyacinth *(Eichhornia crassipes)* | 0.1 - 0.2 | 6.7 - 13.5 | 5 - 9 |
| Salvinia *(Salvinia minima, Salvinia molesta)* | 0.05 - 0.2 | 3.4 - 13.5 | 2 - 9 |
| Duckweed (*Lemna* spp.) | 0.2 | 6.7 - 13.5 | 5 - 9 |
| Mosquito fern *(Azolla caroliniana)* | 0.2 | 13.5 | 9 |
| Water spinach *(Ipomoea aquatica)* | 0.2 | 13.5 | 9 |
| Watermeals (*Wolffia* spp.) | 0.2 | 13.5 | 9 |
| Alligatorweed *(Alternanthera philoxeroides)* (Suppression) | 0.2 | 6.7 - 13.5 | 5 - 9 |
| Water primrose *(Ludwigia octovalvis)* (Suppression) | 0.2 | 13.5 | 9 |

Use higher rates in the rate range when plants are mature, when the weed mass is dense, or for difficult to control species. Retreatment may be necessary for plants missed in previous application and for regrowth.

**SURFACE APPLICATION**

Use a backpack or knapsack sprayer for shoreline applications or a spray boom, handgun or other similar suitable equipment mounted on a boat or vehicle. In mixed weed populations, select the rate from the range corresponding to the most difficult to control weed. Thorough wetting of foliage is essential for maximum effectiveness. Use 20 to 200 gallons of spray mixture per acre. Special precautions such as the use of low spray pressure or large droplet producing nozzles may minimize spray drift in areas near sensitive crops.

**IF POSTING IS REQUIRED BY YOUR STATE OR TRIBE - CONSULT THE AGENCY RESPONSIBLE FOR PESTICIDE REGULATIONS FOR SPECIFIC DETAILS.**

## SUBMERGED WEEDS

For control of Eurasian watermilfoil *(Myriophyllum spicatum)* and other susceptible submerged weeds in ponds, lakes, reservoirs, and in non-irrigation canals or ditches that have little or no continuous outflow, apply Stingray as a subsurface application or as a surface application with a suitable polymer to sink the spray mixture (See Subsurface Application below). The amount of Stingray needed per surface acre can be determined from the chart below to provide an initial carfentrazone-ethyl (active ingredient) concentration of 200 ppb in treated water. Total concentration of carfentrazone-ethyl must not exceed 200 ppb in the treated water area.

Apply in spring or early summer when Eurasian watermilfoil or other submersed weeds are actively growing.

**Subsurface Application**

Inject desired amount of Stingray spray mixture directly into the water through a boat-mounted application system. Stingray may be applied as a surface spray only in combination with a suitable polymer or similar adjuvant that will ensure rapid sinking and mixing of the spray mix.

| Gallons of Stingray per Surface Acre at Specified Depth | |
|---|---|
| **Water Depth (feet)** | **Gallons of Stingray per Surface Acre** |
| 1 | 0.286 |
| 2 | 0.574 |
| 3 | 0.858 |
| 4 | 1.15 |
| 5 | 1.43 |
| 6 | 1.72 |
| 7 | 2.01 |
| 8 | 2.29 |
| 9 | 2.58 |
| 10 | 2.86 |
| 15 | 4.30 |
| 20 | 5.74 |

## STORAGE AND DISPOSAL

**Pesticide Storage**

Keep out of reach of children and animals. Store in original containers only. Store in a cool, dry place and avoid excess heat. Carefully open containers. After partial use, replace lids and close tightly. Do not put concentrate or dilute material into food or drink containers. Do not contaminate other pesticides, fertilizers, water, food, or feed by inappropriate storage or disposal.

In case of spill, avoid contact, isolate area and keep out unprotected persons and animals. Confine spills.

To confine spill: If liquid, dike surrounding area or absorb with sand, cat litter, commercial clay or gel absorbents. If dry material, cover to prevent dispersal. Place damaged package in a holding container. Identify contents.

**Pesticide Disposal**

Waste resulting from the use of this product may be disposed of at an approved waste disposal facility.

**Container Disposal**

**Metal or Plastic Containers -** Nonrefillable container. Do not reuse or refill this container. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times.

Then offer for recycling if available, or reconditioning, or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities. Do not cut or weld metal containers.

## TERMS AND CONDITIONS OF USE

If terms of the following *Warranty Disclaimer, Inherent Risks of Use* and *Limitation of Remedies* are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, to the extent consistent with applicable law, use by the buyer or any other user constitutes acceptance of the terms under *Warranty Disclaimer, Inherent Risks of Use,* and *Limitation of Remedies*.

## WARRANTY DISCLAIMER

SePRO Corporation warrants that the product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, SEPRO CORPORATION MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

## INHERENT RISKS OF USE

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of SePRO Corporation or the seller. To the extent consistent with applicable law, all such risks shall be assumed by buyer.

## LIMITATION OF REMEDIES

To the extent consistent with applicable law, the exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories) shall be limited to, at SePRO Corporation's election, one of the following:

(1) Refund of purchase price paid by buyer or user for product bought, or
(2) Replacement of amount of product used.

To the extent consistent with applicable law, SePRO Corporation shall not be liable for losses or damages resulting from handling or use of this product unless SePRO Corporation is promptly notified of such losses or damages in writing. In no case shall SePRO Corporation be liable for consequential or incidental damages or losses.

The terms of the *Warranty Disclaimer, Inherent Risks of Use* and this *Limitation of Remedies* cannot be varied by any written or verbal statements or agreements. No employee or sales agent of SePRO Corporation or the seller is authorized to vary or exceed the terms of the *Warranty Disclaimer* or this *Limitation of Remedies* in any manner.

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**SePRO Corporation**
11550 North Meridian Street, Suite 600
Carmel, IN 46032, U.S.A.

# SAFETY DATA SHEET

# Stingray

## Aquatic Herbicide

## Section 1. Identification

**GHS product identifier** Stingray Aquatic Herbicide

**Other means of identification** : Not available.

**EPA Registration No.** : 279-3279-67690

**Recommended use of the chemical and restrictions on use**

**Recommended Use:** Aquatic herbicide

**Restrictions on Use:** Use as recommended by the label

**Manufacturer Address** : SePRO Corporation
11550 North Meridian Street
Suite 600
Carmel, IN 46032 U.S.A.
Tel: 317-580-8282
Toll free: 1-800-419-7779
Fax: 317-580-8290
Monday - Friday, 8am to 5pm E.S.T.
www.sepro.com

**Emergency telephone number** INFOTRAC - 24-hour service 1-800-535-5053

**The following recommendations for exposure controls and personal protection are intended for the manufacture, formulation and packaging of this product. For applications and/or use, consult the product label. The label directions supersede the text of this Safety Data Sheet for application and/or use.**

## Section 2. Hazards identification

**Classification**

**OSHA Regulatory Status**

This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 191 0. 1200)

| | |
|---|---|
| Carcinogenicity | Category 2 |
| Aspiration toxicity | Category 1 |

**GHS Label elements, including precautionary statements**

**Emergency overview**

**Danger**

**Hazard Statements**

H304 – May be fatal if swallowed and enters airways
H351 – Suspected of causing cancer

**Precautionary Statements - Prevention**

P202 - Do not handle until all safety precautions have been read and understood
P281 -Use personal protective equipment as required

**Precautionary Statements - Response**

P308 + P313 - IF exposed or concerned: Get medical advice/ attention
P301 + P310- IF SWALLOWED: Immediately call a POISON CENTER or doctor
P331 -Do NOT induce vomiting

**Precautionary Statements - Storage**

P405 - Store locked up

**Precautionary Statements - Disposal**

P501 - Dispose of contents/ container to an approved waste disposal plant

**Hazards not otherwise classified (HNOC)**

No hazards not otherwise classified were identified.

**Other Information**

No information available

## Section 3. Composition/information on ingredients

**Chemical Family** Triazolinones

| Chemical Name | CAS-No | Weight % |
|---|---|---|
| Carfentrazone-ethyl | 128639-02-1 | 21.3 |
| Naphtha (petroleum, heavy aromatic | 64742-94-5 | 20-30 |
| 2-Methylnaphthalene | 91-57-6 | 1-5 |
| Propylene glycol | 57-55-6 | 1-5 |
| 1-Methylnaphthalene | 90-12-0 | 1-5 |
| Naphthalene | 91-20-3 | 1-5 |

Synonyms are provided in Section 1.

## Section 4. First aid measures

**Eye Contact**:

Hold eyes open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing. Call a poison control center or doctor for further treatment advice.

**Skin Contact**: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for further treatment advice.

**Inhalation**: Move to fresh air. If person is not breathing, contact emergency medical services, then give artificial respiration, preferably mouth-to-mouth if possible. Call a poison control center or doctor for further treatment advice.

**Ingestion:** Immediately call a poison control center or doctor. Do not induce vomiting unless told to do so by a poison control center or doctor Do not give any liquid to the person Do not give anything by mouth to an unconscious person. Immediately call a poison control center or doctor. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give any liquid to the person. Do not induce vomiting or give anything by mouth to an unconscious person.

**Most Important symptoms and effects, both acute and delayed:** Central nervous system effects. Gastrointestinal effects.

**Indication of immediate medical attention and special treatment needed, if necessary:** Treatment is symptomatic and supportive. Contains petroleum distillate. Vomiting may cause aspiration pneumonia.

## Section 5. Fire-fighting measures

**Suitable Extinguishing Media:** Carbon dioxide ($C0_2$), Foam, Dry powder, Water spray.

**Specific Hazards Arising from the Chemical:** Slightly combustible. May support combustion at elevated temperatures.

**Explosion Data**
**Sensitivity to Mechanical Impact:** Not sensitive.

**Sensitivity to Static Discharge** Not sensitive.

**Protective equipment and precautions for firefighters:** Wear self-contained breathing apparatus and protective suit.

## Section 6. Accidental release measures

**Personal precautions** Isolate and post spill area. Remove all sources of ignition. Wear suitable protective clothing, gloves and eye/face protection. For personal protection see section 8.

**Other** For further clean-up instructions, call FMC Emergency Hotline number listed in Section 1 "Product and Company Identification" above.

**Environmental Precautions** Keep people and animals away from and upwind of spill/leak. Keep material out of lakes, streams, ponds, and sewer drains.

**Methods for Containment** Dike to prevent runoff. Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal.

**Methods for cleaning up** Clean and neutralize spill area, tools and equipment by washing with bleach water and soap. Absorb rinsate and add to the collected waste. Waste must be classified and labeled prior to recycling or disposal. Dispose of waste as indicated in Section 13.

## Section 7. Handling and storage

**Handling** Do not contaminate other pesticides, fertilizers, water, food, or feed by storage or disposal.

**Storage** Keep in a dry, cool and well-ventilated place. Keep away from open flames, hot surfaces and sources of ignition. Keep out of reach of children and animals. Keep/store only in original container.

**Incompatible products** None known.

## Section 8. Exposure controls/personal protection

**Control parameters**

| Chemical Name | ACGIH TLV | OSHA PEL | NIOSH | Mexico |
|---|---|---|---|---|
| 2-Methylnaphthalene<br>91-57-6 | S*<br>TWA: 0.5 ppm | - | - | - |
| 1-Methylnaphthalene<br>90-12-0 | S*<br>TWA: 0.5 ppm | - | - | - |
| Naphthalene<br>91-20-3 | S*<br>TWA: 10 ppm | TWA: 10 ppm<br>TWA: 50 mg/m$^3$ | IDLH: 250 ppm<br>TWA: 10 ppm<br>TWA: 50 mg/m$^3$<br>STEL: 15 ppm<br>STEL: 75 mg/m$^3$ | Mexico: TWA 10 ppm<br>Mexico: TWA 50 mg/m$^3$<br>Mexico: STEL 15 ppm<br>Mexico: STEL 75 mg/m$^3$ |
| **Chemical Name** | **British Columbia** | **Quebec** | **Ontario TWAEV** | **Alberta** |
| 2-Methylnaphthalene<br>91-57-6 | TWA: 0.5 ppm<br>Skin | - | TWA: 0.5 ppm<br>Skin | - |
| Propylene glycol<br>57-55-6 | - | - | TWA: 10 mg/m$^3$<br>(aerosol only)<br><br>TWA: 50 ppm<br>(aerosol vapor)<br><br>TWA: 155 mg/m$^3$<br>(aerosol only) | - |
| 1-Methylnaphthalene<br>90-12-0 | TWA: 0.5 ppm | - | TWA: 0.5 ppm<br>Skin | - |
| Naphthalene<br>91-20-3 | TWA: 10 ppm<br>STEL: 15 ppm<br>Skin | TWA: 10 ppm<br>TWA: 52 mg/m$^3$<br>STEL: 15 ppm<br>STEL: 79 mg/m$^3$ | TWA: 10 ppm<br>STEL: 15 ppm<br>Skin | TWA: 10 ppm<br>TWA: 52 mg/m$^3$<br>STEL: 15 ppm<br>STEL: 79 mg/m$^3$ |

**Appropriate engineering controls**

**Engineering measures:** Apply technical measures to comply with the occupational exposure limits. When working in confined spaces (tanks, containers, etc.), ensure that there is a supply of air suitable for breathing and wear the recommended equipment.

**Individual protection measures, such as personal protective equipment**

**Eye/Face Protection:** This product does not cause significant eye irrigation or eye toxicity requiring special protection. Where there is significant potential for *eye* contact, wear chemical goggles and have eye flushing equipment available.

**Skin and Body Protection:** Wear long-sleeved shirt, long pants, socks, and shoes.

**Hand Protection:** Waterproof gloves.

**Respiratory Protection:** If exposure limits are exceeded or irritation is experienced, NIOSH/MSHA approved respiratory protection should be worn. Respiratory protection must be provided in accordance with current local regulations.

**Hygiene measures:** Clean water should be available for washing in case of eye or skin contamination. Wash skin prior to eating, drinking, chewing gum or using tobacco. Shower or bathe at the end of working. Remove and wash contaminated clothing before re-use. Launder work clothing separately from regular household laundry.

**General Information:** If the product is used in mixtures, it is recommended that you contact the appropriate protective equipment suppliers. These recommendations apply to the product as supplied.

## Section 9. Physical and chemical properties

**Information on basic physical and chemical properties**

| | |
|---|---|
| **Appearance** | Liquid, Off-white |
| **Physical State** | Liquid |
| **Color** | Off-white |
| **Odor** | Solvent |
| **Odor threshold** | No information available |
| **pH** | 4.3 |
| **Melting point/freezing point** | Not applicable |
| **Boiling Point/Range** | No information available |
| **Flash point** | 104 °C / 219 °F Seta Closed Cup |
| **Evaporation Rate** | No information available |
| **Flammability (solid, gas)** | No information available |
| **Flammability Limit in Air** | |
| **Upper flammability limit:** | No information available |
| **Lower flammability limit:** | No information available |
| **Vapor pressure** | No information available |
| **Vapor density** | No information available |
| **Density** | 8.80 lb/gal |
| **Specific gravity** | No information available |
| **Water solubility** | No information available |
| **Solubility in other solvents** | No information available |
| **Partition coefficient** | No information available |
| **Autoignition temperature** | No information available |
| **Decomposition temperature** | No information available |
| **Viscosity, kinematic** | No information available |
| **Viscosity, dynamic** | No information available |
| **Explosive properties** | No information available |
| **Oxidizing properties** | No information available |
| **Molecular weight** | No information available |
| **Bulk density** | 8.80 lb/gal |

## Section 10. Stability and reactivity

| | |
|---|---|
| **Reactivity** | None under normal use conditions |
| **Chemical Stability** | Stable under recommended storage conditions |
| **Possibility of Hazardous Reactions** | None under normal processing |
| **Hazardous polymerization** | Hazardous polymerization does not occur |
| **Conditions to avoid** | Heat, flames and sparks |
| **Incompatible materials** | None known |
| **Hazardous Decomposition Products** | Carbon oxides (COx), Hydrogen chloride, Hydrogen fluoride, Nitrogen oxides (NOx) |

## Section 11. Toxicological information

| | |
|---|---|
| **Product Information** | |
| **LD50 Oral** | Similar formulation: 4077 mg/kg (rat) |
| **LD50 Dermal** | Similar formulation: > 4000 mg/kg (rat) |
| **LC50 Inhalation** | Similar formulation: > 6.31 mg/L (4-hr) (rat) |
| **Serious eye damage/eye irritation** | Mildly irritating. |
| **Skin corrosion/irritation** | Mildly irritating (rabbit). |
| **Sensitization** | Based on a similar formulation, this product is not expected to produce skin sensitization. |
| **Information on toxicological effects** | |
| **Symptoms** | Signs of toxicity in laboratory animals included mydriasis, cyanosis, ataxia, dyspnea, lacrimation, and diarrhea. |
| **Delayed and immediate effects as well as chronic effects from short and long-term exposure** | |
| **Chronic toxicity** | Effects are expected to be similar to those that are seen with acute toxicity. Chronic exposure to aromatic hydrocarbons may cause headaches, dizziness, loss of sensations or feelings (such as numbness), and liver and kidney damage. Naphthalene causes cataracts in humans, rats, rabbits and mice. It has been classified as potential carcinogen based on animal data. |
| **Mutagenicity** | Carfentrazone-ethyl : Not genotoxic in animal studies. |
| **Carcinogenicity** | Carfentrazone-ethyl : Did not show carcinogenic effects in animal experiments. Not recognized as carcinogenic by Research Agencies (IARC, NTP, OSHA, ACGIH). There was no evidence of carcinogenic activity of naphthalene in male mice, but there was some evidence of carcinogenic activity in female mice and clear evidence of carcinogenic activity in male and female rats in 2-year inhalation studies conducted by the National Toxicology Program (NTP). |
| **Neurological effects** | Carfentrazone-ethyl : Not neurotoxic. |
| **Reproductive toxicity** | Carfentrazone-ethyl : No toxicity to reproduction in animal studies. |
| **Developmental toxicity** | Carfentrazone-ethyl : Not teratogenic in animal studies. |
| **STOT - single exposure** | Not classified. |
| **STOT - repeated exposure** | Not classified. |
| **Target organ effects** | Carfentrazone-ethyl : Red blood cell reduction can occur due to hemoglobin biosynthesis inhibition. Accumulation of precursors of hemoglobin may lead to secondary toxicity to liver and other organs. |
| **Neurological effects** | Carfentrazone-ethyl : Not neurotoxic. |
| **Aspiration hazard** | Potential for aspiration if swallowed. Vomiting after ingestion of this product may cause aspiration of aromatic hydrocarbons into the lungs, which may result in fatal pulmonary edema. |

| Chemical name | ACGIH | IARC | NTP | OSHA |
|---|---|---|---|---|
| Naphthalene<br>91-20-3 | A3 | Group 2B | Reasonably Anticipated | X |

**Legend:**
***ACGIH (American Conference of Governmental Industrial Hygienists)***
*A3 - Animal Carcinogen*
***IARC (International Agency for Research on Cancer)***
*Group 2B - Possibly Carcinogenic to Humans*
***NTP (National Toxicology Program)***
*Reasonably Anticipated - Reasonably Anticipated to be a Human Carcinogen*
***OSHA (Occupational Safety and Health Administration of the US Department of Labor)***
*X - Present*

## Section 12. Ecological information

Ecotoxicity

**Carfentrazone-ethyl (128639-02-1)**

| Active Ingredients | Duration | Species | Value | Units |
|---|---|---|---|---|
| Carfentrazone-ethyl | 72 h EC50 | Algae | 0.012 | mg/L |
| | 96 h LC50 | Fish | 1.6 | mg/L |
| | 48 h LC50 | Daphnia | >9.8 | mg/L |
| | 96 h NOEC | Algae | 1.0 | µg/L |
| | 21 d NOEC | Fish | 0.0187 | mg/L |
| | 21 d NOEC | Crustacea | 0.22 | mg/L |

**Persistence and degradability** Non-persistent. Readily hydrolyzed. Not readily biodegradable.

**Bioaccumulation** The substance does not have a potential for bioconcentration.

**Mobility** Mobility in soil: Not relevant

## Section 13. Disposal considerations

**Waste disposal methods** Improper disposal of excess pesticide, spray mixture, or rinsate is prohibited. If these wastes cannot be disposed of by use according to label instructions, contact appropriate disposal authorities for guidance.

**Contaminated Packaging** Containers must be disposed of in accordance with local, state and federal regulations. Refer to the product label for container disposal instructions.

## Section 14. Transport information

**DOT** This material is not a hazardous material as defined by U.S. Department of Transportation at 49 CFR Parts 100 through 185.

**TDG** The "Marine Pollutant" marking is only applicable when shipped by vessel, and is not applicable when shipped only by road or rail in Canada.

| | |
|---|---|
| **UN/ID no** | UN3082 |
| **Proper Shipping Name** | Environmentally hazardous substance, liquid, n.o.s. |
| **Hazard class** | 9 |
| **Packing Group** | III |
| **Marine Pollutant** | Carfentrazone-ethyl |
| **Description** | UN3082, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.* (Carfentrazone-ethyl, Naphthalene), 9, PG III, Marine Pollutant |

**ICAO/IATA**

| | |
|---|---|
| **UN/ID no** | UN3082 |
| **Proper Shipping Name** | Environmentally hazardous substance, liquid, n.o.s. |
| **Hazard class** | 9 |
| **Packing Group** | III |
| **Marine Pollutant** | Carfentrazone-ethyl |
| **Description** | UN3082, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.* (Carfentrazone-ethyl, Naphthalene), 9, PG III, Marine Pollutant |

**IMDG/IMO**

| | |
|---|---|
| **UN/ID no** | UN3082 |
| **Proper Shipping Name** | Environmentally hazardous substance, liquid, n.o.s. |
| **Hazard class** | 9 |
| **Packing Group** | III |
| **EmS No.** | **F-A, S-F** |
| **Marine Pollutant** | Carfentrazone-ethyl |
| **Description** | UN3082, ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S.* (Carfentrazone-ethyl, Naphthalene), 9, PG III, Marine Pollutant |

## Section 15. Regulatory information

**U.S. Federal Regulations**

**SARA 313**

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product contains a chemical or chemicals which are subject to the report requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372:

| Chemical Name | CAS-No | Weight % | Sara 313 - Threshold Values % |
|---|---|---|---|
| Naphthalene - 91-20-3 | 91-20-3 | 1-5 | 0.1 |

**SARA 311/312 Hazard Categories**

| | |
|---|---|
| **Acute health hazard** | Yes |
| **Chronic health hazard** | Yes |
| **Fire hazard** | No |
| **Sudden release of pressure hazard** | No |
| **Reactive Hazard** | No |

**Clear Water Act**

This product contains the following substances which are regulated pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42):

| Chemical Name | CWA - Reportable Quantities | CWA - Toxic Pollutants | CWA - Priority Pollutants | CWA - Hazardous Substances |
|---|---|---|---|---|
| Naphthalene - 91-20-3 | 100 lb | X | X | X |

**CERCLA** This material, as supplied, contains one or more substances regulated as a hazardous substance under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302):

| Chemical Name | Hazardous Substances RQs | Extremely Hazardous Substances RQs | RQ |
|---|---|---|---|
| Naphthalene<br>91-20-3 | 100 lb | | RQ 100 lb final RQ<br>RQ 45.4 kg final RQ |

***FIFRA Information*** *This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and for workplace labels of non-pesticide chemicals. Following* is *the hazard information as required on the pesticide label:*

*CAUTION*
*Harmful if swallowed, absorbed through the skin or inhaled. Causes moderate eye irritation.*

**US State Regulations**

**California Proposition 65** This product contains the following Proposition 65 chemicals:

| Chemical Name | California Prop. 65 |
|---|---|
| Naphthalene - 91-20-3 | Carcinogen |

**U.S. State Right-to-Know Regulations**

| Chemical Name | New Jersey | Massachusetts | Pennsylvania |
|---|---|---|---|
| 2-Methylnaphthalene<br>91-57-6 | X | | |
| Propylene glycol<br>57-55-6 | X | | X |
| Naphthalene<br>91-20-3 | X | X | X |
| 1-Methylnaphthalene<br>90-12-0 | X | X | X |

**International Inventories**

| Component | TSCA (United States) | DSL (Canada) | EINECS/ELINCS (Eurpoe) | ENCS (Japan) | China (IECSC) | KECL (Korea) | PICCS (Philippines) | AICS (Australia) |
|---|---|---|---|---|---|---|---|---|
| Carfentrazone-ethyl 128639-02-1 (21.3) | | | | | X | | | |
| Naphtha (petroleum), heavy aromatic 64742-94-5 (20-30) | X | X | X | X | X | X | X | X |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2-Methylnaphthalene 91-57-6 (1-5) | X | X | X | X | X | | X | X |
| Propylene glycol 57-55-6 (1-5) | X | X | X | X | X | X | X | X |
| 1-Methylnaphthalene 90-12-0 (1-5) | X | X | X | X | X | | X | X |
| Naphthalene 91-20-3 (1-5) | X | X | X | X | X | X | X | X |

**Mexico – Grade** No known effect based on information supplied

**Canada**

**WHMIS Statement** This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR

**WHMIS Hazard Class** D2A – Very toxic materials

## Section 16. Other information

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **NFPA** | **Health Hazards** 1 | **Flammability** 1 | **Instability** 0 | **Special Hazards** - |
| **HMIS** | **Health Hazards** 1* | **Flammability** 1 | **Physical hazard** 0 | **Personal Protection** X |

**Indicates a chronic health hazard.*

**History**

**Date of issue:** 08/12/15

**Notice to reader**

**To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.**

Product #'s
263450

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 21 Apr 14 Reviewer Townzen
Reg. No. 100-1091-ZB

PULL HERE TO OPEN

# Reward®

## Landscape and aquatic herbicide

syngenta®

# Herbicide

**TO PREVENT ACCIDENTAL POISONING, NEVER PUT INTO FOOD, DRINK, OR OTHER CONTAINERS, AND USE STRICTLY IN ACCORDANCE WITH ENTIRE LABEL.**

**DO NOT USE THIS PRODUCT FOR REFORMULATION.**

| | |
|---|---|
| *Active Ingredient:* | |
| Diquat dibromide [6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium dibromide] | 37.3% |
| *Other Ingredients:* | 62.7% |
| *Total:* | 100.0% |

Contains 2 lbs. diquat cation per gal. (3.73 lbs. diquat dibromide per gal.)

**KEEP OUT OF REACH OF CHILDREN.**

# CAUTION

See additional precautionary statements on label.

**EPA Reg. No. 100-1091 EPA Est. 100-LA-001**

**Product of United Kingdom**
**Formulated in the USA**

**SCP 1091A-L2G 1009**
**4034800**

**2.5 gallons**
**Net Contents**

6307-10900 02-16-14 SCP 01-00 (02-21-14)
Reward Landscape and Aquatic Herbicide –
2.5 Gallon Booklet/Base – Mech/FPL
SCP 3703... 4899... 672... 1693... 2094... 3464... 6307...

AGI: 107035
Print Size – Booklet: 5.75" wide X 6.75" high
Base: 6.75" wide X 6.75" high
Pantone colors: Pantone Black, PMS 349, PMS 368, PMS 542
No. of pages: 16

## NOTES

| FIRST AID | |
|---|---|
| If inhaled | • Move person to fresh air.<br>• If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth, if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| If swallowed | • Call a poison control center or doctor immediately for treatment advice.<br>• Have person sip a glass of water if able to swallow.<br>• Do not induce vomiting unless told to do so by the poison control center or doctor.<br>• Do not give anything by mouth to an unconscious person. |
| If in eyes | • Hold eye open and rinse slowly and gently with water for 15-20 minutes.<br>• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.<br>• Call a poison control center or doctor for treatment advice. |
| If on skin or clothing | • Take off contaminated clothing.<br>• Rinse skin immediately with plenty of water for 15-20 minutes.<br>• Call a poison control center or doctor for treatment advice. |

**NOTE TO PHYSICIANS**

To be effective, treatment for diquat poisoning must begin **IMMEDIATELY**. Treatment consists of binding diquat in the gut with suspensions of activated charcoal or bentonite clay, administration of cathartics to enhance elimination, and removal of diquat from the blood by charcoal hemoperfusion or continuous hemodialysis.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment.

**HOTLINE NUMBER**

For 24-Hour Medical Emergency Assistance (Human or Animal) or Chemical Emergency Assistance (Spill, Leak, Fire, or Accident), Call
**1-800-888-8372**

## PRECAUTIONARY STATEMENTS

**Hazards to Humans and Domestic Animals**

**CAUTION**

Harmful if inhaled. Harmful if swallowed. Causes moderate eye irritation. Avoid breathing spray mist. Avoid contact with eyes, skin, or clothing.

*continued...*

## PRECAUTIONARY STATEMENTS *(continued)*

### Personal Protective Equipment (PPE)

Some materials that are chemical-resistant to this product are: barrier laminate, butyl rubber ≥14 mils, nitrile rubber ≥14 mils. If you want more options, follow the instructions for Category A on an EPA Chemical Resistance Category Selection Chart.

**Mixers, Loaders, Applicators and other handlers must wear:**

- Coveralls over short-sleeved shirt and short pants or coveralls over long-sleeved shirt and long pants
- Chemical-resistant gloves
- Chemical-resistant footwear plus socks
- Protective eyewear
- Chemical-resistant headgear for overhead exposure
- Chemical-resistant apron when cleaning equipment, mixing, or loading
- Face shield when mixing or loading

**Exception:** After this product has been diluted to 0.50% Reward or less in water (i.e., the labeled rate for some spot applications), applicators for AQUATIC SURFACE APPLICATIONS must, at a minimum, wear (Note - Mixers and Loaders for this application method must still wear the personal protective equipment (PPE) as described in the above section):

- Long-sleeved shirt and long pants
- Shoes plus socks
- Waterproof gloves
- Protective eyewear

**Exception:** At a minimum, applicators for AQUATIC SUBSURFACE APPLICATIONS must wear (Note - Mixers and Loaders for this application method must still wear the personal protective equipment (PPE) as described in the above section):

- Short-sleeved shirt and short pants
- Waterproof gloves
- Chemical-resistant footwear plus socks

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

### Engineering Control Statements

Mixers and loaders supporting aerial applications are required to use closed systems that provide dermal protection. The closed system must be used in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4)]. When using the closed system, mixers and loaders' PPE requirements may be reduced or modified as specified in the WPS.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

### User Safety Recommendations

**Users should:**

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Prolonged contact of the product with the skin may produce burns.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

### Environmental Hazards

This pesticide is toxic to aquatic invertebrates. **For Terrestrial Uses,** do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash water. **For Aquatic Uses** do not apply directly to water except as specified on this label.

## CONDITIONS OF SALE AND LIMITATION OF WARRANTY AND LIABILITY

**NOTICE:** Read the entire Directions for Use and Conditions of Sale and Limitation of Warranty and Liability before buying or using this product. If the terms are not acceptable, return the product at once, unopened, and the purchase price will be refunded.

The Directions for Use of this product must be followed carefully. It is impossible to eliminate all risks inherently associated with the use of this product. Crop injury, ineffectiveness or other unintended consequences may result because of such factors as manner of use or application, weather or crop conditions, presence of other materials or other influencing factors in the use of the product, which are beyond the control of SYNGENTA CROP PROTECTION, LLC or Seller. To the extent permitted by applicable law, Buyer and User agree to hold SYNGENTA and Seller harmless for any claims relating to such factors.

SYNGENTA warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated in the Directions for Use, subject to the inherent risks referred to above, when used in accordance with directions under normal use conditions. To the extent permitted by applicable law: (1) this warranty does not extend to the use of the product contrary to label instructions or under conditions not reasonably foreseeable to or beyond the control of Seller or SYNGENTA, and, (2) Buyer and User assume the risk of any such use. To the extent permitted by applicable law, SYNGENTA MAKES NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE NOR ANY OTHER EXPRESS OR IMPLIED WARRANTY EXCEPT AS WARRANTED BY THIS LABEL.

To the extent permitted by applicable law, in no event shall SYNGENTA be liable for any incidental, consequential or special damages resulting from the use or handling of this product. **TO THE EXTENT PERMITTED BY APPLICABLE LAW, THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE EXCLUSIVE LIABILITY OF SYNGENTA AND SELLER FOR ANY AND ALL CLAIMS, LOSSES, INJURIES OR DAMAGES (INCLUDING CLAIMS BASED ON BREACH OF WARRANTY, CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, SHALL BE THE RETURN OF THE PURCHASE PRICE OF THE PRODUCT OR, AT THE ELECTION OF SYNGENTA OR SELLER, THE REPLACEMENT OF THE PRODUCT.**

SYNGENTA and Seller offer this product, and Buyer and User accept it, subject to the foregoing Conditions of Sale and Limitation of Warranty and Liability, which may not be modified except by written agreement signed by a duly authorized representative of SYNGENTA.

## DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling.

**READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH PRECAUTIONARY STATEMENTS AND DIRECTIONS, AND WITH APPLICABLE STATE AND FEDERAL REGULATIONS.**

**Do not apply this product through any type of irrigation system.**

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

### AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about personal protective equipment (PPE), and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.

**Do not enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 24 hours.**

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water is:

- Coveralls over short-sleeved shirt and short pants, or coveralls over long-sleeved shirt and long pants
- Chemical-resistant gloves made of any waterproof material
- Chemical-resistant footwear plus socks
- Protective eyewear
- Chemical-resistant headgear for overhead exposure

**NON-AGRICULTURAL USE REQUIREMENTS**

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

**Keep all unprotected persons out of operating areas or vicinity where there may be drift.**

**For terrestrial uses,** do not enter or allow entry of maintenance workers into treated areas, or allow contact with treated vegetation wet with spray, dew, or rain, without appropriate protective clothing until spray has dried.

**For aquatic uses,** do not enter treated areas while treatments are in progress.

## SPECIFIC USE DIRECTIONS

Reward Landscape and Aquatic Herbicide is a nonvolatile herbicidal chemical for use as a general herbicide to control weeds in commercial greenhouses and nurseries; ornamental seed crops (flowers, bulbs, etc. – except in the state of California); landscape, industrial, recreational, commercial, residential, and public areas; turf renovation (all turf areas except commercial sod farms); dormant established turfgrass (bermudagrass, zoysiagrass – nonfood or feed crop); and aquatic areas. Absorption and herbicidal action is usually quite rapid with effects visible in a few days. Reward Landscape and Aquatic Herbicide controls weeds by interfering with photosynthesis within green plant tissue. Weed plants should be succulent and actively growing for best results. Rinse all spray equipment thoroughly with water after use. Avoid spray drift to crops, ornamentals, and other desirable plants during application, as injury may result. Application to muddy water may result in reduced control. Minimize creating muddy water during application. Use of dirty or muddy water for Reward Landscape and Aquatic Herbicide dilution may result in reduced herbicidal activity. Avoid applying under conditions of high wind, water flow, or wave action.

### SPRAY DRIFT MANAGEMENT

Avoiding spray drift at the application site is the responsibility of the applicator and the grower. The interaction of many equipment- and weather-related factors determine the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

The following drift management requirements must be followed to avoid off-target movement from aerial applications to agricultural field crops. These requirements do not apply to forestry applications, public health uses, or to applications using dry formulations.

- The distance of the outermost nozzles on the boom must not exceed 3/4 the length of the wingspan or rotor.
- Nozzles must always point backward parallel with the air stream and never be pointed downward more than 45 degrees.

Where states have more stringent regulations, they should be observed.

### Droplet Size

The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (See **Wind, Temperature and Humidity,** and **Temperature Inversions**).

### Controlling Droplet Size

- **Volume** – Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- **Pressure** – Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types, lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of Nozzles** – Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle Orientation** – Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is the recommended practice. Significant deflection from horizontal will reduce droplet size and increase drift potential.
- **Nozzle Type** – Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift.

### Boom Length

For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.

### Application Height

Applications should not be made at a height greater than 10 ft. above the top of the target plants, unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

### Swath Adjustment

When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase with increasing drift potential (higher wind, smaller drops, etc.).

### Wind

Drift potential is lowest between wind speeds of 2-10 mph. However, many factors, including droplet size and equipment type, determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. **Note:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

### Temperature and Humidity

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

### Temperature Inversions

Applications should not occur during a temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

### Sensitive Areas

The pesticide should only be applied when the wind is blowing away from adjacent sensitive areas (e.g., residential areas, bodies of water, known habitat for threatened or endangered species, nontarget crops).

### COMMERCIAL GREENHOUSES AND NURSERIES

For general weed control in commercial greenhouses (beneath benches), field grown and container stock, and other similar areas, Reward Landscape and Aquatic Herbicide may be applied preplant or postplant preemergence in field grown ornamental nursery plantings or postemergence as a directed spray. Reward Landscape and Aquatic Herbicide may also be applied preemergence in ornamental seed crops (except in the state of California). Avoid contact with desirable foliage as injury may occur. Do not use on food or feed crops.

**Spot spray:** 1-2 qts. Reward Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per 100 gals. of water, or 0.75 oz. (22 mls.) Reward Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per 1 gal. of water.

**Broadcast:** 1-2 pts. Reward Landscape and Aquatic Herbicide in a minimum of 15 gals. of water per acre. Add the labeled rate of a 75% or greater nonionic surfactant per 100 gals. of spray mixture. Use an adequate spray volume to insure good coverage.

### ORNAMENTAL SEED CROPS (FLOWERS, BULBS, ETC.) EXCEPT IN THE STATE OF CALIFORNIA

For preharvest desiccation of ornamental seed crops. NOT FOR FOOD OR FIBER CROPS.

**Broadcast (Air or Ground):** 1.5-2 pts. Reward Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per acre in sufficient water (minimum of 5 gals. by air; 15 gals. by ground) for desiccation and weed burndown. Repeat as needed at no less than 5-day intervals up to three applications. Do not use seed, screenings, or waste as feed or for consumption.

## DIRECTIONS FOR LANDSCAPE, INDUSTRIAL, RECREATIONAL, COMMERCIAL, RESIDENTIAL, AND PUBLIC AREAS

Reward Landscape and Aquatic Herbicide provides fast control of broadleaf and grassy weeds in industrial, recreational, golf course, commercial, residential, and public areas.

Reward Landscape and Aquatic Herbicide is a nonselective herbicide that rapidly kills undesirable above ground weed growth in 24-36 hours. Avoid application of Reward Landscape and Aquatic Herbicide to desirable plants.

Reward Landscape and Aquatic Herbicide is a contact/desiccant herbicide; it is essential to obtain complete coverage of the target weeds to get good control. Improper application technique and/or application to stressed weeds may result in unacceptable weed control. For best results, apply to actively growing, young weeds.

Difficult weeds (such as perennial or deeply-rooted weeds) can often be controlled by tank mixing Reward Landscape and Aquatic Herbicide with other systemic-type herbicides. Refer to other product labels for specific application directions.

For residual weed control, tank mix Reward Landscape and Aquatic Herbicide with a preemergent herbicide labeled for the intended use site. When mixing Reward Landscape and Aquatic Herbicide with another herbicide, it is recommended to mix just a small amount first to determine if the mixture is physically compatible before proceeding with larger volumes.

Syngenta has not tested all possible tank mixtures with other herbicides for compatibility, efficacy or other adverse effects. Before mixing with other herbicides Syngenta recommends you first consult your state experimental station, state university or extension agent.

**Grounds maintenance weed control:** Reward Landscape and Aquatic Herbicide can be used as a spot or broadcast spray to control weeds in public, commercial and residential landscapes, including landscape beds, lawns, golf courses and roadsides. Reward Landscape and Aquatic Herbicide can also be used for weed control around the edges and nonflooded portions of ponds, lakes and ditches.

**Trim and Edge weed control:** Reward Landscape and Aquatic Herbicide can be used to eliminate undesired grass and broadleaf plant growth in a narrow band along driveways, walkways, patios, cart paths, fence lines, and around trees, ornamental gardens, buildings, other structures, and beneath noncommercial greenhouse benches. Vegetation control with Reward Landscape and Aquatic Herbicide is limited to the spray application width. Do not exceed the labeled rate of Reward Landscape and Aquatic Herbicide as excessive rates may result in staining of concrete-based materials.

Reward Landscape and Aquatic Herbicide, since it does not translocate systemically, can be used as an edging or pruning tool when precisely applied to select areas of grass or to undesirable growth on desirable ornamental bedding plants, ground covers, etc.

**Industrial weed control:** Reward Landscape and Aquatic Herbicide can be used as a spot or broadcast spray either alone or in combination with other herbicides as a fast burndown or control weeds in rights-of-ways, railroad beds/yards, highways, roads, dividers and medians, parking lots, pipelines, pumping stations, public utility lines, transformer stations and substations, electric utilities, storage yards, and other non-crop areas.

**Spot spray:** Apply either 1-2 qts. of Reward Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per 100 gals. water, or 0.75 oz. (22 mls.) Reward Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per 1 gal. of water.

**Broadcast:** 1-2 pts. Reward Landscape and Aquatic Herbicide per acre in sufficient water to insure good spray coverage. Add the labeled rate of 75% or greater nonionic surfactant per 100 gals. spray mixture. Greater water volumes are necessary if the target plants are tall and/or dense. It is recommended that 60 gals. or greater water volume be used to obtain good coverage of dense weeds.

## TURF RENOVATION (ALL TURF AREAS EXCEPT COMMERCIAL SOD FARMS)

To desiccate golf course turf and other turf areas prior to renovation, apply 1-2 pts. of Reward Landscape and Aquatic Herbicide per acre plus the labeled rate of a 75% or greater nonionic surfactant in 20-100 gals. of water (4 teaspoons of Reward Landscape and Aquatic Herbicide plus the labeled rate of a 75% or greater nonionic surfactant per 1 gal. of water) using ground spray equipment. Apply for full coverage and thorough contact with the turfgrass. Apply only when the turf is dry, free from dew and incidental moisture. For enhanced turf desiccation, especially in the case of thick turfgrass, water volumes should approach 100 gals. of water per acre.

For **suppression** of regrowth and quick desiccation of treated turfgrass, Reward Landscape and Aquatic Herbicide may be mixed with other systemic nonselective or systemic postemergence grassy weed herbicides. Refer to other product labels for specific application directions and restrictions.

Avoid spray contact with, or spray drift to, foliage of ornamental plants or food crops.

Do not graze livestock on treated turf or feed treated thatch to livestock.

## DORMANT ESTABLISHED TURFGRASS (BERMUDAGRASS, ZOYSIAGRASS), NONFOOD OR FEED CROP

For control of emerged annual broadleaf and grass weeds, including Little Barley*, Annual Bluegrass, Bromes including Rescuegrass, Sixweeks fescue, Henbit, Buttercup, and Carolina Geranium in established dormant bermudagrass lawns, parks, golf courses, etc.

Apply 1-2 pts. Reward Landscape and Aquatic Herbicide per acre in 20-100 gals. of spray mix by ground as a broadcast application. Add the labeled rate of a 75% or greater nonionic surfactant per 100 gals. of spray mixture.

Bermudagrass must be dormant at application. Application to actively growing bermudagrass may cause delay or permanent injury. Users in the extreme Southern areas should be attentive to the extent of dormancy at the time of application.

*For control of Little Barley, apply Reward Landscape and Aquatic Herbicide prior to the mid-boot stage.

## AQUATIC USE DIRECTIONS

### New York – Not for Sale or Use in New York State without Supplemental Special Local Needs Labeling.

Necessary approval and/or permits must be obtained prior to application if required. Consult the responsible State Agencies (i.e., Fish and Game Agencies, State Water Conservation authorities, or Department of Natural Resources).

Treatment of dense weed areas may result in oxygen loss from decomposition of dead weeds. This loss of oxygen may cause fish suffocation. Therefore, treat only 1/3 to 1/2 of the water body area at one time and wait 14 days between treatments.

For best results on submersed weeds, Reward Landscape and Aquatic Herbicide should be applied to actively growing (photosynthesizing) weeds when water temperatures have reached or exceeded approximately 50°F, typically during the Spring or early Summer.

For application only to **still water** (i.e. ponds, lakes, and drainage ditches) where there is minimal or no outflow to public waters.

and/or

For applications to **public waters** in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, canals, streams, rivers, and other slow-moving or quiescent bodies of water for control of aquatic weeds. For use by:

- Corps of Engineers; or
- Federal or State Public Agencies (i.e., Water Management District personnel, municipal officials); or
- Applicators and/or Licensees (certified for aquatic pest control) that are authorized by the State or Local government.

Treated water may be used according to the following table or until such time as an approved assay (example: PAM II Spectromatic Method) shows that the water does not contain more than the designated maximum contaminant level goal (MCLG) of 0.02 mg/l. (ppm) of diquat dibromide (calculated as the cation).

### Water Use Restrictions Following Applications With Reward Landscape And Aquatic Herbicide (Days)

| Application Rate | Drinking | Fishing and Swimming | Livestock/ Domestic Animals Consumption | Spray Tank Applications** and Irrigation to Turf and Landscape Ornamentals | Spray Tank Applications** and Irrigation to Food Crops and Production Ornamentals |
|---|---|---|---|---|---|
| 2 gals./surface acre | 3 days | 0 | 1 day | 3 days | 5 days |
| 1 gal./surface acre | 2 days | 0 | 1 day | 2 days | 5 days |
| 0.75 gal./surface acre | 2 days | 0 | 1 day | 2 days | 5 days |
| 0.50 gal./surface acre | 1 day | 0 | 1 day | 1 day | 5 days |
| Spot Spray* (<0.5 gal./surface acre) | 1 day | 0 | 1 day | 1 day | 5 days |

*Add a nonionic surfactant (with at least 75% of the constituents active as a spray adjuvant) at the rate recommended by the manufacturer.

**For preparing agricultural sprays for food crops, turf or ornamentals (to prevent phytotoxicity), do not use water treated with Reward Landscape and Aquatic Herbicide before the specified time period.

When the contents of more than one spray tank is necessary to complete a single aquatic application, no water holding restrictions apply between the consecutive spray tanks.

No applications are to be made in areas where commercial processing of fish, resulting in the production of fish protein concentrate or fish meal, is practiced. Before application, coordination and approval of local and/or State authorities must be obtained.

### Floating and Marginal Weeds Including:

Water lettuce, *Pistia stratiotes*
Water hyacinth, *Eichhornia crassipes*
Duckweed, *Lemna* spp.
Salvinia spp. (including *S. molesta*)
Pennywort (*Hydrocotyle* spp.)
Frog's Bit[1], *Limnobium spongia*
Cattails, *Typha* spp.

[1]Not for use in California

Reward Landscape and Aquatic Herbicide may be applied by backpack, airboat, spray handgun, helicopter, airplane, or similar application equipment that results in thorough spray coverage.

**Spot Treatment:** Apply Reward Landscape and Aquatic Herbicide at 2 quarts per 100 gallons spray carrier (0.5% solution) with an approved aquatic wetting agent at 0.25-1.0% v/v (1 quart to 1 gallon per 100 gallons water). For cattail control, Reward Landscape and Aquatic Herbicide should be applied prior to flowering at the maximum application rate (8 quarts of Reward Landscape and Aquatic Herbicide/100 gallons spray carrier) plus the wetting agent. Repeat treatments may be necessary for complete control.

Spray to completely wet target weeds but not to runoff. Densely packed weeds or mats may require additional applications due to incomplete spray coverage. Re-treat as needed. For best results, re-treat weed escapes within 2 weeks of the initial treatment.

**Broadcast Treatment:** Apply Reward Landscape and Aquatic Herbicide at the rate of 0.5-2.0 gallons per surface acre in sufficient carrier along with 16-32 oz./A of an approved wetting agent. Re-treat as necessary for densely populated weed areas. Good coverage is necessary for control of the target weeds.

For duckweed control, apply Reward Landscape and Aquatic Herbicide at 1-2 gallons/A.

**Submersed Weeds Including:**

Bladderwort, *Utricularia* spp.
Hydrilla, *Hydrilla verticillata*
Watermilfoils (including Eurasian), *Myriophyllum* spp.
Pondweeds[1], *Potamogeton* spp.
Coontail, *Ceratophyllum demersum*
Elodea, *Elodea* spp.
Brazilian Elodea, *Egeria densa*
Naiad, *Najas* spp.
Algae[2], *Spirogyra* spp. and *Pithophora* spp.

[1] Reward Landscape and Aquatic Herbicide controls *Potamogetan* species except Richardson's pondweed, *P. richardsonii*.

[2] Suppression only. For control of *Spirogyra* and/or *Pithophora*, use Reward Landscape and Aquatic Herbicide in a tank mix with an approved algaecide.

For severe weed or algae infestations, the use of an approved algaecide either as a pretreatment to the Reward Landscape and Aquatic Herbicide application or in a tank mix, may result in enhanced weed control.

To control submersed weeds, apply Reward Landscape and Aquatic Herbicide in water at 0.5-2.0 gallons per surface acre (per 4 foot water depth). For severe weed infestations, use the 2.0 gallon per surface acre rate. For best results, re-treat as necessary on 14-21 day intervals. The table below shows how many gallons of Reward Landscape and Aquatic Herbicide to apply per surface acre based on water depth.

| | Gallons of Reward Landscape and Aquatic Herbicide per Surface Acre Average Water Depth | | | |
|---|---|---|---|---|
| | 1 Foot | 2 Feet | 3 Feet | 4 Feet |
| 1 gallon/acre rate | 0.25 gal. | 0.50 gal. | 0.75 gal. | 1.0 gal. |
| 2 gallon/acre rate | 0.50 gal. | 1.0 gal. | 1.5 gals. | 2.0 gals. |

**Note:** For water depths of 2 feet or less including shorelines, do not exceed 1 gallon per surface acre.

**Subsurface Applications:** Where the submersed weed growth, especially Hydrilla, has reached the water surface, apply either in a water carrier or an invert emulsion through boom trailing hoses carrying nozzle tips to apply the dilute spray below the water surface to insure adequate coverage.

**Bottom Placement:** Where submersed weeds such as Hydrilla, Bladderwort, or Coontail have reached the water surface and/or where the water is slowly moving through the weed growth, the use of an invert emulsion carrier injecting diluted Reward Landscape and Aquatic Herbicide near the bottom with weighted hoses may improve control. The addition of a copper based algaecide may improve control. If algae are present along with the submersed weeds, a pretreatment with a copper based algaecide may improve overall control.

**Surface Application for Submerged Aquatic Weeds:** Apply the recommended rate of Reward Landscape and Aquatic Herbicide as a spray in sufficient carrier to fully cover the target area. Applications should be made to ensure complete coverage of the weed areas. In mixed weed populations, use the high rate of application as indicated by weeds present. For dense submersed weeds or water over 2 feet deep, a surface spray is not recommended (Reward Landscape and Aquatic Herbicide should be applied subsurface in these situations.)

**If posting is required by your state or tribe – consult the agency responsible for pesticide regulations for specific details.**

## STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

### Pesticide Storage

Keep pesticide in original container. Do not put concentrate or dilute into food or drink containers. Do not contaminate feed, foodstuffs, or drinking water. Do not store or transport near feed or food. Store at temperatures above 32°F. For help with any spill, leak, fire, or exposure involving this material, call **1-800-888-8372.**

### Pesticide Disposal

Open dumping is prohibited. Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

### Container Handling [less than 5 gallons]

Non-refillable container. Do not reuse or refill this container. Offer for recycling if available. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use and disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

## Container Handling [Bulk/Mini-Bulk]

Refillable container. Refill this container with Reward Landscape and Aquatic Herbicide only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the person refilling. To clean container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10 percent full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times. Then offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures allowed by state and local authorities. If the container is damaged, leaking or obsolete, contact Syngenta Crop Protection at 1-800-888-8372.

For minor spills, leaks, etc., follow all precautions indicated on this label and clean up immediately. Take special care to avoid contamination of equipment and facilities during cleanup procedures and disposal of wastes. In the event of a major spill, fire, or other emergency, call 1-800-888-8372, day or night.

**CONTAINER IS NOT SAFE FOR FOOD, FEED, OR DRINKING WATER!**

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the SYNGENTA Logo and the PURPOSE ICON
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For non-emergency (e.g., current product information), call Syngenta Crop Protection at 1-800-334-9481.

Manufactured for:
Syngenta Crop Protection, LLC
P. O. Box 18300
Greensboro, North Carolina 27419-8300

**SCP 1091A-L2G 1009**
**4034800**

# Reward®
Landscape and aquatic herbicide

# Landscape and Aquatic Herbicide

**TO PREVENT ACCIDENTAL POISONING, NEVER PUT INTO FOOD, DRINK, OR OTHER CONTAINERS, AND USE STRICTLY IN ACCORDANCE WITH ENTIRE LABEL.**

**DO NOT USE THIS PRODUCT FOR REFORMULATION.**

| Active Ingredient: | |
|---|---|
| Diquat dibromide [6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium dibromide] | 37.3% |
| Other Ingredients: | 62.7% |
| Total: | 100.0% |

Contains 2 lbs. diquat cation per gal. (3.73 lbs. diquat dibromide per gal.)

See additional precautionary statements in booklet.

**AGRICULTURAL USE REQUIREMENTS**

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR part 170. Refer to supplemental labeling under "Agricultural Use Requirements" in the Directions for Use section for information about this standard.

EPA Reg. No. 100-1091
EPA Est. 100-LA-001

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Manufactured for:
Syngenta Crop Protection, LLC
P. O. Box 18300
Greensboro, North Carolina 24719-8300

**SCP 1091A-L2G 1009**
**4034800**

(01) 0 07 02941 73710 5

## KEEP OUT OF REACH OF CHILDREN.

# CAUTION

### FIRST AID

**If inhaled:** Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.

**If swallowed:** Call poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.

**If in eyes:** Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

**If on skin or clothing:** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

**NOTE TO PHYSICIANS:** To be effective, treatment for diquat poisoning must begin **IMMEDIATELY.** Treatment consists of binding diquat in the gut with suspensions of activated charcoal or bentonite clay, administration of cathartics to enhance elimination, and removal of diquat from the blood by charcoal hemoperfusion or continuous hemodialysis.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment.

**HOT LINE NUMBER:** For 24-Hour Medical Emergency Assistance (Human or Animal) or Chemical Emergency Assistance (Spill, Leak, Fire, or Accident), Call 1-800-888-8372.

## PRECAUTIONARY STATEMENTS

**Hazards to Humans and Domestic Animals**

**CAUTION**

Harmful if inhaled. Harmful if swallowed. Causes moderate eye irritation. Avoid breathing spray mist. Avoid contact with eyes, skin, or clothing.

**Environmental Hazards:** This pesticide is toxic to aquatic invertebrates. For Terrestrial Uses, do not apply directly to water, or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of equipment wash water. For Aquatic Uses do not apply directly to water except as specified on this label.

## STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

**Pesticide Storage:** Keep pesticide in original container. Do not put concentrate or dilute into food or drink containers. Do not contaminate feed, foodstuffs, or drinking water. Do not store or transport near feed or food. Store at temperatures above 32°F. For help with any spill, leak, fire, or exposure involving this material, call 1-800-888-8372.

**Pesticide Disposal:** Open dumping is prohibited. Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

**Container Handling [less than 5 gallons]:** Non-refillable container. Do not reuse or refill this container. Offer for recycling if available. Triple rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use and disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration, or if allowed by State and local authorities, by burning. If burned, stay out of smoke.

For minor spills, leaks, etc., follow all precautions indicated on this label and clean up immediately. Take special care to avoid contamination of equipment and facilities during cleanup procedures and disposal of wastes. In the event of a major spill, fire, or other emergency, call 1-800-888-8372, day or night.

**CONTAINER IS NOT SAFE FOR FOOD, FEED, OR DRINKING WATER!**

# 2.5 gallons
**Net Contents**

syngenta®

Product Label

syngenta

# FIFRA 24(c) Special Local Need Label (SLN)

## FOR DISTRIBUTION AND USE ONLY WITHIN THE STATE OF CALIFORNIA

**For The Control of *Egeria Densa* And Other Submersed Weeds**

# REWARD® Landscape and Aquatic Herbicide

**EPA Reg No. 100-1091** **EPA SLN No. CA-040012**

**This label expires and must not be distributed or used in accordance with this SLN registration after September 30, 2020**

FAILURE TO FOLLOW THE DIRECTIONS FOR USE AND PRECAUTIONS ON THIS LABEL MAY RESULT IN POOR PEST CONTROL, CROP INJURY, OR ILLEGAL RESIDUES.

## DIRECTIONS FOR USE

- It is a violation of federal law to use this product in a manner inconsistent with its labeling.
- This state-specific Section 24(c) labeling must be in the possession of the user at the time of application.
- Follow all applicable directions, restrictions, and precautions on the EPA-registered Reward® Landscape and Aquatic Herbicide, EPA Reg No. 100-1091 label and this label.

**For applications to public waters in ponds, lakes, reservoirs, marshes, bayous, drainage ditches, canals, streams, rivers and other slow-moving or quiescent bodies of water for control of aquatic weeds. For use by:**

- **Corps of Engineers; or**
- **Federal or State Public Agencies; or**
- **Applicators and/or licensees (Certified for aquatic pest control) that are authorized by the State or local government.**

**Treated water may be used according to the table outlined on the Federal label (also listed below) or until such time as an approved assay (example: PAM II Spectromatic Method) shows that the water does not contain more than the designated maximum contaminant level goal (MCLG) of 0.02 mg/l (ppm) of diquat dibromide (calculated as the cation).**

**For the control of submersed weeds, apply REWARD Landscape and Aquatic Herbicide at the rate of 0.5 - 2 gallons per 4 acre feet of water (target concentration not to exceed 0.37 ppm ). These rates are based on a maximum water depth of 4 feet. If water depth exceeds 4 feet, higher rates per surface acre may be required for submersed weeds to obtain control. Use the table below to determine rate for specific water depth greater than 4 feet.**

**Application Rates for Submersed Weeds**

| WATER DEPTH | RATE OF REWARD PER TREATED SURFACE AREA |
|---|---|
| < 2 feet | 0.5 - 1.0 gal |
| 2-4 feet | 1.0 - 2.0 gal |
| 5 feet | 1.0 - 2.5 gal |
| 6 feet | 1.0 - 3.0 gal |
| 7 feet | 1.0 - 3.5 gal |
| 8 feet | 1.0 - 4.0 gal |
| 9 feet | 1.0 - 4.5 gal |
| 10 feet | 1.0 - 5.0 gal |
| 11 feet | 1.0 - 5.5 gal |
| 12 feet | 1.0 - 6.0 gal |

Apply REWARD Herbicide in sufficient carrier to ensure good weed plant coverage either to the surface in a low/no pressure application or subsurface.

Repeat applications should be made on 14-day intervals as needed to ensure control of missed plants and regrowth.

- For best results, begin applications when water temperatures reach 50 degrees. Applications to water colder than 50 degrees may result in unacceptable control.

- For best results, begin applications in the early spring when plants are young and in the early stages of growth.

Do not make more than 4 applications to a treated area per year.

## WATER USE RESTRICTIONS FOLLOWING APPLICATIONS WITH REWARD Landscape and Aquatic Herbicide (Days)

| Application Rate | Drinking | Fishing and Swimming | Livestock Consumption | Spray Tank Applications** and Irrigation to Turf and Ornamentals | Spray Tank Applications** and Irrigation to Food Crops |
|---|---|---|---|---|---|
| ≥ 2 gal/surface acre | 3 days | 0 | 1 day | 3 days | 5 days |
| 1 gal/surface acre | 2 days | 0 | 1 day | 2 days | 5 days |
| 0.75 gal/surface acre | 2 days | 0 | 1 day | 2 days | 5 days |
| 0.50 gal/surface acre | 1 day | 0 | 1 day | 1 day | 5 days |
| Spot spray* (< 0.5 gal/surface area) | 1 day | 0 | 1 day | 1 day | 5 days |

* Rates refer to total surface area.

** For preparing agricultural sprays for food crops, turf or ornamentals (to prevent phytotoxicity), do not use water treated with REWARD landscape and Aquatic Herbicide before the specified time period. When the contents of more than one spray tank is necessary to complete a single aquatic application, no water holding restrictions apply between the consecutive spray tanks.

No applications are to be made in areas where commercial processing of fish, resulting in the production of fish protein concentrate or fish meal, is practiced. Before application, coordination and approval of local and/or State authorities must be obtained.

This product must be used in accordance with Interim Measure bulletins for endangered species in affected counties.

Reward® Landscape and Aquatic Herbicide is a registered trademark of a Syngenta Group Company

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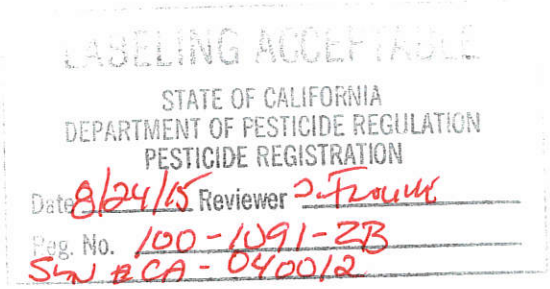
24(c) registrant:
Syngenta Crop Protection, LLC
Greensboro, North Carolina 27419
Phone Number: 1-800-334-9481

EPA SLN No.: CA-040012

Label Code: CA1091062BA0815



# MATERIAL SAFETY DATA SHEET

**Syngenta Crop Protection, Inc.**
**Post Office Box 18300**
**Greensboro, NC 27419**

**In Case of Emergency, Call**
**1-800-888-8372**

## 1. PRODUCT IDENTIFICATION

Product Name: **REWARD LANDSCAPE AND AQUATIC HERBICIDE** Product No.: A12872A

EPA Signal Word: Warning

Active Ingredient(%): Diquat dibromide (37.3%) CAS No.: 85-00-7

Chemical Name: [6,7-dihydrodipyrido(1,2-a:2',1'-c)pyrazinediium dibromide]

Chemical Class: Bipyridilium (dipyridilium) contact herbicide

EPA Registration Number(s): 100-1091 (formerly 10182-404) **Section(s) Revised: All sections**

## 2. COMPOSITION/INFORMATION ON INGREDIENTS

| Material | OSHA PEL | ACGIH TLV | Other | NTP/IARC/OSHA Carcinogen |
|---|---|---|---|---|
| Diquat dibromide (37.3%) | Not Established | 0.5 mg/m³ TWA (total dust); 0.08 mg/m³ TWA (respirable dust) | 0.5 mg/m³ TWA** | No |

** recommended by NIOSH

Ingredients not precisely identified are proprietary or non-hazardous. Values are not product specifications.

## 3. HAZARDS IDENTIFICATION

Symptoms of Acute Exposure

Harmful if inhaled or swallowed. Dust, mist or vapor irritating to eyes and respiratory tract. May cause skin irritation.

Hazardous Decomposition Products

Can decompose at high temperatures forming toxic gases.
Flammable hydrogen gas may be formed on contact with aluminum. See "Conditions to Avoid", Section 10.

Physical Properties

Appearance: Dark brown liquid

Odor: Odorless

Unusual Fire, Explosion and Reactivity Hazards

This product may form flammable and explosive hydrogen gas when in contact with aluminum.

## 4. FIRST AID MEASURES

Have the product container, label or Material Safety Data Sheet with you when calling Syngenta (800-888-8372), a poison contol center or doctor, or going for treatment.

Ingestion: If swallowed: Call Syngenta (800-888-8372), a poison control center or doctor immediately for treatment advice. Have the person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so after calling 800-888-8372 or by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

Eye Contact: If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after 5 minutes, then continue rinsing eye. Call Syngenta (800-888-8372), a poison control center or doctor for treatment advice.

Skin Contact: If on skin or clothing: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call Syngenta (800-888-8372), a poison control center or doctor for treatment advice.

Inhalation: If inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call Syngenta (800-888-8372), a poison control center or doctor for further treatment advice.

Notes to Physician

There is no specific antidote if this product is ingested.

Treat symptomatically.

Medical Condition Likely to be Aggravated by Exposure

None known.

## 5. FIRE FIGHTING MEASURES

Fire and Explosion

| | | |
|---|---|---|
| Flash Point (Test Method): | Not Applicable | |
| Flammable Limits (% in Air): | Lower: % Not Applicable | Upper: % Not Applicable |
| Autoignition Temperature: | Not Applicable | |
| Flammability: | Not Applicable | |

Unusual Fire, Explosion and Reactivity Hazards

This product may form flammable and explosive hydrogen gas when in contact with aluminum.

In Case of Fire

Use dry chemical, foam or CO2 extinguishing media. Wear full protective clothing and self-contained breathing apparatus. Evacuate nonessential personnel from the area to prevent human exposure to fire, smoke, fumes or products of combustion. Prevent use of contaminated buildings, area, and equipment until decontaminated. Water runoff can cause environmental damage. If water is used to fight fire, dike and collect runoff.

## 6. ACCIDENTAL RELEASE MEASURES

In Case of Spill or Leak

Control the spill at its source. Contain the spill to prevent it from spreading, contaminating soil, or entering sewage and drainage systems or any body of water. Clean up spills immediately, observing precautions outlined in Section 8. If a solid, sweep up material and place in a compatible disposal container. If a liquid, cover entire spill with absorbing material and place into compatible disposal container. Scrub area with hard water detergent (e.g. commercial products such as Tide, Joy, Spic and Span). Pick up wash liquid with additional absorbent and place into compatible disposal container. Once all material is cleaned up and placed in a disposal container, seal container and arrange for disposition.

## 7. HANDLING AND STORAGE

This product reacts with aluminum to produce flammable hydrogen gas. Do not mix or store in containers or systems made of aluminum or having aluminum fittings.

Store the material in a well-ventilated, secure area out of reach of children and domestic animals. Do not store food, beverages or tobacco products in the storage area. Prevent eating, drinking, tobacco use, and cosmetic application in areas where there is a potential for exposure to the material. Wash thoroughly with soap and water after handling.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

**THE FOLLOWING RECOMMENDATIONS FOR EXPOSURE CONTROLS/PERSONAL PROTECTION ARE INTENDED FOR THE MANUFACTURE, FORMULATION AND PACKAGING OF THE PRODUCT.**

**FOR COMMERCIAL APPLICATIONS AND ON-FARM APPLICATIONS CONSULT THE PRODUCT LABEL.**

Ingestion: Prevent eating, drinking, tobacco usage and cosmetic application in areas where there is a potential for exposure to the material. Wash thoroughly with soap and water after handling.

| | |
|---|---|
| Eye Contact: | Where eye contact is likely, use chemical splash goggles. Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. |
| Skin Contact: | Where contact is likely, wear chemical-resistant (such as nitrile or butyl) gloves, coveralls, socks and chemical-resistant footwear. For overhead exposure, wear chemical-resistant headgear. |
| Inhalation: | Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below exposure limits. A NIOSH-certified combination air-purifying respirator with an N, P or R 95 or HE class filter and an organic vapor cartridge may be permissible under certain circumstances where airborne concentrations are expected to exceed exposure limits. Protection provided by air-purifying respirators is limited. Use a pressure demand atmosphere-supplying respirator if there is any potential for uncontrolled release, exposure levels are not known, or under any other circumstances where air-purifying respirators may not provide adequate protection. |

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | |
|---|---|
| Appearance: | Dark brown liquid |
| Odor: | Odorless |
| Melting Point: | Not Available |
| Boiling Point: | Not Available |
| Specific Gravity/Density: | 1.20 g/mL @ 68°F (20°C) |
| pH: | 4-6 |

Solubility in H2O

| | |
|---|---|
| Diquat dibromide: | 718,000 mg/L @ 68°F (20°C) and pH 7.2 |

Vapor Pressure

| | |
|---|---|
| Diquat dibromide: | <10(-8) mmHg @ 77°F (25°C) |

## 10. STABILITY AND REACTIVITY

| | |
|---|---|
| Stability: | Stable under normal use and storage conditions. |
| Hazardous Polymerization: | Will not occur. |
| Conditions to Avoid: | Concentrate should not be stored in aluminum containers. Spray solutions should not be mixed, stored or applied in containers other than plastic, plastic-lined steel, stainless steel or fiberglass. |
| Materials to Avoid: | Strong alkalis and anionic wetting agents (e.g., alkyl and alkylaryl sulfonates). Corrosive to aluminum. |
| Hazardous Decomposition Products: | Can decompose at high temperatures forming toxic gases. Flammable hydrogen gas may be formed on contact with aluminum. See "Conditions to Avoid", Section 10. |

## 11. TOXICOLOGICAL INFORMATION

Acute Toxicity/Irritation Studies (Finished Product)

| | | |
|---|---|---|
| Ingestion: | Slightly Toxic | |
| | Oral (LD50 Rat) : | = 600 mg/kg body weight |
| Dermal: | Moderately Toxic | |
| | Dermal (LD50 Rabbit) : | = 260 mg/kg body weight |
| Inhalation: | Moderately Toxic | |
| | Inhalation (LC50 Rat) : | = 0.121 mg/l air - 4 hours |
| Eye Contact: | Irritant | |
| Skin Contact: | Not Available | |
| Skin Sensitization: | Not Available | |

Neurotoxicity

Diquat dibromide: No evidence for neurotoxic effects in rats dosed up to 400 ppm ion in the diet for 13 weeks.

Reproductive Effects

Diquat dibromide: Mutagenicity: No evidence in in vivo assays.

Development Toxicity: In rabbit studies a small percentage of fetuses had minor defects at 3 and 10 mg ion/kg/d.

Chronic/Subchronic Toxicity Studies

Diquat dibromide: Kidney weight decreases and cataracts seen in dogs at 12.5 mg ion/kg/d.

Carcinogenicity

Diquat dibromide: No evidence of carcinogenicity in rat and mouse studies.

Other Toxicity Information

None.

Toxicity of Other Components

Not Applicable

Target Organs

Active Ingredients

Diquat dibromide: Eye, kidney

Inert Ingredients

: Not Applicable

## 12. ECOLOGICAL INFORMATION

Summary of Effects

Diquat dibromide:

This material is toxic to fish and wildlife.

Eco-Acute Toxicity

Diquat dibromide: Rainbow Trout 96-hour LC50 21 mg/L
Mirror Carp 96 hours LC50 67 mg/L

Eco-Chronic Toxicity

Diquat dibromide: Not Available

Environmental Fate

Diquat dibromide:

No data available for the formulation. The information presented here is for the active ingredient, diquat debromide.
Sorption: Extremely tightly adsorbed to (negatively-charged) soil particles due to its dicationic nature. Diquat is primarily adsorbed to clay, less so to OM. Diquat bound to soil is unavailable for plant uptake and is largely unavailable to soil microbes.
Koc: Average is 1,000,000 mL/g (estimated).
Photodegradation: Losses probably occur on sprayed leaf surfaces and on dead and decaying vegetation. Photochemical decomposition of diquat has been measured in the lab by irradiating thin layers of soil, but has not been unequivocally demonstrated under field conditions.
Other degradation: Certain microbe species in soil-less culture media decompose diquat. However, they degrade diquat bound to soil slowly or not at all.
Persistence: Typical half-life is 1000 d. Diquat is highly persistent due to strong binding to clay and unavailability to microbes. Diquat in soil is not taken up by plants, so any crop can be seeded at any time after application.
Mobility: Immobile in soil.
Volatilization: No losses.

## 13. DISPOSAL CONSIDERATIONS

Disposal

Do not reuse product containers. Dispose of product containers, waste containers, and residues according to local, state, and federal health and environmental regulations.

Characteristic Waste: Not Applicable

Listed Waste: Not Applicable

## 14. TRANSPORT INFORMATION

DOT Classification

Corrosive Liquid, N.O.S. (diquat dibromide, 37.3%), 8, UN1760, PGIII

B/L Freight Classification

Herbicides, NOIBN

Comments

International Transportation
Corrosive Liquid, N.O.S. (diquat dibromide, 37.3%), Class 8, UN1760, PGIII

## 15. REGULATORY INFORMATION

EPCRA SARA Title III Classification

Section 311/312 Hazard Classes: Acute Health Hazard
Chronic Health Hazard

Section 313 Toxic Chemicals: Not Applicable

California Proposition 65

None

CERCLA/SARA 302 Reportable Quantity (RQ)

None

RCRA Hazardous Waste Classification (40 CFR 261)

Not Applicable

TSCA Status

Exempt from TSCA, subject to FIFRA

## 16. OTHER INFORMATION

| NFPA Hazard Ratings | | HMIS Hazard Ratings | |
|---|---|---|---|
| Health: | 2 | Health: | 2 |
| Flammability: | 1 | Flammability: | 1 |
| Instability: | 0 | Reactivity: | 0 |

| | |
|---|---|
| 0 | Minimal |
| 1 | Slight |
| 2 | Moderate |
| 3 | Serious |
| 4 | Extreme |

For non-emergency questions about this product call:

1-800-334-9481

Original Issued Date: 04/11/2002
Revision Date: Replaces:

The information and recommendations contained herein are based upon data believed to be correct. However, no guarantee or warranty of any kind, expressed or implied, is made with respect to the information contained herein.

RSVP# : SCP-955-00349A

End of MSDS

Product File
270023

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 8/28/15 Reviewer Chris Corsen
Reg. No. 70506-176-AA

Actual size

2020205 Aquathol K 2.5G BNB 70506-176 5336CR3 3/25/15 8:34 AM Page 1

AQUATIC HABITAT MANAGEMENT

# AQUATHOL® K

## AQUATIC HERBICIDE

**For aquatic plant control in quiescent, slow moving, and flowing water aquatic sites.**

| | |
|---|---|
| **ACTIVE INGREDIENT:** | |
| Dipotassium salt of endothall* | 40.3% |
| **OTHER INGREDIENTS:** | 59.7% |
| **TOTAL** | 100.0% |

Contains 4.23 lbs. dipotassium endothall* per gallon
*7-oxabicyclo [2.2.1]heptane-2,3-dicarboxylic acid equivalent 28.6%

## KEEP OUT OF REACH OF CHILDREN
## DANGER PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

### FIRST AID

**IF IN EYES:**
- Hold eye open and rinse slowly and gently with water for 15-20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing.
- Call a poison control center or doctor for treatment advice.

**IF SWALLOWED:**
- Call a poison control center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told by a poison control center or doctor.
- Do not give anything by mouth to an unconscious person.

**IF ON SKIN OR CLOTHING:**
- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15-20 minutes.
- Call a poison control center or doctor for treatment advice.

**IF INHALED:**
- Move person to fresh air.
- If person is not breathing, call 911 or ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.
- Call a poison control center or doctor for treatment advice.

**HOT LINE NUMBER:** Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 866-673-6671 (Rocky Mountain Poison Control Center) for emergency medical treatment information.

See inside for additional precautionary statements.

**NOTE TO PHYSICIAN:** Measures against circulatory shock, respiratory depression, and convulsion may be needed.

**EPA Registration No. 70506-176**

**Net Contents: 2.5 Gallons**

UPI

**United Phosphorus, Inc.**
630 Freedom Business Center, Suite 402
King of Prussia, PA 19406 • 1-800-438-6071

## PRODUCT INFORMATION

Aquathol K is a liquid concentrate soluble in water which is effective against a broad range of aquatic plants. Dosage rates indicated for the application of Aquathol K are measured in parts per million (ppm) of dipotassium endothall.

## PRECAUTIONARY STATEMENTS
## HAZARDS TO HUMANS AND DOMESTIC ANIMALS

# DANGER

CORROSIVE. CAUSES IRREVERSIBLE EYE DAMAGE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. DO NOT GET IN EYES, ON SKIN, OR ON CLOTHING. AVOID BREATHING VAPORS OR SPRAY MIST. PROLONGED OR FREQUENTLY REPEATED SKIN CONTACT MAY CAUSE ALLERGIC REACTIONS IN SOME INDIVIDUALS.

**Personal Protective Equipment (PPE)**

Mixers, Loaders, Applicators and other handlers must wear:

- Long-sleeved shirt and long pants,
- Shoes and socks,
- Chemical-resistant gloves made of any waterproof material,
- Protective eyewear,
- NIOSH-approved respirator with a dust/mist filter with MSHA/NIOSH approval number prefix TC-21C or any N, R, P, or HE filter.

  Exception: During application, the respirator need not be worn, provided that the pesticide is applied in a manner (such as direct metering or subsurface application from the rear of a vessel that is moving into the wind) such that the applicator will have no contact with the pesticide.

See Engineering Controls for additional requirements.

**User Safety Requirements:**

Follow the manufacturers' instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

Discard clothing or other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them.

**Engineering Controls:**

When mixers and loaders use a closed system designed by the manufacturer to enclose the pesticide to prevent it from contacting handlers or other people AND the system is functioning properly and is used and maintained in accordance with the manufacturers written operating instructions, the handlers need not wear a respirator, provided the required respirator is immediately available for use in an emergency such as a spill or equipment breakdown.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

**User Safety Recommendations**

User should:

- Wash hands thoroughly after handling and before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

## ENVIRONMENTAL HAZARDS

Do not contaminate water by cleaning of equipment or disposal of equipment washwaters.

This pesticide is toxic to mammals.

Treatment of aquatic plants can result in oxygen loss from decomposition of dead plants. This loss can cause fish suffocation. Water bodies containing very high plant density should be treated in sections to prevent suffocation of fish.

## DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift.

- For quiescent or slow moving water treatments: Waters treated with Aquathol K may be used for swimming, fishing, and irrigating turf, ornamental plants and crops immediately after treatment.
- Do not use treated water for animal consumption within the following periods:

  0.5 ppm dipotassium salt – 7 days after application

  4.25 ppm dipotassium salt – 14 days after application

  5.0 ppm dipotassium salt – 25 days after application
- For flowing water treatments: Waters treated with Aquathol K may be used for swimming, fishing, livestock watering, and irrigating turf, ornamental plants and crops immediately after treatment.
- Phytotoxicity is not expected on plants or crops irrigated with Aquathol K treated water, however, all species and cultivars (varieties) have not been tested.
- Undiluted Aquathol K may be injurious to crops, grass, ornamentals, and other foliage.
- Do not use Aquathol K treated water for chemigation as interactions between Aquathol K and other pesticides and fertilizers are not known.
- Do not use Aquathol K in brackish or saltwater.
- Wash out spray equipment with water after each operation.
- Avoid contact of spray concentrate (product) directly or by drift with non-target plants or crops as injury may result.
- United Phosphorus, Inc. recommends not reducing Aquathol K rates below those specified within this label, when using Aquathol K in a treatment combination, or as a tank mix, with product(s) containing ALS inhibitor active ingredients, unless specified otherwise on this label or a United Phosphorus, Inc. supplemental label.

### HOW TO APPLY:

Aquathol K is a contact herbicide; consequently, apply when target plants are present.

Aquathol K should be sprayed on the water or injected below the water surface. It may be applied as a concentrate or diluted with water depending on the equipment.

In instances where the plant(s) to be controlled is an exposed surface problem (i.e., some of the broad-leaved pond weeds), coverage is important. For best results, apply the concentrate with the least amount of water compatible with the application equipment.

**Drinking Water (Potable Water)**

Consult with appropriate state or local water authorities before applying this product to public waters. State or local agencies may require permits.

The drinking water (potable water) restrictions on this label are to ensure that consumption of water by the public is allowed only when the concentration of endothall acid in the water is less than the MCL (Maximum Contamination Level) of 0.1 ppm. Applicators should consider the unique characteristics of the treated waters to assure that endothall acid concentrations in potable drinking water do not exceed 0.1 ppm at the time of consumption.

**For Lakes, Ponds, and other Quiescent Water Bodies:**

- For Aquathol K applications, the drinking water setback distance from functioning potable water intakes in the treated water body must be greater than or equal to 600 feet.
- Note: Existing potable water intakes that are no longer in use, such as those replaced by a connection to a municipal water system or a potable water well, are not considered to be functioning potable water intakes.

**For Flowing Water Bodies:**

- Applicator is responsible to assure that treated water exceeding the MCL of 0.1 ppm does not enter potable water intakes. For Aquathol K applications, potable water intakes must be closed when treated water exceeding the MCL of 0.1 ppm is present at the intake. In the event the water intake cannot be closed (when treated water is present that exceeds 0.1 ppm), treatments must only be made downstream from the intake in order to assure Aquathol K treated water above 0.1 ppm does not enter the potable water system.

## QUIESCENT OR SLOW MOVING WATER TREATMENTS: SURFACE OR INJECTED APPLICATIONS

For aquatic plant control in quiescent or slow moving water, Aquathol K use rates can be found in the following chart. Since the active ingredient is water soluble and tends to diffuse from the treated area, select the dosage rate applicable to the area to be treated. Marginal treatments of large bodies of water require higher rates as indicated.

Use higher labeled rates of Aquathol K when making treatments to small areas with an increased potential for rapid dilution or when treating narrow areas such as boat lanes or shoreline treatments where dilution may reduce the exposure of plants to Aquathol K.

Use lower labeled rates of Aquathol K for large contiguous treatment blocks or in protected areas such as coves where reduced water movement will not result in rapid dilution of Aquathol K from the target treatment area or when treating entire lakes or ponds.

### PLANTS CONTROLLED AND AQUATHOL K DOSAGE RATES FOR SURFACE OR INJECTED APPLICATION IN QUIESCENT OR SLOW-MOVING WATER

| | APPLICATION RATE | | | |
|---|---|---|---|---|
| | Entire Pond/Lake or Large Area Treatment | | Spot or Lake Margin Treatment | |
| Aquatic Plant | ppm Dipotassium Endothall | gallons Aquathol K per Acre Ft. | ppm Dipotassium Endothall | gallons Aquathol K per Acre Ft. |
| Coontail, *Ceratophyllum* spp. | 2.0-3.0 | 1.3-1.9 | 3.0-5.0 | 1.9-3.2 |
| Horned Pondweed, *Zannichellia palustris* | 2.0-3.0 | 1.3-1.9 | 3.0-5.0 | 1.9-3.2 |
| Sago Pondweed, *Stuckenia pectinata* | 1.0-2.0 | 0.6-1.3 | 2.0-5.0 | 1.3-3.2 |
| Hydrilla, *Hydrilla verticillata* | 1.0-4.0 | 0.6-2.6 | 2.0-5.0 | 1.3-3.2 |
| Hygrophila*, *Hygrophila polysperma* | 4.0-5.0 | 2.6-3.2 | 5.0 | 3.2 |
| Milfoil, *Myriophyllum* spp. | 2.0-3.0 | 1.3-1.9 | 3.0-5.0 | 1.9-3.2 |
| Naiad, *Najas* spp. | 2.0-4.0 | 1.3-2.6 | 3.0-5.0 | 1.9-3.2 |
| Pondweed, *Potamogeton* spp. | 0.75-3.0 | 0.45-1.9 | 1.5-5.0 | 1.0-3.2 |
| **Including:** | | | | |
| American, *P. nodosus* | 2.0-3.0 | 1.3-1.9 | 3.0-5.0 | 1.9-3.2 |
| Largeleaf (Bass Weed), *P. amplifolius* | 2.0-3.0 | 1.3-1.9 | 3.0-5.0 | 1.9-3.2 |
| Curlyleaf, *P. crispus* | 0.75-1.5 | 0.45-1.0 | 1.5-5.0 | 1.0-3.2 |
| Flatstem, *P. zosteriformis* | 2.0-3.0 | 1.3-1.9 | 3.0-5.0 | 1.9-3.2 |
| Floating-leaf, *P. natans* | 1.0-2.0 | 0.6-1.3 | 2.0-5.0 | 1.3-3.2 |
| Illinois, *P. illinoensis* | 1.5-2.5 | 1.0-1.6 | 2.5-5.0 | 1.6-3.2 |
| Narrowleaf, *P. pusillus* | 1.0-2.0 | 0.6-1.3 | 2.0-5.0 | 1.3-3.2 |
| Threadleaf, *P. filiformis* | 2.0-3.0 | 1.3-1.9 | 3.0-5.0 | 1.9-3.2 |
| Variable Leaf, *P. diversifolius* | 1.0-2.0 | 0.6-1.3 | 2.0-5.0 | 1.3-3.2 |
| Parrotfeather, *Myriophyllum aquaticum* | 2.0-3.0 | 1.3-1.9 | 3.0-5.0 | 1.9-3.2 |
| Water Stargrass, *Heteranthera* spp. | 2.0-3.0 | 1.3-1.9 | 3.0-5.0 | 1.9-3.2 |

* Suppression only

The following charts indicate the quantity of Aquathol K to be applied.

**Gallons of Aquathol K to Treat One Acre-Foot of Water**

| | Rate (ppm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.75 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| | gallons/A-ft. | | | | | | |
| 1 acre ft. | 0.45 | 0.6 | 1.0 | 1.3 | 1.9 | 2.6 | 3.2 |

**Fluid Ounces of Aquathol K to Treat 1,000 Square-Feet per Foot of Depth**

| | Rate (ppm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.75 | 1.0 | 1.5 | 2.0 | 3.0 | 4.0 | 5.0 |
| | fl. oz./1,000 ft.$^2$ | | | | | | |
| 1,000 ft.$^2$ | 1.4 | 1.9 | 2.8 | 3.8 | 5.7 | 7.6 | 9.4 |

## FLOWING WATER TREATMENTS (WITH THE EXCEPTION OF IRRIGATION CANALS): DRIP OR METERING SYSTEM APPLICATIONS

For aquatic plant control in flowing water, Aquathol K use rates can be found in the following chart. Apply Aquathol K in a manner to achieve the desired rate and adequate mixing so product is distributed throughout the entire water column. Adequate concentration (rate) and exposure time (length of treatment) will impact Aquathol K efficacy on the target plant species. Although Aquathol K is a contact herbicide adequate exposure time is critical. The following rate chart has been developed based on Concentration Exposure Time (CET) data for Aquathol K. The CET concept allows rates and the length of exposure to be adjusted for different treatment scenarios.

### AQUATHOL K APPLICATION RATES FOR DRIP OR METERING APPLICATION SYSTEMS IN FLOWING WATER

| | Length of Treatment (hours) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 6 | 8 | 12 | 18 | 24 | 36 | 48 | 72 |
| **Plant Species** | Rate (ppm) | | | | | | | |
| Pondweeds *(Potamogeton* spp.*)*<br>Sago Pondweed *(Stuckenia pectinata)* | 4.0-5.0 | 3.0-4.0 | 2.0-3.0 | 1.5-2.5 | 1.0-2.0 | 0.75-1.5 | 0.5-1.0 | 0.5 |
| Milfoil *(Myriophyllum* spp.*)*<br>Parrotfeather *(Myriophyllum aquaticum)*<br>Coontail *(Ceratophyllum* spp.*)*<br>Horned pondweed *(Zannichellia* spp.*)*<br>Hydrilla *(Hydrilla verticillata)*<br>Naiad *(Najas* spp.*)*<br>Water Stargrass *(Heteranthera* spp.*)* | 5.0 | 4.0-5.0 | 3.0-4.0 | 2.0-3.0 | 1.5-2.5 | 1.0-2.0 | 0.75-1.5 | 0.5-1.0 |

NOTE: Hygrophila *(Hygrophila polysperma)* may be suppressed at the higher application rates listed in this table.

**Restrictions:** Do not apply more than 30 ppm per growing season, not to exceed 5 ppm per application. Do not apply more than a total of 5 ppm within a 7-day interval.

**Note:** There is no Pre-harvest Interval (PHI) for crops irrigated with treated water.

To calculate the amount of Aquathol K required for a particular treatment use the following formula:

**[Cubic Feet per Second (CFS) X Length of Treatment (hrs.) X Rate (ppm)] x 0.052947 = Gallons of Aquathol K Needed for Treatment**

To calculate the amount of Aquathol K to be applied per hour use the following formula:

**Gallons of Aquathol K per Hour = Total Gallons of Aquathol K / Length of Treatment (hrs.)**

## STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage and disposal.

**Pesticide Storage:** Store in the original container. Do not store in a manner where cross-contamination with other pesticides, fertilizers, food or feed could occur. Storage at temperatures below 32°F may result in the product freezing or crystallizing. Should this occur the product must be warmed to 50°F or higher and thoroughly agitated. In the event of a spill during handling or storage, absorb with sand or other inert material and dispose of absorbent in accordance with the Pesticide Disposal instructions listed below.

**Pesticide Disposal:** Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

**Container Handling: Nonrefillable container. Do not reuse or refill this container.** Triple rinse or pressure rinse container (or equivalent) promptly after emptying.

Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times.

Or

Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 PSI for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

Then offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

## EMERGENCY TELEPHONE NUMBERS

**CHEMTREC: (800) 424-9300**

**MEDICAL: (866) 673-6671 Rocky Mountain Poison Control Center**

**IMPORTANT INFORMATION**
**READ BEFORE USING PRODUCT**

## CONDITIONS OF SALE AND LIMITATION OF WARRANTY AND LIABILITY

**NOTICE:** Read the entire Directions for Use and Conditions of Sale and Limitation of Warranty and Liability before buying or using this product. If the terms are not acceptable, return the product at once, unopened, and the purchase price will be refunded.

The Directions for Use of this product reflect the opinion of experts based on field use and tests, and must be followed carefully. It is impossible to eliminate all risks associated with the use of this product. Crop injury, ineffectiveness or other unintended consequences may result because of such factors as manner of use or application, weather or crop conditions, presence of other materials or other influencing factors in the use of the product, which are beyond the control of United Phosphorus, Inc. or Seller. Handling, storage, and use of the product by Buyer or User are beyond the control of United Phosphorus, Inc. and Seller. To the extent consistent with applicable law, all such risks shall be assumed by Buyer and User, and Buyer and User agree to hold United Phosphorus, Inc. and Seller harmless for any claims relating to such factors.

**TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, UNITED PHOSPHORUS, INC. AND SELLER MAKE NO WARRANTIES OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE NOR ANY OTHER EXPRESS OR IMPLIED WARRANTY EXCEPT AS STATED ON THIS LABEL.**

To the extent consistent with applicable law, United Phosphorus, Inc. or Seller shall not be liable for any incidental, consequential or special damages resulting from the use or handling of this product and **THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE EXCLUSIVE LIABILITY OF UNITED PHOSPHORUS, INC. AND SELLER FOR ANY AND ALL CLAIMS, LOSSES, INJURIES OR DAMAGES (INCLUDING CLAIMS BASED ON BREACH OF WARRANTY, CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, SHALL BE THE RETURN OF THE PURCHASE PRICE OF THE PRODUCT OR, AT THE ELECTION OF UNITED PHOSPHORUS, INC. OR SELLER, THE REPLACEMENT OF THE PRODUCT.**

United Phosphorus, Inc. and Seller offer this product, and Buyer and User accept it, subject to the foregoing conditions of sale and limitations of warranty and of liability, which may not be modified except by written agreement signed by the duly authorized representative of United Phosphorus, Inc.

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Rev. 3/24/2015
2020205 70506-176(032515-5336)

**NOTES**

# AQUATHOL® K

AQUATIC HERBICIDE

**For aquatic plant control in quiescent, slow moving, and flowing water aquatic sites.**

| | |
|---|---|
| **ACTIVE INGREDIENT:** | |
| Dipotassium salt of endothall* | 40.3% |
| **OTHER INGREDIENTS:** | 59.7% |
| **TOTAL** | 100.0% |

Contains 4.23 lbs. dipotassium endothall* per gallon
*7-oxabicyclo [2.2.1]heptane-2,3-dicarboxylic acid equivalent 28.6%

## KEEP OUT OF REACH OF CHILDREN

## DANGER PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

### FIRST AID

**IF IN EYES:**
- Hold eye open and rinse slowly and gently with water for 15-20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing.
- Call a poison control center or doctor for treatment advice.

**IF SWALLOWED:**
- Call a poison control center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told by a poison control center or doctor.
- Do not give anything by mouth to an unconscious person.

**IF ON SKIN OR CLOTHING:**
- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15-20 minutes.
- Call a poison control center or doctor for treatment advice.

**IF INHALED:**
- Move person to fresh air.
- If person is not breathing, call 911 or ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.
- Call a poison control center or doctor for treatment advice.

**HOT LINE NUMBER:** Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 866-673-6671 (Rocky Mountain Poison Control Center) for emergency medical treatment information.

See attached booklet for additional precautionary statements.

**NOTE TO PHYSICIAN:** Measures against circulatory shock, respiratory depression, and convulsion may be needed.

**EPA Registration No. 70506-176**

**Net Contents: 2.5 Gallons**

AQUATIC HABITAT MANAGEMENT

**United Phosphorus, Inc.**
630 Freedom Business Center, Suite 402
King of Prussia, PA 19406 • 1-800-438-6071

## PRECAUTIONARY STATEMENTS
## HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CORROSIVE. CAUSES IRREVERSIBLE EYE DAMAGE. MAY BE FATAL IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. DO NOT GET IN EYES, ON SKIN, OR ON CLOTHING. AVOID BREATHING VAPORS OR SPRAY MIST. PROLONGED OR FREQUENTLY REPEATED SKIN CONTACT MAY CAUSE ALLERGIC REACTIONS IN SOME INDIVIDUALS.

### ENVIRONMENTAL HAZARDS

Do not contaminate water by cleaning of equipment or disposal of equipment washwaters.
This pesticide is toxic to mammals.
Treatment of aquatic plants can result in oxygen loss from decomposition of dead plants. This loss can cause fish suffocation. Water bodies containing very high plant density should be treated in sections to prevent suffocation of fish.

### DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift.

**See attached booklet for complete Directions For Use.**

### STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage and disposal. **Pesticide Storage:** Store in the original container. Do not store in a manner where cross-contamination with other pesticides, fertilizers, food or feed could occur. Storage at temperatures below 32°F may result in the product freezing or crystallizing. Should this occur the product must be warmed to 50°F or higher and thoroughly agitated. In the event of a spill during handling or storage, absorb with sand or other inert material and dispose of absorbent in accordance with the Pesticide Disposal Instructions listed below. **Pesticide Disposal:** Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance. **Container Handling: Nonrefillable container. Do not reuse or refill this container.** Triple rinse or pressure rinse container (or equivalent) promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. - Or - Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 PSI for at least 30 seconds. Drain for 10 seconds after the flow begins to drip. Then offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

### EMERGENCY TELEPHONE NUMBERS

**CHEMTREC: (800) 424-9300**
**MEDICAL: (866) 673-6671 Rocky Mountain Poison Control Center**

**See attached booklet for Conditions Of Sale And Limitation Of Warranty And Liability.**

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2020205 70506-176(032515-5336)

United Phosphorus, Inc.

# Safety Data Sheet

**Preparation Date** 17-Apr-2015 **Revision date** 18-Nov-2015 **Revision Number:** 2

## 1. Identification of the Substance/Preparation and of the Company/Undertaking

**Product identifier**

**Product Description:** AQUATHOL® K Aquatic Herbicide

**Other means of identification**

**Item#:** 12-204
**UN-No** 2902
**Synonyms** Not Available
**Registration number(s)** 70506-176

**Recommended use of the chemical and restrictions on use**

**Recommended use** Aquatic herbicide.
**Uses advised against** Activties contrary to label recomendation

**Details of the Supplier of the Safety Data Sheet**

**Supplier Address**
United Phosphorus Inc.
630 Freedom Business Center
Suite 402
King of Prussia, PA 19406

**Emergency telephone number**

**Company Phone Number** 1-800-438-6071
**Emergency telephone number** Chemtrec: (800) 424-9300 (24hrs) or (703) 527-3887
Medical: Rocky Mountain Poison Control Center
(866) 673-6671 (24hrs)

## 2. Hazards Identification

**Classification**

**OSHA Regulatory Status**
This chemical is considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

| | |
|---|---|
| Acute toxicity - Dermal | Category 4 |
| Acute toxicity - Inhalation (Vapors) | Category 2 |

**Label elements**

**EMERGENCY OVERVIEW**

**DANGER**

**hazard statements**
Harmful in contact with skin
Fatal if inhaled

| **appearance** Yellow brown | **Physical state** liquid | **Odor** Slight chlorine |
|---|---|---|

**Precautionary Statements - Prevention**
Wear protective gloves/protective clothing/eye protection/face protection
Do not breathe dust/fume/gas/mist/vapors/spray
Use only outdoors or in a well-ventilated area
In case of inadequate ventilation wear respiratory protection

IF ON SKIN: Wash with plenty of soap and water
Call a POISON CENTER or doctor if you feel unwell
Wash contaminated clothing before reuse
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
Immediately call a POISON CENTER or doctor/physician

**Precautionary Statements - Storage**
Store in a well-ventilated place. Keep container tightly closed
Store locked up

**Precautionary Statements - Disposal**
Dispose of contents/container to an approved waste disposal plant

**Hazards Not Otherwise Classified (HNOC)**
**OTHER INFORMATION**

## 3. Composition/information on Ingredients

| Chemical name | CAS-No | Weight % | Trade secret |
|---|---|---|---|
| Dipotassium endothall salt | 2164-07-0 | 40.3 | |

If CAS number is "proprietary", the specific chemical identity and percentage of composition has been withheld as a trade secret.

## 4. First aid measures

**FIRST AID MEASURES**

**Eye contact** Hold eye open and rinse slowly and gently with water for 15 - 20 minutes. Remove contact lenses, if present, after 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice. Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes.

**Skin contact** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call poison control center or doctor for treatment advice. Seek immediate medical attention/advice. Wash off immediately with plenty of water for at least 15 minutes. Remove and wash contaminated clothing before re-use.

**Inhalation** Move to fresh air. MAY CAUSE ALLERGIC RESPIRATORY REACTION. Call a poison control center or doctor for further treatment advice.

**Ingestion** Call a physician or poison control center immediately. May produce an allergic reaction. Clean mouth with water. Never give anything by mouth to an unconscious person. Seek immediate medical attention/advice. Do not induce vomiting without medical advice.

**Most Important Symptoms and Effects, Both Acute and Delayed**

**Most Important Symptoms and Effects** Burning feeling and temporary redness.

**Indication of Any Immediate Medical Attention and Special Treatment Needed**

**Notes to physician** No information available. Treat symptomatically.

## 5. Fire-fighting measures

**Suitable extinguishing media**
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

**Unsuitable extinguishing media** Decomposition by contact with water may generate vapours which can be ignited by heat or open flame.

**Specific hazards arising from the chemical**
No information available.

**Hazardous combustion products** Extreme temperatures convert Endothall product to endothall anhydride which is a strong vessicant causing blistering of eyes, mucous membranes and skin.

**Explosion data**
**Protective equipment and precautions for firefighters**
As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

## 6. Accidental release measures

**Personal precautions, protective equipment and emergency procedures**

**Personal Precautions** Avoid contact with skin, eyes and clothing.

**Environmental Precautions**

**Environmental precautions** Do not flush into surface water or sanitary sewer system. Consult a regulatory specialist to determine appropriate state or local reporting requirements, for assistance in waste characterization and/or hazardous waste disposal and other requirements listed in pertinenet environmental permits.

**Methods and material for containment and cleaning up**

**Methods for Clean-Up** Remove all ignition sources. Soak up with inert absorbent material. Ground and bond containers when transferring material. Keep in suitable and closed containers for disposal.

## 7. Handling and Storage

**Precautions for safe handling**

**Handling** Do not breathe vapours or spray mist. Avoid contact with skin, eyes and clothing. Keep out of reach of children. Empty containers may contain hazardous residues.

**Conditions for safe storage, including any incompatibilities**

**Storage** Store in an area where cross-contamination with pesticides, fertilizers, food or feed could not occur. Keep containers tightly closed in a cool, well-ventilated place.

**incompatible materials** No information available.

## 8. Exposure Controls/Personal Protection

**Exposure guidelines** This product does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

**Engineering controls** Investigate engineering techniques to reduce exposures. Local mechanical exhaust ventilation is preferred. Consult ACGIH ventilation manual or NFPA Standard 91 for design of exhaust systems. PESTICIDE APPLICATORS & WORKERS. THESE WORKERS MUST REFER TO PRODUCT LABELING AND DIRECTIONS FOR USE IN ACCORDANCE WITH EPA WORKER PROTECTION STANDARD 40 CFR PART 170.

**Personal protective equipment**

| | |
|---|---|
| **Eye/Face Protection** | Tightly fitting safety goggles. or. Face-shield. |
| **Skin protection** | Chemical resistant gloves. Chemical resistant footwear plus socks. |
| **Respiratory protection** | Where airborne exposure is likely, use NIOSH approved respiratory protection equipment appropriate to the material and/or its components. Full facepiece equipment is recommended and, if used, replaces need for face shield and/or chemical goggles. If exposures cannot be kept at a minimum with engineering controls, consult respirator manufacturer to determine appropriate type equipment for given application. Observe respirator use limitations specified by NIOSH or the manufacturer. For emergency and other conditions where there may be a potential for significant exposure, use an approved full face positive-pressure, self-contained breathing apparatus. Respiratory protection programs must comply with 29 CFR 1910.134. |

**General hygiene considerations**

Do not eat, drink or smoke when using this product. Handle in accordance with good industrial hygiene and safety practice.

## 9. Physical and Chemical Properties

**Information on basic physical and chemical properties**

| | | | |
|---|---|---|---|
| **Physical state** | liquid | | |
| **appearance** | Yellow brown | **Odor** | Slight chlorine |
| **color** | No information available | | |

| **Property** | **VALUES** | **Remarks/ • Method** |
|---|---|---|
| **pH** | 7.4 | |
| **Melting point/freezing point** | 8.4 °C / 47 °F | |
| **Boiling Point/Range** | >100 °C | |
| **Flash Point** | Not Applicable | |
| **Evaporation Rate** | No information available | |
| **flammability (solid, gas)** | No information available | |
| **Flammability limit in air** | | |
| **Upper Flammability Limit** | No information available | |
| **Lower Flammability Limit** | No information available | |
| **vapor pressure** | No information available | |
| **Vapor Density** | No information available | |
| **Specific gravity** | 1.285 | |
| **Water solubility** | No information available | |
| **Solubility in Other Solvents** | No information available | |
| **Partition coefficient: n-octanol/water** | No information available | |
| **Autoignition temperature** | No information available | |
| **decomposition temperature** | No information available | |
| **Viscosity, kinematic** | No information available | |
| **Dynamic viscosity** | No information available | |
| **Explosive properties** | No information available | |
| **Oxidizing properties** | No information available | |

**OTHER INFORMATION**

| | |
|---|---|
| **Softening point** | No information available |
| **molecular weight** | No information available |
| **VOC Content** | No information available |
| **density** | No information available |
| **Bulk density** | No information available |

## 10. Stability and Reactivity

**Reactivity**

no data available

**Chemical stability**

Stable under recommended storage conditions.

**Possibility of hazardous reactions**

None under normal processing.

**Conditions to avoid**

No information available.

**incompatible materials**

No information available.

**Hazardous decomposition products**

Extreme temperatures may convert endothall product to endothall anhydride, a strong vessicant, causing blistering of eyes, mucous membranes and skin.

## 11. Toxicological Information

**Information on Likely Routes of Exposure**

| | |
|---|---|
| **Inhalation** | Toxic by inhalation. |
| **Eye contact** | May cause irreversible damage to eyes. |
| **Skin contact** | May cause irritation. Repeated or prolonged skin contact may cause allergic reactions with susceptible persons. |
| **Ingestion** | MAY BE HARMFUL IF SWALLOWED. |
| **Component Information** | Although no allergic skin reactions were observed in guinea pigs following exposure to this material in water, allergic skin reactions were observed following expsoure to this material in ethanol. Repeated application to the skin of rats produced severe skin irritation, liver, and kidney effects considered to be secondary to irritation, and increased mortality. Long-term dietary administration produced no adverse effects in rats. Dermal - Slightly toxic to Rabbits (LD50 2,000 mg/kg) Skin irritation - Non-irritating to rabbits Inhalation - Slightly toxic to rats (4 hr LC50 0.83 mg/l) aerosol Eye irritation - Cause irreversible eye damage in rabbits. Endothall- Intentional swallowing of 40 ml led to death within 12-hours. Skin allergy was observed in guinea pigs following repeated exposures. Repeated dietary administration (via gelatin capsules) produced vomiting, diarrhea, sluggish movements, and liver, kidney and blood effects in dogs. Long-term dietary administration to rats and mice produced effects in the glandular stomach. High mortality rates and intestinal tumors considered to be secondary to the effects in the stomach were observed in mice. Long-term application to the skin of mice produced no tumors. No birth defects were observed in the offspring of rats exposed orally during pregnancy, even at dosages that produced adverse effects on the mothers. Skeletal anomalies were observed in the offspring of rabbits and mice exposed orally during pregnancy, but only at dosages that produced adverse effects in the mothers. No genetic changes were observed in tests using bacteria, animal cells or animals. |

**Information on Toxicological Effects**

| | |
|---|---|
| **Symptoms** | No information available. |

**Delayed and immediate effects as well as chronic effects from short and long-term exposure**

| | |
|---|---|
| **sensitization** | No information available. |
| **Mutagenic effects** | No information available. |
| **Carcinogenicity** | There are no known carcinogenic chemicals in this product. |
| **Reproductive effects** | Not Available. |
| **STOT - Single Exposure** | No information available. |
| **STOT - repeated exposure** | No information available. |
| **Aspiration hazard** | No information available. |

**Numerical Measures of Toxicity - Product information**

| | |
|---|---|
| **LD50 Dermal** | 2000 mg/kg |
| **LC50 Inhalation:** | 0.83 mg/l (4-hr) |

## 12. Ecological Information

**ecotoxicity**

Endothall dipotassium salt:
Mallard duck LD50 = 328 mg/kg
Bluegill sunfish EC50= 1071 ppm
Rainbow trout EC50 = 363 ppm
Sheepshed minnow 96 hr EC50 = 340 ppm
Mysid shrimp 96 hr EC50 = 257 ppm
Eastern oyster 96 hr EC50 = 335 ppm

40.3% of the mixture consists of components(s) of unknown hazards to the aquatic environment

**Persistence/Degradability**
No information available.

**Bioaccumulation/ Accumulation**
No information available.

**Other Adverse Effects**
No information available

## 13. Disposal Considerations

**Waste Treatment Methods**

**Waste Disposal Method** Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide or rinsate is a violation of Federal law. If the wastes cannot be disposed of by use or according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

**Contaminated packaging** Non refillable container. Do not reuse this container. Refer to product label.

## 14. Transport Information

**DOT** When shipped as a limited quantity by domestic highway,, as per 49 CFR 173.153 the combination package, not exceeding a gross weight of 66 pounds (30 kg), may contain inner packagings not over 1.3 gallons (5 L ) each. Limited quantity designated packagings are excepted from labeling and packaging specification requirements.
If the limited quantity package is shipped by air the package must also conform to applicable requirements of 173.27.

| | |
|---|---|
| **UN-No** | 2902 |
| **Proper shipping name** | Pesticides, liquid, toxic. n.o.s. (Endothal) |
| **Hazard class** | 6.1 |
| **Packing group** | PG III |
| **Reportable Quantity (RQ):** | 1,000 lbs |

**ICAO**

| | |
|---|---|
| **UN-No** | 2902 |
| **Proper shipping name** | Pesticide, liquid, toxic, n.o.s (Endothall) |
| **Hazard class** | 6.1 |
| **Packing group** | PG III |

**IATA**

| | |
|---|---|
| **UN-No** | 2902 |
| **Proper shipping name** | Pesticide, liquid, toxic, n.o.s (Endothall) |
| **Hazard class** | 6.1 |
| **Packing group** | PG III |

**IMDG/IMO**

| | |
|---|---|
| **UN-No** | 2902 |
| **Proper shipping name** | Pesticide, liquid, toxic, n.o.s (Endothall) |
| **Hazard class** | 6.1 |
| **Packing group** | PG III |
| **EmS No.** | F-A, S-A |

## 15. Regulatory Information

This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and for workplace labels of non-pesticide chemicals. Following is the hazard information as required on the pesticide label:

| | |
|---|---|
| **signal word** | DANGER! |
| **Ventilation Control** | PESTICIDE APPLICATORS & WORKERS THESE WORKERS MUST REFER TO PRODUCT LABELING AND DIRECTIONS FOR USE IN ACCORDANCE WITH EPA WORKER PROTECTION STANDARD 40 CFR PART 170. |

**Corrosive. Causes irreversible eye damage. May be fatal if swallowed. Harmful if inhaled or absorbed through skin. Pesticide is toxic to mammals.**

### International Inventories

| | |
|---|---|
| **USINV** | Not determined |
| **DSL/NDSL** | Not determined |
| **EINECS/ ELINCS** | Complies |
| **ENCS** | Does not comply |
| **China** | Does not comply |
| **KECL** | Does not comply |
| **PICCS** | Does not comply |
| **AICS** | Does not comply |
| **TSCA** | Complies |

**TSCA** - United States Toxic Substances Control Act Section 8(b) Inventory
**DSL/NDSL** - Canadian Domestic Substances List/Non-Domestic Substances List
**EINECS/ELINCS** - European Inventory of Existing Commercial Chemical Substances/EU List of Notified Chemical Substances
**ENCS** - Japan Existing and New Chemical Substances
**IECSC** - China Inventory of Existing Chemical Substances
**KECL** - Korean Existing and Evaluated Chemical Substances
**PICCS** - Philippines Inventory of Chemicals and Chemical Substances
**AICS** - Australian Inventory of Chemical Substances

### Federal Regulations

**SARA 313**

Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product contains a chemical or chemicals which are subject to the reporting requirements of the Act and and Title 40n of the Code of Federal Regulations, Part 372:

| Chemical name | SARA 313 - Threshold Values |
|---|---|
| Dipotassium endothall salt - 2164-07-0 | 1.0 |

**SARA 311/312 Hazardous Categorization**

| | |
|---|---|
| **Acute health hazard** | yes |
| **Chronic health hazard** | NO |
| **Fire hazard** | No |
| **Sudden release of pressure hazard** | No |
| **Reactive Hazard** | yes |

**CERCLA**
**SARA Product RQ** 0

**RCRA**
**Pesticide Information**

**State Regulations**

**State Right-to-Know**

| Chemical name | Massachusetts | New Jersey | Pennsylvania | Illinois | Rhode Island |
|---|---|---|---|---|---|
| Dipotassium endothall salt | | X | | | |

**International regulations**
**U.S. EPA Label information**
**EPA Pesticide registration number** 70506-176

## 16. Other Information

**NFPA** **HEALTH** 3 **flammability** 0 **Instability** 0 **Physical hazard** -

**Preparation Date** 17-Apr-2015
**Revision date** 18-Nov-2015
**Revision Summary**
Update section 15
**Disclaimer**
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**End of MSDS**

Product File

**FORM:** 1791-D
**NAME:** Clipper Herbicide
**KIND:** Composite Booklet
**DATE:** 12-14-12

**PRODUCT SIZE:** 5 Pounds
**BASE LABEL SIZE:** 6-1/4" W x 6-1/2" H
**CLOSED BOOKLET SIZE:** 5-3/4" W x 6-1/2" H
**OPEN BOOKLET SIZE:** 11-1/2" W x 6-1/2" H
**UCC-EAN:** (01) 0 06 53204 095688

Process Cyan
Process Magenta
Process Yellow
Process Black

6-1/2"

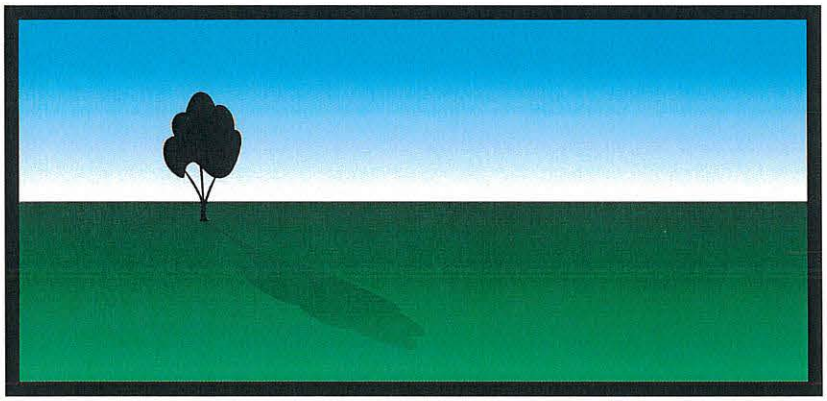
5-3/4"

**GROUP 14 HERBICIDE**

PROFESSIONAL VALENT PRODUCTS

# Clipper®

## HERBICIDE



**FOR THE MANAGEMENT OF UNDESIRABLE AQUATIC VEGETATION IN SLOW MOVING OR QUIESCENT WATERS**

| Active Ingredient | By Wt. |
|---|---|
| *Flumioxazin | 51% |
| Other Ingredients | 49% |
| Total | 100% |

*2-[7-fluoro-3,4-dihydro-3-oxo-4-(2-propynyl)-2*H*-1,4-benzoxazin-6-yl]-4,5,6,7-tetrahydro-1*H*-isoindole-1,3(2*H*)-dione

Clipper® Herbicide is a water dispersible granule containing 51% active ingredient.

EPA Reg. No. 59639-161 EPA Est. 11773-IA-01

**NET WEIGHT 5 POUNDS**

**KEEP OUT OF REACH OF CHILDREN**

**CAUTION**

**SEE NEXT PAGE FOR ADDITIONAL PRECAUTIONARY STATEMENTS**

(01) 0 06 53204 09568 8

Form 1791-D

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 8-8-14 Reviewer S. Sutherland
Reg. No. 59639-161-AA

## PRECAUTIONARY STATEMENTS
## HAZARDS TO HUMANS & DOMESTIC ANIMALS
## CAUTION

Harmful if inhaled or absorbed through the skin. Causes moderate eye irritation. Avoid breathing dust and spray mist. Avoid contact with skin, eyes or clothing.

**FIRST AID**

| | |
|---|---|
| **If inhaled:** | • Move person to fresh air.<br>• If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| **If on skin or clothing:** | • Take off contaminated clothing.<br>• Rinse skin immediately with plenty of water for 15-20 minutes.<br>• Call a poison control center or doctor for treatment advice. |
| **If in eyes:** | • Hold eye open and rinse slowly and gently with water for 15-20 minutes.<br>• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.<br>• Call a poison control center or doctor for treatment advice. |
| **If swallowed:** | • Call a poison control center or doctor immediately for treatment advice.<br>• Have person sip a glass of water if able to swallow.<br>• Do not induce vomiting unless told to by a poison control center or doctor.<br>• Do not give anything by mouth to an unconscious person. |

**HOT LINE NUMBER**

Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact **800-892-0099** for emergency medical treatment information.

**PERSONAL PROTECTIVE EQUIPMENT (PPE):**

Some of the materials that are chemical-resistant to this product are listed below. If you want more options, follow the instructions for category A on an EPA chemical-resistance category selection chart.

**Applicators and other handlers must wear:** long-sleeved shirt and long pants, chemical-resistant gloves made of any waterproof material such as polyethylene or polyvinyl chloride, shoes and socks.

Follow manufacturer's instructions for cleaning/maintaining PPE. If there are no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

**USER SAFETY RECOMMENDATIONS**

Users should:
- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

**ENVIRONMENTAL HAZARDS:**

If not used in accordance with directions on the label, this product can be toxic to non-target plants and aquatic invertebrates. Do not apply to water except as specified on the label. Drift and runoff may be hazardous to non-target plants and aquatic organisms in neighboring areas, if not used in accordance to label directions. Do not apply where runoff is likely to occur. Do not apply when weather conditions favor drift from treated areas. Do not contaminate water when disposing of equipment washwaters.

This pesticide is toxic to plants and should be used strictly in accordance with the drift and run-off precautions on this label in order to minimize off-site exposures.

**DIRECTIONS FOR USE**

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

**READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH PRECAUTIONARY STATEMENTS AND DIRECTIONS, AND WITH APPLICABLE STATE AND FEDERAL REGULATIONS.**

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the treatment area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.



6-1/2"

5-3/4"

## DISCLAIMER, RISKS OF USING THIS PRODUCT, LIMITED WARRANTY AND LIMITATION OF LIABILITY

**IMPORTANT: Read the entire Label including this Disclaimer, Risks of Using this Product, Limited Warranty, and Limitation of Liability before using this product. If the terms are not acceptable THEN DO NOT USE THE PRODUCT; rather, return the unopened product within 15 days of purchase for a refund of the purchase price.**

### RISKS OF USING THIS PRODUCT

The Buyer and User (referred to collectively herein as "Buyer") of this product should be aware that there are inherent unintended risks associated with the use of this product which are impossible to eliminate. These risks include, but are not limited to, injury to plants and crops to which this product is applied, lack of control of the target pests or weeds, resistance of the target pest or weeds to this product, injury caused by drift, and injury to rotational crops caused by carryover in the soil. If the Buyer chooses not to accept these risks, THEN THIS PRODUCT SHOULD NOT BE APPLIED. By applying this product Buyer acknowledges and accepts these inherent unintended risks AND TO THE FULLEST EXTENT ALLOWED BY LAW, AGREES THAT ALL SUCH RISKS ASSOCIATED WITH THE APPLICATION AND USE ARE ASSUMED BY THE BUYER.

Valent shall not be responsible for losses or damages resulting from use of this product in any manner not set forth on the label. Buyer assumes all risks associated with the use of this product in any manner or under conditions not specifically directed or approved on the label.

### LIMITED WARRANTY

**Valent warrants only that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated in the label, under average use conditions, when used strictly in accordance with the label and subject to the Risks of Using This Product as described above. To the extent consistent with applicable law AND AS SET FORTH ABOVE, VALENT MAKES NO OTHER WARRANTIES, EITHER EXPRESSED OR IMPLIED. No agent or representative of Valent or Seller is authorized to make or create any other express or implied warranty.**

### LIMITATION OF LIABILITY

**To the fullest extent allowed by law, Valent or Seller is not liable for any incidental, consequential, indirect**

(continued)

(continued)

**or special damages resulting from the use or handling of this product. TO THE FULLEST EXTENT ALLOWED BY LAW, THE EXCLUSIVE REMEDY OF THE BUYER, AND THE EXCLUSIVE MAXIMUM LIABILITY OF VALENT OR SELLER FOR ANY AND ALL CLAIMS, LOSSES, INJURIES OR DAMAGES (INCLUDING CLAIMS BASED ON BREACH OF WARRANTY, CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT SHALL BE THE RETURN OF THE PURCHASE PRICE OF THIS PRODUCT OR, AT THE ELECTION OF VALENT OR SELLER, THE REPLACEMENT OF THE PRODUCT.**

### PROMPT NOTICE OF CLAIM

To the extent consistent with applicable law allowing such requirements Valent must be provided notice as soon as Buyer has reason to believe it may have a claim, but in no event later than twenty-one days from the date of application so that an immediate inspection of the affected property can be made.

To the extent consistent with applicable law if Buyer does not notify Valent of any claims, in such period, it shall be barred from obtaining any remedy.

### NO AMENDMENTS

Valent and Seller offer this product, and Buyer accepts it, subject to the foregoing **Disclaimer, Risks of Using This Product, Limited Warranty** and **Limitation of Liability,** which may not be modified by any oral or written agreement.

## TANK MIXES

**NOTICE: Tank mixing or use of this product with any other product which is not specifically and expressly authorized by the label shall be the exclusive risk of user, applicator and/or application advisor, to the extent allowed by applicable law.**

Read and follow the entire label of each product to be used in the tank mix with this product.



6-1/2"

5-3/4"

## PRODUCT INFORMATION

*Clipper* Herbicide is a fast acting contact herbicide that controls selected submersed, emergent and floating aquatic weeds. It is most effective when applied to young, actively growing weeds in water with a pH of less than 8.5.

*Clipper* Herbicide may be applied to the following quiescent or slow moving bodies of water:

- Bayous
- Canals
- Drainage ditches
- Lakes
- Marshes
- Ponds (including golf course ponds)
- Reservoirs

Application of *Clipper* Herbicide to public aquatic areas may require special approval and/or permits. Consult with local state agencies, if required.

## USE PRECAUTIONS AND RESTRICTIONS

- Do not apply to intertidal or estuarine areas.
- There is no post-application holding restriction against use of treated water for drinking or recreational purposes (e.g. swimming, fishing).
- In areas with dense weed vegetation only treat 1/2 the water body at one time and wait 10-14 days before treating the remaining area. Do not re-treat the same section of water within 28 days of application.
- Treated water may not be used for irrigation purposes on food crops until at least five (5) days after application.
- Treated water may be used for irrigation purposes on turf and landscape ornamentals as outlined in the *Irrigation Restrictions Following Application* table.
- Do not use in water utilized for crawfish farming.
- Do not re-treat the same section of water with *Clipper* Herbicide more than 6 times per year.
- Do not exceed 400 ppb of *Clipper* Herbicide during any one application.

## IRRIGATION RESTRICTIONS FOLLOWING APPLICATION

| Application Method | Application Rate | Average Water Depth | Turf and Landscape Ornamentals | Ornamentals Grown for Production in Greenhouse and Nursery |
|---|---|---|---|---|
| Surface Spray | 6 to 12 oz per surface acre | Greater than 3 feet | None | 5 days |
| | | Less than 3 feet | 12 hours | 5 days |
| Subsurface | Less than 200 ppb | N/A | 1 day | 5 days |
| | 200 to 300 ppb | N/A | 2 days | 5 days |
| | 300 to 400 ppb | N/A | 3 days | 5 days |

## RESISTANCE MANAGEMENT

*Clipper* Herbicide is a Group 14 herbicide. Any weed population may contain or develop plants that are resistant to *Clipper* Herbicide and other Group 14 herbicides. Weed species with acquired resistance to Group 14 herbicides may eventually dominate the weed population if Group 14 herbicides are used repeatedly in the same water body or in successive years as the primary method of control for targeted species. This may result in partial or total loss of control of those species by *Clipper* Herbicide or other Group 14 herbicides.

To delay or prevent herbicide resistance consider the following recommendations:

- Avoid the use of more than two consecutive applications of *Clipper* Herbicide or other herbicides that have a similar target site of action.
- Alternate herbicides used for aquatic weed control.
- Base herbicide use on a comprehensive Integrated Pest Management (IPM) program.
- Monitor treated weed populations for loss of efficacy.
- Contact your local extension specialist, other experts appropriate to aquatic use, and/or manufacturer for resistance and/or integrated weed management recommendations.

For further information or to report suspected resistance, you may contact Valent U.S.A. Corporation at the following toll-free number: 800-89-VALENT (898-2536).

## SPRAY DRIFT MANAGEMENT FOR FOLIAR OR SURFACE APPLICATIONS

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment and weather-related factors determine the potential for spray drift. The applicator is responsible for considering all these factors when making decisions.



6-1/2"

5-3/4"

Do not spray *Clipper* Herbicide under circumstances where spray droplets may drift on to unprotected persons, or plantings of food, forage or crops that might be damaged, or rendered unfit for sale, use or consumption. These precautions are not applicable for subsurface injection by closed systems.

- Use the largest droplet size consistent with acceptable efficacy. Formation of very small droplets may be minimized by appropriate nozzle selection, by orienting nozzles away from the air stream as much as possible and by avoiding excessive spray boom pressure. For ground boom and aerial applications, use medium or coarser spray nozzles according to ASAE 572 definition for standard nozzles or a volume mean diameter (VMD) of 300 microns or greater for spinning atomizer nozzles.
- Make aerial, ground or watercraft-based surface applications when wind velocity favors on-target product deposition. Apply only when the wind speed is less than or equal to 10 mph.
- Do not make aerial or ground applications into areas of temperature inversions. Inversions are characterized by stable air and increasing temperatures with increasing distance above the ground. Mist or fog may indicate the presence of an inversion in humid areas. Where permissible by local regulations, the applicator may detect the presence of an inversion by producing smoke and observing a smoke layer near the ground surface.
- Low humidity and high temperatures increase the evaporation rate of spray droplets, and therefore the likelihood of increased spray drift. Avoid spraying during conditions of low humidity and/or high temperatures.

Properly maintain and calibrate all aerial, ground and water based application equipment.

Where states have more stringent regulations, they should be observed.

## APPLICATION AND SPRAYER INFORMATION

### Mixing Instructions

- Fill clean spray tank 1/2 full of desired level with water and add buffering agent if necessary.
- Add the required amount of *Clipper* Herbicide to the spray tank while agitating.
- Fill spray tank to desired level with water. Ensure that *Clipper* Herbicide is thoroughly mixed before making applications. Agitation should continue until spray solution has been applied.
- Mix only the amount of spray solution that can be applied the day of mixing. Apply *Clipper* Herbicide within 12 hours of mixing.

### ADDITIVES

When applying *Clipper* Herbicide to the foliage of floating or emerged aquatic weeds, mix with an adjuvant approved for use in aquatic sites. Valent recommends the use of a Chemical Producers and Distributors Association certified adjuvant. Mix *Clipper* Herbicide with a non-ionic surfactant containing at least 80% active ingredient. Follow adjuvant manufacturer's label rates. Mixing compatibility should be verified by a jar test before using.

### Jar Test to Determine Compatibility of Adjuvants and *Clipper* Herbicide

Conduct a jar test before mixing commercial quantities of *Clipper* Herbicide, when using for the first time, when using new adjuvants or when a new water source is being used.

1. Add 1 pt of water to a quart jar. The water should be from the same source and have the same temperature as the water used in the spray tank mixing operation.
2. Add 3 grams (approximately 1 level tsp) of *Clipper* Herbicide for the 8 oz/A rate or 4 grams (approximately 1-1/2 tsp) for 12 oz/A rate to the jar. Gently mix until product disperses.
3. Add 60 ml (4 Tbsp or 2 fl oz) of additive to the quart jar and gently mix.
4. Place cap on jar, invert 10 times, let stand for 15 minutes, evaluate.
5. An ideal tank mix combination will be uniform and free of suspended particles. If any of the following conditions are observed the choice of adjuvant should be questioned:
   a) Layer of oil or globules on the solution surface.
   b) Flocculation: Fine particles in suspension or as a layer on the bottom of the jar.
   c) Clabbering: Thickening texture (coagulated) like gelatin.

### Sprayer Cleanup

If spray equipment is dedicated to application of aquatic herbicides, the following steps are recommended to clean the spray equipment:

- Completely drain the spray tank and rinse the application equipment thoroughly, including the inside and outside of the tank and all in-line screens.

If spray equipment will be used for purposes other than applying aquatic herbicides, it must be thoroughly cleaned



6-1/2"

5-3/4"

following application of *Clipper* Herbicide. The following steps must be used to clean the spray equipment:

1. Completely drain the spray tank and rinse the application equipment thoroughly, including the inside and outside of the tank and all in-line screens.
2. Fill the tank with clean water and flush all hoses, booms, screens and nozzles.
3. Top off tank with clean water.
4. Circulate through sprayer for 5 minutes.
5. Then flush all hoses, booms, screens and nozzles for a minimum of 15 minutes.
6. Drain tank completely.
7. Remove all nozzles and screens and rinse them with clean water.

## AERIAL APPLICATION

To obtain satisfactory weed control, aerial application of *Clipper* Herbicide, must provide uniform coverage of surface weeds and sufficient contact time. When applied by air, *Clipper* Herbicide may not provide adequate control of some submersed weeds. Do not apply by air when significant drift on to non-target plants may occur or when wind velocity is more than 10 mph. Avoid spraying *Clipper* Herbicide within 200 feet of dwellings, adjacent sensitive crops or environmentally sensitive areas. To obtain satisfactory application and avoid drift, the following directions must be observed:

### Volume and Pressure

Apply *Clipper* Herbicide in a minimum of 5 gals of water per acre, with a maximum spray pressure of 40 PSI. Application at less than 5 gals per acre may not provide adequate weed control. Higher gallonage applications generally provide more consistent weed control.

### Nozzles and Nozzle Operation

Use nozzles that produce flat or hollow cone spray patterns. Use non-drip type nozzles such as diaphragm type nozzles to avoid unwanted discharge of spray solution. The nozzle must be directed toward the rear of the aircraft, at an angle between 0° and 15° downward. Do not place nozzles on the outer 25% of the wings or rotors.

### Adjuvants

Refer to the additive section or the tank mix partners label for adjuvant recommendation.

## DIRECTIONS FOR USE TO CONTROL FLOATING AND EMERGED WEEDS USING SURFACE APPLICATION

*Clipper* Herbicide will control weeds and algae listed in Table 1, *Floating and Emerged Weeds* when applied as a broadcast spray with appropriate equipment. For best results, apply *Clipper* Herbicide to the foliage of actively growing weeds.

**Table 1. Floating and Emerged Weeds**

| Common Name | Scientific Name |
|---|---|
| Alligator Weed | *Alternanthera philoxeroides* |
| Duckweed | *Lemna* spp. |
| Frog's-bit | *Limnobium spongia* |
| Water Fern | *Salvinia* spp. |
| Water Lettuce | *Pistia stratiotes* |
| Watermeal | *Wolffia* spp. |
| Water Pennywort | *Hydrocotyle* spp. |
| Filamentous algae | *Pithophora* |
| Filamentous algae | *Cladophora* |

### Surface Application

Apply *Clipper* Herbicide as a broadcast spray at 6 to 12 ounces of formulated product per acre plus an adjuvant approved for use in aquatics.

*Clipper* Herbicide is a contact herbicide that quickly degrades in the water column so plants that do not initially come in contact with the herbicide will not be controlled. Apply *Clipper* Herbicide in a minimum of 30 gals of water per acre to all areas of the water body where weeds exist. Coverage is essential for effective control as all floating weeds need to be exposed to lethal concentrations in all parts of the water body. Any untreated escapes or re-introductions of plants that were not treated will reestablish in areas where surface weeds had previously been controlled. If a second application is required to provide control, it is recommended that a treatment be made once the return of these weeds is first observed, but no sooner than 28 days after the last treatment.

Application of *Clipper* Herbicide during early morning hours may enhance weed control. When applying to densely packed actively growing surface weeds, ensure adequate coverage. Rapid decomposition of vegetation resulting from herbicide treatment can result in loss of oxygen in water. A sudden decrease in dissolved oxygen can result in fish suffocation. If aquatic vegetation is dense, treat floating surface weeds in sections to avoid a rapid decrease in dissolved oxygen.



6-1/2"

5-3/4"

*Clipper* Herbicide may be tank mixed with 2,4-D, diquat, glyphosate or other registered foliar applied herbicides for enhanced control of floating and emergent weeds.

Consult a manufacturer's label for specific rate restrictions and weeds controlled. Always follow the most restrictive label restrictions and precautions for all products used when making an application involving tank mixes.

**Application Equipment**
Apply *Clipper* Herbicide with sprayers equipped with nozzles designed to deliver the desired spray pressure and spray volume. Apply by backpack or handgun sprayer, airboat, helicopter, airplane or other application equipment that will ensure thorough coverage of target plant foliage.

## DIRECTIONS FOR USE TO CONTROL SUBMERSED AND FLOATING WEEDS USING SUBSURFACE APPLICATION

*Clipper* Herbicide will control submersed and floating weeds listed in Table 2, *Submersed and Floating Weeds Controlled by Subsurface Application*, when applied subsurface with appropriate equipment.

**Table 2. Submersed and Floating Weeds Controlled by Subsurface Application**

| Common Name | Scientific Name |
|---|---|
| Coontail | *Ceratophyllum demersum* |
| Duckweed | *Lemna* spp. |
| Fanwort | *Cabomba caroliniana* |
| Hydrilla | *Hydrilla verticillata* |
| Hygrophila | *Hygrophila polysperma* |
| Naiad, Southern | *Najas guadalupensis* |
| Pondweed, Curlyleaf | *Potamogeton crispus* |
| Pondweed, Sago | *Potamogeton pectinatus* |
| Pondweed, Variable-Leaf | *Potamogeton diversifolius* |
| Water Fern | *Salvinia* spp. |
| Water Lettuce | *Pistia stratiotes* |
| Watermeal | *Wolffia* spp. |
| Watermilfoil, Eurasian | *Myriophyllum spicatum* |
| Watermilfoil, Variable-Leaf | *Myriophyllum heterophyllum* |

**Subsurface Application**
Apply *Clipper* Herbicide at a rate that will produce an initial concentration of 200 to 400 ppb (of active ingredient flumioxazin) in the water column.

*Clipper* Herbicide is rapidly absorbed by target plants, but also breaks down quickly in water with a pH greater than 8.5. The pH of water surrounding mats of submersed vegetation can exceed 8.5 by early to mid-day, due to photosynthetic processes. Application of *Clipper* Herbicide under these conditions may provide only partial weed control, and regrowth is likely. For best control, apply *Clipper* Herbicide in a minimum of 30 gals of water per acre in the early morning to actively growing weeds and early in the season before surface matting occurs. Complete coverage and sufficient contact time of submersed weeds with *Clipper* Herbicide is required for optimal performance. Application of *Clipper* Herbicide with subsurface trailing hoses designed to distribute the herbicide within the plant stand will provide more effective and longer term control of submersed weeds. Use Table 3, Subsurface Application Rates to determine the amount of *Clipper* Herbicide needed to achieve desired concentration at different water depths. Use higher concentrations when weed biomass is heavy and/or weeds are more mature and topped out. Any untreated plants that are left in the water column can re-infest treated areas that had previously been controlled. If a second application is required to provide control, it is recommended that a treatment be made once the return of these weeds is first observed, but no sooner than 28 days after the last treatment.

When applying *Clipper* Herbicide to densely packed actively growing submersed weeds, a rapid decomposition of vegetation resulting from herbicide treatment can result in loss of oxygen in water. A sudden decrease in dissolved oxygen can result in fish suffocation. If aquatic vegetation is dense, treat submersed weeds in sections to avoid a rapid decrease in dissolved oxygen.

*Clipper* Herbicide may be tank mixed with other registered submersed applied herbicides for enhanced control of submersed and floating weeds.

**Application Equipment**
To improve distribution in the water column and ensure adequate coverage, apply *Clipper* Herbicide with subsurface trailing hoses in order to place the herbicide under the surface and throughout the biomass of aquatic vegetation. Keep swath width to a minimum in order to maximize contact with submersed aquatic vegetation.



6-1/2"

5-3/4"

**Information on Hydrilla Control in Florida**

*Clipper* Herbicide should be applied as a subsurface treatment for hydrilla control. For best control of hydrilla apply during the late Winter/early Spring and/or early to late Fall. Efficacy of *Clipper* Herbicide will be enhanced at these timings due to lower potential biomass present and lower pH of the water. If applied to mature topped out hydrilla, *Clipper* Herbicide will cause some discoloration and loss of growing tips, but regrowth will be rapid.

Tank mixing *Clipper* Herbicide with other registered herbicides is recommended, especially if hydrilla is approaching maturity or biomass is heavy.

**Table 3. Subsurface Application Rates**

| Water Depth (feet) | Pounds of *Clipper* Herbicide required per surface acre to achieve desired water concentration | | |
|---|---|---|---|
| | 200 ppb | 300 ppb | 400 ppb |
| 1 | 1.1 | 1.6 | 2.1 |
| 2 | 2.1 | 3.2 | 4.2 |
| 3 | 3.2 | 4.8 | 6.4 |
| 4 | 4.2 | 6.4 | 8.5 |
| 5 | 5.3 | 8.0 | 10.6 |
| 6 | 6.4 | 9.5 | 12.7 |
| 7 | 7.4 | 11.1 | 14.8 |

Example: to achieve an initial concentration of 200 ppb of flumioxazin in a 4 foot deep water column, apply 4.2 lbs of *Clipper* Herbicide per surface acre.

## STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage, disposal or cleaning of equipment.

**PESTICIDE STORAGE**

Keep pesticide in original container.
Store in a cool, dry, secure place.
Do not put formulation or dilute spray solution into food or drink containers.
Do not contaminate food or foodstuffs.
Do not store or transport near feed or food.
Not for use or storage in or around the home.
For help with any spill, leak, fire or exposure involving this material, call day or night **(800) 892-0099.**

**PESTICIDE DISPOSAL**

Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

**CONTAINER HANDLING**

Nonrefillable container. Do not reuse or refill this container. Clean container promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container 1/4 full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times. Then offer for recycling if available or puncture and dispose of in a sanitary landfill, or by incineration.

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*Clipper* is a registered trademark of Valent U.S.A. Corporation

Manufactured for:
**Valent U.S.A. Corporation**
P.O. Box 8025
Walnut Creek CA 94596-8025
Made in U.S.A.
Form 1791-D
059639-00161.20121018.CLP.Notif
EPA Reg. No. 59639-161
EPA Est. 11773-IA-01



6-1/2"

5-3/4"

**FORM:** 1791-D
**NAME:** Clipper Herbicide
**KIND:** Composite Booklet

**PRODUCT SIZE:** 5 Pounds
**BASE LABEL SIZE:** 6-1/4" W x 6-1/2" H
**CLOSED BOOKLET SIZE:** 5-3/4" W x 6-1/2" H
**OPEN BOOKLET SIZE:** 11-1/2" W x 6-1/2" H
**UCC-EAN:** (01) 0 06 53204 095688

Process Cyan
Process Magenta
Process Yellow
Process Black

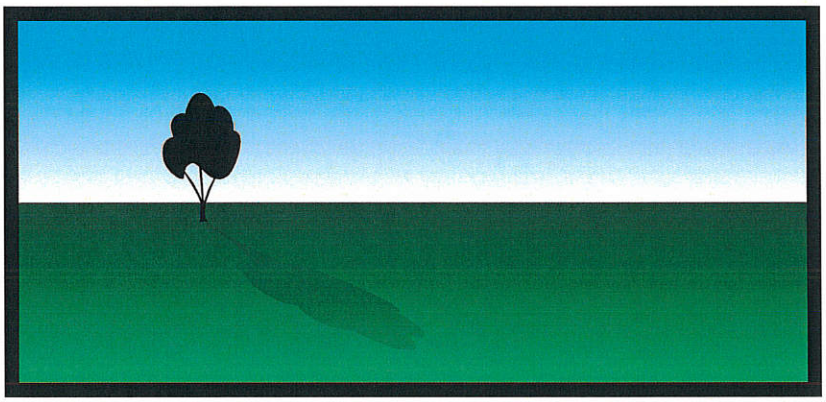
Base

6-1/2"

**GROUP 14 HERBICIDE**

PROFESSIONAL VALENT PRODUCTS

# Clipper®
## HERBICIDE



**FOR THE MANAGEMENT OF UNDESIRABLE AQUATIC VEGETATION IN SLOW MOVING OR QUIESCENT WATERS**

| Active Ingredient | By Wt. |
|---|---|
| *Flumioxazin | 51% |
| Other Ingredients | 49% |
| Total | 100% |

*2-[7-fluoro-3,4-dihydro-3-oxo-4-(2-propynyl)-2*H*-1,4-benzoxazin-6-yl]-4,5,6,7-tetrahydro-1*H*-isoindole-1,3(2*H*)-dione

Clipper® Herbicide is a water dispersible granule containing 51% active ingredient.

EPA Reg. No. 59639-161 EPA Est. 11773-IA-01

**NET WEIGHT 5 POUNDS**

**KEEP OUT OF REACH OF CHILDREN**

**CAUTION**

**SEE INSIDE BOOKLET FOR ADDITIONAL PRECAUTIONARY STATEMENTS**

Form 1791-D

6-1/4"

# Safety Data Sheet

**Clipper™ Herbicide**

## 1. IDENTIFICATION: CHEMICAL PRODUCT AND COMPANY

**PRODUCT NAME:** Clipper™ Herbicide
**VC NUMBER(S):** 1420
**PRODUCT CODE:** 88508
**EPA REGISTRATION NUMBER:** 59639-161

**PRODUCT DESCRIPTION:** Aquatic Herbicide

**MANUFACTURER/DISTRIBUTOR**
VALENT U.S.A. CORPORATION
P.O. Box 8025
1600 Riviera Avenue, Suite 200
Walnut Creek, CA 94596-8025

**EMERGENCY TELEPHONE NUMBERS**
HEALTH EMERGENCY OR SPILL (24 hr):
(800) 892-0099
TRANSPORTATION (24 hr.): CHEMTREC
(800) 424-9300 or (202) 483-7616

**PRODUCT INFORMATION**
PROFESSIONAL PRODUCTS: (800) 898-2536

The current SDS is available through our website (www.valent.com), or by calling the product information numbers listed above.

## 2. HAZARDS IDENTIFICATION

**For EPA FIFRA-specific information see Section 15**

**Classification**

| | |
|---|---|
| Reproductive toxicity | Category 2 |

**Label elements**

**EMERGENCY OVERVIEW**

## WARNING

**Hazard statements**
Suspected of damaging fertility or the unborn child

**Precautionary Statements - Prevention**
Read product label prior to using this product. For specific handling instruction refer to Section 7, Handling and Storage

**Precautionary Statements - Response**
See Section 4, First Aid Measures

**Precautionary Statements - Storage**
For information on Storage and Handling see Section 7.

**Precautionary Statements - Disposal**
For further information on product and container disposal see Section 13.

**Hazards not otherwise classified (HNOC)**
**Other Information**
25% of the mixture consists of ingredient(s) of unknown toxicity

For information on Transportation requirements see Section 14.

## 3. COMPOSITION/INFORMATION ON INGREDIENTS

| Chemical Name | CAS Number | Weight/ Percent | TRADE SECRET |
|---|---|---|---|
| Flumioxazin | 103361-09-7 | 51 | |
| Kaolin clay | 1332-58-7 | 12-17 | |
| Sodium lauryl sulfate | 151-21-3 | 1-4 | |
| Others | Various CAS#s | 30-35 | |

* The chemical name, CAS number and/or exact percentage have been withheld as a trade secret

Other ingredients, which may be maintained as trade secrets, are any substances other than an active ingredient contained in this product. Some of these may be hazardous, but their identities are withheld because they are considered trade secrets. The hazards associated with the other ingredients are addressed in this document. Specific information on other ingredients for the management of exposures, spills, or safety assessments can be obtained by a treating physician or nurse by calling **(800) 892-0099** at any time.

## 4. FIRST AID MEASURES

**EMERGENCY NUMBER (800) 892-0099**

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact **1-800-892-0099** for emergency medical treatment information.

**EYE CONTACT:**
Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

**SKIN CONTACT:**
Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

**INGESTION:**
Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. DO NOT induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.

**INHALATION:**
Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.

**NOTES TO PHYSICIAN:**
None

## 5. FIRE FIGHTING MEASURES

**EXTINGUISHING MEDIA:** Water fog, carbon dioxide, foam, dry chemical

**NFPA RATING:**

| | |
|---|---|
| Health: | 1 |
| Flammability: | 1 |
| Reactivity: | 0 |
| Special: | None |

(Least-0, Slight-1, Moderate-2, High-3, Extreme-4). These values are obtained using professional judgement. Values were not available in the guidelines or published evaluations prepared by the National Fire Protection Association, NFPA.

**FIRE FIGHTING INSTRUCTIONS:** Will not burn but if involved in a fire toxic fumes may be evolved. Avoid breathing smoke and mists. Avoid personnel and equipment contact with fallout and runoff. Minimize the amount of water used for fire fighting. Do not enter any enclosed area without full protective equipment, including self-contained breathing equipment. Contain and isolate runoff and debris for proper disposal. Decontaminate personal protective equipment and fire fighting equipment before reuse. Read the entire document.

**HAZARDOUS DECOMPOSITION PRODUCTS:** Normal combustion forms carbon dioxide, water vapor and may produce: Nitrogen compounds Fluorine compounds. Incomplete combustion can produce carbon monoxide.

## 6. ACCIDENTAL RELEASE MEASURES

**VALENT EMERGENCY PHONE NUMBER: (800) 892-0099**
**CHEMTREC EMERGENCY PHONE NUMBER: (800) 424-9300**
**OBSERVE PRECAUTIONS IN SECTION 8: PERSONAL PROTECTION**
Stop the source of the spill if safe to do so. Contain the spill to prevent further contamination of the soil, surface water, or ground water. For additional spill response information refer to the North American Emergency Response Guidebook.

**UN/NA NUMBER:** Not applicable **EMERGENCY RESPONSE GUIDEBOOK NO.:** Not applicable

**FOR SPILLS ON LAND:**

**CONTAINMENT:** Reduce airborne dust. Avoid runoff into storm sewers or other bodies of water.

**CLEANUP:** Clean up spill immediately. Vacuum or sweep up material and place in a chemical waste container. Wash area with soap and water. Pick up wash liquid with additional absorbent and place in a chemical waste container.

**FOR SPILLS IN WATER:**

**CONTAINMENT:** This material will disperse or dissolve in water. Stop the source of the release. Contain and isolate to prevent further release into soil, surface water and ground water.

**CLEANUP:** Clean up spill immediately. Absorb spill with inert material. Remove contaminated water for treatment or disposal.

## 7. HANDLING AND STORAGE

**END USER MUST READ AND OBSERVE ALL PRECAUTIONS ON PRODUCT LABEL.**

**HANDLING:**
Do not contaminate food or feed. Do not put material into food or drink containers. Do not dilute material in food or drink containers. Users should wash hands thoroughly with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet.

**STORAGE:**
Keep pesticide in original container only. Store in a cool, dry place, out of direct sunlight. Do not store or transport near food or feed. Not for use or storage in or around the home.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

**END USER MUST READ AND OBSERVE ALL PRECAUTIONS ON PRODUCT LABEL.**

**INFORMATION FOR END USERS**

**EYES & FACE:** Do not get this material in your eyes. Eye contact can be avoided by wearing protective eyewear.

**RESPIRATORY PROTECTION:** Use this material only in well ventilated areas. If ventilation is not adequate to keep airborne concentrations below recommended exposure standards, approved respiratory protection should be worn.

**SKIN & HAND PROTECTION:** Avoid contact with skin or clothing. Skin contact should be minimized by wearing protective clothing including long pants, long-sleeved shirt and shoes plus socks and chemical-resistant gloves. Remove contaminated clothing. Wash before reuse.

**EXPOSURE LIMITS**

| Chemical Name | ACGIH Exposure Limits | OSHA Exposure Limits | Manufacturer's Exposure Limits |
|---|---|---|---|
| Flumioxazin | None | None | None |
| Kaolin clay | 2 mg/m³ TWA (respirable fraction) | 15 mg/m³ TWA<br>5 mg/m³ TWA | None |
| Sodium lauryl sulfate | None | None | None |
| Others | None | None | None |

## 9. PHYSICAL AND CHEMICAL PROPERTIES

| | | | |
|---|---|---|---|
| **Physical state** | Solid | | |
| **Appearance** | Granules | **Odor** | SLIGHT |
| **Color** | Light brown | **Odor threshold** | No information available |

| **PROPERTIES** | **Values** | **Remarks • Method** |
|---|---|---|
| **pH** | 5.4 @ 25°C (1% suspension) | |
| **Melting point/freezing point** | No information available | |
| **Boiling point/boiling range** | No information available | |
| **Flash point** | | |
| **Evaporation rate** | No information available | |
| **Flammability (solid, gas)** | No information available | |
| **Flammability Limits in Air** | | |
| **Upper flammability limits** | No information available | |
| **Lower flammability limit** | No information available | |
| **Vapor pressure** | No information available | |
| **Vapor density** | No information available | |
| **Specific Gravity** | No information available | |
| **Water solubility** | Dispersible in water | |
| **Solubility in other solvents** | No information available | |
| **Partition coefficient** | No information available | |
| **Autoignition temperature** | No information available | |
| **Decomposition temperature** | No information available | |
| **Viscosity** | Not Applicable | |
| **Explosive properties** | No information available | |
| **Oxidizing properties** | No information available | |
| **Density** | No information available | |
| **Bulk density** | 0.49 g/cc (30.8 lb./cu. ft.) | |

## 10. STABILITY AND REACTIVITY

**Reactivity**
No data available

**Chemical stability**
Stable under recommended storage conditions.

**Possibility of Hazardous Reactions**
None under normal processing.

**Conditions to avoid**
Extremes of temperature and direct sunlight.

**Incompatible materials**
May react with strong oxidizing agents, such as chlorates, nitrates, peroxides, etc.

**Hazardous Decomposition Products**
None known based on information supplied.

## 11. TOXICOLOGICAL INFORMATION

**ACUTE TOXICITY:**

The following information is for the technical material or a similar formulation.

| | | | |
|---|---|---|---|
| Oral Toxicity $LD_{50}$ (rats) | > 5,000 mg/kg | EPA Tox Category | IV |
| Dermal Toxicity $LD_{50}$ (rabbits) | > 2,000 mg/kg | EPA Tox Category | III |
| Inhalation Toxicity $LC_{50}$ (rats) | > 0.969 mg/L | EPA Tox Category | III |
| Eye Irritation | Brief and/or minor irritation | EPA Tox Category | III |
| Skin Irritation | Brief and/or minor irritation | EPA Tox Category | IV |
| Skin Sensitization | Probable non-sensitizer | EPA Tox Category | Not applicable |

**CARCINOGEN CLASSIFICATION**

| Chemical Name | IARC | OSHA - Select Carcinogens | NTP Carcinogen List |
|---|---|---|---|
| Flumioxazin | Not listed | Not listed | Not listed |
| Kaolin clay | Not listed | Not listed | Not listed |
| Sodium lauryl sulfate | Not listed | Not listed | Not listed |
| Others | Not listed | Not listed | Not listed |

**TOXICITY OF FLUMIOXAZIN TECHNICAL:**

**SUBCHRONIC:** Compound related effects of Flumioxazin Technical noted in rats following subchronic exposures at high dose levels were hematotoxicity including anemia, and increases in liver, spleen, heart, kidney and thyroid weights. In dogs, the effects produced at high dose levels included a slight prolongation in activated partial thromboplastin time, increased cholesterol and phospholipid, elevated alkaline phosphatase, increased liver weights and histological changes in the liver. The lowest no-observable-effect-level (NOEL) in subchronic studies was 30 ppm in the three-month toxicity study in rats.

**CHRONIC/CARCINOGENICITY:** In a one year dog feeding study, Flumioxazin Technical produced treatment-related changes in blood chemistry and increased liver weights at 100 and 1000 mg/kg/day. Minimal treatment-related histological changes were noted in the livers of animals in the 1000 mg/kg/day group. Based on these data the NOEL is 10 mg/kg/day. Dietary administration of Flumioxazin Technical for 18 months produced liver changes in mice of the 3000 and 7000 ppm groups. There was no evidence of any treatment-related oncogenic effect. The NOEL for this study is 300 ppm. Dietary administration of Flumioxazin Technical for 24 months produced anemia and chronic nephropathy in rats of the 500 and 1000 ppm groups. The anemia lasted throughout the treatment period, however, it was not progressive nor aplastic in nature. No evidence of an oncogenic effect was observed. The NOEL for this study is 50 ppm.

**DEVELOPMENTAL TOXICITY:** Flumioxazin Technical produces developmental toxicity in rats in the absence of maternal toxicity at doses of 30 mg/kg/day by the oral route and 300 mg/kg/day by the dermal route. The developmental effects noted consisted primarily of decreased number of live fetuses and fetal weights, cardiovascular abnormalities, wavy ribs and decreased number of ossified sacrococcygeal vertebral bodies. The developmental NOEL in the rat oral and dermal developmental toxicity studies were 10 and 100 mg/kg/day, respectively. The response in rabbits was very different from that in rats. No developmental toxicity was noted in rabbits at doses up to 3000 mg/kg/day, a dose well above the maternal NOEL of 1000 mg/kg/day.

Mechanistic studies indicate that the effects seen in the rat are highly unlikely to occur in the human and that flumioxazin would not be a developmental toxicant in the human.

**REPRODUCTION:** Reproductive toxicity was observed in F1 males, P1 females and F1 females at 300 ppm Flumioxazin Technical, the highest dose tested and a dose that also produced signs of systemic toxicity. Toxicity was also observed in the F1 and F2 offspring at doses of 200 ppm and greater.

**MUTAGENICITY:** Flumioxazin Technical was not mutagenic in most *in vitro* assays: gene mutation and a chromosome aberration assay in the absence of metabolic activation. In three *in vivo* assays, chromosome aberration, unscheduled DNA synthesis and micronucleus assay, Flumioxazin Technical was not mutagenic. The only positive response was observed in the *in vitro* chromosome aberration assay in the presence of metabolic activation. Overall, Flumioxazin Technical does not present a genetic hazard.

For a summary of the potential for adverse health effects from exposure to this product, refer to Section 2. For information regarding regulations pertaining to this product, refer to Section 15.

## 12. ECOLOGICAL INFORMATION

**AVIAN TOXICITY:**

Based upon EPA designation, Flumioxazin Technical is practically non-toxic to avian species. The following results were obtained from studies with Flumioxazin Technical:

Oral $LD_{50}$ bobwhite quail: greater than 2250 mg/kg
Dietary $LC_{50}$ bobwhite quail: greater than 5620 ppm
Dietary $LC_{50}$ mallard duck: greater than 5620 ppm.

Flumioxazin Technical in the diet. In mallard ducks, a slight, but not statistically significant reduction in hatchlings and 14-day old survivors was observed. Based on a possible, slight effect on egg production at 500 ppm, the NOEL for this study was 250 ppm.

**AQUATIC ORGANISM TOXICITY:**

Based upon EPA designation, Flumioxazin Technical is slightly to moderately toxic to freshwater fish; moderately toxic to freshwater invertebrates; moderately toxic to estuarine/marine fish and moderately to highly toxic to estuarine/marine invertebrates, based on the following tests:

96-hour $LC_{50}$ rainbow trout: 2.3 mg/L
96-hour $LC_{50}$ bluegill sunfish: greater than 21 mg/L
48-hour $LC_{50}$ Daphnia magna: greater than 5.5 mg/L
96-hour $LC_{50}$ sheepshead minnow: greater than 4.7 mg/L
96-hour (shell deposition) $EC_{50}$ eastern oyster: 2.8 mg/L
96-hour $LC_{50}$ mysid shrimp: 0.23 mg/L
Fish early life-stage (rainbow trout): NOEC >7.7 µg/L, <16 µg/L
Chronic toxicity (mysid shrimp): NOEC >15 µg/L, <27 µg/L
Chronic toxicity (Daphnia magna): NOEC >52 µg/L, <99 µg/L.

**OTHER NON-TARGET ORGANISM TOXICITY:**

Flumioxazin Technical is practically non-toxic to bees. The acute contact LC50 in bees was greater than 105 µg/bee.

## 13. DISPOSAL CONSIDERATIONS

**END USERS MUST DISPOSE OF ANY UNUSED PRODUCT AS PER THE LABEL RECOMMENDATIONS.**

**PRODUCT DISPOSAL:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

**CONTAINER DISPOSAL:** Triple rinse container (or equivalent) promptly after emptying. Then offer for recycling or reconditioning or puncture and dispose of in a sanitary landfill, or by other procedures approved by state and local authorities.

**DISPOSAL METHODS:** Check government regulations and local authorities for approved disposal of this material. Dispose of in accordance with applicable laws and regulations.

## 14. TRANSPORTATION INFORMATION

| | |
|---|---|
| **DOT (ground) SHIPPING NAME:** | Not regulated for domestic ground transport by US DOT or Canada TDG. |
| **EMERGENCY RESPONSE GUIDEBOOK NO.:** | Not Applicable |
| **ICAO/IATA SHIPPING NAME:** | UN 3077 Environmentally Hazardous Substance, Solid, N.O.S. (Flumioxazin), 9, III, Marine Pollutant |
| **REMARKS:** | Single or inner packaging less than 5 L (liquid) or 5 Kg net (solids) excepted from Dangerous Goods regulations -- see UN Special Provision 375. |
| **IMDG SHIPPING NAME:** | UN 3077, Environmentally Hazardous Substance, Solid, N.O.S. (flumioxazin), Marine pollutant |
| **EMS NO.:** | F-A, S-F |

## 15. REGULATORY INFORMATION

### EPA-FIFRA LABEL INFORMATION THAT DIFFERS FROM OSHA-GHS REQUIREMENTS:

This material is a pesticide product registered by the EPA under FIFRA and is subject to certain labeling requirements under federal pesticide law. These requirements may differ from the classification criteria and hazard information required by OSHA GHS for safety data sheets, and for workplace labels of non-pesticide chemicals. The following is the hazard information as required on the FIFRA pesticide label:

### EPA FIFRA SIGNAL WORD: CAUTION

- ***Harmful if inhaled or absorbed through skin.***
- ***Avoid breathing dust or spray mist***
- ***Avoid contact with eyes, skin and clothing***
- ***Causes moderate eye irritation***
- ***Keep out of reach of children.***

**PESTICIDE REGULATIONS:** All pesticides are governed under FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act). Therefore, the regulations presented below are pertinent only when handled outside of the normal use and applications of pesticides. This includes waste streams resulting from manufacturing/formulation facilities, spills or misuse of products, and storage of large quantities of products containing hazardous or extremely hazardous substances.

**U.S. FEDERAL REGULATIONS:** Ingredients in this product are reviewed against an inclusive list of federal regulations. Therefore, the user should consult appropriate authorities. The federal regulations reviewed include: Clean Water Act, SARA, CERCLA, RCRA, DOT, TSCA and OSHA. If no components or information is listed in the space below this paragraph, then none of the regulations reviewed are applicable.

**Kaolin clay**
TSCA Inventory List - Present

**Sodium lauryl sulfate**
TSCA Inventory List - *

**SARA (311, 312):**

| | |
|---|---|
| Immediate Health: | Yes |
| Chronic Health: | Yes |
| Fire: | No |
| Sudden Pressure: | No |
| Reactivity: | No |

**STATE REGULATIONS:** Each state may promulgate standards more stringent than the federal government. This section cannot encompass an inclusive list of all state regulations. Therefore, the user should consult state or local authorities. The state regulations reviewed include: California Proposition 65, California Directors List of Hazardous Substances, Massachusetts Right to Know, Michigan Critical Materials List, New Jersey Right to Know, Pennsylvania Right to Know, Rhode Island Right to Know and the Minnesota Hazardous Substance list. For Washington State Right to Know, see Section 8 for Exposure Limit information. For Louisiana Right to Know refer to SARA information listed under U.S. Regulations above. If no components or information is listed in the space below this paragraph, then none of the regulations reviewed are applicable.

**Kaolin clay**

| | |
|---|---|
| MA Right To Know | Present |
| NJ Right To Know | 4016 |
| PA Right To Know | Present |
| RI Right To Know | Listed |
| MN Hazardous Substance | Present |

For information regarding potential adverse health effects from exposure to this product, refer to Sections 2 and 11.

## 16. OTHER INFORMATION

| | |
|---|---|
| **REASON FOR ISSUE:** | Updated information to meet OSHA Hazcom 2012 (GHS) regulations. Updated transportation information. |
| **SDS NO.:** | 0381 |
| **EPA REGISTRATION NUMBER:** | 59639-161 |
| **REVISION NUMBER:** | 1 |
| **REVISION DATE:** | 05/12/2015 |
| **SUPERCEDES DATE:** | None |
| **RESPONSIBLE PERSON(S):** | Valent U.S.A. Corporation, Corporate EH&S, (925) 256-2803 |

This Safety Data Sheet (SDS) serves different purposes than and DOES NOT REPLACE OR MODIFY THE EPA-APPROVED PRODUCT LABELING (attached to and accompanying the product container). This SDS provides important health, safety, and environmental information for employers, employees, emergency responders and others handling large quantities of the product in activities generally other than product use, while the labeling provides that information specifically for product use in the ordinary course.

Use, storage and disposal of pesticide products is regulated by the EPA under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) through the product labeling. All necessary and appropriate precautionary, use, storage, and disposal information is set forth on that labeling. It is a violation of federal law to use a pesticide product in any manner not prescribed on the EPA-approved label.

The information in this SDS is based on data available to us as of the revision date given herein, and believed to be correct. Contact Valent U.S.A. Corporation to confirm if you have the most current SDS.

Judgments as to the suitability of information herein for the individual's own use or purposes are necessarily the individual's own responsibility. Although reasonable care has been taken in the preparation of such information, Valent extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the individual's purposes or the consequences of its use.

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Product File

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 10-9-13 Reviewer S. Sutherland
Reg. No. 67690-45-AA

1073.20

# SonarOne®

## Aquatic Herbicide

SePRO

**An herbicide for management of aquatic vegetation in fresh water ponds, lakes, reservoirs, potable water sources, drainage canals, irrigation canals and rivers.**

| | |
|---|---|
| **Active Ingredient** | |
| fluridone: 1-methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4(1*H*) pyridinone | 5.0% |
| **Other Ingredients** | 95.0% |
| **TOTAL** | 100.0% |

Contains 0.05 pound active ingredient per pound of product.

## Keep Out of Reach of Children

# CAUTION / PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand the label, find someone to explain it to you in detail.)

**Refer to the inside of the label booklet for additional precautionary information and Directions for Use including Storage and Disposal.**

**NOTICE:** Read the entire label before using. Use only according to label directions. **Before buying or using this product, read *Terms and Conditions of Use, Warranty Disclaimer, Inherent Risks of Use* and *Limitation of Remedies* inside label booklet.**

EPA Reg. No. 67690-45
EPA Est. No. 067690-NC-002
FPL20120928
177302

Sonar is a registered trademark of SePRO Corporation.
**SePRO Corporation** 11550 North Meridian Street, Suite 600, Carmel, IN 46032, U.S.A.

Aquatic Herbicide

Net weight **20 pounds** (Non-refillable)

## PRECAUTIONARY STATEMENTS

### HAZARDS TO HUMANS AND DOMESTIC ANIMALS

**CAUTION.** Harmful If Swallowed. Causes moderate eye irritation. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco. Avoid contact with eyes or clothing. Wear protective eyewear.

# KEEP OUT OF REACH OF CHILDREN

# CAUTION/PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

| FIRST AID | |
|---|---|
| **If swallowed** | • Call a poison control center or doctor immediately for treatment advice.<br>• Have person sip a glass of water if able to swallow.<br>• Do not induce vomiting unless told to do so by a poison control center or doctor.<br>• Do not give anything by mouth to an unconscious person. |
| **If in eyes** | • Hold eye open and rinse slowly and gently with water for 15 to 20 minutes.<br>• Remove contact lenses, if present, after the first 5 minutes; then continue rinsing eye.<br>• Call a poison control center or doctor for treatment advice. |
| **If on skin or clothing** | • Take off contaminated clothing.<br>• Rinse skin immediately with plenty of water for 15 to 20 minutes.<br>• Call a poison control center or doctor for treatment advice. |
| **If inhaled** | • Move person to fresh air.<br>• If person is not breathing, call 911 or an ambulance; then give artificial respiration, preferably mouth-to-mouth, if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| **HOTLINE NUMBER** | |
| Have the product container or label with you when calling a poison control center or doctor, or going for treatment. In case of emergency endangering health or the environment involving this product, call **INFOTRAC** at **1-800-535-5053.** | |

## ENVIRONMENTAL HAZARDS

Do not apply to water except as specified on the label. Do not contaminate water outside the intended treatment area by disposal of equipment washwaters. Do not apply in tidewater/brackish water. Lowest rates should be used in shallow areas where the water depth is considerably less than the average depth of the entire treatment site, for example, shallow shoreline areas. Trees and shrubs growing in water treated with SonarOne herbicide may occasionally develop chlorosis. Follow use directions carefully so as to minimize adverse effects on non-target organisms.

## DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

Read all *Directions for Use* carefully before applying.

## PRODUCT INFORMATION

SonarOne herbicide is a selective systemic aquatic herbicide for management of aquatic vegetation in fresh water ponds, lakes, reservoirs, drainage canals, irrigation canals, and rivers. SonarOne is a pelleted formulation containing 5% fluridone. SonarOne is absorbed from water by plant shoots and from hydrosoil by the roots of aquatic vascular plants. It is important to maintain SonarOne in contact with the target plants for as long as possible. Rapid water movement or any condition which results in rapid dilution of SonarOne in treated water will reduce its effectiveness. In susceptible plants, SonarOne inhibits the formation of carotene. In the absence of carotene, chlorophyll is rapidly degraded by sunlight.

Herbicidal symptoms of SonarOne appear in 7 - 10 days and appear as white (chlorotic) or pink growing points. Under optimum conditions 30 - 90 days are required before the desired level of aquatic weed management is achieved with SonarOne. Species susceptibility to SonarOne may vary depending on time of year, stage of growth and water movement. For best results, apply SonarOne prior to initiation of weed growth or when weeds begin active growth. Application to mature target plants may require an application rate at the higher end of the specified rate range and may take longer to control.

SonarOne is not corrosive to application equipment.

This label provides recommendations on the use of a chemical analysis for the active ingredient. SePRO Corporation recommends the use of High-Performance Liquid Chromatography (HPLC) for the determination of the active ingredient concentration in the water. Contact SePRO Corporation to incorporate this test, known as a FasTEST, into your treatment program. Other proven chemical analyses for the active ingredient may also be used. The FasTEST is referenced in this label as the preferred method for the rapid determination of the concentration of the active ingredient in the water.

Application rates are provided in pounds of SonarOne to achieve a desired concentration of the active ingredient in part per billion (ppb). **The maximum application rate or sum of all application rates is 90 ppb in ponds and 150 ppb in lakes and reservoirs per annual growth cycle.** This maximum concentration is the amount of product calculated as the target application rate, NOT determined by testing the concentrations of the active ingredient in the treated water.

### Use Precautions and Restrictions

- **Obtain Required Permits:** Consult with appropriate state or local water authorities before applying this product to public waters. Permits and/or posting treatment notification may be required by state or local public agencies.
- **New York State:** Application of SonarOne is not permitted in waters less than two (2) feet deep, except as permitted under FIFRA Section 24(c), Special Local Need registration.
- **Hydroponic Farming:** Do not use SonarOne treated water for hydroponic farming unless a FasTEST has been run and confirmed that concentrations are less than 1 ppb.
- **Greenhouse and Nursery Plants:** Consult with SePRO Corporation for site-specific recommendations prior to any use of SonarOne treated water for irrigating greenhouse or nursery plants. Without site-specific guidance from SePRO, do not use SonarOne treated water for irrigating greenhouse or nursery plants unless a FasTEST has been run and confirmed that concentrations are less than 1 ppb.
- **Water Use Restrictions Following Application with SonarOne (Days)**

| Application Rate | Drinking† | Fishing | Swimming | Livestock/Pet Consumption | Irrigation†† |
|---|---|---|---|---|---|
| Maximum Rate (150 ppb) or less | 0 | 0 | 0 | 0 | See irrigation instructions below |

† Note below, under *Potable Water Intakes*, the information for application of SonarOne within ¼ miles (1,320) feet of a functioning potable water intake.

†† Note below, under *Irrigation*, specific time frames or fluridone concentrations that provide the widest safety margin for irrigating with fluridone treated water.

- **Potable Water Intakes:** Concentrations of the active ingredient fluridone up to 150 ppb are allowed in potable water sources; however, in lakes and reservoirs or other sources of potable water, do not apply SonarOne at application rates greater than 20 ppb within one- fourth (¼) mile (1,320 feet) of any functioning potable water intake. At application rates of 8-20 ppb, SonarOne may be applied within ¼ mile where functioning potable water intakes are present. **NOTE: Existing potable water intakes which are no longer in use, such as those replaced by connections to potable water wells or a municipal water system, are not considered to be functioning potable water intakes.**
- **Irrigation:** Irrigation with SonarOne treated water may result in injury to the irrigated vegetation. Follow these precautions and inform those who irrigate from areas treated with SonarOne of the irrigation time frames or water FasTEST requirements presented in the table below. Follow the following time frames and FasTEST directions to reduce the potential for injury to vegetation irrigated with water treated with SonarOne. Greater potential for crop injury occurs where SonarOne treated water is applied to crops grown on low organic and sandy soils.

| Application Site | Days After Application | | |
|---|---|---|---|
| | Established Tree Crops | Established Row Crops/Turf/Plants | Newly Seeded Crops/Seedbeds or Areas to be Planted Including Overseeded Golf Course Greens |
| Ponds and Static Canals † | 7 | 30 | FasTEST required |
| Canals | 7 | 7 | FasTEST required |
| Rivers | 7 | 7 | FasTEST required |
| Lakes and Reservoirs †† | 7 | 7 | FasTEST required |

† For purposes of SonarOne labeling, a pond is defined as a body of water 10 acres or less in size. A lake or reservoir is greater than 10 acres.

†† In lakes and reservoirs where one-half or greater of the body of water is treated, use the pond and static canal irrigation precautions.

Where the use of SonarOne treated water is desired for irrigating crops prior to the time frames established above, use the FasTEST to measure the concentration in the treated water. Where a FasTEST has determined that concentrations are less than 10 parts per billion, there are no irrigation precautions for irrigating established tree crops, established row crops or turf. **For tobacco, tomatoes, peppers or other plants within the Solanaceae Family and newly seeded crops or newly seeded grasses such as overseeded golf course greens, do not use SonarOne treated water if concentrations are greater than 5 ppb; furthermore, when rotating crops, do not plant members of the Solanaceae family in land that has been previously irrigated with fluridone concentrations in excess of 5 ppb. It is recommended that a SePRO Aquatic Specialist be consulted prior to commencing irrigation of these sites.**

## PLANT CONTROL INFORMATION

SonarOne selectivity is dependent upon dosage, time of year, stage of growth, method of application, and water movement. The following categories: controlled, partially controlled, and not controlled, are provided to describe expected efficacy under ideal treatment conditions using higher to maximum label rates. Use of lower rates will increase selectivity of some species listed as controlled or partially controlled. Additional aquatic plants may be controlled, partially controlled, or tolerant to SonarOne. It is recommended to consult a SePRO Aquatic Specialist prior to application of SonarOne to determine a plant's susceptibility to SonarOne. **NOTE: algae (chara, nitella, and filamentous species) are not controlled by SonarOne.**

### Vascular Aquatic Plants Controlled By SonarOne: ‡

**Submersed Plants:**
bladderwort (*Utricularia* spp.)
common coontail (*Ceratophyllum demersum*) †
common Elodea (*Elodea canadensis*) †
egeria, Brazilian Elodea (*Egeria densa*)
fanwort, Cabomba (*Cabomba caroliniana*)
hydrilla (*Hydrilla verticillata*)
naiad (*Najas* spp.) †
pondweed (*Potamogeton* spp., except Illinois pondweed) †
watermilfoil (*Myriophyllum* spp. except variable-leaf milfoil)

**Floating Plants:**
salvinia (*Salvinia* spp.)
duckweed (*Lemna*†, *Spirodela*†, and *Landoltia* spp.)
mosquito fern (*Azolla caroliniana*) ‡

**Shoreline Grasses:**
paragrass (*Urochloa mutica*)

‡ Species denoted by a dagger (†) are native plants that are often tolerant to fluridone at lower use rates. Please consult a SePRO Aquatic Specialist for recommended SonarOne use rates (not to exceed maximum labeled rates) when selective control of exotic species is desired.

## Vascular Aquatic Plants Partially Controlled By SonarOne:

**Submersed Plants:**
Illinois pondweed (*Potamogeton illinoensis*)
limnophila (*Limnophila sessiliflora*)
tapegrass, American eelgrass (*Vallisneria americana*)
watermilfoil--variable-leaf (*Myriophyllum heterophyllum*)

**Emersed Plants:**
alligatorweed (*Alternanthera philoxeroides*)
American lotus (*Nelumbo lutea*)
cattail (*Typha* spp.)
creeping waterprimrose (*Ludwigia peploides*)
parrotfeather (*Myriophyllum aquaticum*)
smartweed (*Polygonum* spp.)
spatterdock (*Nuphar luteum*)
spikerush (*Eleocharis* spp.)
waterlily (*Nymphaea* spp.)
waterpurslane (*Ludwigia palustris*)
watershield (*Brasenia schreberi*)

**Shoreline Grasses:**
barnyardgrass (*Echinochloa crusgalli*)
giant cutgrass (*Zizaniopsis miliacea*)
reed canarygrass (*Phllaris arundinaceae*)
southern watergrass (*Hydrochloa caroliniensis*)
torpedograss (*Panicum* repens)

## Vascular Aquatic Plants Not Controlled By SonarOne:

**Emersed Plants:**
American frogbit (*Limnobium spongia*)
arrowhead (*Sagittaria* spp.)
bacopa (*Bacopa* spp.)
big floatingheart, banana lily (*Nymphoides aquatica*)
bulrush (*Scirpus* spp.)
pickerelweed, lanceleaf (*Pontederia* spp.)
rush (*Juncus* spp.)
water pennywort (*Hydrocotyle* spp.)

**Floating Plants:**
floating waterhyacinth (*Eichhornia crassipes*)
waterlettuce (*Pistia stratiotes*)

**Shoreline Grasses:**
maidencane (*Panicum hemitomon*)

NOTE: Algae (chara, nitella, and filamentous species) are not controlled by SonarOne

## APPLICATION DIRECTIONS

The aquatic plants present in the treatment site should be identified prior to application to determine their susceptibility to SonarOne. It is important to determine the area (acres) to be treated and the average depth in order to select the proper application rate. Do not exceed the maximum labeled rate for a given treatment site per annual growth cycle.

**Application to Ponds**
SonarOne may be applied to the entire surface area of a pond. For single applications, rates may be selected to provide 30 - 90 ppb to the treated water, although actual concentrations in treated water may be substantially lower at any point in time due to the slow-release formulation of this product. When treating for optimum selective control, lower rates may be applied for sensitive target species. Use the higher rate within the rate range where there is a dense weed mass, when treating more difficult to control species, and for ponds less than 5 acres in size with an average depth less than 4 feet. Application rates necessary to obtain these concentrations in treated water are shown in the following table. For additional application rate calculations, refer to the *Application Rate Calculation—Ponds, Lakes and Reservoirs* section of this label. Split or multiple applications may be used where dilution of treated water is anticipated; however, the sum of all applications should total 30 - 90 ppb and must not exceed a total of 90 ppb per annual growth cycle.

| Average Water Depth of Treatment Site (feet) | Pounds of SonarOne per Treated Surface Acre | |
|---|---|---|
| | 45 ppb | 90 ppb |
| 1 | 2.5 | 5.0 |
| 2 | 5.0 | 10.0 |
| 3 | 7.5 | 15.0 |
| 4 | 10.0 | 20.0 |
| 5 | 12.5 | 25.0 |
| 6 | 15.0 | 30.0 |
| 7 | 17.0 | 34.0 |
| 8 | 19.5 | 39.0 |
| 9 | 22.0 | 44.0 |
| 10 | 24.5 | 49.0 |

## Application to Lakes and Reservoirs

The following treatments may be used for treating both whole lakes or reservoirs and partial areas of lakes or reservoirs (bays, etc.). For best results in treating partial lakes and reservoirs, SonarOne treatment areas should be a minimum of 5 acres in size. Treatment of areas smaller than 5 acres or treatment of narrow strips such as boat lanes or shorelines may not produce satisfactory results due to dilution by untreated water. Rate ranges are provided as a guide to include a wide range of environmental factors, such as target species, plant susceptibility, selectivity and other aquatic plant management objectives. Application rates and methods should be selected to meet the specific lake/reservoir aquatic plant management goals.

**NOTE:** In treating lakes or reservoirs that contain potable water intakes and where the application requires treating within one-fourth (¼) mile of a potable water intake, no single application can exceed 20 ppb. Additionally, the sum of all applications cannot exceed 150 ppb per annual growth cycle.

**A. Whole Lake or Reservoir Treatments (Limited or No Water Discharge)**

Single Application to Whole Lakes or Reservoirs

Where single applications to whole lakes or reservoirs are desired, apply SonarOne at an application rate of **16 - 90** ppb. Application rates necessary to obtain these concentrations in treated water are shown in the following table. For additional application rate calculations, refer to the *Application Rate Calculation—Ponds, Lakes and Reservoirs* section of this label. Choose an application rate from the table below to meet the aquatic plant management objective. **Where greater plant selectivity is desired such as when controlling Eurasian watermilfoil and curlyleaf pondweed, choose an application rate lower in the rate range.** For other plant species, SePRO recommends contacting a SePRO Aquatic Specialist in determining when to choose application rates lower in the rate range to meet specific plant management goals. Use the higher rate within the rate range where there is a dense weed mass or when treating more difficult to control plant species or in the event of a heavy rainfall event where dilution has occurred. In these cases, a second application or more may be required; however, the sum of all applications cannot exceed 150 ppb per annual growth cycle. Refer to the section of this label entitled, *Split or Multiple Applications to Whole Lakes or Reservoirs*, for guidelines and maximum rate allowed.

| Average Water Depth of Treatment Site (feet) | Pounds of SonarOne Per Treated Surface Acre | |
|---|---|---|
| | 16 ppb | 90 ppb |
| 1 | 0.9 | 5.0 |
| 2 | 1.7 | 10.0 |
| 3 | 2.6 | 15.0 |
| 4 | 3.5 | 20.0 |
| 5 | 4.3 | 25.0 |
| 6 | 5.2 | 30.0 |
| 7 | 6.0 | 34.0 |
| 8 | 6.9 | 39.0 |
| 9 | 7.8 | 44.0 |
| 10 | 8.6 | 49.0 |
| 11 | 9.5 | 54.0 |
| 12 | 10.4 | 59.0 |
| 13 | 11.2 | 64.0 |
| 14 | 12.1 | 68.0 |
| 15 | 13.0 | 73.0 |
| 16 | 13.8 | 78.0 |
| 17 | 14.7 | 83.0 |
| 18 | 15.6 | 88.0 |
| 19 | 16.4 | 93.0 |
| 20 | 17.3 | 98.0 |

Split or Multiple Applications to Whole Lakes or Reservoirs

To meet certain plant management objectives, split or multiple applications may be desired in making whole lake treatments. Split or multiple application programs are desirable when the objective is to use the minimum effective dose and to maintain this lower dose for the sufficient time to ensure efficacy and enhance selectivity. Under these situations, use the lower rates (16 - 75 ppb) within the rate range. **In controlling Eurasian watermilfoil and curlyleaf pondweed and where greater plant selectivity is desired, choose an application rate lower in the rate range.** For other plant species, SePRO recommends contacting a SePRO Aquatic Specialist in determining when to choose application rates lower in the rate range to meet specific plant management goals. For split or repeated applications, the sum of all applications must not exceed 150 ppb per annual growth cycle.

## B. Partial Lake or Reservoir Treatments

Where dilution of SonarOne with untreated water is anticipated, such as in partial lake or reservoir treatments, split or multiple applications may be used to extend the contact time to the target plants. The application rate and use frequency of SonarOne in a partial lake is highly dependent upon the treatment area. An application rate at the higher end of the specified rate range may be required and frequency of applications will vary depending upon the potential of untreated water diluting the SonarOne concentration in the treatment area. Use a rate at the higher end of the rate range where greater dilution with untreated water is anticipated.

Application Sites Greater Than ¼ Mile from a Functioning Potable Water Intake

For single applications, apply SonarOne at application rates from 45 - 150 ppb. Split or multiple applications may be made; however, the sum of all applications cannot exceed 150 ppb per annual growth cycle. Split applications should be conducted to maintain a sufficient concentration in the target area for a period of 45 days or longer. The use of a FasTEST is recommended to maintain the desired concentration in the target area over time.

Application Sites within ¼ Mile of a Functioning Potable Water Intake

In treatment areas that are within ¼ mile of a potable water intake, no single application can exceed 20 ppb. When utilizing split or repeated applications of SonarOne for sites which contain a potable water intake, a FasTEST is required to determine the actual concentration in the water. Additionally, the sum of all applications cannot exceed 150 ppb per annual growth cycle.

## Application Rate Calculation — Ponds, Lakes and Reservoirs

The amount of SonarOne to be applied to provide the desired ppb concentration of active ingredient equivalents in treated water may be calculated as follows:

Pounds of SonarOne required per treated acre = Avg. water depth of treatment site x
Desired ppb concentration of active ingredient equivalents x 0.054

For example: the pounds per acre of SonarOne required to provide a concentration of 25 ppb of active ingredient equivalents in water with an average depth of 5 feet is calculated as follows:

5 x 25 x 0.054 = 6.75 pounds per treated surface acre.

**NOTE:** Calculated rates may not exceed the maximum allowable rate in pounds per treated surface acre for the water depth listed in the application rate table for the site to be treated.

## Application to Drainage Canals, Irrigation Canals and Rivers

Static Canals

In static drainage and irrigation canals, apply SonarOne at the rate of 20 - 40 pounds per surface acre.

Moving Water Canals and Rivers

The performance of SonarOne will be enhanced by restricting or reducing water flow. In slow moving bodies of water use an application technique that maintains a concentration of 10 - 40 ppb in the applied area for a minimum of 45 days. SonarOne can be applied by split or multiple broadcast applications or by metering in the product to provide a uniform concentration of the herbicide based upon the flow pattern. The use of a FasTEST is recommended to maintain the desired concentration in the target area over time.

Static or Moving Water Canals or Rivers Containing a Functioning Potable Water Intake

In treating a static or moving water canal or river which contains a functioning potable water intake, applications of SonarOne greater than 20 ppb must be made more than ¼ mile from a functioning potable water intake. Applications less than 20 ppb may be applied within ¼ mile from a functioning potable water intake; however, if applications of SonarOne are made within ¼ mile from a functioning water intake, a FasTEST must be utilized to demonstrate that concentrations do not exceed 150 ppb at the potable water intake.

## Application Rate Calculation — Drainage Canals, Irrigation Canals and Rivers

The amount of SonarOne to be applied through a metering system to provide the desired ppb concentration of active ingredient in treated water may be calculated as follows:

1. Average flow rate (ft. per second) x average width (ft.) x average depth (ft.) x 0.9 = CFS (cubic feet per second)
2. CFS x 1.98 = acre feet per day (water movement)
3. Acre feet per day x desired ppb x 0.054 = pounds SonarOne required per day.

# STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.
**Pesticide Storage:** Store in original container only. Do not store near feed or foodstuffs. In case of leak or spill, contain material and dispose as waste.
**Pesticide Disposal:** Wastes resulting from use of this product may be used according to label directions or disposed of at an approved waste disposal facility.
**Container Handling**
**Nonrefillable Container. DO NOT reuse or refill this container.** Triple rinse or pressure rinse container (or equivalent) promptly after emptying; then offer for recycling, if available, or reconditioning, if appropriate, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures approved by state and local authorities.
**Triple rinse containers small enough to shake (capacity ≤ 50 pounds) as follows:** Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank, or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times.
**Triple rinse containers too large to shake (capacity >50 pounds) as follows:** Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank, or store rinsate for later use or disposal. Repeat this procedure two more times.
**Pressure rinse as follows:** Empty the remaining contents into application equipment or mix tank. Hold container upside down over application equipment or mix tank, or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container and rinse at about 40 PSI for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.
**Refillable Container.** Refill this container with pesticide only. **DO NOT** reuse this container for any other purpose. Triple rinsing the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller.
Triple rinse as follows: To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10% full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times.
When this container is empty, replace the cap and seal all openings that have been opened during use; return the container to the point of purchase or to a designated location. This container must only be refilled with a pesticide product. Prior to refilling, inspect carefully for damage such as cracks, punctures, abrasions, worn-out threads and closure devices. Check for leaks after refilling and before transport. **DO NOT** transport if this container is damaged or leaking. If the container is damaged, or leaking, or obsolete and not returned to the point of purchase or to a designated location, triple rinse emptied container and offer for recycling, if available, or dispose of container in compliance with state and local regulations.

## TERMS AND CONDITIONS OF USE

If terms of the following *Warranty Disclaimer, Inherent Risks of Use* and *Limitation of Remedies* are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, to the extent consistent with applicable law, use by the buyer or any other user constitutes acceptance of the terms under *Warranty Disclaimer, Inherent Risks of Use*, and *Limitation of Remedies*.

## WARRANTY DISCLAIMER

SePRO Corporation warrants that the product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, SEPRO CORPORATION MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

## INHERENT RISKS OF USE

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of SePRO Corporation or the seller. To the extent consistent with applicable law, all such risks shall be assumed by buyer.

## LIMITATION OF REMEDIES

To the extent consistent with applicable law, the exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories) shall be limited to, at SePRO Corporation's election, one of the following:

(1) Refund of purchase price paid by buyer or user for product bought, or
(2) Replacement of amount of product used.

To the extent consistent with applicable law, SePRO Corporation shall not be liable for losses or damages resulting from handling or use of this product unless SePRO Corporation is promptly notified of such losses or damages in writing. In no case shall SePRO Corporation be liable for consequential or incidental damages or losses.

The terms of the *Warranty Disclaimer*, *Inherent Risks of Use* and this *Limitation of Remedies* cannot be varied by any written or verbal statements or agreements. No employee or sales agent of SePRO Corporation or the seller is authorized to vary or exceed the terms of the *Warranty Disclaimer* or this *Limitation of Remedies* in any manner.

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SePRO

# SonarOne®

Aquatic Herbicide

1073.20

**Active Ingredient**

| | |
|---|---|
| fluridone: 1-methyl-3-phenyl-5-[3-(trifluoromethyl) phenyl]-4(1*H*)-pyridinone | 5.0% |
| **Other Ingredients** | 95.0% |
| **TOTAL** | 100.0% |

Contains 0.05 pound active ingredient per pound of product.

## Keep Out of Reach of Children

# CAUTION / PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail).

## PRECAUTIONARY STATEMENTS

### Hazards to Humans and Domestic Animals

**CAUTION.** Harmful If Swallowed. Causes moderate eye irritation. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco. Avoid contact with eyes or clothing. Wear protective eyewear.

## ENVIRONMENTAL HAZARDS

Do not apply to water except as specified on the label. Do not contaminate water outside the intended treatment area by disposal of equipment washwaters. Do not apply in tidewater/brackish water. Lowest rates should be used in shallow areas where the water depth is considerably less than the average depth of the entire treatment site, for example, shallow shoreline areas. Trees and shrubs growing in water treated with SonarOne herbicide may occasionally develop chlorosis. Follow use directions carefully so as to minimize adverse effects on non-target organisms.

**Refer to the inside of the label booklet for additional precautionary information and directions for use.**

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Carmel, IN 46032, U.S.A.

**Aquatic Herbicide**

| FIRST AID | |
|---|---|
| **If swallowed** | • Call a poison control center or doctor immediately for treatment advice.<br>• Have person sip a glass of water if able to swallow.<br>• Do not induce vomiting unless told to do so by a poison control center or doctor.<br>• Do not give anything by mouth to an unconscious person. |
| **If in eyes** | • Hold eye open and rinse slowly and gently with water for 15 to 20 minutes.<br>• Remove contact lenses, if present, after the first 5 minutes; then continue rinsing eye.<br>• Call a poison control center or doctor for treatment advice. |
| **If on skin or clothing** | • Take off contaminated clothing.<br>• Rinse skin immediately with plenty of water for 15 to 20 minutes.<br>• Call a poison control center or doctor for treatment advice. |
| **If inhaled** | • Move person to fresh air.<br>• If person is not breathing, call 911 or an ambulance; then give artificial respiration, preferably mouth-to-mouth, if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| **HOTLINE NUMBER** | |
| Have the product container or label with you when calling a poison control center or doctor, or going for treatment. In case of emergency endangering health or the environment involving this product, call **INFOTRAC** at **1-800-535-5053.** | |

## STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.
**Pesticide Storage:** Store in original container only. Do not store near feed or foodstuffs. In case of leak or spill, contain material and dispose as waste.
**Pesticide Disposal:** Wastes resulting from use of this product may be used according to label directions or disposed of at an approved waste disposal facility.
**Container Handling**
**Nonrefillable Container. DO NOT reuse or refill this container.** Triple rinse or pressure rinse container (or equivalent) promptly after emptying; then offer for recycling, if available, or reconditioning, if appropriate, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures approved by state and local authorities.
**Refillable Container.** Refill this container with pesticide only. **DO NOT** reuse this container for any other purpose. Triple rinsing the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. **See attached booklet for complete container disposal directions including triple rinsing and pressure rinsing instructions.**

**Net weight 20 pounds (Non-refillable)**

8 11055 01092 6

PEEL FILM HERE ▲

# SAFETY DATA SHEET

# SonarOne® Aquatic Herbicide

## Section 1. Identification

**GHS product identifier** : SonarOne® Aquatic Herbicide

**Other means of identification** : Not available.

**EPA Registration No. :** 67690-45

**Relevant identified uses of the substance or mixture**

Aquatic herbicide.

**Supplier's details** : SePRO Corporation
11550 North Meridian Street
Suite 600
Carmel, IN 46032 U.S.A.
Tel: 317-580-8282
Toll free: 1-800-419-7779
Fax: 317-580-8290
Monday - Friday, 8am to 5pm E.S.T.
www.sepro.com

**Emergency telephone number (with hours of operation)** : **INFOTRAC - 24-hour service 1-800-535-5053**

**The following recommendations for exposure controls and personal protection are intended for the manufacture, formulation and packaging of this product. For applications and/or use, consult the product label. The label directions supersede the text of this Safety Data Sheet for application and/or use.**

## Section 2. Hazards identification

**OSHA/HCS status** : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

**Classification of the substance or mixture** : SERIOUS EYE DAMAGE/ EYE IRRITATION - Category 2B
AQUATIC HAZARD (LONG-TERM) - Category 3

**GHS label elements**

**Signal word** : Warning

**Hazard statements** : Causes eye irritation.
Harmful to aquatic life with long lasting effects.

**Precautionary statements**

**Prevention** : Avoid accidental release to the environment. Do not eat, drink or smoke when using this product. Wash hands thoroughly after handling.

**Response** : IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical attention.

**Storage** : Not applicable.

**Disposal** : Dispose of contents and container in accordance with all local, regional, national and international regulations.

**Hazards not otherwise classified** : None known.



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# Section 3. Composition/information on ingredients

**Substance/mixture** : Mixture

**Other means of identification** : Not available.

**CAS number/other identifiers**

**CAS number** : Not applicable.

| Ingredient name | % | CAS number |
|---|---|---|
| Proprietary ingredient 2 | 40 - 80 | - |
| Proprietary ingredient 3 | 10 - 40 | - |
| Proprietary ingredient 4 | 10 - 40 | - |
| 1-Methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4-pyridone | 5 | 59756-60-4 |
| Proprietary ingredient 1 | 1 - 5 | - |

Any concentration shown as a range is to protect confidentiality or is due to batch variation.

**There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.**

**Occupational exposure limits, if available, are listed in Section 8.**

# Section 4. First aid measures

**Description of necessary first aid measures**

**Eye contact** : Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 20 minutes. If irritation persists, get medical attention.

**Inhalation** : Remove victim to fresh air and keep at rest in a position comfortable for breathing. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Get medical attention if adverse health effects persist or are severe. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband. In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

**Skin contact** : Flush contaminated skin with plenty of water. Get medical attention if symptoms occur. Wash clothing before reuse. Clean shoes thoroughly before reuse.

**Ingestion** : Wash out mouth with water. Remove dentures if any. Remove victim to fresh air and keep at rest in a position comfortable for breathing. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. Stop if the exposed person feels sick as vomiting may be dangerous. Do not induce vomiting unless directed to do so by medical personnel. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Get medical attention if adverse health effects persist or are severe. Never give anything by mouth to an unconscious person. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. Loosen tight clothing such as a collar, tie, belt or waistband.

**Most important symptoms/effects, acute and delayed**

**Potential acute health effects**

**Eye contact** : Causes eye irritation.

**Inhalation** : No known significant effects or critical hazards.

**Skin contact** : No known significant effects or critical hazards.

**Ingestion** : No known significant effects or critical hazards.



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# Section 4. First aid measures

**Over-exposure signs/symptoms**

**Eye contact** : Adverse symptoms may include the following:
pain or irritation
watering
redness

**Inhalation** : No known significant effects or critical hazards.

**Skin contact** : No known significant effects or critical hazards.

**Ingestion** : No known significant effects or critical hazards.

**Indication of immediate medical attention and special treatment needed, if necessary**

**Notes to physician** : In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

**Specific treatments** : No specific treatment.

**Protection of first-aiders** : No action shall be taken involving any personal risk or without suitable training. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation.

**See toxicological information (Section 11)**

# Section 5. Fire-fighting measures

**Extinguishing media**

**Suitable extinguishing media** : Use an extinguishing agent suitable for the surrounding fire.

**Unsuitable extinguishing media** : None known.

**Specific hazards arising from the chemical** : This material is harmful to aquatic life with long lasting effects. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

**Hazardous thermal decomposition products** : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide
nitrogen oxides
halogenated compounds
metal oxide/oxides

**Special protective actions for fire-fighters** : No special measures are required.

**Special protective equipment for fire-fighters** : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

# Section 6. Accidental release measures

**Personal precautions, protective equipment and emergency procedures**

**For non-emergency personnel** : No action shall be taken involving any personal risk or without suitable training. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.

**For emergency responders** : If specialized clothing is required to deal with the spillage, take note of any information in Section 8 on suitable and unsuitable materials. See also the information in "For non-emergency personnel".


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# Section 6. Accidental release measures

**Environmental precautions** : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). May be harmful to the environment if accidentally released in large quantities.

**Methods and materials for containment and cleaning up**

**Spill** : Move containers from spill area. Approach release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Avoid dust generation. Do not dry sweep. Vacuum dust with equipment fitted with a HEPA filter and place in a closed, labeled waste container. Dispose of via a licensed waste disposal contractor. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

# Section 7. Handling and storage

**Precautions for safe handling**

**Protective measures** : Put on appropriate personal protective equipment (see Section 8). Do not ingest. Avoid contact with eyes, skin and clothing. Avoid accidental release to the environment. Keep in the original container or an approved alternative made from a compatible material, kept tightly closed when not in use. Empty containers retain product residue and can be hazardous. Do not reuse container.

**Advice on general occupational hygiene** : Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. See also Section 8 for additional information on hygiene measures.

**Conditions for safe storage, including any incompatibilities** : Store in accordance with local regulations. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10) and food and drink. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabeled containers. Use appropriate containment to avoid environmental contamination.

# Section 8. Exposure controls/personal protection

**Control parameters**

**Occupational exposure limits**

None.

**Appropriate engineering controls** : Good general ventilation should be sufficient to control worker exposure to airborne contaminants.

**Environmental exposure controls** : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation.

**Individual protection measures**

**Hygiene measures** : Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.


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## Section 8. Exposure controls/personal protection

**Eye/face protection** : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists, gases or dusts. If contact is possible, the following protection should be worn, unless the assessment indicates a higher degree of protection: chemical splash goggles.

**Skin protection**

**Hand protection** : Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

**Body protection** : Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

**Other skin protection** : Appropriate footwear and any additional skin protection measures should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

**Respiratory protection** : Use a properly fitted, particulate filter respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

## Section 9. Physical and chemical properties

**Appearance**

**Physical state** : Solid. [Pellets.]

**Color** : Brown to gray.

**Odor** : Faint earthy/musty.

**Odor threshold** : Not available.

**pH** : 7.8 [Conc. (% w/w): 31%]

**Melting point** : Not available.

**Boiling point** : Not available.

**Flash point** : Not applicable.

**Burning time** : Not available.

**Burning rate** : Not available.

**Evaporation rate** : Not available.

**Flammability (solid, gas)** : Not available.

**Lower and upper explosive (flammable) limits** : Not available.

**Vapor pressure** : Not available.

**Vapor density** : Not available.

**Relative density** : 1.02 at 20°C

**Solubility** : Not available.

**Solubility in water** : Insoluble. Pellet disintegrates in water.

**Partition coefficient: n-octanol/water** : Not available.

**Auto-ignition temperature** : Not available.

**Decomposition temperature** : Not available.



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# Section 9. Physical and chemical properties

**SADT** : Not available.

**Viscosity** : Not available.

# Section 10. Stability and reactivity

**Reactivity** : No specific test data related to reactivity available for this product or its ingredients.

**Chemical stability** : The product is stable.

**Possibility of hazardous reactions** : Under normal conditions of storage and use, hazardous reactions will not occur.

**Conditions to avoid** : No specific data.

**Incompatible materials** : Reactive or incompatible with the following materials: oxidizing materials.

**Hazardous decomposition products** : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

# Section 11. Toxicological information

## Information on toxicological effects

### Acute toxicity

| Product/ingredient name | Result | Species | Dose | Exposure |
|---|---|---|---|---|
| SonarOne® Aquatic Herbicide | LD50 Dermal<br>LD50 Oral | Rabbit<br>Rat | >2000 mg/kg<br>>5000 mg/kg | -<br>- |

### Irritation/Corrosion

| Product/ingredient name | Result | Species | Score | Exposure | Observation |
|---|---|---|---|---|---|
| SonarOne® Aquatic Herbicide | Eyes - Mild irritant<br>Skin - Mild irritant | Rabbit<br>Rabbit | -<br>- | -<br>- | -<br>- |

### Sensitization

| Product/ingredient name | Route of exposure | Species | Result |
|---|---|---|---|
| SonarOne® Aquatic Herbicide | skin | Guinea pig | Not sensitizing |

### Mutagenicity

There is no data available.

### Carcinogenicity

There is no data available.

### Reproductive toxicity

There is no data available.

### Teratogenicity

There is no data available.

### Specific target organ toxicity (single exposure)

There is no data available.

### Specific target organ toxicity (repeated exposure)

There is no data available.


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# Section 11. Toxicological information

**Aspiration hazard**

There is no data available.

**Information on the likely routes of exposure** : Routes of entry anticipated: Oral, Dermal, Inhalation.

**Potential acute health effects**

**Eye contact** : Causes eye irritation.

**Inhalation** : No known significant effects or critical hazards.

**Skin contact** : No known significant effects or critical hazards.

**Ingestion** : No known significant effects or critical hazards.

**Symptoms related to the physical, chemical and toxicological characteristics**

**Eye contact** : Adverse symptoms may include the following:
pain or irritation
watering
redness

**Inhalation** : No known significant effects or critical hazards.

**Skin contact** : No known significant effects or critical hazards.

**Ingestion** : No known significant effects or critical hazards.

**Delayed and immediate effects and also chronic effects from short and long term exposure**

**Short term exposure**

**Potential immediate effects** : No known significant effects or critical hazards.

**Potential delayed effects** : No known significant effects or critical hazards.

**Long term exposure**

**Potential immediate effects** : No known significant effects or critical hazards.

**Potential delayed effects** : No known significant effects or critical hazards.

**Potential chronic health effects**

**General** : No known significant effects or critical hazards.

**Carcinogenicity** : No known significant effects or critical hazards.

**Mutagenicity** : No known significant effects or critical hazards.

**Teratogenicity** : No known significant effects or critical hazards.

**Developmental effects** : No known significant effects or critical hazards.

**Fertility effects** : No known significant effects or critical hazards.

**Numerical measures of toxicity**

**Acute toxicity estimates**

There is no data available.


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# Section 12. Ecological information

**Toxicity**

| Product/ingredient name | Result | Species | Exposure |
|---|---|---|---|
| 1-Methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4-pyridone | Acute EC50 3 mg/L Fresh water | Daphnia - Daphnia magna | 48 hours |
| | Acute LC50 8 mg/L Fresh water | Crustaceans - Eucyclops sp. | 48 hours |
| | Acute LC50 1.8 mg/L Fresh water | Fish - Sander vitreus | 96 hours |
| | Chronic NOEC 0.2 mg/L Fresh water | Daphnia - Daphnia magna | 21 days |
| | Chronic NOEC 0.43 mg/L | Fish - Oncorhynchus tshawytscha | 75 days |

**Persistence and degradability**

There is no data available.

**Bioaccumulative potential**

| Product/ingredient name | $LogP_{ow}$ | BCF | Potential |
|---|---|---|---|
| 1-Methyl-3-phenyl-5-[3-(trifluoromethyl)phenyl]-4-pyridone | 3.16 | - | low |

**Mobility in soil**

**Soil/water partition coefficient ($K_{OC}$)** : Not available.

**Other adverse effects** : No known significant effects or critical hazards.

# Section 13. Disposal considerations

**Disposal methods** : The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Care should be taken when handling empty containers that have not been cleaned or rinsed out. Empty containers or liners may retain some product residues. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

# Section 14. Transport information

| | DOT Classification | IMDG | IATA |
|---|---|---|---|
| **UN number** | Not regulated. | Not regulated. | Not regulated. |
| **UN proper shipping name** | - | - | - |
| **Transport hazard class(es)** | - | - | - |
| **Packing group** | - | - | - |



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## Section 14. Transport information

| | | | |
|---|---|---|---|
| **Environmental hazards** | No. | No. | No. |
| **Additional information** | - | - | - |

**Special precautions for user** : **Transport within user's premises:** always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

**Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code** : Not available.

## Section 15. Regulatory information

**U.S. Federal regulations** : **TSCA 8(a) CDR Exempt/Partial exemption**: Not determined

**United States inventory (TSCA 8b)**: All components are listed or exempted.

**Clean Air Act Section 112 (b) Hazardous Air Pollutants (HAPs)** : Not listed

**Clean Air Act Section 602 Class I Substances** : Not listed

**Clean Air Act Section 602 Class II Substances** : Not listed

**DEA List I Chemicals (Precursor Chemicals)** : Not listed

**DEA List II Chemicals (Essential Chemicals)** : Not listed

**SARA 302/304**

**Composition/information on ingredients**

No products were found.

**SARA 304 RQ** : Not applicable.

**SARA 311/312**

**Classification** : Immediate (acute) health hazard

**Composition/information on ingredients**

| Name | % | Fire hazard | Sudden release of pressure | Reactive | Immediate (acute) health hazard | Delayed (chronic) health hazard |
|---|---|---|---|---|---|---|
| Fluridone | 5 | No. | No. | No. | Yes. | No. |

**SARA 313**

No products were found.

**State regulations**

**Massachusetts** : None of the components are listed.



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## Section 15. Regulatory information

**New York** : None of the components are listed.

**New Jersey** : The following components are listed: Proprietary ingredient 2

**Pennsylvania** : The following components are listed: Proprietary ingredient 2

**California Prop. 65**

No products were found.

**International regulations**

**International lists** : **Australia inventory (AICS)**: Not determined.
**China inventory (IECSC)**: Not determined.
**Japan inventory**: Not determined.
**Korea inventory**: Not determined.
**Malaysia Inventory (EHS Register)**: Not determined.
**New Zealand Inventory of Chemicals (NZIoC)**: All components are listed or exempted.
**Philippines inventory (PICCS)**: Not determined.
**Taiwan inventory (CSNN)**: All components are listed or exempted.

**Chemical Weapons Convention List Schedule I Chemicals** : Not listed

**Chemical Weapons Convention List Schedule II Chemicals** : Not listed

**Chemical Weapons Convention List Schedule III Chemicals** : Not listed

## Section 16. Other information

**Hazardous Material Information System (U.S.A.)**

**Health :** 1 * **Flammability :** 0 **Physical hazards :** 0

**Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risks, and 4 representing significant hazards or risks Although HMIS® ratings are not required on SDSs under 29 CFR 1910.1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® is a registered mark of the National Paint & Coatings Association (NPCA). HMIS® materials may be purchased exclusively from J. J. Keller (800) 327-6868.**

**The customer is responsible for determining the PPE code for this material.**

**National Fire Protection Association (U.S.A.)**

**Health :** 1 **Flammability :** 0 **Instability :** 0

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**Copyright ©2001, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health and reactivity hazards of chemicals. The user is referred to certain limited number of chemicals with recommended classifications in NFPA 49 and NFPA 325, which would be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 systems to classify chemicals does so at their own risk.**

**History**

**Date of issue mm/dd/yyyy** : 09/15/2015

**Date of previous issue** : 04/15/2013

**Version** : 4

**Revised Section(s)** : 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

**Prepared by** : KMK Regulatory Services Inc.



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## Section 16. Other information

**Key to abbreviations** : ATE = Acute Toxicity Estimate
BCF = Bioconcentration Factor
GHS = Globally Harmonized System of Classification and Labelling of Chemicals
IATA = International Air Transport Association
IBC = Intermediate Bulk Container
IMDG = International Maritime Dangerous Goods
LogPow = logarithm of the octanol/water partition coefficient
MARPOL 73/78 = International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978. ("Marpol" = marine pollution)
UN = United Nations

**Notice to reader**

**To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.**
**Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.**


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LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 3.3.14 Reviewer S Sutherland
Reg. No. 524-343-76

Product File

## PRECAUTIONARY STATEMENTS

### Hazards to Humans and Domestic Animals

Keep Out of Reach of Children.

CAUTION!

DOMESTIC ANIMALS: This product is considered to be relatively nontoxic to dogs and other domestic animals; however, ingestion of this product or large amounts of freshly sprayed vegetation may result in temporary gastrointestinal irritation (vomiting, diarrhea, colic, etc.). If such symptoms are observed, provide the animal with plenty of fluids to prevent dehydration. Call a veterinarian if symptoms persist for more than 24 hours.

**Personal Protective Equipment (PPE)**

**Applicators and other handlers must wear:** long-sleeved shirt and long pants, shoes plus socks. Follow manufacturer's instructions for cleaning/maintaining PPE (Personal Protective Equipment). If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

Engineering Control Statements: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

**User Safety Recommendations:**
Users should:
- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove contaminated clothing and wash clothing before reuse.

### Environmental Hazards

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of SPILL or LEAK, soak up and remove to a landfill.

### Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, fiberglass, plastic or plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

## DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulations.

### Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. Refer to supplemental labeling under "AGRICULTURAL USE REQUIREMENTS" in the DIRECTIONS FOR USE section for information about this standard.

### Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

Keep people and pets off treated areas until spray solution has dried.

For product information or assistance in using this product, call toll-free 1-800-332-3111.

MONSANTO

GROUP 9 HERBICIDE

TRUEBLUE ADVANTAGE
PROVEN | RELIABLE | SUPPORTED™

# Roundup CUSTOM™

## FOR AQUATIC & TERRESTRIAL USE

Roundup Custom™ for Aquatic and Terrestrial Use is a complete broad-spectrum postemergence herbicide for aquatic, crop, non-agricultural crop, industrial, turf, ornamental, forestry, roadside, and utility rights-of-way weed control

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

**Carefully follow detailed instructions in label booklet.**

Read the entire label before using this product.

See label booklet for Complete Directions for Use.

Use only according to label instructions.

Read the "LIMIT OF WARRANTY AND LIABILITY" statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION OR REPACKAGING.

Keep Out of Reach of Children.

CAUTION!

| ACTIVE INGREDIENT: | |
|---|---|
| *Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt | 53.8% |
| OTHER INGREDIENTS: | 46.2% |
| | 100.0% |

*Contains 648 grams per liter or 5.4 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt. Equivalent to 480 grams per liter or 4.0 pounds per U.S. gallon of the acid, glyphosate.

No license granted under any non-U.S. patent(s).

EPA Reg. No. 524-343

EPA Est. 524-IA-1

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Packed For:
MONSANTO COMPANY
800 N. LINDBERGH BLVD.
ST. LOUIS, MISSOURI, 63167 USA
©2012

NET 30 GAL

21153L2-27/53M

Printed 95% of Original Size

## Storage and Disposal

Proper pesticide storage and disposal are essential to protect against exposure to people and the environment due to leaks and spills, excess product or waste, and vandalism. Do not allow this product to contaminate water, foodstuffs, feed or seed by storage and disposal. **PESTICIDE STORAGE:** STORE ABOVE 5°F (-15°C) TO KEEP PRODUCT FROM CRYSTALLIZING. Crystals will settle to the bottom. If allowed to crystallize, place in a warm room 68°F (20°C) for several days to redissolve and roll or shake container or recirculate in mini-bulk containers to mix well before using. Store pesticides away from food, pet food, feed, seed, fertilizers, and veterinary supplies. Keep container closed to prevent spills and contamination. **PESTICIDE DISPOSAL:** To avoid wastes, use all material in this container, including rinsate, by application according to label directions. If wastes cannot be avoided, offer remaining product to a waste disposal facility or pesticide disposal program. Such programs are often run by state or local governments or by industry. All disposal must be in accordance with applicable federal, state and local regulations and procedures. **CONTAINER HANDLING AND DISPOSAL:** Nonrefillable container. Do not reuse this container to hold materials other than pesticides or dilute pesticides (rinsate). After emptying and cleaning, it may be allowable to temporarily hold rinsate or other pesticide-related materials in the container. Contact your state regulatory agency to determine allowable practices in your state. Triple rinse or pressure rinse (or equivalent) this container promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times. Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container, and rinse at about 40 PSI for at least 30 seconds. Drain for 10 seconds after the flow begins to drip. Once properly rinsed, some plastic pesticide containers can be taken to a container collection site or picked up for recycling. To find the nearest site, contact your chemical dealer or Monsanto at 1-800-768-6387. If recycling is not available, dispose of in accordance with federal, state and local regulations and procedures, which may include puncturing the properly rinsed container and disposing in a sanitary landfill.

### LIMIT OF WARRANTY AND LIABILITY

Monsanto Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth in the Complete Directions for Use label booklet ("Directions") when used in accordance with those Directions under the conditions described therein. NO OTHER EXPRESS WARRANTY OR IMPLIED WARRANTY OF FITNESS FOR PARTICULAR PURPOSE OR MERCHANTABILITY IS MADE. This warranty is also subject to the conditions and limitations stated herein. Buyer and all users shall promptly notify this Company of any claims whether based in contract, negligence, strict liability, other tort or otherwise. To the fullest extent permitted by law, buyer and all users are responsible for all loss or damage from use or handling which results from conditions beyond the control of this Company, including, but not limited to, incompatibility with products other than those set forth in the Directions, application to or contact with desirable vegetation, unusual weather, weather conditions which are outside the range considered normal at the application site and for the time period when the product is applied, as well as weather conditions which are outside the application ranges set forth in the Directions, application in any manner not explicitly set forth in the Directions, moisture conditions outside the moisture range specified in the Directions, or the presence of products other than those set forth in the Directions in or on the soil, crop or treated vegetation. This Company does not warrant any product reformulated or repackaged from this product except in accordance with this Company's stewardship requirements and with express written permission from this Company. THE EXCLUSIVE REMEDY OF THE USER OR BUYER, AND THE LIMIT OF THE LIABILITY OF THIS COMPANY OR ANY OTHER SELLER FOR ANY AND ALL LOSSES, INJURIES OR DAMAGES RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT (INCLUDING CLAIMS BASED IN CONTRACT, NEGLIGENCE, STRICT LIABILITY, OTHER TORT OR OTHERWISE) SHALL BE THE PURCHASE PRICE PAID BY THE USER OR BUYER FOR THE QUANTITY OF THIS PRODUCT INVOLVED, OR, AT THE ELECTION OF THIS COMPANY OR ANY OTHER SELLER, THE REPLACEMENT OF SUCH QUANTITY, OR, IF NOT ACQUIRED BY PURCHASE, REPLACEMENT OF SUCH QUANTITY. TO THE FULLEST EXTENT PERMITTED BY LAW, IN NO EVENT SHALL THIS COMPANY OR ANY OTHER SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES. Upon opening and using this product, buyer and all users are deemed to have accepted the terms of this LIMIT OF WARRANTY AND LIABILITY which may not be varied by any verbal or written agreement. If terms are not acceptable, return at once unopened.

(01)00883580764919

(91)02115313227531

**Return Properly Rinsed Container to Monsanto for Recycling**
**Contact 1-800-766-6387.**

Product File

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 3-3-14 Reviewer S Sutherland
Reg. No. 524-343-2G

GROUP 9 HERBICIDE

TRUEBLUE ADVANTAGE
PROVEN | RELIABLE | SUPPORTED

# Roundup CUSTOM®

## FOR AQUATIC & TERRESTRIAL USE

Roundup Custom™ for Aquatic and Terrestrial Use is a complete broad-spectrum postemergence herbicide for aquatic, crop, non-agricultural crop, industrial, turf, ornamental, forestry, roadside, and utility rights-of-way weed control

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

**Carefully follow detailed instructions in label booklet.**

Read the entire label before using this product.

Use only according to label instructions.

Read the "LIMIT OF WARRANTY AND LIABILITY" statement, which appears in the label booklet, before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION OR REPACKAGING.

### PRECAUTIONARY STATEMENTS

### Hazards to Humans and Domestic Animals

Keep Out of Reach of Children.

CAUTION!

DOMESTIC ANIMALS: This product is considered to be relatively nontoxic to dogs and other domestic animals; however, ingestion of this product or large amounts of freshly sprayed vegetation may result in temporary gastrointestinal irritation (vomiting, diarrhea, colic, etc.). If such symptoms are observed, provide the animal with plenty of fluids to prevent dehydration. Call a veterinarian if symptoms persist for more than 24 hours.

**Personal Protective Equipment (PPE)**

**Applicators and other handlers must wear:** long-sleeved shirt and long pants, shoes plus socks. Follow manufacturer's instructions for cleaning/maintaining PPE (Personal Protective Equipment). If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

Engineering Control Statements: When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

**User Safety Recommendations:**
Users should:
- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove contaminated clothing and wash clothing before reuse.

### Environmental Hazards

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of SPILL or LEAK, soak up and remove to a landfill.

### Physical or Chemical Hazards

Spray solutions of this product should be mixed, stored and applied using only stainless steel, fiberglass, plastic or plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas which may form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

### DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulations.

### Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. Refer to supplemental labeling under "AGRICULTURAL USE REQUIREMENTS" in the DIRECTIONS FOR USE section for information about this standard.

### Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

Keep people and pets off treated areas until spray solution has dried.

### Storage and Disposal

Proper pesticide storage and disposal are essential to protect against exposure to people and the environment due to leaks and spills, excess product or waste, and vandalism. Do not allow this product to contaminate water, foodstuffs, feed or seed by storage and disposal.

**PESTICIDE STORAGE:** STORE ABOVE 5°F (-15°C) TO KEEP PRODUCT FROM CRYSTALLIZING. Crystals will settle to the bottom. If allowed to crystallize, place in a warm room 68°F (20°C) for several days to redissolve and roll or shake container or recirculate in mini-bulk containers to mix well before using. Store pesticides away from food, pet food, feed, seed, fertilizers, and veterinary supplies. Keep container closed to prevent spills and contamination.

MONSANTO

**PESTICIDE DISPOSAL:** To avoid wastes, use all material in this container, including rinsate, by application according to label directions. If wastes cannot be avoided, offer remaining product to a waste disposal facility or pesticide disposal program. Such programs are often run by state or local governments or by industry. All disposal must be in accordance with applicable federal, state and local regulations and procedures.

**CONTAINER HANDLING AND DISPOSAL:** Nonrefillable container. Do not reuse or refill this container.

Triple rinse or pressure rinse (or equivalent) this container promptly after emptying.

Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times.

Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container and rinse at about 40 PSI for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

Then offer this container for recycling, if available.

Some container manufacturers offer container recycling. See additional information regarding manufacturer recycling programs attached to this container, if available. If no recycling information is available on this container, contact your chemical dealer or Monsanto Company at 1-800-768-6387 to find the nearest recycling location.

If recycling is not available, dispose of this container in accordance with federal, state and local regulations and procedures, which may include puncturing the properly rinsed container and disposing in a sanitary landfill.

(See label booklet for Complete Directions for Use.)

| ACTIVE INGREDIENT: | |
|---|---|
| *Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt | 53.8% |
| OTHER INGREDIENTS: | 46.2% |
| | 100.0% |

*Contains 648 grams per liter or 5.4 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt. Equivalent to 480 grams per liter or 4.0 pounds per U.S. gallon of the acid, glyphosate.

For product information or assistance in using this product, call toll-free 1-800-332-3111.

No license granted under any non-U.S. patent(s).

EPA Reg. No. 524-343

Roundup Custom and Monsanto and Vine Design are trademarks of Monsanto Technology LLC.

Packed For:
MONSANTO COMPANY
800 N. LINDBERGH BLVD.
ST. LOUIS, MISSOURI, 63167 USA

©2013

21153L3-33/53M

Printed 93% of Original Size

NET 265 GAL

EPA Est. 524-IA-1

(01)00883580765008

Product File

Container Label - Smart Pack

TOI #060113

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 8-5-13 Reviewer S. Sutherland
Reg. No. 524-343-26

Roundup Custom™ for Aquatic & Terrestrial Use

3 GALLONS

## Easy to Handle

## Easy to Pour

| GROUP | 9 | HERBICIDE |
|---|---|---|

TRUEBLUE ADVANTAGE
PROVEN | RELIABLE | SUPPORTED
™

# Roundup CUSTOM™

## FOR AQUATIC & TERRESTRIAL USE

Roundup Custom™ for Aquatic and Terrestrial Use is a complete broad-spectrum postemergence herbicide for aquatic, crop, non-agricultural crop, industrial, turf, ornamental, forestry, roadside, and utility rights-of-way weed control.

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, GREEN STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

Keep out of reach of children

CAUTION! See precautions on back panel

Read the entire label before using this product. See label booklet for Complete Directions for Use. Use only according to label instructions.

For product information or assistance in using this product, call toll-free 1-800-332-3111.

Read the "LIMIT OF WARRANTY AND LIABILITY" statement that appears in the label booklet before buying or using. If terms are not acceptable, return at once unopened.

THIS IS AN END-USE PRODUCT. MONSANTO DOES NOT INTEND AND HAS NOT REGISTERED IT FOR REFORMULATION OR REPACKAGING.

ACTIVE INGREDIENT:

| | |
|---|---|
| *Glyphosate, N-(phosphonomethyl)glycine, in the form of its isopropylamine salt | 53.8% |
| OTHER INGREDIENTS: | 46.2% |
| | 100.0% |

*Contains 648 grams per liter or 5.4 pounds per U.S. gallon of the active ingredient glyphosate, in the form of its isopropylamine salt. Equivalent to 480 grams per liter or 4.0 pounds per U.S. gallon of the acid, glyphosate.

Patents pending. No license granted under any non-U.S. patent(s).

MONSANTO

Roundup Custom™ for Aquatic & Terrestrial Use

3 GALLONS

REMOVED EPA REG NO. AND EPA EST. NO.

# Roundup CUSTOM™

## FOR AQUATIC & TERRESTRIAL USE

## PRECAUTIONARY STATEMENTS

### Hazards to Humans and Domestic Animals

Keep out of reach of children

CAUTION!

**DOMESTIC ANIMALS:** This product is considered to be relatively nontoxic to dogs and other domestic animals; however, ingestion of this product or large amounts of freshly sprayed vegetation may result in temporary gastrointestinal irritation (vomiting, diarrhea, colic, etc.). If such symptoms are observed, provide the animal with plenty of fluids to prevent dehydration. Call a veterinarian if symptoms persist for more than 24 hours.

**Personal Protective Equipment (PPE)**

**Applicators and other handlers must wear:** long-sleeved shirt and long pants, shoes plus socks.

Follow manufacturer's instructions for cleaning/maintaining PPE (Personal Protective Equipment). If there are no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. Do not reuse them.

When handlers use closed systems, enclosed cabs, or aircraft in a manner that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d) (4-6)], the handler PPE requirements may be reduced or modified as specified in the WPS.

IMPORTANT: When reduced PPE is worn because a closed system is being used, handlers must be provided all PPE specified above for "applicators and other handlers" and have such PPE immediately available for use in an emergency, such as a spill or equipment breakdown.

**User Safety Recommendations**

Users should:

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

### Environmental Hazards

Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Treatment of aquatic weeds can result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss can cause fish suffocation.

In case of SPILL or LEAK, soak up and remove to a landfill.

21153L2-29M

## Physical or Chemical Hazards

Spray solutions of this product can be mixed, stored and applied using only stainless steel, fiberglass, plastic or plastic-lined steel containers.

DO NOT MIX, STORE OR APPLY THIS PRODUCT OR SPRAY SOLUTIONS OF THIS PRODUCT IN GALVANIZED STEEL OR UNLINED STEEL (EXCEPT STAINLESS STEEL) CONTAINERS OR SPRAY TANKS. This product or spray solutions of this product react with such containers and tanks to produce hydrogen gas, which can form a highly combustible gas mixture. This gas mixture could flash or explode, causing serious personal injury, if ignited by open flame, spark, welder's torch, lighted cigarette or other ignition source.

## DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling. This product can only be used in accordance with the Directions for Use on this label or in separately published Monsanto supplemental labeling. Supplemental labeling can be obtained from your Authorized Monsanto Retailer or Monsanto Company Representative.

### Agricultural Use Requirements

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. Refer to supplemental labeling under "AGRICULTURAL USE REQUIREMENTS" in the DIRECTIONS FOR USE section for information about this standard.

### Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

Keep people and pets off treated areas until spray solution has dried.

## STORAGE AND DISPOSAL

Proper pesticide storage and disposal are essential to protect against exposure to people and the environment due to leaks and spills, excess product or waste, and vandalism. Do not allow this product to contaminate water, foodstuffs, feed or seed by storage and disposal.

**PESTICIDE STORAGE:** Store pesticides away from food, pet food, feed, seed, fertilizers, and veterinary supplies. Keep container closed to prevent spills and contamination. Do not store this container unprotected from the weather, especially precipitation, for extended periods of time. DO NOT REMOVE INNER PLASTIC CONTAINER FROM THE PACKAGE UNTIL IT HAS BEEN EMPTIED AND PROPERLY RINSED.

**PESTICIDE DISPOSAL:** To avoid wastes, use all material in this container, including rinsate, by application according to label directions. If wastes cannot be avoided, offer remaining product to a waste disposal facility or pesticide disposal program. Such programs are often run by state or local governments or by industry. All disposal must be in accordance with applicable federal, state and local regulations and procedures.

**CONTAINER HANDLING AND DISPOSAL:** Nonrefillable container. Do not reuse or refill this container. Triple rinse or pressure rinse (or equivalent) the inner plastic container promptly after emptying. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times.

Pressure rinse as follows: Empty the remaining contents into application equipment or a mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank or collect rinsate for later use or disposal. Insert pressure rinsing nozzle into the inner plastic container through the opening in the cardboard packaging at the bottom of the container, ensuring that you puncture the inner plastic container, and rinse at about 40 PSI for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

Once properly rinsed, open the outer cardboard packaging and remove the inner plastic container. Some plastic pesticide containers can be taken to a container collection site or picked up for recycling. To find the nearest site, contact your chemical dealer or Monsanto Company at 1-800-768-6387. Recycle the cardboard separately. If recycling is not available, dispose of each component in accordance with federal, state and local regulations and procedures, which may include puncturing the properly rinsed inner plastic container and disposing both the outer cardboard packaging and inner plastic container in a sanitary landfill.

EPA Est. 524-IA-1 EPA Reg. No. 524-343

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800 N. LINDBERGH BLVD.
ST. LOUIS, MISSOURI 63167 USA ©2013

**883580764902**
**UPC**

# SUPPLEMENTAL LABELING

READ THE ENTIRE LABEL FOR ROUNDUP CUSTOM™ FOR AQUATIC & TERRESTRIAL USE BEFORE PROCEEDING WITH THE USE DIRECTIONS CONTAINED IN THIS SUPPLEMENTAL LABELING.

When using Roundup Custom For Aquatic & Terrestrial Use as permitted according to this supplemental labeling, read and follow all applicable directions, restrictions, and precautions on the label booklet provided with the pesticide container and on this supplemental labeling. This supplemental labeling must be in the possession of the user at the time of pesticide application.

This supplementary label expires on 12-31-2014 and must not be used beyond that date.

Roundup CUSTOM™ FOR AQUATIC & TERRESTRIAL USE

EPA Reg. No. 524-343

Roundup Custom is a trademark of Monsanto Technology LLC.

## LIMITATIONS ON AERIAL APPLICATIONS IN CALIFORNIA ONLY, Including Fresno County, CA

Keep out of reach of children.

# CAUTION!

In case of an emergency involving this product, Call Collect, day or night, (314) 694-4000.

### DIRECTIONS FOR USE

It is a violation of Federal law to use this product in any manner inconsistent with its labeling.

This labeling must be in the possession of the user at the time of herbicide application.

AVOID CONTACT OF HERBICIDE WITH FOLIAGE, STEMS, EXPOSED NON-WOODY ROOTS OR FRUIT OF CROPS, DESIRABLE PLANTS AND TREES, BECAUSE SEVERE INJURY OR DESTRUCTION MAY RESULT.

See **PRODUCT INFORMATION** and **MIXING** sections of the label booklet for Roundup Custom For Aquatic & Terrestrial Use for essential product performance information.

When applied as directed under the conditions described, this product controls annual and perennial weeds and woody brush and trees listed in the Roundup Custom For Aquatic & Terrestrial Use label booklet. See the **WEEDS CONTROLLED** section of the label booklet for rates.

### AQUATIC AND OTHER SITES

Do not spray open bodies of water where woody brush, trees and herbaceous weeds do not exist. The maximum application rate of 7.5 pints per acre must not be exceeded in a single over-water broadcast application except as follows, where any labeled rate may be applied:

- Stream crossings in utility rights-of-way
- Where applications will result in less than 20 percent of the total water area being treated.

Aerial applications of this product are allowed in the following situations:

1. Forestry sites
2. Prior to the emergence or transplanting of labeled crops
3. Aid to burning for establishment and maintenance of fuel breaks
4. Establishing fire perimeters and black lines
5. Aid to prescribed burning
6. Along fire roads
7. Range conversion
8. Habitat restoration and management
9. Wildlife food plots
10. Chaparral areas

## AERIAL APPLICATIONS

Aerial applications may be made with helicopters only and only in non-residential areas.

AVOID DRIFT—DO NOT APPLY WHEN WINDS ARE GUSTY OR UNDER ANY OTHER CONDITION WHICH WILL ALLOW DRIFT. DRIFT MAY CAUSE DAMAGE TO ANY VEGETATION CONTACTED TO WHICH TREATMENT IS NOT INTENDED. TO PREVENT INJURY TO ADJACENT DESIRABLE VEGETATION, APPROPRIATE BUFFER ZONES MUST BE MAINTAINED.

Use the following guidelines when aerial applications are made near crops or desirable perennial vegetation after bud break and before total leaf drop, and/or near other desirable vegetation or annual crops.

1. Do not apply within 100 feet of any desirable vegetation or crop(s).
2. If wind up to 5 miles per hour is blowing toward desirable vegetation or crop(s), do not apply within a minimum of 500 feet of the desirable vegetation or crop(s).
3. Winds blowing from 5 to 10 miles per hour toward desirable vegetation or crop(s) may require buffer zones in excess of 500 feet.
4. Do not apply when winds are in excess of 10 miles per hour or when inversion conditions exist.
5. APPLY BY AIR ONLY TO NON-RESIDENTIAL AREAS.

## ADDITIONAL INFORMATION FOR FRESNO COUNTY, CALIFORNIA ONLY

### Applicable Area

This following information applies only from February 15 through March 31 within the following boundaries of Fresno County, California.

North: Fresno County line
South: Fresno County line
East: State Highway 99
West: Fresno County line

Always read and follow the label directions and precautionary statements for all products used in the aerial application.

Observe the following directions to minimize off-site movement during aerial application of this product. Minimization of off-site movement is the responsibility of the grower, Pest Control Advisor and aerial applicator.

### Written Directions

Written directions MUST be submitted by or on behalf of the applicator to the Fresno County Agricultural Commissioner 24 hours prior to the application. This written direction MUST state the proximity of surrounding crops, and that conditions of each manufacturer's product label and this label have been satisfied.

### Aerial Applicator Training and Equipment

Aerial application of this product is limited to pilots who have successfully completed a Fresno County Agricultural Commissioner and California Department of Pesticide Regulation approved training program for aerial application of herbicides. All aircraft must be inspected, critiqued in flight and certified at a Fresno County Agricultural Commissioner approved fly-in. Test and calibrate spray equipment at intervals sufficient to insure that proper rates of herbicides and adjuvants are being applied during commercial use. Applicator must document such calibrations and testing. Demonstration of performance at Fresno County Agricultural Commissioner approved fly-ins constitutes such documentation, or other written records showing calculations and measurements of flight and spray parameters acceptable to the Fresno County Agricultural Commissioner.

**Applications at Night—**Do not apply this product by air earlier than 30 minutes prior to sunrise and/or later than 30 minutes after sunset without prior permission from the Fresno County Agricultural Commissioner.

To report known or suspected misuse of this product, call 1-800-332-3111.

For additional information on the proper aerial application of this product, call 916-784-1718.

**Read the "LIMIT OF WARRANTY AND LIABILITY" in the label booklet for Roundup Custom For Aquatic & Terrestrial Use before using. These terms apply to this supplemental labeling and if these terms are not acceptable, return the product unopened at once.**

MONSANTO COMPANY
800 N. LINDBERGH BLVD.
ST. LOUIS, MISSOURI, 63167 U.S.A
©2012

1/5/2012 21153K1-25

# MONSANTO COMPANY

Safety Data Sheet
Commercial Product

## 1. PRODUCT AND COMPANY IDENTIFICATION

**Product name**
**Roundup Custom[TM] for Aquatic & Terrestrial Use**

**EPA Reg. No.**
524-343
**Product use**
Herbicide
**Chemical name**
Not applicable.
**Synonyms**
None.
**Company**
MONSANTO COMPANY, 800 N. Lindbergh Blvd., St. Louis, MO, 63167
**Telephone:** 800-332-3111, **Fax:** 314-694-5557
**E-mail:** safety.datasheet@monsanto.com
**Emergency numbers**
FOR CHEMICAL EMERGENCY, SPILL LEAK, FIRE, EXPOSURE, OR ACCIDENT Call CHEMTREC - Day or Night: 1-800-424-9300 toll free in the continental U.S., Puerto Rico, Canada, or Virgin Islands. For calls originating elsewhere: 703-527-3887 (collect calls accepted).
FOR MEDICAL EMERGENCY - Day or Night: +1 (314) 694-4000 (collect calls accepted).

## 2. HAZARDS IDENTIFICATION

**Emergency overview**
**Appearance and odour (colour/form/odour):** Colourless - Amber / Liquid, (viscous) / Odourless

CAUTION!

**Potential health effects**
**Likely routes of exposure**
Skin contact, eye contact, inhalation
**Eye contact, short term**
Not expected to produce significant adverse effects when recommended use instructions are followed.
**Skin contact, short term**
Not expected to produce significant adverse effects when recommended use instructions are followed.
**Inhalation, short term**
Not expected to produce significant adverse effects when recommended use instructions are followed.
**Single ingestion**
Not expected to produce significant adverse effects when recommended use instructions are followed.

Refer to section 11 for toxicological and section 12 for environmental information.

**OSHA Status**
This product is not hazardous according to the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

## 3. COMPOSITION/INFORMATION ON INGREDIENTS

**Active ingredient**

Isopropylamine salt of N-(phosphonomethyl)glycine; {Isopropylamine salt of glyphosate}

**Composition**

| COMPONENT | CAS No. | % by weight (approximate) |
|---|---|---|
| Isopropylamine salt of glyphosate | 38641-94-0 | 53.8 |
| Water | 7732-18-5 | 46.2 |

## 4. FIRST AID MEASURES

Use personal protection recommended in section 8.

**Eye contact**

If in eyes, hold eye open and rinse slowly and gently for 15-20 minutes. Remove contact lenses, if present, after first 5 minutes, then continue rinsing. Call a poison control center or doctor for treatment advice.

**Skin contact**

Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.
Wash clothes and clean shoes before re-use.

**Inhalation**

If inhaled, move person to fresh air. If person is not breathing, call emergency number or ambulance, then give artificial respiration, preferably mouth-to-mouth, if possible. Call a poison control center or doctor for treatment advice.

**Ingestion**

Call poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison center or doctor. Do not give anything by mouth to an unconscious person.

**Advice to doctors**

This product is not an inhibitor of cholinesterase.

**Antidote**

Treatment with atropine and oximes is not indicated.

## 5. FIRE-FIGHTING MEASURES

**Flash point**

Does not flash.

**Extinguishing media**

Recommended: Water, foam, dry chemical, carbon dioxide (CO2)

**Unusual fire and explosion hazards**

None.
Minimise use of water to prevent environmental contamination.
Environmental precautions: see section 6.

**Hazardous products of combustion**

Carbon monoxide (CO), phosphorus oxides (PxOy), nitrogen oxides (NOx)

**Fire fighting equipment**

Self-contained breathing apparatus.
Equipment should be thoroughly decontaminated after use.

## 6. ACCIDENTAL RELEASE MEASURES

**Environmental precautions**

SMALL QUANTITIES:
Low environmental hazard.
LARGE QUANTITIES:
Minimise spread.
Keep out of drains, sewers, ditches and water ways.

**Methods for cleaning up**

SMALL QUANTITIES:
Absorb only in non-combustible material.
Sweep, scoop or vacuum to remove.
LARGE QUANTITIES:
Absorb in earth, sand or absorbent material.
Dig up heavily contaminated soil.
Collect in containers for disposal.
Flush residues with small quantities of water.
Minimise use of water to prevent environmental contamination.
Refer to section 7 for types of containers.

Refer to section 13 for disposal of spilled material.
Use handling recommendations in Section 7 and personal protection recommendations in Section 8.

## 7. HANDLING AND STORAGE

Good industrial practice in housekeeping and personal hygiene should be followed.

**Handling**

Avoid contact with eyes, skin and clothing.
When using do not eat, drink or smoke.
Wash hands thoroughly after handling or contact.
Wash contaminated clothing before re-use.
Thoroughly clean equipment after use.
Do not contaminate drains, sewers and water ways when disposing of equipment rinse water.
Refer to section 13 of the safety data sheet for disposal of rinse water.
Emptied containers retain vapour and product residue.

**Storage**

Minimum storage temperature: -15 °C
Maximum storage temperature: 50 °C
Compatible materials for storage: stainless steel, fibreglass, plastic
Incompatible materials for storage: galvanised steel, unlined mild steel, see section 10.
Keep out of reach of children.
Keep away from food, drink and animal feed.
Keep only in the original container.
Keep container tightly closed in a cool, well-ventilated place.
Partial crystallization may occur on prolonged storage below the minimum storage temperature.
If frozen, place in warm room and shake frequently to put back into solution.
Minimum shelf life: 5 years.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

**Airborne exposure limits**

| Components | Exposure Guidelines |
|---|---|
| Isopropylamine salt of glyphosate | No specific occupational exposure limit has been established. |

| | |
|---|---|
| Water | No specific occupational exposure limit has been established. |

**Engineering controls**
No special requirement when used as recommended.

**Eye protection**
No special requirement when used as recommended.

**Skin protection**
No special requirement when used as recommended.

**Respiratory protection**
No special requirement when used as recommended.

When recommended, consult manufacturer of personal protective equipment for the appropriate type of equipment for a given application.

## 9. PHYSICAL AND CHEMICAL PROPERTIES

These physical data are typical values based on material tested but may vary from sample to sample. Typical values should not be construed as a guaranteed analysis of any specific lot or as specifications for the product.

| | |
|---|---|
| Colour/colour range: | Colourless - Amber |
| Odour: | Odourless |
| Form: | Liquid, (viscous) |
| Physical form changes (melting, boiling, etc.): | |
| Melting point: | Not applicable. |
| Boiling point: | No data. |
| Flash point: | Does not flash. |
| Explosive properties: | No data. |
| Auto ignition temperature: | No data. |
| Specific gravity: | 1.206 @ 20 °C / 15.6 °C |
| Vapour pressure: | No significant volatility; aqueous solution. |
| Vapour density: | No data. |
| Evaporation rate: | No data. |
| Dynamic viscosity: | No data. |
| Kinematic viscosity: | No data. |
| Density: | 1.206 g/cm3 @ 20 °C |
| Solubility: | Water: Completely miscible. |
| pH: | 4.6 - 4.8 @ 63 g/l |
| Partition coefficient: | log Pow: < 0.000 (active ingredient) |

## 10. STABILITY AND REACTIVITY

**Stability**
Stable under normal conditions of handling and storage.

**Oxidizing properties**
No data.

**Materials to avoid/Reactivity**

Reacts with galvanised steel or unlined mild steel to produce hydrogen, a highly flammable gas that could explode.

**Hazardous decomposition**
Thermal decomposition: Hazardous products of combustion: see section 5.

**Self-accelerating decomposition temperature (SADT)**
No data.

## 11. TOXICOLOGICAL INFORMATION

This section is intended for use by toxicologists and other health professionals.

Data obtained on product, similar products and on components are summarized below.

**Mutagenicity**
**Micronucleus test(s)**:
Not mutagenic.
**Ames test(s)**:
Not mutagenic with and without metabolic activation.

**Isopropylamine salt of glyphosate (62%)**

Data obtained on product and components are summarized below.

**Acute oral toxicity**
**Rat, LD50 (limit test)**: > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.
No mortality.
**Mouse, LD50 (limit test)**: > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.
No mortality.
**Acute dermal toxicity**
**Rabbit, LD50 (limit test)**: > 5,000 mg/kg body weight
Practically non-toxic.
FIFRA category IV.
No mortality.
**Skin irritation**
**Rabbit, 6 animals, Draize test**:
Days to heal: 3
Primary Irritation Index (PII): 0.0/8.0
Essentially non irritating.
FIFRA category IV.
**Eye irritation**
**Rabbit, 6 animals, OECD 405 test**:
Days to heal: 0
FIFRA category IV.
**Acute inhalation toxicity**
**Rat, LC50, 4 hours, aerosol**: > 4.24 mg/L
Practically non-toxic.
FIFRA category IV.
No mortality. Maximum attainable concentration.
**Skin sensitization**
**Guinea pig, 3-induction Buehler test**:
Positive incidence: 0 %

**N-(phosphonomethyl)glycine; { glyphosate}**

**Mutagenicity**
**In vitro and in vivo mutagenicity test(s)**:
Not mutagenic.
**Repeated dose toxicity**
**Rabbit, dermal, 21 days**:
NOAEL toxicity: > 5,000 mg/kg body weight/day
Target organs/systems: none
Other effects: none
**Rat, oral, 3 months**:
NOAEL toxicity: > 20,000 mg/kg diet
Target organs/systems: none
Other effects: none
**Chronic effects/carcinogenicity**
**Rat, oral, 24 months**:
NOAEL toxicity: ~ 8,000 mg/kg diet
Target organs/systems: eyes
Other effects: decrease of body weight gain, histopathologic effects
NOEL tumour: > 20,000 ppm
Tumours: none
**Toxicity to reproduction/fertility**
**Rat, oral, 2 generations**:
NOAEL toxicity: 10,000 ppm
NOAEL reproduction: > 30,000 mg/kg diet
Target organs/systems in parents: none
Other effects in parents: decrease of body weight gain
Target organs/systems in pups: none
Other effects in pups: decrease of body weight gain
Effects on offspring only observed with maternal toxicity.
**Developmental toxicity/teratogenicity**
**Rat, oral, 6 - 19 days of gestation**:
NOAEL toxicity: 1,000 mg/kg body weight
NOAEL development: 1,000 mg/kg body weight
Other effects in mother animal: decrease of body weight gain, decrease of survival
Developmental effects: weight loss, post-implantation loss, delayed ossification
Effects on offspring only observed with maternal toxicity.
**Rabbit, oral, 6 - 27 days of gestation**:
NOAEL toxicity: 175 mg/kg body weight
NOAEL development: 175 mg/kg body weight
Target organs/systems in mother animal: none
Other effects in mother animal: decrease of survival
Developmental effects: none

## 12. ECOLOGICAL INFORMATION

This section is intended for use by ecotoxicologists and other environmental specialists.

Data obtained on components are summarized below.

**Isopropylamine salt of glyphosate (62%)**

**Aquatic toxicity, fish**
**Bluegill sunfish (Lepomis macrochirus):**
Acute toxicity, 96 hours, static, LC50: > 1,000 mg/L
Practically non-toxic.

**Rainbow trout (Oncorhynchus mykiss):**
Acute toxicity, 96 hours, static, LC50: > 1,000 mg/L
Practically non-toxic.

**Aquatic toxicity, invertebrates**

**Water flea (Daphnia magna):**
Acute toxicity, 48 hours, static, EC50: 930 mg/L
Practically non-toxic.

**Aquatic toxicity, algae/aquatic plants**

**Green algae (Scenedesmus subspicatus):**
Acute toxicity, 72 hours, static, EbC50 (biomass): 72.9 mg/L
Slightly toxic.

**Soil organism toxicity, invertebrates**

**Earthworm (Eisenia foetida):**
Acute toxicity, 14 days, LC50: > 5,000 mg/kg dry soil
Practically non-toxic.

**N-(phosphonomethyl)glycine; { glyphosate}**

**Avian toxicity**

**Bobwhite quail (Colinus virginianus):**
Dietary toxicity, 5 days, LC50: > 4,640 mg/kg diet
No more than slightly toxic.

**Mallard duck (Anas platyrhynchos):**
Dietary toxicity, 5 days, LC50: > 4,640 mg/kg diet
No more than slightly toxic.

**Bobwhite quail (Colinus virginianus):**
Acute oral toxicity, single dose, LD50: > 3,851 mg/kg body weight
Practically non-toxic.

**Arthropod toxicity**

**Honey bee (Apis mellifera):**
Oral, 48 hours, LD50: 100 µg/bee

**Honey bee (Apis mellifera):**
Contact, 48 hours, LD50: > 100 µg/bee
Practically non-toxic.

**Bioaccumulation**

**Bluegill sunfish (Lepomis macrochirus):**
Whole fish: BCF: < 1
No significant bioaccumulation is expected.

**Dissipation**

**Soil, field:**
Half life: 2 - 174 days
Koc: 884 - 60,000 L/kg
Adsorbs strongly to soil.

**Water, aerobic:**
Half life: < 7 days

## 13. DISPOSAL CONSIDERATIONS

**Product**

Not classified as hazardous waste by the Resource, Conservation and Recovery Act (RCRA), 40 CFR 261.
Keep out of drains, sewers, ditches and water ways.
Recycle if appropriate facilities/equipment available.
Burn in proper incinerator.
Follow all local/regional/national/international regulations.

**Container**

Dispose of as non hazardous industrial waste.

See the individual container label for disposal information.
Emptied containers retain vapour and product residue.
Observe all labelled safeguards until container is cleaned, reconditioned or destroyed.
Empty packaging completely.
Triple or pressure rinse empty containers.
Pour rinse water into spray tank.
Do NOT contaminate water when disposing of rinse waters.
Do NOT re-use containers.
Store for collection by approved waste disposal service.
Follow all local/regional/national/international regulations.

Use handling recommendations in Section 7 and personal protection recommendations in Section 8.

## 14. TRANSPORT INFORMATION

The data provided in this section is for information only. Please apply the appropriate regulations to properly classify your shipment for transportation.

Not hazardous under the applicable DOT, ICAO/IATA, IMO, TDG and Mexican regulations.

## 15. REGULATORY INFORMATION

**TSCA Inventory**
All components are on the US EPA's TSCA Inventory

**SARA Title III Rules**
Section 311/312 Hazard Categories
Not applicable.
Section 302 Extremely Hazardous Substances
Not applicable.
Section 313 Toxic Chemical(s)
Not applicable.

**CERCLA Reportable quantity**
Not applicable.

## 16. OTHER INFORMATION

The information given here is not necessarily exhaustive but is representative of relevant, reliable data.
Follow all local/regional/national/international regulations.
Please consult supplier if further information is needed.
For more information refer to product label.
Please consult Monsanto if further information is needed.
In this document the British spelling was applied.
® Registered trademark of Monsanto Company or its subsidiaries.

| | Health | Flammability | Instability | Additional Markings |
|---|---|---|---|---|
| NFPA | 0 | 1 | 1 | |

0 = Minimal hazard, 1 = Slight hazard, 2 = Moderate hazard, 3 = Severe hazard, 4 = Extreme hazard

Full denomination of most frequently used acronyms. BCF (Bioconcentration Factor), BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), EC50 (50% effect concentration), ED50 (50% effect dose), I.M. (intramuscular), I.P. (intraperitoneal), I.V. (intravenous), Koc (Soil adsorption coefficient), LC50 (50% lethality concentration), LD50 (50% lethality dose), LDLo (Lower limit of lethal dosage), LEL (Lower Explosion Limit), LOAEC (Lowest Observed Adverse Effect Concentration), LOAEL (Lowest Observed Adverse Effect Level), LOEC (Lowest Observed Effect Concentration), LOEL (Lowest Observed Effect Level), MEL (Maximum Exposure limit), MTD (Maximum Tolerated Dose), NOAEC (No Observed Adverse Effect Concentration), NOAEL (No Observed Adverse Effect Level), NOEC (No Observed Effect Concentration), NOEL (No Observed Effect Level), OEL (Occupational Exposure Limit), PEL (Permissible Exposure Limit), PII (Primary

Irritation Index), Pow (Partition coefficient n-octanol/water), S.C. (subcutaneous), STEL (Short-Term Exposure Limit), TLV-C (Threshold Limit Value-Ceiling), TLV-TWA (Threshold Limit Value - Time Weighted Average), UEL (Upper Explosion Limit)

This Material Safety Data Sheet (MSDS) serves different purposes than and DOES NOT REPLACE OR MODIFY THE EPA-APPROVED PRODUCT LABELING (attached to and accompanying the product container). This MSDS provides important health, safety, and environmental information for employers, employees, emergency responders and others handling large quantities of the product in activities generally other than product use, while the labeling provides that information specifically for product use in the ordinary course. Use, storage and disposal of pesticide products are regulated by the EPA under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) through the product labeling, and all necessary and appropriate precautionary, use, storage, and disposal information is set forth on that labeling. It is a violation of federal law to use a pesticide product in any manner not prescribed on the EPA-approved label.

Although the information and recommendations set forth herein (hereinafter "Information") are presented in good faith and believed to be correct as of the date hereof, MONSANTO Company or any of its subsidiaries makes no representations as to the completeness or accuracy thereof. Information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for the purposes prior to use. In no event will MONSANTO Company or any of its subsidiaries be responsible for damages of any nature whatsoever resulting from the use of or reliance upon information. NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OF ANY OTHER NATURE ARE MADE HEREUNDER WITH RESPECT TO INFORMATION OR TO THE PRODUCT TO WHICH INFORMATION REFERS.

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Product File

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 6-22-15 Reviewer SSutherland
Reg. No. 241-437-AA-67690

1068.15

# Clearcast®

## Herbicide

GROUP 2 HERBICIDE

SePRO

**For the control of vegetation in and around aquatic and non-cropland sites including areas that may be grazed or cut for hay.**

| | |
|---|---|
| **Active Ingredient** | |
| ammonium salt of imazamox 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol- 2-yl]-5-(methoxymethyl)-3-pyridinecarboxylic acid[1] | 12.1% |
| **Other Ingredients** | 87.9% |
| **TOTAL** | 100.0% |

[1] Equivalent to 11.4% 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-(methoxymethyl)-3-pyridinecarboxylic acid

1 gallon contains 1.0 pound of active ingredient as the free acid

## Keep Out of Reach of Children

## CAUTION / PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

In case of emergency endangering life or property involving this product, call **INFOTRAC** at **1-800-535-5053.**

**Refer to inside of label booklet for additional precautionary information and directions for use, including storage and disposal.**

**Notice:** Read the entire label before using. Use only according to label directions. **Before buying or using this product, read *Terms and Conditions of Use, Warranty Disclaimer, Inherent Risks of Use* and *Limitation of Remedies* inside label booklet.**

EPA Reg. No. 241-437-67690
EPA Est. No. 067690-NC-002
FPL20150410
166804
**NVA 2014-04-299-0109**

*Clearcast is a registered trademark of BASF Corporation.
Manufactured for: **SePRO Corporation** 11550 N. Meridian St., Ste. 600, Carmel, IN 46032 U.S.A.

8 11055 01111 4

Net Contents **15 gallons** (Non-refillable)

## Keep Out of Reach of Children

# CAUTION / PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

| FIRST AID | |
|---|---|
| **If on skin or clothing** | • Take off contaminated clothing.<br>• Rinse skin immediately with plenty of water for 15 to 20 minutes.<br>• Call a poison control center or doctor for treatment advice. |
| **If in eyes** | • Hold eyes open and rinse slowly and gently with water for 15 to 20 minutes.<br>• Remove contact lenses, if present, after the first 5 minutes; then continue rinsing eyes.<br>• Call a poison control center or doctor for treatment advice. |
| **If inhaled** | • Move person to fresh air.<br>• If person is not breathing, call 911 or an ambulance; then give artificial respiration, preferably mouth to mouth if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| **HOTLINE NUMBER** | |
| Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact INFOTRAC for emergency medical treatment information: **1-800-535-5053.** | |

## PRECAUTIONARY STATEMENTS

### Hazards to Humans and Domestic Animals

**CAUTION.** Harmful if absorbed through skin or inhaled. Causes moderate eye irritation. Avoid breathing spray mist. Avoid contact with skin, eyes or clothing.

### PERSONAL PROTECTIVE EQUIPMENT (PPE)

**Applicators and other handlers must wear:**

- Long-sleeved shirt and long pants;
- Chemical-resistant gloves such as barrier laminate, butyl rubber ≥ 14 mils, nitrile rubber ≥ 14 mils, neoprene rubber ≥ 14 mils, natural rubber (includes natural rubber blends and laminates) ≥ 14 mils, polyethylene, polyvinyl chloride (PVC) ≥ 14 mils, or Viton ≥ 14 mils; and
- Shoes plus socks.

Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

### USER SAFETY RECOMMENDATIONS

**Users should:**

- Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

## ENVIRONMENTAL HAZARDS

This pesticide may be hazardous to plants outside the treated area. **DO NOT** apply to water except as specified in this label. **DO NOT** contaminate water when disposing of equipment washwaters and rinsate.

## DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling. This labeling must be in the possession of the user at the time of pesticide application.

**DO NOT** apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the agency responsible for pesticide regulation.

Ensure spray drift to nontarget susceptible species does not occur.

**DO NOT** apply **Clearcast® Herbicide** in any manner not specifically described in this label.

Observe all cautions and limitations on this label and on the labels of products used in combination with **Clearcast**. **DO NOT** use **Clearcast** other than in accordance with the instructions set forth on this label. Keep containers closed to avoid spills and contamination.

## STORAGE AND DISPOSAL

**DO NOT** contaminate food, feed or water by storage or disposal.

**Pesticide Storage**

Keep from freezing. **DO NOT** store below 32°F.

**Pesticide Disposal**

Wastes resulting from the use of this product may be disposed of on-site or at an approved waste disposal facility.

**Container Handling**

**Nonrefillable Container. DO NOT** reuse or refill this container. Triple rinse or pressure rinse container (or equivalent) promptly after emptying; then offer for recycling, if available, or reconditioning, if appropriate, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures approved by state and local authorities.

**Triple rinse containers small enough to shake (capacity ≤ 5 gallons) as follows:** Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank, or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times.

**Triple rinse containers too large to shake (capacity >5 gallons) as follows:** Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank, or store rinsate for later use or disposal. Repeat this procedure two more times.

**Pressure rinse as follows:** Empty the remaining contents into application equipment or mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank, or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container and rinse at about 40 PSI for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

**Refillable Container.** Refill this container with pesticide only. **DO NOT** reuse this container for any other purpose. Triple rinsing the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller.

**Triple rinse as follows:** To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10% full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times.

When this container is empty, replace the cap and seal all openings that have been opened during use; return the container to the point of purchase or to a designated location. This container must only be refilled with a pesticide product. Prior to refilling, inspect carefully for damage such as cracks, punctures, abrasions, worn-out threads and closure devices. Check for leaks after refilling and before transport. **DO NOT** transport if this container is damaged or leaking. If the container is damaged, or leaking, or obsolete and not returned to the point of purchase or to a designated location, triple rinse emptied container and offer for recycling, if available, or dispose of container in compliance with state and local regulations.

## IN CASE OF EMERGENCY

In case of large-scale spill of this product, call INFOTRAC at 1-800-535-5053.

In case of medical emergency regarding this product, call:

- Your local doctor for immediate treatment
- Your local poison control center (hospital)
- INFOTRAC: 1-800-535-5053

**Steps to take if material is released or spilled:**

- Dike and contain the spill with inert material (sand, earth, etc.) and transfer liquid and solid diking material to separate containers for disposal.
- Remove contaminated clothing, and wash affected skin areas with soap and water.
- Wash clothing before reuse.
- Keep the spill out of all sewers and open bodies of water.

## PRODUCT INFORMATION

**Clearcast® herbicide** is an aqueous formulation that may be diluted in water and either applied directly to water for the control/ suppression of certain submerged aquatic vegetation or applied as a broadcast or spot spray to floating and emergent vegetation. Aquatic sites that may be treated include estuarine and marine sites, ponds, lakes, reservoirs, wetlands, marshes, swamps, bayous, arroyos, ditches, canals, streams, rivers, creeks and other slow-moving or quiescent bodies of water. **Clearcast** may also be used during drawdown conditions. **Clearcast** may also be applied for terrestrial and riparian vegetation control in industrial noncropland sites, and railroad, utility, and highway rights-of-way. Industrial noncropland sites include utility plant sites, tank farms, pumping installations, storage areas, fence rows and ditch banks. **Clearcast** may also be used for the establishment and maintenance of wildlife openings. **Clearcast** may also be used on those sites listed above that may be grazed or cut for hay.

**Clearcast** is quickly absorbed by foliage and/or plant roots and rapidly translocated to the growing points stopping growth. Susceptible plants may develop a yellow appearance or general discoloration and will eventually die or be severely growth inhibited.

**Clearcast** is herbicidally active on many submerged, emergent and floating broadleaf and monocot aquatic plants. The relative levels of control and selectivity can be manipulated by using a choice of rates and herbicide placement (water injected or floating/emergent foliar application).

To help maintain the utility of herbicide programs, the use of herbicides with different modes of action is effective in managing weed resistance.

**Spray Adjuvants**

Applications of **Clearcast** to emergent, floating or shoreline species require the use of a spray adjuvant. Always use a spray adjuvant that is appropriate for aquatic sites.

**Nonionic Surfactants** - Use a nonionic surfactant at 0.25% volume/volume (v/v) or higher (see manufacturer's label) of the spray solution (0.25% v/v is equivalent to 1 quart in 100 gallons). For best results, select a nonionic surfactant with an HLB (hydrophilic to lipophilic balance) ratio between 12 and 17 with at least 70% surfactant in the formulated product (alcohols, fatty acids, oils, ethylene glycol or diethylene glycol should not be considered as surfactants to meet the above requirements).

**Methylated Seed Oils or Vegetable Oil Concentrates** - Instead of a surfactant, a methylated seed oil or vegetable-based seed oil concentrate may be used at 1.5 to 2 pints per acre. When using spray volumes greater than 30 gallons per acre, mix methylated seed oil or vegetable-based seed oil concentrates at 1% of the total spray volume, or alternatively use a nonionic surfactant as described above. Research indicates that these oils may aid in **Clearcast** deposition and uptake by plants under stress.

**Silicone-based Surfactants** - See manufacturer's label for specific rate recommendations. Silicone-based surfactants may reduce the surface tension of the spray droplet allowing greater spreading on the leaf surface as compared to conventional nonionic surfactants. However, some silicone-based surfactants may dry too quickly, limiting herbicide uptake.

**Invert Emulsions – Clearcast** can be applied as an invert emulsion. The spray solution results in an invert (water-in-oil) spray emulsion designed to minimize spray drift and spray runoff, resulting in more herbicide on the target foliage. The spray emulsion may be formed in a single tank (batch mixing) or injected (in-line mixing). Consult the invert chemical label for proper mixing directions.

**Other** - An antifoaming agent, spray pattern indicator, sinking agent or drift-reducing agent may be applied at the product labeled rate if necessary or desired.

**Spray Drift Requirements for Aerial Application**

- Applicators are required to use a coarse or coarser droplet size (ASABE S572) or, if specifically using a spinning atomizer nozzle, applicators are required to use a volume mean diameter (VMD) of 385 microns or greater for release heights below 10 feet. Applicators are required to use a very coarse or coarser droplet size or, if specifically using a spinning atomizer nozzle, applicators are required to use a VMD of 475 microns or greater for release heights above 10 feet. Applicators must consider the effects of nozzle orientation and flight speed when determining droplet size.
- Applicators are required to use upwind swath displacement.
- The boom length must not exceed 60% of the fixed wingspan or 90% of the rotor blade diameter to reduce spray drift.
- **DO NOT** apply when wind speed is greater than 10 mph.
- If applying at wind speeds less than 3 mph, the applicator must determine if
  1. Conditions of temperature inversion exist **or**
  2. Stable atmospheric conditions exist at or below nozzle height.

**DO NOT** make applications into areas of temperature inversions or stable atmospheric conditions.

**Spray Drift Requirements for Ground Boom Application**

- Applicators are required to use a nozzle height below 4 feet above the ground or plant canopy and coarse or coarser droplet size (ASABE S572) or, if specifically using a spinning atomizer nozzle, applicators are required to use a volume mean diameter (VMD) of 385 microns or greater.
- Applications with wind speeds greater than 10 mph are prohibited.
- Applications into temperature inversions are prohibited.

**DO NOT** apply when wind conditions may result in drift, when temperature inversion conditions exist, or when spray may be carried to sensitive areas. See Managing Off-target Movement section for more drift reduction recommendations.

**AQUATIC USE DIRECTIONS**

**Clearcast® herbicide** may be applied directly to the water for the control of submerged aquatic plant species and some emergent and floating species, or as a foliar application specifically for emergent and floating species.

**DO NOT** exceed maximum use rate per application:

- Water treatment - 500 parts per billion (ppb) (173 fl ozs of **Clearcast** per acre foot)
- Foliar broadcast application – 1 gallon per acre (1.0 lb ae/A)
- Foliar spot application - up to 5% **Clearcast** by volume

**Clearcast** may be applied by surface and aerial equipment including both fixed-wing aircraft and helicopter.

**Foliar Application**

**Targeted Emergent and/or Floating Vegetation Application**

To make surface applications targeting emergent or floating vegetation, uniformly apply with properly calibrated broadcast or spot treatment equipment in 10 or more gallons of water per acre. Spot treatments can be made with up to 5% **Clearcast** by volume. To ensure thorough spray coverage, higher spray volumes may be required when treating areas with large and/or dense vegetation. Use an appropriate spray pressure to minimize the drift potential depending upon spray equipment, conditions and application objectives.

**Foliar Treatment of Emergent and Floating Vegetation Guidelines**

- Always use a surfactant for foliar applications of emergent and floating weeds.

- Foliar applications of **Clearcast** may be made as a broadcast spray or as a spot spray with a percent spray solution ranging from 0.25% to 5% **Clearcast** by volume.
- Control will be reduced if spray is washed off foliage by wave action.

In aquatic sites, those application techniques described in the *Terrestrial Use Directions* section may be used to treat emergent vegetation.

**Application to Water**

**Water Application to Target Submerged and/or Emergent/Floating Vegetation**

**Clearcast** may be broadcast-applied to the water surface or injected below the water surface. **Clearcast** may be applied as undiluted product or diluted with water prior to application. Under surface-matted conditions, inject **Clearcast** below the water surface to achieve better product distribution.

Apply **Clearcast** to water to achieve a final concentration of the active ingredient of no more than 500 ppb. Multiple applications of **Clearcast** may be made during the annual growth cycle to maintain the desired vegetation response.

| Clearcast Rates Per Treated Surface Acre | | | | |
|---|---|---|---|---|
| Average Water Depth of Treatment Site (feet) | Desired Active Ingredient Concentration (ppb)† | | | |
| | 50 | 100 | 200 | 500 |
| | Clearcast Rate per Treated Surface Acre (fl ozs) | | | |
| 1 | 17 | 35 | 69 | 173 |
| 2 | 35 | 69 | 138 | 346 |
| 3 | 52 | 104 | 207 | 518 |
| 4 | 70 | 138 | 277 | 691 |
| 5 | 87 | 173 | 346 | 864 |
| 6 | 104 | 207 | 415 | 1,037 |
| 7 | 122 | 242 | 484 | 1,210 |
| 8 | 139 | 277 | 553 | 1,382 |
| 9 | 157 | 311 | 622 | 1,555 |
| 10 | 174 | 346 | 691 | 1,728 |

†Clearcast contains 1.0 pound of active ingredient per gallon. There are 128 fl ozs in one gallon.

**Aerial Application**

**Clearcast** may be applied by both fixed-wing aircraft and helicopter. There is no minimum spray volume when making applications directly to the water. For applications targeting emergent and/or floating vegetation, uniformly apply with properly calibrated equipment in 5 or more gallons of water per surface acre. For best results, make aerial applications using a minimum of 20 gallons per acre.

**Drawdown Application**

**Clearcast** may be used in drawdown situations to provide postemergence and/or preemergence control/suppression of aquatic vegetation. Apply **Clearcast** as a broadcast spray at rates up to 1 gallon/A or as a spot spray treatment with up to 5% **Clearcast** by volume. Make applications when water has receded and exposed soil is moist to dry. For postemergence (foliar) applications, wait at least two weeks after application before reintroducing water. When treating irrigation canals, the initial flush of recharge water after application must not be used for irrigation purposes.

**RESTRICTIONS AND LIMITATIONS**

- **DO NOT** apply **Clearcast** to achieve a total active ingredient concentration in the water greater than 500 ppb.
- **DO NOT** apply more than 1 gallon of **Clearcast** per surface acre for the control of emergent and floating vegetation.

**Irrigation Restrictions**

- **DO NOT** use treated water to irrigate greenhouses, nurseries or hydroponics until the imazamox concentration has been determined by an acceptable method to be less than or equal to 1.0 ppb.
- **DO NOT** plant sugar beets, onions, potatoes or non-**CLEARFIELD®** canola in soils that have been previously irrigated with **Clearcast**-treated water until a soil bioassay successfully demonstrates acceptable levels of crop tolerance.
- **DO NOT** use **Clearcast**-treated waters resulting in a concentration greater than 50 ppb for irrigation until residue levels have been shown to be less than or equal to 50 ppb by an acceptable method.
- Wait 24 hours before irrigating from still or quiescent waters after making a **Clearcast** application for submerged vegetation less than 100 feet from an irrigation intake.
- Wait 24 hours before irrigating from still and quiescent waters after making a **Clearcast** application to emergent and/or floating vegetation if greater than 25% of the surface area of the water body has been treated or application was made less than 100 feet from an irrigation intake.
- Flowing waters may be used to irrigate allowable sites with no restrictions when **Clearcast** is applied at less than or equal to 2 quarts per acre to waters with an average depth of greater than or equal to 4 feet.
- After application of **Clearcast** to dry irrigation canals/ditches, the initial flush of water during recharge must not be used for irrigation purposes unless the imazamox concentration has been determined by an acceptable method to be less than 50 ppb.

**Clearcast** applied at less than or equal to 2 quarts per acre in or on waters with a minimum average depth greater than or equal to 4 feet will result in **Clearcast** concentrations less than 50 ppb.

**Other Water Use Restrictions**

There are no restrictions on livestock watering, swimming, fishing, domestic use, or use of treated water for agricultural sprays.

**Potable Water**

**Clearcast** may be applied to potable water sources at concentrations up to 500 ppb to within a distance of ¼ mile from an active potable water intake. Within ¼ mile of an active potable water intake, **Clearcast** may be applied, but water concentrations resulting from injection and/or foliar applications may not exceed 50 ppb. If water concentrations greater than 50 ppb are required, the potable water intake must be shut and, if necessary, an alternate water supply be made available until the water concentration can be shown to be less than 50 ppb by an acceptable method.

**Endangered Plant Species**

To prevent potential negative impacts to endangered plant species, **DO NOT** apply **Clearcast** in a way that adversely affects federally listed endangered and threatened species.

**WEEDS CONTROLLED OR SUPPRESSED BY CLEARCAST**

Efficacy and selectivity of **Clearcast** is dependent upon many factors including: dose, time of year, stage of plant growth, plant susceptibility, method of application, and water movement. Rate selection will be partially dependent on characteristics of the treatment area and whether growth regulation or control is desired. Some areas may require a repeat application to control or suppress regrowth. Consult SePRO Corporation to determine best treatment protocols to manage individual species and to meet specific aquatic plant management objectives.

| Emergent, Floating, and Shoreline Species Controlled with Foliar Application | | | |
|---|---|---|---|
| **Common Name** | **Scientific Name** | **Rate (fl ozs/A)** | **Comments** |
| Alligatorweed | *Alternanthera philoxeroides* | 64 to 128 | Repeat applications may be necessary. Add 1 qt/A of AquaPro® herbicide for quicker brownout. |
| American lotus | *Nelumbo lutea* | 64 to 128 | |
| Arrowhead | *Sagittaria* spp. | 32 to 64 | |
| Cattail | *Typha* spp. | 32 to 64 | Apply after full green up through killing frost. |
| Chinese tallowtree | *Sapium sebiferum* | 64 to 128 | |
| Common reed | *Phragmites* spp. | 96 to 128 | Use 1 qt/A methylated seed oil (MSO); apply in late vegetative stage up to killing frost. Also apply as a spot treatment using 1% to 2% **Clearcast** per spray volume. Older stands of phragmites and stands growing in water may be more difficult to control and will require follow-up applications. |
| Common salvinia | *Salvinia minima* | 32 to 64 | Apply with MSO or MSO + silicone-based surfactant; retreatment will be necessary. |
| Floating heart | *Nymphoides* spp. | 64 to 128 | Also apply as a spot treatment using 2% to 5% **Clearcast** and 1% MSO per spray volume. |
| Floating pennywort | *Hydrocotyle ranunculoides* | 32 to 64 | Repeat applications may be necessary. |
| Flowering rush | *Butomus umbellatus* | 64 to 128 | |
| Four-leaf clover | *Marsilea* spp. | 32 to 64 | |
| Frog's bit | *Lymnobium spongia* | 16 to 32 | |
| Giant cane | *Arundo donax* | 64 to 128 | |
| Japanese knotweed | *Polygonum cuspidatum* | 64 to 128 | |
| Mexican lily | *Nymphaea mexicana* | 32 to 64 | |
| Mosquito fern | *Azolla* spp. | – | Apply using 2% to 5% **Clearcast** and 1% MSO by volume. |
| Parrotfeather | *Myriophyllum aquaticum* | 64 to 128 | Apply only to emergent vegetation. |
| Pickerelweed | *Pontederia cordata* | 32 to 64 | |
| Saltcedar | *Tamarix* spp. | 64 to 128 | Also apply using 2% to 5% **Clearcast** and 1% MSO per spray volume. |
| Smartweed, ladysthumb<br>Smartweed, Pennsylvania<br>Smartweed, swamp | *Polygonum persicaria*<br>*Polygonum pensylvanicum*<br>*Polygonum coccineum* | 64 to 128 | |
| Spatterdock | *Nuphar lutea* | 64 to 128 | |
| Variable-leaf milfoil | *Myriophyllum heterophyllum* | 64 to 128 | Apply with MSO (1% v/v) as an emergent foliar treatment when plants have emerged on the surface. Also apply as a spot treatment using 1% to 3% **Clearcast** per spray volume. |

*(continued)*

| Emergent, Floating, and Shoreline Species Controlled with Foliar Application *(continued)* | | | |
|---|---|---|---|
| Common Name | Scientific Name | Rate (fl ozs/A) | Comments |
| Water chestnut | *Trapa natans* | 64 to 128 | Apply with MSO to emergent part of plant. Also apply as a spot treatment using 2% to 5% **Clearcast** per spray volume. |
| Water hyacinth | *Eichhornia crassipes* | 16 to 32 | |
| Water lettuce | *Pistia stratiotes* | 48 to 96 | |
| Water lily | *Nymphaea* spp. | 32 to 64 | |
| Water primrose | *Ludwigia* spp. | 32 to 64 | Add 1 qt/A of AquaPro® herbicide for quicker brownout. |
| Watershield | *Brasenia schreberi* | 48 to 64 | |
| Wild taro | *Colocasia esculenta* | 96 to 128 | |

**Species Susceptible to Water-injected Applications**

The following categories are provided to define species that may be growth regulated or controlled with 50 to 500 ppb **Clearcast® herbicide** following in-water applications: susceptible, moderately susceptible, and less susceptible. The rates associated with each susceptibility category, including the *Special Weed Control* section, are provided as guidance with the overriding allowance that an application rate from 50 to 500 ppb may be used depending on the aquatic vegetation management objective and the characteristics of the aquatic vegetation and water body being treated.

Some species that are susceptible to foliar applications of **Clearcast** may be less susceptible to in-water applications. Use of higher rates are necessary to achieve desired control/suppression in areas of greater water exchange; when treating more mature or less susceptible plants; when targeting more difficult-to-control aquatic species; and when treating small areas in larger bodies of water (partial or spot treatments). Lower concentrations are generally used when conducting early season large-scale treatments; when greater selectivity is desired; and treating larger areas, more immature or susceptible plants, and areas with less potential for rapid water exchange.

Use of lower rates may increase selectivity on some species within the same category. Effects on susceptible plants can range from control to growth regulation depending on treatment site characteristics, exposure time, and application rate. Susceptible plant species may exhibit herbicide stress or reduced growth during active treatment phases. Whole lake applications with lower rates may provide plant growth regulation or greater selectivity while higher rates will generally provide broader activity.

**Susceptible Vascular Aquatic Plants (50 to 200 ppb)**

| Common Name | Scientific Name |
|---|---|
| Curlyleaf pondweed | *Potamogeton crispus* |
| Eurasian watermilfoil | *Myriophyllum spicatum* |
| Hydrilla | *Hydrilla verticillata* |
| Sago pondweed | *Stuckenia pectinata* |
| Water hyacinth | *Eichhornia crassipes* |
| Water stargrass | *Heteranthera dubia* |

**Moderately Susceptible Vascular Aquatic Plants (100 to 300 ppb)**

| Common Name | Scientific Name |
|---|---|
| American pondweed | *Potamogeton nodosus* |
| Bladderwort | *Utricularia* spp. |
| Frog's bit | *Lymnobium spongia* |
| Illinois pondweed | *Potamogeton illinoensis* |
| Pickerelweed | *Pontederia cordata* |
| Salvinia | *Salvinia* spp. |
| Spikerush | *Eleocharis baldwinii* |
| Variable-leaf milfoil | *Myriophyllum heterophyllum* |
| Wigeon grass | *Ruppia maritima* |

**Less Susceptible Vascular Aquatic Plants (200 to 500 ppb)**

| Common Name | Scientific Name |
|---|---|
| Bulrush | *Schoenoplectus californicus* |
| Cattail | *Typha* spp. |
| Coontail | *Ceratophyllum demersum* |
| Eelgrass, Japanese | *Zostera japonica* |
| Egeria | *Egeria densa* |
| Flowering rush | *Butomus umbellatus* |
| Southern naiad | *Najas guadalupensis* |
| Spatterdock | *Nuphar lutea* |
| Water lily | *Nymphaea odorata* |
| Watershield | *Brasenia schreberi* |

**Special Weed Control**

**Eurasian Watermilfoil.** Apply **Clearcast** at 100 to 200 ppb to actively growing plants early in the growing season. Applications made to mature Eurasian watermilfoil (vegetation topped out) may require multiple applications.

**Hydrilla.** Apply **Clearcast** at 150 to 200 ppb to actively growing plants early in the growing season. Applications made prior to topped-out hydrilla may require repeat application. A single application of 50 to 75 ppb can be used to suppress and growth-regulate hydrilla for up to 10 to 12 weeks. If desired, an additional 50 to 75 ppb can be applied to extend the period of growth suppression when normal hydrilla growth resumes.

**Japanese Eelgrass.** Japanese eelgrass is a submerged aquatic plant which can be found in tidal and intertidal areas. **Clearcast** herbicide may be applied directly to the water or directly to the plant (e.g. at low tide).

- **Low-tide application** - To make applications when the plant is exposed at low tide, uniformly apply with properly calibrated broadcast or spot treatment equipment in 10 or more gallons of water per acre. An appropriate spray adjuvant approved for aquatic use may be used but is not required. Spot treatments can be made with up to 5% **Clearcast** by volume. To ensure thorough spray coverage, higher spray volumes may be required when treating areas with large and/or dense vegetation. Use an appropriate spray pressure to minimize drift potential depending upon spray equipment, conditions, and application objectives. Apply 4 fl ozs to 32 fl ozs **Clearcast**/A. Use the lower rate for management of seedlings. An appropriate aquatic use spray adjuvant may be used but is not required.
- **In-water application** - When Japanese eelgrass is submerged, **Clearcast** may be broadcast-applied to the water surface or injected below the water surface. **Clearcast** may be applied as undiluted product or diluted with water before application. Under surface-matted conditions, inject **Clearcast** below the water surface to achieve better product distribution. Apply Clearcast to water to achieve a final concentration of the active ingredient of no more than 500 ppb. Multiple applications of Clearcast may be made during the annual growth cycle to maintain the desired vegetation response.

**Sago Pondweed.** In dry ditches (drainage and irrigation), sago pondweed may be controlled or growth-suppressed with soil-applied **Clearcast** at 64 to 128 fl ozs/A. In irrigation canals, apply **Clearcast** after drawdown and prior to water recharge.

TERRESTRIAL USE DIRECTIONS

**Clearcast** may be applied with ground and aerial equipment including both fixed-wing aircraft and helicopter. Applications may be made using foliar broadcast spray, foliar spot spray, injection (hack and squirt), frill and girdle, cut stump, or basal methods.

**Broadcast Spray Application**
**DO NOT** apply more than 1 gallon of **Clearcast** per acre.

**Foliar Spot Application**
Apply **Clearcast** as a percent solution, containing up to 5% **Clearcast** by volume.

**Injection (Hack and Squirt), Frill and Girdle, and Cut Stump Application**
Treatments may be made using up to 100% **Clearcast** by volume.

**Basal Application**
Treatments can be made using up to 25% **Clearcast** by volume. Basal applications require the use of a good emulsion system to maintain **Clearcast** in a stable emulsion with the penetrating agent being used.

All foliar applications of **Clearcast** require the use of a spray adjuvant. Refer to *Spray Adjuvants* section for additional information.

**Managing Off-target Movement**
The following information is general guidance for managing and minimizing off-target exposure of this product. Specific use directions in this label may vary from these general guidelines depending on the application method and objectives and should supersede the general information provided below.

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment-related and weather-related factors determines the potential for spray drift. The applicator and the grower are responsible for considering all these factors when making decisions.

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications:

1. The distance of the outermost nozzles on the boom must not exceed ¾ the length of the fixed wingspan or 90% of rotor blade diameter.
2. Nozzles must always point backward parallel with the airstream and never be pointed downward more than 45 degrees.
3. **DO NOT** apply if wind speed is greater than 10 mph, except when making injection or subsurface applications to water.

Where states have more stringent regulations, they must be observed.

The applicator must be familiar with and take into account the information covered in the following aerial drift reduction advisory information.

**Information on Droplet Size**
The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential but will not prevent drift if applications are made improperly or under unfavorable environmental conditions (see *Wind; Temperature and Humidity*; and *Temperature Inversions*).

**Controlling Droplet Size:**

- **Volume** - Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- **Pressure – DO NOT** exceed the nozzle manufacturer's recommended pressures. For many nozzle types, lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- **Number of Nozzles** - Use the minimum number of nozzles that provides uniform coverage.
- **Nozzle Orientation** - Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is recommended practice. Significant deflection from the horizontal will reduce droplet size and increase drift potential.

- **Nozzle Type** - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid-stream nozzles oriented straight back produce the largest droplets and the lowest drift.

**Boom Length**
For some use patterns, reducing the effective boom length to less than ¾ of the fixed wingspan or 90% of rotor blade diameter may further reduce drift without reducing swath width.

**Application Height**
Applications must not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

**Swath Adjustment**
When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the upwind and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase with increasing drift potential (higher wind, smaller droplets, etc.).

**Wind**
Drift potential is lowest between wind speeds of 2 to 10 mph. However, many factors, including droplet size and equipment type, determine drift potential at any given speed. Application must be avoided below 2 mph due to variable wind direction and high inversion potential.

**NOTE:** Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

**Temperature and Humidity**
When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

**Temperature Inversions**
Applications must not occur during a temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing that causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light, variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light-to-no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

**Sensitive Areas**
The pesticide must only be applied when the potential for drift to adjacent sensitive areas (e.g. residential areas, bodies of water, known habitat for threatened or endangered species, or crops) is minimal (e.g. when wind is blowing away from the sensitive areas).

Applicator is responsible for any loss or damage which results from spraying **Clearcast** in a manner other than directed in this label. In addition, applicator must follow all applicable state and local regulations and ordinances in regard to spraying.

**Clearcast** may be used for the control of the following plant species. **Clearcast** may be effective for the control or suppression of additional plant species not listed below. The use of **Clearcast** for the control or suppression of undesirable plants not listed below may be done at the discretion of the user.

**To the extent consistent with applicable law, the user assumes responsibility for any lack of control or suppression associated with application to weeds not listed on this label.**

| Weeds Controlled | | | |
|---|---|---|---|
| **Common Name** | **Scientific Name** | **Rate Foliar (fl ozs/A)** | **Comments** |
| Alligator weed | *Alternanthera philoxeroides* | 64 to 128 | Addition of AquaPro® herbicide will improve efficacy. |
| Annual ryegrass | *Lolium multiflorum* | 16 to 32 | |
| Artichoke, Jerusalem | *Helianthus tuberosus* | 64 to 128 | |
| Bedstraw | *Galium aparine* | 64 to 128 | |
| Beet, wild | *Beta procumbens* | 64 to 128 | |
| Brazilian pepper*<br>Christmasberry* | *Schinus terebinthifolius* | 96 to 128 | Also apply using 2% to 5% **Clearcast** per spray volume |
| Buckwheat, wild | *Polygonum convolvulus* | 64 to 128 | |
| Buttercup | *Ranunculus* spp. | 64 to 128 | |
| California bulrush* | *Schoenoplectus californicus* | 64 to 128 | |
| Camphor tree* | *Cinnamomum camphora* | 2% to 5% v/v | |
| Canola, volunteer (non-**Clearfield®**) | *Brassica campestris*<br>*Brassica napus* | 64 to 128 | |
| Cattail | *Typha* spp. | 32 to 64 | |
| Chickweed, common | *Stellaria media* | 64 to 128 | |
| Chinese tallowtree;<br>Popcorn tree | *Sapium sebiferum* | 64 to 128 | See *Special Weed Control* section. |
| Cocklebur, common | *Xanthium strumarium* | 64 to 128 | |
| Filaree, redstem<br>Filaree, whitestem | *Erodium cicutarium*<br>*Erodium moschatum* | 64 to 128 | |
| Flixweed | *Descurainia sophia* | 64 to 128 | |
| Giant ragweed** | *Ambrosia trifida* | 32 to 64 | |
| Henbit | *Lamium amplexicaule* | 64 to 128 | |
| Jamaican nightshade* | *Solanum jamaicense* | 2% to 5% v/v | |
| Japanese stiltgrass | *Microstegium vimineum* | 32 to 64 | Use MSO at 1% by spray volume. **Clearcast** will provide some residual control of subsequent seedling emergence. |
| Jimsonweed | *Datura stramonium* | 64 to 128 | |
| Johnsongrass, rhizome<br>Johnsongrass, seedling | *Sorghum halepense* | 32 to 64<br>16 to 32 | |
| Knotweed, prostrate | *Polygonum aviculare* | 64 to 128 | |
| Kochia | *Kochia scoparia* | 64 to 128 | |
| Lambsquarters, common | *Chenopodium album* | 64 to 128 | |
| Lettuce, miner's | *Montia perfoliata* | 64 to 128 | |
| Mallow, common<br>Mallow, Venice | *Malva neglecta*<br>*Hibiscus trionum* | 64 to 128 | |
| Mustard spp. | *Brassica* spp. | 64 to 128 | |

*(continued)*

| Weeds Controlled *(continued)* | | | |
|---|---|---|---|
| **Common Name** | **Scientific Name** | **Rate Foliar (fl ozs/A)** | **Comments** |
| Nettle, burning | *Urtica urens* | 64 to 128 | |
| Nettleleaf goosefoot | *Chenopodium murale* | 64 to 128 | |
| Nightshade, black<br>Nightshade, Eastern black<br>Nightshade, hairy | *Solanum nigrum*<br>*Solanum ptycanthum*<br>*Solanum sarrachoides* | 64 to 128 | |
| Old world climbing fern* | *Lygodium microphyllum* | 5% v/v | |
| Pennycress, field | *Thlaspi arvense* | 64 to 128 | |
| Phragmites* | *Phragmites australis* | 64 to 128 | Use 1 qt/A methylated seed oil (MSO); apply in late vegetative stage up to killing frost. Also apply as a spot treatment using 1% to 2% **Clearcast** per spray volume. Older stands of phragmites and stands growing in water may be more difficult to control and will require follow-up applications. |
| Pigweed, prostrate<br>Pigweed, redroot<br>Pigweed, smooth<br>Pigweed, spiny | *Amaranthus blitoides*<br>*Amaranthus retroflexus*<br>*Amaranthus hybridus*<br>*Amaranthus spinosus* | 64 to 128 | |
| Puncturvine | *Tribulus terrestris* | 64 to 128 | |
| Purple loosestrife* | *Lythrum salicaria* | 32 to 64 | |
| Purslane, common | *Portulaca oleracea* | 64 to 128 | |
| Radish, wild | *Raphanus raphanistrum* | 64 to 128 | |
| Ragweed, common<br>Ragweed, giant | *Ambrosia artemisiifolia*<br>*Ambrosia trifida* | 64 to 128 | |
| Rocket, London<br>Rocket, yellow | *Sisymbrium irio*<br>*Barbarea vulgaris* | 64 to 128 | |
| Saltcedar* | *Tamarix* spp. | 64 to 128 | Also apply using 2% to 5% **Clearcast** and 1% MSO per spray volume. |
| Sedge*, purple<br>Sedge*, yellow | *Cyperus rotundus*<br>*Cyperus esculentus* | 32 to 64 | Also apply using 2% to 5% **Clearcast** per spray volume. |
| Shepherd's-purse | *Capsella bursa-pastoris* | 64 to 128 | |
| Smartweed, ladysthumb<br>Smartweed, Pennsylvania<br>Smartweed, swamp | *Polygonum persicaria*<br>*Polygonum pensylvanicum*<br>*Polygonum coccineum* | 64 to 128 | |
| Spike rush* | *Eleocharis* spp. | 64 to 128 | |
| Spurge, prostrate | *Euphorbia maculata* | 64 to 128 | |
| Sunflower, common | *Helianthus annuus* | 64 to 128 | |
| Swinecress | *Coronopus didymus* | 64 to 128 | |
| Tansymustard, green | *Descurainia pinnata* | 64 to 128 | |
| Taro | *Taro* spp. | 64 to 128<br>5% v/v | |

*(continued)*

| Weeds Controlled *(continued)* | | | |
|---|---|---|---|
| **Common Name** | **Scientific Name** | **Rate Foliar (fl ozs/A)** | **Comments** |
| Thistle, Russian | *Salsola iberica* | 64 to 128 | |
| Tropical soda apple* | *Solanum viarum* | 2% to 5% v/v | |
| Water primrose | *Ludwigia* spp. | 32 to 64 | Addition of AquaPro® herbicide will improve efficacy. |
| Wetland nightshade* | *Solanum tampicense* | 2% to 5% v/v | |
| Whitetop*<br>Hoary cress* | *Cardaria draba* | 8 to 16 | |
| Willoweed panicle | *Epilobium brachycarpum* | 64 to 128 | |
| Velvetleaf | *Abutilon theophrasti* | 64 to 128 | |
| * Use not permitted in California unless otherwise directed by supplemental labeling<br>** Suppression of larger, well-established plants | | | |

In general, the use of methylated seed oil (MSO) at 1% v/v will provide the best control with foliar applications.

**Special Weed Control - Chinese tallowtree - Clearcast** at 64 to 128 fl ozs/A or 0.5 to 2.0% v/v may be applied as a foliar application for selective control of Chinese tallowtree in and around tolerant tree species. Control Chinese tallowtree with foliar applications using aerial, handgun, or backpack application methods. When treating Chinese tallowtree, ensure that application method and spray volume provide adequate coverage of targeted Chinese tallowtree plants. Add methylated seed oil at 32 fl ozs/A for broadcast applications, or at 1% v/v for spot backpack and handgun applications. Tolerant hardwood species may exhibit varying degrees of leaf discoloration and temporary injury.

**Areas that may be Grazed or Cut for Hay**
Apply **Clearcast** to listed aquatic and terrestrial noncrop sites that may be grazed or cut for hay at a maximum use rate of 1 gallon per acre of **Clearcast** or 5% (v/v) spray solution for spot treatments. There are no grazing or haying restrictions.

## TERMS AND CONDITIONS OF USE

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## WARRANTY DISCLAIMER

SePRO Corporation warrants that the product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, SEPRO CORPORATION MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

## INHERENT RISKS OF USE

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of SePRO Corporation or the seller. To the extent consistent with applicable law, all such risks shall be assumed by buyer.

## LIMITATION OF REMEDIES

To the extent consistent with applicable law, the exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories) shall be limited to, at SePRO Corporation's election, one of the following:

(1) Refund of purchase price paid by buyer or user for product bought, or
(2) Replacement of amount of product used.

To the extent consistent with applicable law, SePRO Corporation shall not be liable for losses or damages resulting from handling or use of this product unless SePRO Corporation is promptly notified of such losses or damages in writing. In no case shall SePRO Corporation be liable for consequential or incidental damages or losses.

The terms of the Warranty Disclaimer, Inherent Risks of Use and this Limitation of Remedies cannot be varied by any written or verbal statements or agreements. No employee or sales agent of SePRO Corporation or the seller is authorized to vary or exceed the terms of the Warranty Disclaimer or this Limitation of Remedies in any manner.

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AquaPro is a registered trademark of Trademark of The Dow Chemical Company ("Dow") or an affiliated company of Dow.

SePRO Corporation
11550 N. Meridian St., Ste. 600
Carmel, IN 46032

SePRO

1068.15

# Clearcast®

## Herbicide

GROUP 2 HERBICIDE

PEEL FILM HERE

| Active Ingredient | |
|---|---|
| ammonium salt of imazamox 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-(methoxymethyl)-3-pyridinecarboxylic acid† | 12.1% |
| Other Ingredients | 87.9% |
| TOTAL | 100.0% |

† Equivalent to 11.4% 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-(methoxymethyl)-3-pyridinecarboxylic acid

1 gallon contains 1.0 pound of active ingredient as the free acid

## PRECAUTIONARY STATEMENTS

**Hazards to Humans and Domestic Animals**

**CAUTION.** Harmful if absorbed through skin or inhaled. Causes moderate eye irritation. Avoid breathing spray mist. Avoid contact with skin, eyes or clothing.

## Keep Out of Reach of Children

## CAUTION/PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

| FIRST AID | |
|---|---|
| If on skin or clothing | • Take off contaminated clothing.<br>• Rinse skin immediately with plenty of water for 15 to 20 minutes.<br>• Call a poison control center or doctor for treatment advice. |
| If in eyes | • Hold eyes open and rinse slowly and gently with water for 15 to 20 minutes.<br>• Remove contact lenses, if present, after the first 5 minutes; then continue rinsing eyes.<br>• Call a poison control center or doctor for treatment advice. |
| If inhaled | • Move person to fresh air.<br>• If person is not breathing, call 911 or an ambulance; then give artificial respiration, preferably mouth to mouth if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| HOTLINE NUMBER | |
| Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact INFOTRAC for emergency medical treatment information: 1-800-535-5053. | |

## ENVIRONMENTAL HAZARDS

This pesticide may be hazardous to plants outside the treated area. DO NOT apply to water except as specified in this label. DO NOT contaminate water when disposing of equipment washwaters and rinsate.

## DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling. This labeling must be in the possession of the user at the time of pesticide application.

**Refer to inside of label booklet for additional precautionary information and directions for use.**

## STORAGE AND DISPOSAL

**DO NOT** contaminate food, feed or water by storage or disposal.

**Pesticide Storage**

Keep from freezing. **DO NOT** store below 32° F.

**Pesticide Disposal**

Wastes resulting from the use of this product may be disposed of on-site or at an approved waste disposal facility.

**Container Handling**

**Nonrefillable Container. DO NOT reuse or refill this container.** Triple rinse or pressure rinse container (or equivalent) promptly after emptying; then offer for recycling, if available, or reconditioning, if appropriate, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures approved by state and local authorities.

**Refillable Container.** Refill this container with pesticide only. **DO NOT** reuse this container for any other purpose. Triple rinsing the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. **See attached booklet for complete container disposal directions including triple rinsing and pressure rinsing instructions.**

**Notice:** Read the entire label before using. Use only according to label directions. **Before buying or using this product, read *Terms and Conditions of Use, Warranty Disclaimer, Inherent Risks of Use* and *Limitation of Remedies* inside label booklet.**

EPA Reg. No. 241-437-67690
FPL20150410

EPA Est. No. 067690-NC-002
166804
NVA 2014-04-299-0109

Clearcast is a registered trademark of BASF Corporation.

Manufactured for: SePRO Corporation 11550 N. Meridian St., Ste. 600, Carmel, IN 46032 U.S.A.

**Net Contents 15 gallons (Non-refillable)**

Product File

# Supplemental Label

| GROUP | 2 | HERBICIDE |
|---|---|---|

SePRO

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 11-12-14 Reviewer S.Sutherland
Reg. No. 241-437-AA-67690

# Clearcast®

HERBICIDE

## For control of Japanese eelgrass

This supplemental label expires December 31, 2016, and must not be used or distributed after this date.

**Active Ingredient:**

| | |
|---|---|
| ammonium salt of imazamox: 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-(methoxymethyl)-3-pyridinecarboxylic acid* | 12.1% |
| **Other Ingredients:** | 87.9% |
| **Total:** | 100.0% |

*Equivalent to 11.4% 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-5-(methoxymethyl)-3-pyridinecarboxylic acid

1 gallon contains 1.0 pound of active ingredient as the free acid.

**EPA Reg. No. 241-437-67690**

## Directions For Use

- It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.
- The supplemental labeling and the entire **Clearcast® herbicide** container label, EPA Reg. No. 241-437-67690, must be in possession of the user at the time of application.
- Read the label affixed to the container for **Clearcast** before applying.
- Use of **Clearcast** according to this labeling is subject to the use precautions and limitations imposed by the label affixed to the container for **Clearcast**.

**Japanese Eelgrass** (*Zostera japonica)*
Japanese eelgrass is a submerged aquatic plant which can be found in tidal and intertidal areas. **Clearcast** may be applied directly to the water or directly to the plant (e.g. at low tide).

**Low-tide Application**
To make applications when the plant is exposed at low tide, uniformly apply with properly calibrated broadcast or spot treatment equipment in 10 or more gallons of water per acre. An appropriate spray adjuvant approved for aquatic use may be used but is not required. Spot treatments can be made with up to 5% **Clearcast** by volume. To ensure thorough spray coverage, higher spray volumes may be required when treating areas with large and/or dense vegetation. Use an appropriate spray pressure to minimize drift potential depending upon spray equipment, conditions, and application objectives. Apply 4 fl ozs to 32 fl ozs **Clearcast**/A. Use the lower rate for management of seedlings. An appropriate aquatic use spray adjuvant may be used but is not required.

**In-water Application**
When Japanese eelgrass is submerged, **Clearcast** may be broadcast-applied to the water surface or injected below the water surface. **Clearcast** may be applied as undiluted product or diluted with water before application. Under surface-matted conditions, inject **Clearcast** below the water surface to achieve better product distribution. Apply **Clearcast** to water to achieve a final concentration of the active ingredient of no more than 500 ppb. Multiple applications of **Clearcast** may be made during the annual growth cycle to maintain the desired vegetation response.

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## INHERENT RISKS OF USE

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Manufactured for: SePRO Corporation; 11550 N. Meridian St., Ste. 600, Carmel, IN 46032
NVA 2014-04-299-0110

Conforms to HazCom 2012/United States

# SAFETY DATA SHEET

# Clearcast

## Herbicide

## Section 1. Identification

**GHS product identifier:** Clearcast Herbicide
**Other means of identification:** Not available.
**EPA Registration No.:** 241-437-67690

**Supplier's details** : SePRO Corporation
11550 North Meridian Street
Suite 600
Carmel, IN 46032 U.S.A.
Tel: 317-580-8282
Toll free: 1-800-419-7779
Fax: 317-580-8290
Monday - Friday, 8am to 5pm
E.S.T. www.sepro.com

**Emergency telephone number (with hours of operation):** **INFOTRAC - 24-hour service 1-800-535-5053**

**The following recommendations for exposure controls and personal protection are intended for the manufacture, formulation and packaging of this product. For applications and/or use, consult the product label. The label directions supersede the text of this Safety Data Sheet for application and/or use.**

## Section 2. Hazards identification

**According to Regulation 2012 OSHA Hazard Communication Standard; 29 CFR Part 1910.1200**

**Classification of the product:** No need for classification according to GHS criteria for this product.

**Label elements (Emergency overview)** The product does not require a hazard warning label in accordance with GHS criteria.

**Hazards not otherwise classified**
Labeling of special preparations (GHS):
The following percentage of the mixture consists of components(s) with unknown hazards regarding the acute toxicity:
0 - 2 % dermal
0 - 2 % oral
15 - 18 % Inhalation - vapor
15 - 18 % Inhalation – mist

**Emergency overview**

**According to Regulation 1994 OSHA Hazard Communication Standard; 29 CFR Part 1910.1200**

CAUTION:
HARMFUL IF ABSORBED THROUGH SKIN.
HARMFUL IF INHALED.
KEEP OUT OF REACH OF CHILDREN.
KEEP OUT OF REACH OF DOMESTIC ANIMALS.
Avoid contact with the skin, eyes and clothing.
Avoid inhalation of mists/vapors.

## Section 3. Composition/information on ingredients

**According to Regulation 2012 OSHA Hazard Communication Standard; 29 CFR Part 1910.1200**

| CAS Number | Content (W/W) | Chemical name |
|---|---|---|
| 247057-22-3 | 12.1% | ammonium salt of imazamox (active ingredient) |

**According to Regulation 2012 OSHA Hazard Communication Standard; 29 CFR Part 1910.1200**

| CAS Number | Content (W/W) | Chemical name |
|---|---|---|
| 247057-22-3 | 12.1% | ammonium salt of imazamox (active ingredient) |
| | 87.9% | Proprietary ingredient |

## Section 4. First aid measures

**Description of first aid measures**

**General advice:** First aid providers should wear personal protective equipment to prevent exposure. Remove contaminated clothing. Move person to fresh air. If person is not breathing, call 911 or ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call a poison control center or physician for treatment advice. Have the product container or label with you when calling a poison control center or doctor or going for treatment.

**If inhaled:** Remove the affected individual into fresh air and keep the person calm. Assist in breathing if necessary.

**If on skin:** Rinse skin immediately with plenty of water for 15 - 20 minutes.

**If in eyes:** Hold eyes open and rinse slowly and gently with water for 15 to 20 minutes. Remove contact lenses, if present, after first 5 minutes, then continue rinsing.

**If swallowed:** Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to by a poison control center or doctor. Never induce vomiting or give anything by mouth if the victim is unconscious or having convulsions.

**Most important symptoms and effects, both acute and delayed** Symptoms: No significant reaction of the human body to the product known.

**Indication of any immediate medical attention and special treatment needed**

Note to physician — Treatment: Symptomatic treatment (decontamination, vital functions).

## Section 5. Fire-fighting measures

**Extinguishing media**

Suitable extinguishing media:
Foam, dry powder, carbon dioxide, water spray

**Special hazards arising from the substance or mixture**

Hazards during fire-fighting: carbon monoxide, carbon dioxide, nitrogen oxide, nitrogen dioxide, Ammonium, Hydrocarbons, If product is heated above decomposition temperature, toxic vapours will be released. The substances/groups of substances mentioned can be released in case of fire.

**Advice for fire-fighters**

Protective equipment for fire-fighting: Firefighters should be equipped with self-contained breathing apparatus and turn-out gear.

**Further information**

Evacuate area of all unnecessary personnel. Contain contaminated water/firefighting water. Do not allow to enter drains or waterways.

## Section 6. Accidental release measures

**Personal precautions**

Take appropriate protective measures. Clear area. Shut off source of leak only under safe conditions. Extinguish sources of ignition nearby and downwind. Ensure adequate ventilation. Wear suitable personal protective clothing and equipment.

**Environmental precautions**

Do not discharge into the subsoil/soil. Do not discharge into drains/surface waters/groundwater. Contain contaminated water/firefighting water.

**Methods and material for containment and cleaning up**

Dike spillage. Pick up with suitable absorbent material. Place into suitable containers for reuse or disposal in a licensed facility. Spilled substance/product should be recovered and applied according to label rates whenever possible. If application of spilled substance/product is not possible, then spills should be contained, solidified, and placed in suitable containers for disposal. After decontamination, spill area can be washed with water. Collect wash water for approved disposal.

## Section 7. Handling and storage

**Precautions for safe handling**

RECOMMENDATIONS ARE FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS. PESTICIDE APPLICATORS & WORKERS must refer to the Product Label and Directions for Use attached to the product for Agricultural Use Requirements in accordance with the EPA Worker Protection Standard 40 CFR part 170. Ensure adequate ventilation. Provide good ventilation of working area (local exhaust ventilation if necessary). Keep away from sources of ignition - No smoking. Keep container tightly sealed. Protect contents from the effects of light. Protect against heat. Protect from air. Handle and open container with care. Do not open until

ready to use. Once container is opened, content should be used as soon as possible. Avoid aerosol formation. Avoid dust formation. Provide means for controlling leaks and spills. Do not return residues to the storage containers. Follow label warnings even after container is emptied. The substance/ product may be handled only by appropriately trained personnel. Avoid all direct contact with the substance/product. Avoid contact with the skin, eyes and clothing. Avoid inhalation of dusts/mists/vapors. Wear suitable personal protective clothing and equipment.

Protection against fire and explosion: The relevant fire protection measures should be noted. Fire extinguishers should be kept handy. Avoid all sources of ignition: heat, sparks, open flame. Sources of ignition should be kept well clear. Avoid extreme heat. Keep away from oxidizable substances. Electrical equipment should conform to national electric code. Ground all transfer equipment properly to prevent electrostatic discharge. Electrostatic discharge may cause ignition.

**Conditions for safe storage, including any incompatibilities** Segregate from incompatible substances. Segregate from foods and animal feeds. Segregate from textiles and similar materials.

Further information on storage conditions: Keep only in the original container in a cool, dry, well-ventilated place away from ignition sources, heat or flame. Protect containers from physical damage. Protect against contamination. The authority permits and storage regulations must be observed.

Storage stability: If substance/product crystallizes, thaw at room temperature.

Protect from temperatures below: 0 °C. Changes in the properties of the product may occur if substance/product is stored below indicated temperature for extended periods of time.
Protect from temperatures above: 40 °C. Changes in the properties of the product may occur if substance/product is stored above indicated temperature for extended periods of time.

## Section 8. Exposure controls/personal protection

**Users of a pesticidal product should refer to the product label for personal protective equipment requirements.**

**Advice on system design:** Whenever possible, engineering controls should be used to minimize the need for personal protective equipment.

**Personal protective equipment**

**RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS:**

**Respiratory protection:** Wear respiratory protection if ventilation is inadequate. Wear a NIOSH-certified (or equivalent) TC23C Chemical/Mechanical type filter system to remove a combination of particles, gas and vapours. For situations where the airborne concentrations may exceed the level for which an air purifying respirator is effective, or where the levels are unknown or Immediately Dangerous to Life or Health (IDLH), use NIOSH-certified full facepiece pressure demand self-contained breathing apparatus (SCBA) or a full facepiece pressure demand supplied-air respirator (SAR) with escape provisions.

| | |
|---|---|
| **Hand protection:** | Chemical resistant protective gloves, Protective glove selection must be based on the user's assessment of the workplace hazards. |
| **Eye protection:** | Safety glasses with side-shields. Tightly fitting safety goggles (chemical goggles). Wear face shield if splashing hazard exists. |
| **Body protection:** | Body protection must be chosen depending on activity and possible exposure, e.g. head protection, apron, protective boots, chemical-protection suit. |
| **General safety and hygiene measures:** | Wear long sleeved work shirt and long work pants in addition to other stated personal protective equipment. Work place should be equipped with a shower and an eye wash. Handle in accordance with good industrial hygiene and safety practice. Personal protective equipment should be decontaminated prior to reuse. Gloves must be inspected regularly and prior to each use. Replace if necessary (e.g. pinhole leaks). Take off immediately all contaminated clothing. Store work clothing separately. Hands and/or face should be washed before breaks and at the end of the shift. No eating, drinking, smoking or tobacco use at the place of work. Keep away from food, drink and animal feeding stuffs. |

## Section 9. Physical and chemical properties

| | |
|---|---|
| Form: | liquid |
| Odor: | acidic, mild |
| Odor threshold: | No data available. |
| Color: | pale, yellow, clear |
| pH value: | approx. 5 – 7 (20 °C) |
| Freezing point: | approx. 0 °C (1,013.3 hPa) Information applies to the solvent. |
| Boiling point: | approx. 100 °C (1,013.3 hPa) Information applies to the solvent. |
| Flash point: | A flash point determination is unnecessary due to the high water content. |
| Flammability: | Based on the structure or composition there is no indication of flammability |
| Lower explosion limit: | As a result of our experience with this product and our knowledge of its composition we do not expect any hazard as long as the product is used appropriately and in accordance with the intended use. |
| Upper explosion limit: | As a result of our experience with this product and our knowledge of its composition we do not expect any hazard as long as the product is used appropriately and in accordance with the intended use. |
| Autoignition: | Based on the water contents the product does not ignite. |
| Vapor pressure: | approx. 23.3 hPa (20 °C) Information applies to the solvent. |
| Density: | 1.0486 g/cm3 (20 °C)<br>8.7510 Lb/USg (68 °F) |

| | |
|---|---|
| Vapour density: | not applicable |
| Partitioning coefficient n-octanol/water (log Pow): | not applicable |
| Thermal decomposition: | carbon monoxide, carbon dioxide, nitrogen oxide, nitrogen dioxide, Ammonium, Hydrocarbons<br>Stable at ambient temperature. If product is heated above decomposition temperature toxic vapours may be released. If product is heated above decomposition temperature hazardous fumes may be released. |
| Viscosity, dynamic: | approx. 3.7 mPa.s (20 °C) |
| Solubility in water: | soluble |
| Molar mass: | 320.4 g/mol |
| Other information: | If necessary, information on other physical and chemical parameters is indicated in this section. |

## Section 10. Stability and reactivity

**Reactivity**

| | |
|---|---|
| Additional information: | No hazardous reactions if stored and handled as prescribed/indicated. |
| Corrosion to metals: | Corrosive effects to metal are not anticipated. |
| Oxidizing properties: | Not an oxidizer. |
| **Chemical stability** | The product is stable if stored and handled as prescribed/indicated. |

**Possibility of hazardous reactions**

| | |
|---|---|
| Hazardous reactions: | The product is chemically stable.<br>No hazardous reactions if stored and handled as prescribed/indicated. |

**Conditions to avoid**

| | |
|---|---|
| Conditions to avoid: | Avoid all sources of ignition: heat, sparks, open flame. Avoid electro-static charge. Avoid prolonged storage. Avoid contamination. Avoid prolonged exposure to extreme heat. Avoid extreme temperatures. |

**Incompatible materials**

| | |
|---|---|
| Substances to avoid: | oxidizing agents |

**Hazardous decomposition products**

| | |
|---|---|
| Decomposition products: | Hazardous decomposition products: No hazardous decomposition products if stored and handled as prescribed/indicated. |
| Thermal decomposition: | Possible thermal decomposition products: carbon monoxide, carbon dioxide, nitrogen oxide, nitrogen dioxide, Ammonium, Hydrocarbons Stable at ambient temperature. If product is heated above decomposition temperature toxic vapours may be released. If product is heated above decomposition temperature hazardous fumes may be released. |

## Section 11. Toxicological information

**Primary routes of exposure**

Routes of entry for solids and liquids are ingestion and inhalation, but may include eye or skin contact. Routes of entry for gases include inhalation and eye contact. Skin contact may be a route of entry for liquefied gases.

**Acute Toxicity/Effects**

Acute toxicity

Assessment of acute toxicity:

Relatively nontoxic after single ingestion. Slightly toxic after short-term skin contact. Relatively nontoxic after short-term inhalation.

*contact.*

| Product/ingredient name | Result | Species | Dose | Exposure |
|---|---|---|---|---|
| Clearcast | LC50 Inhalation Vapor | Rat | >5 mg/L | 4 hours |
| | LD50 Dermal | Rat | >4000 mg/kg | - |
| | LD50 Oral | Rat | >5000 mg/kg | - |

Irritation / corrosion

Assessment of irritating effects:

May cause slight but temporary irritation to the eyes. May cause slight irritation to the skin.

*Information on: isopropylamine*

*Assessment of irritating effects: Highly corrosive! Damages skin and eyes. Causes temporary irritation of the respiratory tract.*

| Product/ingredient name | Result | Species | Score | Exposure | Observation |
|---|---|---|---|---|---|
| Clearcast | Eyes – non-irritating | Rabbit | - | - | - |
| | Skin – non-irritating | Rabbit | - | - | - |

Sensitization

Assessment of sensitization:

Skin sensitizing effects were not observed in animal studies.

Sensitization

Assessment of sensitization:

There is no evidence of a skin-sensitizing potential. modified Buehler test
Species: guinea pig
Result: Skin sensitizing effects were not observed in animal studies.

**Chronic Toxicity/Effects**

Repeated dose toxicity

Assessment of repeated dose toxicity: The product has not been tested. The statement has been derived from the properties of the individual components. No substance-specific organ toxicity was observed after repeated administration to animals.

Genetic toxicity

Assessment of mutagenicity: The product has not been tested. The statement has been derived from the properties of the individual components. Mutagenicity tests revealed no genotoxic potential.

Carcinogenicity

*Information on: imazamox*

*Assessment of carcinogenicity:*

*In long-term studies in rats and mice in which the substance was given by feed, a carcinogenic effect was not observed.*

Reproductive toxicity
Assessment of reproduction toxicity: The product has not been tested. The statement has been derived from the properties of the individual components. The results of animal studies gave no indication of a fertility impairing effect.

*Information on: imazamox*
*Assessment of reproduction toxicity:* *The results of animal studies gave no indication of a fertility impairing effect.*

Teratogenicity
Assessment of teratogenicity: The product has not been tested. The statement has been derived from the properties of the individual components. Animal studies gave no indication of a developmental toxic effect at doses that were not toxic to the parental animals.

*Information on: imazamox*
*Assessment of teratogenicity:* *No indications of a developmental toxic / teratogenic effect were seen in animal studies.*

Other Information: Misuse can be harmful to health.

**Symptoms of Exposure**: No significant reaction of the human body to the product known.

## Section 12. Ecological information

**Toxicity**

Aquatic toxicity
Assessment of aquatic toxicity: There is a high probability that the product is not acutely harmful to aquatic organisms.

Aquatic plants
EC50 (72 h) > 100 mg/l (growth rate), *Pseudokirchneriella subcapitata*

Toxicity to fish
*Information on: imazamox* *LC50 (96 h) > 119 mg/l, Lepomis macrochirus*

Aquatic plants
*Information on: imazamox* *EC50 (72 h) 29.1 mg/l (growth rate), Pseudokirchneriella subcapitata*
*EC50 (7 d) 0.031 mg/l (growth rate), Lemna gibba*

Assessment of terrestrial toxicity: With high probability not acutely harmful to terrestrial organisms.

Other terrestrial non-mammals
*Information on: imazamox* *LC50, Anas platyrhynchos*
*LD50 > 100 ug/bee, Apis mellifera*

**Persistence and degradability**

Assessment biodegradation and elimination (H2O): The product has not been tested. The statement has been derived from the properties of the individual components.

Elimination information: Not readily biodegradable (by OECD criteria).

**Bioaccumulative potential**

| | |
|---|---|
| Assessment bioaccumulation potential | The product has not been tested. The statement has been derived from the properties of the individual components. |

**Mobility in soil**

| | |
|---|---|
| Assessment transport between environmental compartments | The product has not been tested. The statement has been derived from the properties of the individual components. |
| *Information on: imazamox* | *The substance will not evaporate into the atmosphere from the water surface. Following exposure to soil, the product trickles away and can - dependant on degradation – be transported to deeper soil areas with larger water loads.* |

**Additional information**

| | |
|---|---|
| Other ecotoxicological advice: | The ecological data given are those of the active ingredient. Do not release untreated into natural waters. |

## Section 13. Disposal considerations

| | |
|---|---|
| **Waste disposal of substance:** | Pesticide wastes are regulated. Improper disposal of excess pesticide, spray mix or rinsate is a violation of federal law. If pesticide wastes cannot be disposed of according to label instructions, contact the State Pesticide or Environmental Control Agency or the Hazardous Waste representative at the nearest EPA Regional Office for guidance. |
| **Container disposal:** | Rinse thoroughly at least three times (triple rinse) in accordance with EPA recommendations. Consult state or local disposal authorities for approved alternative procedures such as container recycling. Recommend crushing, puncturing or other means to prevent unauthorized use of used containers. |
| **RCRA:** | This product is not regulated by RCRA. |

## Section 14. Transport information

**Land transport**

| | |
|---|---|
| USDOT | Not classified as a dangerous good under transport regulations |

**Sea transport**

| | |
|---|---|
| IMDG | Not classified as a dangerous good under transport regulations |

**Air transport**

| | |
|---|---|
| IATA/ICAO | Not classified as a dangerous good under transport regulations |

## Section 15. Regulatory information

**Federal Regulations**

**Registration status:**

| | | |
|---|---|---|
| Chemical | TSCA, US | blocked / not listed |
| Crop Protection | TSCA, US | released / exempt |

**EPCRA 311/312 (Hazard categories):** Not hazardous

**State regulations**

**CA Prop. 65:** There are no listed chemicals in this product.

**Labeling requirements under FIFRA**

This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and workplace labels of non-pesticide chemicals. Following is the hazard information as required on the pesticide label.

CAUTION:
HARMFUL IF ABSORBED THROUGH SKIN.
HARMFUL IF INHALED.
KEEP OUT OF REACH OF CHILDREN.
KEEP OUT OF REACH OF DOMESTIC ANIMALS.
Avoid contact with the skin, eyes and clothing.

## Section 16. Other information

**SDS Prepared by:**
SePRO Corporation
SDS Prepared on: 05/14/15

**Notice to reader**
**To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.**

Product File

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 12-5-12 Reviewer S. Sutherland
Reg. No. 241-426-AA-67690

# Habitat®

HBAS6416

## Herbicide

SePRO

**For the control of undesirable vegetation growing within specified aquatic sites and nonirrigation ditchbanks.**

| Active Ingredient | |
|---|---|
| isopropylamine salt of imazapyr: (2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-3-pyridinecarboxylic acid)† | 27.77% |
| Other Ingredients | 72.23% |
| TOTAL | 100.00% |

† Equivalent to 22.65% 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-3-pyridinecarboxylic acid or 2 pounds acid per gallon.

**Keep Out of Reach of Children**

# CAUTION / PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

**Refer to inside of label booklet for additional precautionary information and directions for use, including first aid and storage and disposal.**

**Notice:** Read the entire label before using. Use only according to label directions. **Before buying or using this product, read *Terms and Conditions of Use, Warranty Disclaimer, Inherent Risks of Use* and *Limitation of Remedies* inside label booklet.**

Habitat is a registered trademark of BASF Corporation.
Manufactured for: **SePRO Corporation** 11550 N. Meridian St. Suite 600, Carmel, IN 46032 U.S.A.

| FIRST AID | |
|---|---|
| **If swallowed** | • Call a poison control center or doctor immediately for treatment advice.<br>• Have person sip a glass of water if able to swallow.<br>• **DO NOT** induce vomiting unless told to do so by a poison control center or doctor.<br>• **DO NOT** give anything by mouth to an unconscious person. |

**HOTLINE NUMBER**

Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact INFOTRAC for emergency medical treatment information: 1-800-535-5053.

EPA Reg. No. 241-426-67690
EPA Est. No. is indicated by the fifth letter of the lot code printed on this container:
EPA Est. No. 73427-IN-001 (J)
EPA Est. No. 067690-NC-001 (C)
EPA Est. No. 241-PR-002 (M)
EPA Est. No. 65954-VA-001 (A)

FPL20120613
36416001
NVA 2011-04-246-0167

8 11055 01110 7

**Herbicide**

**Net contents 2.5 gallons**
Nonrefillable container

# KEEP OUT OF REACH OF CHILDREN
# CAUTION/PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

| FIRST AID | |
|---|---|
| If swallowed | • Call a poison control center or doctor immediately for treatment advice.<br>• Have person sip a glass of water if able to swallow.<br>• **DO NOT** induce vomiting unless told to do so by a poison control center or doctor.<br>• **DO NOT** give anything by mouth to an unconscious person. |
| HOTLINE NUMBER | |
| Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact INFOTRAC for emergency medical treatment information: 1-800-535-5053. | |

## PRECAUTIONARY STATEMENTS

**Hazards to Humans and Domestic Animals**

**CAUTION.** Harmful if swallowed

### PERSONAL PROTECTIVE EQUIPMENT (PPE)

Some materials that are chemically resistant to this product are listed below. If you want more options, follow the instructions for **Category A** on an EPA chemical–resistance category selection chart.

**Mixers, loaders, applicators and other handlers must wear:**

- Long-sleeved shirt and long pants
- Chemical-resistant gloves (except for pilots)
- Shoes plus socks.

Follow manufacturer's instructions for cleaning and maintaining PPE. If no such instructions are given for washables, use detergent and hot water. Keep and wash PPE separately from other laundry. Discard clothing and other absorbent materials that have been drenched or heavily contaminated with this product's concentrate. **DO NOT** reuse them.

### ENGINEERING CONTROLS

Pilots must use an enclosed cockpit that meets the requirements listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240 (d)(6)].

### USER SAFETY RECOMMENDATIONS

**Users should:**

- Wash hands with plenty of soap and water before eating, drinking, chewing gum, using tobacco or using the toilet.
- Remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

### PHYSICAL AND CHEMICAL HAZARDS

Spray solutions of **Habitat® herbicide** should be mixed, stored and applied only in stainless steel, fiberglass, plastic and plastic-lined steel containers.

Thoroughly clean application equipment, including landing gear, immediately after use of this product. Prolonged exposure of this product to uncoated steel (except stainless steel) surfaces may result in corrosion and failure of the exposed part. The maintenance of an organic coating (paint) may prevent corrosion.

## ENVIRONMENTAL HAZARDS

This product is toxic to plants. Drift and runoff may be hazardous to plants in water adjacent to treated areas. **DO NOT** apply to water except as specified in this label. Treatment of aquatic weeds may result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss may cause the suffocation of some aquatic organisms. **DO NOT** treat more than 1/2 of the surface area of the water in a single operation and wait at least 10 to 14 days between treatments. Begin treatment along the shore and proceed outward in bands to allow aquatic organisms to move into untreated areas. **DO NOT** contaminate water when disposing of equipment washwaters or rinsate. See Directions for Use for additional precautions and requirements.

This pesticide is toxic to vascular plants and must be used strictly in accordance with the drift precautions on the label.

## DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling.

**Habitat® herbicide** must be used only in accordance with the instructions on the leaflet label attached to the container. Keep containers closed to avoid spills and contamination.

**DO NOT** apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application.

### NONAGRICULTURAL USE REQUIREMENTS

The requirements in this box apply to uses of this product that are NOT within the scope of the Worker Protection Standard (WPS) for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries, or greenhouses.

Noncrop weed control is not within the scope of the Worker Protection Standard. See the **Product Information** section of this label for a description of noncrop sites.

**DO NOT** enter or allow others to enter treated areas until sprays have dried.

## STORAGE AND DISPOSAL

**DO NOT** contaminate water, food or feed by storage or disposal.

**Pesticide Storage**

**DO NOT** store below 10° F.

**Pesticide Disposal**

Wastes resulting from the use of this product must be disposed of on-site or at an approved waste disposal facility.

**Container Handling**

**Nonrefillable Container. DO NOT reuse or refill this container.** Triple rinse or pressure rinse container (or equivalent) promptly after emptying; then offer for recycling, if available, or reconditioning, if appropriate, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures approved by state and local authorities.

**Triple rinse containers small enough to shake (capacity ≤ 5 gallons) as follows:** Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank, or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times.

**Triple rinse containers too large to shake (capacity >5 gallons) as follows:** Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and end tip it back and forth several times. Empty the rinsate into application equipment or a mix tank, or store rinsate for later use or disposal. Repeat this procedure two more times.

**Pressure rinse as follows:** Empty the remaining contents into application equipment or mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank, or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container and rinse at about 40 PSI for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

**Refillable Container.** Refill this container with pesticide only. **DO NOT** reuse this container for any other purpose. Triple rinsing the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller.

**Triple rinse as follows:** To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10% full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times.

When this container is empty, replace the cap and seal all openings that have been opened during use; return the container to the point of purchase or to a designated location. This container must only be refilled with a pesticide product. Prior to refilling, inspect carefully for damage such as cracks, punctures, abrasions, worn-out threads and closure devices. Check for leaks after refilling and before transport. **DO NOT** transport if this container is damaged or leaking. If the container is damaged, or leaking, or obsolete and not returned to the point of purchase or to a designated location, triple rinse emptied container and offer for recycling, if available, or dispose of container in compliance with state and local regulations.

## IN CASE OF EMERGENCY

In case of large-scale spillage regarding this product, call:

- INFOTRAC 1-800-535-5053

In case of medical emergency regarding this product, call:

- Your local doctor for immediate treatment
- Your local poison control center (hospital)
- INFOTRAC 1-800-535-5053.

**Steps to be taken in case material is released or spilled:**

- Dike and contain the spill with inert material (sand, earth, etc.) and transfer liquid and solid diking material to separate containers for disposal.
- Remove contaminated clothing and wash affected skin areas with soap and water.
- Wash clothing before reuse.
- Keep the spill out of all sewers and open bodies of water.

**PRODUCT USE PRECAUTIONS AND RESTRICTIONS**

Applications may be made for the control of undesirable vegetation growing within specified aquatic sites. Aquatic sites consist of standing and flowing water, estuarine/marine, wetland and riparian areas and nonirrigation ditchbanks.

**Restrictions**

- **DO NOT** use on food crops.
- **DO NOT** apply this product within 1/2 mile upstream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water, such as a lake, pond or reservoir.
- **DO NOT** apply to water used for irrigation except as described in **Product Use Precautions and Restrictions** section of this label.
- Keep from contact with fertilizers, insecticides, fungicides and seeds.
- **DO NOT** drain or flush equipment on or near desirable trees or other plants, or on areas where their roots may extend, or in locations where the treated soil may be washed or moved into contact with their roots.
- **DO NOT** side trim desirable vegetation with this product unless severe injury and plant death can be tolerated. Prevent drift of spray to desirable plants.
- Clean application equipment after using this product by thoroughly flushing with water.

**Aquatic Sites**

- **DO NOT** apply more than 1.5 lbs ae imazapyr (equivalent to 96 fl ozs of **Habitat® herbicide**) per acre per year.
- **Public waters.** Application of **Habitat** to water can only be made by federal or state agencies, such as Water Management District personnel, municipal officials, and the U.S. Army Corps of Engineers, or those applicators who are licensed or certified as aquatic pest control applicators and are authorized by the state or local government. Treatment to other than non-native invasive species is limited to only those plants that have been determined to be a nuisance by a federal or state government entity.
- **Permitting.** Consult local state fish and game agency and water control authorities before applying this product to public water. Permits may be required to treat such water.
- **Private waters.** Applications may be made to private waters that are still, such as ponds, lakes and drainage ditches where there is minimal or no outflow to public waters.
- **Aerial application.** Aerial application to aquatic sites is restricted to helicopter only.
- **Irrigation water.** Application to water used for irrigation that results in **Habitat** residues > 1.0 ppb **MUST NOT** be used for irrigation purposes for 120 days after application or until **Habitat** residue levels are determined by laboratory analysis or other appropriate means of analysis to be 1.0 ppb or less. When applications are made within 500 feet of an active irrigation intake, **DO NOT** irrigate for at least 24 hours following application to allow for dissipation.

**Recreational use of water in treatment area.** There are no restrictions on the use of water in the treatment area for recreational purposes, including swimming and fishing.

**Livestock use of water in/from treatment area.** There are no restrictions on livestock consumption of water from the treatment area.

**Precautions for potable water intakes. DO NOT** apply **Habitat** directly to water within 1/2 mile upstream of an active potable water intake in flowing water (i.e., river, stream, etc.) or within 1/2 mile of an active potable water intake in a standing body of water such as a lake, pond or reservoir. To make aquatic applications around and within 1/2 mile of active potable water intakes, the water intake **must** be turned off during application and for a minimum of 48 hours after the application. These aquatic applications may be made only in the cases where there are alternative water sources or holding ponds that would permit the turning off of an active potable water intake for a minimum period of 48 hours after the applications.

**NOTE:** Existing potable water intakes that are no longer in use, such as those replaced by connections to wells or a municipal water system, are not considered to be active potable water intakes.

**Quiescent or Slow-moving Waters.** In lakes and reservoirs, **DO NOT** apply **Habitat** within one (1) mile of an active irrigation water intake during the irrigation season. Applications less than one (1) mile from an active irrigation water intake may be made during the off-season, provided that the irrigation intake will remain inactive for a minimum of 120 days after application or until **Habitat** residue levels are determined by laboratory analysis or other appropriate means of analysis to be 1.0 ppb or less.

PRODUCT INFORMATION

**Habitat® herbicide** is an aqueous solution to be mixed with water and a surfactant and applied as a spray solution to control undesirable vegetation growing within specified aquatic sites. Aquatic sites consist of standing and flowing water, estuarine/marine, wetland, riparian areas and nonirrigation ditchbanks.

**Herbicidal Activity. Habitat** will control most annual and perennial grasses and broadleaf weeds in addition to many brush and vine species with some residual control of undesirable species that germinate above the waterline. **Habitat** is readily absorbed through emergent leaves and stems and is translocated rapidly throughout the plant with accumulation in the meristematic regions. For maximum activity, weeds should be growing vigorously at the time of application, and the spray solution should include a surfactant (see **Adjuvants** section for specific use directions). Treated plants stop growing soon after spray application. Chlorosis appears first in the newest leaves, and necrosis spreads from this point. In perennials, the herbicide is translocated into, and **kills**, underground or submerged storage organs, which prevents regrowth. Chlorosis and tissue necrosis may not be apparent in some plant species until 2 or more weeks after application. Complete kill of plants may not occur for several weeks. Applications of **Habitat** are rainfast 1 hour after treatment.

**Application Methods. Habitat** may be selectively applied by using low-volume directed application techniques or may be broadcast applied by using ground equipment, watercraft, or aircraft (aerial applications to aquatic sites must be made by helicopter). In addition, Habitat may also be applied using cut stump, cut stem, and frill and girdle treatment techniques within aquatic sites (see **Aerial Application** and **Ground Application** sections for additional details).

PRECAUTIONS FOR AVOIDING INJURY TO NONTARGET PLANTS

Untreated desirable plants can be affected by root uptake of **Habitat** from treated soil. Injury or loss of desirable plants may result if **Habitat** is applied on or near desirable plants, on areas where their roots extend, or in locations where the treated soil may be washed or moved into contact with their roots. When making applications along shorelines where desirable plants may be present, caution should be exercised to avoid spray contact with their foliage or spray application to the soil in which they are rooted. Shoreline plants that have roots which extend into the water in an area where **Habitat** has been applied generally will not be adversely affected by uptake of the herbicide from the water. If treated vegetation is to be removed from the application site, **DO NOT** use the vegetative matter as mulch or compost on or around desirable species.

**Wind Erosion**

Avoid treating powdery, dry or light sandy soils when conditions are favorable for wind erosion. Under these conditions, the soil surface should first be settled by rainfall or irrigation.

**Spray Drift Requirements**

**Aerial Application**

- Applicators are required to use a coarse or coarser droplet size (ASABE S572) or, if specifically using a spinning atomizer nozzle, applicators are required to use a volume mean diameter (VMD) of 385 microns or greater for release heights below 10 feet. Applicators are required to use a very coarse or coarser droplet size or, if specifically using a spinning atomizer nozzle, applicators are required to use a VMD of 475 microns or greater for release heights above 10 feet. Applicators must consider the effects of nozzle orientation and flight speed when determining droplet size.
- Applicators are required to use upwind swath displacement.
- The boom length must not exceed 60% of the wingspan or 90% of the rotor blade diameter to reduce spray drift.
- Applications with wind speeds less than 3 mph and with wind speeds greater than 10 mph are prohibited.
- Applications into temperature inversions are prohibited.

**Ground Boom Application**

- Applicators are required to use a nozzle height below 4 feet above the ground or plant canopy and coarse or coarser droplet size (ASABE S572) or, if specifically using a spinning atomizer nozzle, applicators are required to use a volume mean diameter (VMD) of 385 microns or greater.
- Applications with wind speeds greater than 10 mph are prohibited.
- Applications into temperature inversions are prohibited.

ADJUVANTS

Postemergence applications of **Habitat** require the addition of a spray adjuvant. When making aquatic applications, only spray adjuvants that are approved or appropriate for aquatic use must be utilized.

**Nonionic Surfactants.** Use a nonionic surfactant (NIS) at the rate of 0.25% volume/volume (v/v) or higher (see manufacturer's label) of the spray solution (0.25% v/v is equivalent to 1 quart in 100 gallons). For best results, select a nonionic surfactant with an HLB (hydrophilic to lipophilic balance) ratio between 12 and 17 with at least 70% surfactant in the formulated product (alcohols, fatty acids, oils, ethylene glycol or diethylene glycol should not be considered as surfactants to meet the above requirements).

**Methylated Seed Oils or Vegetable Oil Concentrates.** Instead of a surfactant, a methylated seed oil (MSO) or vegetable-based seed oil concentrate may be used at the rate of 1.5 to 2 pints per acre. When using spray volumes greater than 30 gallons per acre, methylated seed oil or vegetable-based seed oil concentrates should be mixed at a rate of 1% of the total spray volume, or alternatively use a nonionic surfactant as described above. Research indicates that these oils may aid in **Habitat** deposition and uptake by plants under moisture or temperature stress.

**Silicone-based Surfactants.** See manufacturer's label for specific rates. Silicone-based surfactants may reduce the surface tension of the spray droplet allowing greater spreading on the leaf surface as compared to conventional nonionic surfactants. However, some silicone-based surfactants may dry too quickly, limiting herbicide uptake.

**Invert Emulsions. Habitat® herbicide** can be applied as an invert emulsion. The spray solution results in an invert (water-in-oil) spray emulsion designed to minimize spray drift and spray runoff, resulting in more herbicide on the target foliage. The spray emulsion may be formed in a single tank (batch mixing) or injected (in-line mixing). Consult the invert chemical label for proper mixing directions.

**Other.** An antifoaming agent, spray pattern indicator, or drift-reducing agent may be applied at the product labeled rate if necessary or desired.

TANK MIXES

**Habitat® herbicide** may be tank mixed with other herbicides.

Consult manufacturer's labels for specific rate restrictions and weeds controlled. Always follow the more restrictive label restrictions and precautions for all products used when making an application involving tank mixes.

AERIAL APPLICATION

All precautions must be taken to minimize or eliminate spray drift. Only helicopters can be used for aquatic applications. **DO NOT** make applications by helicopter unless appropriate buffer zones can be maintained to prevent spray drift out of the target area. Aerial equipment designed to minimize spray drift, such as a helicopter equipped with a **Microfoil™ boom, Thru-Valve™ boom**, or raindrop nozzles, must be used and calibrated. Except when applying with a **Microfoil boom**, a drift control agent may be added at the specified label rate. DO NOT side trim with **Habitat** unless death of treated tree can be tolerated.

Uniformly apply the specified amount of **Habitat** in 2 to 30 gallons of water per acre. A foam-reducing agent may be added at the specified label rate, if needed.

**IMPORTANT:** Thoroughly clean application equipment, including landing gear, immediately after use of this product. Prolonged exposure of this product to uncoated steel (except stainless steel) surfaces may result in corrosion and failure of the exposed part. The maintenance of an organic coating (paint) may prevent corrosion.

GROUND APPLICATION

FOLIAR APPLICATIONS

**Low-volume Foliar Application**

Use equipment calibrated to deliver 5 to 20 gallons of spray solution per acre. To prepare the spray solution, thoroughly mix in water 0.5% to 5% **Habitat** plus surfactant (see the **Adjuvants** section of this label for specific use directions). A foam-reducing agent may be applied at the specified label rate, if needed. For control of difficult species (see **Aquatic Weeds Controlled** section for relative susceptibility of weed species), use the higher concentrations of herbicide and/or spray volumes, but **DO NOT** apply more than 6 pints of **Habitat** per acre in aquatic sites. Excessive wetting of foliage is not necessary. See **Spray Solution Mixing Guide for Low-volume Foliar Applications** following for specified volumes of **Habitat** and water.

For low-volume foliar application, select proper nozzles to avoid overapplication. Proper application is critical to ensure desirable results. Best results are achieved when the spray covers the crown and approximately 70 percent of the plant. The use of an even, flat-fan tip with a spray angle of 40 degrees or less will aid in proper deposition.

Appropriate tip sizes include 4004E or 1504E. For a straight-stream and cone pattern, adjustable cone nozzles, such as 5500 X3 or 5500 X4, may be used. Attaching a rollover valve onto a Spraying Systems Model 30 gunjet or other similar spray gun allows for the use of both flat-fan and cone tips on the same gun.

Moisten, but **DO NOT** drench target vegetation causing spray solution to run off.

**Low-volume Foliar Application with Backpacks**

For low-growing species, spray down on the crown, covering crown and penetrating approximately 70% of the plant.

For target species 4 to 8 feet tall, swipe the sides of target vegetation by directing spray to at least 2 sides of the plant in smooth vertical motions from the crown to the bottom. Make sure to cover the crown whenever possible.

For target species over 8 feet tall, lace sides of the target vegetation by directing spray to at least 2 sides of the target in smooth zigzag motions from crown to bottom.

**Low-volume Foliar Application with Hydraulic Handgun Application Equipment**

Use the same technique as described above for **Low-volume Foliar Application with Backpacks.**

For broadcast applications, simulate a gentle rain near the top of target vegetation allowing spray to contact the crown and penetrate the target foliage without falling to the understory. Herbicide spray solution that contacts the understory may result in severe injury or death of plants in the understory.

**Spray Solution Mixing Guide for Low-volume Foliar Applications**

| Spray Solution Prepared (gallons) | Desired Concentration (% v/v) | | | | |
|---|---|---|---|---|---|
| | 0.5% | 0.75% | 1% | 1.5% | 5% |
| | (amount of **Habitat** to use) | | | | |
| 1 | 0.6 fl oz | 0.9 fl oz | 1.3 fl ozs | 1.9 fl ozs | 6.5 fl ozs |
| 3 | 1.9 fl ozs | 2.8 fl ozs | 3.8 fl ozs | 5.8 fl ozs | 2 pints |
| 4 | 2.5 fl ozs | 3.8 fl ozs | 5.1 fl ozs | 7.7 fl ozs | 1.6 pints |
| 5 | 3.2 fl ozs | 4.8 fl ozs | 6.5 fl ozs | 9.6 fl ozs | 2 pints |
| 50 | 2 pints | 3 pints | 4 pints | 6 pints | 10 quarts |
| 100 | 4 pints | 6 pints | 8 pints | 6 quarts | 5 gallons |
| 2 tablespoons = 1 fluid ounce | | | | | |

**High-volume Foliar Application**
For optimum performance when spraying medium-density to high-density vegetation, use equipment calibrated to deliver up to 100 gallons of spray solution per acre (GPA). Spray solutions exceeding 100 GPA may result in excessive spray runoff, causing increased ground cover injury, and injury to desirable species. To prepare the spray solution, thoroughly mix **Habitat® herbicide** in water and add a surfactant (see **Adjuvants** section for specific use directions and rates for surfactants). A foam-reducing agent may be added at the specified label rate, if needed. For control of difficult species (see **Aquatic Weeds Controlled** chart for relative susceptibility of weed species), use the higher concentrations of herbicide and/or spray volumes, but **DO NOT** apply more than 6 pints of **Habitat** per acre in aquatic sites. Uniformly cover the foliage of the vegetation to be controlled, but **DO NOT** apply to runoff. Excessive wetting of foliage is not necessary.

**Side Trimming**
**DO NOT** side trim with **Habitat** unless severe injury or death of the treated tree can be tolerated. **Habitat** is readily translocated and can result in death of the entire tree.

**CUT-SURFACE TREATMENT**
**Habitat** may be used to control undesirable woody vegetation by applying the **Habitat** solution to the cambium area of freshly cut stump surfaces or to fresh cuts on the stem of the target woody vegetation. Applications can be made at any time of the year except during periods of heavy sap flow in the spring. **DO NOT** overapply solution causing runoff from the cut surface.

Injury may occur to desirable woody plants if the shoots extend from the same root system or their root systems are grafted to those of the treated tree.

**Cut-surface Application with Dilute and Concentrate Solutions**
**Habitat** may be mixed as either a concentrated or dilute solution. The dilute solution may be used for applications to the cut surface of the stump or to cuts on the stem of the target woody vegetation. Concentrated solutions may be used for applications to cuts on the stem. Use of the concentrated solution permits application to fewer cuts on the stem, especially for large-diameter trees. Follow the application instructions to determine proper application techniques for each type of solution.

- To prepare a dilute solution, mix 8 to 12 fluid ounces of **Habitat** with 1 gallon of water. The use of a surfactant or penetrating agent may improve uptake through partially callused cambiums.
- To prepare a concentrated solution, mix 2 quarts of **Habitat** with no more than 1 quart of water.

**Cut-stump Treatment**
- **Dilute Solution.** Spray or brush the solution onto the cambium area of the freshly cut stump surface. Ensure that the solution thoroughly wets the entire cambium area (the wood next to the bark of the stump).

**Cut-stem (injection, hack and squirt) Treatment**
- **Dilute Solution.** Using standard injection equipment, apply 1 milliliter of solution at each injection site around the tree with no more than 1-inch intervals between cut edges. Ensure that the injector completely penetrates the bark at each injection site.
- **Concentrate Solution.** Using standard injection equipment, apply 1 milliliter of solution at each injection site. Make at least 1 injection cut for every 3 inches of Diameter at Breast Height (DBH) on the target tree. For example, a 3-inch DBH tree will receive 1 injection cut, and a 6-inch DBH tree will receive 2 injection cuts. On trees requiring more than 1 injection site, place the injection cuts at approximately equal intervals around the tree.

**Frill or Girdle Treatment**
- Using a hatchet, machete, or chainsaw, make cuts through the bark and completely around the tree to expose the cambium. The cut should angle downward extending into the cambium enough to expose at least 2 growth rings. Using a spray applicator or brush, apply a 25% to 100% solution of **Habitat** into each cut until thoroughly wet. Avoid applying so much herbicide that runoff to the ground or water occurs.

**AQUATIC WEED CONTROL**
**Habitat** may be applied for the control of floating and emergent undesirable vegetation (see the **Aquatic Weeds Controlled** section) in or near bodies of water that may be flowing, nonflowing, or transient. **Habitat** may be applied to aquatic sites that include lakes, rivers, streams, ponds, seeps, drainage ditches, canals, reservoirs, swamps, bogs, marshes, estuaries, bays, brackish water, transitional areas between terrestrial and aquatic sites, riparian sites, and seasonal wet areas. See **Product Use Precautions and Restrictions** section of this label for precautions, restrictions, and instructions on aquatic uses.

**Habitat** must be applied to the emergent foliage of the target vegetation and has little-to-no activity on submerged aquatic vegetation. **Habitat** concentrations resulting from direct application to water are not expected to be of sufficient concentration nor duration to provide control of target vegetation. Application should be made in such a way as to maximize spray interception by the target vegetation while minimizing the amount of overspray that enters the water.

**Habitat** does not control plants that are completely submerged or have a majority of their foliage under water.

**Habitat** should be applied with surface or helicopter application equipment in a minimum of 2 gallons of water per acre. When applying by helicopter, follow directions under the **Aerial Application** section of this label; otherwise, refer to the **Ground Application** section when using surface equipment.

Applications made to moving bodies of water should be made while traveling upstream to prevent concentration of this herbicide in water. **DO NOT** apply to bodies of water or portions of bodies of water where emergent and/or floating weeds do not exist.

When application is to be made to target vegetation that covers a large percentage of the surface area of impounded water, treating the area in strips may avoid oxygen depletion due to decaying vegetation. Oxygen depletion may result in the suffocation of some sensitive aquatic organisms. If oxygen depletion is a concern, treat no more than 1/2 of the surface area of the water in a single operation and wait at least 10 to 14 days between treatments. Begin treatment along the shore and proceed outward in bands to allow aquatic organisms to move into untreated areas.

Avoid washoff of sprayed foliage by spray boat or recreational boat backwash for 1 hour after application.

Apply **Habitat® herbicide** at 2 to 6 pints per acre depending on species present and weed density. **DO NOT** exceed the maximum label rate of 6 pints per acre (1.5 lbs ae/A) per year. Use the higher labeled rates for heavy weed pressure. Consult the **Aquatic Weeds Controlled** section of this label for specific rates.

**Habitat** may be applied as a draw-down treatment in areas described above. Apply **Habitat** to weeds after water has been drained and allow **14** days before reintroduction of water.

## WEEDS CONTROLLED

**Aquatic Weeds Controlled**

**Habitat will control the following target species as specified in the Use Rates and Application Directions column of the table. Rates are expressed in terms of product volume for broadcast applications and as a % solution for directed applications including spot treatments. For % solution applications, DO NOT apply more than the equivalent of 6 pints of Habitat per acre.**

| Common Name | Scientific Name | Use Rates and Application Directions |
|---|---|---|
| Floating | | |
| *Floating heart | *Nymphodes* spp. | 2 to 4 pints/A (0.5 to 1.0% solution) applied in 100 GPA water mix. Ensure 100% coverage of actively growing emergent foliage. |
| *Frogbit | *Limnobium spongia* | 1 to 2 pints/A (0.5% solution) applied in 100 GPA water mix. Ensure 100% coverage of actively growing emergent foliage. |
| *Spatterdock | *Nuphar luteum* | Apply a tank mix of 2 to 4 pints/A **Habitat** + 4 to 6 pints/A glyphosate (0.5% **Habitat** + 1.5% glyphosate) in 100 GPA water for best control. Ensure 100% coverage of actively growing emergent foliage. |
| *Water hyacinth | *Eichhornia crassipes* | 1 to 2 pints/A (0.5% solution) applied in 100 GPA water to actively growing foliage. |
| *Water lettuce | *Pistia stratiotes* | 1 to 2 pints/A (0.5% solution) applied in 100 GPA water mix. Ensure 100% coverage of actively growing emergent foliage. |
| Emerged | | |
| *Alligatorweed | *Alternanthera philoxeroides* | 1 to 4 pints/A (0.5% solution) applied in 100 GPA water mix. Ensure 100% coverage of actively growing emergent foliage. |
| *Arrowhead, duck-potato | *Sagittaria* spp. | 1 to 2 pints/A (0.5% solution) applied in 100 GPA water mix. Ensure 100% coverage of actively growing emergent foliage. |
| *Bacopa, lemon | *Bacopa* spp. | 1 to 2 pints/A (0.5% solution) applied in 100 GPA water mix. Ensure 100% coverage of actively growing emergent foliage. |
| *Parrot feather | *Myriophyllum aquaticum* | Must be foliage above water for sufficient **Habitat** uptake. Apply 2 to 4 pints/A to actively growing emergent foliage. |
| *Pennywort | *Hydrocotyle* spp. | 1 to 2 pints/A (0.5% solution) applied in 100 GPA water mix. Ensure 100% coverage of actively growing emergent foliage. |
| *Pickerelweed | *Pontederia cordata* | 2 to 3 pints/A (1% solution) applied in 100 GPA water mix. Ensure 100% coverage of actively growing emergent foliage. |
| *Taro, wild Dasheen Elephant's ear Coco yam | *Colocasia esculentum* | 4 to 6 pints/A (1.5% solution) applied in 100 GPA with a high quality "sticker" adjuvant. Ensure good coverage of actively growing emergent foliage. |
| *Water chestnut | *Trappa natans* | 4 to 6 pints/A (1.5% solution) applied in 100 GPA with a high quality "sticker" adjuvant. Ensure good coverage of actively growing emergent foliage. |
| *Water lily | *Nymphaea odorata* | 2 to 3 pints/A (1% solution) applied in 100 GPA water mix. Ensure 100% coverage of actively growing emergent foliage. |
| *Water primrose | *Ludwigia uruguayensis* | 4 to 6 pints/A (1.5% solution). Ensure 100% coverage of actively growing emergent foliage. |

***Use not permitted in California unless otherwise directed by supplemental labeling.**

*(continued)*

**Aquatic Weeds Controlled** *(continued)*

| Common Name | Scientific Name | Use Rates and Application Directions |
|---|---|---|
| **Terrestrial/Marginal** | | |
| *Soda apple<br>Aquatic nightshade | *Solanum tampicense* | 2 pints/A applied to foliage |
| *Bamboo, Japanese | *Phyllostachys* spp. | 3 to 4 pints/A applied to the foliage when plant is actively growing; before setting seed head. More foliage will result in greater herbicide uptake, resulting in greater root kill. |
| Beach, vitex | *Vitex rotundifolia* | 5% solution + 1% MSO foliar spray. 17% solution stem injection (hack and squirt) |
| Brazilian pepper<br>Christmasberry | *Schinus terebinthifolius* | 2 to 4 pints/A applied to foliage |
| Cattail | *Typha* spp. | 2 to 4 pints/A (1% solution) applied to actively growing green foliage after full leaf elongation. Lower rates will control cattail in the North; higher rates are needed in the South. |
| Chinese tallow tree | *Sapium sebiferum* | 16 to 24 fl ozs/A applied to foliage |
| Cogon grass | *Imperata cylindrica* | Burn foliage, till area; then fall-spray 2 quarts/A **Habitat®** herbicide + MSO applied to new growth. |
| Cordgrass, prairie | *Spartina* spp. | 4 to 6 pints/A applied to actively growing foliage |
| *Cutgrass | *Zizaniopsis miliacea* | 4 to 6 pints/A applied to actively growing foliage |
| *Elephant grass<br>Napier grass | *Pennisetum purpureum* | 3 pints/A applied to actively growing foliage |
| *Flowering rush | *Butomus umbellatus* L. | 2 to 3 pints/A applied to actively growing foliage |
| Giant reed<br>Wild cane | *Arundo donax* | 4 to 6 pints/A applied in spring to actively growing foliage |
| *Golden bamboo | *Phyllostachys aurea* | 3 to 4 pints/A applied to foliage when plant is actively growing; before setting seed head. More foliage will result in greater herbicide uptake, resulting in greater root kill. |
| Junglerice | *Echinochloa colonum* | 3 to 4 pints/A applied to actively growing foliage |
| Knapweed | *Centaurea spp.* | Russian knapweed: 2 to 3 pints + 1 quart/A MSO fall-applied after senescence begins |
| Knotweed, Japanese | *Polygonum cuspidatum*<br>*Fallopia japonica* | 3 to 4 pints/A applied post-emergence to actively growing foliage |
| Melaleuca<br>Paperbark tree | *Melaleuca quinquenervia* | For established stands, apply 6 pints/A **Habitat** + 6 pints/A glyphosate + spray adjuvant. For best results, use 4 quarts/A methylated seed oil as an adjuvant. For ground foliar application, uniformly apply to ensure 100% coverage. For broadcast foliar control, apply aerially in a minimum of 2 passes at 10 gallons/A applied cross treatment. For spot treatment, use a 25% **Habitat** + 25% solution of glyphosate + 1.25% MSO in water applied as a frill or stump treatment. |
| *Nutgrass<br>Kili'p'opu | *Cyperus rotundus* | 2 pints **Habitat** + 1 quart/A MSO applied early post-emergence |
| *Nutsedge | *Cyperus* spp. | 2 to 3 pints post-emergence to foliage or pre-emergence incorporated, nonincorporated, pre-emergence applications will not control. |
| Phragmites<br>Common reed | *Phragmites australis* | 4 to 6 pints/A applied to actively growing green foliage after full leaf elongation. Ensure 100% coverage. If stand has a substantial amount of old stem tissue, mow or burn, allow to regrow to approximately 5 feet tall before treatment. Lower rates will control phragmites in the North; higher rates are needed in the South. |
| *Poison hemlock | *Conium maculatum* | 2 pints **Habitat** + 1 quart/A MSO applied pre-emergence to early post-emergence to rosette prior to flowering |
| Purple loosestrife | *Lythrum salicaria* | 1 pint/A applied to actively growing foliage |
| Reed canarygrass | *Phalaris arundinacea* | 3 to 4 pints/A applied to actively growing foliage |
| Rose, swamp | *Rosa palustris* | 2 to 3 pints/A applied to actively growing foliage |
| Russian olive | *Elaeagnus angustifolia* | 2 to 4 pints/A or a 1% solution applied to foliage |
| Saltcedar<br>Tamarisk | *Tamarix* spp. | Aerial apply 2 quarts **Habitat** + 0.25% v/v NIS applied to actively growing foliage during flowering. For spot spraying, use 1% solution of **Habitat** + 0.25% v/v NIS and spray to wet foliage. After application, wait at least 2 years before disturbing treated saltcedar. Earlier disturbance can reduce overall control. |
| Smartweed | *Polygonum* spp. | 2 pints/A applied early post-emergence |
| Sumac | *Rhus* spp. | 2 to 3 pints/A applied to foliage |

*Use not permitted in California unless otherwise directed by supplemental labeling.

*(continued)*

**Aquatic Weeds Controlled** *(continued)*

| Common Name | Scientific Name | Use Rates and Application Directions |
|---|---|---|
| **Terrestrial/Marginal** *(continued)* | | |
| Swamp morningglory<br>Water spinach<br>Kangkong | *Ipomoea aquatica* | 1 to 2 pints/A **Habitat® herbicide** + 1 quart/A MSO applied early post-emergence |
| Torpedo grass | *Panicum repens* | 4 pints/A (1 to 1.5% solution); ensure good coverage to actively growing foliage. |
| *White top<br>Hoary cress | *Cardaria draba* | 1 to 2 pints/A applied in spring to foliage during flowering |
| Willow | *Salix* spp. | 2 to 3 pints/A Habitat applied to actively growing foliage. Ensure good coverage. |

***Use not permitted in California unless otherwise directed by supplemental labelling.**

## TERMS AND CONDITIONS OF USE

If terms of the following *Warranty Disclaimer, Inherent Risks of Use* and *Limitation of Remedies* are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, to the extent consistent with applicable law, use by the buyer or any other user constitutes acceptance of the terms under *Warranty Disclaimer, Inherent Risks of Use*, and *Limitation of Remedies*.

## WARRANTY DISCLAIMER

SePRO Corporation warrants that the product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, SEPRO CORPORATION MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

## INHERENT RISKS OF USE

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label such as unfavorable temperatures, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of SePRO Corporation or the seller. To the extent consistent with applicable law, all such risks shall be assumed by buyer.

## LIMITATION OF REMEDIES

To the extent consistent with applicable law, the exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories) shall be limited to, at SePRO Corporation's election, one of the following:

(1) Refund of purchase price paid by buyer or user for product bought, or
(2) Replacement of amount of product used.

To the extent consistent with applicable law, SePRO Corporation shall not be liable for losses or damages resulting from handling or use of this product unless SePRO Corporation is promptly notified of such losses or damages in writing. In no case shall SePRO Corporation be liable for consequential or incidental damages or losses.

The terms of the *Warranty Disclaimer, Inherent Risks of Use* and this *Limitation of Remedies* cannot be varied by any written or verbal statements or agreements. No employee or sales agent of SePRO Corporation or the seller is authorized to vary or exceed the terms of the *Warranty Disclaimer* or this *Limitation of Remedies* in any manner.

***Habitat*** is a registered trademark of BASF Corporation.
***Microfoil*** is a trademark of Rhone Poulenc Ag Company.
***Thru-Valve*** is a trademark of Waldrum Specialties.

**NVA 2011-04-246-0167**
FPL20120423

SePRO Corporation
11550 N. Meridian St., Ste. 600
Carmel, IN 46032

NOTES

NOTES

# Habitat®

Herbicide

HBAS6416

SePRO

**Active Ingredient**

| | |
|---|---|
| isopropylamine salt of imazapyr: (2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-3-pyridinecarboxylic acid)†: | 27.77% |
| **Other Ingredients** | 72.23% |
| **TOTAL** | 100.00% |

†Equivalent to 22.65% 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1*H*-imidazol-2-yl]-3-pyridinecarboxylic acid or 2 pounds acid per gallon.

## KEEP OUT OF REACH OF CHILDREN

# CAUTION/PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

| FIRST AID | |
|---|---|
| **If swallowed** | • Call a poison control center or doctor immediately for treatment advice.<br>• Have person sip a glass of water if able to swallow.<br>• **DO NOT** induce vomiting unless told to do so by a poison control center or doctor.<br>• **DO NOT** give anything by mouth to an unconscious person. |
| **HOTLINE NUMBER** | |
| Have the product container or label with you when calling a poison control center or doctor or going for treatment. You may also contact INFOTRAC for emergency medical treatment information: 1-800-535-5053. | |

## PRECAUTIONARY STATEMENTS

**Hazards to Humans and Domestic Animals**

**CAUTION.** Harmful if swallowed.

### PHYSICAL AND CHEMICAL HAZARDS

Spray solutions of **Habitat® herbicide** should be mixed, stored and applied only in stainless steel, fiberglass, plastic and plastic-lined steel containers.

### ENVIRONMENTAL HAZARDS

This product is toxic to plants. Drift and runoff may be hazardous to plants in water adjacent to treated areas. **DO NOT** apply to water except as specified in this label. Treatment of aquatic weeds may result in oxygen depletion or loss due to decomposition of dead plants. This oxygen loss may cause the suffocation of some aquatic organisms. **DO NOT** treat more than 1/2 of the surface area of the water in a single operation and wait at least 10 to 14 days between treatments. Begin treatment along the shore and proceed outward in bands to allow aquatic organisms to move into untreated areas. **DO NOT** contaminate water when disposing of equipment washwaters or rinsate.

See Directions for Use for additional precautions and requirements.

This pesticide is toxic to vascular plants and should be used strictly in accordance with the drift precautions on the label.

## STORAGE AND DISPOSAL

**DO NOT** contaminate water, food or feed by storage or disposal.

**Pesticide Storage**

**DO NOT** store below 10° F.

**Pesticide Disposal**

Wastes resulting from the use of this product must be disposed of on-site or at an approved waste disposal facility.

**Container Handling**

**Nonrefillable Container. DO NOT reuse or refill this container.** Triple rinse or pressure rinse container (or equivalent) promptly after emptying; then offer for recycling, if available, or reconditioning, if appropriate, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures approved by state and local authorities.

**Refillable Container.** Refill this container with pesticide only. **DO NOT** reuse this container for any other purpose. Triple rinsing the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. **See attached booklet for complete container disposal directions including triple rinsing and pressure rinsing instructions.**

**Refer to inside of label booklet for additional precautionary information and directions for use.**

**Notice:** Read the entire label before using. Use only according to label directions. **Before buying or using this product, read *Terms and Conditions of Use, Warranty Disclaimer, Inherent Risks of Use* and *Limitation of Remedies* inside label booklet.**

EPA Reg. No. 241-426-67690

EPA Est. No. is indicated by the fifth letter of the lot code printed on this container:

EPA Est. No. 73427-IN-001 (J)
EPA Est. No. 067690-NC-001 (C)
EPA Est. No. 241-PR-002 (M)
EPA Est. No. 65954-VA-001 (A)

FPL20120613
36416001
NVA 2011-04-246-0167

**Manufactured for:**
**SePRO Corporation** 11550 N. Meridian St., Ste. 600, Carmel, IN 46032 U.S.A.
Product of U.S.A.

Herbicide

**Net Contents 2.5 gallons**

Nonrefillable container

Conforms to HazCom 2012/United States

# SAFETY DATA SHEET

# Habitat Herbicide

## Section 1. Identification

**GHS product identifier** : Habitat Herbicide

**Recommended use of the chemical and restriction on use**

Recommended use* : Herbicide

**EPA Registration No.** : 241-426-67690

**Supplier's details** : SePRO Corporation
11550 North Meridian Street
Suite 600
Carmel, IN 46032 U.S.A.
Tel: 317-580-8282
Toll free: 1-800-419-7779
Fax: 317-580-8290
Monday - Friday, 8am to 5pm E.S.T.
www.sepro.com

**Emergency telephone number (with hours of operation)** : **INFOTRAC - 24-hour service 1-800-535-5053**

**Other means of identification**

Substance number : 63383
Molecular formula : C(13) H(15) N(3) O(3). C(3) H(9) N
Chemical family : imidazole derivative
Synonyms : Isopropylamine salt of imazapyr

**The following recommendations for exposure controls and personal protection are intended for the manufacture, formulation and packaging of this product. For applications and/or use, consult the product label. The label directions supersede the text of this Safety Data Sheet for application and/or use.**

## Section 2. Hazards identification

**According to Regulation 2012 OSHA Hazard Communication Standard; 29 CFR Part 1910.1200**

**Label elements** The product does not require a hazard warning label in accordance with GHS criteria.

**Hazards not otherwise classified**

Labeling of special preparations (GHS):

The following percentage of the mixture consists of components(s) with unknown hazards regarding the acute toxicity: 0 - 1 % dermal
The following percentage of the mixture consists of components(s) with unknown hazards regarding the acute toxicity: 0 - 1 % oral
The following percentage of the mixture consists of components(s) with unknown hazards regarding the acute toxicity: 0 - 1 % Inhalation - vapor
The following percentage of the mixture consists of components(s) with unknown hazards regarding the acute toxicity: 0 - 1 % Inhalation - mist

**According to Regulation 1994 OSHA Hazard Communication Standard; 29 CFR Part 1910.1200**

**Emergency overview**

CAUTION:
KEEP OUT OF REACH OF CHILDREN.
Avoid contact with the skin, eyes and clothing.
Avoid inhalation of mists/vapors.

## Section 3. Composition/information on ingredients

**According to Regulation 2012 OSHA Hazard Communication Standard; 29 CFR Part 1910.1200**

| CAS Number | Weight % | Chemical Name |
|---|---|---|
| 81510-83-0 | 27.8% | Isopropylamine salt of imazapyr |

**According to Regulation 1994 OSHA Hazard Communication Standard; 29 CFR Part 1910.1200**

| CAS Number | Weight % | Chemical Name |
|---|---|---|
| 81510-83-0 | ≥ 27.77 - ≤ 27.8% | Isopropylamine salt of imazapyr |
| | 72.2% | Proprietary ingredients |

## Section 4. First aid measures

**Description of first aid measures**

**General advice:** First aid personnel should pay attention to their own safety. If the patient is likely to become unconscious, place and transport in stable sideways position (recovery position). Immediately remove contaminated clothing.

**If inhaled:** Keep patient calm, remove to fresh air, seek medical attention. Immediately administer a corticosteroid from a controlled/metered dose inhaler.

**If on skin:** Immediately wash thoroughly with plenty of water, apply sterile dressings, consult a skin specialist.

**If in eyes:** Immediately wash affected eyes for at least 15 minutes under running water with eyelids held open, consult an eye specialist.

**If swallowed:** Do not induce vomiting. Immediately rinse mouth and then drink 200-300 ml of water, seek medical attention.

**Most important symptoms and effects, both acute and delayed** Symptoms: No significant reaction of the human body to the product known.

**Indication of any immediate medical attention and special treatment needed**

Note to physician Treatment: Treat according to symptoms (decontamination, vital functions), no know specific antidote.

## Section 5. Fire-fighting measures

**Extinguishing media**

Suitable extinguishing media: Foam, dry powder, carbon dioxide, water spray

**Special hazards arising from the substance or mixture**

Hazards during fire-fighting: Carbon monoxide, carbon dioxide, nitrogen oxide, nitrogen dioxide, hydrocarbons. If product is heated above decomposition temperature, toxic vapors will be released. The substances/groups of substances mentioned can be released if the product is involved in a fire.

**Advice for fire-fighters** Protective equipment for fire-fighting: Firefighters should be equipped with self-contained breathing apparatus and turn-out gear.

**Further information:** Evacuate area of all unnecessary personnel. Contain contaminated water/firefighting water. Do not allow to enter drains or waterways.

## Section 6. Accidental release measures

**Personal precautions, protective equipment and emergency procedures** Take appropriate protective measures. Clear area. Shut off source of leak only under safe conditions. Extinguish sources of ignition nearby and downwind. Ensure adequate ventilation. Wear suitable personal protective clothing and equipment.

**Environmental precautions** Do not discharge into the subsoil/soil. Do not discharge into drains/surface waters/groundwater. Contain contaminated water/firefighting water.

**Methods and material for containment and cleaning up** Dike spillage. Pick up with suitable absorbent material. Place into suitable containers for reuse or disposal in a licensed facility. Spilled substance/product should be recovered and applied according to label rates whenever possible. If application of spilled substance/product is not possible, then spills should be contained, solidified, and placed in suitable containers for disposal. After decontamination, spill area can be washed with water. Collect wash water for approved disposal.

## Section 7. Handling and storage

**Precautions for safe handling** RECOMMENDATIONS ARE FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS. PESTICIDE APPLICATORS & WORKERS must refer to the Product Label and Directions for Use attached to the product for Agricultural Use Requirements in accordance with the EPA Worker Protection Standard 40 CFR part 170.

Ensure adequate ventilation. Provide good ventilation of working area (local exhaust ventilation if necessary). Keep away from sources of ignition - No smoking. Keep container tightly sealed. Protect contents from the effects of light. Protect against heat. Protect from air. Handle and open container with care. Do not open until ready to use. Once container is opened, content should be used as soon as possible. Avoid aerosol formation. Avoid dust formation. Provide means for controlling leaks and spills. Do not return residues to the storage containers. Follow label warnings even after container is emptied. The substance/ product may be handled only by appropriately trained personnel. Avoid all direct contact with the substance/product. Avoid contact with the skin, eyes and clothing. Avoid inhalation of dusts/mists/vapours. Wear suitable personal protective clothing and equipment.

Protection against fire and explosion:

The relevant fire protection measures should be noted. Fire extinguishers should be kept handy. Avoid all sources of ignition: heat, sparks, open flame. Sources of ignition should be kept well clear. Avoid extreme heat. Keep away from oxidizable substances. Electrical equipment should conform to national electric code. Ground all transfer equipment properly to prevent electrostatic discharge. Electrostatic discharge may cause ignition.

**Conditions for safe storage, including any incompatibilities**

Segregate from incompatible substances. Segregate from foods and animal feeds. Segregate from textiles and similar materials.

Further information on storage conditions: Keep only in the original container in a cool, dry, well-ventilated place away from ignition sources, heat or flame. Protect containers from physical damage. Protect against contamination. The authority permits and storage regulations must be observed.

Protect from temperatures below: 0 °C

Changes in the properties of the product may occur if substance/product is stored below indicated temperature for extended periods of time.

Protect from temperatures above: 40 °C

Changes in the properties of the product may occur if substance/product is stored above indicated temperature for extended periods of time.

## Section 8. Exposure controls/personal protection

**Users of a pesticidal product should refer to the product label for personal protective equipment requirements.**

**Advice on system design:** Whenever possible, engineering controls should be used to minimize the need for personal protective equipment.

**Personal protective equipment**

**RECOMMENDATIONS FOR MANUFACTURING, COMMERCIAL BLENDING, AND PACKAGING WORKERS:**

**Respiratory protection:** Wear respiratory protection if ventilation is inadequate. Wear a NIOSH-certified (or equivalent) TC23C Chemical/Mechanical type filter system to remove a combination of particles, gas and vapours. For situations where the airborne concentrations may exceed the level for which an air purifying respirator is effective, or where the levels are unknown or Immediately Dangerous to Life or Health (IDLH), use NIOSH-certified full facepiece pressure demand self-contained

breathing apparatus (SCBA) or a full facepiece pressure demand supplied-air respirator (SAR) with escape provisions.

**Hand protection:** Chemical resistant protective gloves, Protective glove selection must be based on the user's assessment of the workplace hazards.

**Eye protection:** Safety glasses with side-shields. Tightly fitting safety goggles (chemical goggles). Wear face shield if splashing hazard exists.

**Body protection:** Body protection must be chosen depending on activity and possible exposure, e.g. head protection, apron, protective boots, chemical-protection suit.

**General safety and hygiene measures:** Wear long sleeved work shirt and long work pants in addition to other stated personal protective equipment. Work place should be equipped with a shower and an eye wash. Handle in accordance with good industrial hygiene and safety practice. Personal protective equipment should be decontaminated prior to reuse. Gloves must be inspected regularly and prior to each use. Replace if necessary (e.g. pinhole leaks). Take off immediately all contaminated clothing. Store work clothing separately. Hands and/or face should be washed before breaks and at the end of the shift. No eating, drinking, smoking or tobacco use at the place of work. Keep away from food, drink and animal feeding stuffs.

## Section 9. Physical and chemical properties

| | |
|---|---|
| Form: | liquid |
| Odor: | ammonia-like, faint odor |
| Odor threshold: | not applicable, odor not perceivable |
| Color: | blue, clear |
| pH value: | 6.6 – 7.2 |
| Freezing point: | approx. 0 °C (1,013.3 hPa) Information applies to the solvent. |
| Boiling point: | approx. 100 °C (1,013.3 hPa) Information applies to the solvent. |
| Flash point: | A flash point determination is unnecessary due to the high water content. |
| Flammability: | Not applicable |
| Lower explosion limit: | As a result of our experience with this product and our knowledge of its composition we do not expect any hazard as long as the product is used appropriately and in accordance with the intended use. |
| Upper explosion limit: | As a result of our experience with this product and our knowledge of its composition we do not expect any hazard as long as the product is used appropriately and in accordance with the intended use. |
| Autoignition: | Based on the water contents the product does not ignite. |
| Vapor pressure: | approx. 23.3 hPa (20 °C) Information applies to the solvent.<br>< 100 hPa (50 °C) Information apples to the solvent. |
| Density: | 1.04 – 1.09 g/ml |
| Vapor density: | not applicable |
| Partitioning coefficient n-octanol/water (log Pow): | not applicable |
| Thermal decomposition: | carbon monoxide, carbon dioxide, nitrogen oxide. Stable at ambient temperature. If product is heated above decomposition temperature toxic vapors may be released. If product is heated above decomposition temperature hazardous fumes may be released. |
| Viscosity, dynamic: | approx. 26.3 mPa.s (20 °C) |
| Solubility in water: | miscible |
| Molar mass: | 320.4 g/mol |
| Evaporation rate: | not applicable |
| Other information: | If necessary, information on other physical and chemical parameters is indicated in this section. |

## Section 10. Stability and reactivity

**Reactivity**
No hazardous reactions if stored and handled as prescribed/indicated.
Corrosion to metals: Corrosive effect on: mild steel brass
Oxidizing properties: Not an oxidizer.

**Chemical stability**
The product is stable if stored and handled as prescribed/indicated.

**Possibility of hazardous reactions**
The product is chemically stable.

**Conditions to avoid**
Avoid all sources of ignition: heat, sparks, open flame. Avoid prolonged storage. Avoid electrostatic discharge. Avoid contamination. Avoid prolonged exposure to extreme heat. Avoid extreme temperatures.

**Incompatible materials**
oxidizing agents, reducing agents

**Hazardous decomposition products**
Decomposition products:

Hazardous decomposition products:
No hazardous decomposition products if stored and handled as prescribed/indicated., Prolonged thermal loading can result in products of degradation being given off.

Thermal decomposition:

Possible thermal decomposition products:
carbon monoxide, carbon dioxide, nitrogen oxide

Stable at ambient temperature. If product is heated above decomposition temperature toxic vapours may be released. If product is heated above decomposition temperature hazardous fumes may be released.

## Section 11. Toxicological information

**Primary routes of exposure**
Routes of entry for solids and liquids are ingestion and inhalation, but may include eye or skin contact. Routes of entry for gases include inhalation and eye contact. Skin contact may be a route of entry for liquefied gases.

**Acute Toxicity/Effects**

Acute toxicity
Assessment of acute toxicity: Relatively nontoxic after single ingestion. Slightly toxic after short-term skin contact. Relatively nontoxic after short-term inhalation.

Oral
Type of value: LD50;
Species: rat (male/female);
Value: > 5,000 mg/kg

Inhalation
Type of value: LC50;
Species: rat (male/female);
Value: > 5.3 mg/l (OECD Guideline 403)
Exposure time: 4 h
An aerosol was tested.

| | |
|---|---|
| Dermal | Type of value: LD50<br>Species: rabbit (male/female)<br>Value: > 2,000 mg/kg |
| Irritation / corrosion | Assessment of irritating effects: May cause slight but temporary irritation to the eyes. May cause slight irritation to the skin. |
| Skin | Species: rabbit<br>Result: Slightly irritating.<br>Method: Primary skin irritation test |
| Eye | Species: rabbit<br>Result: non-irritant |
| Sensitization | Assessment of sensitization: Skin sensitizing effects were not observed in animal studies. |
| Skin sensitization test | Species: guinea pig<br>Result: Skin sensitizing effects were not observed in animal studies. |

**Chronic Toxicity/Effects**

| | |
|---|---|
| Repeated dose toxicity | Assessment of repeated dose toxicity: The product has not been tested. The statement has been derived from the properties of the individual components. No substance-specific organ toxicity was observed after repeated administration to animals. |
| Genetic toxicity | Assessment of mutagenicity: The product has not been tested. The statement has been derived from the properties of the individual components. Mutagenicity tests revealed no genotoxic potential. |
| Carcinogenicity | Assessment of carcinogenicity: The product has not been tested. The statement has been derived from the properties of the individual components. The results of various animal studies gave no indication of a carcinogenic effect. |
| Reproductive toxicity | Assessment of reproduction toxicity: The product has not been tested. The statement has been derived from the properties of the individual components. The results of animal studies gave no indication of a fertility impairing effect. |
| Teratogenicity | Assessment of teratogenicity: The product has not been tested. The statement has been derived from the properties of the individual components. Animal studies gave no indication of a developmental toxic effect at doses that were not toxic to the parental animals. |
| Other Information | Misuse can be harmful to health. |
| **Symptoms of Exposure** | No significant reaction of the human body to the product known. |
| Medical conditions aggravated by overexposure | Data available do not indicate that there are medical conditions that are generally recognized as being aggravated by exposure to this substance/product. See MSDS section 11 - Toxicological information. |

# Section 12. Ecological information

**Toxicity**

Aquatic toxicity

Assessment of aquatic toxicity: There is a high probability that the product is not acutely harmful to fish. There is a high probability that the product is not acutely harmful to aquatic invertebrates. Acutely harmful for aquatic plants.

Toxicity to fish
*Information on: Imazapyr* *LC50 (96 h) >100PPM, Oncorhynchus mykiss (static)*
*LC50 (96 h) >100 ppm, Lepomis macrochirus (static)*

Aquatic invertebrates
*Information on: Imazapyr* *EC50 (24 h) > 100 ppm, Daphnia magna*

Aquatic plants
*Information on: Imazapyr* *EC50 (96 h) >1 ppm, Selenastrum capricornutum (static)*
*EC50 (14 d) 24, Lemna gibba*

Chronic toxicity to fish
*Information on: Imazapyr* *No observed effect concentration (62 d) > 92.4 mg/l, Oncorhynchus mykiss*

Chronic toxicity to aquatic invertebrates
*Information on: Imazapyr* *No observed effect concentration (21 d) > 97.1 mg/l, Daphnia magna*

Assessment of terrestrial toxicity
With high probability not acutely harmful to terrestrial organisms.

Other terrestrial non-mammals
*Information on: imazapyr* *LC50, Anas platyrhynchos*
*With high probability not acutely harmful to terrestrial organisms.*
*LD50 > 100 ug/bee, Apis mellifera*
*With high probability not acutely harmful to terrestrial organisms.*

**Persistence and degradability**

Assessment biodegradation and elimination (H2O) The product has not been tested. The statement has been derived from the properties of the individual components.

Elimination information Not readily biodegradable (by OECD criteria).

**Bioaccumulative potential**

Assessment bioaccumulation potential The product has not been tested. The statement has been derived from the properties of the individual components.

*Information on: Imazapyr: Does not accumulate in organisms.*

**Mobility in soil**

Assessment transport between environmental compartments: The product has not been tested. The statement has been derived from the properties of the individual components.

*Information on: Imazapyr*: *The substance will not evaporate into the atmosphere from the water surface. Following exposure to soil, the product trickles away and can - dependant on degradation - be transported to deeper soil areas with larger water loads.*

**Additional information**

Other ecotoxicological advice: The ecological data given are those of the active ingredient. Do not release untreated into natural waters.

## Section 13. Disposal considerations

**Waste disposal of substance:** Pesticide wastes are regulated. Improper disposal of excess pesticide, spray mix or rinsate is a violation of federal law. If pesticide wastes cannot be disposed of according to label instructions, contact the State Pesticide or Environmental Control Agency or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

**Container disposal:** Rinse thoroughly at least three times (triple rinse) in accordance with EPA recommendations. Consult state or local disposal authorities for approved alternative procedures such as container recycling. Recommend crushing, puncturing or other means to prevent unauthorized use of used containers.

**RCRA:** This product is not regulated by RCRA.

## Section 14. Transport information

**Land transport**
USDOT: Not classified as a dangerous good under transport regulations
**Sea transport**
IMDG

| | |
|---|---|
| Hazard class: | 9 |
| Packing group: | III |
| ID number: | UN 3082 |
| Hazard label: | 9, EHSM |
| Marine pollutant: | YES |
| Proper shipping name: | ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (contains SOLVENT NAPHTHA) |

**Air transport**
IATA/ICAO

| | |
|---|---|
| Hazard class: | 9 |
| Packing group: | III |
| ID number: | UN 3082 |
| Hazard label: | 9, EHSM |
| Proper shipping name: | ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (contains SOLVENT NAPHTHA) |

## Section 15. Regulatory information

**Federal Regulations**

**Registration status:**

| | | |
|---|---|---|
| Chemical | TSCA, US | blocked / not listed |
| Crop Protection | TSCA, US | released / exempt |

**EPCRA 311/312 (Hazard categories):** Acute; Chronic

**CA Prop. 65:** There are no listed chemicals in this product.

**NFPA Hazard codes:** Health : 1 Fire: 1 Reactivity: 1 Special:

**Labeling requirements under FIFRA**

This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and workplace labels of non-pesticide chemicals. Following is the hazard information as required on the pesticide label.

CAUTION: KEEP OUT OF REACH OF CHILDREN.
Avoid contact with the skin, eyes and clothing. Avoid inhalation of mists/vapors.

## Section 16. Other information

**SDS Prepared by:**
SePRO Corporation
SDS Prepared on: 06/15/16

**Notice to reader**
**To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.**

Product File

LABELING ACCEPTABLE
STATE OF CALIFORNIA
DEPARTMENT OF PESTICIDE REGULATION
PESTICIDE REGISTRATION
Date 9-4-13 Reviewer SSutherland
Reg. No. 67690-47-AA

1069.61

# Galleon® SC

## Aquatic Herbicide

SePRO

A selective systemic aquatic herbicide for management of freshwater aquatic vegetation in: ponds; lakes; reservoirs; marshes; wetlands; bayous; drainage ditches; canals; and slow-moving or quiescent bodies of water; including shoreline and riparian areas within or adjacent to these and other aquatic sites.

| Active Ingredient | |
|---|---|
| penoxsulam: 2-(2,2-difluoroethoxy)-6-(trifluoromethyl)-N-(5,8-dimethoxy[1,2,4]triazolo-[1,5c]pyrimidin-2-yl)-benzenesulfonamide | 21.7% |
| Other Ingredients | 78.3% |
| TOTAL | 100.0% |

Contains 2 pounds of active ingredient (a.i.) per gallon.

## Keep Out of Reach of Children

## CAUTION / PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

In case of emergency endangering health or the environment involving this product, call INFOTRAC at 1-800-535-5053.

**Agricultural Chemical:** Do not ship or store with food, feeds, drugs or clothing.

Refer to inside of label booklet for additional precautionary information and *Directions for Use* including *First Aid* and *Storage and Disposal*.

**Notice:** Read the entire label before using. Use only according to label directions. Before buying or using this product, read *Terms and Conditions of Use, Warranty Disclaimer, Inherent Risks of Use,* and *Limitations of Remedies* at the end of the label booklet. If terms are unacceptable, return unopened at once.

EPA Reg. No. 67690-47
EPA Est. No. 067690-NC-001
FPL20120831
166905

## Shake well before using.

® Galleon is a registered trademark of SePRO Corporation.
Manufactured for: SePRO Corporation, 11550 North Meridian Street, Suite 600, Carmel, IN 46032

Aquatic Herbicide Net contents 1 quart Nonrefillable

## PRECAUTIONARY STATEMENTS

### Hazards to Humans and Domestic Animals

**Harmful if inhaled. Avoid breathing spray mist.**

| FIRST AID | |
|---|---|
| **If inhaled** | • Move person to fresh air.<br>• If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| Have the product container or label with you when calling a poison control center or doctor, or going for treatment. In case of emergency endangering health or the environment involving this product, call **INFOTRAC at 1-800-535-5053.** | |

## ENVIRONMENTAL HAZARDS

Drift and runoff may be hazardous to non-target plants in neighboring areas if not used in accordance to label directions.

Do not contaminate water when disposing of equipment washwaters or rinsate.

**For aquatic applications:** Do not apply to water except as specified on the label.

**For terrestrial applications:** Do not apply where runoff is likely to occur. Do not apply when weather conditions favor drift from treated areas.

## STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage and disposal.
**Pesticide Storage:** Store in cool dry place in original container.
**Pesticide Disposal:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.
**Container Disposal**
**Nonrefillable Container. DO NOT reuse or refill this container.** Triple rinse or pressure rinse container (or equivalent) promptly after emptying; then offer for recycling, if available, or reconditioning, if appropriate, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures approved by state and local authorities.
**Refillable Container.** Refill this container with pesticide only. DO NOT reuse this container for any other purpose. Triple rinsing the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller.
**See attached booklet for complete container disposal directions including triple rinsing and pressure rinsing instructions.**

# Galleon® SC

Aquatic Herbicide

FPL20120831
166904

**Net contents 1 quart Nonrefillable**

8 11055 01095 7

## Keep Out of Reach of Children

# CAUTION / PRECAUCIÓN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand the label, find someone to explain it to you in detail.)

## PRECAUTIONARY STATEMENTS

### Hazards to Humans and Domestic Animals

**Harmful if inhaled. Avoid breathing spray mist.**

| FIRST AID | |
|---|---|
| **If inhaled** | • Move person to fresh air.<br>• If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| Have the product container or label with you when calling a poison control center or doctor, or going for treatment. In case of emergency endangering health or the environment involving this product, call INFOTRAC at **1-800-535-5053.** | |

## PERSONAL PROTECTIVE EQUIPMENT (PPE)

**For all types of applications, mixers and loaders must wear:**
- Long-sleeved shirt and long pants;
- Shoes plus socks; and
- Chemical-resistant gloves made of any waterproof material.

**For in-water (i.e., subsurface) applications, applicators must wear:**
- Short-sleeved shirt and long pants;
- Shoes plus socks; and
- Chemical-resistant gloves made of any waterproof material.

**For non-water applications, applicators must wear:**
- Long-sleeved shirt and long pants;
- Shoes plus socks; and
- Chemical-resistant gloves made of any waterproof material.

Remove and wash contaminated clothing before reuse. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables exist, use detergent and hot water. Keep and wash PPE separately from other laundry.

## USER SAFETY RECOMMENDATIONS

**Users should:**

- Wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

## ENVIRONMENTAL HAZARDS

Drift and runoff may be hazardous to non-target plants in neighboring areas if not used in accordance to label directions.

Do not contaminate water when disposing of equipment washwaters or rinsate.

**For aquatic applications:** Do not apply to water except as specified on the label.

**For terrestrial applications:** Do not apply where runoff is likely to occur. Do not apply when weather conditions favor drift from treated areas.

## DIRECTION FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

Read all Directions for Use carefully before applying.

### Shake Well Before Using

**IMPORTANT:** Do not use water from any treated site for food crop irrigation until concentrations are determined to be less than or equal to 1 ppb (see exceptions under *Applications to Waters Used For Irrigation* section of this label). Concentrations in food-crop irrigation water must be monitored until concentrations are 1 ppb or less. Water samples must be collected and analyzed using FasTEST or other approved analytical methods. Please refer to all precautions and restrictions under the *Applications to Waters Used for Irrigation* section of this label.

**Do not make in-water applications** to areas subject to rapid dilution of treated water and/or where sufficient exposure with targeted vegetation cannot be maintained, such as small spot or shoreline treatments in larger bodies of water.

### PRODUCT INFORMATION

Galleon® SC herbicide is a selective systemic aquatic herbicide for management of freshwater aquatic vegetation in: ponds, lakes, reservoirs, marshes, wetlands, bayous, drainage ditches, canals, and slow-moving or quiescent bodies of water, including shoreline and riparian areas within or adjacent to these and other aquatic sites.

Galleon SC may be applied directly into water or sprayed onto emergent foliage of aquatic plants or exposed sediment after drawdown. Depending upon method of application and target plant, Galleon SC is absorbed by aquatic vascular plants through emergent or floating leaves, from water through submersed plant shoots, or from hydrosoil by roots. For in-water treatments, rapid water movement or any condition resulting in rapid dilution of Galleon SC in treated water will reduce its effectiveness. Herbicidal symptoms of Galleon SC include: immediate growth inhibition, a chlorotic growing point with some tissue reddening, necrosis of the terminal bud after 2 or more weeks of exposure, and slow plant death over a period of 60 to 120 days or longer depending upon conditions for in-water applications. The level of control will depend upon timing of initial application, application rate or concentration, exposure period, and weed species. Species susceptibility to Galleon SC may vary depending upon time of year, stage of growth, and water movement. For best results, apply Galleon SC immediately after weeds begin active growth. Application to mature target plants may require higher application rates and longer exposure periods to achieve control.

This label describes both required and recommended uses of a chemical analysis for the active ingredient. SePRO Corporation recommends the use of High-Performance Liquid Chromatography (HPLC))for the determination of the active ingredient concentration in water. Contact SePRO Corporation for the incorporation of this analysis, known as a FasTEST, into your treatment program. Other proven chemical analysis for the active ingredient may also be used. The FasTEST is referenced in this label as the preferred method for the rapid determination of the concentration of the active ingredient in the water.

## Use Precautions and Restrictions

- Obtain Required Permits: Consult with appropriate state or local pesticide and/or water authorities before applying this product in or around pubic waters. Permits and posting or treatment notification may be required by state or local public agencies.
- There are no restrictions on consumption of treated water for potable use or by livestock, pets or other animals.
- There are no restrictions on the use of treated water for recreational purposes, including swimming and fishing.
- Chemigation: Do not apply Galleon SC through any type of irrigation system.
- For post-emergence foliar applications or exposed sediment treatments, Galleon SC should be mixed with a surfactant. Use only surfactants that are approved or appropriate for aquatic use. Use of organosilicone surfactants with Galleon SC is not recommended.

- For treatments out of water, do not permit spray mists containing Galleon SC to drift onto desirable broadleaf plants as injury may occur. Further information on spray drift management is provided in the *Spray Drift Management* section of this label.

## Application to Waters Used For Irrigation

### Irrigation Restrictions

Irrigation using water treated with Galleon SC may result in injury to sensitive irrigated vegetation. The following restrictions are required for irrigation use of treated water:

- Do not use water treated with Galleon SC for hydroponic farming.
- Do not use water treated with Galleon SC for irrigating greenhouse or nursery plants.
- **Food crops:** Do not irrigate established food crops, other than rice, if concentrations of Galleon SC in irrigation source water exceed 1 ppb as determined using FasTEST or other analytical techniques.
- **Rice:** Do not irrigate established rice if concentrations in treated water exceed 30 ppb.
- **Turf irrigation:** There is no restriction on use of water treated with Galleon SC for turf irrigation, if concentrations are less than 30 ppb.
- **Non-food crop irrigation:** For other non-food crop irrigation (e.g., landscape ornamentals) or for other irrigation uses not described above, confer with SePRO Corporation prior to commencing irrigation if concentrations in treated water exceed 1 ppb as determined using FasTEST or other analytical techniques.
- **Application to Exposed Sediments:** Galleon SC may be applied to exposed sediments of dewatered areas of aquatic sites. Upon inundation, all label restrictions apply to the use of water from these treated areas (Note: refer to section titled *Application to Exposed Sediments of Dewatered Irrigation Canals* for specific directions following application in dewatered irrigation canals).
- Areas previously irrigated with water treated with Galleon SC may be planted in rice or turf. For other food crops and in areas irrigated with Galleon SC at concentrations exceeding 1 ppb, consult with SePRO Corporation for site-specific risk evaluations before planting.
- Do not apply Galleon SC to actively moving or running waters (i.e. lotic waters) used for food-crop irrigation, including rivers and streams, unless the irrigation intake can be shut-off until concentrations are 1 ppb or less.
- When making applications near an active irrigation water intake, the intake must be shut-off until concentrations in the water are 1 ppb or less as determined using FasTEST or other analytical techniques, except when irrigating turf or rice or other non-food crops. The intakes must be shut off for a sufficient period of time to allow penoxsulam in *treated water to decrease to 1 ppb or less at* the intake before use can resume.

## Spray Drift Management

Avoiding spray drift at the application site is the responsibility of the applicator. The interaction of many equipment- and weather-related factors determine the potential for spray drift. Make applications only when there is little or no hazard from spray drift. The applicator is responsible for considering all these factors when making decisions.

The following drift management requirements must be followed to avoid off-target drift movement from aerial applications:

1. The distance between the outer most nozzles on the boom must not exceed 70% of the wingspan of fixed-wing aircraft or 80% of the helicopter rotor width.
2. Nozzle set up must use a coarse spray quality category per ASABE S-572 Standard.

Where states have more stringent regulations, they must be followed.

The applicator should be familiar with and take into account the information covered in the *Aerial Drift Reduction Advisory*. In general, the best drift management strategy is to apply the largest droplets that provide sufficient coverage and control.

### *Aerial Drift Reduction Advisory*

**Information on Droplet Size:** For S-572 ASABE Standard compliance, see nozzle manufacturer catalogs, NAAA booklet, or USDA literature or website for nozzle and application conditions. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Larger droplets reduce drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (see *Wind, Temperature and Humidity*, and *Temperature Inversions*).

### Controlling Droplet Size:

- **Volume** - Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- **Pressure** - Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types lower pressure produces larger droplets.
- **Number of Nozzles** - Use the minimum number of nozzles that provide uniform coverage.
- **Nozzle Orientation** - Orienting nozzles so that the spray is released parallel to the air stream produces larger droplets than other orientations and is the recommended practice.
- **Nozzle Type** - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift.

**Boom Length:** Reducing the effective boom length to 70% of the wingspan of fixed-wing aircraft or 80% of the helicopter rotor width may further reduce drift without reducing swath width.

**Application Height:** Applications should not be made at a height greater than 10 feet above the top of the largest plants unless a greater height is required for aircraft safety. Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

**Swath Adjustment:** When applications are made with a crosswind, the swath will be displaced downwind. Therefore, the applicator must compensate for this displacement by adjusting the path of the aircraft or boom on-off. Swath adjustment distance should increase, with increasing drift potential (higher wind, height, smaller drops, etc.).

**Wind:** Drift potential is lowest between wind speeds of 2 to 10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 2 mph due to variable wind direction and high inversion potential. NOTE: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift. NOTE: State and local regulations with regard to minimum and maximum wind speeds during aerial application may be more restrictive. Aerial applicators should be familiar with these regulations.

**Temperature and Humidity:** When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is greatest when conditions are both hot and dry.

**Temperature Inversions:** Applications should not occur during a local, low level temperature inversion because drift potential is high. Small droplets can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of the smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

**Sensitive Areas:** Galleon SC should only be applied to the intended treatment area when the potential for drift to adjacent sensitive areas (e.g., residential areas, known habitat for threatened or endangered species, non-target vegetation) is minimal (e.g., when wind is blowing away from the sensitive areas). Refer to the section of this label on *Wind* under *Spray Drift Management* for more specific details.

## AQUATIC PLANTS CONTROLLED BY GALLEON SC

Performance and selectivity of Galleon SC is dependent upon dosage, time of year, stage of growth, method of application, and water movement. The following categories — controlled and partially controlled — are provided in Table 1 to describe expected efficacy under ideal treatment conditions using typical treatment rates. Plants listed as partially controlled are less susceptible under most use conditions but may show herbicide stress or partial control during active treatment phase. Use of lower rates will increase selectivity on some species listed below. Consult with SePRO Corporation prior to applying Galleon SC to determine best treatment protocols for given target vegetation.

**TABLE 1. AQUATIC PLANTS CONTROLLED BY GALLEON SC**

| Vascular Aquatic Plants Controlled | |
|---|---|
| **Common name** | **Scientific name** |
| ***Floating Plants*** | |
| duckweed | multiple including *Lemna* spp.[1] |
| frog's bit | *Limnobium spongia* |
| mosquito fern | *Azolla caroliniana* |
| water fern | *Salvinia minima* and *molesta* |
| water hyacinth | *Eichhornia crassipes* |
| water lettuce | *Pistia stratiotes* |
| ***Emersed Plants*** | |
| water pennywort | *Hydrocotyle umbellata* |
| floating heart | *Nymphoides* spp. |
| ***Submersed Plants*** | |
| baby's tears | *Micranthemum* spp. |
| cabomba | *Cabomba caroliniana* |
| egeria, Brazilian elodea | *Egeria densa* |
| Eurasian watermilfoil | *Myriophyllum spicatum* |
| hydrilla | *Hydrilla verticillata* |
| sago pondweed | *Stuckenia pectinatus* |
| curlyleaf pondweed | *Potamogeton crispus* |
| horned pondweed | *Zannichellia palustris* |

*(continued)*

| TABLE 1. AQUATIC PLANTS CONTROLLED BY GALLEON SC | |
|---|---|
| **Vascular Aquatic Plants Partially Controlled** | |
| **Common name** | **Scientific name** |
| ***Floating Plants*** | |
| common watermeal | *Wolffia columbiana* |
| ***Emersed Plants*** | |
| alligatorweed | *Alternanthera philoxeroides* |
| arrowhead | *Sagittaria* spp.[1] |
| parrotfeather | *Myriophyllum aquaticum* |
| pickerelweed, lanceleaf | *Pontederia* spp. |
| soft-stem bulrush | *Scirpus validus* |
| smartweed | *Polygonum* spp.[1] |
| **Submersed Plants** | |
| bacopa | *Bacopa* spp.[1] |
| Illinois pondweed | *Potamogeton illinoensis*[1] |
| southern naiad | *Najas guadalupensis*[1] |
| spikerush | *Eleocharis* spp.[1] |

[1] Susceptibility will likely vary between species within this genus

## APPLICATION INFORMATION

### MIXING INSTRUCTIONS

**In-Water Application to Submersed or Floating Aquatic Weeds**
Galleon SC can be applied undiluted or diluted with water for in-water applications. To dilute with water, it is recommended to fill the spray tank to one-half full with water. Start agitation. Add correct quantity of Galleon SC. Continue agitation while filling spray tank to required volume and during application.

**Foliar Application to Floating and Emergent Weeds**
Dilute Galleon SC with water to achieve proper coverage of treated plants. To dilute with water, it is recommended to fill spray tank to one-half full with water. Start agitation. A surfactant must also be used with all post-emergent foliar applications of Galleon SC. Use only surfactants that are approved or appropriate for aquatic use. Based upon surfactant label recommendations, add appropriate volume of surfactant when adding Galleon SC to spray tank. Read and follow all use directions and precautions on aquatic surfactant label. After adding Galleon SC and surfactant, continue agitation while filling spray tank to required volume and during application.

**Exposed Sediment Application for Pre-Emergence Control of Aquatic Weeds**
Galleon SC must be diluted with water for pre-emergence, exposed sediment applications. To dilute with water, it is recommended to fill spray tank to one-half full with water. Start agitation. Add correct quantity of Galleon SC. When using a surfactant, add appropriate volume of surfactant (based upon surfactant label recommendations) when adding Galleon SC to spray tank. Read and follow all use directions and precautions on surfactant label. After adding Galleon SC and any surfactant, continue agitation while filling spray tank to required volume and during application.

## APPLICATION METHODS

**In-Water Application to Submersed or Floating Aquatic Weeds**
Galleon SC can be applied as an in-water application to control weeds such as hydrilla, Eurasian watermilfoil, water hyacinth, and other susceptible weed species.

**Do not make in-water applications** to areas subject to rapid dilution of treated water and/or where sufficient exposure with targeted vegetation cannot be maintained, such as small spot or shoreline treatments in larger bodies of water.

Where greater plant selectivity is desired such as when controlling hydrilla and Eurasian watermilfoil or when targeting more susceptible species, choose an application rate lower in the rate range. SePRO Corporation recommends contacting a SePRO Aquatic Specialist to determine when to choose application rates lower in the range to meet specific plant management goals.

- **Single In-Water Application to Treatment Zone**: Where single applications to whole ponds, lakes, and reservoirs are desired, under typical treatment conditions Galleon SC should be applied at a minimum effective concentration of 25 to 75 ppb. Choose an application rate to meet the aquatic plant management objectives. Application rates necessary to obtain these concentrations in treated water are shown below. It may be necessary to re-treat the body of water if mature or more tolerant vegetation is present in the target area or heavy rainfall has diluted the treatment concentration. If re-treatment is necessary, refer to the *Split or Multiple In-Water Applications to Treatment Zone* section of the label. NOTE: The concentration of any single application or sum of all applications must not exceed 150 ppb per annual growth cycle.

- **Split or Multiple In-Water Applications to Treatment Zone:** Split or multiple applications of Galleon SC may be desirable to ensure efficacy, maintain exposure, and enhance selectivity. Under typical treatment conditions or when targeting the most susceptible species, Galleon SC should be applied initially at the minimum effective dose of 10 to 30 ppb to the treatment zone and, through the use of water analysis, add additional Galleon SC to maintain the concentration to achieve specific plant management objectives. Retreat the water to maintain a sufficient concentration for a minimum of 60 days or until satisfactory weed control is achieved. Higher concentrations and longer exposure times may be necessary when targeting less susceptible species, mature plants, and/or under conditions favorable for slower plant growth. For water analysis, use FasTEST or other analytical techniques to determine the actual concentration of Galleon SC in the water over time. NOTE: The concentration of any single application or sum of all applications must not exceed 150 ppb per annual growth cycle.

Apply Galleon SC to the treatment area at the appropriate rate to achieve target concentration. Define both size (in acres) and mean water depth (in feet) of the treatment zone prior to treatment. For each part per billion (ppb) of final concentration of active ingredient in the treatment zone, apply 0.174 fl oz per acre-foot of water. For example, for a 50 ppb treatment of 5 acres with a mean depth of 5 ft (25 acre-ft):

0.174 fl oz x 50 ppb x 25 acre ft = 217.5 fl oz (6.8 quarts or 1.7 gallons) Galleon SC applied.

The rate needed to treat 1 surface acre of water should be selected according to Table 2.

| TABLE 2. TARGET CONCENTRATION OF PENOXSULAM IN WATER (PPB) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Average Water Depth (ft) | 5 | 10 | 20 | 25 | 50 | 75 | 100 | 150 |
| | Fl. oz. (Quarts) of Galleon SC per Surface Acre at Specified Depth | | | | | | | |
| 1 | 0.9 (0.03) | 1.7 (0.05) | 3.5 (0.11) | 4.4 (0.14) | 8.7 (0.27) | 13.1 (0.41) | 17.4 (0.54) | 26.1 (0.82) |
| 2 | 1.7 (0.05) | 3.5 (0.11) | 7.0 (0.22) | 8.7 (0.27) | 17.4 (0.54) | 26.1 (0.82) | 34.8 (1.09) | 52.2 (1.63) |
| 3 | 2.6 (0.08) | 5.2 (0.16) | 10.4 (0.33) | 13.1 (0.41) | 26.1 (0.82) | 39.2 (1.22) | 52.2 (1.63) | 78.3 (2.45) |
| 4 | 3.5 (0.11) | 7.0 (0.22) | 13.9 (0.44) | 17.4 (0.54) | 34.8 (1.09) | 52.2 (1.63) | 69.6 (2.18) | 104.4 (3.26) |
| 5 | 4.4 (0.14) | 8.7 (0.27) | 17.4 (0.54) | 21.8 (0.68) | 43.5 (1.36) | 65.3 (2.04) | 87.0 (2.72) | 130.5 (4.08) |
| 6 | 5.2 (0.16) | 10.4 (0.33) | 20.9 (0.65) | 26.1 (0.82) | 52.2 (1.63) | 78.3 (2.45) | 104.4 (3.26) | 156.6 (4.89) |
| 7 | 6.1 (0.19) | 12.2 (0.38) | 24.4 (0.76) | 30.5 (0.95) | 60.9 (1.90) | 91.4 (2.86) | 121.8 (3.81) | 182.7 (5.71) |
| 8 | 7.0 (0.22) | 13.9 (0.44) | 27.8 (0.87) | 34.8 (1.09) | 69.6 (2.18) | 104.4 (3.26) | 139.2 (4.35) | 208.8 (6.53) |
| 9 | 7.8 (0.24) | 15.7 (0.49) | 31.3 (0.98) | 39.2 (1.22) | 78.3 (2.45) | 117.5 (3.67) | 156.4 (4.89) | 234.9 (7.34) |
| 10 | 8.7 (0.27) | 17.4 (0.54) | 34.8 (1.09) | 43.5 (1.36) | 87.0 (2.72) | 130.5 (4.08) | 174.0 (5.44) | 261.0 (8.15) |

For in-water applications, the maximum target concentration in any treated area is 150 ppb active ingredient per annual growth cycle.

**Foliar Application to Floating and Emergent Weeds**
Galleon SC can be applied as a foliar application to control weeds such as water hyacinth, water lettuce, water pennywort and other susceptible floating and emergent species. Applications should be conducted in a manner to maximize spray interception by target weeds while minimizing the amount of overspray that inadvertently enters the water.

For all foliar applications, apply Galleon SC at the rate of 2 to 5.6 fl. oz. per acre. Use of a surfactant is required for all foliar applications of Galleon SC. Use only surfactants that are approved or appropriate for aquatic use. Use of organosilicone surfactants with Galleon SC is not recommended. Refer to the surfactant label for use directions. Apply Galleon SC to actively growing weeds only. Do not apply to emerged weeds that are not actively growing due to moisture stress or stress due to adverse weather conditions.

**Aerial Foliar Application to Floating and Emergent Weeds**
Apply Galleon SC in a spray volume of 10 gallons per acre (gpa) or more when making a post-emergence application by air. Apply with coarse droplet category per S-572 ASABE standard; see NAAA, USDA or nozzle manufacturer guidelines. Follow guidelines in the *Spray Drift Management* and *Aerial Drift Reduction Advisory* sections to minimize potential drift to off-target vegetation. Aircraft should be patterned per Operation Safe/PAASS program for calibration and uniformity to provide sufficient coverage and control.

**Boat or Ground Foliar Application to Floating and Emergent Weeds**
When applying Galleon SC by boat or with ground equipment to emergent or floating-leaved vegetation, use boom-type, backpack or hydraulic handgun equipment. Apply Galleon SC in a sufficient spray volume (up to 100 gpa) to provide accurate and uniform distribution of spray particles over the treated vegetation while minimizing runoff. Use higher spray volumes for medium to high density vegetation. For boom spraying, use coarse or coarser nozzle spray quality per S-572 ASABE standard; see USDA literature or nozzle manufacturer guidelines. Follow nozzle manufacturer's recommendations for nozzle pressure, spacing and boom height to provide a uniform spray pattern. Follow appropriate spray drift management information where drift potential is a concern.

**Exposed Sediment Application for Pre- and Post-emergence Control of Aquatic Weeds**
Galleon SC may be applied to exposed sediments of dewatered aquatic sites for post- and pre-emergent control of susceptible weed species. Apply Galleon SC at the rate of 5.6 to 11.2 fl. oz. per acre in a total spray volume of 20 to 100 gpa to the target area of exposed sediment using boom-type, backpack, or hydraulic handgun equipment for pre-emergence weed control. For boom spraying, use coarse or coarser nozzle spray quality per S-572 ASABE standard; see USDA literature or nozzle manufacturer guidelines. Follow nozzle manufacturer's recommendations for nozzle pressure, spacing and boom height to provide a uniform spray pattern. Follow appropriate spray drift management information where drift potential is a concern. Best treatment timing and rates will be based on various factors including current and historical rainfall, soil type, and timing of reflood, all of which should be discussed with SePRO Corporation prior to treatment. For post-emergent applications, use a surfactant according to its label instructions. When present, do not apply to target emerged weeds that are not actively growing due to moisture stress or stress due to adverse weather conditions.

Refer to *Applications to Waters Used for Irrigation* section of this label for irrigation restrictions following exposed sediment applications. Upon inundation, all label restrictions apply to the use of water from these treated areas. Consult with SePRO Corporation for site specific recommendations for sampling water upon inundation.

**Application to Exposed Sediments of Dewatered Irrigation Canals**
**Applications to dewatered irrigation canals are only for use by Irrigation Districts in the Western U.S. in canals that are seasonally filled and where the Irrigation District is aware of potential downstream use of water and can ensure water is not used for irrigation purposes during the recharge or refill process.** It is recommended that the Irrigation District consult with SePRO Corporation for site specific recommendations.

Galleon SC may be applied to exposed sediments of dewatered irrigation canals during the irrigation off-season when the canals are dewatered or drained. Applications of Galleon SC to dewatered irrigation canals is only for use by Irrigation Districts, Irrigation Water Suppliers or those applicators who are licensed or certified as aquatic pest control applicators and are authorized by the Irrigation District.

Applications to dewatered irrigation canals must be conducted a minimum of 14 days prior to re-flooding. The initial flush of water during recharge or refill must not be used for irrigation purposes unless the penoxsulam concentration has been determined by an acceptable method to be 1 ppb or less. After canals have been refilled with continuous flow for a minimum of 24 hours, canal water may then be used for irrigation purposes.

## TANK MIXES WITH OTHER AQUATIC HERBICIDES

Galleon SC may be mixed with other herbicides or algaecides registered for aquatic use provided that this label does not prohibit such mixing. When tank mixing, read and follow the labeled precautionary statements, directions for use, weeds controlled, and other restrictions for each tank mix product. **Use in accordance with the most restrictive label limitations and precautions of the products used in the tank-mix.** No labeled rate or dose should be exceeded. To ensure compatibility, a jar test is recommended before field application of any tank mix combination. Consult with SePRO Corporation for latest tank mix recommendations.

NOTE: Tank mixing or use of Galleon SC with any other product which is not specifically and expressly authorized by the label shall be at the exclusive risk of the user, applicator and/or application adviser, to the extent allowed by applicable law.

**Galleon SC plus endothall (e.g. Aquathol K®)**
Galleon SC plus endothall is a combination of two modes of herbicidal action for improved control of hydrilla and other submersed weeds. Use only the dipotassium salt of endothall as the active ingredient in a tank mix with Galleon SC.

For best results, apply Galleon SC at concentrations from 5 to 40 ppb (0.9 to 7.0 fl. oz./acre foot) in combination with the dipotassium salt of endothall at concentrations from 0.25 to 2.0 ppm a.i. (e.g.

0.15 to 1.3 gallons Aquathol K/acre foot). Higher concentrations of Galleon SC + endothall may be used, but do not exceed the maximum allowed rate for either product. Galleon SC + endothall may be mixed in a tank or directly metered individually via the application pump system. DO NOT MIX CONCENTRATES IN A TANK WITHOUT FIRST ADDING WATER. Add Galleon SC to the tank diluted with water prior to adding endothall.

Additional or multiple applications of Galleon SC may be conducted following the initial Galleon SC + endothall treatment to meet certain plant management objectives (refer to section on *Split or Multiple In-Water Applications to Treatment Zone*). Please consult with SePRO Corporation for site and plant specific recommendations.

NOTE: Application sequencing is important to maximize the positive interaction between these two modes of action. It is best to apply Galleon SC + endothall simultaneously in a tank mix or individually at the same time, or to apply Galleon SC following endothall treatment.

NOTE: For Drinking (Potable) Water

- The drinking (potable) water restrictions for applications of Galleon SC plus endothall are to ensure that consumption of water by the public is allowed only when the concentration of endothall in the water is less than the MCL (Maximum Contamination Level) of 0.1 ppm. Applicators should consider the unique characteristics of the treated waters to assure that endothall concentrations in potable drinking water do not exceed 0.1 ppm at the time of consumption.
- For applications of Galleon SC plus endothall, the drinking water setback distance from functioning potable water intakes is ≥ 600 feet. Note: Existing potable water intakes that are no longer in use, such as those replaced by a connection to a municipal water system or a potable water well, are not considered to be functioning potable water intakes.

Galleon SC + endothall is relatively fast acting, and susceptible plants generally collapse and start to decompose in 2 to 4 weeks following treatment. Fish breathe dissolved oxygen in the water and decaying weeds also use oxygen. Therefore, when treating continuous, dense weed masses, it may be appropriate to treat only part of the infestation at a time. Waters having limited and less dense weed infestations and applications during periods of cooler water temperatures may not require partial treatments.

## RESISTANCE MANAGEMENT

The mode of action of Galleon SC is the inhibition of the acetolactate synthase (ALS) enzyme. Weed populations may develop biotypes that are resistant to different herbicides with the same mode of action. If herbicides with the same mode of action are used repeatedly at the same site, resistant biotypes may eventually dominate the weed population and may not be controlled by these products.

## STEWARDSHIP GUIDELINES FOR USE

Apply this product in compliance with Best Management Practices (BMP) that include: site assessment, prescription, and implementation. BMP have been developed to maintain and/or monitor target concentrations over large areas, ensure accurate applications and maximize treatment performance, minimize resistance development, and to monitor concentrations in water used for potential irrigation. SePRO Corporation technical specialists will work with applicators and resource managers to ensure compatibility with potential uses of the water and management objectives.

The most effective use of Galleon SC, especially in larger treatment areas, requires knowledge of the concentration of Galleon SC in treated water. This knowledge provides critical information for maximum performance, resistance management, irrigation restrictions, and overall product stewardship. This label describes both required and recommended uses of a chemical analysis for the active ingredient. SePRO Corporation recommends the use of High-Performance Liquid Chromatography (HPLC) for the determination of the active ingredient concentration in water. Contact SePRO Corporation for the incorporation of this analysis in your treatment program. Other proven chemical analysis for the active ingredient may also be used.

NOTE: For all forms of Galleon SC use, water sampling must be conducted as necessary to meet other label requirements for treated water use. Concentrations in food-crop irrigation water must be monitored until concentrations are 1 ppb or less before treated water may be used for irrigation.

In order to accurately determine the concentrations of Galleon SC in treated water, recommendations for the minimum number of water sampling locations per treated area are provided below. The number of sampling locations will vary by site based on site morphology, bathymetry, inflows, presence of irrigation intakes, and other plant management objectives. Site locations for such sampling should be geographically referenced (i.e., GPS coordinates) and evenly distributed throughout the treated water body. Consult with SePRO Corporation for site specific recommendations.

Depending upon the application method and site specific information, water sample(s) should be collected every 10 to 30 days. Sampling should be conducted more frequently as necessary to comply with any water use restrictions and to ensure efficacy.

| TABLE 3: WATER SAMPLING GUIDELINES | |
|---|---|
| Size of Treated Area (acres) | Number of Water Sample Locations |
| <100 | 1 |
| 101 – 1,000 | 1 – 3 |
| 1,001 – 2,500 | 3 – 5 |
| 2,501 – 5,000 | 5 – 8 |
| 5,001 – 10,000 | 8 – 15 |
| >10,001 | 1 additional site for every 1,000 acres |

Best practices for use of any aquatic herbicide demand the highest level of environmental assessment and stewardship. Treatment prescriptions should be tailored to meet site-specific resource management plans. Implementation of treatment programs should be conducted with equipment and protocols designed to increase treatment success through precision and quick reaction to changing environmental conditions.

## STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage and disposal.
**Pesticide Storage:** Store in cool dry place in original container.
**Pesticide Disposal:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.
**Container Disposal**
**Nonrefillable Container. DO NOT reuse or refill this container.** Triple rinse or pressure rinse container (or equivalent) promptly after emptying; then offer for recycling, if available, or reconditioning, if appropriate, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures approved by state and local authorities.
**Triple rinse containers small enough to shake (capacity ≤ 5 gallons) as follows:** Empty the remaining contents into application equipment or a mix tank and drain for 10 seconds after the flow begins to drip. Fill the container ¼ full with water and recap. Shake for 10 seconds. Pour rinsate into application equipment or a mix tank, or store rinsate for later use or disposal. Drain for 10 seconds after the flow begins to drip. Repeat this procedure two more times.

*(continued)*

## STORAGE AND DISPOSAL *(continued)*

**Triple rinse containers too large to shake (capacity >5 gallons) as follows:** Empty the remaining contents into application equipment or a mix tank. Fill the container ¼ full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Turn the container over onto its other end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank, or store rinsate for later use or disposal. Repeat this procedure two more times.

**Pressure rinse as follows:** Empty the remaining contents into application equipment or mix tank and continue to drain for 10 seconds after the flow begins to drip. Hold container upside down over application equipment or mix tank, or collect rinsate for later use or disposal. Insert pressure rinsing nozzle in the side of the container and rinse at about 40 PSI for at least 30 seconds. Drain for 10 seconds after the flow begins to drip.

**Refillable Container.** Refill this container with pesticide only. **DO NOT** reuse this container for any other purpose. Triple rinsing the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller.

**Triple rinse as follows:** To clean the container before final disposal, empty the remaining contents from this container into application equipment or mix tank. Fill the container about 10% full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times.

When this container is empty, replace the cap and seal all openings that have been opened during use; return the container to the point of purchase or to a designated location. This container must only be refilled with a pesticide product. Prior to refilling, inspect carefully for damage such as cracks, punctures, abrasions, worn-out threads and closure devices. Check for leaks after refilling and before transport. **DO NOT** transport if this container is damaged or leaking. If the container is damaged, or leaking, or obsolete and not returned to the point of purchase or to a designated location, triple rinse emptied container and offer for recycling, if available, or dispose of container in compliance with state and local regulations.

## TERMS AND CONDITIONS OF USE

If terms of the following *Warranty Disclaimer, Inherent Risks of Use,* and *Limitations of Remedies* are not acceptable, return unopened package at once to the seller for a full refund of purchase price paid. Otherwise, to the extent consistent with applicable law, use by the buyer or any other user constitutes acceptance of the terms under *Warranty Disclaimer, Inherent Risks of Use,* and *Limitations of Remedies.*

## WARRANTY DISCLAIMER

SePRO Corporation warrants that this product conforms to the chemical description on the label and is reasonably fit for the purposes stated on the label when used in strict accordance with the directions, subject to the inherent risks set forth below. TO THE EXTENT CONSISTENT WITH APPLICABLE LAW, SEPRO CORPORATION MAKES NO OTHER EXPRESS OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR ANY OTHER EXPRESS OR IMPLIED WARRANTY.

## INHERENT RISKS OF USE

It is impossible to eliminate all risks associated with use of this product. Plant injury, lack of performance, or other unintended consequences may result because of such factors as use of the product contrary to label instructions (including conditions noted on the label, such as unfavorable temperature, soil conditions, etc.), abnormal conditions (such as excessive rainfall, drought, tornadoes, hurricanes), presence of other materials, the manner of application, or other factors, all of which are beyond the control of SePRO Corporation or the seller. To the extent consistent with applicable law, all such risks shall be assumed by Buyer.

## LIMITATIONS OF REMEDIES

To the extent consistent with applicable law, the exclusive remedy for losses or damages resulting from this product (including claims based on contract, negligence, strict liability, or other legal theories), shall be limited to, at Sellers election, one of the following:

1. Refund of purchase price paid by buyer or user for product bought, or
2. Replacement of amount of product used.

To the extent consistent with applicable law, SePRO Corporation shall not be liable for losses or damages resulting from handling or use of this product unless SePRO Corporation is promptly notified of such loss or damage in writing. In no case shall SePRO Corporation be liable for consequential or incidental damages or losses.

The terms of the *Warranty Disclaimer, Inherent Risks of Use*, and *Limitations of Remedies* cannot be varied by any written or verbal statements or agreements. No employee or sales agent of the Seller or the seller is authorized to vary or exceed the terms of the *Warranty Disclaimer* or this *Limitations of Remedies* in any manner.

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® Aquathol K is a trademark of United Phosphorus, Inc.

## PRECAUTIONARY STATEMENTS

### Hazards to Humans and Domestic Animals

**Harmful if inhaled. Avoid breathing spray mist.**

| FIRST AID | |
|---|---|
| If inhaled | • Move person to fresh air.<br>• If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.<br>• Call a poison control center or doctor for further treatment advice. |
| Have the product container or label with you when calling a poison control center or doctor, or going for treatment. In case of emergency endangering health or the environment involving this product, call **INFOTRAC** at **1-800-535-5053.** | |

## ENVIRONMENTAL HAZARDS

Drift and runoff may be hazardous to non-target plants in neighboring areas if not used in accordance to label directions.

Do not contaminate water when disposing of equipment washwaters or rinsate.

**For aquatic applications:** Do not apply to water except as specified on the label.

**For terrestrial applications:** Do not apply where runoff is likely to occur. Do not apply when weather conditions favor drift from treated areas.

## STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage and disposal.
**Pesticide Storage:** Store in cool dry place in original container.
**Pesticide Disposal:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.
**Container Disposal**
**Nonrefillable Container. DO NOT reuse or refill this container.** Triple rinse or pressure rinse container (or equivalent) promptly after emptying; then offer for recycling, if available, or reconditioning, if appropriate, or puncture and dispose of in a sanitary landfill, or by incineration, or by other procedures approved by state and local authorities.
**Refillable Container.** Refill this container with pesticide only. DO NOT reuse this container for any other purpose. Triple rinsing the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller.
**See attached booklet for complete container disposal directions including triple rinsing and pressure rinsing instructions.**

# Galleon® SC

**Aquatic Herbicide**

FPL20120831
166904

**Net contents 1 quart Nonrefillable**

Conforms to HazCom 2012/United States

# SAFETY DATA SHEET

# Galleon® SC

## Aquatic Herbicide

## Section 1. Identification

**GHS product identifier** : Galleon® SC Aquatic Herbicide

**Other means of identification** : Not available.

**EPA Registration No.** : 67690-47

**Supplier's details** : SePRO Corporation
11550 North Meridian Street
Suite 600
Carmel, IN 46032 U.S.A.
Tel: 317-580-8282
Toll free: 1-800-419-7779
Fax: 317-580-8290
Monday - Friday, 8am to 5pm E.S.T.
www.sepro.com

**Emergency telephone number (with hours of operation)** : **INFOTRAC - 24-hour service 1-800-535-5053**

**The following recommendations for exposure controls and personal protection are intended for the manufacture, formulation and packaging of this product. For applications and/or use, consult the product label. The label directions supersede the text of this Safety Data Sheet for application and/or use.**

## Section 2. Hazards identification

**Hazard classification** This material is not hazardous under the criteria of the Federal OSHA Hazard Communication Standard 29CFR 1910.1200.

**Other hazards** No data available

## Section 3. Composition/information on ingredients

**Chemical Nature:** Mixture
This product is a mixture.

| Component | CASRN | Concentration |
|---|---|---|
| Penoxsulam | 219714-96-2 | 21.7% |
| Propylene glycol | 57-55-6 | 4.5% |
| Balance | Not available | 73.8% |



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## Section 4. First aid measures

**Description of first aid measures**

**General advice:** If potential for exposure exists refer to Section 8 for specific personal protective equipment.

**Inhalation:** Move person to fresh air. If person is not breathing, call an emergency responder or ambulance, then give artificial respiration; if by mouth to mouth use rescuer protection (pocket mask etc). Call a poison control center or doctor for treatment advice.

**Skin contact:** Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

**Eye contact:** Hold eyes open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eyes. Call a poison control center or doctor for treatment advice.

**Ingestion:** No emergency medical treatment necessary.

**Most important symptoms and effects, both acute and delayed:** Aside from the information found under Description of first aid measures (above) and Indication of immediate medical attention and special treatment needed (below), any additional important symptoms and effects are described in Section 11: Toxicology Information.

**Indication of any immediate medical attention and special treatment needed**

**Notes to physician:** No specific antidote. Treatment of exposure should be directed at the control of symptoms and the clinical condition of the patient. Have the Safety Data Sheet, and if available, the product container or label with you when calling a poison control center or doctor, or going for treatment.

## Section 5. Fire-fighting measures

**Suitable extinguishing media:** To extinguish combustible residues of this product use water fog, carbon dioxide, dry chemical or foam.

**Unsuitable extinguishing media:** No data available

**Special hazards arising from the substance or mixture**

**Hazardous combustion products:** Under fire conditions some components of this product may decompose. The smoke may contain unidentified toxic and/or irritating compounds. Combustion products may include and are not limited to: Sulfur oxides. Nitrogen oxides. Hydrogen fluoride. Fluorinated hydrocarbons. Carbon monoxide. Carbon dioxide.

**Unusual Fire and Explosion Hazards:** This material will not burn until the water has evaporated. Residue can burn.



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**Advice for firefighters**

**Fire Fighting Procedures:** Keep people away. Isolate fire and deny unnecessary entry. Use water spray to cool fire exposed containers and fire affected zone until fire is out and danger of re-ignition has passed. To extinguish combustible residues of this product use water fog, carbon dioxide, dry chemical or foam. Contain fire water run-off if possible. Fire water run-off, if not contained, may cause environmental damage. Review the "Accidental Release Measures" and the "Ecological Information" sections of this (M)SDS.

**Special protective equipment for firefighters:** Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers, boots, and gloves). If protective equipment is not available or not used, fight fire from a protected location or safe distance.

## Section 6. Accidental release measures

**Personal precautions, protective equipment and emergency procedures:** Use appropriate safety equipment. For additional information, refer to Section 8, Exposure Controls and Personal Protection.

**Environmental precautions:** Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. See Section 12, Ecological Information. Spills or discharge to natural waterways is likely to kill aquatic organisms.

**Methods and materials for containment and cleaning up:** Contain spilled material if possible. Small spills: Absorb with materials such as: Clay. Dirt. Sand. Sweep up. Collect in suitable and properly labeled containers. Large spills: Contact SePRO Corporation for clean-up assistance. See Section 13, Disposal Considerations, for additional information.

## Section 7. Handling and storage

**Precautions for safe handling:** Keep out of reach of children. Do not swallow. Avoid contact with eyes, skin, and clothing. Avoid breathing vapor or mist. Wash thoroughly after handling. Use with adequate ventilation. See Section 8, EXPOSURE CONTROLS AND PERSONAL PROTECTION.

**Conditions for safe storage:** Store in a dry place. Store in original container. Keep container tightly closed when not in use. Do not store near food, foodstuffs, drugs or potable water supplies.

## Section 8. Exposure controls/personal protection

**Control parameters**

Exposure limits are listed below, if they exist.

| Component | Regulation | Type of listing | Value/Notation |
|---|---|---|---|
| Propylene glycol | US WEEL | TWA | 10 mg/m3 |

RECOMMENDATIONS IN THIS SECTION ARE FOR MANUFACTURING, COMMERCIAL BLENDING AND PACKAGING WORKERS. APPLICATORS AND HANDLERS SHOULD SEE THE PRODUCT LABEL FOR PROPER PERSONAL PROTECTIVE EQUIPMENT AND CLOTHING.



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**Exposure controls**

**Engineering controls:** Use local exhaust ventilation, or other engineering controls to maintain airborne levels below exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, general ventilation should be sufficient for most operations. Local exhaust ventilation may be necessary for some operations.

**Individual protection measures**

**Eye/face protection:** Use safety glasses (with side shields).

**Skin protection**

**Hand protection:** Chemical protective gloves should not be needed when handling this material. Consistent with general hygienic practice for any material, skin contact should be minimized.

**Other protection:** No precautions other than clean body-covering clothing should be needed.

**Respiratory protection:** Respiratory protection should be worn when there is a potential to exceed the exposure limit requirements or guidelines. If there are no applicable exposure limit requirements or guidelines, wear respiratory protection when adverse effects, such as respiratory irritation or discomfort have been experienced, or where indicated by your risk assessment process. For most conditions no respiratory protection should be needed; however, if discomfort is experienced, use an approved air-purifying respirator. The following should be effective types of air-purifying respirators: Organic vapor cartridge with a particulate pre-filter.

## Section 9. Physical and chemical properties

| | |
|---|---|
| **Appearance** | |
| **Physical State** | Liquid |
| **Color** | Tan |
| **Odor** | Musty |
| **Odor Threshold** | No test data available |
| **pH** | 4.7 1% *pH Electrode* (1% aqueous solution) |
| **Melting point/range** | Not applicable |
| **Freezing point** | No test data available |
| **Boiling point (760 mmHg)** | No test data available |
| **Flash point** | **closed cup** > 100 °C ( > 212 °F) *Setaflash Closed Cup ASTM D3828* |
| **Evaporation Rate (Butyl Acetate = 1)** | No test data available |
| **Flammability (solid, gas)** | No |
| **Lower explosion limit** | No test data available |
| **Upper explosion limit** | No test data available |
| **Vapor Pressure** | Not applicable |
| **Relative Vapor Density (air = 1)** | No test data available |
| **Relative Density (water = 1)** | 1.110 at 20 °C (68 °F) *Digital Density Meter (Oscillating Coil)* |
| **Water solubility** | Not applicable |
| **Partition coefficient: n-octanol/water** | No data available |
| **Auto-ignition temperature** | No test data available |
| **Decomposition temperature** | No test data available |
| **Dynamic Viscosity** | No test data available |
| **Kinematic Viscosity** | No test data available |
| **Explosive properties** | No *Thermal* |
| **Oxidizing properties** | No |
| **Liquid Density** | 1.110 g/cm3 at 20 °C (68 °F) *Digital density meter* |
| **Molecular weight** | No data available |
| **Surface tension** | 60.0 mN/m at 20 °C (68 °F) *EC Method A5* |



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NOTE: The physical data presented above are typical values and should not be construed as a specification.

## Section 10. Stability and reactivity

**Reactivity:** No data available

**Chemical stability:** Thermally stable at typical use temperatures.

**Possibility of hazardous reactions:** Polymerization will not occur.

**Conditions to avoid:** Some components of this product can decompose at elevated temperatures. Generation of gas during decomposition can cause pressure in closed systems.

**Incompatible materials:** Avoid contact with: Strong oxidizers.

**Hazardous decomposition products:** Decomposition products depend upon temperature, air supply and the presence of other materials.

## Section 11. Toxicological information

*Toxicological information appears in this section when such data is available.*

**Acute toxicity**

**Acute oral toxicity** Very low toxicity if swallowed. Harmful effects not anticipated from swallowing small amounts.
As product: LD50, Rat, > 5,000 mg/kg No deaths occurred at this concentration.

**Acute dermal toxicity** Prolonged skin contact is unlikely to result in absorption of harmful amounts.
As product: LD50, Rat, > 5,000 mg/kg No deaths occurred at this concentration.

**Acute inhalation toxicity** No adverse effects are anticipated from single exposure to mist. Excessive exposure may cause irritation to upper respiratory tract (nose and throat).
As product: LC50, Rat, 4 Hour, Aerosol, > 0.74 mg/l
Maximum attainable concentration.

**Skin corrosion/irritation** Essentially nonirritating to skin.

**Serious eye damage/ eye irritation** Essentially nonirritating to eyes.

**Sensitization** As product: Did not cause allergic skin reactions when tested in guinea pigs.
For respiratory sensitization: No relevant data found.

**Specific Target Organ Systemic Toxicity (Single Exposure)** Evaluation of available data suggests that this material is not an STOT-SE toxicant.

**Specific Target Organ Systemic Toxicity (Repeated Exposure)** For the active ingredient(s):
In animals, effects have been reported on the following organs: Kidney; Liver.



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For the minor component(s):
In animals, effects have been reported on the following organs after exposure to aerosols: Lung.

**Carcinogenicity** Active ingredient did not cause cancer in laboratory animals.

**Teratogenicity** For the active ingredient(s): Did not cause birth defects or any other fetal effects in laboratory animals.

**Reproductive toxicity** In animal studies, active ingredient did not interfere with reproduction.

**Mutagenicity** For the active ingredient(s): In vitro genetic toxicity studies were negative. Animal genetic toxicity studies were negative.

**Aspiration Hazard** Based on physical properties, not likely to be an aspiration hazard.

## Section 12. Ecological information

*Ecotoxicological information appears in this section when such data is available.*

**Toxicity**

**Acute toxicity to fish** For the active ingredient: Material is very highly toxic to aquatic organisms on an acute basis (LC50/EC50 <0.1 mg/L in the most sensitive species).

As product: LC50, Oncorhynchus mykiss (rainbow trout), static test, 96 Hour, > 762 mg/l, OECD Test Guideline 203 or Equivalent

**Acute toxicity to aquatic invertebrates** EC50, Daphnia magna (Water flea), static test, 48 Hour, > 457 mg/l, OECD Test Guideline 202 or Equivalent

**Acute toxicity to algae/aquatic plants** ErC50, Pseudokirchneriella subcapitata (green algae), 72 Hour, Growth rate inhibition, 1.07 mg/l, OECD Test Guideline 201 or Equivalent

For the active ingredient: EbC50, Lemna gibba, 14 d, 0.00329 mg/l

**Toxicity to Above Ground Organisms**

Material is practically non-toxic to birds on an acute basis (LD50 > 2000 mg/kg).

Oral LD50, Colinus virginianus (Bobwhite quail), > 10000mg/kg bodyweight.

Oral LD50, Apis mellifera (bees), 48 Hour, > 99micrograms/bee

Contact LD50, Apis mellifera (bees), 48 Hour, > 100micrograms/bee

**Toxicity to soil-dwelling organisms**

LC50, Eisenia fetida (earthworms), 14 d, > 10,000 mg/kg

**Persistence and degradability**

**Penoxsulam**

**Biodegradability:** Material is expected to biodegrade very slowly (in the environment). Fails to pass OECD/EEC tests for ready biodegradability.



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10-day Window: Fail
**Biodegradation:** 14.7 %
**Exposure time:** 28 d
**Method:** OECD Test Guideline 301B or Equivalent

**Photodegradation**
**Sensitizer:** OH radicals
**Atmospheric half-life:** 2.1 Hour
**Method:** Estimated.

**Propylene glycol**

**Biodegradability:** Material is readily biodegradable. Passes OECD test(s) for ready biodegradability. Biodegradation may occur under anaerobic conditions (in the absence of oxygen).
10-day Window: Pass
**Biodegradation:** 81 %
**Exposure time:** 28 d
**Method:** OECD Test Guideline 301F or Equivalent
10-day Window: Not applicable
**Biodegradation:** 96 %
**Exposure time:** 64 d
**Method:** OECD Test Guideline 306 or Equivalent

**Theoretical Oxygen Demand:** 1.68 mg/mg

**Chemical Oxygen Demand:** 1.53 mg/mg

**Biological oxygen demand (BOD)**

| Incubation Time | BOD |
|---|---|
| 5 d | 69.000% |
| 10 d | 70.000% |
| 20 d | 86.000% |

**Photodegradation**
**Atmospheric half-life:** 10 Hour
**Method:** Estimated.

**Balance** **Biodegradability:** No relevant data found.

**Bioaccumulative potential**

**Penoxsulam** **Bioaccumulation:** Bioconcentration potential is low (BCF < 100 or Log Pow < 3).
**Partition coefficient: n-octanol/water(log Pow):** -0.602 Measured

**Propylene glycol** **Bioaccumulation:** Bioconcentration potential is low (BCF < 100 or Log Pow < 3).
**Partition coefficient: n-octanol/water(log Pow):** -1.07 Measured
**Bioconcentration factor (BCF):** 0.09 Estimated.

**Balance**

**Bioaccumulation:** No relevant data found.

**Mobility in soil**

**Penoxsulam** Potential for mobility in soil is high (Koc between 50 and 150).
**Partition coefficient(Koc):** 73 Measured



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**Propylene glycol**

Given its very low Henry's constant, volatilization from natural bodies of water or moist soil is not expected to be an important fate process.
Potential for mobility in soil is very high (Koc between 0 and 50).
**Partition coefficient(Koc):** < 1 Estimated.

**Balance** No relevant data found.

## Section 13. Disposal considerations

**Disposal methods:** If wastes and/or containers cannot be disposed of according to the product label directions, disposal of this material must be in accordance with your local or area regulatory authorities. This information presented below only applies to the material as supplied. The identification based on characteristic(s) or listing may not apply if the material has been used or otherwise contaminated. It is the responsibility of the waste generator to determine the toxicity and physical properties of the material generated to determine the proper waste identification and disposal methods in compliance with applicable regulations. If the material as supplied becomes a waste, follow all applicable regional, national and local laws.

## Section 14. Transport information

**DOT** Not regulated for transport

**Classification for SEA transport (IMO-IMDG):**

**Proper shipping name** ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Penoxsulam)

**UN number** UN 3082

**Class** 9

**Packing group** III

**Marine pollutant** Penoxsulam

**Transport in bulk according to Annex I or II of MARPOL 73/78 and the IBC or IGC Code** Consult IMO regulations before transporting ocean bulk.

**Classification for AIR transport (IATA/ICAO):**

**Proper shipping name** Environmentally hazardous substance, liquid, n.o.s.(Penoxsulam)
**UN number** UN 3082
**Class** 9
**Packing group** III

This information is not intended to convey all specific regulatory or operational requirements/information relating to this product. Transportation classifications may vary by container volume and may be influenced by regional or country variations in regulations. Additional transportation system information can be obtained through an authorized sales or customer service representative. It is the responsibility of the transporting organization to follow all applicable laws, regulations and rules relating to the transportation of the material.



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## Section 15. Regulatory information

**OSHA Hazard Communication Standard**

This product is not a “Hazardous Chemical” as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

**Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Sections 311 and 312**

Chronic Health Hazard

**Superfund Amendments and Reauthorization Act of 1986 Title III (Emergency Planning and Community Right-to-Know Act of 1986) Section 313**

This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

**California Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986)**

This product contains no listed substances known to the State of California to cause cancer, birth defects or other reproductive harm, at levels which would require a warning under the statute.

**Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Hazardous Substances List and/or Pennsylvania Environmental Hazardous Substance List:**

The following product components are cited in the Pennsylvania Hazardous Substance List and/or the Pennsylvania Environmental Substance List, and are present at levels which require reporting.

| **Components** | **CASRN** |
|---|---|
| Propylene glycol | 57-55-6 |

**Pennsylvania (Worker and Community Right-To-Know Act): Pennsylvania Special Hazardous Substances List:**

To the best of our knowledge, this product does not contain chemicals at levels which require reporting under this statute.

**United States TSCA Inventory (TSCA)**

This product contains chemical substance(s) exempt from U.S. EPA TSCA Inventory requirements. It is regulated as a pesticide subject to Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requirements.

**Federal Insecticide, Fungicide and Rodenticide Act**

EPA Registration Number: 67690-47
This chemical is a pesticide product registered by the Environmental Protection Agency and is subject to certain labeling requirements under federal pesticide law. These requirements differ from the classification criteria and hazard information required for safety data sheets, and for



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workplace labels of non-pesticide chemicals. Following is the hazard information as required on the pesticide label:

CAUTION
Harmful if inhaled

## Section 16. Other information

**Hazard Rating System**
**NFPA**

Health: 0 Fire: 1 Reactivity: 0

**Legend**

| | |
|---|---|
| TWA | 8-hr TWA |
| US WEEL | USA. Workplace Environmental Exposure Levels (WEEL) |

**Information Source and References**
This SDS is prepared by Product Regulatory Services and Hazard Communications Groups from information supplied by internal references within our company.

**History**

**Date of issue:** 12/21/15

**Notice to reader**
**To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.**



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# AGRI-DEX®

## A Crop Oil Concentrate

*PRINCIPAL FUNCTIONING AGENTS:
Heavy range paraffinic oil, Polyol fatty acid esters, and
Polyethoxylated derivatives thereof ..... 99.0%
CONSTITUENTS INEFFECTIVE AS SPRAY ADJUVANTS ..... 1.0%
TOTAL ..... 100.0%

Surfactant Content: ..... 17.0%
Unsulfonated Oil Residue (UR) Value ..... 95.0% minimum

*All ingredients are accepted for use under CFR 40, 180.
CONTAINS PETROLEUM DISTILLATES

KEEP OUT OF REACH OF CHILDREN

## WARNING

May be harmful if swallowed
May be harmful in contact with skin
Harmful if inhaled
Causes mild skin irritation
Causes eye irritation

CA Reg. No. 5905-50094-AA SN 020114
NET CONTENTS:

MANUFACTURED FOR
HELENA CHEMICAL COMPANY
225 SCHILLING BOULEVARD, SUITE 300
COLLIERVILLE, TENNESSEE 38017
(901) 761-0050

### PRECAUTIONARY STATEMENT

### HAZARDS TO HUMANS AND DOMESTIC ANIMALS

BEFORE USING THIS PRODUCT, READ ALL PRECAUTIONS, DIRECTIONS FOR USE, CONDITIONS OF SALE–LIMITED WARRANTY AND LIITATIONS OF LIABILITY AND REMEDIES.

May be harmful if swallowed. May be harmful in contact with skin. Harmful if inhaled. Causes mild skin irritation. Causes eye irritation. Avoid contact with skin, eyes or clothing. Avoid breathing spray mist. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum or smoking tobacco. Remove and wash contaminated clothing before reuse. Keep out of reach of children.
Personal Protective Equipment: Wear chemical-resistant gloves, long-sleeved shirt and long pants, shoes plus socks when mixing or applying AGRI-DEX®.

### FIRST AID

IF IN EYES:
- Hold eye open and rinse slowly and gently with water for 15-20 minutes.
- Remove contact lenses, if present after the first 5 minutes, then continue rinsing eye.
- Call a poison control center or doctor for treatment advice.

IF SWALLOWED:
- Call a poison control center or doctor immediately for treatment advice.
- Do not induce vomiting unless told to do so by a poison control center or doctor.
- Do not give any liquid to the person.
- Do not give anything by mouth to an unconscious person.

IF INHALED:
- Move person to fresh air.
- If not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.
- Call a poison control center or doctor for further treatment advice.

IF ON SKIN OR CLOTHING:
- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15-20 minutes.
- Call a poison control center or doctor for treatment advice.

NOTE TO PHYSICIAN: Petroleum distillate may pose an aspiration pneumonia hazard.

HOT LINE NUMBER
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-424-9300 for emergency medical treatment information.

### STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage or disposal.
STORAGE: Store in original container only. Keep container tightly closed. Do not allow water to be introduced into the contents of this container. Do not store near heat or open flame. Do not store with oxidizing agents or ammonium nitrate.
PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be dispersed of on site or at an approved waste disposal facility. Do not contaminate water sources by runoff from cleaning of equipment, disposal of cleaning equipment wash waters, or spray waste.
CONTAINER DISPOSAL:
Do not reuse empty container. Triple rinse (or equivalent) during mixing and loading and add rinsate to spray tank. Recycling decontaminated containers is the best option of container disposal. The Agricultural Container Recycling Council (ACRC) operates the national recycling program. To contact your state and local ACRC recycler visit the ACRC web page at www.acrecycle.org. Decontaminated containers may also be disposed of in a sanitary landfill. For help in chemical emergencies involving spill, leak, fire or exposure, call toll free 1-800-424-9300.
REFILLABLE CONTAINER:
Refill this container with adjuvants only. Do not reuse this container for any other purpose. Cleaning the container before final disposal is the responsibility of the person disposing of the container. Cleaning before refilling is the responsibility of the refiller. To clean the container before final disposal, empty the remaining contents from the container into application equipment or mix tank. Fill the container about 10 percent full with water. Agitate vigorously or recirculate water with the pump for 2 minutes. Pour or pump rinsate into application equipment or rinsate collection system. Repeat this rinsing procedure two more times. If the container is not being refilled, return the container to the point of purchase.

### GENERAL INFORMATION

AGRI-DEX® is a non-ionic blend of special surfactants and a highly refined spray oil and is designed for use with a broad range of pesticides where an oil concentrate adjuvant is recommended. Subject to the cautionary statements set forth in the Directions for Use, AGRI-DEX® may be used with other pesticides and/or fertilizer products. The addition of AGRI-DEX® to a spray tank improves pesticide application by modifying the wetting and deposition characteristics of the spray solution resulting in a more even and uniform spray deposit. AGRI-DEX® can positively affect pesticide spray application and pesticide efficacy. Optimum application and effects, however, can be influenced by the crop, pest, spray equipment, spray volume, pressure, droplet size, spray mixture and environmental factors. Consequently, it is recommended that careful observations of the spray deposit be made and adjuvant concentrations be adjusted accordingly.

### DIRECTIONS FOR USE

FOR USE WITH PRODUCTS REGISTERED FOR: AGRICULTURAL, AQUATIC, FORESTRY, INDUSTRIAL, MUNICIPAL, NON-CROPLAND, ORNAMENTAL, RIGHTS-OF-WAY, AND TURF.
The addition of an adjuvant to some pesticides or pesticide tank mix combinations may cause phytotoxicity to the foliage and/or fruit of susceptible crops. Prior to the addition of AGRI-DEX® to spray tank mixes or prior to the use of AGRI-DEX® with a pesticide or fertilizer where an oil concentrate adjuvant is not specifically recommended but not prohibited by the manufacturer, the user or application advisor must have experience with the combination or must have conducted a phytotoxicity trial.
AGRI-DEX® may be applied by Ground, CDA, Aerial or Aquatic spray equipment and any other type spray equipment recommended by pesticide labels. In most applications, use enough AGRI-DEX® to allow for uniform wetting and deposition of the spray onto plant surfaces without undue runoff.
GROUND: Use 1-4 pints per acre or 1.0% by v/v with a minimum of .50% by volume.
AERIAL, LOW VOLUME, CDA: Use 4-8 pints per 100 gallons water or .50-1.00 % v/v concentration.
AQUATIC: Use 1-4 pints per acre.
NOTE: The above use recommendations are considered to be adequate for most uses. Do not exceed 2.5% v/v concentration. Some pesticides, however, may require higher or lower rates for optimum effect. Follow the pesticide label directions when this occurs.
CAUTION: Do not mix with oxidizing agents unless oxidizing agents are in solution.

### MIXING

Prior to any pesticide application all spray mixing and application equipment must be cleaned. Carefully observe all cleaning directions on the pesticide label.
Fill spray tank one-half full with water and begin agitation. Add pesticides and/or fertilizers as directed by labeling or in the following sequence:
1. Dry flowables or water dispersible granules
2. Wettable powders
3. Flowables
4. Solutions
5. Emulsifiable concentrates

and continue filling. Add AGRI-DEX® last and continue agitating.

Disclaimer: Always refer to the label on the product before using Helena or any other product.

SPECIMEN

CONDITIONS OF SALE–LIMITED WARRANTY AND LIMITATIONS OF LIABILITY AND REMEDIES

Read the Conditions of Sale–Warranty and Limitations of Liability and Remedies before using this product. If the terms are not acceptable, return the product, unopened, and the full purchase price will be refunded.

The directions on this label are believed to be reliable and must be followed carefully. Insufficient control of pests and/or injury to the crop to which the product is applied may result from the occurrence of extraordinary or unusual weather conditions or the failure to follow the label directions or good application practices, all of which are beyond the control of Helena Chemical Company (the "Company") or the seller. In addition, failure to follow label directions may cause injury to crops, animals, man or the environment. The Company warrants that this product conforms to the chemical description on the label and is reasonably fit for the purpose referred to in the directions for use subject to the factors noted above which are beyond the control of the Company. The Company makes no other warranties or representations of any kind, express or implied, concerning the product, including no implied warranty of merchantability or fitness for any particular purpose, and no such warranty shall be implied by law.

The exclusive remedy against the Company for any cause of action relating to the handling or use of this product shall be limited to, at Helena Chemical Company's election, one of the following:

1. Refund of the purchase price paid by buyer or user for product bought, or
2. Replacement of the product used

To the extent allowed by law, the Company shall not be liable and any and all claims against the Company are waived for special, indirect, incidental, or consequential damages or expense of any nature, including, but not limited to, loss of profits or income. The Company and the seller offer this product and the buyer and user accept it, subject to the foregoing conditions of sale and limitation of warranty, liability and remedies.

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SPECIMEN LABEL

Disclaimer: Always refer to the label on the product before using Helena or any other product.

# Safety Data Sheet



## 1. Identification

**Product Name** : AGRI-DEX
**Synonyms** : None
**Product Use** : Crop Oil Concentrate
**Manufacturer/Supplier** : Helena Chemical Company
**Address** : 225 Schilling Blvd. Collierville, TN 38017
**General Information** : 901-761-0050
**Transportation Emergency Number** : CHEMTREC:800-424-9300

## 2. Hazard Identification

**Signal Word** : Warning
**Skin Irritation** : Non-irritating
**Eye Irritation** : Rated non-irritating
**Acute Toxicity Oral** : LD50 (rat) >5,000 mg/kg
**Acute Toxicity Dermal** : LD50 (rat) >5,050 mg/kg

**Hazard Categories** : Oral/Dermal Toxicity - 5/5; Eye Irritation - 2B; Skin Irritation - 3; Inhalation Toxicity - 4

**Hazard Statement** : May be harmful if swallowed
May be harmful in contact with skin
Causes eye irritation
Causes mild skin irritation
Harmful if inhaled

## 3. Composition / Information on Ingredients

| Component | CAS Number | Weight % |
|---|---|---|
| Heavy range paraffinic oil, Polyol fatty acid esters, and Polyethoxylated derivatives thereof | Proprietary | 99.00 |
| Constituents ineffective as spray adjuvants | Nonhazardous | 1.00 |

## 4. First Aid Measures

**Eye** : Hold eye open and rinse slowly and gently with water for 15 to 20 minutes. Remove contact lenses, if present, after the first 5 minutes then continue rinsing the eye. Call a poison control center or doctor for treatment advice.

**Skin** : Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 to 20 minutes. Call a poison control center or doctor for treatment advice.

**Inhalation** : Move person to fresh air. If not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth, if possible. Call a poison control center or doctor for further treatment advice.

**Ingestion** : Call a poison control center or doctor immediately for treatment advice. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give any liquid to the person. Do not give anything by mouth if unconscious.

**Indication of Immediate Medical Attention and Special Treatment Needed** : Treatment should be directed toward control of the symptoms. Pulmonary aspiration hazard - if swallowed and/or vomiting occurs, can enter lungs and cause damage.

## 5. Fire Fighting Measures

**Extinguishing Media** : Use water fog, foam, dry chemical or carbon dioxide extinguishing agents.
**Specific Hazards Arising from the Chemical** : Not a flammable liquid but can be made to burn.
**Special Fire Fight Proc** : Wear self-contained breathing apparatus and full protective clothing.

## 6. Accidental Release Measures

**Personal Precautions** : Keep unprotected and unnecessary personnel out of spill area.
**Protective Equipment** : Splashproof goggles or faceshield, impervious gloves, impervious apron and footwear. Eyewash should be available in work area. Respiratory protection is not needed unless heated or misted.
**Emergency Procedures** : Dike spill to prevent spreading and entering any waterways, drains or sewers.
**Methods and Materials for Containment and Cleanup** : Use an oil absorbent material, such as clay, sand or sawdust. Collect and place in suitable chemical waste disposal container for proper disposal.

## 7. Handling and Storage

**Precautions for Safe Handling** : Keep out of reach of children. Do not contaminate water supplies, lakes, streams, ponds or drains.
**Conditions for Safe Storage** : Do not store with food, feed or other material to be consumed or used by humans or animals. Store in original container only. Keep container tightly closed. Do not allow water to be introduced into the contents of this container. Do not store near heat or open flame. Do not store with oxidizing agents or ammonium nitrate.

## 8. Exposure Controls / Personal Protection

**TLV/PEL** : PEL 5 mg/m3 (paraffin oil mist)
**Appropriate Engineering Controls** : Ventilate as needed to comply with exposure limit.
**Personal Protective Equipment** : Splashproof goggles or faceshield, impervious gloves, impervious apron and footwear. Eyewash should be available in work area. Respiratory protection is not needed unless heated or misted.

## 9. Physical and Chemical Properties

**Odor/Appearance** : Clear amber liquid, mineral oil odor.
**Flash Point, $^0$F** : >200 Degrees F.
**Boiling Point, $^0$F** : 625 - 830 Degrees F.
**Melting Point(Freezing point), $^0$C** : <10 Degrees F.
**Vapor Pressure, mm Hg @ 20 $^0$C** : <0.0001 mmHg
**Vapor Density** : 10+
**Solubility in Water** : Dispersible
**Molecular Formula** : Not applicable, formulated mixture.
**Density, g/mL @ 25 $^0$C** : 0.870-0.890
**Evaporation Rate(Butyl Acetate = 1)** : 1000X
**Octanol/Water Partition Coefficient** : No information found
**pH** : Not applicable
**Flammable Limits (approximate volume % in air)** : No information found

**Auto-ignition Temperature** : 670 Degrees F. (estimate)
**Decomposition temperature** : No information found

## 10. Stability and Reactivity

**Reactivity** : No information found
**Chemical Stability** : Stable
**Hazardous Decomposition Products** : May produce carbon monoxide, carbon dioxide and asphyxiants under fire conditions.
**Hazardous Polymerization** : Will not occur
**Conditions to Avoid** : Avoid heat, sparks and open flames.
**Incompatible Materials** : Alkalies and strong oxidizers

## 11. Toxicological Information

**Acute Toxicity (Oral LD50)** : >5,000 mg/L (rat)
**Acute Toxicity (Dermal LD50)** : >5,050 mg/L (rat)
**Acute Toxicity Inhalation LC50** : >2.17 mg/L (rat)
**Likely Routes of Exposure** : Inhalation, skin, eyes.
**Skin Irritation** : Non-irritating
**Eye Irritation** : Rated non-irritating
**Skin Sensitization** : Non-sensitizing (Buehler) on Guinea pig
**Carcinogenic** : Not listed by IARC, NTP or OSHA.
**Chronic Effects** : No information found
**Other Hazards** : No information found

## 12. Ecological Information

**Ecotoxicity** : No information found
**Persistence and Degradability** : No information found
**Bioaccumulative Potential** : No information found
**Mobility in Soil** : No information found
**Other Adverse Effects** : Do not contaminate water supplies, lakes, streams, ponds or drains.

## 13. Disposal Considerations

**Waste Disposal Method** : This material must be disposed of according to Federal, State or Local procedures under the Resource Conservation and Recovery Act.

## 14. Transport Information

**UN Proper Shipping Name** : Not regulated by DOT, IATA or IMDG.
**Transport Hazard Class** : None
**UN Identification Number** : None
**Packaging Group** : None
**Environmental Hazards** : No information found
**Transport in Bulk** : No information found
**Special Precautions for Transportation** : No information found
**Freight Classification** : Adhesives, Adjuvants, Spreaders or Stickers, N.O.I. (NMFC Item 42652, Class 60)

## 15. Regulatory Information

**National Fire Protection Association Rating** :

Health: 1 Fire: 1 Reactivity: 0

Rating Level: (4-Extreme, 3-High, 2-Moderate, 1-Slight, 0-Minimum)

**S.A.R.A Title III Hazard Classification (Yes/No)** :

| | |
|---|---|
| Immediate( Acute) Health: | Y |
| Delayed (Chronic) Health: | N |
| Sudden Release of Pressure: | N |
| Fire: | N |
| Reactive: | N |

## 16. Other Information

**Data of Preparation/Revision** : 28-March-2015

# BREAK-THRU® SP 133

OMRI LISTED
For Organic Use

## A NONIONIC SPREADER / PENETRANT

**PRINCIPAL FUNCTIONING AGENT**

POLYGLYCEROL OLEATE, POLYOXYETHYLENE SORBITAN FATTY ACID ESTER.....100%

CA REGISTRATION #1051059-50006

All ingredients are exempt from the requirements of tolerance as specified in 40 CFR 180.910

## KEEP OUT OF REACH OF CHILDREN

## WARNING

**Causes eye irritation**

**Read entire label for additional precautionary statements.**

Packaged for
Evonik Corporation
914 E. Randolph Road
Hopewell, VA 23860
1-800-446-1809

**NET CONTENTS 1 GALLON (3.785 LITERS)**

BREAK-THRU® is a registered trademark of Evonik Corporation

### PRECAUTIONARY STATEMENTS

- AVOID CONTACT WITH EYES, SKIN, AND CLOTHING
- AVOID INGESTION
- AVOID BREATHING VAPOR OR MIST
- AVOID USING PRODUCT IN A MANNER AS TO DIRECTLY, OR THROUGH DRIFT, EXPOSE WORKERS OR OTHER PERSONS
- ALWAYS FOLLOW THE PRECAUTIONARY STATEMENTS ON THE LABEL OF THE PESTICIDE(S) OR SPRAY OILS THAT ARE TO BE USED WITH BREAK-THRU® SP 133
- ALWAYS CONSULT THE SAFETY DATA SHEET FOR SPECIFIC INSTRUCTIONS
- IT IS RECOMMENDED FOR APPLICATORS AND OTHER HANDLERS TO WEAR PERSONAL PROTECTIVE EQUIPMENT INCLUDING EYE PROTECTION (SUCH AS SAFETY GLASSES, GOGGLES, OR A SPLASH SHIELD), IMPERVIOUS GLOVES (SUCH AS PVC, NITRILE, OR NEOPRENE), PROTECTIVE CLOTHING, AND A MIST FILTERING RESPIRATOR
- KEEP OUT OF THE REACH OF CHILDREN

### FIRST AID

- IN EYES - Immediately wash eyes with large amounts of water for at least 15 minutes, lifting the lower and upper lids. Remove contact lenses if present and continue rinsing. If irritation persists, seek medical attention IMMEDIATELY.
- ON SKIN - Remove contaminated clothing and immediately wash contaminated area with large amounts of water for at least 15 minutes. If contact is made with the spray solution containing pesticides follow the First Aid Section on pesticide label. Seek medical attention.
- IF SWALLOWED – If person is conscious, immediately give large amounts of water and induce vomiting UNLESS OTHERWISE DIRECTED BY LABEL ON PESTICIDE(S). Do not induce vomiting or give fluids by mouth to an unconscious person. Seek medical attention immediately.
- IF INHALED – Move person to fresh air and check to ensure adequate respiration. Seek medical attention.

### IN CASE OF EMERGENCY OR SPILL

**Contact CHEMTREC at 1-800-424-9300**

**NJ Trade Secret Nos. 800937-5081P/800937-5068P**

Applicators and other handlers should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet. Remove protective clothing and equipment after handling. Wash the outside of gloves before removing. Wash thoroughly and change into clean clothing.

### STORAGE AND DISPOSAL

- Storage: Keep container tightly closed. Store in original container only. Keep in a secure and locked storage area. Do not add water to the contents of this container.
- Disposal: Triple rinse container and pour rinsate into spray tank. Do not reuse container. Recycling decontaminated containers is the best option of container disposal. The Agricultural Container Recycling Council (ACRC) operates the national recycling program. To contact your state and local ACRC recycler visit www.acrecycle.org. Dispose of contents/container in accordance with local/national regulations.

# BREAK-THRU® SP 133

## GENERAL INFORMATION:

BREAK-THRU® SP 133 is a mixture of fatty acid esters. It is designed to increase spreading onto and penetration into hydrophobic surfaces such as leaves.

Careful observation of spray application is recommended to determine proper and efficient pesticide application. This will optimize the pesticide and spreader load levels. Read precautionary statements carefully before use.

While BREAK-THRU SP 133 has been proven to be a highly effective spreading/penetration enhancer; timing, weather conditions, methods of application, crop conditions, and /or mixture with other chemicals not specifically recommended are beyond the control of the seller. Therefore, the user should carefully observe spray deposits, rate efficiencies, compatibilities, and effectiveness in initial applications and adjust the spreader rates accordingly.

## DIRECTIONS FOR USE:

As an additive in agricultural formulations, BREAK-THRU SP 133 is best suited for water-based formulations such as SC, SE, and SL. It is also compatible with various oil-based formulations as a co-emulsifier. Use BREAK-THRU® SP 133 by replacing 1 to 10% w/w of diluent in the formulation.

In tank mix applications BREAK-THRU SP 133 may be added first to the formulated product prior to dilution or directly into the spray tank.

Pesticide manufacturers may recommend a rate of nonionic adjuvant to be used with their product. Follow the pesticide or active ingredient label recommendations for the use of adjuvant. However, if the pesticide or active ingredient label does not have a specific recommendation for use, but does not prohibit the use of a nonionic adjuvant, BREAK-THRU SP 133 should be applied at the rates listed below. Careful observation of spray performance in a trial application with the combination of chemicals to be applied is recommended to determine proper and efficient spreader rates.

**NOT FOR AQUATIC USE IN THE STATE OF CALIFORNIA**

## AS A SPRAY ADJUVANT FOR PESTICIDES

WITH HERBICIDES: Apply BREAK-THRU SP 133 at a rate of 16-48 ounces per 100 gallons of spray solution.

WITH DEFOLIANTS: Apply BREAK-THRU SP 133 at a rate of 16-48 ounces per 100 gallons of spray solution.

WITH MICRO-NUTRIENTS: Apply BREAK-THRU SP 133 at a rate of 16-48 ounces per 100 gallons of spray solutions.

WITH INSECTICIDES: Apply BREAK-THRU SP 133 at a rate of 16-48 ounces per 100 gallons of spray solution.

WITH FUNGICIDES: Apply BREAK-THRU SP 133 at a rate of 16-48 ounces per 100 gallons of spray solution.

WITH AERIAL APPLICATIONS: Apply BREAK-THRU SP 133 at a rate of 16-48 ounces per 100 gallons of spray.

## MIXING INSTRUCTIONS:

1. Fill tank to 2/3 to 3/4 full of water. If foaming is anticipated, add an anti-foaming agent before pesticide and BREAK-THRU SP 133.
2. Add pesticide as directed by pesticide label.
3. Continue agitations.
4. Add BREAK-THRU SP 133 and continue filling tank while maintaining agitation.

## CONDITIONS OF SALE
## LIMITATION OF LIABILITY AND REMEDIES
## EVONIK CORPORATION

Conditions of sales and limitations of liability and remedies. Insufficient control of pests and/or injury to the turf or crop area to which the product may result from the occurrence of extraordinary or unusual weather conditions which are beyond the control of the seller. In addition, failure to follow label directions may cause injury to other crops, animals, man or the environment.

This product is to be used and applied according to the label directions by professionals trained in the use of agricultural chemicals. This material is not intended for use by nor should be used by consumers. The seller warrants that this product conforms to the chemical description of the label and is reasonably fit for the purpose referred to in the DIRECTIONS FOR USE subject to the factors noted above which are beyond the control of the seller.

THE SELLER MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND, EXPRESSED OR IMPLIED, CONCERNING THE PRODUCT, INCLUDING NO IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, AND NO SUCH WARRANTY SHALL BE IMPLIED BY LAW.

THE EXCLUSIVE REMEDY AGAINST THE SELLER FOR ANY CAUSE OF ACTION RELATING TO THE HANDLING OR USE OF THIS PRODUCT IS CLAIM FOR DAMAGE, AND IN NO EVENT SHALL DAMAGES OR ANY OTHER RECOVERY OF ANY KIND AGAINST THE SELLER EXCEED THE PRICE OF THE PRODUCT WHICH CAUSES THE ALLEGED LOSS, DAMAGE, INJURY OR OTHER CLAIM. THE SELLER SHALL NOT BE LIABLE AND ANY AND ALL CLAIMS AGAINST THE SELLER ARE WAIVED, FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR EXPENSES, OF ANY NATURE INCLUDING BUT NOT LIMITED TO, LOSS OF PROFITS OR INCOME, OR ANY LIABILITY INCURRED BY THE BUYER TO ANY THIRD PARTY IN ANY WAY ARISING OUT OF OR RELATING TO THE HANDLING OR USE OF THIS PRODUCT, WHETHER OR NOT BASED ON THE SELLER'S NEGLIGENCE, BREACH OF WARRANTY, STRICT LIABILITY IN TORT OF ANY OTHER CAUSE OF ACTION.

The seller offers this product and the buyer and user accept it, subject to the foregoing conditions of sale and limitation of warranty, liabilities and remedies.

## 1. Identification of the substance/mixture and of the company/undertaking

### 1.1. Product identifier

| | | |
|---|---|---|
| Trade name | : | BREAK-THRU SP 133 |
| Chemical Name | : | Mixture of fatty acid esters |

### 1.2. Recommended use of the chemical and restrictions on use

| | | |
|---|---|---|
| Recommended use | : | Industrial Use |
| Non-recommended use(s) | : | None known. |

### 1.3. Details of the supplier of the safety data sheet

| | | |
|---|---|---|
| Company | : | Evonik Corporation<br>Nutrition & Care<br>PO Box 34628<br>Richmond VA 23234<br>USA |
| Telephone | : | +1 (0)804-727-0700 |
| Telefax | : | +1 (0)804-727-0845 |
| E-mail | : | us-productsafety-cs@evonik.com |

**Contact Canada**

| | | |
|---|---|---|
| Company | : | Evonik Canada Inc.<br>3380 South Service<br>Burlington ON L7N 3J5<br>Canada |
| Telephone | : | +1 (0)905-336-3423- |
| Telefax | : | +1 (0)905-332-5632 |
| E-mail | : | us-productsafety-cs@evonik.com |

### 1.4. Emergency telephone number

| | | |
|---|---|---|
| Emergency information | : | Non-Emergency Phone Number : (800) 732-5616<br>In case of emergency call CHEMTREC US: 1-800-424-9300, CHEMTREC WORLD: 1-703-527-3887. |

24 HOUR EMERGENCY TELEPHONE NUMBERS:
CHEMTREC - US & CANADA toll free: +1-800-424-9300
CHEMTREC - MEXICO toll free: 01-800-681-9531
CHEMTREC GLOBAL - Collect calls accepted: +1-703-527-3887

## 2. Hazards identification

### 2.1. Classification of the substance or mixture

Not a hazardous substance or mixture.

### 2.2. Label elements

Not a hazardous substance or mixture.

### 2.3. Other hazards

None known

## 3. Composition/information on ingredients

### 3.1. Substances

-

### 3.2. Mixtures

No hazardous ingredients

## 4. First aid measures

### 4.1. Description of first aid measures

| | | |
|---|---|---|
| General advice | : | Remove soiled or soaked clothing immediately |
| Inhalation | : | Ensure supply of fresh air.<br>In the event of symptoms seek medical advice. |
| Skin contact | : | In case of contact with skin wash off with soap and water.<br>In the event of symptoms seek medical advice. |
| Eye contact | : | In case of contact with eyes rinse thoroughly with water.<br>In the event of symptoms seek medical advice. |
| Ingestion | : | Thoroughly clean the mouth with water<br>In the event of symptoms seek medical advice. |

### 4.2. Most important symptoms and effects, both acute and delayed

| | | |
|---|---|---|
| Symptoms | : | No special hints. |

### 4.3. Indication of any immediate medical attention and special treatment needed

Treat symptomatically.

## 5. Fire-fighting measures

### 5.1. Extinguishing media

| | | |
|---|---|---|
| Suitable extinguishing media | : | foam, carbon dioxide, dry powder, water spray. |
| Unsuitable extinguishing media | : | Full water jet |

### 5.2. Special hazards arising from the substance or mixture

In the event of fire the following can be released:
- carbon dioxide, carbon monoxide

### 5.3. Advice for firefighters

Do not inhale explosion and/or combustion gases
Use self-contained breathing apparatus

## 6. Accidental release measures

### 6.1. Personal precautions, protective equipment and emergency procedures

Use personal protective equipment.

### 6.2. Environmental precautions

Do not allow to enter drains or waterways
Do not discharge into the subsoil/soil.

### 6.3. Methods and material for containment and cleaning up

Take up with absorbent material (eg sand, kieselguhr, universal binder)
Dispose of absorbed material in accordance with the regulations.

## 7. Handling and storage

### 7.1. Precautions for safe handling

| | | |
|---|---|---|
| Advice on safe handling | : | No special measures necessary if stored and handled as prescribed.<br>Wear respiratory protection when spraying. |
| Hygiene measures | : | Do not eat, drink or smoke when working.<br>Wash hands before breaks and after work.<br>Remove soiled or soaked clothing immediately. |
| General protective measures | : | Do not inhale gases/vapours/aerosols.<br>Avoid contact with eyes and skin |

### 7.2. Conditions for safe storage, including any incompatibilities

**Prevention of fire and explosion**

| | | |
|---|---|---|
| Information | : | No special measures required. |

**Storage**

| | | |
|---|---|---|
| Information | : | none |
| Further information on storage conditions | : | Keep container tightly closed |

## 8. Exposure controls/personal protection

### 8.1. Control parameters

Contains no substances with occupational exposure limit values.

### 8.2. Exposure controls

**Engineering controls**

**Personal protective equipment**

| | | |
|---|---|---|
| Eye protection | : | Always wear eye protection when the potential for inadvertent eye contact with the product cannot be excluded. |
| Hand protection | : | Glove material: impermeable gloves<br>The protective gloves to be worn must satisfy the specifications of EC Guideline 89/686/EEC and the resulting Standard EN374.<br>Specific workplace situations must be considered separately. |
| Body Protection | : | protective clothing |
| Respiratory protection | : | in case of formation of vapours/aerosols:<br>Short term: filter apparatus, combination filter A-P2 |

## 9. Physical and chemical properties

### 9.1. Information on basic physical and chemical properties

| | | |
|---|---|---|
| Physical state | : | liquid |
| Form | : | Viscous |
| Colour | : | colourless to yellowish |
| Odour | : | characteristic |
| Odour Threshold | : | not measured |

| | | |
|---|---|---|
| pH | : | 6.5 - 7.5 |
| Melting point | : | not measured |
| Boiling point | : | not measured |
| Flash point | : | > 212.00 °F |
| Evaporation rate | : | not measured |
| Flammability | : | no data available |
| Upper Explosion/Ignition Limit | : | not measured |
| Lower explosion limit | : | not measured |
| Vapour pressure | : | not measured |
| Relative vapour density | : | not measured |
| Relative density | : | no data available |
| Solubility(ies) | : | Medium: Alcohol<br>Remarks: soluble<br>Medium: Aromatic hydrocarbons<br>Remarks: soluble<br>Medium: vegetable oil<br>Remarks: soluble |
| Water solubility | : | dispersible |
| Partition coefficient: n-octanol/water | : | not measured |
| Autoignition temperature | : | not measured |
| Thermal decomposition | : | not measured |
| Viscosity, kinematic | : | no data available |
| Viscosity, dynamic | : | 380 mPa.s<br>(25 °C)<br>Method: DIN 53015 (Höppler) |
| Explosive properties | : | not measured |
| Oxidising properties | : | not oxidizing |

### 9.2. Other information

| | | |
|---|---|---|
| Density | : | 0.96 - 0.98 g/cm3 |

(25 °C)
Method: DIN 51757

Metal corrosion : Not corrosive to metals.

Ignition temperature : not measured

## 10. Stability and reactivity

### 10.1. Reactivity

see section "Possibility of hazardous reactions"

### 10.2. Chemical stability

The product is stable under normal conditions.

### 10.3. Possibility of hazardous reactions

No hazardous reactions with proper storage and handling.

### 10.4. Conditions to avoid

Unknown

### 10.5. Incompatible materials

Unknown

### 10.6. Hazardous decomposition products

None with proper storage and handling.

## 11. Toxicological information

### 11.1. Information on toxicological effects

Acute toxicity (oral) : LD50
Species: rat
Dose: > 5,000 mg/kg
Method: OECD Test Guideline 425
GLP: Yes
Remarks: Own study
Information given is based on tests on the mixture itself.

Acute toxicity (inhalation) : no data available

Acute toxicity (dermal) : LD50
Species: rat
Dose: > 5,000 mg/kg
Method: OECD 402
GLP: Yes
Remarks: Own test result.
Toxicological investigations on the product.

Irritation/corrosion of the skin : Species: Rabbit
Result: slightly irritating
Classification: No labelling required
Method: OECD 404
Exposure duration: 4 h
GLP: Yes
Remarks: Own test result.

Serious eye damage/ eye irritation : Species: Rabbit
Result: slightly irritating
Classification: No labelling required

Method: OECD 405
GLP: Yes
Remarks: Own test result.

Respiratory/skin sensitization : no data available

Repeated dose toxicity : no data available

**CMR assessment**

Carcinogenicity : no data available

Mutagenicity : no data available

Teratogenicity : no data available

Toxicity to reproduction : no data available

**US. National Toxicology Program (NTP) Report on Carcinogens**
No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

**US. IARC Monographs on Occupational Exposures to Chemical Agents**
No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

**US. OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)**
No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

**US. ACGIH Threshold Limit Values**
No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.

Specific Target Organ Toxicity - Single exposure : no data available

Specific Target Organ Toxicity - Repeated exposure : no data available

Aspiration hazard : No aspiration toxicity classification

Other information : Proper use provided, no adverse health effects have been observed or have been come to our knowledge.

## 12. Ecological information

**Ecotoxicology Assessment**

Acute aquatic toxicity : no data available

Chronic aquatic toxicity : no data available

### 12.1. Toxicity

Aquatoxicity, fish : static
Species: Danio rerio (zebra fish)
Exposure duration: 96 h

LC50: > 100 mg/l
Method: OECD 203
GLP: yes
Remarks: Own test result.

static test
Species: Oncorhynchus mykiss
Exposure duration: 96 h
LC50: > 1,000 mg/l
Method: OPPTS 850.1075
GLP: yes
Remarks: Own test result.

Aquatoxicity, invertebrates : static
Species: Daphnia magna (Water flea)
Exposure duration: 48 h
EC50: > 100 mg/l
Method: OECD 202
GLP: yes
Own test result.

Aquatoxicity, algae / aquatic plants : no data available

Toxicity in microorganisms : no data available

chronic toxicity in fish : no data available

Chronic toxicity in aquatic Invertebrates : no data available

Toxicity in organisms which live in the soil : no data available

Toxicity in terrestrial plants : no data available

Toxicity to Above-Ground Organisms : no data available

### 12.2. Persistence and degradability

Photodegradation : no data available

Biological degradability : no data available

Biochemical Oxygen Demand (BOD) : no data available

Chemical Oxygen Demand (COD) : no data available

relation of BOD/COD : no data available

### 12.3. Bioaccumulative potential

Bioaccumulation : no data available

**12.4. Mobility in soil**

Environmental distribution : no data available

**12.5. Results of PBT and vPvB assessment**

PBT and vPvB assessment : no data available

**12.6. Other adverse effects**

General Information : Do not allow to enter soil, waterways or waste water canal.

## 13. Disposal considerations

**13.1. Waste treatment methods**

Product : In accordance with local authority regulations, take to special waste incineration plant

Contaminated packaging : If empty contaminated containers are recycled or disposed of, the receiver must be informed about possible hazards.

## 14. Transport information

**Not classified as dangerous in the meaning of transport regulations.**

| | | |
|---|---|---|
| 14.1 | UN number: | -- |
| 14.2 | UN proper shipping name: | -- |
| 14.3 | Transport hazard class(es): | -- |
| 14.4 | Packing group: | -- |
| 14.5 | Environmental hazards: | -- |
| 14.6 | Special precautions for user: | No |

## 15. Regulatory information

**Canada**

This product has been classified in accordance with the hazard criteria of the Controlled Products Regulation and the (M)SDS contains all information required by the Controlled Products Regulation

Canada : WHMIS CLASSIFICATION
Not Rated

**US Federal Regulations**
SARA Title III Section 311/312 Hazard Categories
- No SARA Hazards

US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title III Section 302 Extremely Hazardous Substance (40 CFR 355, Appendix A)
- This material does not contain any components with a SARA 302 RQ.

SARA 304 - Emergency Release Notification
- This material does not contain any components with a section 304 EHS RQ.

US. EPA CERCLA Hazardous Substances (40 CFR 302)
- This material does not contain any components with a CERCLA RQ.

US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title III Section 313 Toxic Chemicals (40 CFR 372.65) - Supplier Notification Required
- This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

US. EPA Emergency Planning and Community Right-To-Know Act (EPCRA) SARA Title III Section 302 Extremely Hazardous Substance (40 CFR 355, Appendix A)
- No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

**State Regulations**
US. Pennsylvania Worker and Community Right-to-Know Law (34 Pa. Code Chap. 301-323)
- No components are subject to the Pennsylvania Right to Know Act.

US. Massachusetts Commonwealth's Right-to-Know Law (Appendix A to 105 Code of Massachusetts Regulations Section 670.000)
- No components are subject to the Massachusetts Right to Know Act.

US. New Jersey Worker and Community Right-to-Know Act (New Jersey Statute Annotated Section 34:5A-5)
- No components are subject to the New Jersey Right to Know Act.

US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)
- This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

HMIS Ratings

| | |
|---|---|
| Health: | 1 |
| Flammability: | 1 |
| Reactivity: | 0 |
| Personal Protection: | X |

**Notification status**

| | | |
|---|---|---|
| USA (TSCA) | : | listed/registered or exempted |
| Canada (DSL) | : | listed/registered or exempted |

## 16. Other information

**List of references**

Revision date : 11/22/2016

Changes since the last version are highlighted in the margin. This version replaces all previous versions.
This information and any recommendations, technical or otherwise, are presented in good faith and believed to be correct as of the date prepared. Recipients of this information and recommendations must make their own determination as to its suitability for their purposes. In no event shall Evonik assume liability for damages or losses of any kind or nature that result from the use of or reliance upon this information and recommendations. EVONIK EXPRESSLY DISCLAIMS ANY REPRESENTATIONS AND WARRANTIES OF ANY KIND, WHETHER EXPRESS OR IMPLIED, AS TO THE ACCURACY, COMPLETENESS, NON-INFRINGEMENT, MERCHANTABILITY AND/OR FITNESS FOR A PARTICULAR PURPOSE (EVEN IF EVONIK IS AWARE OF SUCH PURPOSE) WITH RESPECT TO ANY INFORMATION AND RECOMMENDATIONS PROVIDED. Reference to any trade names used by other companies is neither a recommendation nor an endorsement of the corresponding product, and does not imply that similar products could not be used. Evonik reserves the right to make any changes to the information and/or recommendations at any time, without prior or subsequent notice.

## Legend

| | |
|---|---|
| **ADR** | European Agreement concerning the International Carriage of Dangerous Goods by Road |
| **ADN** | European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways |
| **ADNR** | European agreement concerning the international carriage of dangerous goods by inland waterways (ADN) |
| **ASTM** | American Society for Testing and Materials |
| **ATP** | Adaptation to Technical Progress |
| **BCF** | Bioconcentration factor |
| **BetrSichV** | German Ordinance on Industrial Safety and Health |
| **c.c.** | closed cup |
| **CAS** | Chemical Abstract Services |
| **CESIO** | European Committee of Organic Surfactants and their Intermediates |
| **ChemG** | German Chemicals Act |
| **CMR** | carcinogenic-mutagenic-toxic for reproduction |
| **DIN** | German Institute for Standardization |
| **DMEL** | Derived minimum effect level |
| **DNEL** | Derived no effect level |
| **EINECS** | European Inventory of Existing Commercial Chemical Substances |
| **EC50** | half maximal effective concentration |
| **GefStoffV** | German Ordinance on Hazardous Substances |
| **GGVSEB** | German ordinance for road, rail and inland waterway transportation of dangerous goods |
| **GGVSee** | German ordinance for sea transportation of dangerous goods |
| **GLP** | Good Laboratory Practice |
| **GMO** | Genetic Modified Organism |
| **IATA** | International Air Transport Association |
| **ICAO** | International Civil Aviation Organization |
| **IMDG** | International Maritime Dangerous Goods |
| **ISO** | International Organization For Standardization |
| **LOAEL** | Lowest observed adverse effect level |
| **LOEL** | Lowest observed effect level |
| **NOAEL** | No observed adverse effect level |
| **NOEC** | no observed effect concentration |
| **NOEL** | no observed effect level |
| **o. c.** | open cup |
| **OECD** | Organisation for Economic Cooperation and Development |
| **OEL** | Occupational Exposure Limit |
| **PBT** | Persistent, bioaccumulative, toxic |
| **PEC** | Predicted effect concentration |
| **PNEC** | Predicted no effect concentration |
| **REACH** | REACH registration |
| **RID** | Convention concerning International Carriage by Rail |
| **STOT** | Specific Target Organ Toxicity |
| **SVHC** | Substances of Very High Concern |
| **TA** | Technical Instructions |
| **TPR** | Third Party Representative (Art. 4) |
| **TRGS** | Technical Rules for Hazardous Substances |
| **VCI** | German chemical industry association |
| **vPvB** | very persistent, very bioaccumulative |
| **VOC** | volatile organic compounds |
| **VwVwS** | German Administrative Regulation on the Classification of Substances Hazardous to Waters into Water Hazard Classes |
| **WGK** | Water Hazard Class |
| **WHO** | World Health Organization |

WILBUR-ELLIS®

# COMPETITOR®

## Modified Vegetable Oil

CPDA Certified

U.S. Patent No. 5,631,205

CA Reg. No. 2935-50173 WA Reg. No. 2935-04001

| PRINCIPAL FUNCTIONING AGENTS | % By Wt. |
|---|---|
| Ethyl Oleate, Sorbitan Alkylpolyethoxylate Ester, Dialkyl Polyoxyethylene Glycol | 98% |
| Constituents Ineffective as spray adjuvant | 2% |
| Total | 100% |

**KEEP OUT OF REACH OF CHILDREN**

## CAUTION

### PRECAUTIONARY STATEMENTS
### HAZARDS TO HUMANS AND DOMESTIC ANIMALS

CAUTION: Harmful if swallowed. Avoid breathing vapors or spray mist. Avoid contact with skin, eyes or clothing. Causes eye and skin irritation. Do not get in eyes, on skin or on clothing. Wear proper eye protection to reduce splash exposure. Wear protective gloves and proper personal protective equipment to reduce skin exposure. Wash thoroughly with soap and water after handling. Remove and wash contaminated clothing before reuse. This product may cause an allergic reaction in sensitive individuals.

### FIRST AID

**IF SWALLOWED**, Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person. **IF IN EYES**, Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice. **IF ON SKIN OR CLOTHING**, Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice. **IF INHALED**, Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call a poison control center or doctor for further treatment advice.

READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH PRECAUTIONARY STATEMENTS AND DIRECTIONS AND WITH APPLICABLE STATE REGULATIONS.

Read label of pesticide carefully. Keep container tightly closed and DO NOT allow water to be introduced to contents of this container.

### GENERAL INFORMATION

COMPETITOR is a Modified Vegetable Oil containing a non-ionic emulsifier system. COMPETITOR can be used with products where a modified vegetable oil or crop oil concentrate is recommended.

### PREPARATION OF SPRAY MATERIAL

Fill spray tank one-half full of water. Add the required amount of pesticide while agitating. Add remainder of the water. Add the recommended amount of COMPETITOR last and continue agitation until completion of spraying.

### DIRECTIONS FOR USE

**Aquatics:** COMPETITOR may be used as an additive with aquatically labeled pesticides. The use rates for COMPETITOR should follow the recommended adjuvant rate that is specified on the pesticide product label.

If there is no recommended adjuvant rate on the pesticide label, COMPETITOR should be used at the rate of 1 to 2 pints per acre in 5-30 gallons of water. For volumes greater than 30 gallons of water, do not exceed a rate of 1% volume/volume.

For handgun or backpack applications, do not exceed a rate of 5% volume/volume.

**Herbicides:** Use 1 to 4 pints of COMPETITOR per acre. The addition of a nitrogen fertilizer such as 28%-32% N solution or ammonium sulfate may be required to improve control under extreme environmental conditions or to satisfy certain label requirements. For over-the-Top Application, use caution at the higher application rates when temperatures exceed 85° F on sensitive crops such as seedling alfalfa.

**Insecticides:** Use 1/2 to 2 pints per 100 gallons of spray mix or use 1/4 to 1 pint per acre in concentrate sprays of 50 gallons or less.

For pesticides/herbicides that permit use of an adjuvant at a higher rate, follow instructions on that pesticide/herbicide label. **HOWEVER, DO NOT ADD THIS PRODUCT AT A RATE WHICH EXCEEDS 5% OF THE FINISHED SPRAY VOLUME, EXCEPT WHEN USED AS A DILUENT IN DORMANT, BASAL, SITE PREPARATION OR OTHER SIMILAR APPLICATIONS, PER LABEL INSTRUCTIONS.**

Use caution at the higher application rates. When applying to a sensitive crop, first treat a small area to determine if there may be adverse effects on the crop.

### STORAGE AND DISPOSAL

Do not contaminate water, food or feed by storage, disposal or cleaning of equipment. Open dumping is prohibited.
**STORAGE:** Keep product in original container. Do not put concentrate or dilute into food or drink containers. For help with any spill, leak, fire or exposure involving this material, call day or night CHEMTREC (800) 424-9300.
**PESTICIDE DISPOSAL:** Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.
**CONTAINER DISPOSAL:** Triple rinse (or equivalent). Do not reuse container. Offer for recycling or reconditioning or puncture and dispose of in a sanitary landfill or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

**NET CONTENTS: _____GALLON(S)**

Manufactured by:

**WILBUR-ELLIS COMPANY**
PO BOX 16458 – FRESNO CA 93755

Specimen

Conditions of Sale and Limitation of Warranty and Liability:

NOTICE: Read the entire Directions for Use and Conditions of Sale and Limitation of Warranty and Liability before buying or using the product. If the terms are not acceptable, return the product at once, unopened, and the purchase price will be refunded.

**ALL STATEMENTS MADE HEREIN ARE SUBJECT TO APPLICABLE LAW, AND TO THE EXTENT THERE IS ANY INCONSISTENCY OR CONTENTION, APPLICABLE LAW SHALL GOVERN.**

The Directions for Use of the product must be followed carefully. It is impossible to eliminate all risks inherently associated with the use of this product. Crop injury, ineffectiveness, or other unintended consequences may result because of many different factors including, without limitation, manner of use or application, weather, combination with other products, or crop conditions. All such risks shall be assumed by Buyer and User, and Buyer and User agree to hold Manufacturer and Seller harmless from any claims relating to such factors.

**Seller warrants that this product conforms to the chemical description on the label. EXCEPT FOR THIS WARRANTY, THE PRODUCT IS FURNISHED "AS-IS," AND NEITHER SELLER NOR MANUFACTURER MAKES ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THE SELECTION, PURCHASE OR USE OF THIS PRODUCT; SELLER AND MANUFACTURER SPECIFICALLY DISCLAIM ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE BEYOND WHAT IS STATED ON THE LABEL. Buyer and User accept all risks arising from any use of this product, including without limitation, uses contrary to label instructions, or under conditions not reasonably foreseeable to (or beyond the control of) Seller or Manufacturer.**

Neither Manufacturer nor Seller shall be liable for any incidental, consequential or special damages resulting from the use or handling of this product. THE EXCLUSIVE REMEDY OF THE BUYER OR USER, AND THE EXCLUSIVE LIABILITY OF MANUFACTURER AND SELLER, FOR ANY AND ALL CLAIMS, LOSSES, INJURIES OR DAMAGES (INCLUDING CLAIMS BASED ON BREACH OF WARRANTY, CONTRACT, NEGLIGENCE, TORT, STRICT LIABILITY OR OTHERWISE) RESULTING FROM THE USE OR HANDLING OF THIS PRODUCT, SHALL BE THE RETURN OF THE PURCHASE PRICE OF THIS PRODUCT, OR, AT THE ELECTION OF MANUFACTURER OR SELLER, THE REPLACEMENT OF THE PRODUCT.

These Conditions of Sale and Limitation of Warranty and Liability shall be interpreted, unless otherwise required by the law of the state of purchase, in accordance with the laws of the State of California, excluding its conflicts of laws rules, and may not be amended by any oral or written agreement.

WILBUR-ELLIS Logo® and COMPETITOR® are registered trademarks of WILBUR-ELLIS Company.

F-033108-2

IN CASE OF EMERGENCY,
CALL CHEMTREC: (800) 424-9300

Specimen

# SAFETY DATA SHEET

## 1. Identification

**Product identifier** **Competitor**

**Other means of identification** None.

**Recommended use** Ag Product - Adjuvant

**Recommended restrictions** None known.

**Manufacturer/Importer/Supplier/Distributor information**

**Manufacturer**

**Company name** Wilbur-Ellis Company LLC

**Address** Wilbur-Ellis Company LLC
8131 W. Grandbridge Blvd, Suite 200
Kennewick, WA 99336
United States

**Telephone** Branded Products Information (800) 500-1698

**E-mail** SDS@WilburEllis.com

**Emergency phone number** Chemtrec - Domestic (800) 424-9300
Chemtrec - International +1 703-741-5970

## 2. Hazard(s) identification

**Physical hazards** Not classified.

**Health hazards** Not classified.

**OSHA defined hazards** Not classified.

**Label elements**

**Hazard symbol** None.

**Signal word** None.

**Hazard statement** The mixture does not meet the criteria for classification.

**Precautionary statement**

**Prevention** Not applicable.

**Response** Not applicable.

**Storage** Not applicable.

**Disposal** Not applicable.

**Hazard(s) not otherwise classified (HNOC)** None known.

**Supplemental information** None.

## 3. Composition/information on ingredients

**Mixtures**

| Chemical name | Common name and synonyms | CAS number | % |
|---|---|---|---|
| Nonionic Surfactants | | Proprietary | 80 - < 90 |
| Ethyl and Methyl Esters of Canola Oil | | Proprietary | 20 - < 30 |

Percentage ranges of composition to protect confidentiality or due to batch variation.

## 4. First-aid measures

**Inhalation** Move to fresh air. Call a physician if symptoms develop or persist.

**Skin contact** Wash off with soap and water. Get medical attention if irritation develops and persists.

**Eye contact** Rinse with water. Get medical attention if irritation develops and persists.

**Ingestion** Rinse mouth. Get medical attention if symptoms occur.

| | |
|---|---|
| **Most important symptoms/effects, acute and delayed** | Direct contact with eyes may cause temporary irritation. |
| **Indication of immediate medical attention and special treatment needed** | Treat symptomatically. |
| **General information** | Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. |

## 5. Fire-fighting measures

| | |
|---|---|
| **Suitable extinguishing media** | Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2). |
| **Unsuitable extinguishing media** | Do not use water jet as an extinguisher, as this will spread the fire. |
| **Specific hazards arising from the chemical** | During fire, gases hazardous to health may be formed. |
| **Special protective equipment and precautions for firefighters** | Self-contained breathing apparatus and full protective clothing must be worn in case of fire. |
| **Fire fighting equipment/instructions** | Move containers from fire area if you can do so without risk. |
| **Specific methods** | Use standard firefighting procedures and consider the hazards of other involved materials. |
| **General fire hazards** | No unusual fire or explosion hazards noted. |

## 6. Accidental release measures

| | |
|---|---|
| **Personal precautions, protective equipment and emergency procedures** | Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Keep out of low areas. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. For personal protection, see section 8 of the SDS. |
| **Methods and materials for containment and cleaning up** | Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Cover with plastic sheet to prevent spreading. Absorb in vermiculite, dry sand or earth and place into containers. Prevent entry into waterways, sewer, basements or confined areas. Following product recovery, flush area with water.<br><br>Small Spills: Wipe up with inert absorbent material. Clean surface thoroughly to remove residual contamination.<br><br>Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS. |
| **Environmental precautions** | Avoid discharge into drains, water courses or onto the ground. |

## 7. Handling and storage

| | |
|---|---|
| **Precautions for safe handling** | Observe good industrial hygiene practices. |
| **Conditions for safe storage, including any incompatibilities** | Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS). |

## 8. Exposure controls/personal protection

**Occupational exposure limits**

**U.S. - OSHA**

| Material | Type | Value | Form |
|---|---|---|---|
| Competitor (CAS Mixture) | PEL | 5 mg/m3 | Respirable Fraction |
| | | 15 mg/m3 | Total Dust |

**ACGIH**

| Material | Type | Value | Form |
|---|---|---|---|
| Competitor (CAS Mixture) | TWA | 10 mg/m3 | Mist |

| | |
|---|---|
| **Biological limit values** | No biological exposure limits noted for the ingredient(s). |
| **Appropriate engineering controls** | Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. |

**Individual protection measures, such as personal protective equipment**

| | |
|---|---|
| **Eye/face protection** | Wear safety glasses with side shields (or goggles). |

| | |
|---|---|
| **Skin protection** | |
| **Hand protection** | Wear appropriate chemical resistant gloves. |
| **Other** | Wear suitable protective clothing. |
| **Respiratory protection** | In case of insufficient ventilation, wear suitable respiratory equipment. |
| **Thermal hazards** | Wear appropriate thermal protective clothing, when necessary. |
| **General hygiene considerations** | Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. |

## 9. Physical and chemical properties

| | |
|---|---|
| **Appearance** | Clear liquid with brown tint |
| **Physical state** | Liquid. |
| **Form** | Liquid. |
| **Color** | Clear / brown |
| **Odor** | Garlic odor |
| **Odor threshold** | Not available. |
| **pH** | Not available. |
| **Melting point/freezing point** | Not available. |
| **Initial boiling point and boiling range** | > 392 °F (> 200 °C) |
| **Flash point** | > 302.0 °F (> 150.0 °C) |
| **Evaporation rate** | Not available. |
| **Flammability (solid, gas)** | Not available. |
| **Upper/lower flammability or explosive limits** | |
| **Flammability limit - lower (%)** | Not available. |
| **Flammability limit - upper (%)** | Not available. |
| **Explosive limit - lower (%)** | Not available. |
| **Explosive limit - upper (%)** | Not available. |
| **Vapor pressure** | Not available. |
| **Vapor density** | Not available. |
| **Relative density** | Not available. |
| **Solubility(ies)** | |
| **Solubility (water)** | Emulsifiable |
| **Partition coefficient (n-octanol/water)** | Not available. |
| **Auto-ignition temperature** | Not available. |
| **Decomposition temperature** | Not available. |
| **Viscosity** | Not available. |
| **Other information** | |
| **Density** | 7.51 lb/gal |
| **Pour point** | 14 °F (-10 °C) |
| **Specific gravity** | 0.9 |

## 10. Stability and reactivity

| | |
|---|---|
| **Reactivity** | The product is stable and non-reactive under normal conditions of use, storage and transport. |
| **Chemical stability** | Material is stable under normal conditions. |
| **Possibility of hazardous reactions** | No dangerous reaction known under conditions of normal use. |
| **Conditions to avoid** | Avoid temperatures exceeding the flash point. Contact with incompatible materials. |
| **Incompatible materials** | Strong oxidizing agents. |

| | |
|---|---|
| **Hazardous decomposition products** | Irritating and/or toxic fumes and gases may be emitted upon the products decomposition. |

## 11. Toxicological information

**Information on likely routes of exposure**

| | |
|---|---|
| **Inhalation** | No adverse effects due to inhalation are expected. |
| **Skin contact** | No adverse effects due to skin contact are expected. |
| **Eye contact** | Direct contact with eyes may cause temporary irritation. |
| **Ingestion** | Expected to be a low ingestion hazard. |
| **Symptoms related to the physical, chemical and toxicological characteristics** | Direct contact with eyes may cause temporary irritation. |

**Information on toxicological effects**

| | |
|---|---|
| **Acute toxicity** | Not available. |
| **Skin corrosion/irritation** | Prolonged skin contact may cause temporary irritation. |
| **Serious eye damage/eye irritation** | Direct contact with eyes may cause temporary irritation. |

**Respiratory or skin sensitization**

| | |
|---|---|
| **Respiratory sensitization** | Not available. |
| **Skin sensitization** | This product is not expected to cause skin sensitization. |
| **Germ cell mutagenicity** | No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic. |
| **Carcinogenicity** | This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA. |

**OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)**

Not listed.

| | |
|---|---|
| **Reproductive toxicity** | This product is not expected to cause reproductive or developmental effects. |
| **Specific target organ toxicity - single exposure** | Not classified. |
| **Specific target organ toxicity - repeated exposure** | Not classified. |
| **Aspiration hazard** | Not available. |

## 12. Ecological information

| | |
|---|---|
| **Ecotoxicity** | The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment. |
| **Persistence and degradability** | No data is available on the degradability of this product. |
| **Bioaccumulative potential** | No data available. |
| **Mobility in soil** | No data available. |
| **Other adverse effects** | No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component. |

## 13. Disposal considerations

| | |
|---|---|
| **Disposal instructions** | Collect and reclaim or dispose in sealed containers at licensed waste disposal site. |
| **Local disposal regulations** | Dispose in accordance with all applicable regulations. |
| **Hazardous waste code** | The waste code should be assigned in discussion between the user, the producer and the waste disposal company. |
| **Waste from residues / unused products** | Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions). |
| **Contaminated packaging** | Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied. |

## 14. Transport information

**DOT**

Not regulated as dangerous goods.

**IATA**

Not regulated as dangerous goods.

**IMDG**

Not regulated as dangerous goods.

**Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code** Not established.

## 15. Regulatory information

**US federal regulations** All components are on the U.S. EPA TSCA Inventory List.
This product is not known to be a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

**TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)**

Not regulated.

**CERCLA Hazardous Substance List (40 CFR 302.4)**

Not listed.

**SARA 304 Emergency release notification**

Not regulated.

**OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)**

Not listed.

**Superfund Amendments and Reauthorization Act of 1986 (SARA)**

**Hazard categories** Immediate Hazard - Yes
Delayed Hazard - No
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

**SARA 302 Extremely hazardous substance**

Not listed.

**SARA 311/312 Hazardous chemical** No

**SARA 313 (TRI reporting)**

Not regulated.

**Other federal regulations**

**Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List**

Not regulated.

**Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)**

Not regulated.

**Safe Drinking Water Act (SDWA)** Not regulated.

**US state regulations**

**US. California Controlled Substances. CA Department of Justice (California Health and Safety Code Section 11100)**

Not listed.

**US. Massachusetts RTK - Substance List**

Not regulated.

**US. New Jersey Worker and Community Right-to-Know Act**

Not listed.

**US. Pennsylvania Worker and Community Right-to-Know Law**

Not listed.

**US. Rhode Island RTK**

Not regulated.

**US. California Proposition 65**

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

**International Inventories**

| Country(s) or region | Inventory name | On inventory (yes/no)* |
|---|---|---|
| United States & Puerto Rico | Toxic Substances Control Act (TSCA) Inventory | Yes |

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

## 16. Other information, including date of preparation or last revision

**Issue date** 02-23-2016

**Version #** 01

**NFPA ratings** Health: 1
Flammability: 0
Instability: 0

**NFPA ratings**

**Disclaimer** This information was developed from information on the constituent materials. No warranty is expressed or implied regarding the completeness or continuing accuracy of the information contained herein, and Wilbur-Ellis disclaims all liability for reliance thereon. The user should satisfy himself that he has all current data relevant to his particular use.

# CYGNET PLUS

## SPRAY ADJUVANT FOR PESTICIDES

**ACTIVATOR/PENETRANT • NONIONIC • BIODEGRADABLE • WATER EMULSIFIER • LOW VISCOSITY**

### CAUTION

Do not take internally. Avoid skin contact. KEEP OUT OF THE REACH OF CHILDREN.

### ANTIDOTE:

**If Swallowed:** Do not induce vomiting. Get medical attention. In case of skin contact, flush thoroughly with water.

FLASH POINT: 155°F
Combustible.

**STORAGE AND DISPOSAL:** Do not store near heat or open flame. Store in original container. Do not reuse empty container. Triple rinse (or equivalent) then dispose of or recondition container through the regulations set by local and state authorities.

CYGNET PLUS is noncorrosive to metal and chemical resistant hose; in continued use it is detrimental to rubber and plastic.

### ACTIVE INGREDIENTS:

| | |
|---|---|
| limonene | 75% |
| methylated vegetable oil | 15% |
| alkyl hydroxypoly oxyethylene | 10% |
| TOTAL | 100% |

**CYGNET PLUS** is a wetting agent, activator and penetrant all in one.

**CYGNET PLUS** is compatible with most terrestrial and aquatic herbicides, insecticides and other pesticides.

**CYGNET PLUS** contains no nonylphenol ethoxylates.

### DIRECTIONS FOR USE

| Type of Herbicide Application | HIGH VOLUME APPLICATION | | LOW VOLUME & AERIAL APPLICATION per acre |
|---|---|---|---|
| | per 100 gal. | per acre | |
| Aquatic - surface | 1 pint-2 quarts | 1 pint-2 quarts | 1 pint-2 quarts |
| Aquatic - submerged | 1-2 gallons | 1-2 gallons | 1-2 gallons |
| Agriculture/Citrus/Turf | 1-2 pints | 1-2 pints | 1-2 pints |
| Forest Site Preparation | 1-2 quarts | 1-2 quarts | 1-2 quarts |
| Utility Rights-of-Way and Roadside: Foliar | 1 pint-2 quarts | 1 pint-2 quarts | 1 pint-2 quarts |

**NET CONTENTS:**

### CONDITIONS OF SALE

We warrant that this product conforms to the chemical description on the label and is reasonably fit for the purposes set forth on the label when used according to directions under normal use conditions.

THERE ARE NO OTHER WARRANTIES, WHETHER EXPRESSED OR IMPLIED, INCLUDING A WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.

This warranty does not extend to the handling or use of this product contrary to label instructions or under abnormal conditions or under conditions not reasonably foreseeable to seller, and buyer assumes all risk of any such use.

Surfactants in CYGNET PLUS are exempt from the requirements of tolerance under Title 40, CFR, 180 Subpart D.

This Product is registered in California for aquatic uses under CA-1051114-50001

Manufactured by:
**BREWER International**
P.O. BOX 690037 VERO BEACH, FL 32969-0037
(772) 562-0555 1-800-228-1833
© 2014 BREWER INTERNATIONAL, INC.
www.brewerint.com

Manufactured for:
**CYGNET ENTERPRISES, INC.**
1860 Bagwell Street
FLINT, MI 48503-4406
1-800-359-7531
www.cygnetenterprises.com

# SAFETY DATA SHEET
# Cygnet Plus

**SDS DATE:** *revised* 8/16/2013

## SECTION 1: IDENTIFICATION

PRODUCT IDENTIFIER: Cygnet Plus

PRODUCT USE: Agriculture, forestry, fishery
Adjuvants, Surface active agents
Industrial spraying
Wide dispersive outdoor use of processing aids in open systems

SUPPLIER DETAILS: Name: Brewer International, Incorporated
Address: PO Box 690037
Vero Beach, FL 32969
Phone: (800) 228-1833
Fax: (772) 778-2490

EMERGENCY PHONE: Chem Tel (800) 255-3924 available 24 hours

## SECTION 2: HAZARD(S) IDENTIFICATION

**HAZARD CLASSIFICATION:** Skin Irritation, category 2
Eye Irritation, category 1
Skin Allergy, category 1

**EMERGENCY OVERVIEW**

**ROUTES OF ENTRY:** Eye Contact, Skin Contact, Inhalation, Ingestion

**HEALTH EFFECTS:**

Eyes: **WARNING** causes serious eye irritation.

Skin: **WARNING** causes skin irritation. **WARNING** may cause an allergic skin reaction.

## SECTION 3: COMPOSITION/INFORMATION ON HAZARDOUS INGREDIENTS

INGREDIENT: Blend of Limonenes

| CAS # | WT% |
|---|---|
| Not applicable | 32 |

INGREDIENT: Blend of Alcohol Ethoxylates

| CAS # | WT% |
|---|---|
| Not applicable | 11 |

## SECTION 4: FIRST-AID MEASURES

**IF IN EYES:** Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a doctor for medical advice.

**IF ON SKIN:** Wash with plenty of water and soap. If skin irritation or rash occurs, get medical advice. Take off contaminated clothing and wash it before reuse.

**IF SWALLOWED:** Rinse mouth. Call a doctor if you feel unwell.

**IF INHALED:** Remove person to fresh air and keep comfortable for breathing. Call a doctor if you feel unwell.

## SECTION 5: FIRE-FIGHTING MEASURES

**FLASH POINT:**
**F:** >200°
**C:** >93°

**SUITABLE EXTINGUISHING MEDIA:** Dry chemicals, alcohol-resistant foam, carbon dioxide, or water fog.

**UNSUITABLE EXTINGUISHING MEDIA:** Direct water stream may spread fire.

**SPECIFIC HAZARDS ARISING FROM THE CHEMICAL:** Incomplete combustion may produce carbon monoxide or carbon dioxide. Burning may produce noxious and toxic fumes.

**SPECIAL PROTECTIVE ACTIONS FOR FIRE-FIGHTERS:** Treat as oil fire. Evacuate the area promptly. Do not scatter spilled material with high pressure water streams. Use water spray to cool unopened containers. Wear self-contained breathing apparatus and full protective clothing.

## SECTION 6: ACCIDENTAL RELEASE MEASURES

**PERSONAL PRECAUTIONS:** Keep unnecessary personnel away. **DO NOT** touch damaged containers or spilled material unless wearing appropriate protective gear. Keep people away from and upwind of spill/leak. Keep out of low areas. Ensure adequate ventilation. Ventilate closed spaces before entering them. Material can create slippery conditions.

**ENVIRONMENTAL PRECAUTIONS:** Prevent further leakage or spillage if safe to do so. Keep out of drains, sewers ditches and waterways.

**METHODS FOR CONTAINMENT: ELIMINATE** all ignition sources (no smoking, flares, sparks or flames in the immediate area). Stop the flow of the material and dike spill area when possible without exposure to unnecessary risk.

**METHODS FOR CLEANING UP: DO NOT** release this product into the environment. Use equipment rated for use around combustible materials. For large spills, absorb spilled liquid with suitable non-combustible absorbent material such as dirt or sand. For small spills, wipe up with suitable absorbent material such as cloth. Clean exposed surfaces thoroughly to remove any residual contamination. Never return spills in original containers for re-use. Dispose any contaminated absorbents appropriately. For waste disposal, see section 13 of this MSDS.

## SECTION 7: HANDLING AND STORAGE

**PRECAUTIONS FOR SAFE HANDLING:** Wash hands and exposed skin thoroughly after handling. **DO NOT** breathe vapors or spray. Use only out doors or in a well-ventilated area. Keep material away from heat, sparks, and flame. Use appropriate personal protective equipment. Wear eye protection and protective gloves. **DO NOT** get in eyes, on skin or on clothing. Avoid prolonged and repeated contact. **DO NOT** swallow. Eating, drinking and smoking in work areas is prohibited. Remove contaminated clothing and protective equipment before entering eating areas. Contaminated work clothing must not be allowed out of the workplace.The container is hazardous when emptied and should be disposed of appropriately.

**STORAGE:** Store in a well-ventilated place with proper sprinkler/fire deterrent system. Keep cool. Avoid extreme temperatures. Keep container tightly closed. **DO NOT** cut, drill, grind or weld on or near this container. Keep out of the reach of children. Store locked up.

## SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

| INGREDIENT(S) | EXPOSURE LIMITS |
|---|---|
| Ethoxylated Alcohol | OSHA PEL: Not Established<br>ACGIH TWA: Not Established<br>ACGIH STEL: Not Established |
| Blend of Limonenes | OSHA PEL: Not Established<br>ACGIH TWA: Not Established<br>ACGIH STEL: Not Established |

PEL= Permissible Exposure Limits
TWA= Time Weighted Average
STEL= Short term Exposure Limit
ACGIH= American Conference of Governmental Industrial Hygienists
OSHA= Occupational Safety and Health Administration

**ENGINEERING CONTROLS:** Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. Maintain air concentrations below occupational exposure limits. Use local exhaust when misting occurs. Natural ventilation is adequate in absence of mists. Keep away from sparks and flames.

**RESPIRATORY PROTECTION:** No personal respiratory protective equipment normally required. An approved respirator must be worn if airborne concentrations are above any recommended exposure limits. In misty atmospheres, use an approved respirator.

**EYE PROTECTION:** If material could be misted or splashed into eyes, wear safety glasses with side shields (or goggles). Eye wash fountain should be available.

**SKIN PROTECTION:** Impervious gloves are recommended. Boots, apron, bodysuit, or other suitable protective clothing should be worn as necessary.

**WORK HYGIENIC PRACTICES:** When using, do not eat, drink or smoke. Do not get in eyes. Do not get this material in contact with skin. Wash hands and face before breaks and immediately after handling the product. Launder contaminated clothing before reuse. Have eye wash and emergency shower facilities immediately available. Handle in accordance with good industrial hygiene and safety practice.

## SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

**APPEARANCE:** Clear

**ODOR:** Low pine odor

**ODOR THRESHOLD:** No data available

**PHYSICAL STATE:** Liquid

**pH:** No data available

**FREEZING POINT:** No data available

**BOILING POINT:** No data available

**FLASH POINT:** >200°F (93.3°C)

**EVAPORATION RATE (N-Butyl Acetate = 1):** <1

**FLAMMABILITY (SOLID, GAS):** No data available

**UPPER/LOWER FLAMMABILITY:** No data available

**VAPOR PRESSURE (mmHg):** No data available
@ 68°F (20.0°C)

**VAPOR DENSITY (AIR = 1):** >1

**SPECIFIC GRAVITY (H2O = 1):** No data available
@ 68°F (20.0°C)

**SOLUBILITY IN WATER:** Insoluble

**PARTITION COEFFICIENT (N-Octanol/Water):** No data available

**AUTO-IGNITION TEMPERATURE:** No data available

**DECOMPOSITION TEMPERATURE:** No data available

**VISCOSITY:** No data available

## SECTION 10: STABILITY AND REACTIVITY

**REACTIVITY/POSSIBILITY OF HAZARDOUS REACTIONS:** Hazardous polymerization does not occur. Prevent oxidation by avoiding long-term exposure to air.

**CHEMICAL STABILITY:** Material is stable under normal conditions.

**CONDITIONS TO AVOID:** Keep away from heat, sparks, static discharge or flame and exposure to elevated temperatures.

**INCOMPATIBLE MATERIALS:** Strong acids and bases, including acidic clays; alkali metals; halogens; peroxides; vinyl chloride; and iodine pentafluoride.

**HAZARDOUS DECOMPOSITION OR BY-PRODUCTS:** Carbon monoxide, carbon dioxide, oxides of limonene and other organic compounds which may be toxic.

## SECTION 11: TOXICOLOGICAL INFORMATION

**ACUTE TOXICITY:** Oral, $ATE_{mix}$ = $LD_{50}$ 12,000 mg/kg for rats
Dermal, $ATE_{mix}$ = $LD_{50}$ 18,000 mg/kg for rabbits
Inhalation, no data available

**SKIN CORROSION/IRRITATION:** Causes skin irritation.

**EYE DAMAGE/IRRITATION:** Causes serious eye damage.

**RESPIRATORY OR SKIN SENSITIZATION:** May cause an allergic reaction.

**GERM CELL MUTAGENICITY:** No data available

**CARCINOGENICITY:** No components present in excess of 0.1% by weight listed as carcinogens by OSHA, NTP, IARC or ACGIH.

**REPRODUCTIVE TOXICITY:** No data available

**SPECIFIC TARGET ORGAN TOXICITY**

**SINGLE EXPOSURE:** Not expected

**REPEATED EXPOSURE:** Not expected

**ASPIRATION HAZARD:** Not expected

## SECTION 12: ECOLOGICAL INFORMATION

**ECOTOXICITY**

**Fish:** $ATE_{mix}$ = $LC_{50}$ 9 mg/L, fish/96 hr
**Daphnia:** $ATE_{mix}$ = $EC_{50}$ 4 mg/L, daphnia/48 hr

**PERSISTENCE AND DEGRADABILITY:** No data available

**BIOACCUMULATIVE POTENTIAL:** No data available

**MOBILITY IN SOIL:** No data available

**OTHER ADVERSE EFFECTS:** An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.

## SECTION 13: DISPOSAL CONSIDERATIONS

**WASTE DISPOSAL METHOD:** Incinerate or dispose of in accordance with Local, State, and Federal Regulations. Commercially clean containers prior to disposal. Oil soaked rags should be disposed of properly to prevent spontaneous combustion. Do not allow this material to drain into sewers/water supplies. For the safety of persons conducting disposal, please refer to the information in section 8.

## SECTION 14: TRANSPORT INFORMATION

**DOT**
Not regulated

**IATA**
Not regulated

**IMDG**
Not regulated

**TDG**
Not regulated

## SECTION 15: REGULATORY INFORMATION

**U.S. FEDERAL REGULATIONS:** This product is a Hazardous Chemical as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200. All components are on the U.S. EPA TSCA Inventory List or exempt under 40 CFR 720.30.

**CERCLA (COMPREHENSIVE RESPONSE COMPENSATION, AND LIABILITY ACT) reportable substances:**
not regulated

**SARA TITLE III (SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT)**

**HAZARD CATEGORIES**

**IMMEDIATE HAZARD:** Yes
**DELAYED HAZARD:** No
**FIRE HAZARD:** No
**PRESSURE HAZARD:** No
**REACTIVE HAZARD:** No

**313 REPORTABLE INGREDIENTS:** No

**302 EXTREMELY HAZARDOUS SUBSTANCE:** No

**CALIFORNIA PROPOSITION 65:** *The following statement is made in order to comply with the California Safe Drinking Water and Toxic Enforcement Act of 1986.* This product does not contain any chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

## SECTION 16: OTHER INFORMATION

**NFPA RATINGS**

**HEALTH:** 2
**FIRE:** 1
**REACTIVITY:** 0

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Kingscote CHEMICALS

# Safety Data Sheet

**Issue Date:** 09-Nov-2013 **Revision Date:** 06-Feb-2017 **Version Number:** 2.1

## 1. Identification

**Product Identifiers**
**Product Name:** Bright Dyes® FLT Yellow/Green Tablet

**Product Number:** 101101

**Recommended Use & Restrictions on Use**
Water tracing & leak detection dye

**Manufacturer/Supplier**
Kingscote Chemicals, Inc.
3334 South Tech Blvd.
Miamisburg, OH 45342
U.S.A.

**Emergency Telephone Number**
**Company Telephone Number:** (937) 886-9100
**Emergency Telephone (24 hr):** INFOTRAC (800) 535-5053 (North America)
+1-352-323-3500 (International)

## 2. Hazards Identification

**Classification**
This chemical does not meet the hazardous criteria set forth by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200). However, this Safety Data Sheet (SDS) contains valuable information critical to the safe handling and proper use of this product. This SDS should be retained and available for employees and other users of this product.

## 3. Composition/Information on Ingredients

This product is not hazardous according to OSHA 29 CFR 1910.1200. Components not listed are not hazardous or are below reportable limits.

## 4. First-Aid Measures

**First-Aid Measures**

| | |
|---|---|
| **Eye Contact** | Rinse immediately with plenty of water, also under the eyelids, for at least 15 minutes. If eye irritation persists: Get medical advice/attention. |
| **Skin Contact** | Wash thoroughly with plenty of soap and water. If skin irritation occurs: Get medical advice/attention. |
| **Inhalation** | Remove to fresh air. If breathing is difficult, administer oxygen; seek medical attention immediately. |

**Ingestion** Rinse mouth. DO NOT induce vomiting. Drink plenty of water. Never give anything by mouth to an unconscious person. Get medical attention if large quantities were ingested or if nausea occurs.

**Most Important Symptoms and Effects**

**Symptoms** Will cause staining of the skin on contact. May cause eye irritation. Inhalation of dust may cause respiratory irritation. Ingestion may cause urine to be a yellow/green color until the dye has been washed through the system.

**Indication of Any Immediate Medical Attention and Special Treatment Needed**

**Notes to Physician** Treat symptomatically.

## 5. Fire-Fighting Measures

**Suitable Extinguishing Media**
Water spray (fog). Carbon dioxide (CO2). Dry chemical.

**Unsuitable Extinguishing Media**
Not determined

**Specific Hazards Arising from the Chemical**
Remote possibility of dust explosion. Burning may produce oxides of carbon and nitrogen (NOx).

**Protective Equipment and Precautions for Firefighters**
Wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear.

## 6. Accidental Release Measures

**Personal Precautions, Protective Equipment and Emergency Procedures**

**Personal Precautions** Use personal protective equipment as recommended in Section 8.

**Environmental Precautions** Prevent from entering into soil, ditches, sewers, waterways and/or groundwater. See Section 12 and Section 13.

**Methods and Material for Containment and Cleaning Up**

**Methods for Containment** Prevent further leakage or spillage if safe to do so.

**Methods for Cleaning Up** Sweep up and collect into suitable containers for disposal. Flush area with water.

## 7. Handling and Storage

**Precautions for Safe Handling**

**Advice on Safe Handling** Handle in accordance with good industrial hygiene and safety practices. Use personal protection recommended in Section 8. Avoid contact with skin, eyes, or clothing. Avoid breathing dusts. Contaminated clothing should not be allowed out of the workplace.

**Conditions for Safe Storage, Including Incompatibilities**

| | |
|---|---|
| **Storage Conditions** | Keep container tightly closed and store in a cool, dry, and well-ventilated area. Store away from heat, sparks, open flame or any other ignition source. |
| **Incompatible Materials** | Bromine trifluoride. Lithium. Strong acids, bases, and oxidizing agents. |

## 8. Exposure Controls / Personal Protection

**Exposure Guidelines**

This product, as supplied, does not contain any hazardous materials with occupational exposure limits established by the region specific regulatory bodies.

**Engineering Controls**

Ensure adequate ventilation, especially in confined areas. Eyewash stations. Showers.

**Individual Protection Measures, Such as Personal Protective Equipment:**

| | |
|---|---|
| **Eye/Face Protection** | Avoid contact with eyes. |
| **Skin & Body Protection** | Rubber gloves. Suitable protective clothing. |
| **Respiratory Protection** | Use NIOSH-approved dust mask if dusty conditions exist. |
| **Hygiene Measures** | Handle in accordance with good industrial hygiene and safety practices. |

## 9. Physical and Chemical Properties

**Information on Basic Physical and Chemical Properties**

| | | | |
|---|---|---|---|
| **Physical State** | Solid | **Odor** | None apparent |
| **Appearance** | Orange tablet | **Odor Threshold** | Not determined |
| **Color** | Orange | | |

| **Property** | **Values** |
|---|---|
| **pH** | Not applicable |
| **Melting/Freezing Point** | Not applicable |
| **Boiling Point/Range** | Not applicable |
| **Flash Point** | Not applicable |
| **Evaporation Rate** | Not applicable |
| **Flammability (solid, gas)** | Not flammable |
| **Upper Flammability Limits** | Not applicable |
| **Lower Flammability Limits** | Not applicable |
| **Vapor Pressure** | Not applicable |
| **Vapor Density** | Not applicable |
| **Relative Density** | Not applicable |
| **Specific Gravity** | Not applicable |
| **Solubility** | Highly soluble in water with small amounts of insoluble residue |
| **Partition Coefficient** | Not determined |
| **Auto-ignition Temperature** | Not determined |
| **Decomposition Temperature** | Not determined |
| **Viscosity** | Not determined |

## 10. Stability and Reactivity

**Reactivity**
Not reactive under normal conditions.

**Chemical Stability**
Stable under recommended storage conditions.

**Possibility of Hazardous Reactions**
None under normal processing.

**Conditions to Avoid**
Keep separated from incompatible substances. Keep out of reach of children.

**Incompatible Materials**
Bromine trifluoride. Lithium. Strong acids, bases, and oxidizing agents.

**Hazardous Decomposition Products**
Oxides of carbon and nitrogen (NOx).

## 11: Toxicological Information

**Information on Likely Routes of Exposure**

| | |
|---|---|
| **Inhalation** | Avoid inhalation of dust. |
| **Ingestion** | Do not ingest. |
| **Skin Contact** | May cause an allergic skin reaction. |
| **Eye Contact** | Avoid contact with eyes. |

**Delayed, Immediate, and Chronic Effects from Short- and Long-Term Exposure**
May cause an allergic skin reaction.

**Numerical Measures of Toxicity**
Not determined

**Symptoms Associated with Exposure**
See Section 4 of this SDS for symptoms.

**Carcinogenicity**

| | |
|---|---|
| **NTP** | None |
| **IARC** | None |
| **OSHA** | None |

## 12. Ecological Information

**Ecotoxicity**
This product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

**Component Information**
Not available

**Persistence/Degradability**
This product is biodegradable.

**Bioaccumulation**
Not determined

**Mobility**
Not determined

**Other Adverse Effects**
Not determined

## 13. Disposal Considerations

**Waste Disposal Methods**
Dispose of in accordance with federal, state, and local regulations.

**Contaminated Packaging**
Do not re-use empty containers. Dispose of containers in accordance with federal, state, and local regulations.

## 14. Transport Information

**Note**
See current shipping paper for most up-to-date shipping information, including exemptions and special circumstances.

| | |
|---|---|
| **DOT** | Not regulated |
| **IATA** | Not regulated |
| **OMDG** | Not regulated |

## 15: Regulatory Information

**International Inventories**
Not determined

**U.S. Federal Regulations**

| | |
|---|---|
| **CERCLA** | This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund |

Amendments and Reauthorization Act (SARA) (40 CFR 355).

**SARA 313** Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372.

**CWA (Clean Water Act)** This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42).

**U.S. State Regulations**

**California Proposition 65** This product does not contain any Proposition 65 chemicals.

**U.S. State Right-to-Know** This product does not contain any substances regulated under applicable state right-to-know regulations.

## 16: Other Information

**HMIS**

| Health Hazards | Flammability | Instability | Special Hazards |
|---|---|---|---|
| 1 | 0 | 0 | Not determined |

**NFPA**

| Health Hazards | Flammability | Physical Hazards | Personal Protection |
|---|---|---|---|
| 1 | 0 | 0 | B |

**Issue Date** 09-Nov-2013

**Revision Date** 06-Feb-2017

**Revision Note** Content Review

**Disclaimer**

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

**End of Safety Data Sheet**

# Material Safety Data Sheet

## Section 1. Product and Company Identification

**Product Name:** COLORFAST® PURPLE
**Product Code:** BUI/CFASTPURPLE
**Manufacturer Information:** Becker Underwood, Inc.
801 Dayton Avenue
Ames, Iowa 50010
Information Phone: (515) 232-5907
Emergency Phone: Chemtrec (800) 424-9300

**Hazardous Material Information System:**

| | |
|---|---|
| Health | 2 |
| Flammability | 1 |
| Physical Hazard | 1 |
| Personal Protection | X |

## Section 2. Hazards Identification

**Emergency Overview:** May cause respiratory tract, eye, and skin burns.

**Potential Acute Health Effects:** This liquid is expected to be corrosive.

*Eyes:* Eye contact may result in burns and permanent injury.

*Skin:* Exposure to unprotected skin areas may cause temporary staining. Skin contact with the liquid may result in dermatitis and burns.

*Inhalation:* Severe inhalation overexposures to acetic acid may result in pulmonary edema. Inhalation of the vapors or mists causes irritation of the respiratory tract and inflammation of the lungs may result.

*Ingestion:* Ingestion may cause moderate to severe gastric irritation including nausea, vomiting, and severe pain. Ulceration or perforation of the gastrointestinal tract may also occur.

## Section 3. Composition/Information on Ingredients

| Component | CAS Number | Weight Percent |
|---|---|---|
| Acetic Acid* | 64-19-7 | ~30 % |
| Colorant mixture | Proprietary | Proprietary |
| Water | 7732-18-5 | Proprietary |

The exact composition of this material is a trade secret and contains no other components or impurities which will influence the classification with regard to human and environmental risk assessment.

## Section 4. First Aid Measures

**Eye Contact:** Immediately flush eyes with water for at least 15 minutes. Get immediate medical attention.
**Skin Contact:** Immediately wash affected area with soap and water. Get immediate medical attention. Remove and launder contaminated clothing before reuse.
**Inhalation:** If difficulty in breathing occurs, move to fresh air. Seek medical attention.
**Ingestion:** Seek immediate medical attention. Dilute with water. DO NOT INDUCE VOMITING.

## Section 5. Fire Fighting Measures

**Flammability** Not a fire or explosion hazard when stored under normal conditions. At temperatures above 109°F, acetic acid gives off vapors which may form an explosive mixture with air.

**Fire Fighting Media:** Foam, alcohol foam, CO2, dry chemical, water fog.

**Protective Clothing:** No special protective clothing required in addition to standard fire fighting equipment.

## Section 6. Accidental Release Measures

**Clean-Up Procedures:** Spills should be contained, solidified and placed in suitable containers for disposal in a licensed facility. This material is regulated by CERCLA ("Superfund"). Dispose of collected material according to federal, state/provincial and local environmental regulations.

**Spills and Leaks:** Contain the spill or leak to prevent discharges to surface streams or storm sewers. This material is a concentrated colorant. Small quantities in contaminated water solutions will color large volumes.

## Section 7. Handling and Storage

**Handling:** Avoid breathing fumes. General mechanical ventilation can be expected to effectively remove and prevent build up of any vapor or mist generated from handling this product in a closed environment. Protect eyes to prevent contact. Avoid skin contact.

**Storage:** Keep container in a dry place inaccessible to children and pets at temperatures above freezing. Keep containers sealed until ready for use.

## Section 8. Exposure Control/Personal Protection

| **Hazardous Components** | | **Occupational Exposure Limits** | |
|---|---|---|---|
| **Component** | **CAS Number** | **OSHA PEL** | **ACGIH TLV** |
| Acetic Acid* | 64-19-7 | 10 ppm | TWA 10ppm, STEL 15ppm |
| Colorant mixture | Proprietary | Not established | Not established |
| Water | 7732-18-5 | Not established | Not established |
| *Acetic Acid is a CERCLA hazardous waste with a reporting quantity of 5000 pounds. | | | |

**Engineering controls:** General mechanical ventilation can be expected to effectively remove and prevent build up of any vapor or mist generated from handling this product in a closed environment.

**Personal Protection:**

*Eyes:* Wear safety glasses with side shields. Wear additional eye protection such as chemical goggles or face shield if splashing or spraying hazard exists. Have an eye wash station available.

*Body:* To prevent skin contact wear coveralls, apron, boots, or lab coat.

*Hands:* Avoid skin contact by using chemically resistant gloves.

*Respiratory:* Use local exhaust to control excessive vapors/mists. If excessive vapors or mists persist use appropriate NIOSH/MSHA approved organic vapor/mist respirator.

**Other:** Open wounds or skin surface disruptions should be covered with a chemical resistant patch to minimize absorption risks. Clean clothing should be worn daily to avoid possible long-term build up of the product leading to chronic overexposure.

## Section 9. Physical and Chemical Properties

| | | | |
|---|---|---|---|
| **Odor** | Acetic acid odor | **Vapor Density** | Heavier than air |
| **Color** | Dark purple | **Evaporation Rate** | Slower than ether |
| **Physical state** | Liquid | **Density** | 8.85-9.1 lbs/gal |
| **pH** | 2-3 | **Solubility** | Water soluble |
| **Melting/Freezing Point** | NA | | |

## Section 10. Stability and Reactivity

**Chemical Stability:** This material is chemically stable under normal storage and handling conditions.

**Hazardous Decomposition:** When involved in a fire, burning may evolve noxious fumes which may include carbon monoxide, carbon dioxide, nitrous oxides, acetic acid, or other toxic compounds depending on the chemical composition and combustion conditions.

**Hazardous Polymerization:** Is not known to occur.

**Incompatibility (Materials to Avoid):** Long term storage in direct contact with reactive metals such as aluminum, zinc, copper, nickel, magnesium, etc. Other materials to avoid include strong oxidizing agents.

**Conditions to Avoid:** High humidity. Extremes in temperature. At temperatures above 109°F, acetic acid gives off vapors which may form an explosive mixture with air.

## Section 11. Toxicological Information

**Chronic Toxicity:** None known
**Mutagenic Effects:** None known
**Teratogenic Effects:** None known
**Developmental Toxicity:** None known
**Acute Effects on Humans:** This liquid is expected to be corrosive.
**Sensitization:** Repeated or prolonged exposure to the substance at concentration above the exposure limits may cause respiratory tract and lung sensitization.
**Carcinogenic Effects:** None known.
**Existing Medical Conditions Aggravated By Exposure:** May provoke asthmatic response in persons with asthma who are sensitive to airway irritants.

## Section 12. Ecological Information

**Ecotoxicity:** No data available, however the material is not expected to have any deleterious toxic effect.
**Environmental Fate:** No data available regarding the environmental fate or biodegradation.

## Section 13. Disposal Considerations

**EPA Waste Number:** Non-hazardous waste
**Treatment:** Dispose of according to all federal, state/provincial and local environmental regulations.

## Section 14. Transport Information

**D.O.T. Proper Shipping Name & Description:** UN 2790, ACETIC ACID SOLUTION, 8, PGIII, LTD QTY
**D.O.T. Hazard Classification:** 8
**D.O.T. Labels Required:** 8, Corrosive
**D.O.T. Identification:** UN 2790
**D.O.T. Packing Group:** PG III
**Limited Quantity Exceptions:** Less than 30 kgs gross weight; inner packages not to exceed 5 liters net capacity.

## Section 15. Regulatory Information

**Hazardous Material Information System III:**

| | |
|---|---|
| **TSCA Toxic Substances Control Act** | All ingredients are listed or exempt from the requirement. |
| **SARA** Superfund Amendment and Reauthorization Act | |
| **EPCRA** Emergency Planning & Community Right-to-Know Act | |
| Section 302 Extremely Hazardous Substances | None of the chemicals in this product are listed. |
| Section 311 and 312 Hazards *Acute:* | Yes |
| *Chronic:* | Yes |
| *Fire:* | No |
| *Pressure:* | No |
| *Reactive:* | No |
| Section 313 Toxic Chemical Release Inventory | No reportable quantities of toxic chemical(s) subject to the reporting requirements of Section 313 of SARA Title III and of 40 CFR 372 are present |
| **CERCLA** Hazardous substances | Acetic Acid is a CERCLA hazardous waste with a reporting quantity of 5000 pounds. |
| **Clean Air Act** | This material does not contain any hazardous air pollutants, nor any Class 1, 2 ozone depletors. |
| **Clean Water Act** | None of the chemicals in this product are listed as Hazardous Substances, Priority or Toxic Pollutants under the CWA. |
| **California Proposition 65 Carcinogens & Reproductive Toxicity (CRT) List:** | No ingredients in this product are known in the State of California to cause cancer or birth defects |
| **OSHA Regulatory Status:** | This product is considered hazardous under the OSHA Hazard Communication Standard (29CFR 1910.1200). |

## Section 16. Other Information

| | |
|---|---|
| Revision | 6 |
| Date | June 29, 2011 |
| Supersedes | November 4, 2010 |
| Created By: | GF |

**Hazardous Material Information System:**

| | |
|---|---|
| **Health** | 2 |
| **Flammability** | 1 |
| **Physical Hazard** | 1 |
| Personal Protection | X |

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**Safety Data Sheet**

**INTRACID RHODAMINE WT LIQUID**

Safety Data Sheet dated: 5/13/2015 - version 1

Date of first edition: 5/13/2015

## 1. IDENTIFICATION

**Product identifier**

Mixture identification:

Trade name: INTRACID RHODAMINE WT LIQUID

**Other means of identification:**

Trade code: A45171566

**Recommended use of the chemical and restrictions on use**

Recommended use: Industrial color additive

Restrictions on use: Not Determined

**Name, address, and telephone number of the chemical manufacturer, importer, or other responsible party**

Sensient Colors LLC

2515 N. Jefferson

63106 St. Louis, MO (USA)

Phone: 1 800-325-8110

Emergency Number(CHEMTREC): 1-800-424-9300

## 2. HAZARD(S) IDENTIFICATION

The identity of the individual components of this product is proprietary information and is considered a trade secret pursuant to 29 CFR 1910.1200

Hazardous components as defined in the OSHA Hazard Communication Standard: components with a HEALTH hazard (carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, etc.. ) and/or a PHYSICAL hazard (a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive, etc.)

**Classification of the chemical**

| | |
|---|---|
| Skin Irrit. 2 | Causes skin irritation. |
| Eye Irrit. 2B | Causes eye irritation |

**Label elements**

**Symbols:**

Warning

| Code | Description |
|---|---|
| H315 | Causes skin irritation. |
| H320 | Causes eye irritation |

| Code | Description |
|---|---|
| P264 | Wash ... Thoroughly after handling. |
| P280 | Wear protective gloves/protective clothing/eye protection/face protection. |
| P302+P352 | IF ON SKIN: Wash with plenty of water/… |
| P305+P351+P338 | IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. |
| P321 | Specific treatment (see ... On this label). |
| P332+P313 | If skin irritation occurs: Get medical advice/attention. |
| P337+P313 | If eye irritation persists: Get medical advice/attention. |

P362+P364 Take off contaminated clothing and wash it before reuse.

**Ingredient(s) with unknown acute toxicity:**

None

**Hazards not otherwise classified identified during the classification process:**

None

## 3. COMPOSITION/INFORMATION ON INGREDIENTS

**Substances**

Not Determined

**Mixtures**

Hazardous components within the meaning of 29 CFR 1910.1200 and related classification:

**List of components**

| Qty | Name | Ident. Numb. | Classification | Registration Number |
|---|---|---|---|---|
| 10-12.5 % | RHODAMINE LIQUID | CAS:65392-81-6<br>EC:265-730-6 | Skin Irrit. 2, H315; Eye Irrit. 2B, H320 | |
| 10-12.5 % | RHODAMINE LIQUID | CAS:75701-30-3<br>EC:278-292-6 | Skin Irrit. 2, H315; Eye Irrit. 2B, H320 | |
| 1-3 % | TRIMELLITIC ACID | CAS:528-44-9<br>EC:208-432-3 | Skin Irrit. 2, H315; Eye Irrit. 2A, H319; STOT SE 3, H335 | |

## 4. FIRST AID MEASURES

**Description of first aid measures**

In case of skin contact:

Immediately take off all contaminated clothing and shoes.

Immediately remove any contaminated clothing, shoes or stockings.

After contact with skin, wash immediately with soap and plenty of water.

In case of eye contact:

Wash immediately and thoroughly with running water, keeping eyelids regularly raised, for at least 15 minutes. Cold water may be used. Check for and remove any contact lenses at once. OBTAIN A MEDICAL EXAMINATION.

Protect the eyes with a sterile gauze or a clean, dry handkerchief.

In case of ingestion:

Do not induce vomiting, get medical attention showing the MSDS and label hazardous.

In case of inhalation:

Remove casualty to fresh air and keep warm and at rest.

**Most important symptoms/effects, acute and delayed**

Eye irritation

Eye damages

Skin Irritation

Erythema

**Indication of any immediate medical attention and special treatment needed**

In case of accident or unwellness, seek medical advice immediately (show directions for use or safety data sheet if possible).

## 5. FIRE-FIGHTING MEASURES

**Extinguishing media**

Suitable extinguishing media:

Water, CO2, foam, chemical powders, according to the materials involved in the fire.

In case of fire, use foam, dry chemical, CO2.

**Unsuitable extinguishing media:**

None in particular.

**Specific hazards arising from the chemical**

Do not inhale explosion and combustion gases.

Burning produces heavy smoke.

Hazardous combustion products: Not Determined

Explosive properties: Not Determined

Oxidising properties: Not Determined

**Special protective equipment and precautions for fire-fighters**

Use suitable breathing apparatus .

Collect contaminated fire extinguishing water separately. This must not be discharged into drains.

Move undamaged containers from immediate hazard area if it can be done safely.

## 6. ACCIDENTAL RELEASE MEASURES

**Personal precautions, protective equipment and emergency procedures**

Wear personal protection equipment.

Remove persons to safety.

See protective measures under point 7 and 8.

**Methods and material for containment and cleaning up**

Suitable material for taking up: dry and inert absorbing material (e.g. vermiculite, sand, earth).

Wash with plenty of water.

## 7. HANDLING AND STORAGE

**Precautions for safe handling**

Avoid contact with skin and eyes, inhalation of vapours and mists.

Don't use empty container before they have been cleaned.

Before making transfer operations, assure that there aren't any incompatible material residuals in the containers.

Contamined clothing should be changed before entering eating areas.

Do not eat or drink while working.

See also section 8 for recommended protective equipment.

**Conditions for safe storage, including any incompatibilities**

Storage temperature: Not Determined

Incompatible materials:

None in particular.

Instructions as regards storage premises:

Adequately ventilated premises.

## 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

**Control parameters**

No Data Available

Appropriate engineering controls: Not Determined

**Individual protection measures**

Eye/face protection:

Use close fitting safety goggles, don't use eye lens.

Skin protection:

Use clothing that provides comprehensive protection to the skin, e.g. cotton, rubber, PVC or viton.

Hand protection:

Use protective gloves that provide comprehensive protection, e.g. P.V.C., neoprene or rubber.

Respiratory protection:

Not Determined

## 9. PHYSICAL AND CHEMICAL PROPERTIES

**Information on basic physical and chemical properties**

Physical State Liquid

Appearance: Liquid,

Odour: Not Determined

Odour threshold: Not Determined

pH: 10.50

Melting point/ range: Not Determined

Boiling point/ range: Not Determined

Flash point: > 100°C / 212°F

Evaporation rate: Not Determined

Upper/lower flammability or explosive limits: Not Determined

Vapour density: Not Determined

Vapour pressure: Not Determined

Density: Not Determined

Water solubility: Not Determined

Lipid solubility: Not Determined

Partition coefficient (n-octanol/water): Not Determined

Auto-ignition temperature: Not Determined

Decomposition temperature: Not Determined

Viscosity: Not Determined

Explosive properties: Not Determined

Oxidising properties: Not Determined

Flammability (Solid, Gas): Not Determined

**Other information**

Substance group relevant properties: Not Determined
Miscibility: Not Determined
Fat Solubility: Not Determined
Conductivity: Not Determined

## 10. STABILITY AND REACTIVITY

**Reactivity**

Stable under normal conditions.

**Chemical stability**

Data not Available.

**Possibility of hazardous reactions**

Burning produces carbon monoxide and/or carbon dioxide.

**Conditions to avoid**

Stable under normal conditions of temperature and pressure.

**Incompatible materials**

Avoid strong oxidizing agents, peroxides, acids, alkali metals.

**Hazardous decomposition products**

Burning produces carbon monoxide and/or carbon dioxide.

## 11. TOXICOLOGICAL INFORMATION

**Information on toxicological effects**

Toxicological information of the product: No Data Available

**Substance(s) listed on the IARC Monographs:**

None

**Substance(s) listed as OSHA Carcinogen(s):**

None

**Substance(s) listed as NIOSH Carcinogen(s):**

None

**Substance(s) listed on the NTP report on Carcinogens:**

None

## 12. ECOLOGICAL INFORMATION

**Toxicity**

Adopt good working practices, so that the product is not released into the environment.
Eco-toxicity:

**List of Eco-Toxicological properties of the product**

No Data Available

**Persistence and degradability**

Not Determined

**Bioaccumulative potential**

Not Determined

**Mobility in soil**

Not Determined

**Other adverse effects**

Not Determined

## 13. DISPOSAL CONSIDERATIONS

**Waste treatment methods**

Recover if possible. In so doing, comply with the local and national regulations currently in force.

## 14. TRANSPORT INFORMATION

**UN number**

ADR-UN number: N/A
DOT-UN Number: N/A
IATA-Un number: N/A
IMDG-Un number: N/A

**UN proper shipping name**

ADR-Shipping Name: N/A
DOT Proper Shipping Name: N/A
IATA-Technical name: N/A
IMDG-Technical name: N/A

**Transport hazard class(es)**

ADR-Class: N/A
DOT Hazard Class: N/A
IATA-Class: N/A
IMDG-Class: N/A

**Packing group**

ADR-Packing Group: N/A
Exempted for ADR: N/A
IATA-Packing group: N/A
IMDG-Packing group: N/A

**Environmental hazards**

Marine pollutant: No
Environmental Pollutant: Not Determined

**Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code**

Not Determined

**Special precautions**

Department of Transportation (DOT):

DOT-Special Provision(s): N/A
DOT Label(s): N/A
DOT Symbol: N/A
DOT Cargo Aircraft: N/A
DOT Passenger Aircraft: N/A
DOT/TDG Bulk: N/A
DOT Non-Bulk: N/A

Road and Rail (ADR-RID):

ADR-Label: N/A
ADR-Upper number: N/A
ADR Tunnel Restriction Code: N/A

Air (IATA):

IATA-Passenger Aircraft: N/A
IATA-Cargo Aircraft: N/A
IATA-Label: N/A
IATA-Sub Risk: N/A
IATA-Erg: N/A
IATA-Special Provisioning: N/A

Sea (IMDG):

IMDG-Stowage Code: N/A
IMDG-Stowage Note: N/A
IMDG-Sub Risk: N/A
IMDG-Special Provisioning: N/A
IMDG-Page: N/A
IMDG-Label: N/A
IMDG-EMS: N/A
IMDG-MFAG: N/A

## 15. REGULATORY INFORMATION

**USA - Federal regulations**

**TSCA - Toxic Substances Control Act**

**TSCA inventory:**

All the components are listed on the TSCA inventory

**TSCA listed substances:**

| | | |
|---|---|---|
| RHODAMINE LIQUID | is listed in TSCA | Section 8b |
| RHODAMINE LIQUID | is listed in TSCA | Section 8b |
| TRIMELLITIC ACID | is listed in TSCA | Section 8b, Section 5 |

**SARA - Superfund Amendments and Reauthorization Act**

**Section 302 - Extremely Hazardous Substances:**

no substances listed

**Section 304 - Hazardous substances:**

no substances listed

**Section 313 - Toxic chemical list:**

no substances listed

**CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act**

**Substance(s) listed under CERCLA:**

no substances listed

**CAA - Clean Air Act**

**CAA listed substances:**

no substances listed

**CWA - Clean Water Act**

**CWA listed substances:**

no substances listed

**USA - State specific regulations**

**California Proposition 65**

**Substance(s) listed under California Proposition 65:**

no substances listed

**Massachusetts Right to know**

**Substance(s) listed under Massachusetts Right to know:**

no substances listed

**Pennsylvania Right to know**

**Substance(s) listed under Pennsylvania Right to know:**

no substances listed

**New Jersey Right to know**

**Substance(s) listed under New Jersey Right to know:**

no substances listed

## 16. OTHER INFORMATION

| Code | Description |
|---|---|
| H315 | Causes skin irritation. |
| H319 | Causes serious eye irritation. |
| H320 | Causes eye irritation |
| H335 | May cause respiratory irritation. |

Safety Data Sheet dated: 5/13/2015 - version 1

The information contained herein is based on our state of knowledge at the above-specified date. It refers solely to the product indicated and constitutes no guarantee of particular quality. The information relates only to the specific material and may not be valid for such material used in combination with any other material or in any process.

This document was prepared by a competent person who has received appropriate training.

It is the duty of the user to ensure that this information is appropriate and complete with respect to the specific use intended.

This MSDS cancels and replaces any preceding release.

**Legend to abbreviations and acronyms used in the safety data sheet:**

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road.

RID: Regulation Concerning the International Transport of Dangerous Goods by Rail

IMDG: International Maritime Code for Dangerous Goods

IATA: International Air Transport Association

IATA-DGR: Dangerous Goods Regulation by the "International Air Transport Association" (IATA)

ICAO: International Civil Aviation Organization

ICAO-TI: Technical Instructions by the "International Civil Aviation Organization" (ICAO)

GHS: Globally Harmonized System of Classification and Labeling of Chemicals
CLP: Classification, Labeling, Packaging
EINECS: European Inventory of Existing Commercial Chemical Substances
INCI: International Nomenclature of Cosmetic Ingredients
CAS: Chemical Abstracts Service (division of the American Chemical Society)
GefStoffVO: Ordnance on Hazardous Substances, Germany
LC50: Lethal concentration, for 50 percent of test population
LD50: Lethal dose, for 50 percent of test population
DNEL: Derived No Effect Level
PNEC: Predicted No Effect Concentration
TLV: Threshold Limiting Value
TWATLV: Threshold Limiting Value for the Time Weighted Average 8 hour day.(ACGIH Standard)
STEL: Short Term Exposure limit
STOT: Specific Target Organ Toxicity
WGK: German Water Hazard Class
KSt: Explosion coefficient
y for the damage.

Section 3

# UC Davis Toxicity Study Results

# Acute and Chronic Toxicity Testing of New Herbicides and Adjuvants on Delta Smelt, *Hypomesus transpacificus*

Division of Boating and Waterways Contract No. C1370030
Final Report
Draft V. 1.0

Marie Stillway, Krista Callinan Hoffmann, Wilson Ramirez-Duarte, Pedro Triana Garcia, Tomofumi Kurobe, and Swee Teh
Aquatic Health Program Laboratory
6/30/2017

# Table of Contents

List of Tables and Figures ..... 3
Tables ..... 3
Figures ..... 3
Executive Summary ..... 6
Introduction ..... 10
Materials and Methods – Early Life Stage Delta Smelt and Food Web Studies ..... 11
Testing organisms ..... 11
Delta Smelt ..... 11
*Eurytemora affinis* ..... 11
*Thalassiosira pseudonana* ..... 11
Chemical solutions ..... 11
Chemical analyses ..... 12
Toxicity tests ..... 12
Embryo-stage Delta Smelt ..... 12
Larval-stage Delta Smelt ..... 12
Morphometry and Histopathology on early life stages of Delta Smelt ..... 13
*Eurytemora affinis* ..... 14
*Thalassiosira pseudonana* ..... 14
Statistics ..... 14
Materials and Methods – Adult Delta Smelt Endocrine Study ..... 15
Testing organisms ..... 15
Adult Smelt ..... 15
Chemicals ..... 15
Endocrine exposure ..... 15
Chemical Analyses ..... 16
Sample collections ..... 16
Reagents for liquid chromatography ..... 16
Analytical methods ..... 16
Quantifying hepatic 17β-estradiol (E2) concentration ..... 17
Acetylcholinesterase ..... 18
Total glutathione ..... 18
Statistical analyses ..... 18

Results – Early Life Stage Delta Smelt and Food Web Studies ..... 19
Delta Smelt Embryo-stage ..... 19
Penoxsulam, Imazamox, and Agridex ..... 19
Fluridone, Glyphosate, 2,4-D ..... 27
Health indices ..... 29
Delta Smelt Larval-stage ..... 30
Penoxsulam, Imazamox, and Agridex ..... 30
Health indices ..... 32
Histopathology ..... 33
Fluridone, Glyphosate, 2,4-D ..... 34
Health indices ..... 38
*Eurytemora affinis* ..... 39
*Thalassiosira pseudonana* ..... 42
Penoxsulam ..... 42
Imazamox ..... 43
Agridex ..... 45
Competitor ..... 46
Results – Adult Delta Smelt Endocrine Study ..... 48
Chemical concentrations ..... 48
Acute toxicity ..... 48
Hepatic E2 concentration ..... 49
Acetylcholinesterase ..... 50
Total glutathione ..... 53
Discussion – Early Life Stages of Delta Smelt and Food Web Studies ..... 55
Early Life Stages of Delta Smelt ..... 55
Food Web Studies ..... 58
Discussion – Adult Delta Smelt Endocrine Study ..... 59
Conclusion ..... 61
Early Life Stages of Delta Smelt and Food Web Studies ..... 61
Adult Delta Smelt Endocrine Study ..... 62
Literature Cited ..... 63

# List of Tables and Figures

## Tables


1. Histopathological scoring criteria for Delta Smelt exposed to different herbicide treatments… 12
2. Dynamic ranges of ELISA kits for Penoxsulam, Fluridone, and Glyphosate…….. 16
3. Yolk sac perimeter of recently hatched Delta Smelt larvae exposed to Penoxsulam, Imazamox, and Agridex during 96 hours…….. 19
4. Effects of herbicides and mixtures on condition factor and oil globule area, and conclusions based on the combination of responses in Delta Smelt exposures conducted in 2014…….. 21
5. Histopathology summary of newly hatched Delta Smelt larvae exposed to Imazamox, Agridex, and Penoxsulam, during an 11-day embryo-stage toxicity test…….. 22
6. Embryo-stage Delta Smelt exposed to Fluridone: statistical analyses…….. 28
7. Embryo-stage Delta Smelt exposed to Glyphosate: statistical analyses…….. 29
8. Embryo-stage Delta Smelt exposed to 2,4-D: statistical analyses…….. 29
9 Effects of herbicides and mixtures on condition factor and oil globule area, and conclusions based on the combination of responses in Delta Smelt exposures conducted in 2014…….. 32
10. Histopathology summaries of Delta Smelt larvae exposed to Imazamox and Agridex in a 8 day toxicity test…….. 33
11. Generalized Linear Model results for 8d Delta Smelt larval survival in Imazamox + Competitor mixture…….. 37
12. Generalized Linear Model mixture interactions of Penoxsulam + Agridex…….. 42
13. Generalized Linear Model mixture interactions of Penoxsulam + Competitor…….. 42
14. Generalized Linear Model mixture interactions of Imazamox + Agridex…….. 43
15. Generalized Linear Model mixture interactions of Imazamox + Competitor…….. 44
16. Concentrations of Penoxsulam, Imazamox, Fluridone, and Glyphosate…….. 47
17. Brain acetylcholinesterase (AChE) activity in females and males adult Delta Smelt exposed to Penoxsulam, Imazamox, Fluridone, and Glyphosate for 6 hours…….. 50
18. Concentration of total glutathione in liver of Delta Smelt exposed to Penoxsulam, Imazamox, Fluridone, and Glyphosate for 6 hours…….. 52


## Figures


1. Standard curve for Imazamox quantification by LC-PDA…….. 16
2. Herbicide, adjuvant, and herbicide-adjuvant mixture effects on embryo hatching success conducted in 2014…….. 18
3. Imazamox-Agridex and Penoxsulam-Agridex effects on embryo condition factor after 96h exposures and a clean water recovery period until hatching…….. 20

4. Imazamox-Agridex and Penoxsulam-Agridex effects on embryo oil globule area after 96h exposures and a clean water recovery period until hatching..... 20
5. Proportion of recently hatched larvae showing ascites and pericardial edema in embryos exposed to different doses of Imazamox for 96 hours..... 22
6. Proportion of recently hatched larvae showing ascites and pericardial edema in embryos exposed to different doses of Agridex for 96 hours..... 23
7. Proportion of recently hatched larvae showing ascites and pericardial edema in embryos exposed to different doses of Imazamox plus Agridex for 96 hours..... 24
8. Histopathological findings observed in the liver of Delta Smelt exposed during the embryo/newly hatched larval stages to Imazamox, Penoxsulam, and Agridex..... 24
9. Histopathological findings observed in the skeletal muscle of the tail portion of Delta Smelt exposed during the embryo/newly hatched larval stages to Imazamox, Penoxsulam, and Agridex..... 25
10. Histopathological findings observed in the pericardial sac of Delta Smelt exposed during the embryo/newly hatched larval stages to Imazamox, Penoxsulam, and Agridex..... 25
11. Delta Smelt embryo survival data with Fluridone..... 26
12. Delta Smelt embryo survival data with Glyphosate..... 27
13. Delta Smelt embryo survival data with 2,4-D..... 27
14. Delta Smelt embryo survival data with Competitor..... 28
15. Herbicide, adjuvant, and herbicide-adjuvant mixture effects on larval survival conducted in 2014..... 30
16. Estimated survival of Delta Smelt larvae exposed to Imazamox and Agridex in a 7-day toxicity test..... 31
17. Imazamox-Agridex and Penoxsulam-Agridex effects on larvae condition factor after 96h exposures and a three day clean water recovery period..... 31
18. (left) Imazamox-Agridex and Penoxsulam-Agridex effects on larvae oil globule area after 96h exposures and a three day clean water recovery period..... 32
19. Delta Smelt larval 96h survival data with Fluridone..... 33
20. Delta Smelt larval 8d survival data with Fluridone..... 34
21. Delta Smelt larval 96h survival data with Glyphosate..... 34
22. Delta Smelt larval 8d survival data with Glyphosate..... 35
23. Delta Smelt larval 96h survival data with 2,4-D..... 35
24. Delta Smelt larval 8d survival data with 2,4-D..... 36
25. Delta Smelt larval 96h survival data with Competitor..... 36
26. Delta Smelt larval 8d survival data with Competitor..... 37
27. *Eurytemora affinis* mortality data with Penoxsulam..... 38
28. *Eurytemora affinis* mortality data with Imazamox..... 39

29. *Eurytemora affinis* mortality data with Agridex……. 39
30. *Eurytemora affinis* mortality data: Penoxsulam + Agridex mixture……. 40
31. *Eurytemora affinis* mortality data: Imazamox + Agridex mixture…… 40
32. 96-hour toxicity data for *T. pseudonana* exposed to Penoxsulam, and Penoxsulam + Agridex… 41
33. 96-hour toxicity data for *T. pseudonana* exposed to Penoxsulam, and Penoxsulam + Competitor…… 42
34. 96-hour toxicity data of *T. pseudonana* exposed to Imazamox, and Imazamox + Agridex…….. 43
35. 96-hour toxicity data of *T. pseudonana* exposed to Imazamox, and Imazamox + Competitor…. 44
36. 96-hour toxicity data of *T. pseudonana* exposed to Agridex……. 45
37. 96-hour toxicity data of *T. pseudonana* exposed to Competitor…… 46
38. Hepatic E2 concentrations for female and male Delta Smelt exposed to Penoxsulam, Imazamox , Fluridone, and Glyphosate…… 49
39. Brain acetylcholinesterase activity in females and males adult Delta Smelt exposed to Penoxsulam, Imazamox, Fluridone, and Glyphosate for 6 hours…… 51
40. Concentration of total glutathione in liver of females and males adult Delta Smelt exposed to Penoxsulam, Imazamox, Fluridone, and Glyphosate for 6 hours……. 54

Appendix A. Effects of Herbicide-Adjuvant Mixtures on Delta Smelt

Appendix B. The effects of Penoxsulam, Imazamox and Agridex on survival, health indices and histopathology of Early Life Stages of Delta Smelt, *Hypomesus transpacificus*

Appendix C. Sublethal effects of herbicides Penoxsulam, Imazamox, Fluridone and Glyphosate on Delta Smelt (*Hypomesus transpacificus*)

# Executive Summary

The San Francisco Estuary- and Sacramento-San Joaquin Delta is an inherently extremely complex estuarine system, the dynamics of which have been altered by anthropogenic inputs, engineering measures to meet the State of California's water demands, climate change, and invasive species. Among the invasive species, the control of aquatic weeds is necessary for the protection of the environment and its beneficial uses. In order to fulfill the requirements of the United States Fish and Wildlife Service (USFWS) Biological Opinions (81410-2013-F-0005 and 08FBDT00-2013-F-0015), DBW and USFWS has contracted with the Aquatic Health Program to conduct toxicity testing evaluating the new herbicides and adjuvants proposed in the invasive aquatic weed control programs, as well as herbicides currently used in these programs, on Delta Smelt (*Hypomesus transpacificus*), the calanoid copepod *Eurytemora affinis*, and the diatom *Thalassiosira pseudonana*. Test concentrations and mixture ratios were determined from predicted applied/residual water concentrations in the environment. The lower concentrations tested were environmentally relevant, while higher concentrations and mixtures were multiples thereof (up to 100,000x).

### *Early Life Stages of Delta Smelt*

There were no significant effects on embryo hatching success from any of the chemicals tested individually, including Agridex, Imazamox or Penoxsulam; however there was a synergistic interaction between Imazamox and Agridex, resulting in significantly reduced hatching success at the highest concentration of these chemicals in combination, 61 mg/L of Imazamox and 64 mg/L of Agridex. Significant effects on embryo hatching success was observed with all three current-use herbicides (Fluridone $LC_{50}$ = 326.6 mg/L, Glyphosate $LC_{50}$ = 3490.4 mg/L, 2,4-D $LC_{50}$ = 715.5 mg/L). There were no significant effects observed with Imazamox. Competitor also did not exhibit any significant effects on embryo survival or hatching success.

We observed a significant reduction of the yolk sac perimeter in recently hatched larvae exposed to 500 ppb of Penoxsulam, and in Agridex at the 113 µg/L, and 41,000 µg/L treatment concentrations, when compared to the control group. For mixture treatments, we observed a significantly larger yolk sac in larvae exposed to a dose of 5,000 µg/L of Penoxsulam plus 41,000 µg/L of Agridex and a dose of 50,000 µg/L of Imazamox plus 64,000 µg/L of Agridex. Embryo condition factor was significantly decreased by Agridex, but antagonistic interactions in both herbicide-Agridex mixtures reversed the response, causing a significant increase in condition factor. Penoxsulam alone also caused a significant, though small, increase in condition factor. Embryo oil globule area was significantly increased by the mixture of Imazamox and Agridex, but neither chemical individually caused an effect. On the other hand, in the Penoxsulam and Agridex exposure, oil globule area was decreased by Agridex and increased by Penoxsulam individually, and there was a variable effect in the mixture, causing a decrease in oil globule area in all concentrations except the highest, which caused an increase that was not significant. In Delta Smelt embryos exposed to Fluridone, length decreased with increasing Fluridone concentrations. Delta Smelt embryos exposed to Glyphosate did not exhibit significant effects in the morphological endpoints. In Delta Smelt embryos exposed to 2,4-D, oil globule area decreased with increasing 2,4-D concentrations.

In the liver of recently hatched larvae we observed a mean score of 2, from the 10, 500, 5,000 and 100,000 µg/L Penoxsulam doses, compared with the control group. For Agridex, a mild histopathological score was observed for all the concentrations tested, and for Imazamox, no significant effects were observed in the liver. For the mixtures, in general, significant differences were observed in the liver histopathological score from fish exposed to Penoxsulam-Agridex and Imazamox-Agridex mixture doses, with mild to moderate changes observed when compared with control groups. In muscle tissue a mild myodegeneration in the posterior third of the body was observed in larvae exposed to 10,000 and 100,000 µg/L of Penoxsulam, and 500 and 5,000 µg/L of Imazamox. In contrast, no significant differences were observed in the muscle lesion score of larvae exposed to Agridex. In mixture treatments, a mild muscle myodegeneration was observed in the highest dose from Imazamox plus Agridex and Penoxsulam plus Agridex when compared to the control group.

Larval Delta Smelt survival was significantly affected by Agridex in the Penoxsulam-Agridex exposure (96 h $LC_{50}$ = 57.1 mg/L); however an antagonistic interaction mitigated for the toxicity in the mixture, resulting in no significant effect up to the highest tested mixture concentration. In the Penoxsulam and Agridex mixture exposure, there were no significant effects on larvae survival. Significant effects were observed at 96h and 8d for both Fluridone (96h $LC_{50}$ = 160.8, 8d $LC_{50}$ = 138.9 mg/L) and Glyphosate (96h $LC_{50}$ = 1184 mg/L, 8d $LC_{50}$ = 1099 mg/L) in larval Delta Smelt tests. A significant mixture interaction between Imazamox and Competitor was observed in the highest concentration, indicating an additive effect.

Larval condition factor was significantly decreased by Imazamox, Agridex, and their mixture. Agridex also caused a reduction in condition factor in the Penoxsulam-Agridex mixture, while Penoxsulam caused an increase in condition factor and there was no significant effect in the mixture. Larvae oil globule area was significantly affected only by the mixture of Imazamox and Agridex, causing a significant increase. In Delta Smelt larvae exposed to Fluridone, significant effects were observed in the length at 62.5 mg/L and in yolk sack area in the 15.6 mg/L treatment and in the 500 mg/L concentration. There were no significant effects observed in any sub-lethal endpoints in larval Delta Smelt exposed to Glyphosate. There was a significant reduction in larval Delta Smelt length observed in those fish exposed to 62.5 mg/L of 2,4-D, however we believe this is a result of variability among replicates and should be interpreted with caution, as no other endpoints were significantly reduced in any of the other concentrations. There were no significant effects in any of the sub-lethal endpoints in larval Delta Smelt exposed to Competitor.

There was a significant effect of Imazamox dose and liver histopathological alterations. Compared to the control group, larvae exposed to 5,000 and 75,000 µg/L of Imazamox exhibited mild to moderate histopathological alterations in the liver. Similarly, in the Imazamox and Agridex mixture, a mild score mean was observed in the 500 µg/L Imazamox / 6,400 µg/L Agridex dose, and significant differences were found when compared with the control group. No significant differences in the lesions score means were observed among treatments with Agridex when compared to the control group in the liver. On the other hand, for muscle tissue, the Imazamox and Agridex mixture induced a mild myodegeneration in the lowest concentration and the 5,000 µg/L Imazamox / 64,000 µg/L Agridex dose, with significant differences when compared to the control group. Conversely, no significant differences in the muscle lesions score means were observed among Imazamox and Agridex doses alone compared with the control group.

### *Food Web Studies*

Relative sensitivities of *E. affinis* to Penoxsulam, Imazamox, and Agridex were variable when compared to 2014 Delta Smelt effect concentrations. For instance, Penoxsulam had significant effects on *E. affinis* ($LC_{50}$ = 63.7 mg/L), whereas there were no significant effects with this chemical alone observed in Delta Smelt. However, with Imazamox, we were unable to obtain an $LC_{50}$ with *E. affinis* ($LC_{10}$ = 56.6 mg/L), yet larval delta smelt had a 7d $LC_{50}$ of 69.5 mg/L. In comparison, sensitivity to Agridex was relatively similar between *E. affinis* ($LC_{50}$ = 46.7 mg/L) and Delta Smelt ($LC_{50}$ = 36.5 mg/L), with Smelt showing slightly higher sensitivities to this chemical. In the mixture studies, both combinations of Penoxsulam + Agridex ($LC_{50}$ = 24.4 mg/L) and Imazamox + Agridex ($LC_{50}$ = 77.0 mg/L) exhibited additive effects to *E. affinis*. In comparison, Delta Smelt showed decreased sensitivity to these mixtures. There were no survival effects on Delta Smelt in Penoxsulam + Agridex mixtures in 2014, and Imazamox + Agridex showed significant additive effects only at the highest concentration tested (61 mg/L Imazamox with 41 mg/L Agridex).

Due to high growth in all Penoxsulam-only treatments, we were unable to elicit an IC50, as it exceeded the highest test treatment concentration of 100,000 ppb. In the Penoxsulam + Agridex mixtures, there was an antagonistic interaction observed in all three mixture treatments, which reduced the toxicity of Agridex. In the Penoxsulam + Competitor mixtures, the toxicity of Competitor overshadowed any interactions. The 96-hr *T. pseudonana* $IC_{50}$ for Imazamox was 84,390 ppb. In the mixture treatments, there was no interaction observed with Imazamox + Agridex; however there was an antagonistic interaction between Imazamox + Competitor, with the combination reducing the toxicity of Competitor.

### *Adult Endocrine Exposure*

All the fish survived and no mortality was recorded by the 6-hr exposure to Penoxsulam, Imazamox, Fluridone, and Glyphosate. However, both female and male fish exposed to Fluridone at the three high concentrations (nominal concentrations 4.17, 20.9, 104.3 mg/L) became lethargic and were laying on the bottom of the buckets at the end of the 6 hour exposure. No abnormal swimming was observed in fish exposed to Penoxsulam, Imazamox, and Glyphosate.

Penoxsulam and Imazamox exposure had no significant effect on hepatic 17β-Estradiol (E2) levels in female fish. Fluridone exposure had a significant effect on female and male fish. Glyphosate exposure had no significant effects on E2 levels in female fish. However, male fish had significant differences between E2 levels.

Brain AChE activity decreased as Penoxsulam concentrations increased, and statistically significant differences were observed at all the concentrations tested in females and at the two highest concentrations in males. Imazamox also caused a significant reduction of the brain AChE activity at all concentrations tested in females and at the lowest and highest concentrations in males.

In male, the concentration of total glutathione decreased as the Fluridone concentration increased, and statistically significant differences were found at concentrations higher than 0.01 mg/L compared to the control group. Similar effects were observed in females, however the results were not statistically significant. The exposure to Glyphosate also significantly affected the GSH concentration in both male and female, however only the data for males were statistically significant.

Results from this study show that the environmental risks of Imazamox and Penoxsulam applications to early life stages of Delta Smelt are very low. Significant mortality did occur in the highest treatments of Imazamox after the 96h exposure and a 3d recovery period, however toxic concentrations were

hundreds of time greater than those expected in the environment either from overspray or from direct water column injection. Herbicide concentrations were more deleterious to the lower trophic levels in the food web, with copepod and diatom sensitives far lower than those of the Delta Smelt. Although corresponding literature reviews were scarce, it can be inferred that these higher sensitivity organisms can be further impacted by the application of herbicides, and herbicide-adjuvant mixtures, which can have lasting negative effects in terms of population size and persistence. Again, significant negative effects were observed at concentrations well above those considered environmentally relevant due to application rates and dilution factors; however further study is warranted given the variability in species sensitivity to these chemicals. Considering the changes in hepatic E2 synthesis in adult exposure study, Penoxsulam and Imazamox seem to be safer, and less likely to cause severe adverse effects on the reproductive performance of Delta Smelt, compared to Fluridone and Glyphosate.

# Introduction

The San Francisco Estuary- and Sacramento-San Joaquin Delta is an inherently extremely complex estuarine system, the dynamics of which have been altered by anthropogenic inputs, engineering measures to meet the State of California's water demands, climate change, and invasive species. Among the invasive species, the control of aquatic weeds is necessary for the protection of the environment and its beneficial uses. Thus, the Division of Boating and Waterways (DBW) has established three invasive aquatic vegetation control programs; Water Hyacinth Control Program (WHCP), *Egeria densa* Control Program (EDCP), and Spongeplant Control Program (SCP), for the Sacramento-San Joaquin Delta and its tributaries. For the purpose of more efficacious control, the DBW has proposed to use two new herbicides (Penoxsulam and Imazamox) and new adjuvants (Agridex) in 2014; however these chemicals are relatively new and have not been extensively field tested.

Penoxsulam and Imazamox are two acetolactate synthase enzyme inhibitors, used for herbicidal applications on terrestrial and aquatic vegetation. They are highly efficacious, exhibiting weed control at lower concentrations than other commonly used herbicides like glyphosate and 2,4-D (USFWS 2013). Both have demonstrated low toxicity to aquatic species, including copepods (Di Lorenzo et al. 2014), daphnids (Hamelink et al. 1986, Alexander et al. 1985) and multiple fish species (Hamelink et al. 1986, US EPA 2013). Due to their high efficacy and low toxicity, these chemicals are used world-wide (Jabusch and Tjeerdema, 2005). Penoxsulam and Imazamox are relatively new on the pesticide market. To date there are few published studies on the non-target effects of these herbicides and no study has evaluated the effects of these herbicides in combination with an adjuvant. The sensitivity of non-target aquatic organisms to these herbicides is an important consideration, particularly for chemicals that will be applied directly into waterways as is necessary for invasive aquatic weed control. Few herbicides are lethally toxic to vertebrate species at environmentally relevant concentrations, however sub-lethal effects including cellular and oxidative stress, and endocrine disruption have been implicated for a number of herbicides and adjuvants in previous studies (Xie et al. 2005, Patetsini et al. 2013, Murussi et al. 2014).

In order to fulfill the requirements of the United States Fish and Wildlife Service (USFWS) Biological Opinions (81410-2013-F-0005 and 08FBDT00-2013-F-0015), DBW and USFWS has contracted with the Aquatic Health Program to conduct toxicity testing evaluating the new herbicides and adjuvants proposed in the invasive aquatic weed control programs, as well as herbicides currently used in these programs, on Delta Smelt (*Hypomesus transpacificus*), the calanoid copepod *Eurytemora affinis*, and the diatom *Thalassiosira pseudonana*. Research conducted in 2014 evaluated the toxicity of Penoxsulam, Imazamox, and Agridex to embryo- and larval- stage Delta Smelt, including analyses of hatching success, survival, and morphological effects. Year two (2015) evaluated the toxicity of Penoxsulam, Imazamox, Agridex, and their mixtures, to the calanoid copepod *Eurytemora affinis*. Additionally, we evaluated the current-use herbicides, Fluridone (Sonar AS), Glyphosate (Roundup Custom), and 2,4-D (Weedar64), as well as the current-use adjuvant Competitor, on early life stages of Delta Smelt. Year three (2016) of this project evaluated the toxicity of Penoxsulam, Imazamox, Agridex, Competitor, and their mixtures, to the diatom *Thalassiosira pseudonana*, and the endocrine disrupting effects of Imazamox, Penoxsulam, Fluridone, and Glyphosate were evaluated on adult Delta Smelt in a short-term 6-hour bioassay.

# Materials and Methods – Early Life Stage Delta Smelt and Food Web Studies

## Testing organisms

### Delta Smelt

Delta smelt embryos were obtained from the UC Davis Fish Conservation and Culture Laboratory (FCCL) in Byron, CA. Embryos were fertilized at FCCL prior to arrival at the Aquatic Health Program Lab (AHP). Upon receipt, embryos were held in 10% methylene blue solution for 24 h to ward off pathogens and fungi. Subsequent embryo-stage toxicity tests were initiated within 1-2 days post fertilization (dpf), whereas larval-stage toxicity tests were initiated with 2-3 days post hatch (dph) smelt from the same batch of embryos (including 2-3 clutches) for each chemical series test. Embryos were held in 1L glass beakers with 900 mL culture water (UC Davis Reconstituted water was prepared according to the guidelines of the US EPA [Horning and Weber, 1985]) and gently aerated until their use in a test, or until fully hatched.

### *Eurytemora affinis*

*E. affinis* have been maintained in the Aquatic Health Program at UCD since 2006. Briefly, the copepods were raised in 120 L conical vials in US Environmental Protection Agency (US EPA) moderately hard reconstituted water (US EPA, 2002) adjusted for salinity to 5.0 psu using Spectrum Instant Ocean Salt at 20˚C with a 16:8-h light: dark cycle and continuous aeration. Copepods were fed daily with 400 µg C/L/d of instant algae (equal volumes of *Nannochloropsis* and *Pavlova* from Reed Mariculture). Twice weekly, approximately 20% of the culture water was filtered and refreshed with clean reconstituted water to maintain optimal water quality. To reduce density-dependent effects, mass cultures were maintained at a density of ~100 adults/L.

### *Thalassiosira pseudonana*

*T. pseudonana* were cultured and maintained in-house at UCD AHP from cultures originally obtained from The Culture Collection of Algae, University of Texas (UTEX; Austin, TX). Axenic algal cells were placed in modified F/2 medium for 4-7 days prior to test initiation to ensure cells were in exponential growth. Culture methods and conditions followed those outlined in ASTM (2011), with modifications recommended by UTEX.

## Chemical solutions

Imazamox, Penoxsulam, and Fluridone, were obtained from SePRO Corporation (Carmel, IN, USA) in original formulation (Clearcast, Galleon SC, and Sonar AS, respectively). Agridex, Glyphosate (as Roundup Custom), and 2,4-D (as Weedar 64) were obtained from Helena Chemical Company (Collierville, TN, USA); Competitor was obtained from Wilbur Ellis Company (San Francisco, CA, USA). Test concentrations of all herbicides were calculated from the percent active ingredient in the formulation, as either Imazamox, Penoxsulam, Glyphosate, Fluridone, or 2,4-D. Test concentrations of Agridex/Competitor were based on total Agridex/Competitor concentration, given that the solutions are a mixture of oils with no one specific active ingredient.

Test concentrations and mixture ratios were determined from predicted applied/residual water concentrations in the environment. The lower concentrations tested were environmentally relevant, while higher concentrations and mixtures were multiples thereof (up to 100,000x). The upper limits of

test concentrations were determined based on the solubility of each chemical and the point at which the test solution became too murky to see the test organisms from range-finder experiments. Herbicide-Agridex mixtures were based on the application rates and mixture ratios planned for use in the field (NMFS 2013). Agridex and Competitor are dispersible rather than soluble (per formulation label), and treatment waters at the higher concentrations were turbid and white in color. Agridex/Competitor concentrations were thus kept below 100 mg/L and the highest two or three concentrations of herbicide-Agridex/Competitor mixtures contained the same concentration of Agridex/Competitor and increasing concentrations of herbicides only.

## Chemical analyses

For the Embryo- and Larval-stage Delta Smelt tests, multiple treatment water samples were collected over the duration of the experiments. For the 13 d embryo exposures, initial water samples were collected at test initiation on Day 0 and test renewal on Day 2. Final water samples (collected prior to renewal) were collected on Day 4, Day 6 and on the day of test take down, Day 13. For the 7 d larval exposures, initial water samples were collected at test initiation on Day 0 and at test renewals on Day 2 and Day 4. Final water samples were also collected on Day 4 and Day 6.

For the *E. affinis* exposure, initial water samples were collected at test initiation on Day 0 and test renewal on Day 2 and 4. Water samples were collected from *T. pseudonana* tests once at initiation (Day 0). Samples were collected in 4 oz HDPE brown plastic bottles and immediately stored at 4°C until shipped. Samples were then shipped on ice, overnight. Imazamox, Penoxsulam, and Fluridone concentrations were measured using standardized FasTEST methods (SePRO Research and Technology Campus, Whitakers, NC). Glyphosate concentrations were measured using EPA Method 547 (Eurofins-Eaton Analytical, Monrovia, CA).

## Toxicity tests

### Embryo-stage Delta Smelt

Embryo-stage toxicity tests consisted of four 600 mL replicates containing 500 mL treatment water and 30 embryos per replicate. The chemical exposure duration was 96h with a 90% renewal at 48 h. After 96 h, embryos were held in clean water with every other day renewals until hatching (hatching began on day 8, 11 dpf). Embryos were scored daily, and dead or unfertilized eggs were removed when observed. Water quality parameters of dissolved oxygen, electrical conductivity, pH, and temperature were measured on fresh water and wastewater on all renewal days (days 2, 4, 6), freshwater was also analyzed at test initiation (day 0) and wastewater analyzed at test termination (day 13). At termination, surviving newly hatched smelt were euthanized with an overdose of buffered tricaine methanesulfonate (MS-222; Western Chemical Inc., Ferndale, WA, USA) and preserved with a 10% solution of buffered formalin for histopathologic analyses.

### Larval-stage Delta Smelt

Larval-stage toxicity tests consisted of four 600 mL replicates with 500 mL sample and 20 larvae per replicate. Larvae were not fed over the duration of the test. Chemical exposure duration lasted 96 h with an 80% renewal at 48 h. Treatment water was renewed via siphon connected to a screened funnel, to reduce the velocity of water siphoned through the screen. After 96 h, smelt were held in clean water with every other day renewals for an additional 3 days. Smelt were scored daily, with the number of dead smelt recorded and removed from test replicate beakers. Water quality parameters of dissolved

oxygen, electrical conductivity, pH, and temperature were measured on fresh water and wastewater on all renewal days (days 2, 4, 6), freshwater was also analyzed at test initiation (day 0) and wastewater analyzed at test termination (day 8). At termination, surviving smelt were euthanized with an overdose of buffered tricaine methanesulfonate (MS-222; Western Chemical Inc., Ferndale, WA, USA) and preserved with a 10% solution of buffered formalin for histopathologic analyses.

## Morphometry and Histopathology on early life stages of Delta Smelt

### *Health indices*

Preserved smelt were measured in wet weight and visually recorded via photo-microscopy. Micrographs were analyzed using ImageJ software from the National Institute of Health (http://rsbweb.nih.gov/ij/). The resultant coordinate data were exported and used to calculate total body length and yolk sac oil globulin area. Condition factor (CF) was calculated based on the average weight (W) and length (L) of smelt per subsample of 10 fish. This endpoint was used to evaluate energy reserves as a health index of recently hatched fish exposed to herbicides. Equation 1 summarizes the calculation.

$$CF = 100 * \frac{W}{L^3} \qquad \text{eq. 1}$$

### *Histopathological analysis*

Histological analyses were performed on the liver and muscle tissues from six larvae in each replicate per treatment dose; additionally the presence or absence of pericardial edema and ascites from each evaluated fish were recorded. Liver and muscle lesions were evaluated using the criteria proposed by Gibson-Corley et al. (2013), Wolf and Wolfe (2005) (See Table 1). Additionally, ascites and pericardial edema were evaluated using the criteria proposed by Marty et al. (1997), and defined as an accumulation of proteinaceous fluid in the pericardial sac and around the viscera within the coelomic cavity.

Table 1. Histopathological scoring criteria for Delta Smelt exposed to different herbicide treatments.

| Score | Explanations (Liver) |
|---|---|
| **1 (normal)** | Hepatocytes with homogeneous eosinophilic cytoplasm, round to polygonal shape and centrally located nucleus, normal glycogen deposits and occasional intracytoplasmic lipid droplets, along all the observed area of tissue. |
| **2 (mild)** | Focal single cell necrosis and swelling of hepatocytes with mild glycogen depletion or mild lipid-glycogen intracytoplasmic vacuoles that do not displace the cytoplasm of the cell. |
| **3 (moderate)** | Multifocal to focally extensive clusters of acute cell swelling and necrosis, intracytoplasmic eosinophilic droplets and abundant lipid vacuoles that displace the nuclei of the cell and distorts cell architecture. |
| **4 (severe)** | Diffuse, acute cell swelling and necrosis affecting the entire area of evaluated tissue, with rupture of cells, inflammation, cellular debris and vacuolar degeneration including lipids and glycogen inclusions. |
| **Score** | **Explanations (Muscle)** |
| **1 (normal)** | Striations are well differentiated in each myofiber with an eosinophilic cytoplasm, multiple peripheral and prominent nuclei and organization into myomeres without evident spaces between them. |

| | |
|---|---|
| **2 (mild)** | Focally distributed degenerated fibers with small cytoplasmic vacuoles, hyper eosinophilic cytoplasm and occasionally pyknotic nuclei. |
| **3 (moderate)** | Focally extensive areas of degenerated fibers with multiple intracytoplasmic vacuoles, loss of striation and separation from neighboring cells, with occasional clumped and contracted debris from dead myofibers |
| **4 (severe)** | Diffuse disruption of muscle fibers with loss of striation, severe vacuolation, and formation of hypereosinophillic contracted clumps of dead cells with inflammation along the whole body |

### *Eurytemora affinis*

All toxicity tests were conducted using modified EPA static renewal guidelines for acute toxicity testing (EPA, 2002). Briefly, tests were conducted in 600 mL glass beakers with 500 mL of moderately hard water prepared to 5 psu using Instant Ocean (Spectrum Brands, Madison, WI, USA) modified with appropriate treatments. Four replicate beakers were used in all treatments with twenty juvenile copepods added to each beaker. Tests were conducted at 20˚C, under a light cycle of 16 hours light: 8 hours dark. Copepods were fed daily with 400 µg C/L/day of Instant Algae (equal volumes of *Nannochloropsis* and *Pavlova* from Reed Mariculture, Campbell, CA, USA). An 80% water change was conducted at the 48 hour interval, during which, deceased and paralyzed copepods were enumerated. After 96 hours, surviving copepods were enumerated and in some cases decomposition of copepods occurred resulting in missing copepods. Only live copepods were used in calculations.

### *Thalassiosira pseudonana*

The *T. pseudonana* 96-hr chronic tests followed protocols outlined in ASTM (2011) and consisted of four replicate 250 mL glass flasks with 50 mL of sample, and 500 µL of 5 x $10^5$ cells/mL of *T. pseudonana*. Test chambers were incubated in a temperature-controlled environmental chamber maintained at 20 ± 2°C under constant cool white fluorescent light. Flasks were kept in random placement and were randomized twice daily. Test replicates were swirled gently during the second randomization, to ensure even distribution of cells throughout the water column. Cell growth was measured at test termination using a Beckman Coulter Particle Counter ZM.

## Statistics

Linear models were fit to data (including a logit link function for mortality and hatching data) to statistically test for significant chemical effects on the endpoints measured and for significant interactions between chemicals on these endpoints. Herbicides and adjuvants were included as explanatory variables individually, as well as their interaction, with a nested random effect for the experimental vessels (beakers/flasks) in which fish and algae were distributed. All models were fit using the program R (R Core Team). Effect concentration statistics (to determine LC50s) were applied using CETIS statistical software (Tidepool Scientific Software; McKinley, CA).

Additionally, quasi-binomial regressions were fit to the lethal data of hatching success and survival using the “mle2” function (package bbmle) in the R program (Crawley 2012; Bolker and R Core Team 2013; R Core Team 2014). The response variable was proportion hatching or survival, and estimated herbicide or Agridex concentration was used as a predictor. Using the same function, linear regressions were fit to the sub-lethal data of condition factor and oil globule area. Confidence intervals around each model were determined by sampling the naïve posterior of the regression 10,000 times (McElreath, 2013), and

from the resulting models 95% confidence intervals were calculated and plotted. $EC_{50}$ concentrations were calculated from regression models, where applicable, however most responses did not amount to 50% relative to the control, even at the highest concentration. Lowest observed effect concentrations (LOECs) were calculated for all significant effects using Analysis of Variance, including a Dunnett's post hoc comparison.

A logistic regressions model was fitted to evaluate dose-response associations in survival. The response variable was proportion of larvae survival, and Log10 herbicide concentration was used as a predictor. For health indices (yolk sac perimeter) an ANOVA with Dunnett's post hoc comparisons was used and a linear regression model was fitted to assess dose response associations. A Wilcoxon/Kruskal Wallis ANOVA with a post hoc Dunn test for joint ranks was used to assess differences in histopathology scores in the liver and muscle among groups. For ascites and pericardial edema a $\chi^2$ contingency analysis was used to evaluate proportions of ascites/pericardial edema among treatments doses, followed by a logistic regression model to evaluate dose response associations. All the analyses were performed using $\alpha$=0.05 in the JMP software V 12 (SAS institute).

# Materials and Methods – Adult Delta Smelt Endocrine Study

## Testing organisms

### Adult Smelt

Adult male and female Delta Smelt were raised at FCCL (451 ± 1 days post hatch). At the FCCL, ambient water from the California Aqueduct was used for fish culture after basic water treatment processes (including solids removal and UV disinfection). Exposure tests were conducted on-site at the FCCL.

## Chemicals

The endocrine disruption effects were evaluated on Penoxsulam, Imazamox, Fluridone, and Glyphosate (Clearcast, Galleon SC, Sonar AS, and Roundup Custom, respectively), with test concentrations based on the percent active ingredient for the aforementioned herbicides. Adjuvants and mixtures were not included in this phase of the study.

## Endocrine exposure

Exposure tests were conducted at the FCCL. Experimental solutions were prepared by spiking the chemicals into treated-ambient water available at the FCCL. Prior to the fish exposure, water chemistry was measured to confirm that spiking of the chemicals did not significantly alter the water quality parameters of the ambient water (i.e., pH, $NO_2^-$, $NO_3^-$, $NH_4^+$, alkalinity, hardness, and conductivity). Experimental solutions were prepared on site prior to the initiation of the exposure tests.

Due to the intense workloads associated with these assays, the exposure was performed in two separate trials: Day 1, Delta Smelt were exposed to Penoxsulam and Imazamox, and in Day 2 to Fluridone and Glyphosate. A control group was included for each trial. Exposures were initiated by placing adult Delta Smelt (n=5 per sex in triplicate per treatment) into 15 L of experimental solutions in a 20 L High Density Polyethylene (HDPE) black replicate bucket. During the exposure, buckets with fish received continuous aeration and the water temperature was maintained at 15.7°C by placing buckets in large circular water tanks (5 feet in diameter with 869 L of working volume for temperature control).

Chemical exposure duration was 6 hrs. At the end of the six hours, fish were euthanized with an overdose of tricaine methane sulfonate (MS222) solution (500 mg/L), flash frozen in liquid nitrogen for preservation, and then stored in liquid nitrogen until dissection. Fish were dissected at the Aquatic Health Program Laboratory, University of California, Davis, following the method as described by Teh et al. (2016). Liver tissues were partitioned and used for measuring hepatic estradiol concentration, gene expression, and glutathione SH. Brain tissues were used for measuring acetylcholinesterase (AChE) activity.

## Chemical Analyses

### Sample collections

For chemical analysis, a small volume of the experimental solutions (~40 mL) was collected from each bucket in 50 mL conical tubes at the initiation and end of exposure trials. The conical tubes were wrapped with aluminum foil to prevent exposure of the experimental solutions to light, and stored at -20°C.

### Reagents for liquid chromatography

Acetonitrile (HPLC grade) and phosphoric acid (ACS grade) were purchased from Fisher Scientific (Waltham MA, USA) for measuring Imazamox concentrations using liquid chromatography. Water (HPLC grade) and Imazamox PESTANAL analytical standard (99.9% purity) were purchased from Sigma Aldrich (St. Louis, MO, USA). The Imazamox stock standard was serially diluted to prepare standards for the calibration curve with final concentrations of 1000 ppb, 500 ppb, 250 ppb, 100 ppb, and 50 ppb.

### Analytical methods

Concentrations of Penoxsulam, Fluridone, and Glyphosate were measured by commercially available ELISA kits (Abraxis, Inc, Warminster, PA; Table 2). The experimental solutions (0 and 6 hr post-exposure) were diluted using diluent provided by the kits prior to the analysis to be within the dynamic ranges of each kit. The reaction was performed in duplicate for each water sample and averages for the experimental solutions collected in triplicate were used for reporting the data. The reactions were performed following the manufacturer's instruction. The absorbance was measured at 450 nm in 96-well plates (CoStar 3370, Corning, NY, USA) using a plate reader (Tecan Infinite M200, Tecan, Männedorf, Switzerland).

Imazamox was measured by liquid chromatography with a photodiode array detector (LC-PDA) using Surveyor LC, Surveyor Autosampler, and Surveyor PDA (Thermo Finnigan, San Jose, USA). Prior to the analysis, standards and samples were filtered with polyethersulfone (PES) filters (pore size: 0.22 micron, Genesee Scientific, San Diego, USA). A Zorbax SB-C18 column (4.6 x 100 mm, 3.5 µm, Agilent Technologies, Santa Clara, USA) was used with an injection of 15 µL and a constant flow rate of 1.0 mL/min. The mobile phases consisted of acetonitrile (Solvent A) and water with 0.1% phosphoric acid (Solvent B). The mobile phase program started with 0% Solvent A, 100% Solvent B; at 2 minutes 20% Solvent A, 80% Solvent B; at 6 minutes 50% Solvent A, 50% Solvent B; at 8 minutes 80% Solvent A, 20% Solvent B, and finally at 10 minutes 0% Solvent A, 100% Solvent B. Run time was 11 minutes. Imazamox was detected at 250 nm with a retention time of 4.00 minutes. The analytical software used was Xcalibur (Thermo Fisher Scientific, Waltham, MA, USA). A linear non-weighted external calibration curve was used to quantify Imazamox (Figure 1).

Table 2. Dynamic ranges of ELISA kits for Penoxsulam, Fluridone, and Glyphosate.

| Herbicide | Dynamic range (mg/L) | Product number* |
|---|---|---|
| **Penoxsulam** | 0.0025 - 0.010 | 500501 |
| **Fluridone** | 0.0005 - 0.015 | 50051 |
| **Glyphosate** | 0.075 x $10^{-3}$ - 0.004 | 500086 |

* Abraxis, Inc (http://www.abraxiskits.com/)

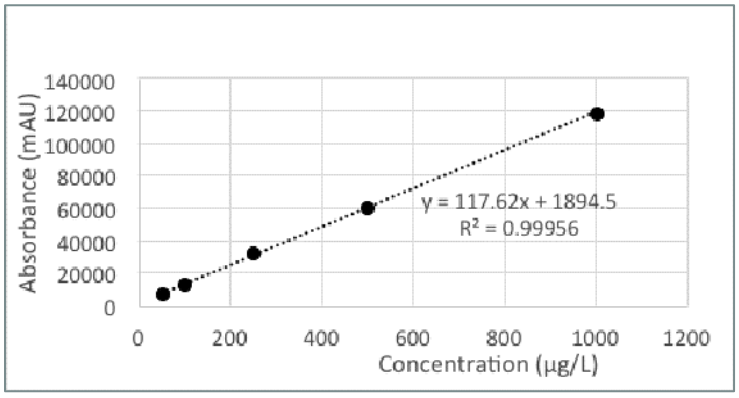



Figure 1. Standard curve for Imazamox quantification by LC-PDA.

## Quantifying hepatic 17β-estradiol (E2) concentration

Concentrations of Delta Smelt hepatic 17β-estradiol (E2) were measured using commercially available ELISA kits (Product Number: K030-H5, Arbor Assay, Ann Arbor, MI, USA). Liver was partitioned on dry ice and at least 8 mg liver tissue was utilized for the analysis. Liver tissue was sonicated in 500 µL of 1XPBS then centrifuged at 12,000 rpm for 10 minutes at 4°C. Supernatant containing E2 and soluble proteins was transferred to clean borosilicate glass tube for E2 extraction. A small portion of liver homogenate (50 µL) was aliquoted and stored at -80°C to measure protein concentration (DC protein assay, Bio-Rad Laboratories, Hercules, CA, USA). Liver homogenate in glass tube was vortexed with 2 mL of dimethyl ether for 2 minutes, followed by flash freezing in dry ice-ethanol cold bath. While the bottom PBS phase was frozen, the top ether phase containing E2 was transferred into new clean borosilicate glass tube by decantation. Glass tubes were covered in foil and allowed to evaporate in a fume hood overnight. E2 was then reconstituted by adding 70 µL of autoclaved Millipore water (18.2 MΩ•cm) and samples were transferred into amber glass vials and stored at -80°C. For the analysis, dynamic range of kit was expanded from manufacturer's range; the 100,000 pg/mL E2 stock solution provided by the ELISA kit was used to generate eight standards: 0.0024, 0.0098, 0.0195, 0.0391, 0.1563, 0.6250, 2.5 and 10 ng/L. The reaction was performed following the manufacturer's instruction. Due to the small amount of liver tissue sample, reaction was done without technical replicates. Absorbance was measured at 450 nm by plate reader (Tecan Infinite M200, Tecan). E2 concentrations were calculated using four parameter logistic curve fitting (4PL) (http://www.elisaanalysis.com/). E2 data were standardized by concentration of soluble protein and expressed as "pg of E2 per mg of soluble protein".

## Acetylcholinesterase

Enzymatic activity of acetylcholinesterase (AChE) was measured by following the Ellman's method (Ellman et al., 1961). Brain (n = 9 – 10 per group in triplicate) were homogenized by grinding at 4°C in 0.1 M sodium phosphate buffer (pH 8.0) in a sample weight: buffer volume ratio of 1: 50. The AChE assay was carried out using the supernatant resulting from a 10,000 x g centrifugation for 15 min at 4°C. AChE activity was measured in triplicate at 25°C. A reaction cocktail of 125 µL containing 100 mM sodium phosphate buffer, 5.12 mM 5,5'-dithiobis(2-nitrobenzoic acid) and 25 µL of supernatant was prepared and incubated at room temperature for 5 min. Then, 25 µL of 75 mM acetylthiocholine iodide were added, and absorbance at 412 nm was measured every 60 sec for 10 min at 25°C in a microtiter plate reader (Tecan Infinite M200) using a 96-well plate (CoStar 3370, Corning, NY, USA). AChE activity was normalized to the concentration of protein in the supernatant and reported as "units/mg protein/min". Protein concentration in the supernatants was measured by Lowry method (Lowry et al., 1951) using the Bio-Rad DC Protein Assay (Bio-Rad Laboratories, Hercules, CA, USA).

## Total glutathione

Concentration of total glutathione (GSH) was measured by following the method published by Baker et al. (1990). Liver (pools of 5 per group) were homogenized by grinding at 4°C in ice-cold 5% 5-sulfosalicylic acid (1:19 wet weight/vol), followed by incubation for 20 min on ice, and centrifugation at 16,300 g for 10 min at 4°C. Then, supernatants were diluted 1:50 in 100 mM $Na_2HPO_4/NaH_2PO_4$ buffer at pH 7.5 containing 1 mM EDTA to obtain a concentration of 0.1% 5-sulfosalicylic acid in sample supernatants. Thereafter, increase in absorbance at 405 nm at 25°C was measured for 2 min at 15 s intervals in 150 µL cocktail containing 50 µL sample supernatant, 0.6 mM DTNB, 0.2 mM NADPH, 1 unit/mL glutathione reductase, 0.66 mM EDTA and 80 mM $Na_2HPO_4/NaH_2PO_4$ buffer. The reaction was run in a microtiter plate reader (Tecan Infinite M200) using a 96-well plate (CoStar 3370, Corning, NY, USA). Concentration of total glutathione was calculated based on a standard curve prepared with known concentrations of reduced glutathione solutions and reported as nmol/mg wet tissue.

## Statistical analyses

In 17β-estradiol analyses, E2 data were standardized by concentration of soluble protein and expressed as "pg of E2 per mg of soluble protein". Statistical analysis was performed using one-way ANOVA. Statistical analysis was performed for males and females separately for Acetylcholinesterase analyses, AChE data for Imazamox, Glyphosate (only for females), and Penoxsulam were log-transformed. Normality was tested using Shapiro-Wilk W test and for homogeneity of variances by the Levene's test, and analyzed by one-way ANOVA with a *post hoc* Dunnett's test. A Welch ANOVA was run for females in Glyphosate experiment since the assumption of homoscedasticity was no fulfilled. Data are shown as mean ± standard error. Significant differences were declared at $P < 0.05$. In total glutathione analyses, GSH data were checked for normality using Shapiro-Wilk W test and for homogeneity of variances by the Levene's test, and analyzed by one-way ANOVA with a *post hoc* Dunnett's test. Data are shown as mean ± standard error. Significant differences were declared at $P < 0.05$.

# Results – Early Life Stage Delta Smelt and Food Web Studies

## Delta Smelt Embryo-stage

### Penoxsulam, Imazamox, and Agridex

There were no significant effects on embryo hatching success from any of the chemicals tested individually, including Agridex, Imazamox or Penoxsulam; however there was a synergistic interaction between Imazamox and Agridex, resulting in significantly reduced hatching success at the highest concentration of these chemicals in combination, 61 mg/L of Imazamox and 64 mg/L of Agridex (Figure 2).

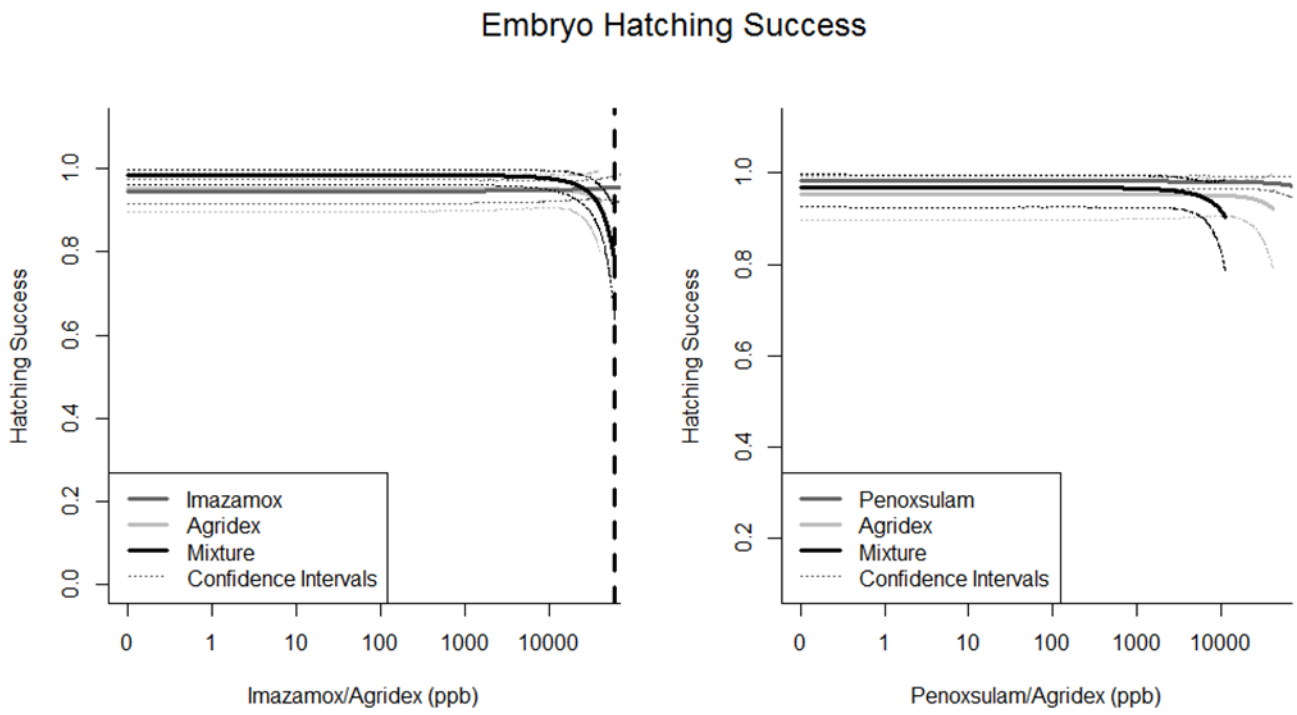



Figure 2. Herbicide, adjuvant, and herbicide-adjuvant mixture effects on embryo hatching success conducted in 2014. As noted in the key, Imazamox or Penoxsulam (herbicide) = dark grey line, Agridex (adjuvant) = light grey, and the mixture = black. Confidence intervals around the models are shown as dotted lines, where a vertical dotted line denotes a significant effect at that concentration (color coded to key).

#### *Health indices*

We observed a significant reduction of the yolk sac perimeter in recently hatched larvae exposed to 500 ppb of Penoxsulam, and in Agridex at the 113 µg/L, and 41,000 µg/L treatment concentrations, when compared to the control group (ANOVA P=<0.0001). In contrast, for the Imazamox treatment, the yolk sac perimeter was significantly larger in the 12, 5,000, 10,000, and 50,000 µg/L doses (ANOVA P=<0.0001). For mixture treatments, we observed a significantly larger yolk sac in larvae exposed to a dose of 5,000 µg/L of Penoxsulam plus 41,000 µg/L of Agridex and a dose of 50,000 µg/L of Imazamox plus 64,000 µg/L of Agridex (ANOVA P=<0.0001). Results are presented below in Table 3.

Table 3. Yolk sac perimeter of recently hatched Delta Smelt larvae exposed to Penoxsulam, Imazamox, and Agridex during 96 hours. (Bolded cases represent significant differences compared to the control group).

| Treatment | Dose (ppb) | Yolk sac perimeter (mm) Mean ± SE |
|---|---|---|
| Control | 0 | 2.35 ± 0.038 |
| Penoxsulam | 2 | 2.23 ± 0.035 |
| | 10 | 2.24 ± 0.042 |
| | **500** | **2.15 ± 0.037** |
| | 5,000 | 2.44 ± 0.032 |
| | 10,000 | 2.33 ± 0.058 |
| | 100,000 | 2.45 ± 0.068 |
| Imazamox | **12** | **2.59 ± 0.054** |
| | 50 | 2.47 ± 0.026 |
| | **500** | **2.45 ± 0.038** |
| | **5,000** | **2.88 ± 0.046** |
| | **10,000** | **2.51 ± 0.042** |
| | 50,000 | 2.68 ± 0.050 |
| | 100,000 | 2.33 ± 0.026 |
| Agridex | **113** | **2.18 ± 0.030** |
| | 462 | 2.37 ± 0.031 |
| | 6,400 | 2.33 ± 0.031 |
| | **41,000** | **2.05 ± 0.031** |
| | 64,000 | 2.33 ± 0.030 |
| Penoxsulam + Agridex | 2 + 164 | 2.45 ± 0.048 |
| | 500 + 41,000 | 2.48 ± 0.051 |
| | **5,000 + 41,000** | **2.72 ± 0.046** |
| | 10,000 + 41,000 | 2.40 ± 0.045 |
| Imazamox + Agridex | 12 + 155 | 2.45 ± 0.041 |
| | 50 +638 | 2.32 ± 0.040 |
| | 500 + 6,400 | 2.44 ± 0.042 |
| | 5,000 + 64,000 | 2.38 ± 0.041 |
| | **50,000 + 64,000** | **2.81 ± 0.041** |

Embryo condition factor was significantly decreased by Agridex (LOEC = 0.113 mg/L), but antagonistic interactions in both herbicide-Agridex mixtures reversed the response, causing a significant increase in condition factor (Figure 3). Penoxsulam alone also caused a significant, though small, increase in condition factor (LOEC = 0.0112 mg/L). Embryo oil globule area was significantly increased by the mixture of Imazamox and Agridex (LOEC = 61 mg/L Imazamox and 64 mg/L Agridex), but neither chemical individually caused an effect (Figure 4). On the other hand, in the Penoxsulam and Agridex exposure, oil globule area was decreased by Agridex (LOEC = 41 mg/L) and increased by Penoxsulam (LOEC = 0.56 mg/L) individually, and there was a variable effect in the mixture, causing a decrease in oil

globule area (LOEC = 0.00224 mg/L) in all concentrations except the highest, which caused an increase that was not significant. Results are presented in Table 4.

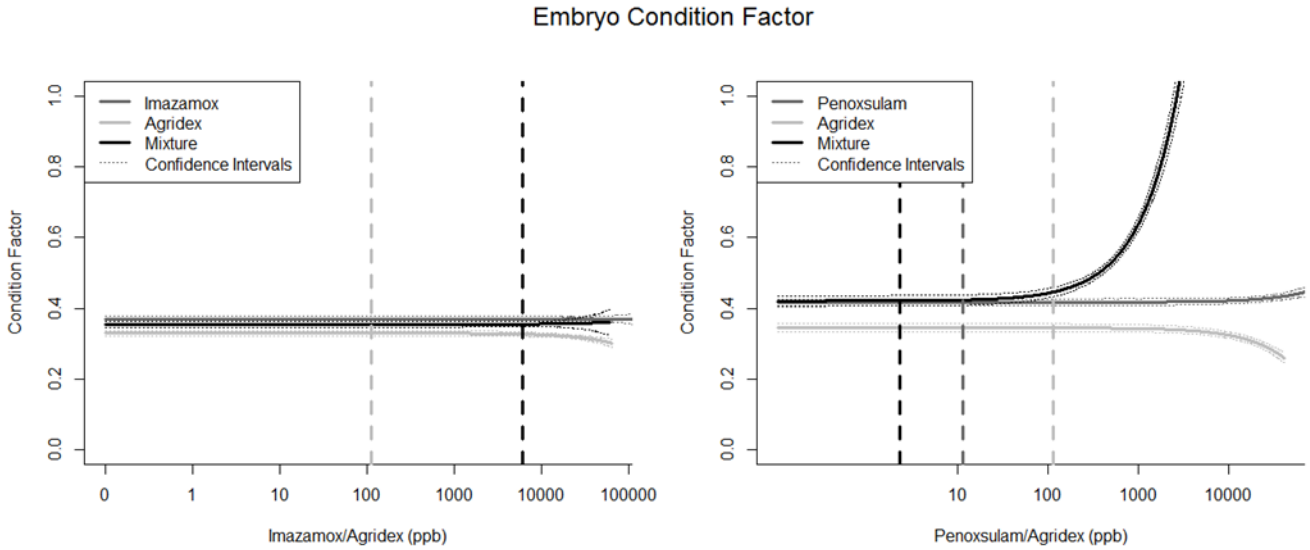



Figure 3. (left) Imazamox-Agridex and (right) Penoxsulam-Agridex effects on embryo condition factor after 96h exposures and a clean water recovery period until hatching. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

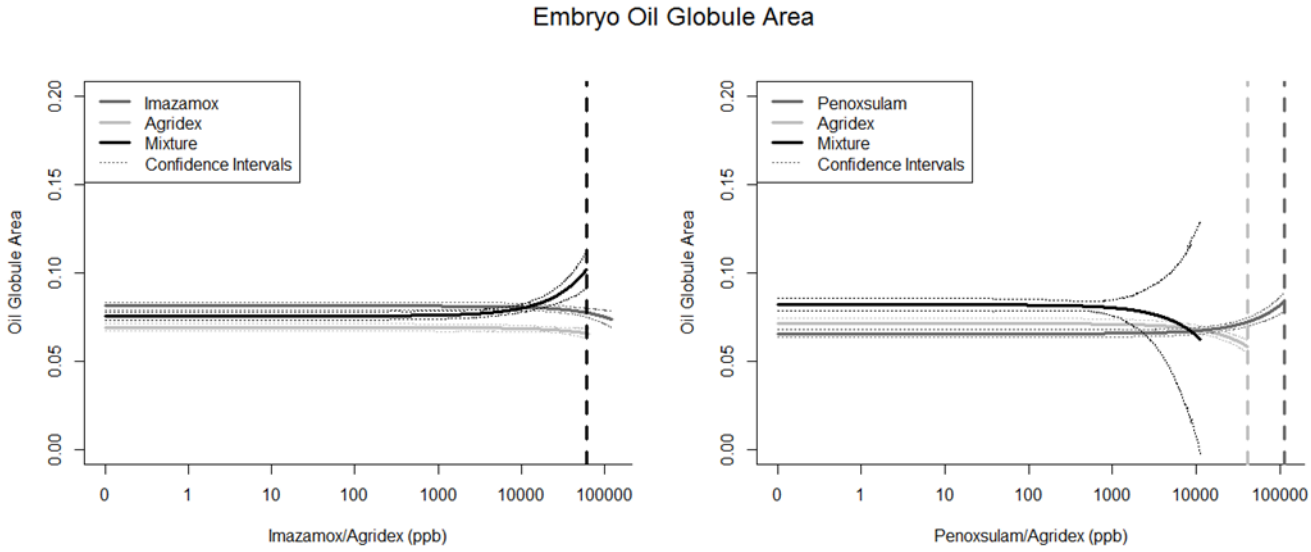



Figure 4. (left) Imazamox-Agridex and (right) Penoxsulam-Agridex effects on embryo oil globule area after 96h exposures and a clean water recovery period until hatching. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

Table 4. Effects of herbicides and mixtures on condition factor and oil globule area, and conclusions based on the combination of responses in Delta Smelt exposures conducted in 2014, where "NE" = No effect, "-" = negative effect, "+" = positive effect. Negative effects are highlighted.

| Chemical(s) | Life Stage | CF | OGA | Conclusion |
|---|---|---|---|---|
| Agridex | Embryo | - | NE | Energy depleted by stress response |
| Imazamox | Embryo | NE | NE | No effect |
| Penoxsulam | Embryo | + | + | Hormesis |
| Imazamox + Agridex | Embryo | + | + | Hormesis |
| Penoxsulam + Agridex | Embryo | + | NE | Hormesis |

*Histopathology*

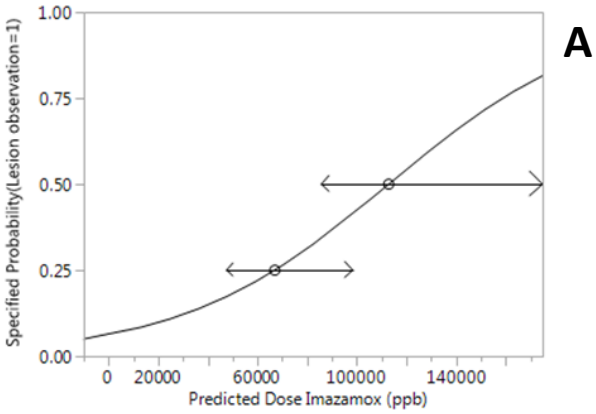
In the liver of recently hatched larvae we observed a mean score of 2, from the 10, 500, 5,000 and 100,000 µg/L Penoxsulam doses, compared with the control group (P=<0.013) (See Table 5). For Agridex, a mild histopathological score was observed for all the concentrations tested (P=0.009), and for Imazamox, no significant effects were observed in the liver (P=0.2183). For the mixtures, in general, significant differences were observed in the liver histopathological score from fish exposed to Penoxsulam-Agridex (P=0.0012) and Imazamox-Agridex (P=0.020) mixture doses, with mild to moderate changes observed when compared with control groups (See Table 5, Figure 8).

In muscle tissue a mild myodegeneration in the posterior third of the body was observed in larvae exposed to 10,000 and 100,000 µg/L of Penoxsulam (P=<0.0001), and 500 and 5,000 µg/L of Imazamox (P=0.0002) (Figure 9). In contrast, no significant differences were observed in the muscle lesion score of larvae exposed to Agridex (P=0.3691).

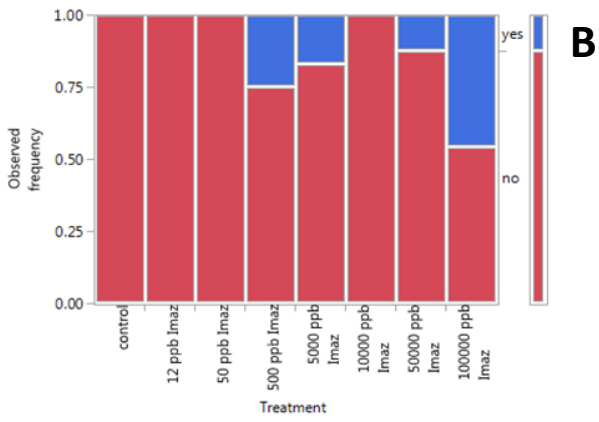
In mixture treatments, a mild muscle myodegeneration was observed in the highest dose from Imazamox plus Agridex (P=0.0016) and Penoxsulam plus Agridex when compared to the control group (P=0.0062). The observation of ascites and pericardial edema (Figure 10) were not significant among doses in the Penoxsulam treatment (Pearson > $\chi^2$=>0.05). In contrast, for Imazamox and Agridex, we observed an increased proportion of larvae with this lesion in the higher dose treatments (Pearson > $\chi^2$=<0.05), and the effect was dose dependent as it was predicted using a logistic regression model (P=<0.05; Odds ratio=10.93). However, despite that the model was accurate in predicting the expected proportion of lesions for the higher concentrations of Imazamox and Agridex with the observed proportion in the contingency analysis, other observed concentrations had different proportions of lesions (See Figures 5 and 6). For the mixture of Penoxsulam and Agridex no significant effects were observed in the occurrence of ascites among treatment dose (Pearson > $\chi^2$=>0.05); in contrast, for the Imazamox and Agridex mixtures, significant differences were observed among doses and the control with a higher proportion in the presentation of ascites in the four first doses (Pearson > $\chi^2$=<0.05) (See Figure 7).

Table 5. Histopathology summary of newly hatched Delta Smelt larvae exposed to Imazamox, Agridex, and Penoxsulam, during an 11-day embryo-stage toxicity test. (Only results with significant differences are shown).

| Treatment | Tissue | Dose (ppb) | Score Mean | P value |
|---|---|---|---|---|
| **Penoxsulam** | **liver** | 10 | 2 (Mild) | 0.019 |
| | | 500 | 2 (Mild) | 0.0047 |
| | | 5,000 | 2 (Mild) | 0.0038 |
| **Agridex** | **Liver** | 100,000 | 2 (Mild) | 0.04 |
| | | 113 | 2 (Mild) | 0.026 |
| | | 6,400 | 2 (Mild) | 0.0032 |
| | | 64,000 | 2 (Mild) | 0.0026 |
| **Penoxsulam + Agridex** | **Liver** | 2+121 | 2-3(Mild to moderate) | 0.0071 |
| | | 500+41,000 | 2-3(Mild to moderate) | 0.0005 |
| | | 10,000+41,000 | 2-3(Mild to moderate) | 0.00143 |
| **Imazamox + Agridex** | **Liver** | 12+155 | 2-3(Mild to moderate) | 0.033 |
| | | 50,000+64,000 | 2-3(Mild to moderate) | 0.0125 |
| **Penoxsulam** | **Muscle** | 10,000 | 2(Mild) | 0.0004 |
| | | 100,000 | 2(Mild) | 0.0002 |
| **Imazamox** | **Muscle** | 500 | 2(Mild) | 0.00086 |
| | | 5,000 | 2(Mild) | 0.0015 |
| **Imazamox + Agridex** | **Muscle** | 50,000+64,000 | 2(Mild) | 0.0016 |
| **Penoxsulam + Agridex** | **Muscle** | 10,000+41,000 | 2(Mild) | 0.0014 |




A




B

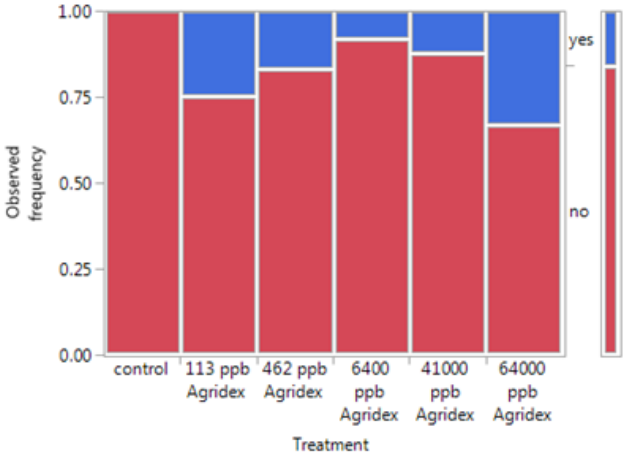
C

Observed frequency

| Treatment | Count / Row % | no | yes | Total |
|---|---|---|---|---|
| control | | 24 | 0 | 24 |
| | | 100.00 | 0.00 | |
| 12 ppb Imaz | | 24 | 0 | 24 |
| | | 100.00 | 0.00 | |
| 50 ppb Imaz | | 24 | 0 | 24 |
| | | 100.00 | 0.00 | |
| 500 ppb Imaz | | 18 | 6 | 24 |
| | | 75.00 | 25.00 | |
| 5000 ppb Imaz | | 20 | 4 | 24 |
| | | 83.33 | 16.67 | |
| 10000 ppb Imaz | | 24 | 0 | 24 |
| | | 100.00 | 0.00 | |
| 50000 ppb Imaz | | 21 | 3 | 24 |
| | | 87.50 | 12.50 | |
| 100000 ppb Imaz | | 13 | 11 | 24 |
| | | 54.17 | 45.83 | |
| Total | | 168 | 24 | 192 |

Figure 5. Proportion of recently hatched larvae showing ascites and pericardial edema in embryos exposed to different doses of Imazamox for 96 hours. A) Logistic regression curve of predicted dose-proportion of lesions B) Mosaic plot showing the distribution of lesions among Imazamox doses. C) Percentage of lesions observed in Imazamox treatment.

A



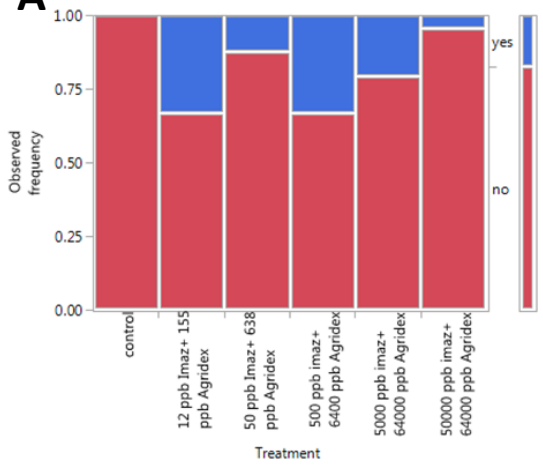

B

Observed frequency

| Treatment | Count / Row % | no | yes | Total |
|---|---|---|---|---|
| control | | 24 | 0 | 24 |
| | | 100.00 | 0.00 | |
| 113 ppb Agridex | | 18 | 6 | 24 |
| | | 75.00 | 25.00 | |
| 462 ppb Agridex | | 20 | 4 | 24 |
| | | 83.33 | 16.67 | |
| 6400 ppb Agridex | | 22 | 2 | 24 |
| | | 91.67 | 8.33 | |
| 41000 ppb Agridex | | 21 | 3 | 24 |
| | | 87.50 | 12.50 | |
| 64000 ppb Agridex | | 16 | 8 | 24 |
| | | 66.67 | 33.33 | |
| Total | | 121 | 23 | 144 |

Figure 6. Proportion of recently hatched larvae showing ascites and pericardial edema in embryos exposed to different doses of Agridex for 96 hours. A) Mosaic plot showing the distribution of lesions among Imazamox doses, B) Percentage of lesions observed in Imazamox treatment.

A




B

Observed frequency

| Treatment | Count / Row % | no | yes | Total |
|---|---|---|---|---|
| control | | 24 | 0 | 24 |
| | | 100.00 | 0.00 | |
| 12 ppb Imaz+ 155 ppb Agridex | | 16 | 8 | 24 |
| | | 66.67 | 33.33 | |
| 50 ppb Imaz+ 638 ppb Agridex | | 21 | 3 | 24 |
| | | 87.50 | 12.50 | |
| 500 ppb imaz+ 6400 ppb Agridex | | 16 | 8 | 24 |
| | | 66.67 | 33.33 | |
| 5000 ppb imaz+ 64000 ppb Agridex | | 19 | 5 | 24 |
| | | 79.17 | 20.83 | |
| 50000 ppb imaz+ 64000 ppb Agridex | | 23 | 1 | 24 |
| | | 95.83 | 4.17 | |
| Total | | 119 | 25 | 144 |

Figure 7. Proportion of recently hatched larvae showing ascites and pericardial edema in embryos exposed to different doses of Imazamox plus Agridex for 96 hours. A) Mosaic plot showing the distribution of lesions among doses, B) Percentage of lesions observed in treatment doses.

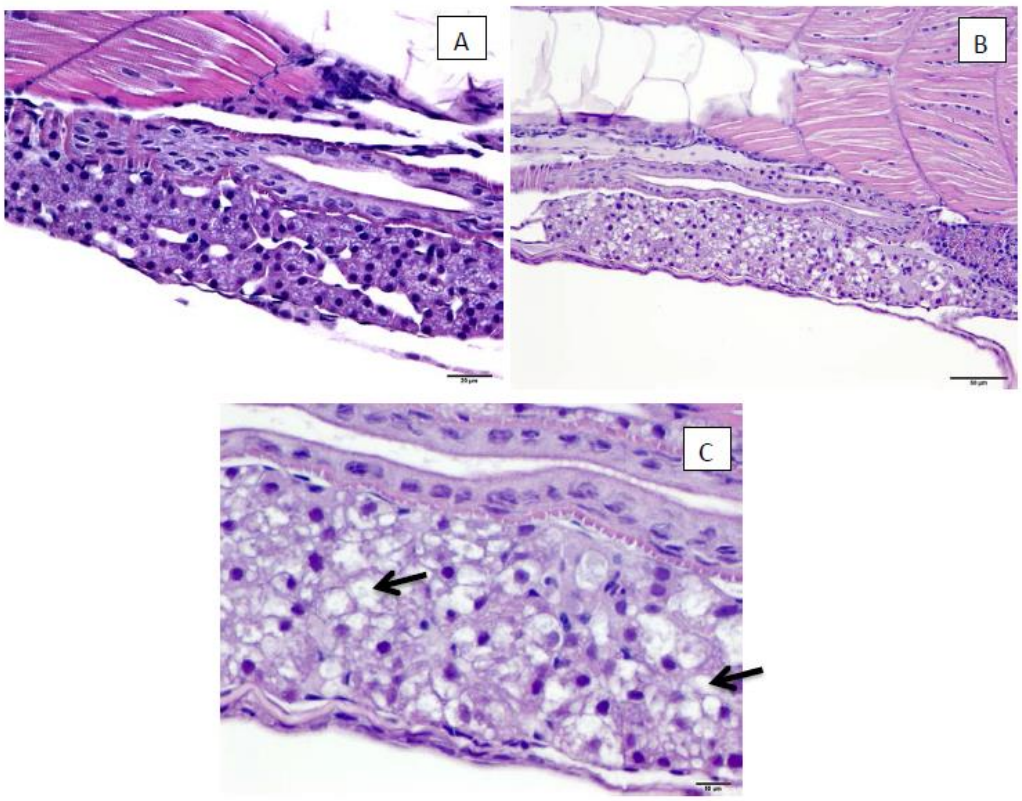



Figure 8. Histopathological findings observed in the liver of Delta Smelt exposed during the embryo/newly hatched larval stages to Imazamox, Penoxsulam, and Agridex. A) Normal control liver, B) Moderate to severe vacuolization of hepatocytese affecting the whole parenchyma, and C) higher magnification of B, showing a detail of the vacuolated hepatocytes (arrows).

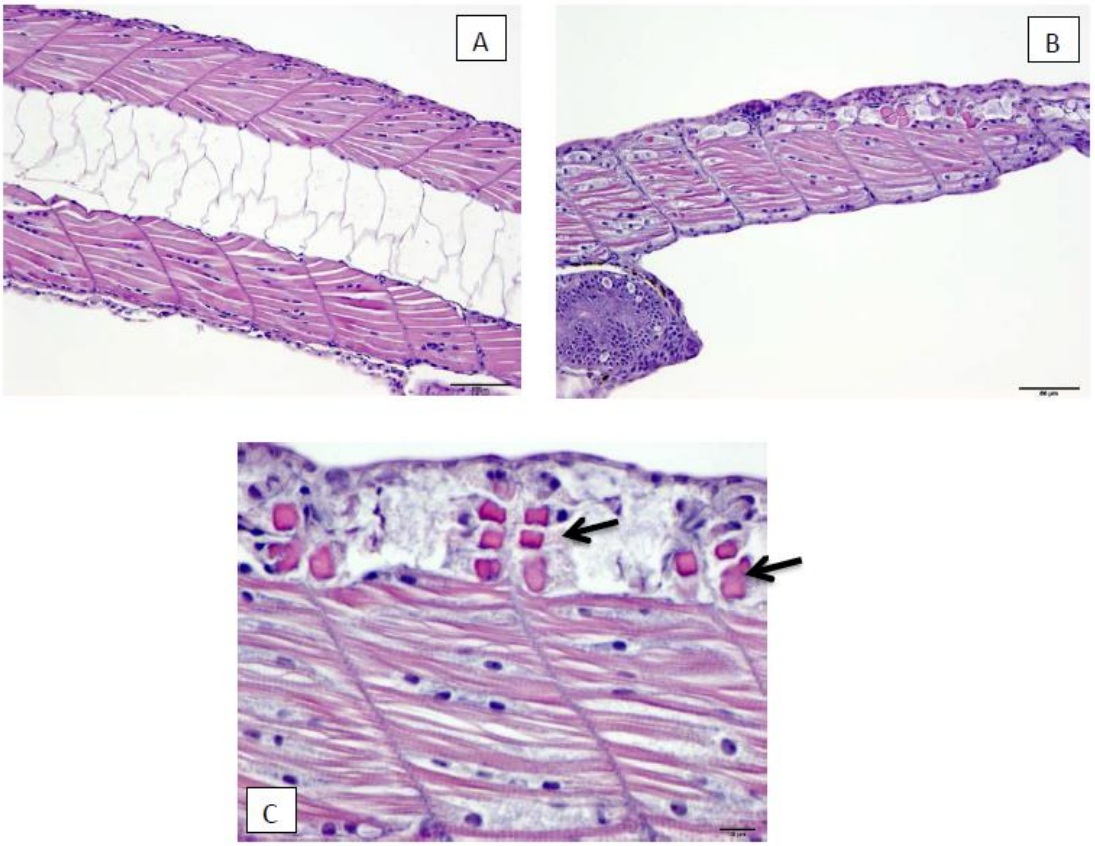



Figure 9. Histopathological findings observed in the skeletal muscle of the tail portion of Delta Smelt exposed during the embryo/newly hatched larval stages to Imazamox, Penoxsulam, and Agridex. A) Normal control muscle, B) Moderate to severe myodegeneration, C) Higher magnification of B, showing detail of the disrupted muscle fibers (arrows).

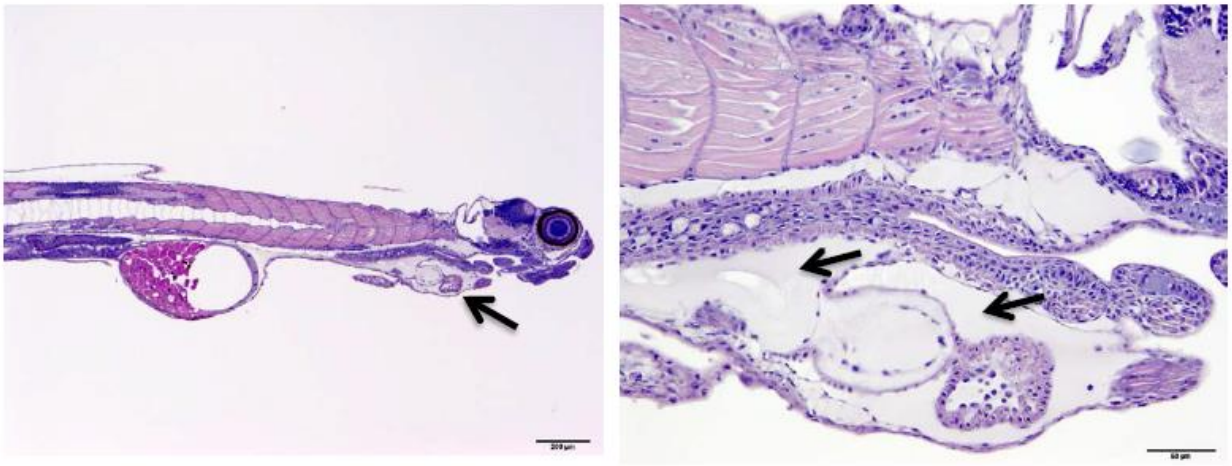


Figure 10. Histopathological findings observed in the pericardial sac of Delta Smelt exposed during the embryo/newly hatched larval stages to Imazamox, Penoxsulam, and Agridex. A) Low magnification image of the fluid buildup in the pericardial sac (arrow), B) Higher magnification of the developing heart and the pericardial sac. Note the glassy material surrounding the heart, interpreted as edema fluid (arrows).

## Fluridone, Glyphosate, 2,4-D

Delta Smelt were exposed to Fluridone, Glyphosate, and 2,4-D, in order to compare toxicity thresholds between these current-use herbicides, and the newer herbicides (Penoxsulam, Imazamox) tested in 2014. In addition, the current-use adjuvant Competitor was tested in conjunction with Imazamox, to compare Delta Smelt sensitivities to this adjuvant in mixture. Imazamox was selected because it was the only chemical to exhibit significant effects in 2014 data and concentrations tested mirrored those used in 2014. Significant effects on embryo hatching success was observed with all three current-use herbicides (Fluridone $LC_{50}$ = 326.6 mg/L, Glyphosate $LC_{50}$ = 3490.4 mg/L, 2,4-D $LC_{50}$ = 715.5 mg/L). There were no significant effects observed with Imazamox. Competitor also did not exhibit any significant effects on embryo survival or hatching success (Imazamox and Competitor data not presented). Data are outlined below in Figures 11-14.

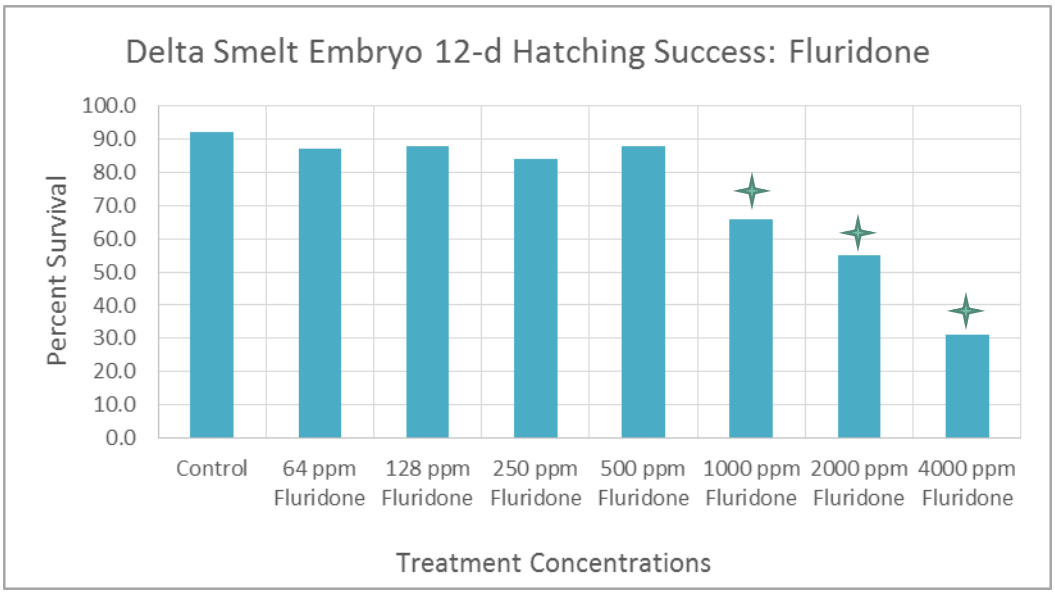



Figure 11. Delta Smelt embryo survival data with Fluridone. Fluridone 12d $LC_{50}$: 326.5 mg/L (95% CI: 278.6, 376.6). Significant reductions in survival compared to the control were observed in the 1000, 2000, and 4000 ppm concentrations, as noted with an asterisk*.

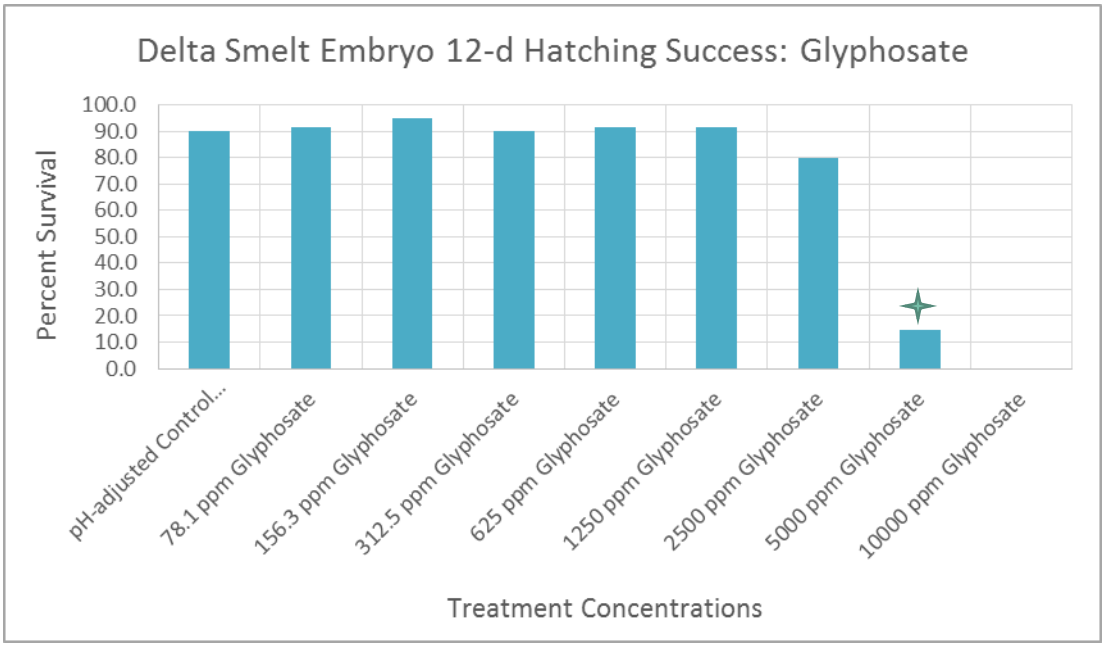



Figure 12. Delta Smelt embryo survival data with Glyphosate. Glyphosate 12d $LC_{50}$: 3490.4 mg/L (95% CI: 2851.1, 4151.0). A significant reduction in survival compared to the control was observed in the 5000 ppm concentration, as noted with an asterisk*.

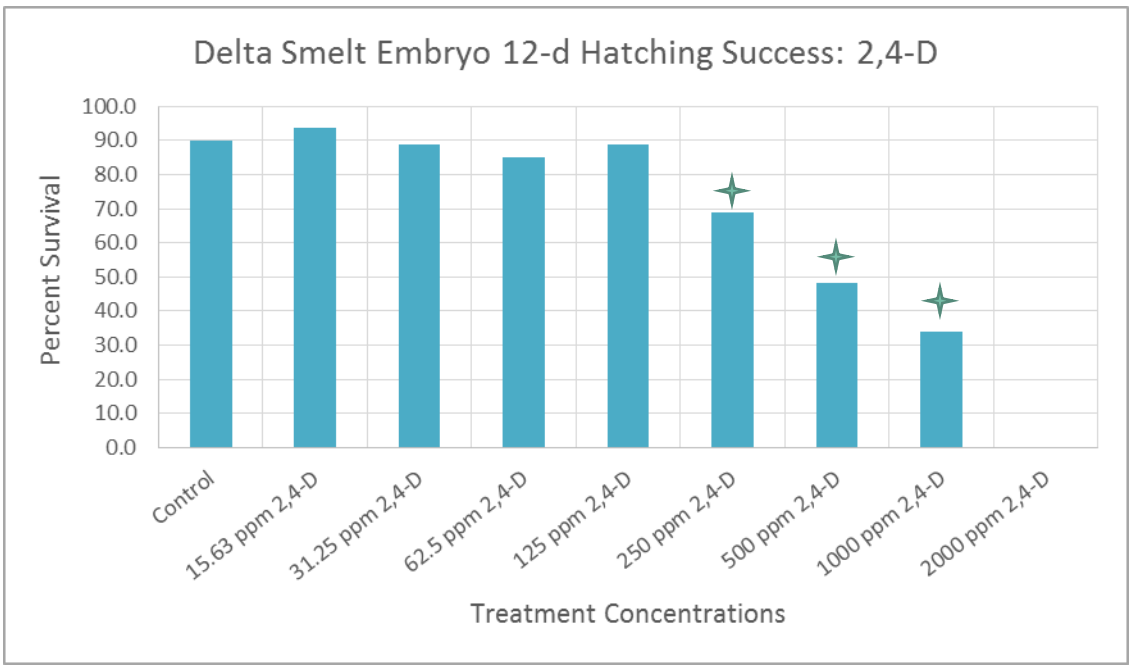



Figure 13. Delta Smelt embryo survival data with 2,4-D. 2,4-D 12d $LC_{50}$: 712.5 mg/L (95% CI: 540.9, 899.5). Significant reductions in survival compared to the control were observed in the 250, 500, and 1000 ppm concentrations, as noted with an asterisk*.

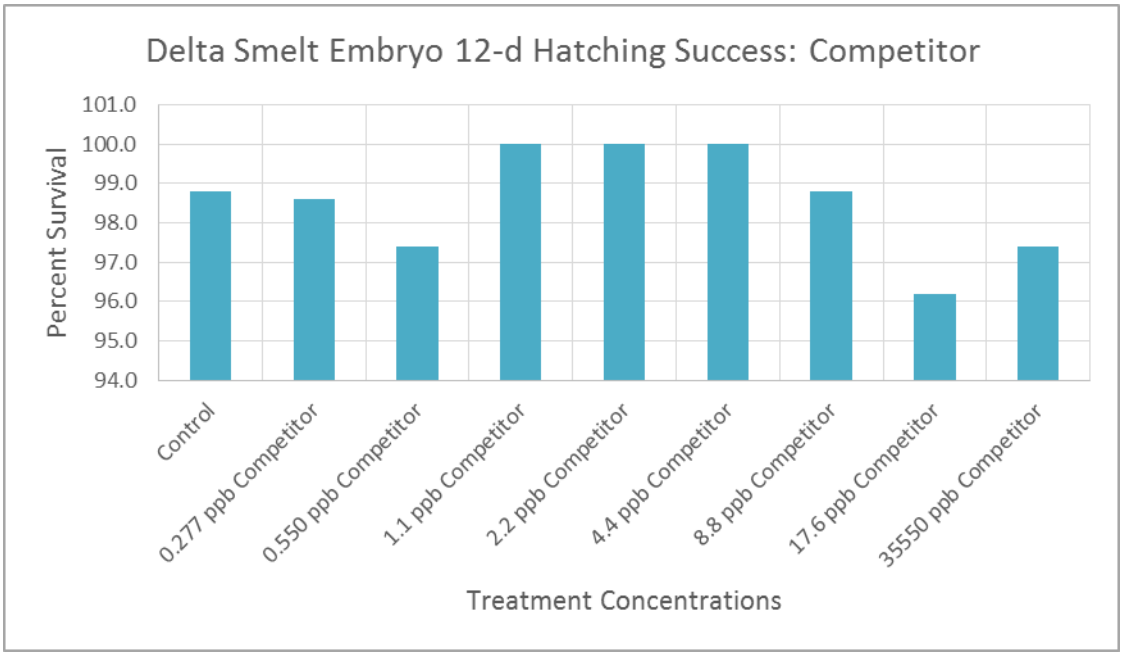


Figure 14. Delta Smelt embryo survival data with Competitor. Competitor 12d LC50: >35.55 mg/L.

## Health indices

### *Fluridone*

In Delta Smelt embryos exposed to Fluridone (Sonar AS), length decreased with increasing Fluridone concentrations. Based on the regression model, the predicted decrease in length from 0 - 4,000 mg/L is 0.546 mm, or 10.47%. The effect of Fluridone on oil globule area was marginally significantly negative. Yolk sac area increased with increasing Fluridone concentration. Based on the regression model, the predicted increase of yolk sac area from 0 - 4,000 mg/L Fluridone is 0.11 $mm^2$, or 52.11%. Weight also decreased as Fluridone concentrations increased. Based on the regression model, the predicted decrease of weight from 0 - 4,000 mg/L Fluridone is 52.3%. Linear regression F-ratios and P values for these endpoints are listed below in Table 6.

Table 6. Embryo-stage Delta Smelt exposed to Fluridone: statistical analyses. Significant effects are highlighted in purple.

| Chemical | Endpoint | F-ratio | P-value |
|---|---|---|---|
| **Fluridone** | Weight | 0.7747 | 0.3858 |
| | Length | 19.9917 | 0.0001 |
| | Oil globule area | 2.4359 | 0.12 |
| | Yolk sac area | 24.1353 | 0.0001 |

### *Glyphosate*

Delta Smelt embryos exposed to Glyphosate (Roundup Custom) did not exhibit significant effects in the morphological endpoints (Figures 5-8). Linear regression F-ratios and P values for these endpoints are listed below in Table 7.

Table 7. Embryo-stage Delta Smelt exposed to Glyphosate: statistical analyses. There were no significant effects observed.

| Chemical | Endpoint | F-ratio | P-value |
|---|---|---|---|
| **Glyphosate** | Weight | 1, 30 = 0.9570 | 0.3358 |
| | Length | 1, 27 = 0.1278 | 0.7235 |
| | Oil globule area | 1, 26.59 = 0.1791 | 0.6756 |
| | Yolk sac area | 1, 27.39 = 1.2385 | 0.2754 |

### *2,4-D*

In Delta Smelt embryos exposed to 2,4-D (Weedar64), oil globule area decreased with increasing 2,4-D concentrations. No significant effects were observed in the other endpoints. Linear Regression F-ratios and P values for these endpoints is outlined below in Table 8.

Table 8. Embryo-stage Delta Smelt exposed to 2,4-D: statistical analyses. Significant effects are high-lighted in purple.

| Chemical | Endpoint | F-ratio | P-value |
|---|---|---|---|
| **2,4-D** | Weight | 1,24 = 0.0017 | 0.9671 |
| | Length | 1, 25.83 = 0.0142 | 0.9062 |
| | Oil globule area | 1, 20.2 = 15.3826 | 0.0008 |
| | Yolk sac area | 1, 25.69 = 1.262 | 0.7253 |

### *Competitor*

As all Competitor concentrations exhibited high survival (>95% survival in all treatments), sub-lethal endpoints were not analyzed for this chemical.

## Delta Smelt Larval-stage

### Penoxsulam, Imazamox, and Agridex

Larval survival was significantly affected by Agridex in the Penoxsulam-Agridex exposure (96 h $LC_{50}$ = 57.1 mg/L); however an antagonistic interaction mitigated for the toxicity in the mixture (Figure 15), resulting in no significant effect up to the highest tested mixture concentration. In the Penoxsulam and Agridex mixture exposure, there were no significant effects on larvae survival. The highest Agridex concentration tested was lower than that tested in the Imazamox-Agridex experiment (41 mg/L compared to 64 mg/L), and therefore did not cause a similar significant effect. A three-day recovery period followed the 96 h exposures and there was little mortality between the two time points in most treatments, however exceptions were individual exposures of Imazamox and Agridex. Though Imazamox alone did not cause significant mortality after the 96 h exposure, mortality increased during the recovery period and was significant at the highest concentration, amounting to 55% mortality at 93 mg/L and 90% mortality at 124 mg/L at the end of the recovery period. Mortality also progressed in exposures to Agridex in both the Imazamox and Penoxsulam tests, such that survival became significantly affected in the Penoxsulam-Agridex test at the highest concentration (41 mg/L) at 17% mortality, and greater in the Imazamox-Agridex test over the recovery period, amounting to 75% mortality at the highest concentration (64 mg/L).

We observed a 4% decrease in the odds of survival for every 10 fold increase in the dose of Imazamox (P=<0.0001; Odds ratio=0.040). In contrast, for Penoxsulam we did not observe any changes in the

survival percentage at the 96 h and 7 days exposure time. Similarly, a significant decrease in survival was not observed in the 113 µg/L Agridex dose at the 96 h period. Conversely, for the highest Agridex dose a significant reduction in survival was observed at both time points. We observed an 8.7% decrease in the odds of survival for every 10 fold increase in the dose of Agridex at day 7 (P=<0.0001; Odds ratio=0.087) (See Figure 16). No significant reductions in survival were observed In the Penoxsulam and Agridex mixture (*P= >0.05*).

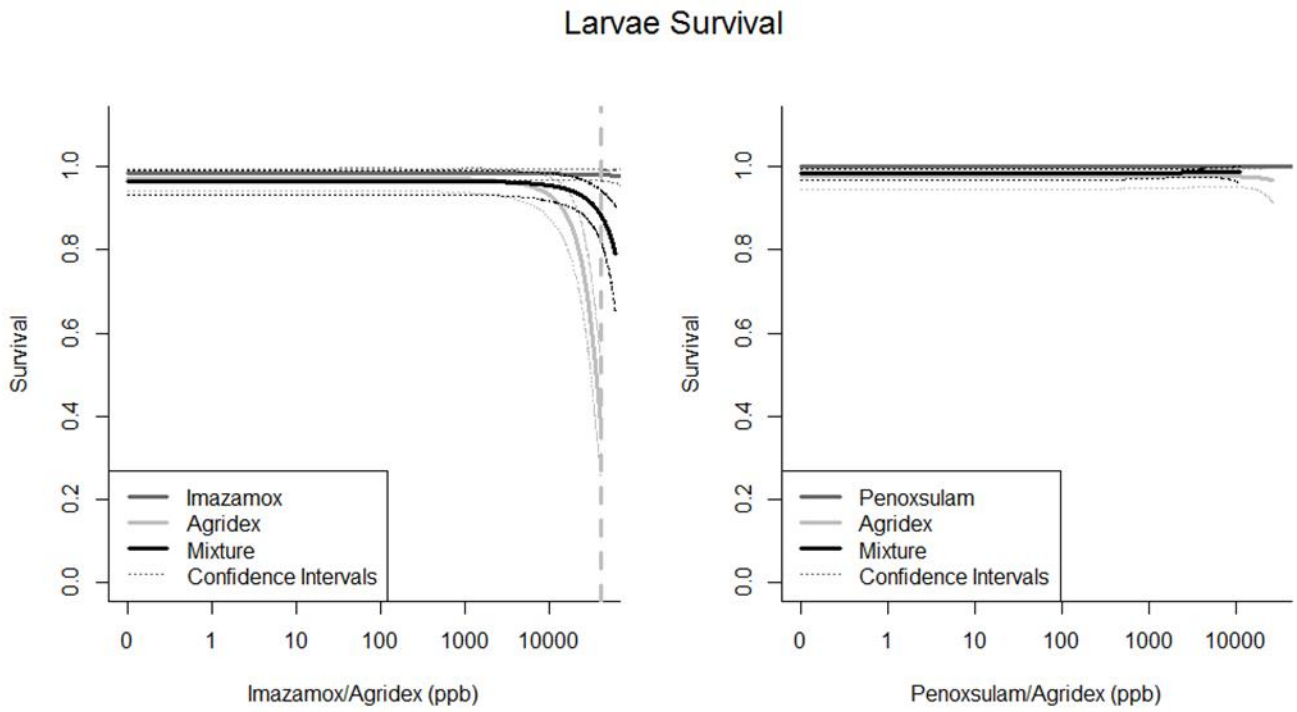



Figure 15. Herbicide, adjuvant, and herbicide-adjuvant mixture effects on larval survival conducted in 2014. Agridex alone caused larvae smelt mortality at the highest test concentration (Max effect = Average of 39% survival at the highest Agridex test concentration of 41 mg/L relative to control of 100%). Mixture with Imazamox mitigated the toxicity (antagonistic mixture interaction) – resulting in an average of 79% survival in the mixture.

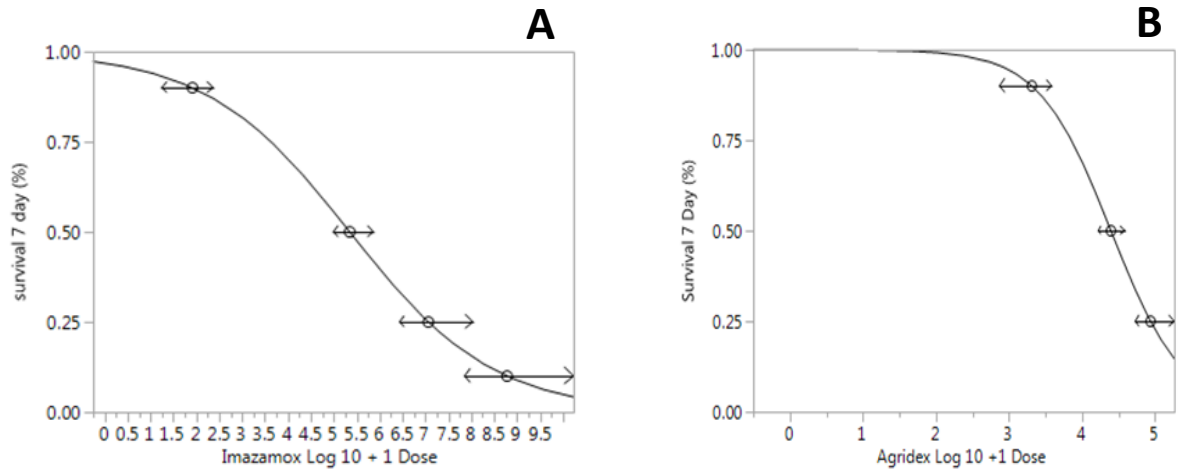



Figure 16. Estimated survival of Delta Smelt larvae exposed to A) Imazamox and B) Agridex in a 7 days toxicity test. (Each point indicate 90, 50, 25 and 10 % probabilities of survival, rows are 95 % confidence interval of $Log_{10}$ dose).

## Health indices

Larval condition factor was significantly decreased by Imazamox (LOEC = 0.062 mg/L), Agridex (LOEC = 6.4 mg/L), and their mixture (LOEC = 6.2 mg/L Imazamox and 64 mg/L Agridex). Agridex also caused a reduction in condition factor in the Penoxsulam-Agridex mixture, while Penoxsulam caused an increase in condition factor and there was no significant effect in the mixture (Figure 17). Larvae oil globule area was significantly affected only by the mixture of Imazamox and Agridex, causing a significant increase (LOEC = 62 mg/L Imazamox and 64 mg/L Agridex; Figure 18, Table 9).

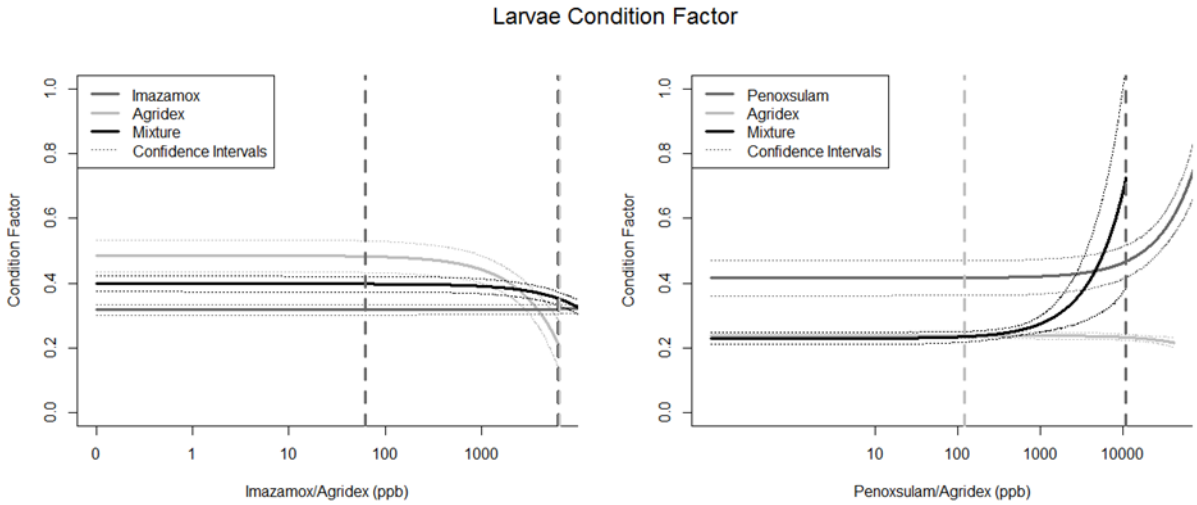



Figure 17. (left) Imazamox-Agridex and (right) Penoxsulam-Agridex effects on larvae condition factor after 96h exposures and a three day clean water recovery period. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

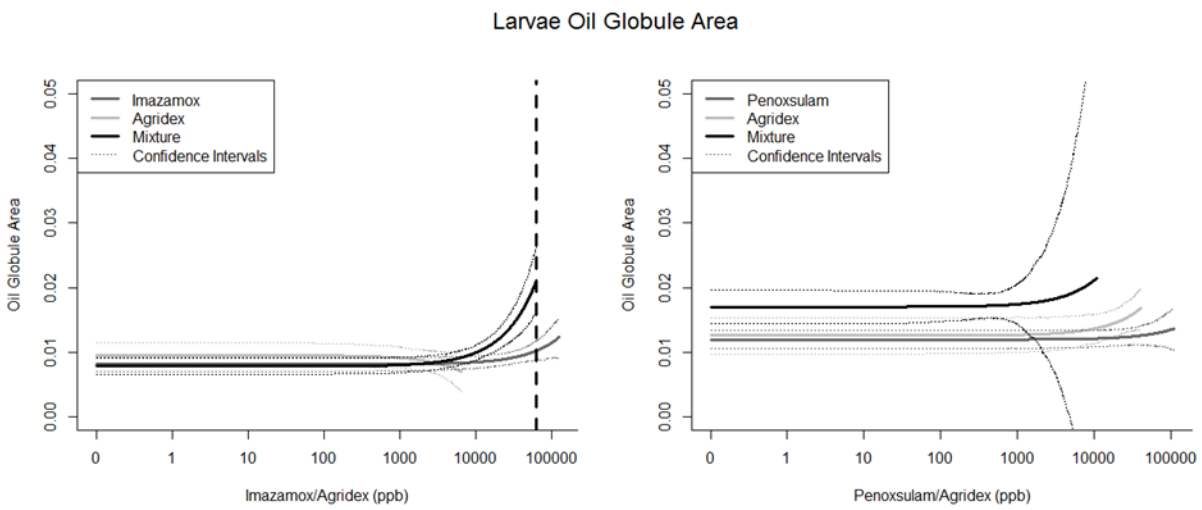



Figure 18. (left) Imazamox-Agridex and (right) Penoxsulam-Agridex effects on larvae oil globule area after 96h exposures and a three day clean water recovery period. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

Table 9. Effects of herbicides and mixtures on condition factor and oil globule area, and conclusions based on the combination of responses in Delta Smelt exposures conducted in 2014, where "NE" = No effect, "-" = negative effect, "+" = positive effect. Negative effects are highlighted in purple.

| Chemical(s) | Life Stage | CF | OGA | Conclusion |
|---|---|---|---|---|
| Agridex | Larvae | - | NE | Energy depleted by stress response |
| Imazamox | Larvae | NE | NE | No effect |
| Penoxsulam | Larvae | + | NE | Hormesis |
| Imazamox + Agridex | Larvae | - | + | Decrease energy metabolism |
| Penoxsulam + Agridex | Larvae | NE | NE | Additive response |

## Histopathology

A Kruskal-Wallis test revealed that there was a significant effect of Imazamox dose and liver histopathological alterations (P=<0.0001). Inspection of the score means suggest that compared to the control group, larvae exposed to 5,000 and 75,000 µg/L of Imazamox exhibited mild to moderate histopathological alterations in the liver (See Table 10). Similarly, in the Imazamox and Agridex mixture, a mild score mean was observed in the 500 µg/L Imazamox / 6,400 µg/L Agridex dose, and significant differences were found when compared with the control group (P=0.0043). No significant differences in the lesions score means were observed among treatments with Agridex when compared to the control group in the liver. On the other hand, for muscle tissue, the Imazamox and Agridex mixture induced a mild myodegeneration in the lowest concentration and the 5,000 µg/L Imazamox / 64,000 µg/L Agridex dose, with significant differences when compared to the control group (P=<0.0001). Conversely, no significant differences in the muscle lesions score means were observed among Imazamox and Agridex doses alone compared with the control group.

Table 10. Histopathology summaries of Delta Smelt larvae exposed to Imazamox and Agridex in an 8 day toxicity test (only results with significant differences are shown).

| Treatment | Tissue | Dose (ppb) | Score Mean | P value |
|---|---|---|---|---|
| Imazamox | **Liver** | Control | 1 (Normal) | |
| | | 5,000 | 2-3 (Mild - Moderate) | 0.0006 |
| | | 75,000 | 2-3 (Mild - Moderate) | 0.0005 |
| Imazamox + Agridex | **Liver** | 500+ 6,400 | 2-3 (Mild - Moderate) | 0.0006 |
| Imazamox + Agridex | **Muscle** | 12+113 | 2-3 (Mild - Moderate) | 0.0017 |
| | | 5,000 + 64,000 | 2-3 (Mild - Moderate) | 0.0057 |

## Fluridone, Glyphosate, 2,4-D

Significant effects were observed at 96h and 8d for both Fluridone (96h $LC_{50}$ = 160.8, 8d $LC_{50}$ = 138.9 mg/L) and Glyphosate (96h $LC_{50}$ = 1184 mg/L, 8d $LC_{50}$ = 1099 mg/L) in larval Delta Smelt tests. A significant mixture interaction between Imazamox and Competitor was observed in the highest concentration, indicating an additive effect (Table 11). Delta smelt larval data are outlined in Figures 19-26.

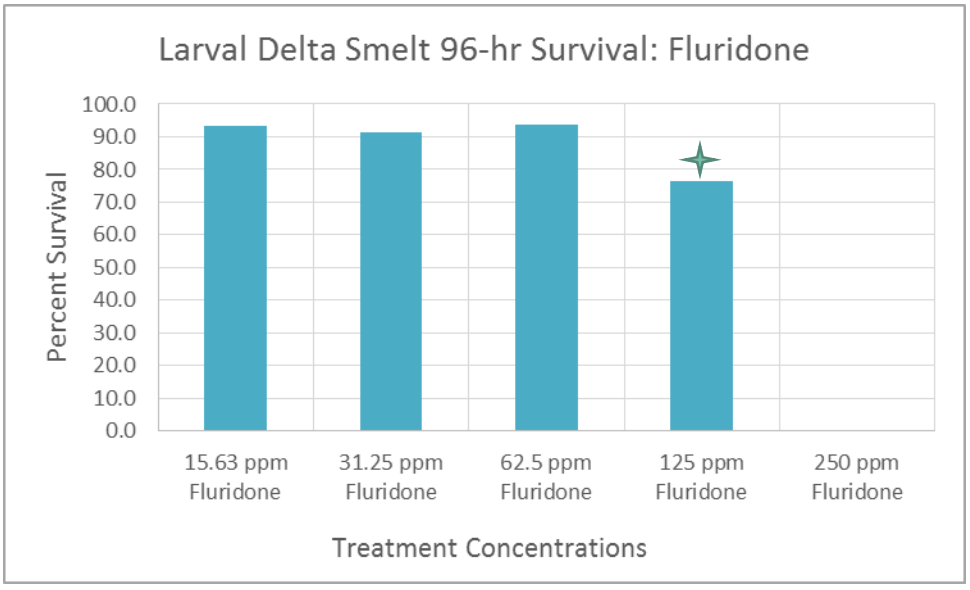



Figure 19. Delta Smelt larval 96h survival data with Fluridone. Fluridone 96h $LC_{50}$: 160.8 mg/L (95% CI: not available). A significant reduction in survival compared to the control was observed in the 125 ppm concentration, as noted with an asterisk*.

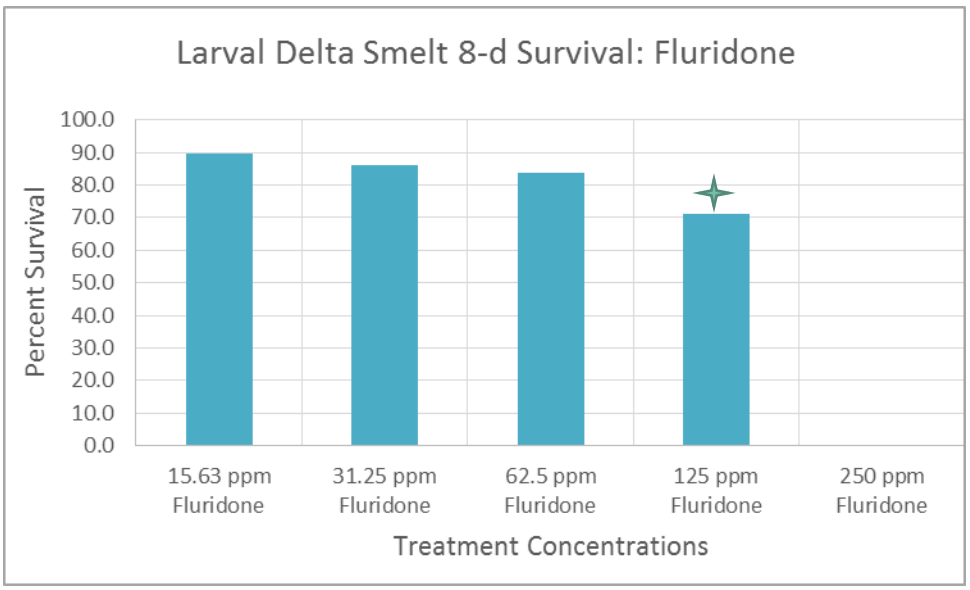



Figure 20. Delta Smelt larval 96h survival data with Fluridone. Fluridone 8d $LC_{50}$: 138.9 mg/L (95% CI: not available). A significant reduction in survival compared to the control was observed in the 125 ppm concentration, as noted with an asterisk*.

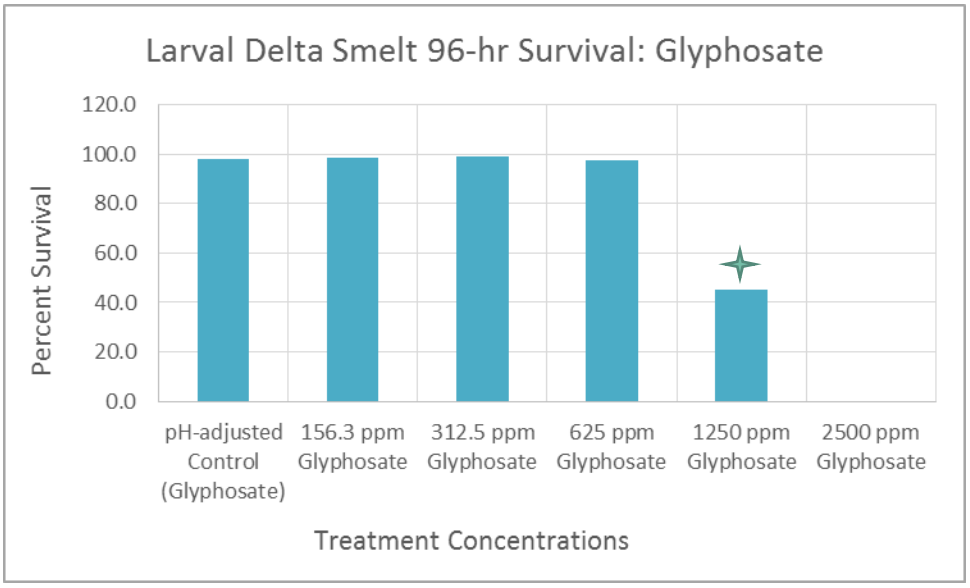



Figure 21. Delta Smelt larval 96h survival data with Glyphosate. Glyphosate 96h $LC_{50}$: 1184 mg/L (95% CI: 983.9-1502). A significant reduction in survival compared to the control was observed in the 1250 ppm concentration, as noted with an asterisk*.

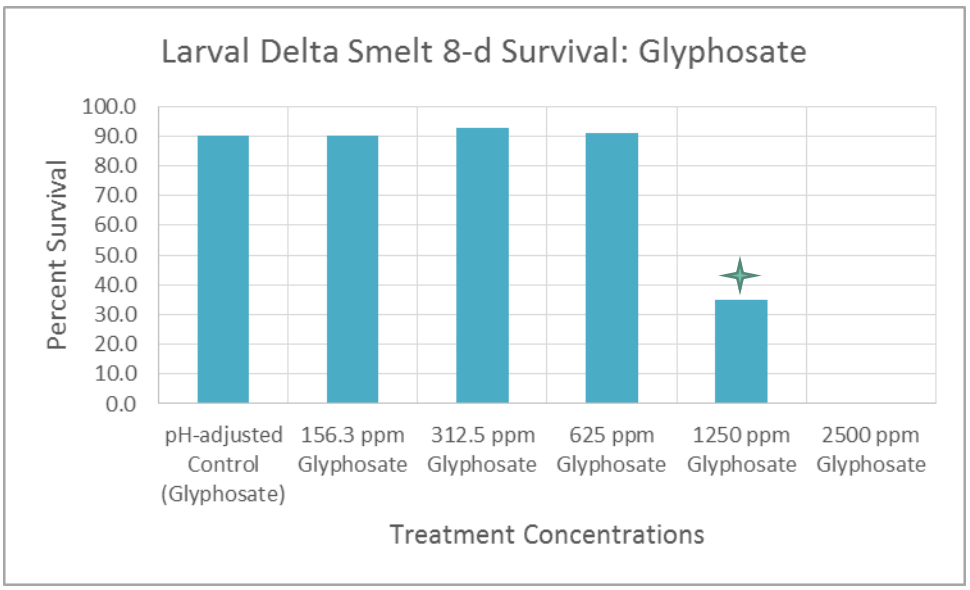



Figure 22. Delta Smelt larval 8d survival data with Glyphosate. Glyphosate 8d $LC_{50}$: 1099 mg/L (95% CI: 837.3-1540). A significant reduction in survival compared to the control was observed in the 1250 mg/L concentration, as noted with an asterisk*.

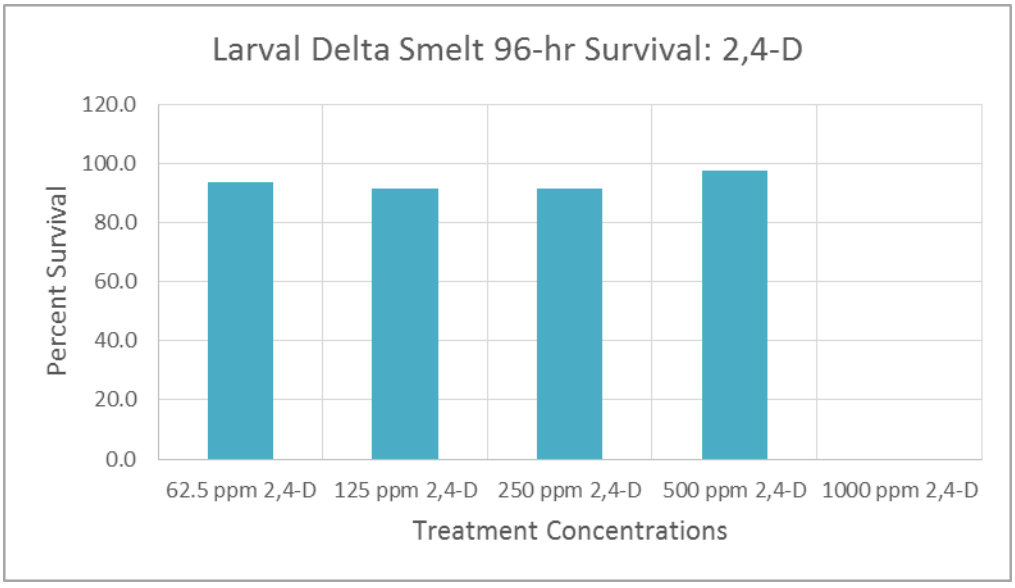



Figure 23. Delta Smelt larval 96h survival data with 2,4-D. 96h $LC_{50}$: 696.4 mg/L (95% CI: 678.5-709.8).

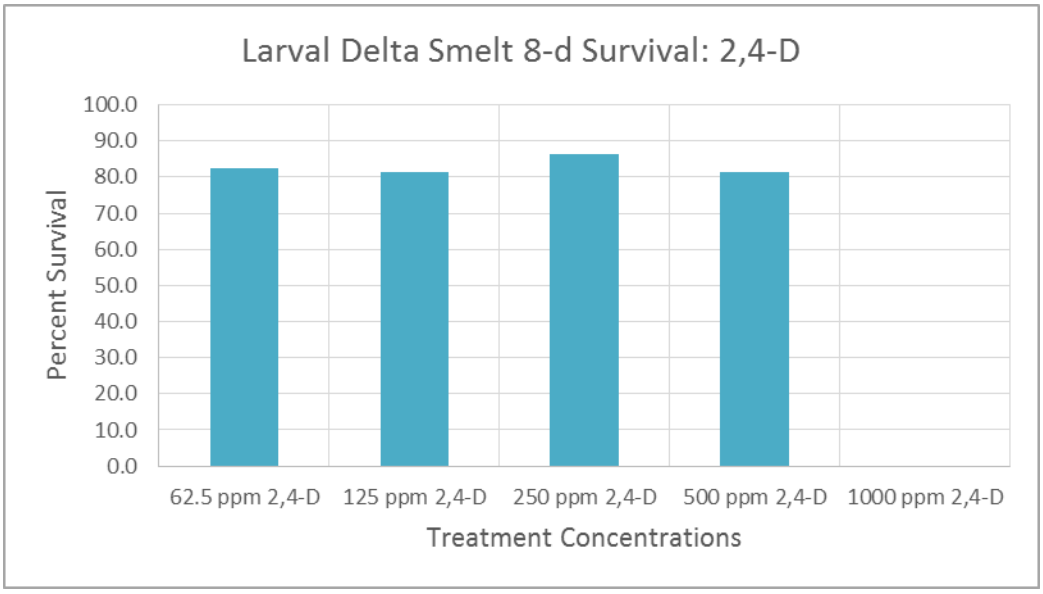



Figure 24. Delta Smelt larval 8d survival data with 2,4-D. 8d $LC_{50}$: 593.9 mg/L (95% CI: not available).

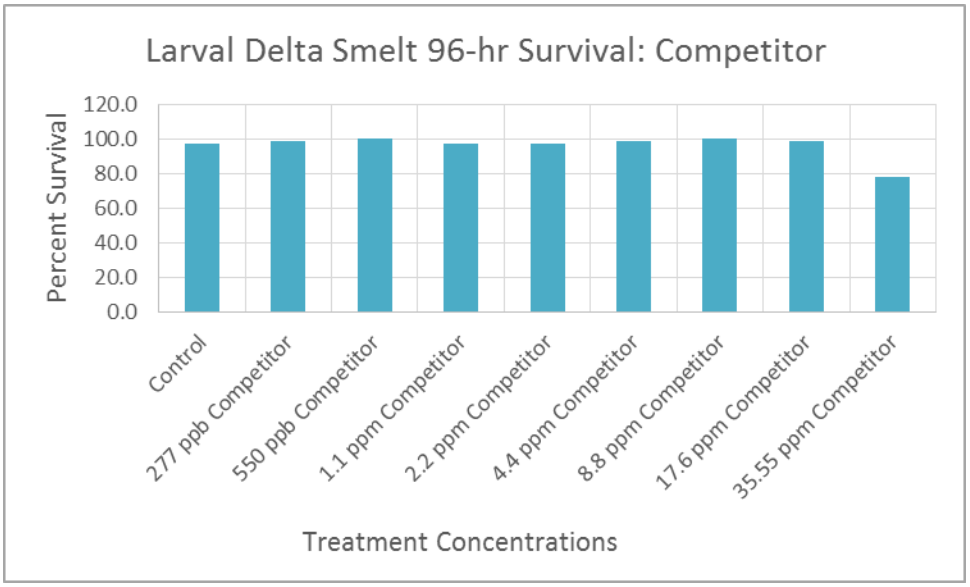



Figure 25. Delta Smelt larval 96h survival data with Competitor. 96h $LC_{50}$: >35.55 mg/L.

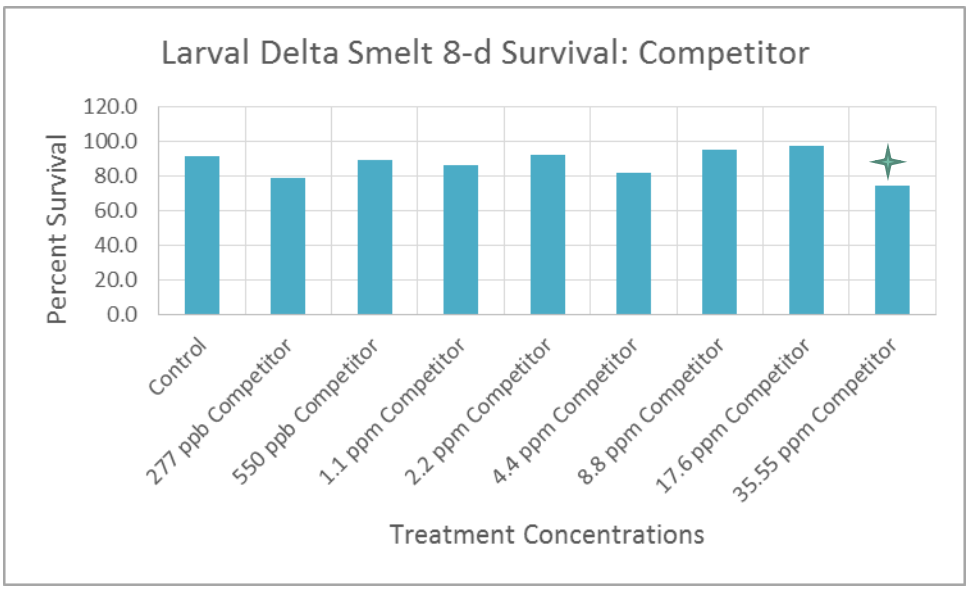



Figure 26. Delta Smelt larval 8d survival data with Competitor. 8d $LC_{50}$: >35.55 mg/L. A significant reduction in survival compared to the control was observed in the 35.55 mg/L concentration, as noted with an asterisk*.

Table 11. Generalized Linear Model results for 8d Delta Smelt larval survival in Imazamox + Competitor mixture. This mixture exhibited an additive significant effect (highlighted).

| Predictor Variable | Parameter Estimate | Standard Error | P-value |
|---|---|---|---|
| **Intercept** | 4.190123 | 0.549657 | 2.20E-09 |
| **Imazamox** | -0.00458 | 0.000747 | 2.78E-07 |
| **Imazamox + Competitor** | -0.03857 | 0.009156 | 0.000135* |

## Health indices

Delta Smelt Larvae endpoints of length, oil globule area, and yolk sack area were analyzed with ANOVA. Instances in which error distributions were not normal and assumptions were not met for normality, were analyzed using non-parametric statistics. Resulting data were the same with both sets of analyses. In general, observed significant effects in these endpoints were few, and in some cases are likely due to variability among replicates.

### *Fluridone*

In Delta Smelt larvae exposed to Fluridone, significant effects were observed in the length at 62.5 mg/L (P=0.394) and in yolk sack area in the 15.6 mg/L treatment (P=0.0361) and in the 500 mg/L concentration (P=0.0169). We believe that given the trend of data in the yolk sack area endpoint, the significant result in the 15.6 mg/L is due to variability and we would interpret this result with caution.

### *Glyphosate*

There were no significant effects observed in any sub-lethal endpoints in larval Delta Smelt exposed to Glyphosate.

### *2,4-D*

There was a significant reduction in larval Delta Smelt length observed in those fish exposed to 62.5 mg/L of 2,4-D (P=0.0175), however we believe this is a result of variability among replicates and should be interpreted with caution, as no other endpoints were significantly reduced in any of the other concentrations.

### *Competitor*

There were no significant effects in any of the sub-lethal endpoints in larval Delta Smelt exposed to Competitor.

## *Eurytemora affinis*

Relative sensitivities of *E. affinis* to Penoxsulam, Imazamox, and Agridex were variable when compared to 2014 Delta Smelt effect concentrations. For instance, Penoxsulam had significant effects on *E. affinis* ($LC_{50}$ = 63.7 mg/L), whereas there were no significant effects with this chemical alone observed in Delta Smelt. However, with Imazamox, we were unable to obtain an $LC_{50}$ with *E. affinis* ($LC_{10}$ = 56.6 mg/L), yet larval delta smelt had a 7d $LC_{50}$ of 69.5 mg/L. In comparison, sensitivity to Agridex was relatively similar between *E. affinis* ($LC_{50}$ = 46.7 mg/L) and Delta Smelt ($LC_{50}$ = 36.5 mg/L), with Smelt showing slightly higher sensitivities to this chemical. In the mixture studies, both combinations of Penoxsulam + Agridex ($LC_{50}$ = 24.4 mg/L) and Imazamox + Agridex ($LC_{50}$ = 77.0 mg/L) exhibited additive effects to *E. affinis*. In comparison, Delta Smelt showed decreased sensitivity to these mixtures. There were no survival effects on Delta Smelt in Penoxsulam + Agridex mixtures in 2014, and Imazamox + Agridex showed significant additive effects only at the highest concentration tested (61 mg/L Imazamox with 41 mg/L Agridex). *E. affinis* data are outlined in Figures 27-31.

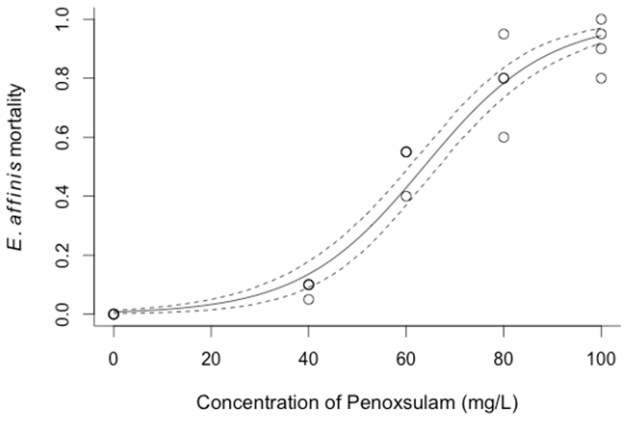



Figure 27. *Eurytemora affinis* mortality data with Penoxsulam. $LC_{50}$: 63.7 mg/L (dotted line 95% CI: 60.6, 66.6), $LC_{10}$: 35.6 mg/L (dotted line 95% CI: 30.1, 41.1).

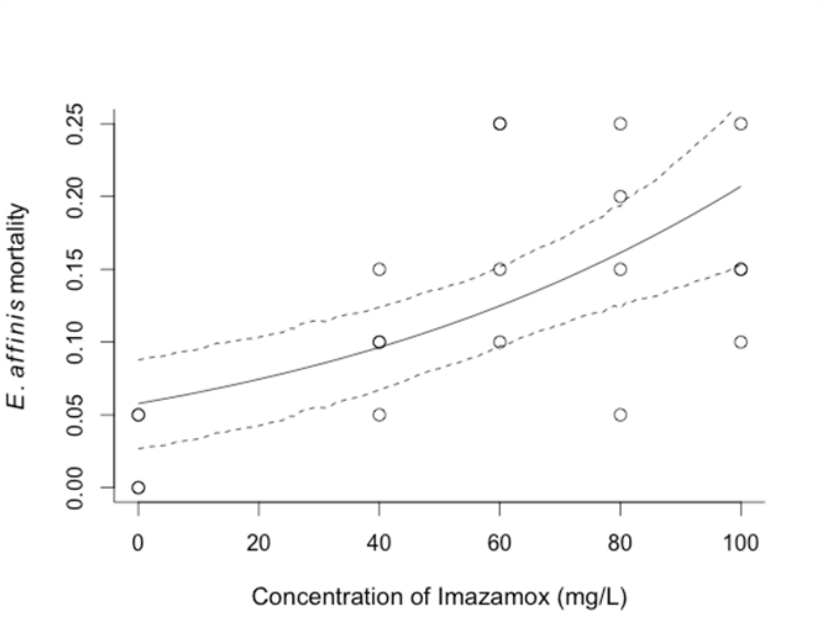



Figure 28. *Eurytemora affinis* mortality data with Imazamox. LC50: none; LC10: 56.6 mg/L (dotted line 95% CI: 17.4, 65.2).

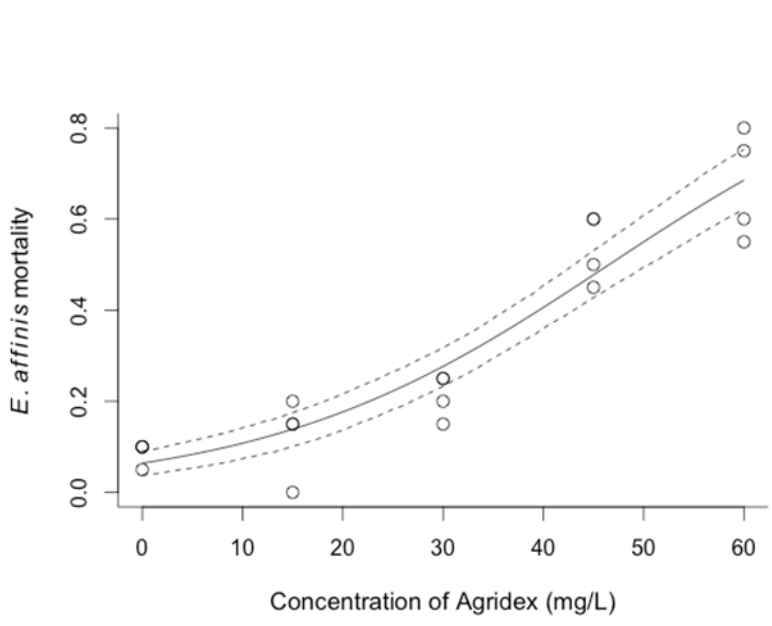



Figure 29. *Eurytemora affinis* mortality data with Agridex. $LC_{50}$: 46.7 mg/L (dotted line 95% CI: 42.8, 50.4); $LC_{10}$: 8.5 mg/L (dotted line 95% CI: 2.3, 15.1).

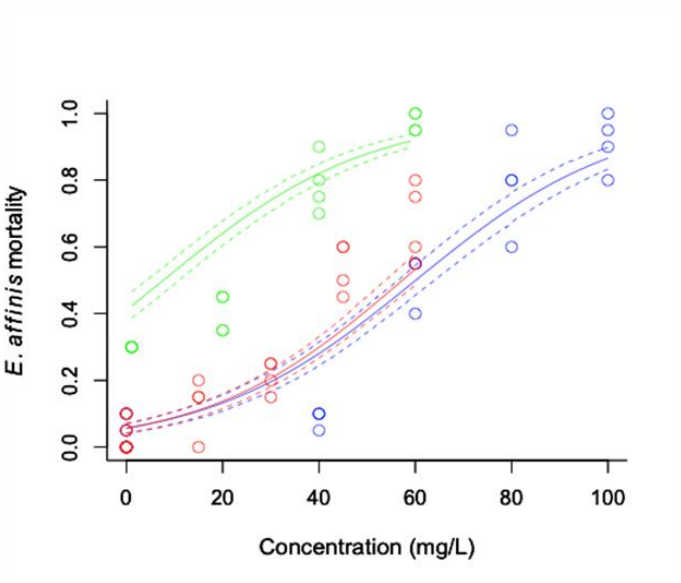



Figure 30. *Eurytemora affinis* mortality data: Penoxsulam + Agridex mixture. Mixture $LC_{50}$: 24.4 mg/L, (dotted line 95% CI: 22.0, 26.8); Mixture $LC_{10}$: 0.5 mg/L (dotted line 95% CI: -2.3, 3.6). Penoxsulam + Agridex has a significant additive effect.

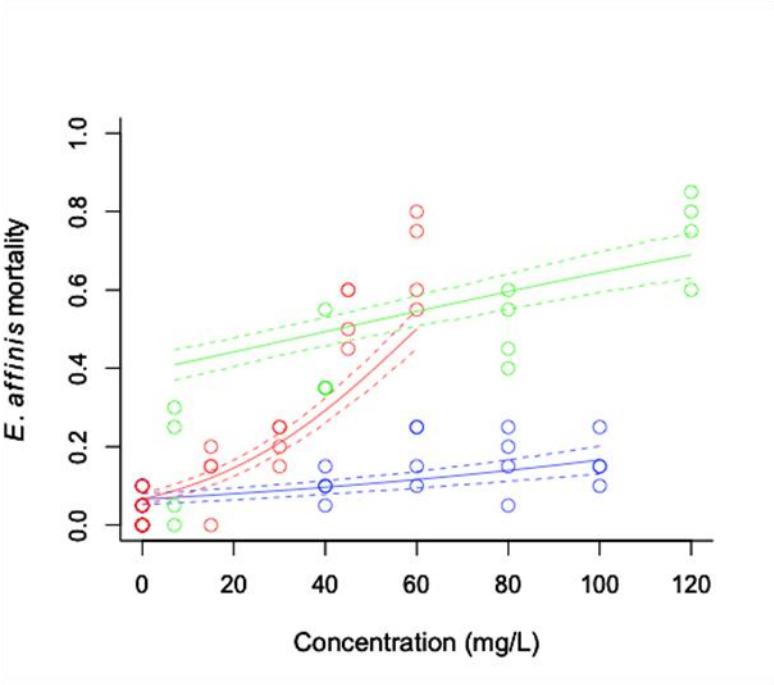



Figure 31. *Eurytemora affinis* mortality data: Imazamox + Agridex mixture. Mixture $LC_{50}$: 77.0 mg/L (dotted line 95% CI: 70.0, 84.0); Mixture $LC_{10}$: 4.5 mg/L (dotted line 95% CI: -4.2 13.4). Imazamox + Agridex has a significant additive effect.

### *Thalassiosira pseudonana*

All *T. pseudonana* tests met the test acceptability criterion of greater than or equal to 1.6 x $10^5$ cell growth in the control, and <20% CV among replicates. Water quality of the modified F/2 medium was within physiological ranges for the test species (hardness 148 mg/L $CaCO_3$, alkalinity 8 mg/L $CaCO_3$, ammonia 0 mg/L).

#### Penoxsulam

Penoxsulam concentrations ranged from 2-100,000 µg/L. Penoxsulam effect concentrations and Agridex mixture treatments were conducted in the same test. Due to high growth in all Penoxsulam-only treatments, we were unable to elicit an IC50, as it exceeded the highest test treatment concentration of 100,000 µg/L (Figure 32). The No Effect Level (NOEL) was 50,000 µg/L, and the Lowest Effect Level (LOEL) was 100,000 µg/L. The Percent Minimum Significant Difference (PMSD) for this test was 13.5%.

In the Penoxsulam + Agridex mixtures, there was an antagonistic interaction observed in all three mixture treatments, which reduced the toxicity of Agridex (Table 12). In the Penoxsulam + Competitor mixtures, the toxicity of Competitor overshadowed any interactions (Figure 33, Table 13).

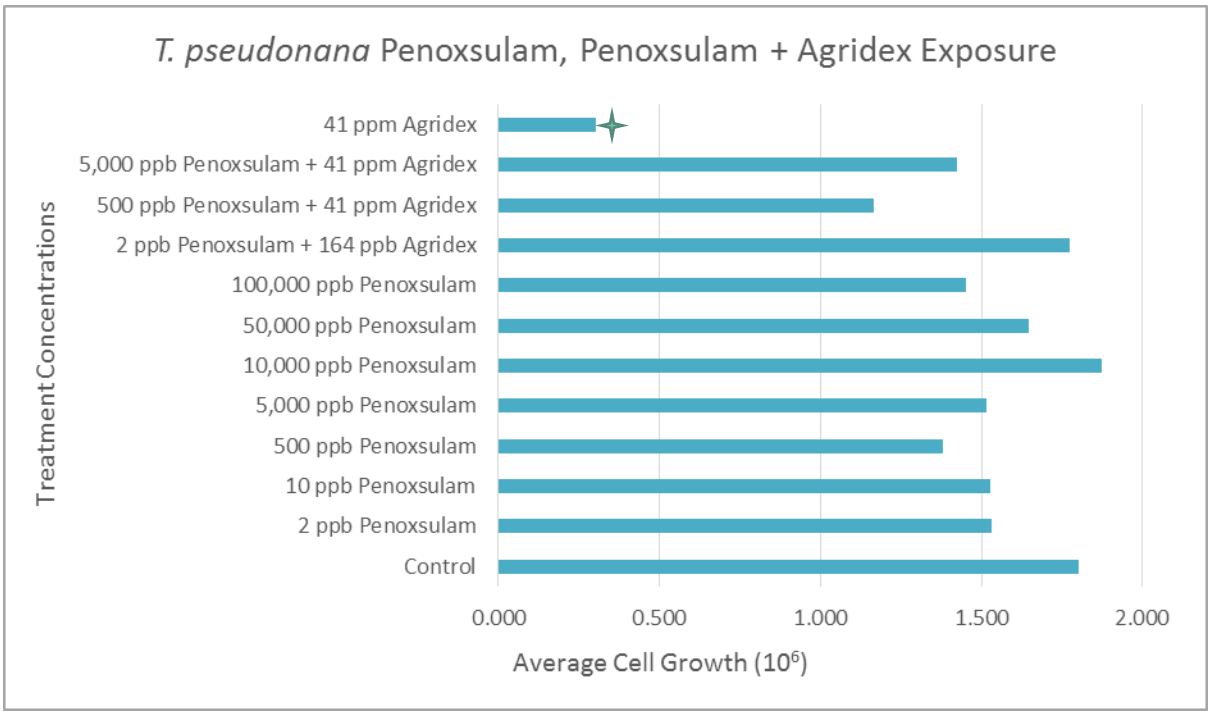



Figure 32. 96-hour toxicity data for *T. pseudonana* exposed to Penoxsulam, and Penoxsulam + Agridex. A significant reduction in cell growth was observed in the highest concentration of Agridex, as noted with an asterisks*.

Table 12. Generalized Linear Model mixture interactions.

| | Estimate | Std..Error | t.value | Pr...t.. | Result | Interaction |
|---|---|---|---|---|---|---|
| **(Intercept)** | 0.9827 | 0.0237 | 41.5040 | 0.0000 | | |
| **Penoxsulam** | 0.0000 | 0.0000 | -2.2293 | 0.0289 | Significant | |
| **Agridex** | -0.0095 | 0.0011 | -8.4541 | 0.0000 | Significant | |
| **Penoxsulam + Agridex** | 0.0000 | 0.0000 | -2.8338 | 0.0060 | Significant | Antagonistic |

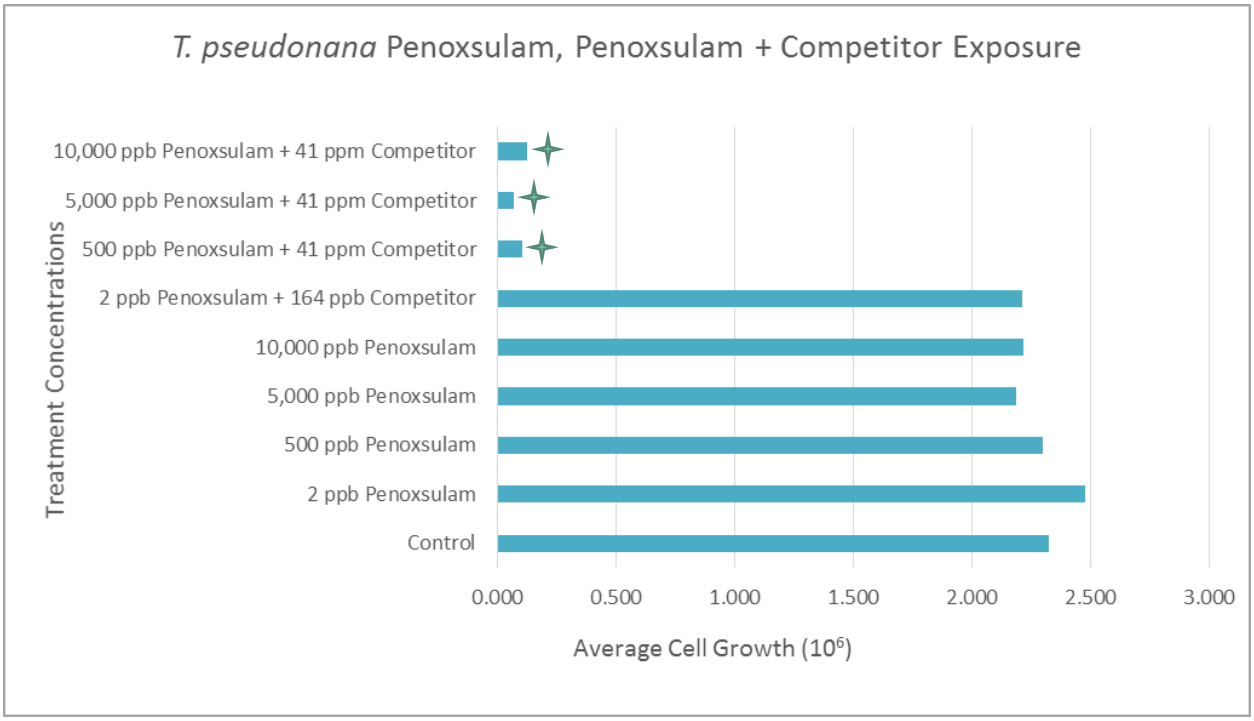



Figure 33. 96-hour toxicity data for *T. pseudonana* exposed to Penoxsulam, and Penoxsulam + Competitor. Significant reductions in cell growth were observed in all mixture treatments containing 41 mg/L Competitor, as noted with asterisks*

Table 13. Generalized Linear Model mixture interactions.

| | Estimate | Std..Error | t.value | Pr...t.. | Result | Interaction |
|---|---|---|---|---|---|---|
| **(Intercept)** | 0.7908 | 0.0443 | 17.8698 | 0.0000 | | |
| **Penoxsulam** | 0.0000 | 0.0000 | 1.5413 | 0.1285 | Not Significant | |
| **Competitor** | -0.0160 | 0.0018 | -8.8421 | 0.0000 | Significant | |
| **Penoxsulam + Competitor** | 0.0000 | 0.0000 | 0.6652 | 0.5085 | Not Significant | None |

## Imazamox

Imazamox concentrations ranged from 12-100,000 µg/L. Imazamox effect concentrations and Agridex mixture treatments were conducted in the same test. The IC50 for Imazamox was 84,390 µg/L (95% CI

79,150-88,940). The NOEL was 5,000 µg/L and the LOEL was 50,000 µg/L. The PMSD for this test was 14.0%.

In the mixture treatments, there was no interaction observed with Imazamox + Agridex (Figure 34, Table 14); however there was an antagonistic interaction between Imazamox + Competitor, with the combination reducing the toxicity of Competitor (Figure 35, Table 15).

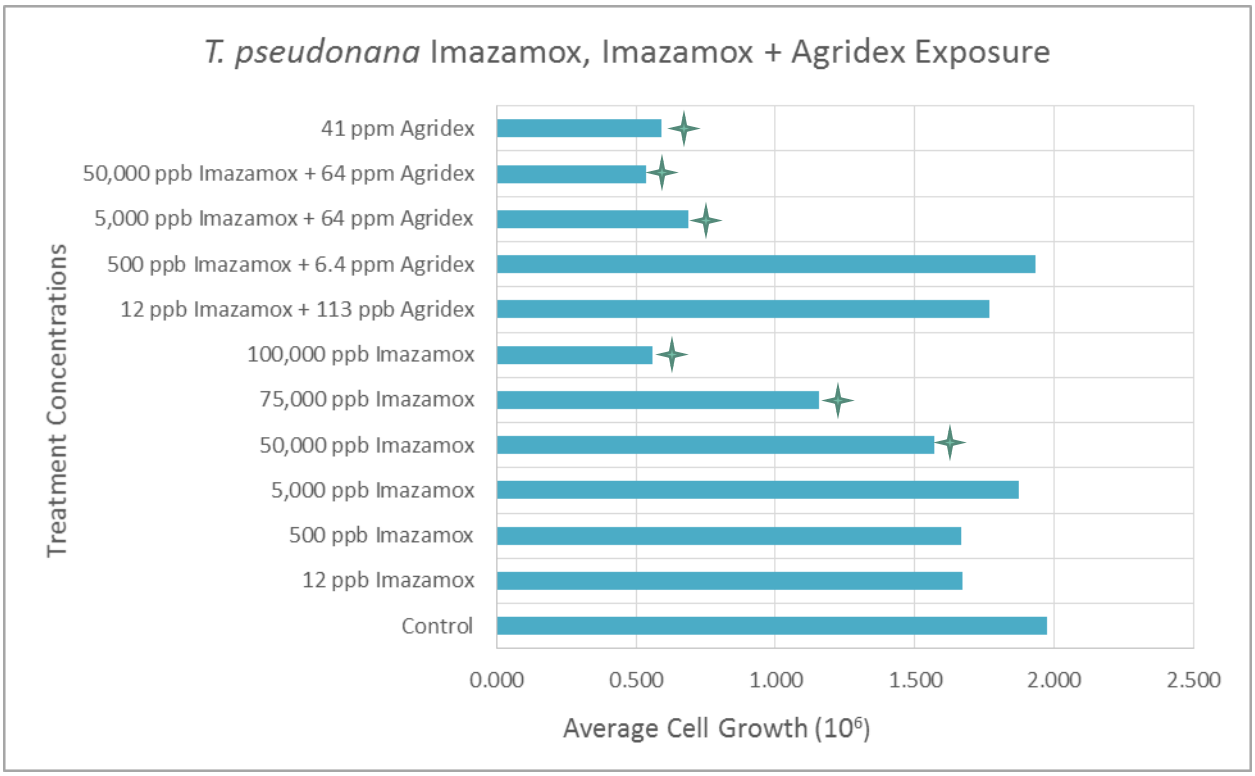



Figure 34. 96-hour toxicity data of *T. pseudonana* exposed to Imazamox, and Imazamox + Agridex. A significant reduction in cell growth compared to the control was observed in multiple single chemical concentrations as well as mixture treatments, as noted with asterisks*.

Table 14. Generalized Linear Model mixture interactions

| | Estimate | Std..Error | t.value | Pr...t.. | Result | Interaction |
|---|---|---|---|---|---|---|
| **(Intercept)** | 1.0127 | 0.0253 | 40.0284 | 0.0000 | | |
| **Imazamox** | 0.0000 | 0.0000 | -9.6984 | 0.0000 | Significant | |
| **Agridex** | -0.0106 | 0.0009 | -11.9055 | 0.0000 | Significant | |
| **Imazamox + Agridex** | 0.0000 | 0.0000 | 0.0290 | 0.9769 | Not Significant | None |

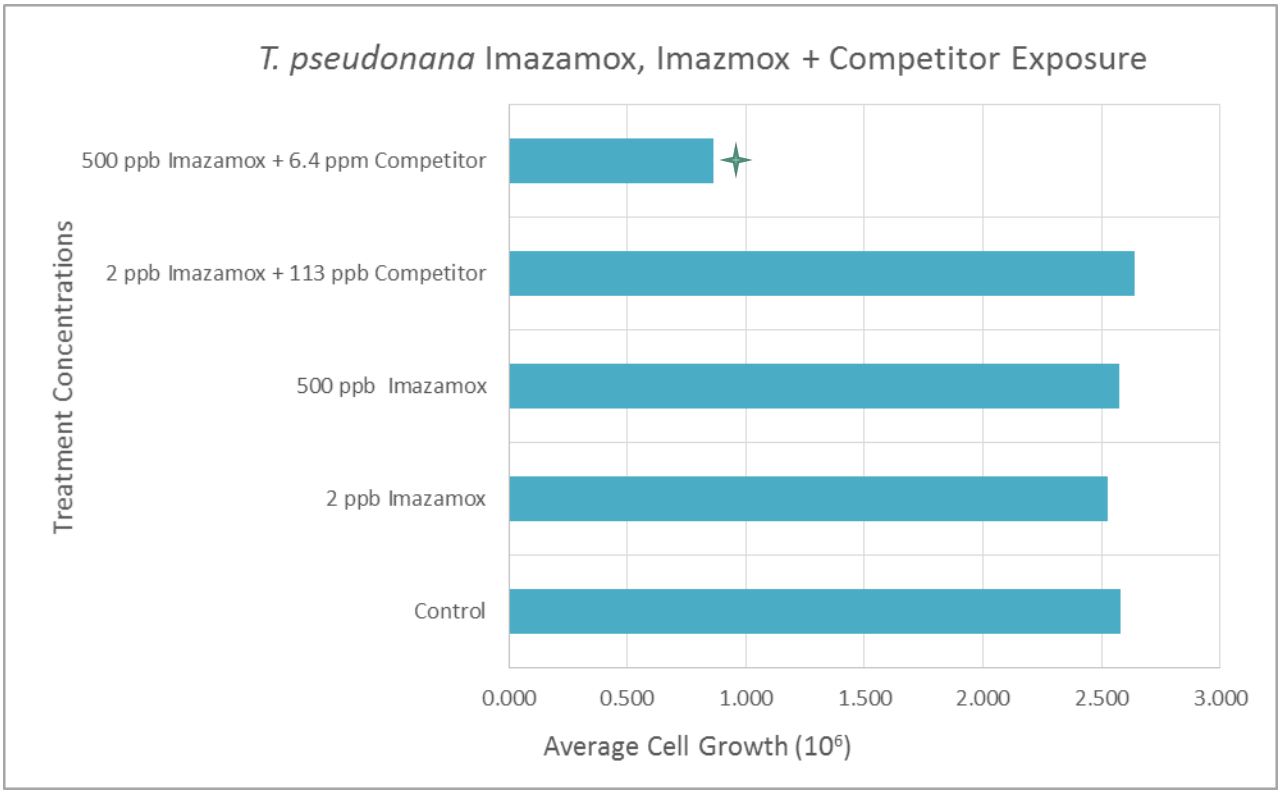



Figure 35. 96-hour toxicity data of *T. pseudonana* exposed to Imazamox, and Imazamox + Competitor. A significant reduction of cell growth compared to the control was observed in the highest mixture concentration; however this mixture interaction was also antagonistic, reducing the toxicity of Competitor.

Table 15. Generalized Linear Model mixture interactions

| | Estimate | Std..Error | t.value | Pr...t.. | Result | Interaction |
|---|---|---|---|---|---|---|
| **(Intercept)** | 0.7611 | 0.0533 | 14.2691 | 0.0000 | | |
| **Imazamox** | 0.0005 | 0.0003 | 1.6473 | 0.1066 | Significant | |
| **Competitor** | -0.0154 | 0.0024 | -6.3391 | 0.0000 | Significant | |
| **Imazamox + Competitor** | -0.0002 | 0.0001 | -2.8816 | 0.0061 | Significant | Antagonistic |

## Agridex

Agridex concentrations ranged from 1,875-60,000 µg/L. The IC50 for Agridex was 38,550 µg/L (95% CI 36,590-40,630). The NOEL was 15,000 µg/L and the LOEL was 30,000 µg/L. The PMSD for this test was 13.3%.

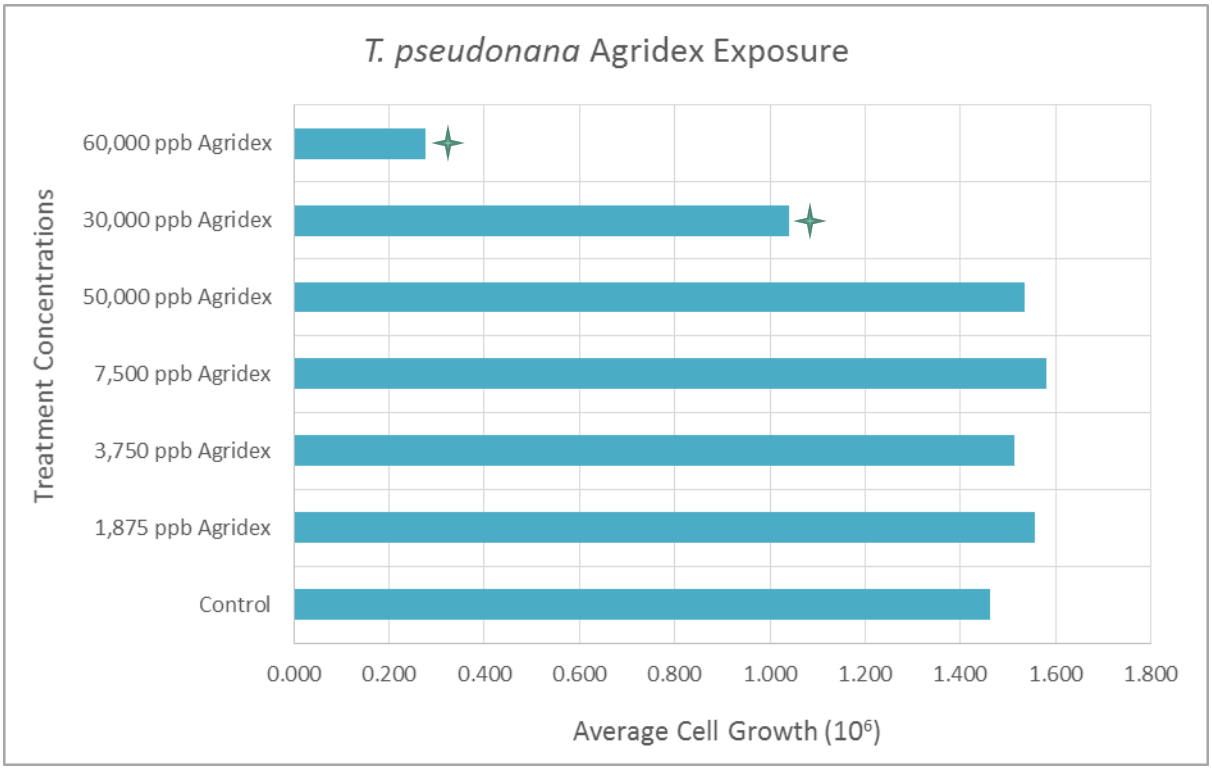



Figure 36. 96-hour toxicity data of *T. pseudonana* exposed to Agridex. A significant reduction in cell growth compared to the control was observed in the two highest concentrations of Agridex, as noted with asterisks*.

## Competitor

Competitor concentrations ranged from 1,875-60,000 µg/L. The IC50 for Competitor was 4,459 µg/L (95% CI 4,140-4,758). The multiple comparisons portion of the statistical analyses could not be run because a P-value of 0.05 was unattainable for this dataset. The P-value for these data was 0.3043, and due to a non-significant trend in the controls, we were unable to obtain NOEL, LOEL, and PMSD values. There was a distinct lack of growth in diatom treatments exposed to 50,000 µg/L and above of Competitor (Figure 37); however the final dissolved oxygen measurement at test termination was low, at 5.02, 3.70, and 1.41 mg/L, respectively, for these treatments. This low dissolved oxygen could account for the inhibition of growth observed in these treatments. The highest test treatment, 60,000 µg/L Competitor, had slightly higher growth than the two lower concentrations, but this was due to interference with the particle counter, with the amount of Competitor present in the replicate flasks. Competitor, as a mixture of oils, tends to sit on the surface of the water column when in higher concentrations and does not go fully into solution (as water and oil do not mix). Thus, it is likely that the Competitor floating on the surface of the water caused the low dissolved oxygen levels observed in the higher concentration test treatments, and the interference with the particle counter.

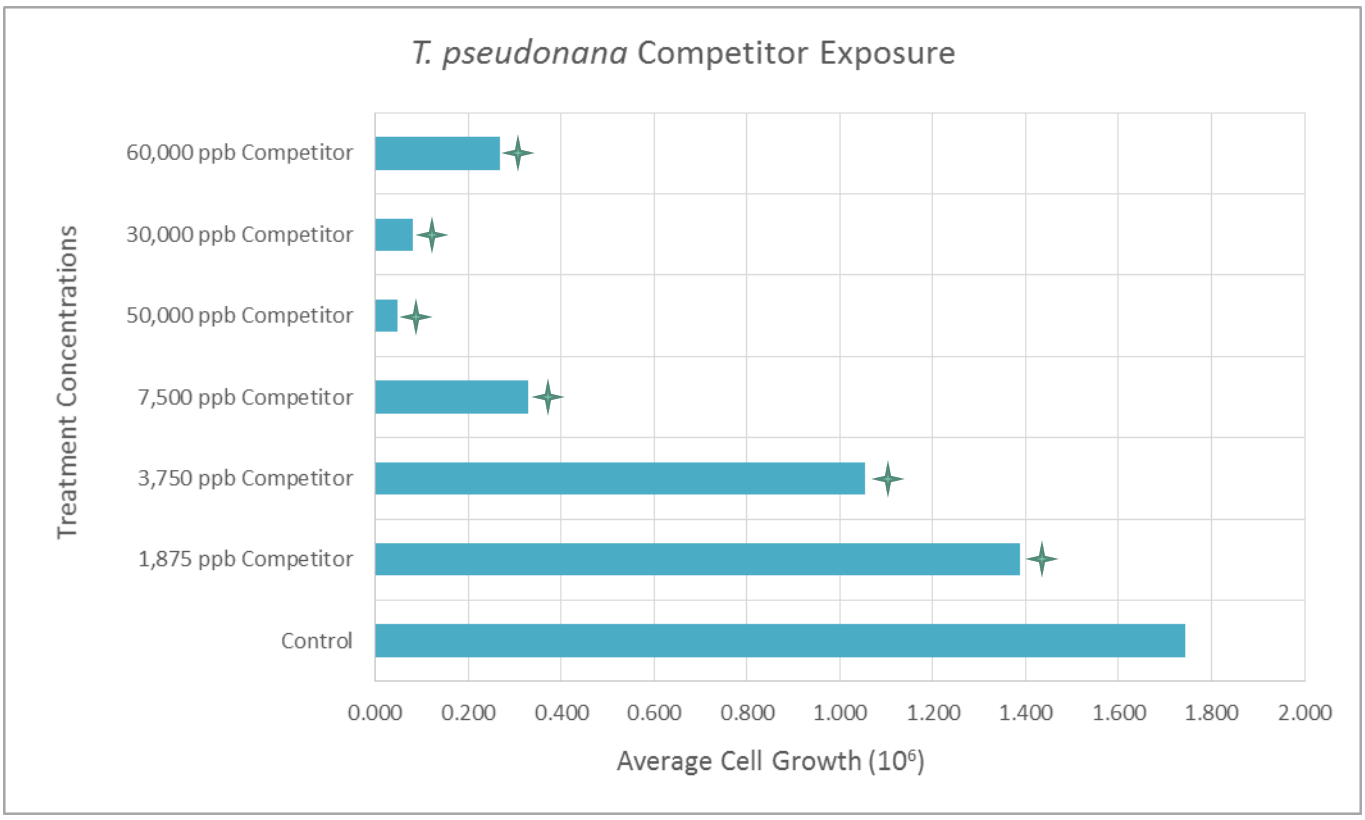



Figure 37. 96-hour toxicity data of *T. pseudonana* exposed to Competitor. Significant reductions in cell growth compared to the control were observed in all Competitor treatments, as noted with asterisks*.

# Results – Adult Delta Smelt Endocrine Study

## Chemical concentrations

Nominal and measured concentrations of Penoxsulam, Fluridone, Glyphosate, and Imazamox by ELISA (Penoxsulam, Fluridone, and Glyphosate) and LC-PDA (Imazamox) are shown in Table 16.

Table 16. Concentrations of Penoxsulam, Imazamox, Fluridone, and Glyphosate. The concentrations of Penoxsulam, Fluridone, and Glyphosate were measured by ELISA and Imazamox by LC-PDA.

| Herbicide | Treatment | Nominal concentration (mg/L) | Measured concentration (mg/L) | Standard deviation |
|---|---|---|---|---|
| **Penoxsulam** | Control | 0 | 0.000384 | 0.00027 |
| | 1 | 0.002 | 0.00307 | 0.00076 |
| | 2 | 0.025 | 0.0436 | 0.0132 |
| | 3 | 0.1 | 0.132 | 0.0226 |
| | 4 | 0.2 | 0.22 | 0.0141 |
| | 5 | 0.4 | 0.425 | 0.0177 |
| **Imazamox** | Control | 0 | Below LOQ* | Below LOQ |
| | 1 | 0.011 | Below LOQ | Below LOQ |
| | 2 | 0.05 | 0.0457 | 0.0056 |
| | 3 | 0.125 | 0.1283 | 0.0197 |
| | 4 | 0.3 | 0.2266 | 0.0202 |
| | 5 | 0.6 | 0.6456 | 0.0087 |
| **Fluridone** | Control | 0 | 0 | 0 |
| | 1 | 0.0834 | 0.0665 | 0.012 |
| | 2 | 0.834 | 0.7285 | 0.0746 |
| | 3 | 4.17 | 2.045 | 1.503 |
| | 4 | 20.85 | 9.70** | 7.88 |
| | 5 | 104.25 | 27.9** | 54 |
| **Glyphosate** | Control | 0 | 0.000399 | 0.00028 |
| | 1 | 0.064 | 0.11 | 0.0325 |
| | 2 | 0.64 | 0.755 | 0.0813 |
| | 3 | 6.4 | 9.31 | 2.06 |
| | 4 | 64 | 104 | 28.3 |
| | 5 | 640 | 831 | 135 |

* The concentrations of Imazamox were below limit of quantification (LOQ) by the LC-PDA.

** The measured Fluridone concentrations are not accurate since the chemical was precipitated.

## Acute toxicity

All the fish survived and no mortality was recorded by the 6-hr exposure to Penoxsulam, Imazamox, Fluridone, and Glyphosate. However, both female and male fish exposed to Fluridone at the three high concentrations (nominal concentrations 4.17, 20.9, 104.3 mg/L) became lethargic and were laying on the bottom of the buckets at the end of the 6 hour exposure. No abnormal swimming was observed in fish exposed to Penoxsulam, Imazamox, and Glyphosate.

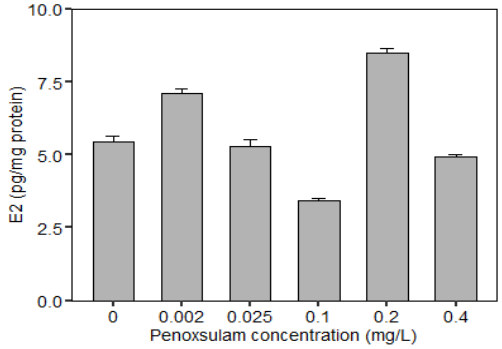
## Hepatic E2 concentration

Penoxsulam (ANOVA, $F_{[5,11.9]}$ = 0.4861, P=0.7804) and Imazamox exposure (ANOVA, $F_{[5,12.24]}$ = 0.4993, P=0.7713) had no significant effect on hepatic 17β-Estradiol (E2) levels in female fish (Figure 38AC). Likewise, there were also no significant effects detected for male fish exposed to Penoxsulam (ANOVA, $F_{[5,11.31]}$ = 2.7114, P=0.0763) or Imazamox (ANOVA, $F_{[5,12.07]}$ = 1.9770, P=0.1543) (Figure 38BD).

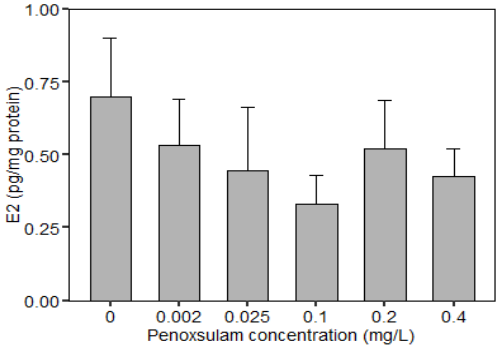
Fluridone exposure had a significant effect on female (ANOVA, $F_{[5,11.99]}$ = 7.7661, P = 0.0018) and male fish (ANOVA, $F_{[5,12.39]}$ = 6.7587, P= 0.0030); a *post-hoc* test revealed that hepatic E2 of female fish exposed to Fluridone at the concentration of 0.01 mg/L (LSM=153, SE=15.1) was significantly different from the control group (LSM=68.2, SE=15.09) while all the other treatments were not distinguishable from the control group (Tukey HSD, α = 0.05) (Figure 38E). Similarly, male fish exposed to Fluridone at the lowest exposure concentration (0.01 mg/L) of Fluridone (LSM=6.56, SE=0.774) was significantly different from the control group (LSM=1.36, SE=0.774) (Tukey HSD, α = 0.05) (Figure 38F).

Glyphosate exposure had no significant effects on E2 levels in female fish (ANOVA, $F_{[5,12.2]}$ = 1.7150, P = 0.2045) (Figure 38G). However, male fish had significant differences between E2 levels (ANOVA, $F_{[5,12]}$ = 6.1678, P = 0.0047) (Figure 38H). Post-hoc Tukey tests showed the highest treatment concentration of 640 mg/L (LSM=4.54, SE=0.552) was distinguishable from the control (LSM=1.36, SE=0.552), but not from the other treatments. Treatment group 0.64 ppm (LSM=4.75, SE=0.552) was the second lowest concentration of Glyphosate, and was also distinguishable from the control. Both of these treatment groups had E2 levels two fold higher than the control.

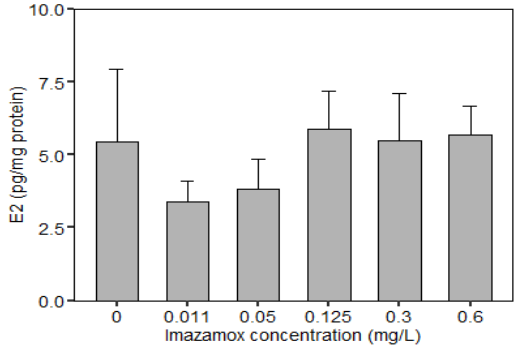
A) Female fish exposed to Penoxsulam



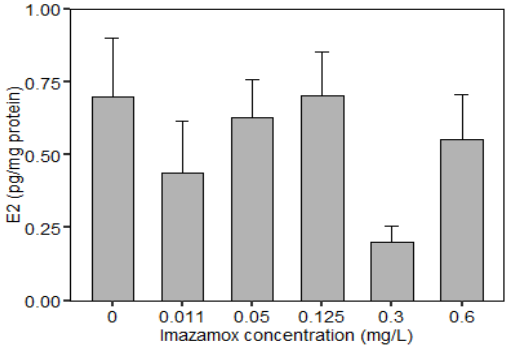

B) Male fish exposed to Penoxsulam




C) Female fish exposed to Imazamox




D) Male fish exposed to Imazamox



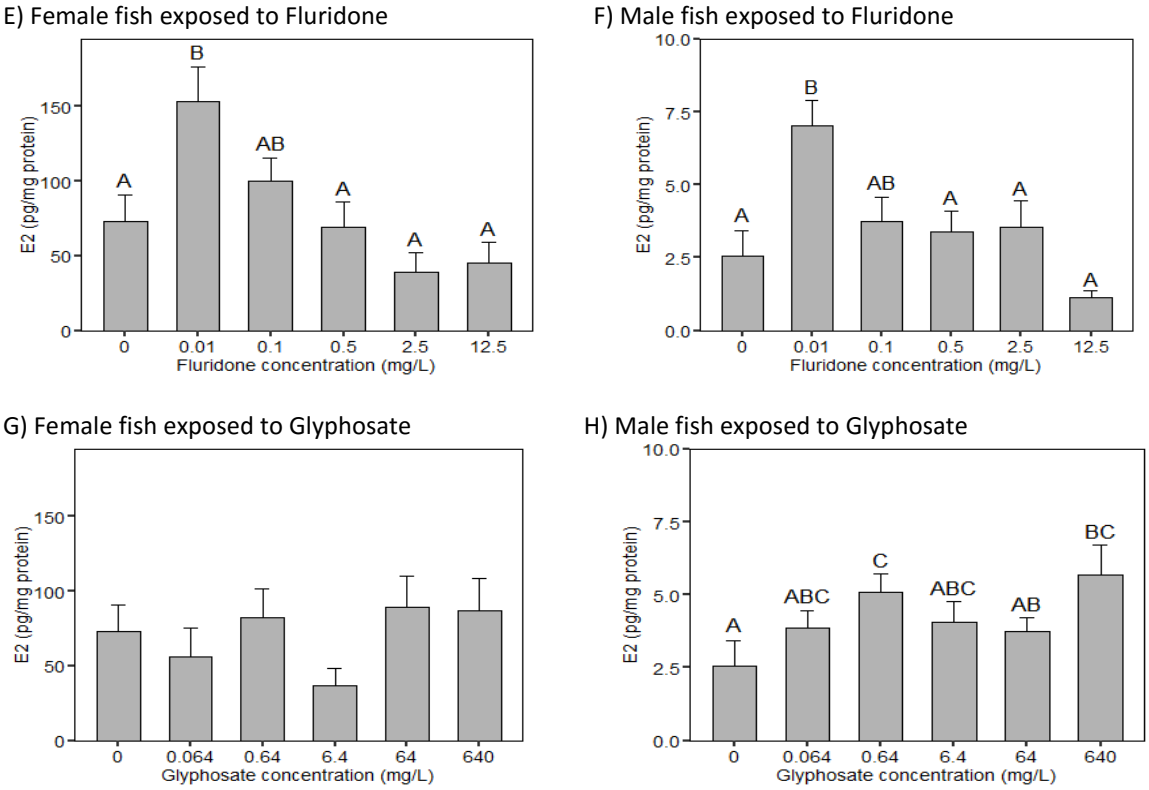



Figure 38. Hepatic E2 concentrations for female and male Delta Smelt exposed to Penoxsulam (A and B), Imazamox (C and D), Fluridone (E and F), and Glyphosate (G and H). The error bars indicate standard error.

## Acetylcholinesterase

Brain AChE activity decreased as Penoxsulam concentrations increased, and statistically significant differences were observed at all the concentrations tested in females and at the two highest concentrations in males (Females: ANOVA, $F_{[5, 17]} = 11.4694$, P = 0.0003; Males: ANOVA, $F_{[5, 17]} = 5.1214$, P = 0.0096) (Table 17 and Figure 39AB). Imazamox also caused a significant reduction of the brain AChE activity at all concentrations tested in females and at the lowest and highest concentrations in males (females: ANOVA, $F_{[5, 17]} = 8.7543$, P = 0.0011; males: ANOVA, $F_{[5, 17]} = 3.1995$, P = 0.0459) (Table 17 and Figure 39CD). Among all the treatment groups with Imazamox, the AChE enzymatic activity was relatively consistent (27.5-39.2 % and 19.3-29.3% reduction in females and males, respectively) and a dose-dependent effect was not observed. Exposure to Fluridone also caused a slight inhibition of the AChE activity only at the lowest concentration (Females: ANOVA, $F_{[5, 17]} = 6.5770$, P = 0.0036; Males: ANOVA, $F_{[5, 17]} = 3.8566$, P = 0.0257) (14.3 – 15.3% in females and males; Table 17 and Figure 39EF). Glyphosate did not influence the AChE activity (Females: ANOVA, $F_{[5, 4.9877]} = 3.6584$, P = 0.0907; Males: ANOVA, $F_{[5, 4.7855]} = 2.1396$, P = 0.2172) (Table 17 and Figure 39GH).

Table 17. Brain acetylcholinesterase (AChE) activity in females and males adult Delta Smelt exposed to Penoxsulam, Imazamox, Fluridone, and Glyphosate for 6 hours. The AChE data are shown as mean ± SE of three replicates. The data were collected from 5 fish per replicate. Asterisks (*) indicate statistically different from control group (0 mg/L) by one-way ANOVA with a post hoc Dunnett's test ($P < 0.05$).

| Penoxsulam (mg/L) | Females | | Males | |
|---|---|---|---|---|
| | AChE[a] | % inhibition | AChE[a] | % inhibition |
| **0 (control)** | 16.5 ± 1.5 | 0 | 14.8 ± 1.3 | 0 |
| **0.002** | *13.1 ± 0.2 | 20.1 | 13.1 ± 1.1 | 11.6 |
| **0.025** | *11.9 ± 0.4 | 27.9 | 12.3 ± 0.0 | 17.0 |
| **0.1** | *12.8 ± 0.4 | 22.1 | 14.1 ± 0.7 | 4.8 |
| **0.2** | *10.2 ± 0.4 | 38.3 | *10.6 ± 0.3 | 28.1 |
| **0.4** | *11.0 ± 0.6 | 33.0 | *10.6 ± 0.7 | 28.4 |

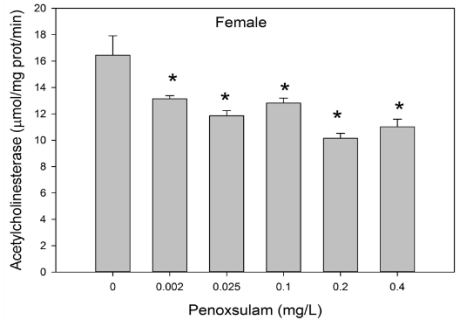
| Imazamox (mg/L) | Females | | Males | |
|---|---|---|---|---|
| | AChE[a] | % inhibition | AChE[a] | % inhibition |
| **0 (Control)** | 16.5 ± 1.5 | 0 | 14.8 ± 1.3 | 0 |
| **0.011** | 10.8 ± 0.9* | 34.5 | 10.4 ± 0.9* | 29.3 |
| **0.05** | 11.9 ± 0.5* | 27.5 | 11.1 ± 0.1 | 25.0 |
| **0.125** | 10.7 ± 0.7* | 34.7 | 11.9 ± 1.3 | 19.3 |
| **0.3** | 10.4 ± 0.3* | 36.5 | 11.0 ± 0.4 | 25.7 |
| **0.6** | 10.0 ± 0.1* | 39.2 | 10.6 ± 0.4* | 28.1 |

| Fluridone (mg/L) | Females | | Males | |
|---|---|---|---|---|
| | AChE[a] | % inhibition | AChE[a] | % inhibition |
| **0 (Control)** | 12.0 ± 0.1 | 0 | 12.4 ± 0.0 | 0 |
| **0.01** | 10.2 ± 0.4* | 15.3 | 10.7 ± 0.5* | 14.3 |
| **0.1** | 11.5 ± 0.7 | 4.0 | 11.4 ± 0.5 | 8.2 |
| **0.5** | 11.1 ± 0.2 | 7.3 | 11.8 ± 0.3 | 5.2 |
| **2.5** | 12.8 ± 0.4 | -6.2 | 12.9 ± 0.6 | -3.5 |
| **12.5** | 12.4 ± 0.2 | -3.1 | 12.2 ± 0.1 | 1.5 |

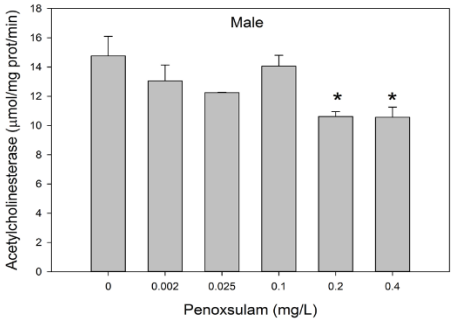
| Glyphosate (mg/L) | Females | | Males | |
|---|---|---|---|---|
| | AChE[a] | % inhibition | AChE[a] | % inhibition |
| **0 (Control)** | 12.0 ± 0.1 | 0.0 | 12.4 ± 0.0 | 0.0 |
| **0.064** | 10.3 ± 0.4 | 14.2 | 12.6 ± 0.2 | -1.3 |
| **0.64** | 12.1 ± 0.5 | -0.9 | 12.7 ± 0.2 | -1.8 |
| **6.4** | 12.5 ± 1.9 | -3.9 | 12.1 ± 0.8 | 2.4 |
| **64** | 10.9 ± 0.5 | 9.6 | 11.3 ± 0.3 | 9.4 |
| **640** | 10.3 ± 0.4 | 14.0 | 11.6 ± 0.6 | 7.0 |

[a] AChE activity is expressed as "µmol/mg prot/min"

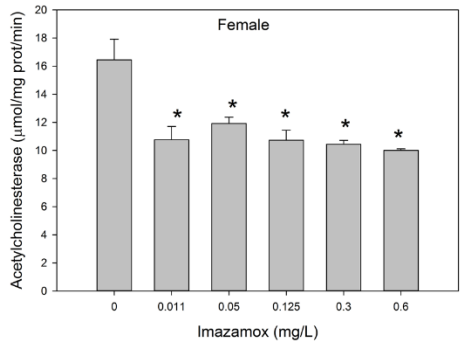
A) Female fish exposed to Penoxsulam



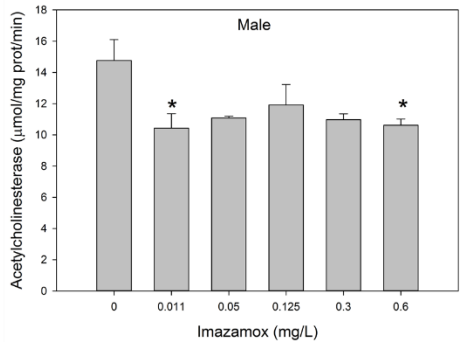

B) Male fish exposed to Penoxsulam



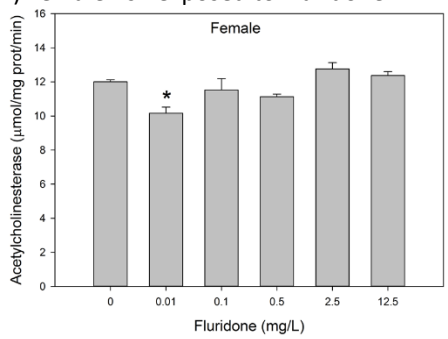

C) Female fish exposed to Imazamox



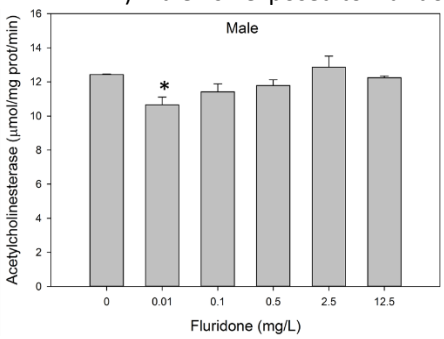

D) Male fish exposed to Imazamox



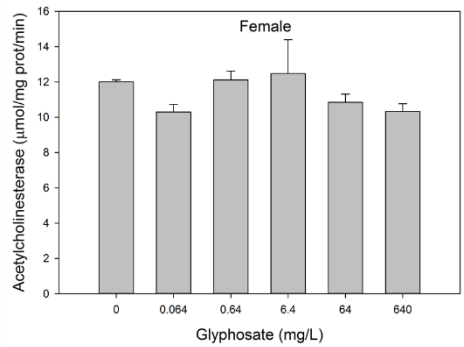

E) Female fish exposed to Fluridone




F) Male fish exposed to Fluridone




G) Female fish exposed to Glyphosate




H) Male fish exposed to Glyphosate

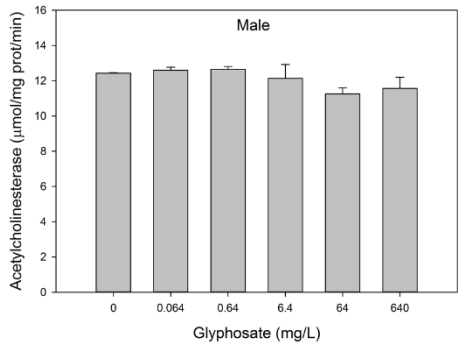



Figure 39. Brain acetylcholinesterase activity in females (A, C, E, and G) and males (B, D, F, and H) adult Delta Smelt exposed to Penoxsulam (A and B), Imazamox (C and D), Fluridone (E and F), and Glyphosate (G and H) for 6 hours. Each bar represents the mean ± SE of three replicates. Data were collected from 5

fish per replicate. Asterisks (*) indicate statistically different from control group (0 mg/L) by one-way ANOVA with a post hoc Dunnett's test ($P < 0.05$).

## Total glutathione

In male, the concentration of total glutathione (GSH) decreased as the Fluridone concentration increased, and statistically significant differences were found at concentrations higher than 0.01 mg/L compared to the control group (ANOVA, $F_{[5, 17]} = 10.9193$, $P = 0.0004$) (Table 18 and Figure 40). Similar effects were observed in females, however the results were not statistically significant (ANOVA, $F_{[5, 17]} = 2.2534$, $P = 0.1156$). The exposure to Glyphosate also significantly affected the GSH concentration in both male and female, however only the data for males were statistically significant (ANOVA, $F_{[5, 17]} = 3.3224$, $P = 0.0410$) but not for females (ANOVA, $F_{[5, 17]} = 1.3986$, $P = 0.2926$). Any significant changes were not observed by Penoxsulam (females: ANOVA, $F_{[5, 17]} = 0.5370$, $P = 0.7450$; males: ANOVA, $F_{[5, 17]} = 1.2823$, $P = 0.3335$) and Imazamox exposure (females: ANOVA, $F_{[5, 17]} = 0.2312$, $P = 0.9415$; males: ANOVA, $F_{[5, 17]} = 2.5147$, $P = 0.0885$).

Table 18. Concentration of total glutathione in liver of Delta Smelt exposed to Penoxsulam, Imazamox, Fluridone, and Glyphosate for 6 hours. The glutathione concentrations are showed as mean ± SE of three replicates. The data were collected from 5 fish per replicate. Asterisks (*) indicate statistically different from control group (0 mg/L) by one-way ANOVA with a post hoc Dunnett's test ($P < 0.05$).

| Penoxsulam (mg/L) | Females | | Males | |
|---|---|---|---|---|
| | GSH[a] | % decrease | GSH[a] | % decrease |
| **0 (Control)** | 0.79 ± 0.12 | 0.0 | 0.72 ± 0.03 | 0.0 |
| **0.002** | 0.85 ± 0.07 | -8.0 | 0.72 ± 0.08 | 8.3 |
| **0.025** | 0.69 ± 0.07 | 11.8 | 0.67 ± 0.10 | 15.2 |
| **0.1** | 0.71 ± 0.10 | 9.5 | 0.58 ± 0.01 | 26.9 |
| **0.2** | 0.80 ± 0.08 | -1.0 | 0.67 ± 0.08 | 14.6 |
| **0.4** | 0.85 ± 0.09 | -7.8 | 0.55 ± 0.05 | 30.6 |

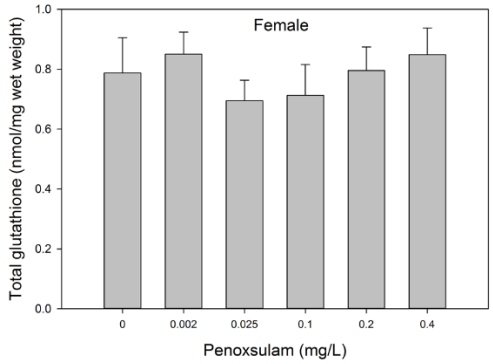
| Imazamox (mg/L) | Females | | Males | |
|---|---|---|---|---|
| | GSH[a] | % decrease | GSH[a] | % decrease |
| **0 (Control)** | 0.79 ± 0.12 | 0.0 | 0.72 ± 0.03 | 0.0 |
| **0.011** | 0.69 ± 0.09 | 12.7 | 0.55 ± 0.10 | 29.7 |
| **0.05** | 0.68 ± 0.01 | 13.5 | 0.63 ± 0.05 | 20.2 |
| **0.125** | 0.72 ± 0.09 | 8.0 | 0.56 ± 0.08 | 29.1 |
| **0.3** | 0.72 ± 0.12 | 8.0 | 0.57 ± 0.06 | 27.8 |
| **0.6** | 0.78 ± 0.09 | 0.5 | 0.79 ± 0.04 | -0.7 |

| Fluridone (mg/L) | Females | | Males | |
|---|---|---|---|---|
| | GSH[a] | % decrease | GSH[a] | % decrease |
| **0 (Control)** | 1.08 ± 0.07 | 0.0 | 0.94 ± 0.03 | 0.0 |
| **0.01** | 1.13 ± 0.09 | -3.8 | 0.87 ± 0.02 | 7.5 |
| **0.1** | 1.13 ± 0.07 | -4.1 | 0.76 ± 0.06* | 19.1 |
| **0.5** | 0.97 ± 0.08 | 10.5 | 0.71 ± 0.02* | 24.8 |
| **2.5** | 0.85 ± 0.10 | 21.8 | 0.64 ± 0.01* | 31.3 |
| **12.5** | 0.91 ± 0.06 | 16.1 | 0.66 ± 0.05* | 30.1 |

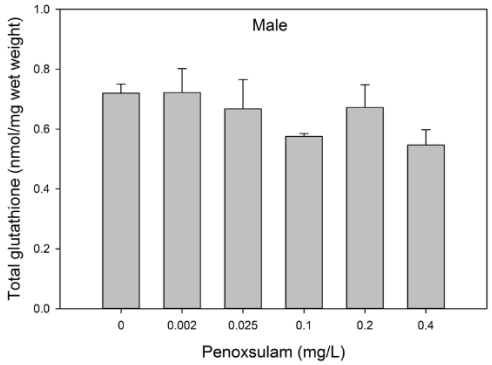
| Glyphosate (mg/L) | Females | | Males | |
|---|---|---|---|---|
| | GSH[a] | % decrease | GSH[a] | % decrease |
| **0 (Control)** | 1.08 ± 0.07 | 0.0 | 0.94 ± 0.03 | 0.0 |
| **0.064** | 1.18 ± 0.09 | -8.6 | 0.89 ± 0.03 | 5.1 |
| **0.64** | 1.05 ± 0.12 | 3.4 | 0.70 ± 0.09* | 25.4 |
| **6.4** | 0.92 ± 0.05 | 14.8 | 0.77 ± 0.00 | 17.3 |
| **64** | 1.01 ± 0.07 | 7.3 | 0.81 ± 0.04 | 13.1 |
| **640** | 0.99 ± 0.02 | 9.1 | 0.80 ± 0.03 | 15.0 |

[a] The total glutathione concentration is expressed as "nmol/mg wet weight"

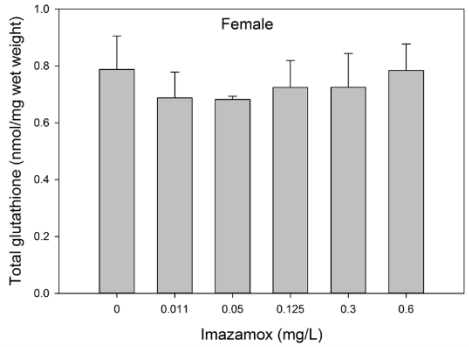
A) Female fish exposed to Penoxsulam



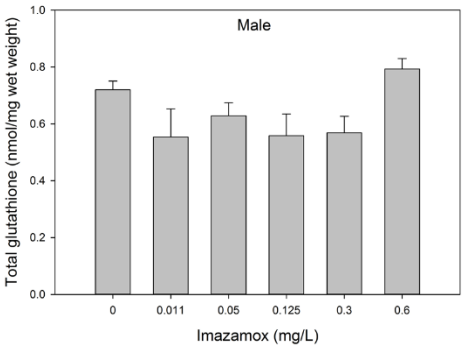

B) Male fish exposed to Penoxsulam



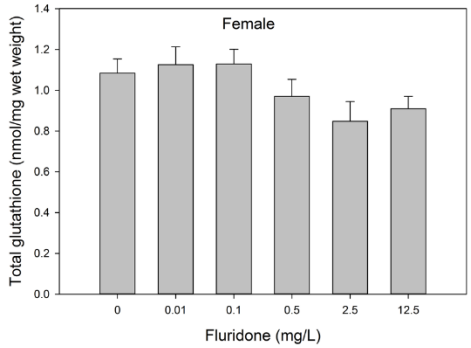

C) Female fish exposed to Imazamox



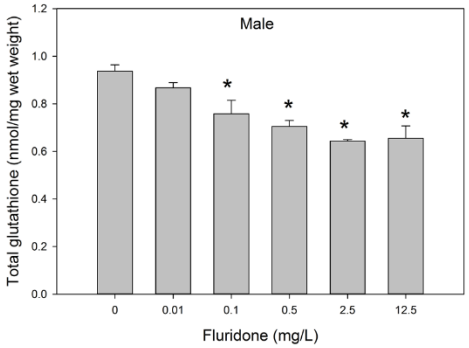

D) Male fish exposed to Imazamox



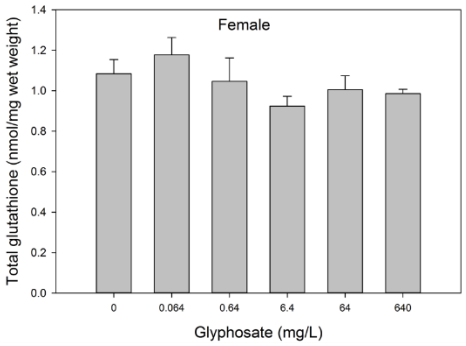

E) Female fish exposed to Fluridone




F) Male fish exposed to Fluridone



G) Female fish exposed to Glyphosate




H) Male fish exposed to Glyphosate

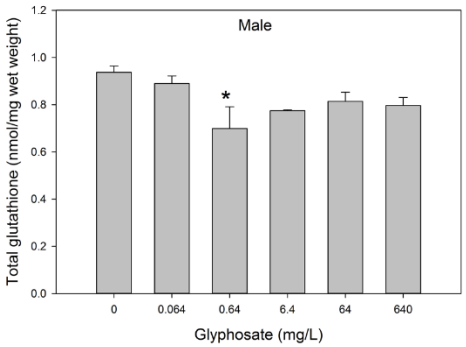



Figure 40. Concentration of total glutathione in liver of females (A, C, E, and G) and males (B, D, F, and H) adult Delta Smelt exposed to Penoxsulam (A and B), Imazamox (C and D), Fluridone (E and F), and Glyphosate (G and H) for 6 hours. Each bar represents the mean ± SE of three replicates. The data were collected from 5 fish per replicate. Asterisks (*) indicate statistically different from control group (0 mg/L) by one-way ANOVA with a post hoc Dunnett's test ($P < 0.05$).

# Discussion – Early Life Stages of Delta Smelt and Food Web Studies

## Early Life Stages of Delta Smelt

Hatching success was significantly inhibited by 21% at the highest concentration of the Imazamox-Agridex mixture and none of the tested chemicals individually had an effect. However, mild mean histopathological scores were observed in liver and muscle of recently hatched larvae from embryo exposed higher concentrations of Penoxsulam, Imazamox, Agridex, and mixtures of Penoxsulam-Agridex and Imazamox-Agridex. No published study has investigated the effects of Imazamox-Agridex mixtures on hatching success in any organism, however multiple studies concur with an inhibitory effect from other herbicide-adjuvant combinations. Most of the published literature has investigated formulations containing Glyphosate, and have found a similar, though more potent, synergistic effect on hatching success. Marc et al. (2005), tested the effects of Glyphosate (as Roundup) and the adjuvant POEA on hatching and survival of sea urchin embryos and found the adjuvant alone to be the most toxic to embryo hatching. Sparling et al. (2006) tested the effects of terrestrial (not aquatic) applications of Glyphosate (as Glypro®) and the surfactant LI700 on hatching and development of the red eared slider frog. Results showed significant effects from both chemicals on hatching success at the highest test concentrations. Druart et al. (2010) also tested terrestrial applications of Glyphosate and its formulation Roundup, using snail embryogenesis as the endpoint, and found that the formulation was more toxic than the Glyphosate component alone.

In the present study, we did not test Glyphosate in combination with an adjuvant, however our Glyphosate toxicity results appear to align with those in the aforementioned literature, as observed $_{LC50}$s for both embryo- and larval-stage Delta Smelt ranged from 1,099 mg/L (8-d LC50 for larval) to 3,490.4 mg/L (96-hr embryo hatching success), which were some of the highest in the present study. Likewise, no significant effects were observed in any of the sub lethal endpoints in both newly-hatched embryo and larval Delta Smelt exposed to Glyphosate sans adjuvant.

Effects on smelt larvae survival were different from those on embryo hatching success. There were no significant effects on larvae survival and liver and muscle histopathology in the Penoxsulam-Agridex

exposure among either of the chemicals individually or in mixture, however in the Imazamox-Agridex exposure, Imazamox alone caused mild liver and muscle histopathology, Agridex alone had a significant and negative impact on larvae survival but no liver and muscle histopathology, however, effects were mitigated in the mixture with Imazamox. At the highest concentration tested, 64 mg/L, Agridex alone caused 60% mortality, while the mixture containing the same level of Agridex and 62 mg/L Imazamox resulted in an average of 20% mortality and was not significantly different from the control. Previous studies have found much more appreciable effects of other adjuvants and herbicide-adjuvant mixtures on fish survival. Tatum et al. (2011) tested four different adjuvants including Entry II, Hasten, Timberland 90, and Timbersurf 90, as well as numerous herbicide-adjuvant mixtures, using Fathead Minnows (*Pimephales promelas*) and among the 23 different adjuvant and herbicide-adjuvant mixture exposures, twelve caused greater than 50% mortality. Concentrations tested ranged between below 0.1 mg/L up to 27 mg/L, conservatively based on estimated maximum environmental concentrations. Tsiu and Chu (2004) tested for effects of Roundup, its component chemicals, and a common adjuvant, POEA on the water flea, *Ceriodaphnia dubia*. Similar to the current study, the adjuvant was found to be the most toxic among the tested chemicals, with an $LC_{50}$ of 1.15 mg/L. The physiological mechanism of adjuvant and herbicide-adjuvant mixture toxicity is uncertain. Because adjuvants, including Agridex and Competitor, are made up of a mixture of fatty acids, the physical properties of the oils, rather than a specific toxic mechanism of an active ingredient may be responsible for the resulting effects. Types of adjuvant oil mixtures were also seen to have an effect on organism sensitivity, in that we observed differences in mixture results between Agridex and Competitor, in that mixtures of Imazamox + Competitor were significantly additive.

In the current-use herbicides, LC50s were generally high. In newly hatched embryos, 12-d LC50s ranged from 326.6 mg/L (Fluridone), 715.5 mg/L (2,4-D), and upwards of 3,490.4 mg/L for Glyphosate. These LC50s decreased slightly with the larval Delta Smelt exposures: Fluridone 160.8 mg/L (96-hr) and 138.9 mg/L (8-d); Glyphosate 1,184 mg/L (96-hr) and 1,099 mg/L (8-d); 2,4-D 696.4 mg/L (96-hr) and 593.9 mg/L (8-d). Additionally, statistically significant reductions in survival were observed in Delta Smelt embryos exposed to 1,000-4,000 mg/L Fluridone, 5,000 mg/L Glyphosate, and between 250-1,000 mg/L of 2,4-D. In the larval exposures, statistically significant reductions in survival were observed in Delta Smelt exposed to 125 mg/L Fluridone and 1,250 mg/L of Glyphosate in both 96-hr and 8-d time points. There were no significant effects observed with 2,4-D in the larval stage Delta Smelt; Conversely with the adjuvant Competitor, we were unable to elicit an LC50 in either life stage of Delta Smelt, although a significant reduction in survival was observed at the highest concentration of Competitor (35.55 mg/L) in the larval Delta Smelt.

These results are far higher than those found in the literature. Hamelink et al. (1986) obtained an average 96-hour Fluridone LC50 of 10.4 mg/L (±3.9 SD), based on results from 28 tests conducted with five species of fish. Even at the highest of the range mentioned (22 mg/L) our results are well above those in the study. This was also true for Delta Smelt exposed to 2,4-D: in comparison, Alexander et al. (1985), observed Fathead minnow (*Pimephales promelas*) 96-LC50s for 2,4-D of 320 mg/L, and 358 mg/L for Rainbow Trout (*O. mykiss*), and they note that their results are higher than those previously observed in earlier studies (Alexander et al. 1985 and the citations noted within). With Glyphosate, Wan et al. (1989) observed 96-hr LC50s of Glyphosate ranging from 94-112 mg/L in Coho, Chum, Chinook, Pink and Rainbow Trout in reconstituted water; much lower than those observed in the present study. Differences observed in the sensitivity of Delta Smelt compared to other fish species could be due to the

recovery period included in the chemical testing with Delta Smelt. After a 96-hour chemical exposure, test solution was replaced with clean reconstituted water for the duration of the test (7 days depuration period for embryo until hatch, and 3-day depuration period in the larval studies until Day 8). Test exposures in the literature were 96-hour chemical only exposure with no recovery period. Moreover, chemical permeability is less likely with embryos when compared to larval fish.

Sub-lethal effects from herbicide and adjuvant mixtures were variable, and some effects occurred at low, environmentally relevant concentrations. Condition factor was the most significantly affected sub-lethal endpoint. Condition factor is an indicator of fish health, where if the factor is low, fish have a lower body mass relative to length and are considered less healthy. Oil globule area was also affected by herbicides, Agridex, and their mixtures, where affected fish most often boasted larger oil globules relative to the controls. Oil globules are present in the yolk sacs of fish larvae after hatching, and are the primary source of energy to fuel growth and development before fish are able to feed. In Delta Smelt, the oil globule is present and utilized for up to 12 dph (Nobriga and Herbold 2009). In the current-use herbicides, sub-lethal effects were more prevalent in the embryo/newly hatched larvae in both Fluridone and 2,4-D. Condition factor decreased with increasing concentrations of Fluridone, and the yolk sack area increased with increasing concentrations of Fluridone. In comparison, in embryos exposed to 2,4-D, oil globule area decreased with increasing concentrations of 2,4-D; thus the energy reserves in these fish were being utilized at a faster than normal rate.

Neither Imazamox nor Penoxsulam caused deleterious sub-lethal effects. Imazamox, individually, caused no significant effects on condition factor or oil globule area in either embryo or larvae exposures. Penoxsulam exposures, however, resulted in an increase in condition factor across both embryo and larvae exposures and a concurrent increase in oil globule area in the embryo exposure only. Positive condition factor responses may be demonstrative of hormesis, a physiological reaction to low levels of stress that cause beneficial effects. Penoxsulam did not affect survival or hatching success in Delta Smelt, even at the highest concentrations tested, therefore all concentrations tested could be considered low levels of stress, and the positive effects on fish condition could be the initial phase of the biphasic hormetic dose response. Hormesis is common in toxicology studies (Calabrese and Baldwin 2003), and is found to be especially pervasive among studies testing toxicant effects on organism growth (Stebbing 1982). Herbicide-Agridex mixture responses in Delta Smelt embryos were also consistent with hormesis. The Imazamox-Agridex mixture caused a significant positive effect on both condition factor and oil globule area, while the Penoxsulam-Agridex mixture caused a positive effect on condition factor only. The specific mechanism of growth stimulation among exposures to Penoxsulam (in embryos and larvae) and herbicide-Agridex mixtures (embryos only) is unknown, however it is clear that the high concentrations tested do not amount to adverse effects on Delta Smelt condition factor or oil globule area.

Individual herbicides, and herbicide-Agridex mixtures, caused different responses in Delta Smelt larvae compared to embryos. The Penoxsulam-Agridex mixture resulted in no significant effects on condition factor or oil globule area, while the Imazamox-Agridex mixture caused a decrease in condition factor but an increase in oil globule area. Both effects largely reflect an additive response between the component chemicals involved. Between Penoxsulam and Agridex, Agridex individually had a negative effect on condition factor and Penoxsulam a positive effect, therefore a lack of response in the mixture is consistent with an additive interaction. Between Imazamox and Agridex, Agridex caused a significant negative response in condition factor and Imazamox did not have an effect, thus a negative effect on

condition factor by the mixture is again consistent with an additive response. The Imazamox-Agridex mixture effect on oil globule area, on the other hand, was not additive. While there were no effects on oil globule area from these chemicals individually, the mixture caused a positive effect. The mechanism of this interaction is unclear. An increase in oil globule area over the course of a larval exposure indicates that the energy stores were somehow preserved. Given the concurrent decrease in condition factor, it may be that the Imazamox-Agridex mixture caused energy metabolism to slow in exposed fish as evident by the mild mean liver lesion score. Such effects could occur by inhibiting processes along the metabolic pathway (Escher et al. 2002), however there are many possible targets and it is uncertain which the Imazamox-Agridex mixture affected. With the current-use herbicides, Delta Smelt larvae sub-lethal endpoints were far more variable and should be interpreted with caution, compared to those in the embryo-stage Delta Smelt. Significant sub-lethal effects were observed in larval smelt exposed to Fluridone and 2,4-D, however it is likely that these differences were due to variability among replicates, as the length endpoint for these larval Smelt were difficult to obtain given the small size of the fish at the end of the exposures.

## Food Web Studies

Acute testing with the calanoid copepod *E. affinis* demonstrated relatively low sensitivity to the herbicides Penoxsulam and Imazamox, and the adjuvant Agridex individually, but these responses were additive when in mixture. Individual chemical LC50s ranged from 46.7 mg/L (Agridex) to 63.7 mg/L (Penoxsulam), and we were unable to elicit an LC50 for Imazamox. In mixture, the LC50 of Penoxsulam increased to 24.4 mg/L in the presence of Agridex, and we obtained an LC50 of 77 mg/L for Imazamox when in combination with Agridex.

Supporting data in the literature is minimal, save for Di Lorenzo et al. (2013, 2015), who evaluated the toxicity of Imazamox to the epigean copepod *Eucyclops senulatus*, and the hypogean copepod *Diacyclops belgicus*. In both species, 96-hour LC50s were well above 100 mg/L, ranging from 232.44 mg/L for *E. senulatus*, and 199.23 mg/L *D. belgicus* at 15°C (2013). In a follow-up study (2015) *E. senulatus* was exposed to Imazamox at both 15°C and 18°C, with LC50s again exceeding 100 mg/L. Di Lorenzo notes that caution should be applied when inferring the sensitivity of groundwater species to toxicants from surface water species, as physiological traits and differences between the two can lead to different sensitives to toxicants (Di Lorenzo et al. 2013, and references within). However, given that the relative sensitivities to Imazamox are similar among the various copepod species tested, we conclude that Imazamox may have little impact to lower zooplankton species.

In the diatom, *T. pseudonana* exhibited relatively low sensitivity to both Penoxsulam and Imazamox. We were unable to obtain an IC50 (>100 mg/L) for Penoxsulam, as there was robust cell growth in all concentrations of this herbicide and no significant differences were observed. With Imazamox, sensitivity was low with an IC50 of 84.4 mg/L; however significantly reduced cell growth when compared to the control was observed in concentrations of Imazamox at 50 mg/L and above.

As with the early life stages of Delta Smelt, *T. pseudonana* exhibited a higher sensitivity to the adjuvants compared to the herbicides, with IC50s of 38.5 mg/L for Agridex, and 4.5 mg/L of Competitor. Moreover, significant reductions in cell growth when compared to the control were observed in the 30 and 60 mg/L concentrations of Agridex, and in all Competitor treatment concentrations.

In the herbicide-adjuvant mixtures, Penoxsulam reduced the toxicity of Agridex, thus the effect was antagonistic. However this trend was not observed with the Penoxsulam/Competitor mixture, where the toxicity of Competitor eclipsed any interaction with Penoxsulam in concentrations containing 41 mg/L of Competitor. This interaction isn't entirely surprising, given the low IC50 of Competitor, however in mixtures with Agridex was included above its IC50 and its toxicity was mitigated by the Penoxsulam.

There were no interactions observed with the Imazamox/Agridex mixtures, however there was an antagonistic response in the Imazamox/Competitor mixture, where the toxicity of Competitor was reduced with the application of Imazamox. These interaction differences may be attributable to the types of oil components between the two different adjuvants, as Agridex is made from heavy range paraffinic oil, whereas Competitor is a modified vegetable oil, and their individual chemical structures may play a part in the interaction with the different herbicides.

There is very little information in the literature discussing herbicide or herbicide/adjuvant mixture effects on phytoplankton; however what data there is available indicate variable responses of herbicide sensitivity among phytoplankton species. For instance, Netherland et al. (2009) tested a variety of planktonic blue-green and beneficial green algae to both Penoxsulam and Imazamox in two-week exposures. Imazamox had little to no effect on any of the species tested, whereas Penoxsulam reduced chlorophyll-a by 90% in the green alga *Scenedesmus quadricauda*, and the blue-green algae *Anabaena* spp. and *Cylindrospemopsis raciborskii*, at the lowest dose of 0.1 mg/L. In the blue-green alga *Pseudanabaena limnetica*, chlorphyll-a was reduced by 58% at 0.1 mg/L, 85% at 0.2 mg/L, and by 90% at 0.5 mg/L Penoxsulam. Conversely, *Microcystis aeruinosa*, *Ankistrodesmus*, and *Selenastrum* species were not affected by any concentrations of Penoxsulam in comparison.

## Discussion – Adult Delta Smelt Endocrine Study

It is noteworthy that Glyphosate and Fluridone showed elevated 17β-estradiol levels in some of the treatments after exposure. Elevation of E2 production is strong evidence of endocrine disruption, since E2 is a primary sex hormone which regulates maturation of female fish (Kurobe et al. 2016). Elevated 17β-estradiol in male fish is concerning, as it can lead to feminization of male fish by inducing the production of egg yolk precursor (VTG), resulting in development of ova-testis in male fish. Estradiol is also involved in other metabolic and cellular processes, including transcription of other proteins and calcium homeostasis (Pinto et al. 2014).

Penoxsulam, Imazamox, and Fluridone also caused inhibition of brain AChE activities, ranging 20.1-38.3%, 27.5-39.2%, and 14.3-15.3%, respectively. AChE is an enzyme that catalyzes the breakdown of acetylcholine (an important neurotransmitter in the central and peripheral nervous systems), and a common target of organophosphates and carbamates as well as some other pollutants (Bradbury et al 2008). Levels of brain neurotransmitters correlate with behavioral states, therefore it is likely that pollutant-induced neurological dysfunction results in behavioral changes in fish (Scott and Sloman, 2004). Sandahl et al. (2005) reported that exposure of Coho Salmon to Chlorpyrifos caused a significant inhibition of brain AChE activity, which was significantly correlated to a reduction in spontaneous swimming and feeding activities. Changes in swimming and feeding behavior were found at AChE inhibition as low as 23 % (Sandahl et al., 2005). Similarly, Beauvais et al. (2000) showed that inhibition of brain AChE at levels similar or higher than the ones observed in this study negatively affected swimming speed and distance in larval Rainbow Trout (*Oncorhynchus mykiss*) by exposure to Diazinon and

Malathion. In Japanese Medaka, exposure to Chlorpyrifos significantly inhibited brain AChE activity (~50-80%), which was highly correlated to decreased swimming speed (Khalil et al., 2013). Although abnormal behavior was not observed in the Penoxsulam and Imazamox treatment groups during the 6 hr exposure, consequences of Delta Smelt exposure to these herbicides, particularly by extended exposure (e.g. chronic exposure), are still unknown and may impair swimming performance or feeding behavior of Delta Smelt.

Besides AChE activity, other factors may affect fish swimming ability. For example, alterations in swimming behavior can be caused by a disruption of multiple metabolic and organ systems, which range from sensory reactions due to changes in water quality and presence of pollutants, to alterations in metabolic or neurochemical processes (Little and Finger, 1990). Interestingly, we observed more pronounced inhibition of AChE activity in females than males exposed to Penoxsulam and Imazamox. AChE activity was decreased 20.1-38.3% in females in all the Penoxsulam concentrations, while in males the activity of AChE was negatively affected (reduction of 28.1-28.4%) only at the two highest concentrations. Imazamox exposure also decreased the activity of AChE in females at all the concentrations tested, while in males the enzyme activity was significantly affected only at the lowest and highest concentrations. Few studies about sex differences in response of AChE activity to pollutants have been reported. In Japanese Medaka, El-Alfy et al (2001) showed that muscular AChE was more strongly inhibited in females than males after exposure to Aldicarb. Additionally, in *Carassius auratus*, it was shown that AChE from females was considerably more sensitive to inhibition by carbamates, and that its activity was recovered more quickly than in males (Yi et al 2006). These results suggest that sex difference could play a role in the response of Delta Smelt to neurotoxic substances that inhibit AChE activity. However, further studies are needed to elucidate the mechanisms behind the gender differences observed in this study.

Glutathione is considered one of the most important non-enzymatic antioxidants by its ability of scavenging free radicals, besides being a cofactor for several enzymatic antioxidants (glutathione peroxidase and glutathione reductase) and for the glyoxalase system (Regoli and Principato 1995; Livingstone, 2001; Lesser, 2011; Monserrat et al., 2011). Glutathione is also involved in the detoxification of endogenous compounds, as well as xenobiotics, by its participation in reactions mediated by glutathione S-transferase, which catalyze a wide variety of conjugation reactions of glutathione with xenobiotic compounds containing electrophilic centers (Regoli and Principato 1995; Glisic et al., 2015). Levels of glutathione have been widely used as biomarkers of environmental pollution (Livingstone, 2001). Different results on glutathione content have been reported in aquatic organisms exposed to organic and inorganic pollutants. Low levels of glutathione were found in the gills and digestive glands of mussels exposed to metals, which were correlated to enhanced levels of lipid peroxidation. Lower levels (by 30-50%) of glutathione were also found in *Mytilus edulis* from field and mesocosm-contaminated sites (Suteau et al., 1988), and in *M. galloprovincialis* exposed to copper (Viarengo et al., 1990). On the other hand, enhanced levels of glutathione in liver were found in Striped Mullet *Mugil cephalus* after 10 d exposure to cadmium, mercury, and several organic compounds (Thomas and Wofford, 1984), and in the Atlantic croaker *Micropagonius undulatus*, after chronic exposure to lead (Thomas and Juedes, 1992). Increased hepatic levels of glutathione were also reported in catfish exposed to chlorothalonil (Gallagher et al., 1992) or to sediments contaminated by aromatic hydrocarbons (Di Giulio et al., 1993). In our study, the short exposure to Fluridone caused an immediate consumption of hepatic glutathione. Other studies have found an acute depletion of glutathione after

exposure to pollutants followed by an increased glutathione concentration after chronic exposure (Steadman et al. 1991). The causes of glutathione depletion observed in our study could not be explained with the endpoints targeted in this study. However, we can hypothesis two possible reasons: 1) conjugation with glutathione is involved in Fluridone detoxification processes, and 2) there is an enhanced production of reactive oxygen/nitrogen species (RO/NS), which increases use of glutathione as direct scavenger of RO/NS, or its enhanced use as cofactor of several enzymatic antioxidants. Acute depletion of the hepatic glutathione pool observed in this study after exposure to Fluridone may predispose fish to oxidative damage, disease, and enhanced mortality induced by other pollutants, as glutathione is a cofactor of several antioxidant enzymes. Moreover, ability to detoxify endogenous and exogenous compounds may be compromised by glutathione depletion, since its involvement in second phase biotransformation processes, i.e. conjugation with glutathione by glutathione S-transferase. Decreased detoxification ability could increase direct tissue toxic damage by pollutants and their metabolites.

# Conclusion

## Early Life Stages of Delta Smelt and Food Web Studies

Herbicides and adjuvants caused minimal effects on embryo hatching success and larvae survival, but toxic responses were prevalent among the sub-lethal effects of condition factor, oil globule area, and histopathology with Penoxsulam, Imazamox, Agridex, and mixtures thereof; sub-lethal effects were less so in those smelt exposed to Glyphosate, and larval Delta Smelt sub-lethal endpoints were too variable to be considered reliable in fish exposed to Fluridone and 2,4-D. Embryo hatching success and larvae survival were affected only at the highest treatment concentrations of Penoxsulam, Imazamox and Agridex, between 57 and 64 mg/L, which is over 700 (Agridex) and over 5,000 (herbicides) times greater than concentrations expected in water bodies immediately after application (NMFS 2013). These values were even higher in Fluridone, Glyphosate, and 2,4-D concentrations. For example, to control invasive aquatic vegetation in the Sacramento San Joaquin Delta (e.g. *Egeria densa*) Imazamox is proposed to be directly injected into a water body with a maximum water column concentration of 500 ppb (Clearcast product label specifications). Results from this study indicate that these concentrations would have no effect on Delta Smelt health or survival, with a safety factor of almost 200.

Results from this study show that the environmental risks of Imazamox and Penoxsulam applications to delta smelt are very low. Significant mortality did occur in the highest treatments of Imazamox after the 96h exposure and a 3d recovery period, however toxic concentrations were hundreds of time greater than those expected in the environment either from overspray or from direct water column injection. Sub-lethal endpoints were also either not affected by the herbicides (in the case of Imazamox) or effects were positive (Penoxsulam). The environmental risk of the adjuvant, Agridex, is less certain, however. Though lethal effects only occurred at extremely high concentrations, deleterious effects on fish condition and energy stores were significant at lower, environmentally relevant levels. Several studies have indicated that toxic effects of the adjuvants applied with herbicides are of greater concern than the herbicides themselves, and this study is no exception. The effects of Agridex in this study, however, were less severe than many other adjuvants tested in previous studies. It is possible that the basic physical oily characteristic of surfactants, necessary for the chemical serve its function, is the cause of the effects found. Further investigation to characterize the mechanism of Agridex effects on fish

embryo condition factor and oil globule area, and to substantiate the environmental risk to delta smelt and other native species in the Sacramento San Joaquin Delta is warranted.

Herbicide concentrations were more deleterious to the lower trophic levels in the food web, with copepod and diatom sensitives far lower than those of the Delta Smelt. Although corresponding literature reviews were scarce, it can be inferred that these higher sensitivity organisms can be further impacted by the application of herbicides, and herbicide-adjuvant mixtures, which can have lasting negative effects in terms of population size and persistence. Again, significant negative effects were observed at concentrations well above those considered environmentally relevant due to application rates and dilution factors; however further study is warranted given the variability in species sensitivity to these chemicals.

## Adult Delta Smelt Endocrine Study

Increased levels of hepatic E2 was observed in Delta Smelt by Glyphosate and Fluridone, even by acute exposure. We consider induction of hepatic E2 in males as a serious warning sign of endocrine disruption, since E2 is the primary hormone that promotes growth of oocytes in male fish, which can impair the reproductive performance of fish. Fate of Delta Smelt chronically exposed to Penoxsulam and Imazamox is still unknown. Although the endocrine disruption effects of the two herbicides appear to be weak, Delta Smelt that are chronically exposed to the two herbicides may exhibit signs of endocrine disruption at higher biological organizations, such as formation of ova-testis (oocytes in testis), and impairment of reproductive performance, since endocrine disruption and any other adverse effects can be enhanced by extended exposure period. In addition, Penoxsulam and Imazamox may negatively affect swimming ability of Delta Smelt by chronic exposure. The activity of brain acetylcholinesterase (AChE) was reduced by Penoxsulam and Imazamox by 6h exposure study. This result indicates that these herbicides are potential neurotoxicants. Although abnormal behavior was not observed in adult Delta Smelt by the 6 h acute exposure study, it is possible that fish may behave differently by extended exposure period.

Considering the changes in hepatic E2 synthesis in adult exposure study, Penoxsulam and Imazamox seem to be safer, and less likely to cause severe adverse effects on the reproductive performance of Delta Smelt, compared to Fluridone and Glyphosate. However, application volume and period of Penoxsulam and Imazamox may need to be somehow regulated since Delta Smelt exposed to the two herbicides may exhibit adverse effects such as neurotoxicity or impaired reproductive performance.

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# The Effects and Interactions of Penoxsulam, Imazamox and Agridex on Early Life Stages of Delta Smelt, *Hypomesus transpacificus*

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## Abstract

Most herbicides are not lethally toxic to fish at environmentally relevant concentrations, however sublethal effects have been implicated from exposures to multiple common use herbicides and herbicide-adjuvant mixtures. Two new herbicides, imazamox and penoxsulam, are proposed for use in the Sacramento San Joaquin Delta (California, USA), yet little information is available on the effects of these chemicals or their proposed adjuvant, Agridex, on local sensitive species. This study investigates the toxic effects of all three chemicals and herbicide-adjuvant mixtures on early life stages of delta smelt, an endemic to the Delta that is federally listed as a threatened species. Survival and hatching success were not sensitive to the chemicals or mixtures tested, except at the highest treatment concentrations, hundreds of times greater than expected in the environment. Sublethal responses were affected at low concentrations, however, including measures of fish condition as condition factor (CF), and fish energy reserves as oil globule area (OGA). The adjuvant, Agridex, resulted in the most significant effects, causing reductions in CF up to 60% at the highest concentrations. Imazamox exposures, individually, did not affect CF or OGA in smelt embryo or larvae, however penoxsulam exposures (both embryo and larvae tests) and herbicide-Agridex mixtures (embryo only) consistently enhanced CF and OGA; possibly an example of hormesis. The only negative herbicide effect occurred in the imazamox-Agridex mixture, which caused both a reduction in CF and an increase in OGA in the larvae exposure, suggesting an effect on energy metabolism.

## Introduction

Penoxsulam and imazamox are two acetolactate synthase enzyme inhibitors, used for herbicidal applications on terrestrial and aquatic vegetation. They are highly efficacious, exhibiting weed control at lower concentrations than other commonly used herbicides like glyphosate and 2,4-D (USFWS 2013). Both have demonstrated low toxicity to aquatic species, including copepods (Di Lorenzo et al. 2014), daphnids (Hamelink et al. 1986, Alexander et al. 1985) and multiple fish species (Hamelink et al. 1986, US EPA 2013). Due to their high efficacy and low toxicity, these chemicals are used world-wide (Jabusch and Tjeerdema 2005). Recently, they have been proposed for invasive aquatic vegetation (IAV) control in the Sacramento San Joaquin Delta (California, USA) (USFWS 2013), where multiple highly sensitive and federally listed species occur, including the endemic delta smelt (*Hypomesus transpacificus*).

Penoxsulam and imazamox are relatively new on the pesticide market. To date there are few published studies on the non-target effects of these herbicides and no study has evaluated the effects of these herbicides in combination with an adjuvant. The sensitivity of non-target aquatic organisms to these herbicides is an important consideration, particularly for chemicals that will be applied directly into waterways as is necessary for IAV control. Few herbicides are lethally toxic to vertebrate species at environmentally relevant concentrations, however sublethal effects including cellular and oxidative stress, and endocrine disruption have been implicated for a number of herbicides and adjuvants in previous studies (Xie et al. 2005, Patetsini et al. 2013, Murussi et al. 2014). To ensure that sensitive fish species in the San Francisco Estuary are not affected by the new herbicides and adjuvants, this study

tested the direct effects of penoxsulam and imazamox, and one adjuvant, Agridex, on delta smelt at early life stages (embryos and newly hatched larvae), including analyses of hatching success, survival, health indices and morphology.

## Materials and Methods

*Delta smelt*

Delta smelt embryos were obtained from the Fish Conservation and Culture Laboratory (FCCL) in Byron, CA. Embryos were fertilized at FCCL prior to arrival at the Aquatic Health Program Lab (AHP). Upon receipt, embryos were held in 10% methylene blue solution for 24 h to ward off pathogens and fungi. Subsequent embryo-stage toxicity tests were initiated within 1-2 days post fertilization (dpf), whereas larval-stage toxicity tests were initiated with 2-3 days post hatch (dph) smelt from the same batch of embryos (including 2-3 clutches) for each chemical series test. Embryos were held in 1L glass beakers with 900 mL culture water (UC Davis Reconstituted water was prepared according to the guidelines of the US EPA [Horning and Weber, 1985]) and gently aerated until their use in a test, or until fully hatched.

*Chemical Solutions*

Imazamox and penoxsulam were obtained from SePRO Corporation (Carmel, IN, USA) in original formulation (Clearcast and Galleon SC, repectively). Test concentrations were calculated from the percent active ingredient, either imazamox or penoxsulam, and were prepared by spiking herbicide formulations directly into water. Agridex was obtained from Helena Chemical Company (Collierville, TN, USA) and test concentrations were based on total Agridex concentration, given that the solution is a mixture of oils with no one specific active ingredient. Test concentrations and mixture ratios were determined from predicted applied/residual water concentrations in the environment. The lower concentrations tested were environmentally relevant, while higher concentrations and mixtures were multiples thereof (up to 100,000x). The upper limits of test concentrations were determined based on the solubility of each chemical and the point at which the test solution became too murky to see the test organisms from range-finder experiments. Herbicide-Agridex mixtures were based on the application rates and mixture ratios planned for use in the field (NMFS 2013). Agridex is dispersible rather than soluble (per formulation label), and treatment waters at the higher concentrations were turbid and white in color. Agridex concentrations were thus kept below 100 mg/L and the highest two or three concentrations of herbicide-Agridex mixtures contained the same concentration of Agridex and increasing concentrations of herbicides only. Some stratification still occurred in high level treatment waters over the course of the exposures, therefore waters were carefully mixed every 48h to ensure exposures were consistent. All toxicity tests were conducted in UC Davis Reconstituted water was prepared according to the guidelines of the US EPA (Horning and Weber, 1985).

*Chemical Analyses*

Multiple treatment water samples were collected over the duration of the experiments. For the 13d embryo exposures, initial water samples were collected at test initiation on Day 0 and test renewal on Day 2. Final water samples (collected prior to renewal) were collected on Day 4, Day 6 and on the day of test take down, Day 13. For the 7d larval exposures, initial water samples were collected at test initiation on Day 0 and at test renewals on Day 2 and Day 4. Final water samples were also collected on Day 4 and Day 6. Samples were collected in 4oz HDPE brown plastic bottles and immediately stored at 4°C until shipped. Samples were then shipped on ice, overnight. Imazamox and penoxsulam

concentrations were measured using standardized FasTEST methods (SePRO Research and Technology Campus, Whitakers, NC).

*Toxicity tests*

*Embryo-stage*

Embryo-stage toxicity tests consisted of four 600mL replicates containing 500mL treatment water and 30 embryos per replicate. The chemical exposure duration was 96h with a 90% renewal at 48h. After 96h, embryos were held in clean water with every other day renewals until hatching (hatching began on day 8, 11 dpf). Embryos were scored daily, and dead or unfertilized eggs were removed when observed. Water quality parameters of dissolved oxygen, electrical conductivity, pH, and temperature were measured on fresh water and wastewater on all renewal days (days 2, 4, 6), freshwater was also analyzed at test initiation (day 0) and wastewater analyzed at test termination (day 13). At termination, surviving newly hatched smelt were euthanized with an overdose of buffered tricaine methanesulfonate (MS-222; Western Chemical Inc., Ferndale, WA, USA) and preserved with a 10% solution of buffered formalin for histopathologic analyses.

*Larval-stage*

Larval-stage toxicity tests consisted of four 600mL replicates with 500mL sample and 20 larvae per replicate. Larvae were not fed over the duration of the test. Chemical exposure duration lasted 96h with an 80% renewal at 48h. Treatment water was renewed via siphon connected to a screened funnel, to reduce the velocity of water siphoned through the screen. After 96h, smelt were held in clean water with every other day renewals for an additional 3 days. Smelt were scored daily, with the number of dead smelt recorded and removed from test replicate beakers. Water quality parameters of dissolved oxygen, electrical conductivity, pH, and temperature were measured on fresh water and wastewater on all renewal days (days 2, 4, 6), freshwater was also analyzed at test initiation (day 0) and wastewater analyzed at test termination (day 7). At termination, surviving smelt were euthanized with an overdose of buffered tricaine methanesulfonate (MS-222; Western Chemical Inc., Ferndale, WA, USA) and preserved with a 10% solution of buffered formalin for histopathologic analyses.

*Sublethal Analyses*

Preserved smelt were measured in wet weight and visually recorded via photo-microscopy. Micrographs were analyzed using ImageJ software from the National Institute of Health (http://rsbweb.nih.gov/ij/). The resultant coordinate data were exported and used to calculate total body length and yolk sac oil globulin area. Condition factor (CF) was calculated based on the average weight (W) and length (L) of smelt per subsample of 10 fish. Equation 1 summarizes the calculation.

$$CF = 100 * \frac{W}{L^3} \qquad \text{eq. 1}$$

*Statistics*

*Toxicity testing and mixture analyses*

Quasi-binomial regressions were fit to the lethal data of hatching success and survival using the "mle2" function (package bbmle) in the program R (Crawley 2012; Bolker and R Core Team 2013; R Core Team 2014). The response variable was proportion hatching or survival, and estimated herbicide or Agridex concentration was used as a predictor. Using the same function, linear regressions were fit to the sublethal data of CF and OGA. Confidence intervals around each model were determined by sampling the naïve posterior of the regression 10,000 times (McElreath 2013), and from the resulting

models 95% confidence intervals were calculated and plotted (figures 1 – 6). $EC_{50}$ concentrations were calculated from regression models, where applicable, however most responses did not amount to 50% relative to the control, even at the highest concentration. Lowest observed effect concentrations (LOECs) were calculated for all significant effects using Analysis of Variance, including a Dunnett's post hoc comparison.

**Results**

*Chemical Analyses*

Measured concentrations of imazamox and penoxsulam across all exposures averaged 117% of nominal concentrations. The greatest differences between nominal and measured concentrations were in the lowest treatments (2-12 ppb) where measured concentrations were up to twice the concentration of nominal. Omitting the lowest concentrations, the average measured to nominal percentage was 106%. Analytical results are summarized in Tables 1 – 2. Results were analyzed based on the average measured concentration per chemical and experiment. Because the ingredients in the surfactant Agridex is proprietary information and is a mixture of fatty acids, it is difficult to measure the actual concentration of surfactant (Moore et al. 2012). As a result, Agridex concentrations were statistically analyzed and are reported as nominal concentrations.

Table 1. Summary of treatment water chemical analyses for embryo exposures. Initial water represents water collected during the chemical exposure period, while final water represents samples collected after consecutive renewals with clean water during the recovery period.

| | | Initial Water | | Final Water | | |
|---|---|---|---|---|---|---|
| **Treatment Details** | **Target (µg/L)** | **Day 0 (µg/L)** | **Day 2 (µg/L)** | **Day 4 (µg/L)** | **Day 6 (µg/L)** | **Day 13 (µg/L)** |
| Control | 0 | 1.2 | 1.1 | 0 | 1.5 | 1.2 |
| 12 ppb Imazamox | 12 | 14.1 | 16.6 | | | |
| 50 ppb Imazamox | 50 | 53.6 | 59.5 | 1.6 | 0 | 1.7 |
| 500 ppb Imazamox | 500 | 687.5 | 703.4 | 33.8 | 1.6 | 0 |
| 50000 ppb Imazamox | 50000 | 53894.1 | 53114 | 1137.1 | 79.9 | 375.3 |
| 12 ppb Imazamox + 113 ppb Agridex | 12 | 15 | 15.4 | | | |
| 50 ppb Imazamox + 462 ppb Agridex | 50 | 54.5 | 60.1 | 1.5 | 0 | 0 |
| 500 ppb Imazamox + 6.4 ppm Agridex | 500 | 711.7 | 673.4 | 42.8 | 0 | 1.3 |
| 50000 ppb Imazamox + 64 ppm Agridex | 50000 | 53096.8 | 53410.6 | 2290.3 | 224.8 | 534.8 |
| Control | 0 | 0 | 0 | 0 | 0 | 1.7 |
| 2 ppb Penoxsulam | 2 | 2.8 | 2.2 | | | |
| 500 ppb Penoxsulam | 500 | 554.2 | 559.1 | 31.8 | 1.2 | 2.2 |
| 5000 ppb Penoxsulam | 5000 | 5076.5 | 5005 | 369.7 | 35.2 | 46 |
| 10000 ppb Penoxsulam | 10000 | 10041.3 | 9969.4 | 474.4 | 50.7 | 57.9 |
| 2 ppb Penoxsulam + 121 ppb Agridex | 2 | 2.9 | 2.7 | | | |
| 500 ppb Penoxsulam + 41 ppm Agridex | 500 | 567 | 577.7 | 39.3 | 3.5 | 5.7 |
| 5000 ppb Penoxsulam + 41 ppm Agridex | 5000 | 5206.4 | 4910.3 | 157.5 | 10.2 | 14 |
| 10000 ppb Penoxsulam + 41 ppm Agridex | 10000 | 10234 | 9899.1 | 444.6 | 35.9 | 43.1 |

Table 2. Summary of treatment water chemical analyses for larvae exposures. Initial water represents water collected during the chemical exposure period, while final water represents samples collected after consecutive renewals with clean water during the recovery period.

| | | Initial Water | | | Final Water | |
|---|---|---|---|---|---|---|
| **Treatment Details** | **Target (µg/L)** | **Day 0 (µg/L)** | **Day 2 (µg/L)** | **Day 4 (µg/L)** | **Day 4 (µg/L)** | **Day 6 (µg/L)** |
| Control | 0 | 1 | 2.5 | 2.1 | 2.7 | 2 |
| 12 ppb Imazamox | 12 | 14.6 | -- | 15.1 | 3.9 | 2.5 |
| 50 ppb Imazamox | 50 | 58.3 | 95.6 | 57 | 14.2 | 3.3 |
| 500 ppb Imazamox | 500 | 573.1 | 560 | 553.1 | 124.3 | 23 |
| 5000 ppb Imazamox | 5000 | 5617.4 | 5193.6 | 5235 | 1296.2 | 271.6 |
| 50000 ppb Imazamox | 50000 | 55111.7 | 52363.3 | 53090.7 | 11859.7 | 1856.4 |
| 12 ppb Imazamox + 113 ppb Agridex | 12 | 17.9 | 24.8 | -- | 47.4 | 3.4 |
| 500 ppb Imazamox + 6.4 ppm Agridex | 500 | 579.4 | 606.2 | 593.5* | 196.9* | 25.7 |
| 5000 ppb Imazamox + 64 ppm Agridex | 5000 | 5480 | 5245.5 | 5202.4 | 1114.1 | 222.3 |
| 50000 ppb Imazamox + 64 ppm Agridex | 50000 | 52177.9 | 53344.5 | 53271.9 | 11695.6 | 1893.5 |
| Control | 0 | 0 | 0 | 1.5 | 1.4 | 0 |
| 2 ppb Penoxsulam | 2 | 4.3 | 3.8 | | | 0 |
| 500 ppb Penoxsulam | 500 | 520.1 | 219.1 | 273.6 | 60.5 | 14.7 |
| 5000 ppb Penoxsulam | 5000 | 4072.8 | 3181.7 | 3356.1 | 744 | 13 |
| 10000 ppb Penoxsulam | 10000 | 7929.6 | 7830.1 | 7748.8 | 1629.9 | 14.7 |
| 2 ppb Penoxsulam + 121 ppb Agridex | 2 | 3 | 4.1 | | | |
| 500 ppb Penoxsulam + 41 ppm Agridex | 500 | 489.8 | 521.9 | 529.3 | 122 | 26.4 |
| 5000 ppb Penoxsulam + 41 ppm Agridex | 5000 | 3749.2 | 4787.5 | 4543.2 | 77.3 | 17.5 |
| 10000 ppb Penoxsulam + 41 ppm Agridex | 10000 | 5938.9 | 9907.9 | 9497.5 | 82.6 | 16.8 |

*Samples switched. Reported based on logical order.

-- Sample results omitted due to aberrant detected concentration.

*96h Survival and Hatching Success*

Hatching success was measured after exposing 2-3 dpf embryos to chemical treatments for 96 hours and acclimating them back to clean water until hatching (day 13). There were no significant effects on embryo hatching success from any of the chemicals tested individually, including Agridex, imazamox or penoxsulam, however there was a synergistic interaction between imazamox and Agridex resulting in significantly reduced hatching success at the highest concentration of these chemicals in combination, 61 mg/L of imazamox and 64 mg/L of Agridex (Figure 1).

Larvae (2-3 dph) were also exposed to chemical treatments for 96h and survival was determined at the end of the exposure period. Larval survival was significantly affected by Agridex in the penoxsulam-Agridex exposure (96h $LC_{50}$ = 57.1 mg/L), however an antagonistic interaction mitigated for the toxicity in the mixture (Figure 2) resulting in no significant effect up to the highest tested mixture concentration. In the penoxsulam and Agridex mixture exposure, there were no significant effects on larvae survival. The highest Agridex concentration tested was lower than that tested in the imazamox-Agridex experiment (41 mg/L compared to 64 mg/L), and therefore did not cause a similar significant effect. A three-day recovery period followed the 96h exposures and there was little mortality between the two time points in most treatments, however exceptions were individual exposures of imazamox and Agridex. Though imazamox alone did not cause significant mortality after the 96h exposure, mortality increased during the recovery period and was significant at the highest concentration, amounting to 55% mortality at 93 mg/L and 90% mortality at 124 mg/L at the end of the recovery period. Mortality also progressed in exposures to Agridex in both the imazamox and penoxsulam tests, such that survival became significantly affected in the penoxsulam-Agridex test at the highest concentration (41 mg/L) at 17% mortality, and greater in the imazamox-Agridex test over the recovery period, amounting to 75% mortality at the highest concentration (64 mg/L). Results are summarized below showing dose response curves for each chemical and their mixture after the 96h exposures (Figures 1 and 2). Where significant effects occurred, a dashed line, shaded according to chemical or mixture, is present at the lowest observed effect concentration.

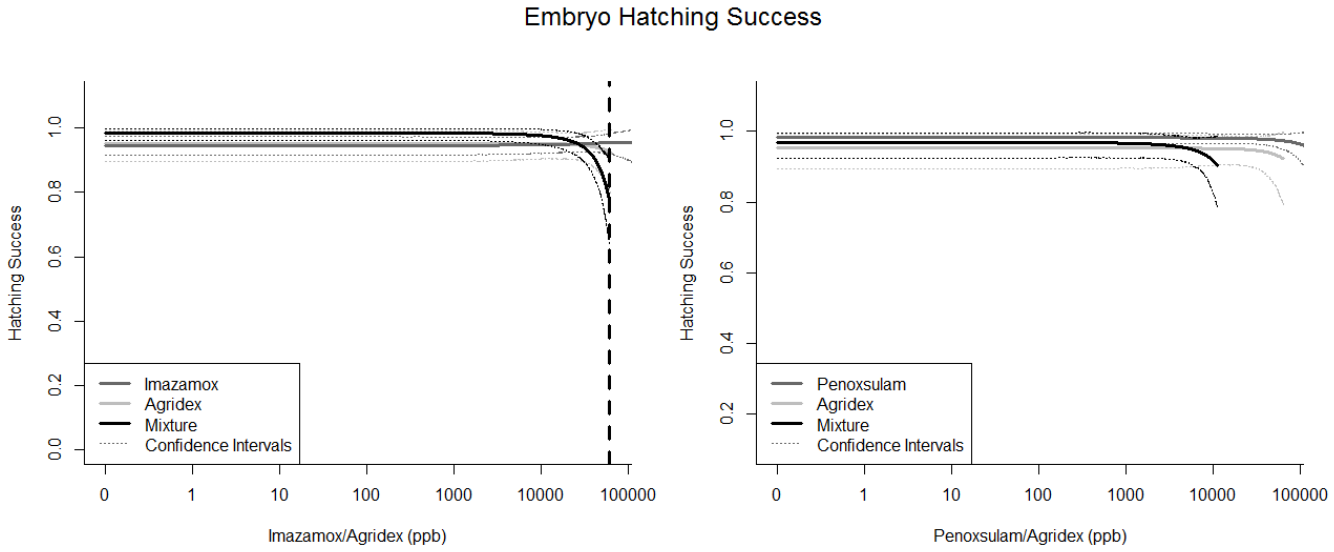


Figure 1. (left) Imazamox-Agridex and (right) penoxsulam-Agridex effects on embryo hatching success after 96h exposures (and adjusted to clean water until hatching). Dotted lines indicate the lowest

observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

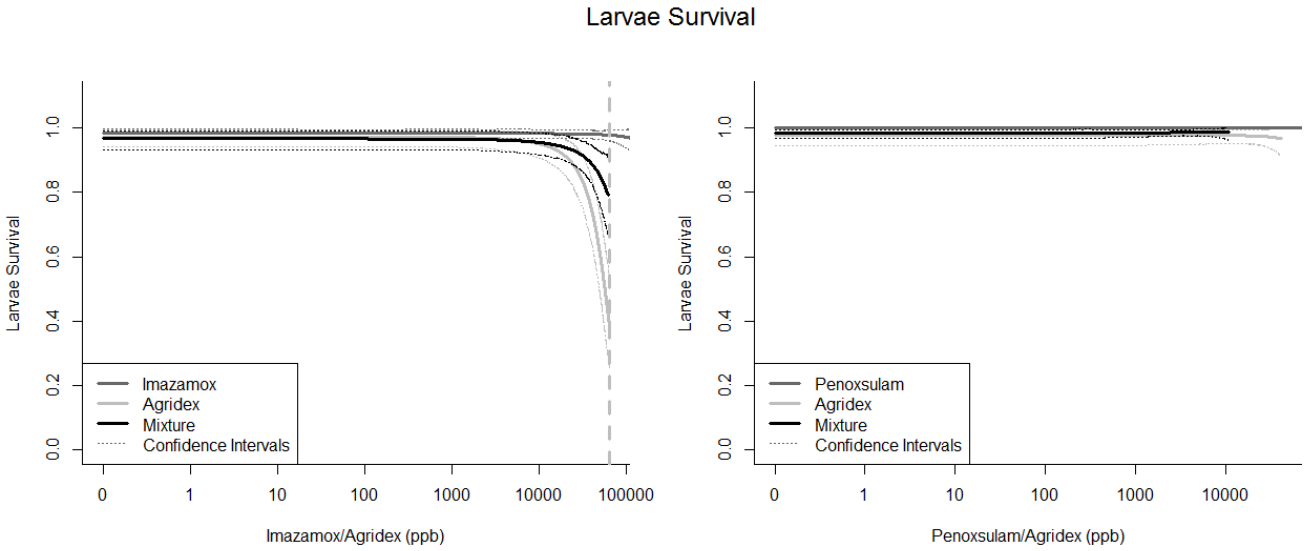


Figure 2. (left) Imazamox-Agridex and (right) penoxsulam-Agridex effects on larval survival after 96h exposures (3a), and 96h exposure with a 3 day grow out phase (3b). Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

*Sublethal Results*

Embryo condition factor (CF) was significantly decreased by Agridex (LOEC = 0.113 mg/L), but antagonistic interactions in both herbicide-Agridex mixtures reversed the response, causing a significant increase in CF (Figure 3). Penoxsulam alone also caused a significant, though small, increase in CF (LOEC = 0.0112 mg/L). Embryo oil globule area (OGA) was significantly increased by the mixture of imazamox and Agridex (LOEC = 61 mg/L imazamox and 64 mg/L Agridex), but neither chemical individually caused an effect (Figure 4). On the other hand, in the penoxsulam and Agridex exposure, OGA was decreased by Agridex (LOEC = 41 mg/L) and increased by penoxsulam (LOEC = 0.56 mg/L) individually and there was a variable effect in the mixture, causing a decrease in OGA (LOEC = 0.00224 mg/L) in all concentrations except the highest, which caused an increase that was not significant.

Larval CF was significantly decreased by imazamox (LOEC = 0.062 mg/L), Agridex (LOEC = 6.4 mg/L) and their mixture (LOEC = 6.2 mg/L imazamox and 64 mg/L Agridex). Agridex also caused a reduction in CF in the penoxsulam-Agridex mixture, while penoxsulam caused an increase in CF and there was no significant effect in the mixture (Figure 5). Larvae OGA was significantly affected only by the mixture of imazamox and Agridex, causing a significant increase (LOEC = 62 mg/L imazamox and 64 mg/L Agridex)(Figure 6).

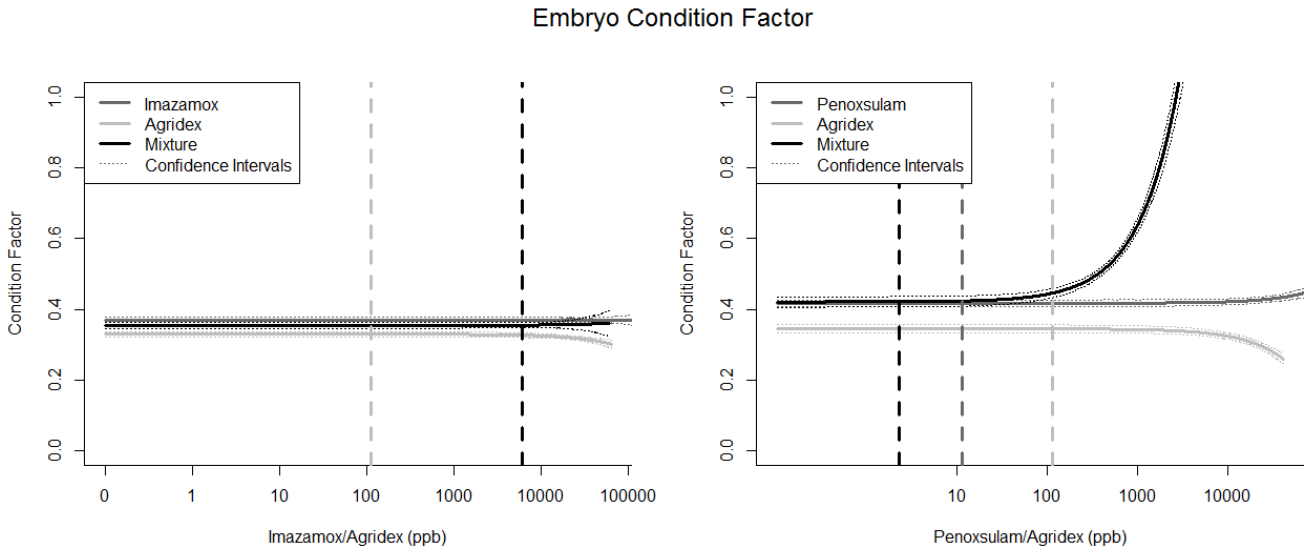


Figure 3. (left) Imazamox-Agridex and (right) penoxsulam-Agridex effects on embryo condition factor after 96h exposures and a clean water recovery period until hatching. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

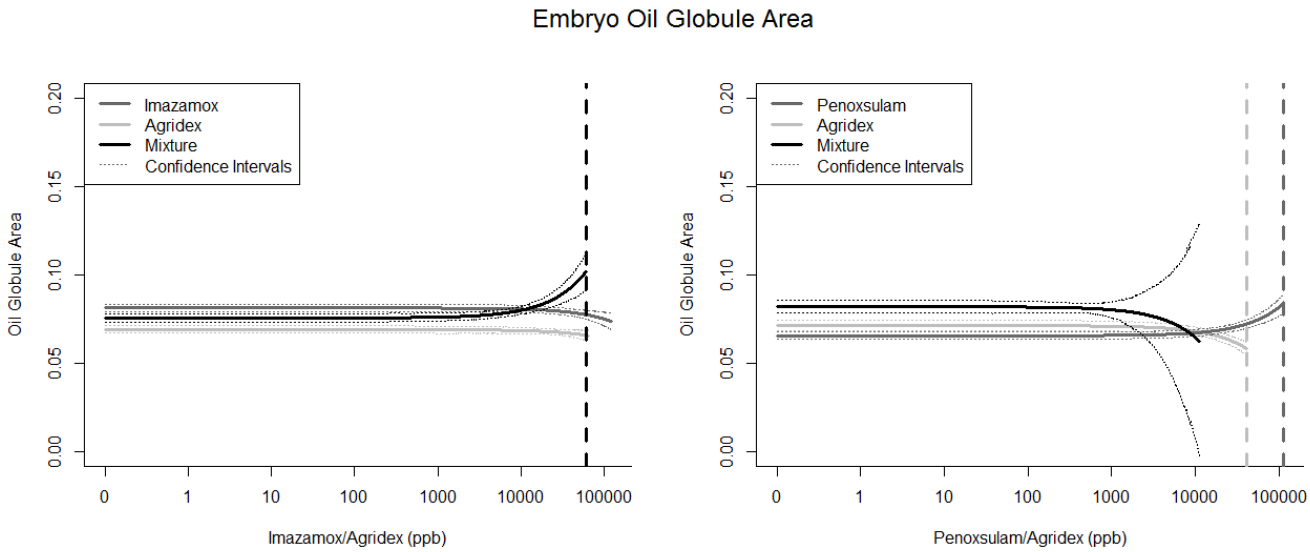


Figure 4. (left) Imazamox-Agridex and (right) Penoxsulam-Agridex effects on embryo oil globule area after 96h exposures and a clean water recovery period until hatching. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

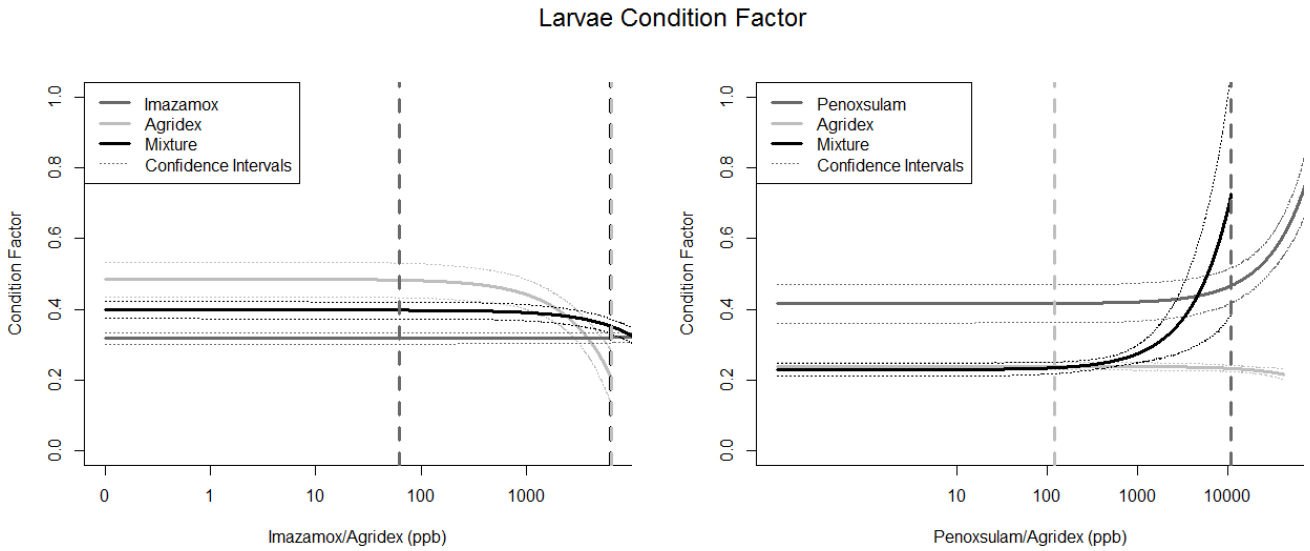


Figure 5. (left) Imazamox-Agridex and (right) penoxsulam-Agridex effects on larvae condition factor after 96h exposures and a three day clean water recovery period. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

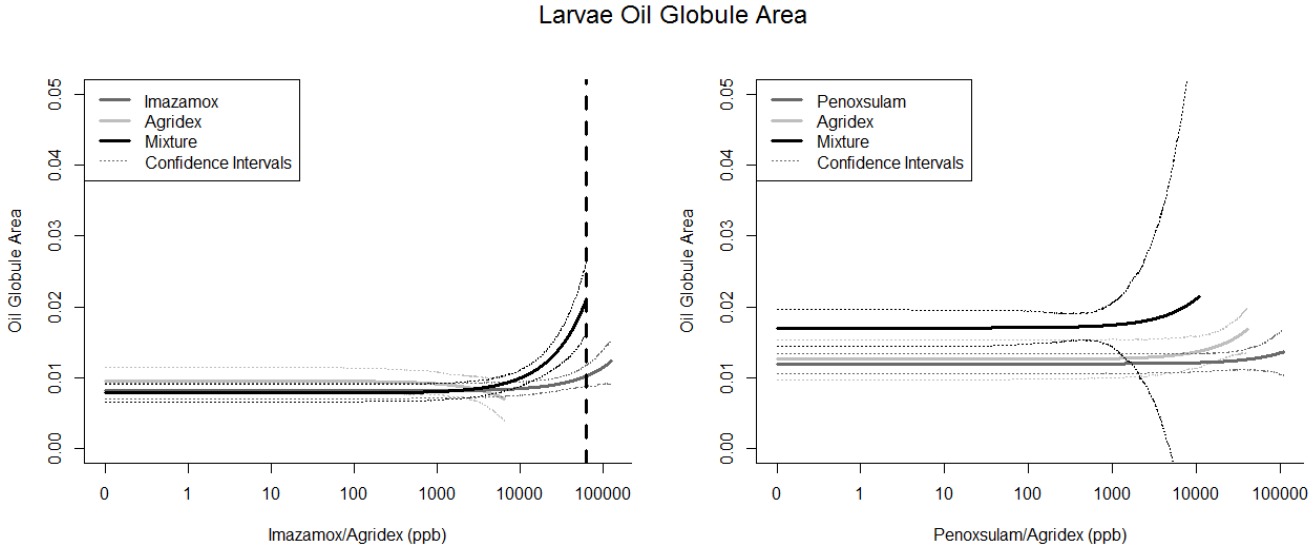


Figure 6. (left) Imazamox-Agridex and (right) penoxsulam-Agridex effects on larvae oil globule area after 96h exposures and a three day clean water recovery period. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

**Discussion**

Herbicides and adjuvants caused minimal effects on embryo hatching success and larvae survival, but toxic responses were prevalent among the sublethal effects of condition factor and oil globule area. Embryo hatching success and larvae survival were affected only at the highest treatment concentrations between 57 and 64 mg/L, which is over 700 (Agridex) and over 5000 (herbicides) times greater than

concentrations expected in water bodies immediately after application (NMFS 2013). To control submerged invasive aquatic vegetation in the Sacramento San Joaquin Delta (e.g. *Egeria densa*) imazamox is proposed to be directly injected into a water body with a maximum water column concentration of 500 ppb (Clearcast product label specifications). Results from this study indicate that these concentrations would have no effect on delta smelt health or survival, with a safety factor of almost 200.

Hatching success was significantly inhibited by 21% at the highest concentration of the imazamox-Agridex mixture, however none of the tested chemicals individually had an effect. No published study has investigated the effects of imazomox-Agridex mixtures on hatching success in any organism, however multiple studies concur with an inhibitory affect from other herbicide-adjuvant combinations. Most of the published literature has investigated formulations containing glyphosate, and have found a similar, though more potent, synergistic effect on hatching success. Marc et al. (2005), tested the effects of glyphosate (as Roundup) and the adjuvant POEA on hatching and survival of sea urchin embryos and found the adjuvant alone to be the most toxic to embryo hatching. Sparling et al. (2006) tested the effects of terrestrial (not aquatic) applications of glyphosate (as Glypro®) and the surfactant LI700 on hatching and development of the red eared slider frog. Results showed significant effects from both chemicals on hatching success at the highest test concentrations. Druart et al. (2010) also tested terrestrial applications of glyphosate and its formulation Roundup, using snail embryogenesis as the endpoint, and found that the formulation was more toxic than the glyphosate component alone.

Effects on smelt larvae survival were different from those on embryo hatching success. There were no significant effects on larvae survival in the penoxsulam-Agridex exposure among either of the chemicals individually or in mixture, however in the imazamox-Agridex exposure, Agridex alone had a significant and negative impact on larvae survival, and effects were mitigated in the mixture with imazamox. At the highest concentration tested, 64 mg/L, Agridex alone caused 60% mortality, while the mixture containing the same level of Agridex and 62 mg/L imazamox resulted in an average of 20% mortality and was not significantly different from the control. Previous studies have found much more appreciable affects of other adjuvants and herbicide-adjuvant mixtures on fish survival. Tatum et al. (2011) tested 4 different adjuvants including Entry II, Hasten, Timberland 90, and Timbersurf 90, as well as numerous herbicide-adjuvant mixtures, using fathead minnows (*Pimephales promelas*) and among the 23 different adjuvant and herbicide-adjuvant mixture exposures, twelve caused greater than 50% mortality. Concentrations tested ranged between below 0.1 mg/L up to 27 mg/L, conservatively based on estimated maximum environmental concentrations. Tsiu and Chu (2003) tested for effects of Roundup, its component chemicals, and a common adjuvant, POEA on the water flea, *Ceriodaphnia dubia*. Similar to the current study, the adjuvant was found to be the most toxic among the tested chemicals, with an $LC_{50}$ of 1.15 mg/L. The physiological mechanism of adjuvant and herbicide-adjuvant mixture toxicity is uncertain. Because adjuvants, including Agridex, are made up of a mixture of fatty acids, the physical properties of the oils, rather than a specific toxic mechanism of an active ingredient may be responsible for the resulting effects.

Sublethal effects from herbicide and adjuvant mixtures were variable, and some effects occurred at low, environmentally relevant concentrations. Condition factor was the most significantly affected sublethal endpoint. Condition factor is an indicator of fish health, where if the factor is low, fish have a lower body mass relative to length (see eq. 1) and are considered less healthy. Oil globule area was also affected by herbicides, Agridex and their mixtures, where effected fish most often boasted larger oil

globules relative to the controls. Oil globules are present in the yolk sacs of fish larvae after hatching, and are the primary source of energy to fuel growth and development before fish are able to feed. In delta smelt, the oil globule is present and utilized for up to 12 dph (Nobriga and Herbold 2009).

The combination of effects on CF and OGA is useful for characterizing the toxicity of the constituents tested. Effects on OGA and CF could be positive or negative depending on the physiological response to the toxicant exposure. Where energy is required to compensate for the effects of a toxicant (including metabolism and elimination), less energy is available for growth and development, and fish condition suffers (Rowe et al. 2001). Several studies provide evidence that toxicant exposures result in shifts in energy metabolism causing reductions in growth and ecological fitness (Hagernaars et al. 2008, McPhee and Janz 2014). Exposures to Agridex, individually, consistently caused decreases in CF across both embryo and larvae exposures, and OGA was simultaneously decreased in the embryo exposure. Significant reductions in CF occurred at Agridex concentrations between 100 - 170 ppb, while concentrations that could occur in the environment immediately after herbicide applications are expected to reach up to 82 ppb (NMFS 2013). Condition factor was decreased by up to 60% at the highest concentrations of Agridex, while the lowest level treatments, between 10 – 25%. These results suggest that Agridex exposures cause an energy-demanding response in delta smelt, and that significant effects on fish condition occur at low concentrations, close to levels expected post-application. Table 1 summarizes the inferred mechanisms of toxicity for each herbicide, adjuvant, and mixture based on their combined effects on CF and OGA.

Table 1. Effects of herbicides, Agridex and herbicide-Agridex mixtures on condition factor and oil globule area, and conclusions based on the combination of responses.

| **Chemical(s)** | **Life Stage** | **CF** | **OGA** | **Conclusion** |
|---|---|---|---|---|
| Agridex | Embryo | - | - | Energy depleted by stress response |
| Imazamox | Embryo | NA | NA | No effect |
| Penoxsulam | Embryo | + | + | Hormesis |
| Imazamox-Agridex | Embryo | + | + | Hormesis |
| Penoxsulam-Agridex | Embryo | + | NA | Hormesis |
| Agridex | Larvae | - | NA | Energy depleted by stress response |
| Imazamox | Larvae | NA | NA | No effect |
| Penoxsulam | Larvae | + | NA | Hormesis |
| Imazamox-Agridex | Larvae | - | + | Decrease energy metabolism |
| Penoxsulam-Agridex | Larvae | NA | NA | Additive response |

Neither herbicide tested, imazamox or penoxsulam, caused deleterious sublethal effects. Imazamox, individually, caused no significant effects on CF or OGA in either embryo or larvae exposures. Penoxsulam exposures, however, resulted in an increase in CF across both embryo and larvae exposures and a concurrent increase in OGA in the embryo exposure only (Table 1). Positive CF responses may be demonstrative of hormesis, a physiological reaction to low levels of stress that cause beneficial

effects. Penoxsulam did not affect survival or hatching success in delta smelt, even at the highest concentrations tested, therefore all concentrations tested could be considered low levels of stress, and the positive effects on fish condition could be the initial phase of the biphasic hormetic dose response. Hormesis is common in toxicology studies (Calabrese and Baldwin 2003), and is found to be especially pervasive among studies testing toxicant effects on organism growth (Stebbing 1982). It is hypothesized that the mechanism of the stimulatory effect of stress on growth is a form of physiological overcompensation following a disruption in homeostasis (Steinberg et al. 2008). An example would be a biosynthetic pathway relying on end product inhibition, that when disrupted by an exogenous chemical, triggers a parallel compensatory response. Toxicological research across multiple species, from plants to vertebrates, support this hypothesis, and Stanley et al. (2013), Schreck (2010), and Steinberg et al. (2008) provide excellent literature reviews on this topic. Herbicide-Agridex mixture responses in delta smelt embryos were also consistent with hormesis. The imazamox-Agridex mixture caused a significant positive effect on both CF and OGA, while the penoxsulam-Agridex mixture caused a positive effect on CF only. The specific mechanism of growth stimulation among exposures to penoxsulam (in embryos and larvae) and herbicide-Agridex mixtures (embryos only) is unknown, however it is clear that the high concentrations tested do not amount to adverse effects on delta smelt CF or OGA.

Herbicide-Agridex mixtures caused different responses in delta smelt larvae compared to embryos. The penoxsulam-Agridex mixture resulted in no significant effects on CF or OGA, while the imazamox-Agridex mixture caused a decrease in CF but an increase in OGA. Both effects largely reflect an additive response between the component chemicals involved. Between penoxsulam and Agridex, Agridex individually had a negative effect on CF and penoxsulam a positive effect, therefore a lack of response in the mixture is consistent with an additive interaction. Between imazamox and Agridex, Agridex caused a significant negative response in CF and imazamox did not have an effect, thus a negative effect on CF by the mixture is again consistent with an additive response. The imazamox-Agridex mixture effect on OGA, on the other hand, was not additive. While there were no effects on OGA from the chemicals individually, the mixture caused a positive effect. The mechanism of this interaction is unclear. An increase in OGA over the course of a larval exposure indicates that the energy stores were somehow preserved. Given the concurrent decrease in CF, it may be that the imazamox-Agridex mixture caused energy metabolism to slow in exposed fish. Such effects could occur by inhibiting processes along the metabolic pathway (Escher et al. 2002), however there are many possible targets and it is uncertain which the imazamox-Agridex mixture affected.

Results from this study show that the environmental risks of imazamox and penoxsulam applications to delta smelt are very low. Significant mortality did occur in the highest treatments of imazamox after the 96h exposure and a 3d recovery period, however toxic concentrations were hundreds of time greater than those expected in the environment either from overspray or from direct water column injection. Sublethal endpoints were also either not affected by the herbicides (in the case of imazamox) or effects were positive (penoxsulam). The environmental risk of the adjuvant, Agridex, is less certain, however. Though lethal effects only occurred at extremely high concentrations, deleterious effects on fish condition and energy stores were significant at lower, environmentally relevant levels. Several studies have indicated that toxic effects of the adjuvants applied with herbicides are of greater concern than the herbicides themselves, and this study is no exception. The effects of Agridex in this study, however, were less severe than many other adjuvants tested in previous studies. It is possible that the basic physical oily characteristic of surfactants, necessary for the chemical serve its function, is the cause of

the effects found.  Further investigation to characterize the mechanism of Agridex effects on fish embryo condition factor and oil globule area, and to substantiate the environmental risk to delta smelt and other native species in the Sacramento San Joaquin Delta is warranted.

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# 1. The effects of Penoxsulam, Imazamox and Agridex on survival, health indices and histopathology of Early Life Stages of Delta Smelt, *Hypomesus transpacificus*

**Abstract**

Delta Smelt (*Hypomesus transpacificus*) is endemic to the San Francisco Bay Delta (Bay-Delta) and currently is near extinction. Recently the use of different herbicides for the control of invasive aquatic weeds has raised concerns on whether these can affect non target organisms at environmentally relevant concentrations in a sublethal manner. In this study, we used Penoxsulam, Imazamox and Agridex at different concentrations to test for survival, hatching success, health indices and histopathological biomarkers in early life stages of Delta Smelt. We measured yolk sac perimeter, oil globule area and length as health indices; on the other hand, we looked for histopathological alterations in liver, muscle and fluid disturbances in the pericardial sac and coelomic cavity. Individually the herbicides did not alter the hatching success on Delta Smelt embryos, however, synergistic interactions of herbicides were observed to reduce hatching success. Reduced yolk sac perimeter was observed in recently hatched larvae exposed to high concentrations of Penoxsulam and Agridex. Conversely at higher concentrations, Imazamox increased yolk sac perimeter in recently hatched larvae. Liver and muscle of recently hatched larvae exposed to Penoxsulam and Agridex showed mild to moderate lesions, additionally, for Imazamox and Agridex treatments an increase in the proportion of ascites and pericardial edema was observed. At higher concentrations Imazamox and Agridex decreased the survival of larvae at higher concentrations; meanwhile, Penoxsulam did not show any alterations in survival rate at different concentrations. Taking all of this together, at environmentally relevant concentrations, these herbicides and their mixtures with the adjuvant do not compromise the survival of Delta Smelt early life stages. Alone, Penoxsulam was the safest herbicide without any evident effects on survival even at high concentrations, compared with Imazamox and Agridex, however these herbicides can cause alterations in the yolk sac perimeter and induce mild histopathological effects in tissues at environmentally relevant concentrations alone or mixed with the adjuvant (Agridex).

**Introduction**

Over the past two decades, the population of Delta Smelt (*Hypomesus transpacificus*) in the San Francisco Bay Delta (Bay- Delta) has sustained a trend of continual decline in abundance and currently is in near extinction. The Bay-Delta is a complex estuarine system and the dynamics of the system have been altered by anthropogenic inputs, engineering measures to meet the State of California's water demands, climate change and invasive species. Among the invasive species, the control of aquatic weeds is necessary for the protection of the environment and its beneficial uses.

Most herbicides commonly used to control aquatic weeds are not lethally toxic to fish at environmentally relevant concentrations, however, sublethal effects have been implicated from exposures to multiple common use herbicides and herbicide-adjuvant mixtures. Two new herbicides, Imazamox and Penoxsulam, and the adjuvant surfactant Agridex have been proposed for use in the Bay-Delta, however, little information is available on the effects of these chemicals or their proposed adjuvant on local sensitive species. Neither chemical has been extensively field tested, so there is uncertainty regarding their effects on non-target aquatic organisms including the endangered Delta Smelt.

In toxicity studies, Penoxsulam showed low toxicity in warm and cold water fish with an LC50 >103 ppm in Blueguill, Rainbow Trout and Common Carp, also, Imazamox has been reported non-toxic to fish at the highest concentrations tested, exhibiting an LC50 >122 ppm in Bluegill, Rainbow trout and 94.2 ppm in Sheepshead minnows (Yurk and Wisk 1994a; Yurk and Wisk 1994b; Olivieri et al. 1998a). According to EPA the bioaccumulation potential of Penoxsulam and Imazamox is low due to a low octanol/water partition coefficient (Kow <1), also, the absorption and excretion of Penoxsulam and Imazamox in fish is fast and tissue concentrations were not detected during the first 24 hours of the depuration process, based on this information, the potential of bioaccumulation or biomagnification in the aquatic food chain is low (Hammel, K, 2012). Regarding sublethal effects none studies have been done until now in Delta smelt and the gap on the knowledge on these endpoints must be fulfilled.

We hypothesize that at environmentally relevant concentrations these herbicides and the adjuvant do not cause considerable effects in the survival and sublethal endpoints in early life stages of Delta smelt, therefore, to ensure that sensitive fish species in the Bay-Delta are not affected by the new herbicides and adjuvants, this study tested the direct effects of Penoxsulam and Imazamox, and one adjuvant, Agridex, on Delta Smelt at early life stages (embryos and newly hatched larvae), including analyses of survival, health indices, and, histopathology.

# Materials and Methods

## Early Life stages of Delta Smelt

Delta Smelt embryos were provided by Dr. Tien-Chieh Hung, the Director of the Fish Conservation and Culture Laboratory (FCCL) in Byron, CA. Embryos were fertilized at FCCL prior to arrival at the Aquatic Health Program Lab (AHP). Upon receipt, embryos were held in 10% methylene blue solution for 24h to ward off bacterial and fungal pathogens. Subsequent embryo-stage toxicity tests were initiated within 1-2 days post fertilization (dpf). Embryos were held in 1L glass beakers with 900 mL Reconstituted culture water (UC Davis distilled water amended with inorganic salts to USEPA moderately hard standards [USEPA, 2002]) and gently aerated until their use in a test (embryo-stage), or until fully hatched (larval-stage).

## Herbicides

Imazamox, Penoxsulam, and Agridex test concentrations and mixture ratios were determined from predicted applied/residual water concentrations in the environment based on the application rates and mixture ratios planned for use in the field (NMFS 2013). The lower concentrations tested were environmentally relevant, while higher concentrations and mixtures were multiples thereof (up to 100,000x). Doses and treatments are described in (Table 1).

Table 1. Herbicides and doses used for Delta Smelt embryo and larvae toxicity test.

| Treatment | Doses (ppb) | Assay |
|---|---|---|
| **Penoxsulam** | 2, 10, 500, 5000, 10,000, 100,000 | 11-day Embryo Delta Smelt toxicity test |
| **Imazamox** | 12, 50, 500, 5000, 10,000, 50,000, 100,000 | |
| **Agridex** | 113, 462, 6400, 41,000, 64,000 | |
| **Penoxsulam + Agridex** | 2 (+164), 500 (+41000), 5000 (+41000), 10000 (+41000) | |
| **Imazamox + Agridex** | 12 (+155), 50 (+638), 500 (+6400), 5000 (+64,000), 50,000 (+64,000) | |
| **Penoxsulam** | 10, 500, 5000, 10,000, 100,000 | 8-day Larval Delta Smelt toxicity test |
| **Imazamox** | 12, 50, 500, 2500, 5000, 25,000, 50,000, 75,000 | |
| **Agridex** | 113, 6400, 64000 | |
| **Penoxsulam + Agridex** | 2 (+121), 500 (+41,000), 5000 (+41,000), 10,000 (+41,000) | |
| **Imazamox + Agridex** | 12 (+113), 500 (+6400), 5000 (+64,000), 50,000 (+64,000) | |

## Toxicity tests

### Embryo-stage

Embryo-stage toxicity tests consisted of four 600 mL replicate beakers with 30 embryos per replicate for each treatment. The chemical exposure duration was 96h. After 96h, embryos were held in clean water with every other day renewals until hatching (11 days). At termination, surviving newly hatched Delta Smelt were recorded, euthanized, and preserved in 10% buffered formalin for morphometry and histopathology analyses.

### Larval-stage

Larval-stage toxicity tests consisted of four 600 mL replicate beakers with 20 larvae per replicate for each treatment. Chemical exposure duration lasted 96h. After 96h, Delta Smelt were held in clean water with every other day renewals for an additional 3 days. At termination, surviving Delta Smelt were recorded, euthanized, and preserved in 10% buffered formalin for morphometry and histopathology.

## Morphometry and Histopathology

### Health indices

Preserved Delta Smelt larvae were measured in wet weight and visually recorded via photo-microscopy. Micrographs were analyzed using ImageJ software from the National Institute of Health (https://imagej.nih.gov/ij/). The resultant coordinate data were used to calculate yolk sac perimeter, oil globule area, and total length. This endpoint was used to evaluate energy reserves as a health index of recently hatched fish exposed to herbicides.

### Histopathological analysis

Histological analyses were performed on the liver and muscle tissues from six larvae in each replicate per treatment dose; additionally the presence or absence of pericardial edema and ascites from each evaluated fish were recorded. Liver and muscle lesions were evaluated using the criteria proposed by Gibson-Corley et al. (2013), Wolf and Wolfe (2005) (See Table 2). Additionally, ascites and pericardial edema were evaluated using the criteria proposed by Marty et al. (1997), and defined as an accumulation of proteinaceous fluid in the pericardial sac and around the viscera within the coelomic cavity.

## Statistical analysis

Quasi-binomial regressions were fit to the lethal data of hatching success and survival using the "mle2" function (package bbmle) in the R program (Crawley 2012; Bolker and R Core Team 2013; R Core Team 2014). The response variable was proportion hatching or survival, and estimated herbicide or Agridex concentration was used as a predictor. Using the same function, linear regressions were fit to the sub-lethal data of condition factor and oil globule area. Confidence intervals around each model were determined by sampling the naïve posterior of the regression 10,000 times (McElreath, 2013), and from the resulting models 95% confidence intervals were calculated and plotted. $EC_{50}$ concentrations were calculated from regression models, where applicable, however most responses did not amount to 50% relative to the control, even at the highest concentration. Lowest observed effect concentrations (LOECs) were calculated for all significant effects using Analysis of Variance, including a Dunnett's post hoc comparison.

Additionally, a logistic regressions model was fitted to evaluate dose-response associations in survival. The response variable was proportion of larvae survival, and Log10 herbicide concentration was used as a predictor. For health indices (yolk sac perimeter) an ANOVA with Dunnett's post hoc comparisons was used and a linear regression model was fitted to assess dose response associations. A Wilcoxon/Kruskal Wallis ANOVA with a post hoc Dunn test for joint ranks was used to assess differences in histopathology scores in the liver and muscle among groups. For ascites and pericardial edema a $\chi^2$ contingency analysis was used to evaluate proportions of ascites/pericardial edema among treatments doses, followed by a logistic regression model to evaluate dose response associations. All the analyses were performed using an $\alpha$=0.05 in the JMP software V 12 (SAS institute)

Table 2. Histopathological scoring criteria for Delta Smelt larvae exposed to different herbicide treatments.

| Score | Explanations (Liver) |
|---|---|
| **1 (normal)** | Hepatocytes with homogeneous eosinophilic cytoplasm, round to polygonal shape and centrally located nucleus, normal glycogen deposits and occasional intracytoplasmic lipid droplets, along all the observed area of tissue. |
| **2 (mild)** | Focal single cell necrosis and swelling of hepatocytes with mild glycogen depletion or mild lipid-glycogen intracytoplasmic vacuoles that do not displace the cytoplasm of the cell. |
| **3 (moderate)** | Multifocal to focally extensive clusters of acute cell swelling and necrosis, intracytoplasmic eosinophilic droplets and abundant lipid vacuoles that displace the nuclei of the cell and distorts cell architecture. |
| **4 (severe)** | Diffuse, acute cell swelling and necrosis affecting the entire area of evaluated tissue, with rupture of cells, inflammation, cellular debris and vacuolar degeneration including lipids and glycogen inclusions. |
| **Score** | **Explanations (Muscle)** |
| **1 (normal)** | Striations are well differentiated in each myofiber with an eosinophilic cytoplasm, multiple peripheral and prominent nuclei and organization into myomeres without evident spaces between them. |
| **2 (mild)** | Focally distributed degenerated fibers with small cytoplasmic vacuoles, hyper eosinophilic cytoplasm and occasionally pyknotic nuclei. |
| **3 (moderate)** | Focally extensive areas of degenerated fibers with multiple intracytoplasmic vacuoles, loss of striation and separation from neighboring cells, with occasional clumped and contracted debris from dead myofibers |
| **4 (severe)** | Diffuse disruption of muscle fibers with loss of striation, severe vacuolation, and formation of hypereosinophillic contracted clumps of dead cells with inflammation along the whole body |

# Results

## Delta Smelt Embryo-stage

### Survival

There were no significant effects on embryo hatching success from any of the chemicals tested individually, including Agridex, Imazamox or Penoxsulam; however there was a synergistic interaction between Imazamox and Agridex, resulting in significantly reduced hatching success at the highest concentration of these chemicals in combination, 61 mg/L of Imazamox and 64 mg/L of Agridex (Figure 1).

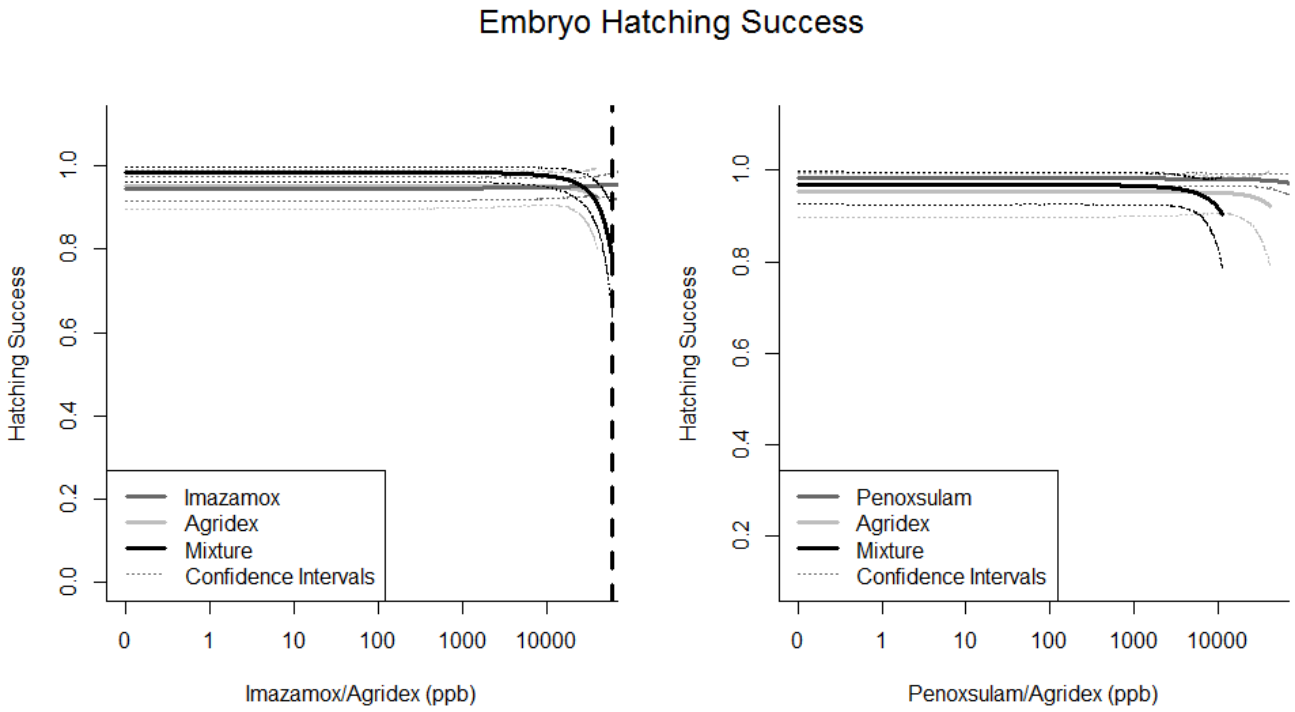



Figure 1. Herbicide, adjuvant, and herbicide-adjuvant mixture effects on embryo hatching success conducted in 2014. As noted in the key, Imazamox or Penoxsulam (herbicide) = dark grey line, Agridex (adjuvant) = light grey, and the mixture = black. Confidence intervals around the models are shown as dotted lines, where a vertical dotted line denotes a significant effect at that concentration (color coded to key).

### Health indices

We observed a significant reduction of the yolk sac perimeter in recently hatched larvae exposed to 500 ppb of Penoxsulam, and in Agridex at the 113 ppb, and 41,000 ppb treatment concentrations, when compared to the control group (ANOVA P=<0.0001). In contrast, for the Imazamox treatment, the yolk sac perimeter was significantly larger in the 12, 5,000, 10,000, and 50,000 ppb doses (ANOVA P=<0.0001) (See Table 3). For mixture treatments, we observed a significantly larger yolk sac in larvae exposed to a dose of 5,000 ppb of Penoxsulam plus 41,000

ppb of Agridex and a dose of 50,000 ppb of Imazamox plus 64,000 ppb of Agridex (ANOVA P=<0.0001) (See Table 3).

Table 3. Yolk sac perimeter of recently hatched Delta Smelt larvae exposed to Penoxsulam, Imazamox, and Agridex during 96 hours. (Bolded cases represent significant differences compared to the control group).

| Treatment | Dose (ppb) | Yolk sac perimeter (mm) Mean±SE |
|---|---|---|
| Control | 0 | 2.35 ± 0.038 |
| Penoxsulam | 2 | 2.23 ± 0.035 |
| | 10 | 2.24 ± 0.042 |
| | **500** | **2.15 ± 0.037** |
| | 5,000 | 2.44 ± 0.032 |
| | 10,000 | 2.33 ± 0.058 |
| | 100,000 | 2.45 ± 0.068 |
| Imazamox | **12** | **2.59 ± 0.054** |
| | 50 | 2.47 ± 0.026 |
| | **500** | **2.45 ± 0.038** |
| | **5,000** | **2.88 ± 0.046** |
| | **10,000** | **2.51 ± 0.042** |
| | 50,000 | 2.68 ± 0.050 |
| | 100,000 | 2.33 ± 0.026 |
| Agridex | **113** | **2.18 ± 0.030** |
| | 462 | 2.37 ± 0.031 |
| | 6,400 | 2.33 ± 0.031 |
| | **41,000** | **2.05 ± 0.031** |
| | 64,000 | 2.33 ± 0.030 |
| Penoxsulam + Agridex | 2 + 164 | 2.45 ± 0.048 |
| | 500 + 41,000 | 2.48 ± 0.051 |
| | **5,000 + 41,000** | **2.72 ± 0.046** |
| | 10,000 + 41,000 | 2.40 ± 0.045 |
| Imazamox + Agridex | 12 + 155 | 2.45 ± 0.041 |
| | 50 +638 | 2.32 ± 0.040 |
| | 500 + 6,400 | 2.44 ± 0.042 |
| | 5,000 + 64,000 | 2.38 ± 0.041 |
| | **50,000 + 64,000** | **2.81 ± 0.041** |

Embryo condition factor was significantly decreased by Agridex (LOEC = 0.113 mg/L), but antagonistic interactions in both herbicide-Agridex mixtures reversed the response, causing a significant increase in condition factor (Figure 2). Penoxsulam alone also caused a significant, though small, increase in condition factor (LOEC = 0.0112 mg/L). Embryo oil globule area was significantly increased by the mixture of Imazamox and Agridex (LOEC = 61 mg/L Imazamox

and 64 mg/L Agridex), but neither chemical individually caused an effect (Figure 3). On the other hand, in the Penoxsulam and Agridex exposure, oil globule area was decreased by Agridex (LOEC = 41 mg/L) and increased by Penoxsulam (LOEC = 0.56 mg/L) individually, and there was a variable effect in the mixture, causing a decrease in oil globule area (LOEC = 0.00224 mg/L) in all concentrations except the highest, which caused an increase that was not significant.

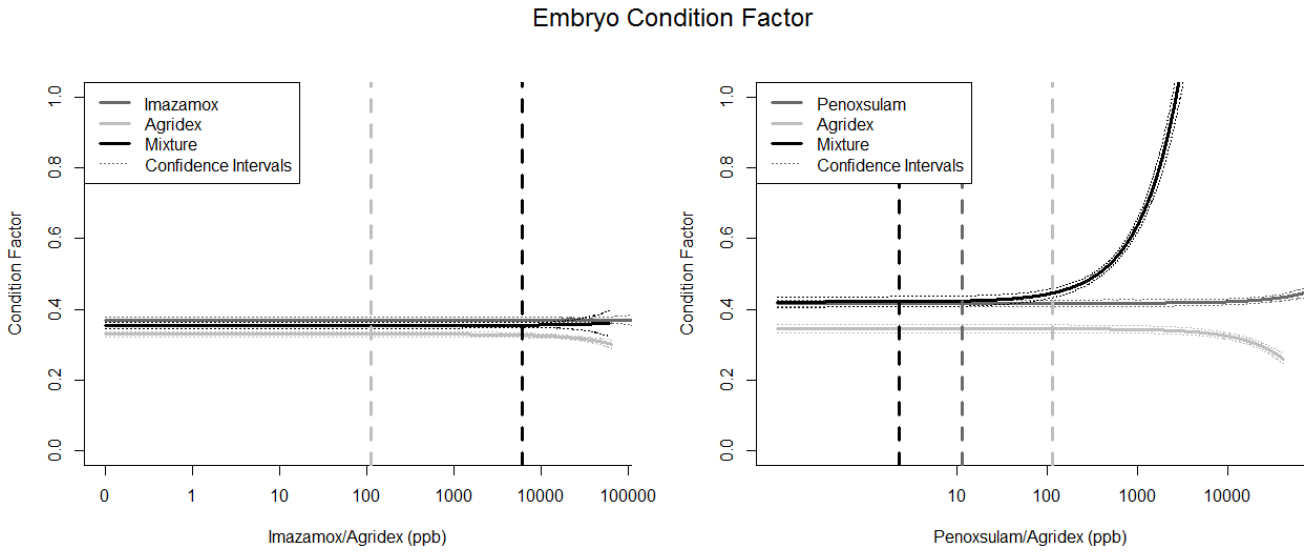



Figure 2. (left) Imazamox-Agridex and (right) Penoxsulam-Agridex effects on embryo condition factor after 96h exposures and a clean water recovery period until hatching. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

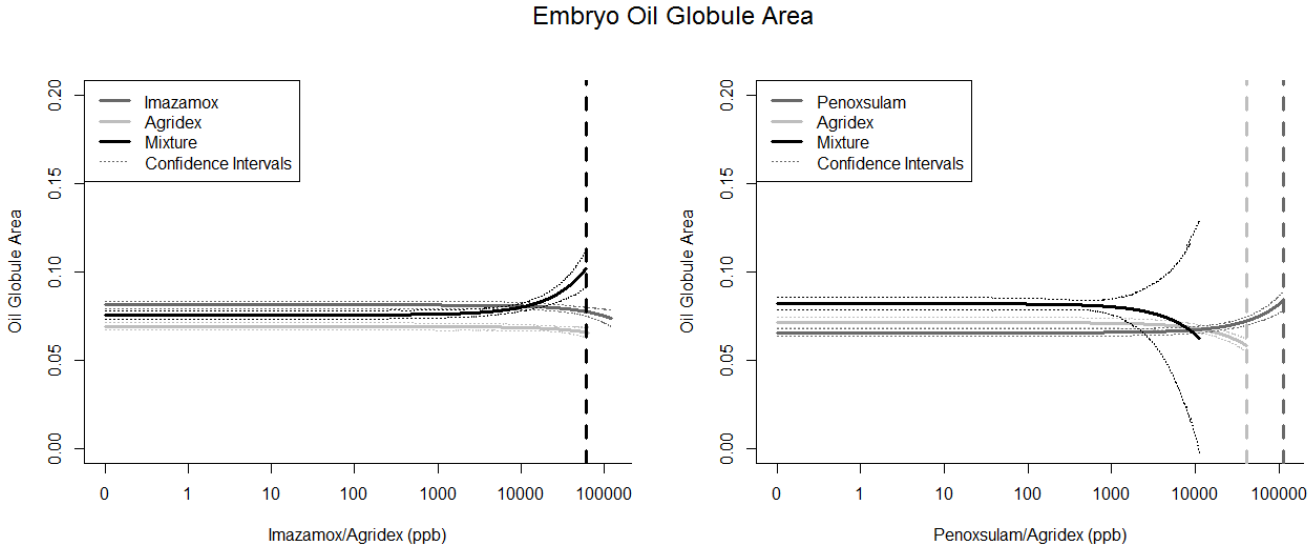


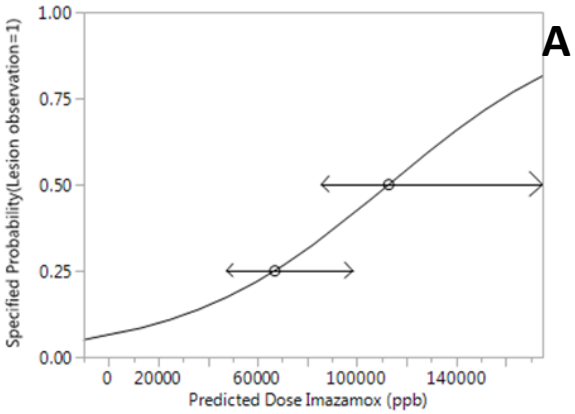

Figure 3. (left) Imazamox-Agridex and (right) Penoxsulam-Agridex effects on embryo oil globule area after 96h exposures and a clean water recovery period until hatching. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

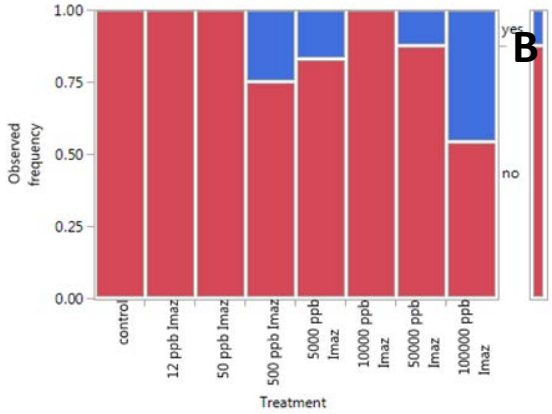
## Histopathology

In the liver of recently hatched larvae we observed a mean score of 2, from the 10, 500, 5,000 and 100,000 ppb Penoxsulam doses, compared with the control group (P=<0.013) (See table 4). For Agridex, a mild histopathological score was observed for all the concentrations tested (P=0.009), and for Imazamox, no significant effects were observed in the liver (P=0.2183). For the mixtures, in general, significant differences were observed in the liver histopathological score from fish exposed to Penoxsulam-Agridex (P=0.0012) and Imazamox-Agridex (P=0.020) mixture doses, with mild to moderate changes observed when compared with control groups (See Table 4, Figure 7). In muscle tissue a mild myodegeneration in the posterior third of the body was observed in larvae exposed to 10,000 and 100,000 ppb of Penoxsulam (P=<0.0001), and 500 and 5,000 ppb of Imazamox (P=0.0002) (Figure 8). In contrast, no significant differences were observed in the muscle lesion score of larvae exposed to Agridex (P=0.3691). In mixture treatments, a mild muscle myodegeneration was observed in the highest dose from Imazamox plus Agridex (P=0.0016) and Penoxsulam plus Agridex when compared to the control group (P=0.0062). The observation of ascites and pericardial edema (Figure 9) were not significant among doses in the Penoxsulam treatment (Pearson > $\chi^2$=>0.05). In contrast, for Imazamox and Agridex, we observed an increased proportion of larvae with this lesion in the higher dose treatments (Pearson > $\chi^2$=<0.05), and the effect was dose dependent as it was predicted using a logistic regression model (P=<0.05; Odds ratio=10.93). However, despite that the model was accurate in predicting the expected proportion of lesions for the higher concentrations of Imazamox and Agridex with the observed proportion in the contingency analysis, other observed concentrations had different proportions of lesions (See Figures 4 and 5). For the mixture of Penoxsulam and Agridex no significant effects were observed in the occurrence of ascites among treatment dose (Pearson > $\chi^2$=>0.05); in contrast, for the Imazamox and Agridex mixtures, significant differences were observed among doses and the control with a higher proportion in the presentation of ascites in the four first doses (Pearson > $\chi^2$=<0.05) (See Figure 6).

Table 4. Histopathology summary of newly hatched Delta Smelt larvae exposed to Imazamox, Agridex, and Penoxsulam, during an 11-day embryo-stage toxicity test. (Only results with significant differences are shown).

| Treatment | Tissue | Dose (ppb) | Score Mean | P value |
|---|---|---|---|---|
| **Penoxsulam** | **liver** | 10 | 2 (Mild) | 0.019 |
| | | 500 | 2 (Mild) | 0.0047 |
| | | 5,000 | 2 (Mild) | 0.0038 |
| **Agridex** | **Liver** | 100,000 | 2 (Mild) | 0.04 |
| | | 113 | 2 (Mild) | 0.026 |
| | | 6,400 | 2 (Mild) | 0.0032 |
| | | 64,000 | 2 (Mild) | 0.0026 |
| **Penoxsulam + Agridex** | **Liver** | 2+121 | 2-3(Mild to moderate) | 0.0071 |
| | | 500+41,000 | 2-3(Mild to moderate) | 0.0005 |
| | | 10,000+41,000 | 2-3(Mild to moderate) | 0.00143 |
| **Imazamox + Agridex** | **Liver** | 12+155 | 2-3(Mild to moderate) | 0.033 |
| | | 50,000+64,000 | 2-3(Mild to moderate) | 0.0125 |
| **Penoxsulam** | **Muscle** | 10,000 | 2(Mild) | 0.0004 |
| | | 100,000 | 2(Mild) | 0.0002 |
| **Imazamox** | **Muscle** | 500 | 2(Mild) | 0.00086 |
| | | 5,000 | 2(Mild) | 0.0015 |
| **Imazamox + Agridex** | **Muscle** | 50,000+64,000 | 2(Mild) | 0.0016 |
| **Penoxsulam + Agridex** | **Muscle** | 10,000+41,000 | 2(Mild) | 0.0014 |



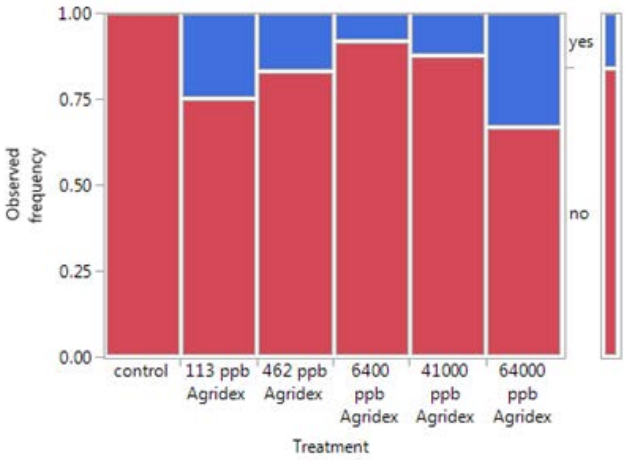

C

Observed frequency

| Treatment | Count / Row % | no | yes | Total |
|---|---|---|---|---|
| control | | 24 | 0 | 24 |
| | | 100.00 | 0.00 | |
| 12 ppb Imaz | | 24 | 0 | 24 |
| | | 100.00 | 0.00 | |
| 50 ppb Imaz | | 24 | 0 | 24 |
| | | 100.00 | 0.00 | |
| 500 ppb Imaz | | 18 | 6 | 24 |
| | | 75.00 | 25.00 | |
| 5000 ppb Imaz | | 20 | 4 | 24 |
| | | 83.33 | 16.67 | |
| 10000 ppb Imaz | | 24 | 0 | 24 |
| | | 100.00 | 0.00 | |
| 50000 ppb Imaz | | 21 | 3 | 24 |
| | | 87.50 | 12.50 | |
| 100000 ppb Imaz | | 13 | 11 | 24 |
| | | 54.17 | 45.83 | |
| Total | | 168 | 24 | 192 |

Figure 4. Proportion of recently hatched larvae showing ascites and pericardial edema in embryos exposed to different doses of Imazamox for 96 hours. A) Logistic regression curve of predicted dose-proportion of lesions B) Mosaic plot showing the distribution of lesions among Imazamox doses. C) Percentage of lesions observed in Imazamox treatment.

A




B

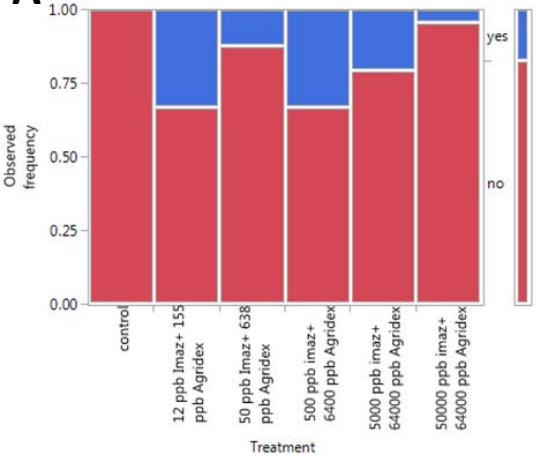
Observed frequency

| Count / Row % | no | yes | Total |
|---|---|---|---|
| control | 24 | 0 | 24 |
| | 100.00 | 0.00 | |
| 113 ppb Agridex | 18 | 6 | 24 |
| | 75.00 | 25.00 | |
| 462 ppb Agridex | 20 | 4 | 24 |
| | 83.33 | 16.67 | |
| 6400 ppb Agridex | 22 | 2 | 24 |
| | 91.67 | 8.33 | |
| 41000 ppb Agridex | 21 | 3 | 24 |
| | 87.50 | 12.50 | |
| 64000 ppb Agridex | 16 | 8 | 24 |
| | 66.67 | 33.33 | |
| Total | 121 | 23 | 144 |

Treatment

Figure 5. Proportion of recently hatched larvae showing ascites and pericardial edema in embryos exposed to different doses of Agridex for 96 hours. A) Mosaic plot showing the distribution of lesions among Imazamox doses, B) Percentage of lesions observed in Imazamox treatment.

A




B

Observed frequency

| Count / Row % | no | yes | Total |
|---|---|---|---|
| control | 24 | 0 | 24 |
| | 100.00 | 0.00 | |
| 12 ppb Imaz+ 155 ppb Agridex | 16 | 8 | 24 |
| | 66.67 | 33.33 | |
| 50 ppb Imaz+ 638 ppb Agridex | 21 | 3 | 24 |
| | 87.50 | 12.50 | |
| 500 ppb imaz+ 6400 ppb Agridex | 16 | 8 | 24 |
| | 66.67 | 33.33 | |
| 5000 ppb imaz+ 64000 ppb Agridex | 19 | 5 | 24 |
| | 79.17 | 20.83 | |
| 50000 ppb imaz+ 64000 ppb Agridex | 23 | 1 | 24 |
| | 95.83 | 4.17 | |
| Total | 119 | 25 | 144 |

Treatment

Figure 6. Proportion of recently hatched larvae showing ascites and pericardial edema in embryos exposed to different doses of Imazamox plus Agridex for 96 hours. A) Mosaic plot showing the distribution of lesions among doses, B) Percentage of lesions observed in treatment doses.

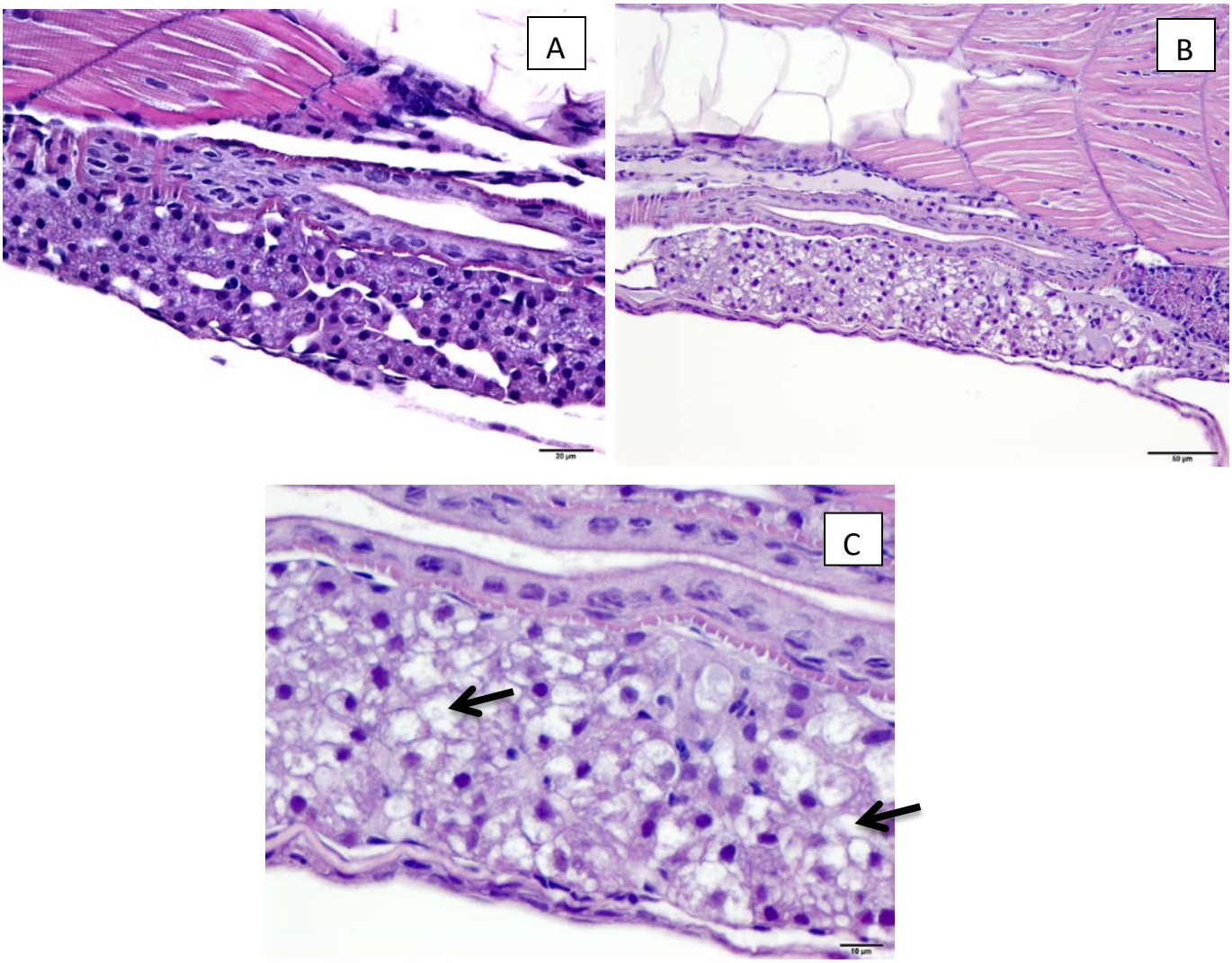



Figure 7. Histopathological findings observed in the liver of Delta Smelt exposed during the embryo and larval stages to Imazamox, Penoxsulam and Agridex. A) Normal control liver. B) Moderate to severe vacuolization of hepatocytes affecting the whole parenchyma. C) Higher magnification of B, showing a detail of the vacuolated hepatocytes (arrows).

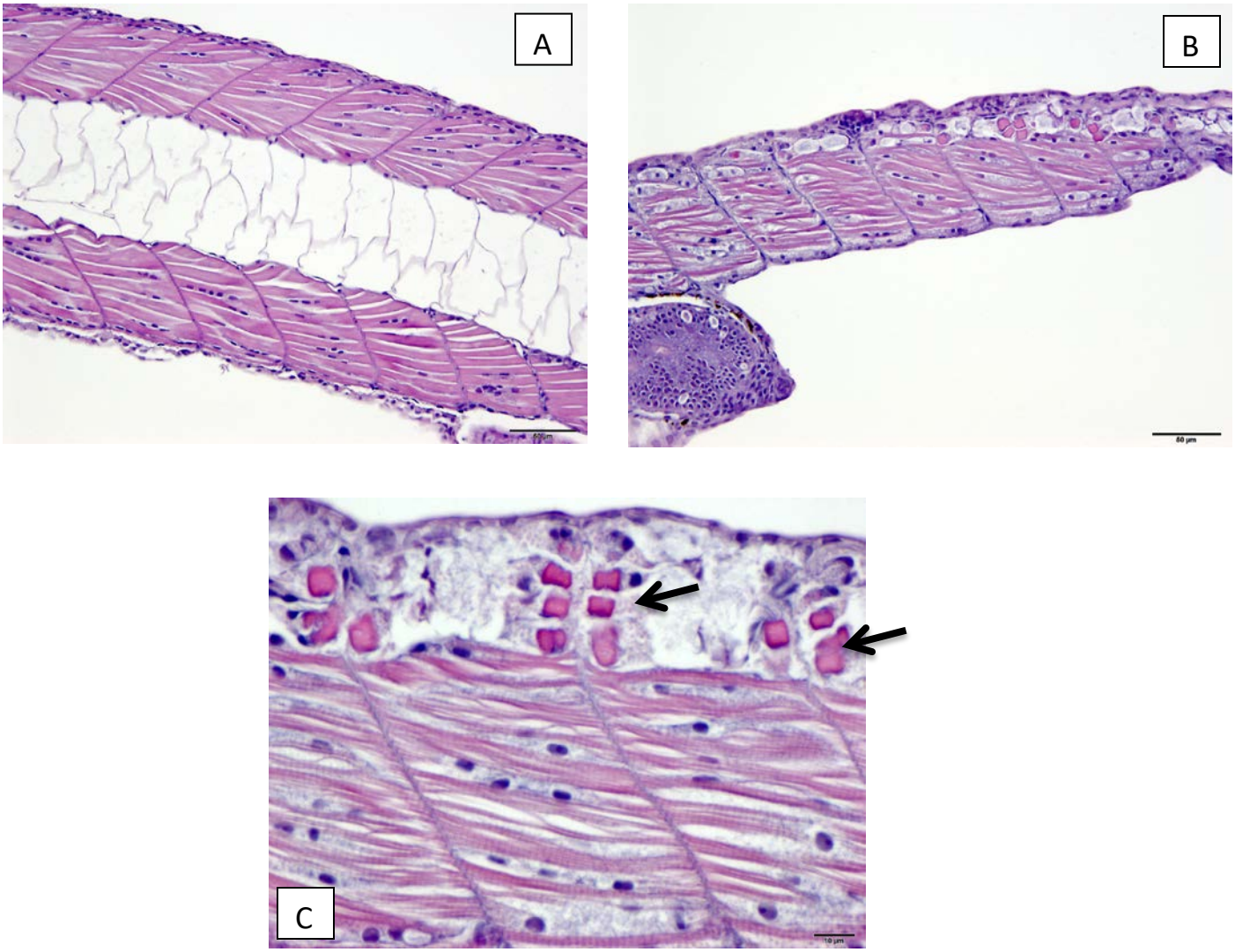



Figure 8. Histopathological findings observed in the skeletal muscle of the tail portion of Delta Smelt exposed during the embryo and larval stages to Imazamox, Penoxsulam and Agridex. A) Normal control Muscle. B) Moderate to severe myodegeneration. C) Higher magnification of B, showing a detail of the disrupted muscle fibers (arrows).

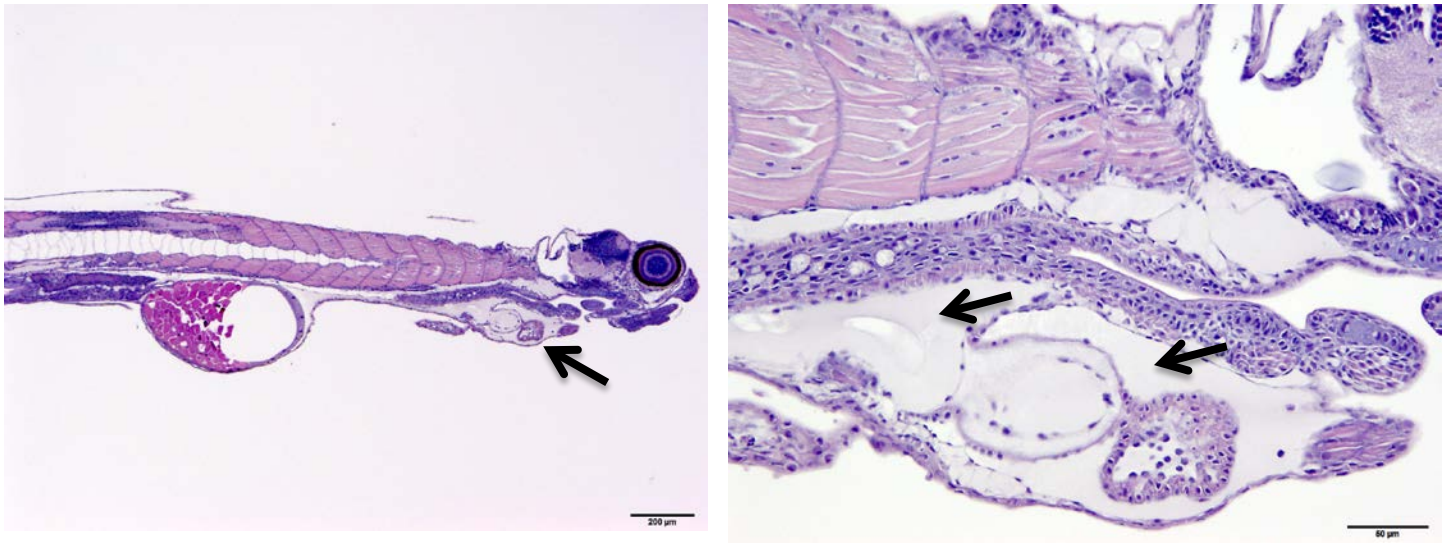


Figure 9. Histopathological findings observed in the pericardial sac of Delta Smelt exposed during the embryo and larval stages to Imazamox, Penoxsulam and Agridex. A) Low magnification Image of the fluid buildup in the pericardial sac (Arrow). B) Higher magnification of the developing heart and the pericardial sac. Note the glassy material surrounding the heart, interpreted as edema fluid (arrows).

## Delta Smelt Larval-stage

### Survival

Larval survival was significantly affected by Agridex in the Penoxsulam-Agridex exposure (96h $LC_{50}$ = 57.1 mg/L); however an antagonistic interaction mitigated for the toxicity in the mixture (Figure 7), resulting in no significant effect up to the highest tested mixture concentration. In the Penoxsulam and Agridex mixture exposure, there were no significant effects on larvae survival. The highest Agridex concentration tested was lower than that tested in the Imazamox-Agridex experiment (41 mg/L compared to 64 mg/L), and therefore did not cause a similar significant effect. A three-day recovery period followed the 96h exposures and there was little mortality between the two time points in most treatments, however exceptions were individual exposures of Imazamox and Agridex. Though Imazamox alone did not cause significant mortality after the 96h exposure, mortality increased during the recovery period and was significant at the highest concentration, amounting to 55% mortality at 93 mg/L and 90% mortality at 124 mg/L at the end of the recovery period. Mortality also progressed in exposures to Agridex in both the Imazamox and Penoxsulam tests, such that survival became significantly affected in the Penoxsulam-Agridex test at the highest concentration (41 mg/L) at 17% mortality, and greater in the Imazamox-Agridex test over the recovery period, amounting to 75% mortality at the highest concentration (64 mg/L).

We observed a 4% decrease in the odds of survival for every 10 fold increase in the dose of Imazamox (P=<0.0001; Odds ratio=0.040). In contrast, for Penoxsulam we did not observe any changes in the survival percentage at the 96 h and 7 days exposure time. Similarly, a significant decrease in survival was not observed in the 113 ppm Agridex dose at the 96 h period. Conversely, for the highest Agridex dose a significant reduction in survival was observed at both time points. We observed an 8.7% decrease in the odds of survival for every 10 fold increase in the dose of Agridex at day 7 (P=<0.0001; Odds ratio=0.087) (See Figure 8). No significant reductions in survival were observed In the Penoxsulam and Agridex mixture (*P= >0.05*).

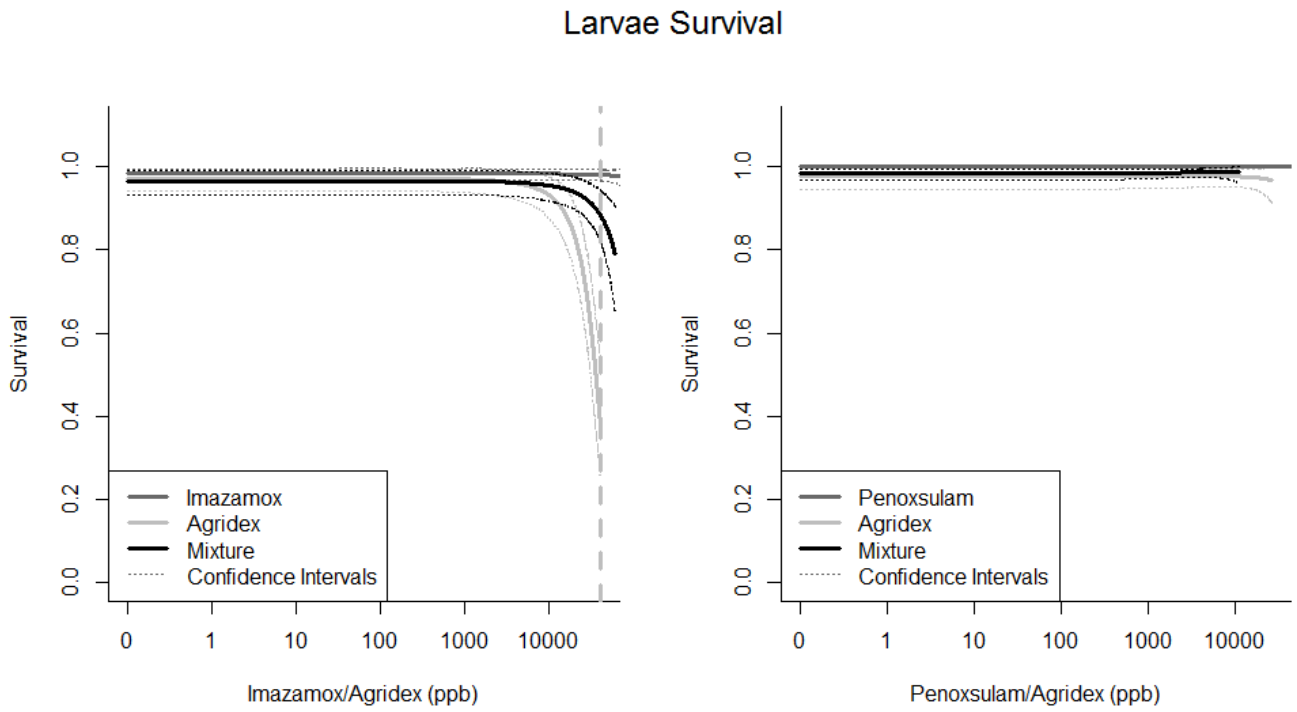



Figure 7. Herbicide, adjuvant, and herbicide-adjuvant mixture effects on larval survival conducted in 2014. Agridex alone caused larvae smelt mortality at the highest test concentration (Max effect = Average of 39% survival at the highest Agridex test concentration of 41 mg/L relative to control of 100%). Mixture with Imazamox mitigated the toxicity (antagonistic mixture interaction) – resulting in an average of 79% survival in the mixture.

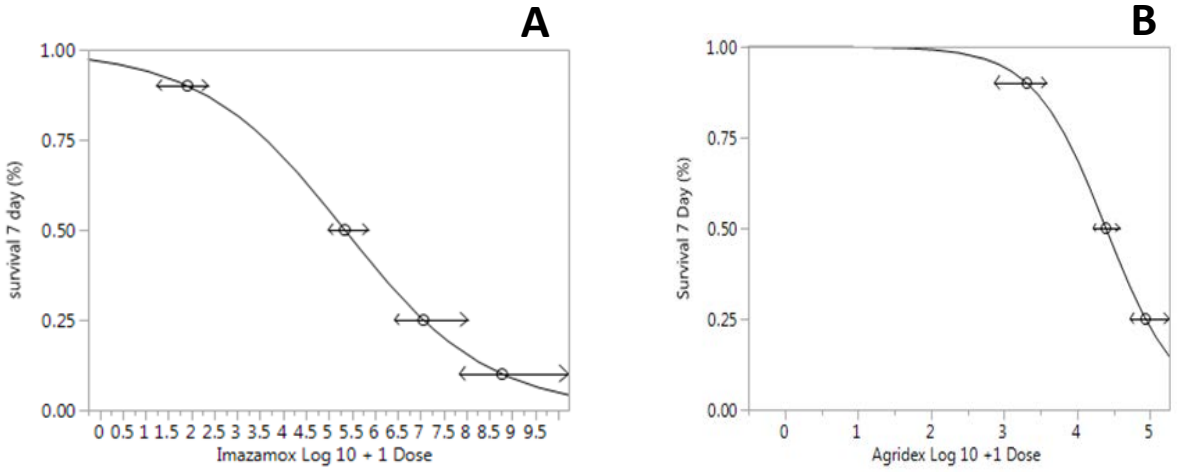



Figure 8. Estimated survival of Delta Smelt larvae exposed to A) Imazamox and B) Agridex in a 7 days toxicity test. (Each point indicate 90, 50, 25 and 10 % probabilities of survival, rows are 95 % confidence interval of $Log_{10}$ dose).

## Health indices

Larval condition factor was significantly decreased by Imazamox (LOEC = 0.062 mg/L), Agridex (LOEC = 6.4 mg/L), and their mixture (LOEC = 6.2 mg/L Imazamox and 64 mg/L Agridex). Agridex also caused a reduction in condition factor in the Penoxsulam-Agridex mixture, while Penoxsulam caused an increase in condition factor and there was no significant effect in the mixture (Figure 9). Larvae oil globule area was significantly affected only by the mixture of Imazamox and Agridex, causing a significant increase (LOEC = 62 mg/L Imazamox and 64 mg/L Agridex)(Figure 10).

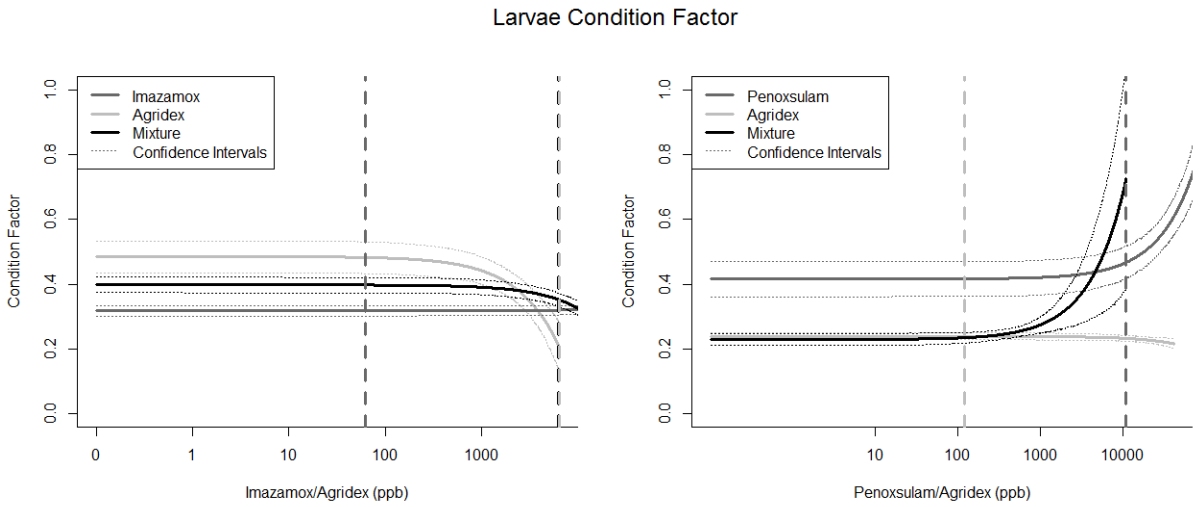



Figure 9. (left) Imazamox-Agridex and (right) Penoxsulam-Agridex effects on larvae condition factor after 96h exposures and a three day clean water recovery period. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

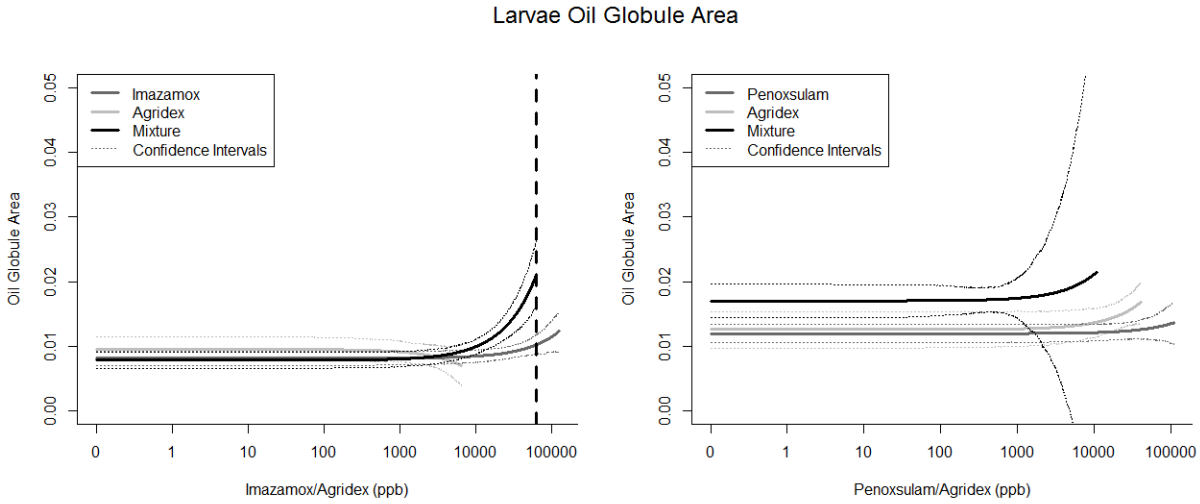



Figure 10. (left) Imazamox-Agridex and (right) Penoxsulam-Agridex effects on larvae oil globule area after 96h exposures and a three day clean water recovery period. Dotted lines indicate the lowest observed effect concentration, the shade of the line corresponds to the chemical or mixture dose response curves. Where a dotted line is not present, there was no significant effect.

### Histopathology

A Kruskal-Wallis test revealed that there was a significant effect of Imazamox dose and liver histopathological alterations (P=<0.0001). Inspection of the score means suggest that compared to the control group, larvae exposed to 5,000 and 75,000 ppb of Imazamox exhibited mild to moderate histopathological alterations in the liver (See Table 5). Similarly, in the Imazamox and Agridex mixture, a mild score mean was observed in the 500 ppb Imazamox / 6,400 ppb Agridex dose, and significant differences were found when compared with the control group (P=0.0043). No significant differences in the lesions score means were observed among treatments with Agridex when compared to the control group in the liver. On the other hand, for muscle tissue, the Imazamox and Agridex mixture induced a mild myodegeneration in the lowest concentration and the 5,000 ppb Imazamox / 64,000 ppb Agridex dose, with significant differences when compared to the control group (P=<0.0001). Conversely, no significant differences in the muscle lesions score means were observed among Imazamox and Agridex doses alone compared with the control group.

Table 5. Histopathology summaries of Delta Smelt larvae exposed to Imazamox and Agridex in a 7 days toxicity test. (Only results with significant differences are shown).

| Treatment | Tissue | Dose (ppb) | Score Mean | P value |
|---|---|---|---|---|
| Imazamox | **Liver** | Control | 1 (Normal) | |
| | | 5,000 | 2-3 (Mild - Moderate) | 0.0006 |
| | | 75,000 | 2-3 (Mild - Moderate) | 0.0005 |
| Imazamox + Agridex | **Liver** | 500+ 6,400 | 2-3 (Mild - Moderate) | 0.0006 |
| Imazamox + Agridex | **Muscle** | 12+113 | 2-3 (Mild - Moderate) | 0.0017 |
| | | 5,000 + 64,000 | 2-3 (Mild - Moderate) | 0.0057 |

## Discussion

Hatching success was significantly inhibited by 21% at the highest concentration of the Imazamox-Agridex mixture and none of the tested chemicals individually had any effect on hatching success. However, mild mean histopathological scores were observed in liver and muscle of recently hatched larvae from embryo exposed to higher concentrations of Penoxsulam, Imazamox, Agridex, and mixtures of Penoxsulam-Agridex and Imazamox-Agridex. Although no published study has investigated the effects of Imazamox-Agridex mixtures on hatching success in any organism, several studies have indicated an inhibitory effect from other herbicide-adjuvant combinations. For example, most of the published literature has investigated formulations containing glyphosate, and have found a similar, though more potent, synergistic effect on hatching success. Marc et al. (2005), tested the effects of Glyphosate (as Roundup) and the adjuvant POEA on hatching and survival of sea urchin embryos and found the adjuvant alone to be the most toxic to embryo hatching. Sparling et al. (2006) tested the effects of terrestrial (not aquatic) applications of Glyphosate (as Glypro®) and the surfactant LI700 on hatching and development of the red eared slider frog. Results showed significant effects from both chemicals on hatching success at the highest test concentrations. Druart et al. (2010) also tested terrestrial

applications of Glyphosate and its formulation Roundup, using snail embryogenesis as the endpoint, and found that the formulation was more toxic than the Glyphosate component alone.

Effects on Delta Smelt larvae survival were different from those on embryo hatching success. There were no significant effects on larvae survival and liver and muscle histopathology in the Penoxsulam-Agridex exposure among either of the chemicals individually or in mixture, however in the Imazamox-Agridex exposure, Imazamox alone caused mild liver and muscle histopathology, Agridex alone had a significant and negative impact on larvae survival but no liver and muscle histopathology, however, effects were mitigated in the mixture with Imazamox. At the highest concentration tested, 64 mg/L, Agridex alone caused 60% mortality, while the mixture containing the same level of Agridex and 62 mg/L Imazamox resulted in an average of 20% mortality and was not significantly different from the control. Previous studies have found much more appreciable effects of other adjuvants and herbicide-adjuvant mixtures on fish survival. Tatum et al. (2011) tested four different adjuvants including Entry II, Hasten, Timberland 90, and Timbersurf 90, as well as numerous herbicide-adjuvant mixtures, using Fathead Minnows (*Pimephales promelas*) and among the 23 different adjuvant and herbicide-adjuvant mixture exposures, twelve caused greater than 50% mortality. Concentrations tested ranged between below 0.1 mg/L up to 27 mg/L, conservatively based on estimated maximum environmental concentrations. Tsiu and Chu (2004) tested for effects of Roundup, its component chemicals, and a common adjuvant, POEA on the water flea, *Ceriodaphnia dubia*. Similar to the current study, the adjuvant was found to be the most toxic among the tested chemicals, with an $LC_{50}$ of 1.15 mg/L. The physiological mechanism of adjuvant and herbicide-adjuvant mixture toxicity is uncertain. Because adjuvants, including Agridex, are made up of a mixture of fatty acids, the physical properties of the oils, rather than a specific toxic mechanism of an active ingredient may be responsible for the resulting effects.

Sub-lethal effects from herbicide and adjuvant mixtures were variable, and some effects occurred at low, environmentally relevant concentrations. Condition factor was the most significantly affected sub-lethal endpoint. Condition factor is an indicator of fish health, where if the factor is low, fish have a lower body mass relative to length and are considered less healthy. Oil globule area was also affected by herbicides, Agridex, and their mixtures, where affected fish most often boasted larger oil globules relative to the controls. Oil globules are present in the yolk sacs of fish larvae after hatching, and are the primary source of energy to fuel growth and development before fish are able to feed. In Delta Smelt, the oil globule is present and utilized for up to 12 dph (Nobriga and Herbold 2009).

The combination of effects on condition factor, oil globule area, and histopathology is useful for characterizing the toxicity of the constituents tested. Effects on oil globule area and condition factor could be positive or negative, depending on the physiological response to the toxicant exposure. Where energy is required to compensate for the effects of a toxicant (including reparation, metabolism and elimination), less energy is available for growth and development, and fish condition suffers (Rowe et al. 2001). Several studies provide evidence that toxicant exposures result in shifts in energy metabolism, causing reductions in growth and ecological fitness (Hagernaars et al. 2008, McPhee and Janz 2014). Exposures to Agridex, individually,

consistently caused decreases in condition factor across both embryo and larvae exposures, and oil globule area was simultaneously decreased in the embryo exposure. Significant reductions in condition factor occurred at Agridex concentrations between 100 - 170 ppb, while concentrations that could occur in the environment immediately after herbicide applications are expected to reach up to 82 ppb (NMFS 2013). Condition factor was decreased by up to 60% at the highest concentrations of Agridex, while the lowest level treatments, between 10 – 25%. These results suggest that Agridex exposures cause an energy-demanding response in Delta Smelt, and that significant effects on fish condition occur at low concentrations, close to levels expected post-application. Table 6 summarizes the inferred mechanisms of toxicity for each herbicide, adjuvant, and mixture based on their combined effects on condition factor and oil globule area.

Table 6. Effects of herbicides and mixtures on condition factor and oil globule area, and conclusions based on the combination of responses in Delta Smelt exposures conducted in 2014, where "NE" = No effect, "-" = negative effect, "+" = positive effect. Negative effects are highlighted.

| Chemical(s) | Life Stage | CF | OGA | Conclusion |
|---|---|---|---|---|
| **Agridex** | Embryo | - | NE | Energy depleted by stress response |
| **Imazamox** | Embryo | NE | NE | No effect |
| **Penoxsulam** | Embryo | + | + | Hormesis |
| **Imazamox + Agridex** | Embryo | + | + | Hormesis |
| **Penoxsulam + Agridex** | Embryo | + | NE | Hormesis |
| **Agridex** | Larvae | - | NE | Energy depleted by stress response |
| **Imazamox** | Larvae | NE | NE | No effect |
| **Penoxsulam** | Larvae | + | NE | Hormesis |
| **Imazamox + Agridex** | Larvae | - | + | Decrease energy metabolism |
| **Penoxsulam + Agridex** | Larvae | NE | NE | Additive response |

Neither herbicide tested, Imazamox or Penoxsulam, caused deleterious sub-lethal effects. Imazamox, individually, caused no significant effects on condition factor or oil globule area in either embryo or larvae exposures. Penoxsulam exposures, however, resulted in an increase in condition factor across both embryo and larvae exposures and a concurrent increase in oil globule area in the embryo exposure only (Table 6). Positive condition factor responses may be demonstrative of hormesis, a physiological reaction to low levels of stress that cause beneficial effects. Penoxsulam did not affect survival or hatching success in Delta Smelt, even at the highest concentrations tested, therefore all concentrations tested could be considered low levels of stress, and the positive effects on fish condition could be the initial phase of the biphasic hormetic dose response. Hormesis is common in toxicology studies (Calabrese and Baldwin 2003), and is found to be especially pervasive among studies testing toxicant effects on organism growth (Stebbing 1982). It is hypothesized that the mechanism of the stimulatory effect of stress on growth is a form of physiological overcompensation following a disruption in homeostasis (Steinberg et al. 2008). An example would be a biosynthetic pathway relying on end product inhibition, that when disrupted by an exogenous chemical, triggers a parallel compensatory response. Toxicological research across multiple species, from plants to vertebrates, support this hypothesis, and Stanley et al. (2013), Schreck (2010), and Steinberg et al. (2008) provide

excellent literature reviews on this topic. Herbicide-Agridex mixture responses in Delta Smelt embryos were also consistent with hormesis. The Imazamox-Agridex mixture caused a significant positive effect on both condition factor and oil globule area, while the Penoxsulam-Agridex mixture caused a positive effect on condition factor only. The specific mechanism of growth stimulation among exposures to Penoxsulam (in embryos and larvae) and herbicide-Agridex mixtures (embryos only) is unknown, however it is clear that the high concentrations tested do not amount to adverse effects on Delta Smelt condition factor or oil globule area.

Herbicide-Agridex mixtures caused different responses in Delta Smelt larvae compared to embryos. The Penoxsulam-Agridex mixture resulted in no significant effects on condition factor or oil globule area, while the Imazamox-Agridex mixture caused a decrease in condition factor but an increase in oil globule area. Both effects largely reflect an additive response between the component chemicals involved. Between Penoxsulam and Agridex, Agridex individually had a negative effect on condition factor and Penoxsulam a positive effect, therefore a lack of response in the mixture is consistent with an additive interaction. Between Imazamox and Agridex, Agridex caused a significant negative response in condition factor and Imazamox did not have an effect, thus a negative effect on condition factor by the mixture is again consistent with an additive response. The Imazamox-Agridex mixture effect on oil globule area, on the other hand, was not additive. While there were no effects on oil globule area from the chemicals individually, the mixture caused a positive effect. The mechanism of this interaction is unclear. An increase in oil globule area over the course of a larval exposure indicates that the energy stores were somehow preserved. Given the concurrent decrease in condition factor, it may be that the Imazamox-Agridex mixture caused energy metabolism to slow in exposed fish as evident by the mild mean liver lesion score. Such effects could occur by inhibiting processes along the metabolic pathway (Escher et al. 2002), however there are many possible targets and it is uncertain which the Imazamox-Agridex mixture affected.

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# Sublethal effects of herbicides penoxsulam, imazamox, fluridone and glyphosate on Delta Smelt (*Hypomesus transpacificus*)


## Abstract

With the widely applied in the field to control aquatic weeds, the residue of herbicides in aquatic environment is a considerable health concern for aquatic organisms. The present study evaluated the sublethal effects of the environmentally relevant herbicides, Penoxsulam, Imazamox, Fluridone and Glyphosate, using Delta Smelt (*Hypomesus transpacificus*), which have been listed as an endangered species. After separately exposed to the 4 herbicides for 6 hours, the concentrations of 17β-estradiol (E2) and glutathione (GSH) in liver, and activity of acetylcholinesterase (AChE) in brain were analyzed. E2 concentrations were significantly increased in both genders by 0.01 mg/L fluridone and in male fish exposed to 0.064, 0.64 and 640 mg/L glyphosate, whereas penoxsulam and imazamox did not have any effect on E2. Significant inhibition of AChE activity was observed in both genders treated with penoxsulam, imazamox, and fluridone, and females were more sensitive than males. All tested concentrations of penoxsulam and imazamox caused a significant reduction in the activity of AChE in females. GSH concentration was decreased in males exposed to fluridone at or higher than 0.83 mg/L and glyphosate at 0.64 mg/L, however no effect was observed in fish exposed to penoxsulam and imazamox. Results indicate that fluridone and glyphosate have the potential to cause endocrine disruption and oxidative damage, whereas penoxsulam, imazamox and fluridone showed neurotoxicity on Delta Smelt after a brief 6 h exposure. The present study suggest the detrimental effects of common used herbicides on Delta Smelt and will help to establish cause–effect relationships in an aquatic environment and consequently to work out the successful management of chemical pollution.



Key words: Penoxulam, imazamox, fluridone, glyphosate, Delta Smelt (*Hypomesus transpacificus*), 17β-estradiol (E2), acetylcholinesterase (AChE), glutathione (GSH)


## Introduction

Over the past two decades, the population of Delta Smelt (*Hypomesus transpacificus*) in the San Francisco Bay Delta (Bay-Delta) has sustained continual declines in abundance, and has been listed as a threatened species by USFWS since 1993. The Bay-Delta is inherently an extremely complex estuarine system, and the dynamics of the system have been altered by anthropogenic inputs, engineering measures to meet the State of California's water demands, climate change, and invasive species. Among the invasive species, the control of aquatic weeds is necessary for the protection of the environment and its beneficial uses. Owing to the effective herbicidal activity, fluridone and glyphosate are widely applied in the Bay-Delta. In addition, two new herbicides, penoxsulam and imazamox, have recently been proposed for use, however, little information is available on the effects of these chemicals on sensitive local species. These chemicals have not been extensively field tested, so there is uncertainty regarding their effects on non−target aquatic organisms, including the endangered Delta Smelt.

Most herbicides commonly used to control aquatic weeds are not lethally toxic to fish at environmentally relevant concentrations; however, sub-lethal effects have been implicated from exposures to multiple commonly used herbicides. Increasing evidence indicates that some herbicides have a hormone-like function and can thus interfere with the endocrine system of aquatic organisms (Sonnenschein and Soto, 1998; Gronen et al., 1999; Mnif et al., 2011; Zhu et al., 2017). For instance, endocrine disruption was observed in Atlantic Salmon (*Salmo salar*), *Xenopus laevis* tadpoles and Rainbow Trout (*Oncorhynchus mykiss*) exposed to atrazine (Nieves-Nieves-Puigdoller et al., 2007; Oka et al., 2008; Salaberria et al., 2009), in adult Zebrafish exposed to butachlor (Chang et al., 2013), and in Jundiá (*Rhamdia quelen*) (Soso et al., 2007) and Zebrafish (*Danio rerio*) (Uren Webster et al., 2014) exposed to glyphosate. To evaluate the effects of endocrine disruption chemicals (EDCs) on fish, changes in 17β-estradiol (E2) concentration has been widely used as an indicator for endocrine disruption (Chang et al., 2013). Altered E2 concentrations as a general response of endocrine disruption have been reported in goldfish (*Carassius auratus*) (Yan et al., 2013), summer flounder (*Paralichthys dentatus*) (Mills et al., 2001), and rare minnow (*Gobiocypris rarus*) (Zhang et al., 2016) after exposure to EDCs. Therefore, the potential function as endocrine disruptors of the herbicides, penoxsulam, imazamox, fluridone and glyphosate, warrant to be further investigated.

Acetylcholinesterase (AChE) activity is inhibited mainly by organophosphates and carbamatos, although some other pesticides can also inhibit its activity (Bradbury et al., 2008; Cattaneo et al., 2011). Inhibition of brain AChE may subsequently cause disruption of nerve function through excessive acetylcholine (ACh) accumulation (Bhattacharya, 1993; Schmidel et al., 2014), and affects growth, survival, and swimming, feeding and reproductive behaviors (Saglio and Trijasse, 1998; Dutta and Arends, 2003). AChE inhibition was reported in Carp (*Cyprinus carpio*) exposed to penoxsulam (Cattaneo et al., 2011; Murussi et al., 2014), in Piava (*Leporinus obtusidens*) exposed to glyphosate (Glusczak et al., 2006) and 2,4-D (Fonseca et al., 2008), and in Rainbow Trout (*Oncorhynchus mykiss*) exposed to imidacloprid (Topal et al., 2017) and linuron (Topal et al., 2016). Brain AChE inhibition appears to be a usual response of fish exposed to chemicals from different classes including herbicides, and is widely used as a biomarker of environmental pollution.

Glutathione, the main non-enzymatic antioxidant in fish, it is widely used as a bioindicator of fish health status due to its ability of scavenging free radicals and its important role as cofactor for several enzymatic antioxidants (glutathione peroxidase and glutathione reductase) and for the glyoxalase system (Regoli and Principato 1995; Livingstone, 2001; Lesser, 2011; Monserrat et al., 2011). Glutathione is also involved in the detoxification of endogenous compounds, as well as xenobiotics, by its participation in reactions mediated by glutathione S-transferase, which catalyze a wide variety of conjugation reactions of glutathione with xenobiotic compounds containing electrophilic centers (Regoli and Principato 1995; Glisic et al., 2015). Previous studies have reported that GSH level can be effected by environmental contaminants such as 2,4-D exposure on goldfish (*Carassius auratus L.*) (Kubrak et al., 2013) and atrazie exposure on catfish (*Rhamdia quelen*) (Mela et al., 2013).

The aim of this study is to assess sublethal effects of the herbicides, penoxsulam, imazamox, fluridone and glyphosate on Delta Smelt by measuring the concentrations of E2 and glutathione in liver, and the activity of acetylcholinesterase in brain. Assessing sublethal effects of herbicides will help to advice environmental agencies regarding which herbicides are safer for non-targeted species such as the endangered Delta Smelt in the San Francisco Estuary.

## Materials and Methods

### *Chemicals*

Penoxsulam (Galleon® SC), imazamox (Clearcast®), and fluridone (Sonar® AS) were obtained from SePRO Corporation (Carmel, IN, USA). Glyphosate (Roundup® Custom) was obtained from Helena Chemical Company (Collierville, TN, USA).

Acetonitrile (HPLC grade) and phosphoric acid (ACS grade) were purchased from Fisher Scientific (Waltham MA, USA) for measuring imazamox concentrations using liquid chromatography. Water (HPLC grade) and imazamox PESTANAL analytical standard (99.9% purity) were purchased from Sigma Aldrich (St. Louis, MO, USA).

### *Fish and exposure tests*

Adult male and female Delta Smelt (451 ± 1 days post hatch) used for the exposure study were raised at the Fish Conservation and Culture Laboratory (FCCL), University of California, Davis. At the FCCL, ambient water from the California Aqueduct was used for fish culture after basic water treatment processes (including solids removal and UV disinfection).

Exposure tests were conducted at the FCCL. Stock solution of the herbicides were prepared based on the percent active ingredient in the commercial formulations. Experimental solutions were prepared on site right before the initiation of the exposure tests by spiking stock solutions in water to get the nominal concentrations shown in Table 1. Prior to the fish exposure, water quality was measured to confirm that spiking of the chemicals did not significantly alter the water quality parameters (i.e. pH, nitrite, nitrate, ammonia, alkalinity, hardness, and conductivity). The quality parameters of FCCL water were as follows: temperature 16.8 ºC, pH 7.78, nitrate < 0.22 mg/L, ammonia < 0.003 mg/L, alkalinity 80 mg/L, hardness 140 mg/L and conductivity 371.55 $\mu S\ cm^{-1}$.

Due to the intense workloads, the exposures were performed in two separate trials; on Day 1, Delta Smelt were exposed to penoxsulam and imazamox, and on Day 2 to fluridone and glyphosate. A control group was included for each trial. Exposures were initiated by placing 10 Delta Smelt (5 females and 5 males) in triplicate per treatment into 15 L of experimental solutions in a 20 L High Density Polyethylene (HDPE) black buckets. During the exposure, fish received continuous aeration and water temperature was maintained at 15.7 ºC by placing buckets in large circular water tanks (5 feet in diameter with 869 L of water for temperature control). For chemical analysis, 40 ml of the experimental solutions were collected from each bucket in 50 mL conical tubes at the initiation and end of exposure trials. The conical tubes were wrapped with aluminum foil and stored at -20 ºC. Exposure lasted for 6 h. At the end of the exposure, fish were euthanized with an overdose of tricaine methane sulfonate (MS222) solution (500 mg/L) and stored in liquid

nitrogen until dissection (Teh et al. 2016). Fish were dissected at the Aquatic Health Program Laboratory, University of California, Davis, following the method described by Teh et al. (2016). Liver tissues were partitioned and used for measuring concentrations of estradiol (E2) and glutathione (GSH). Brain tissue was used for measuring acetylcholinesterase (AChE) activity.

*Chemical analysis*

Concentrations of penoxsulam, fluridone, and glyphosate were measured following the instructions of manufacturer's ELISA kits (Abraxis, Inc, Warminster, PA; Table S1). The experimental solutions (0 and 6 h post-exposure) were analyzed in duplicate for each water sample and averages for the experimental solutions collected in triplicate treatments were used for reporting the data. The absorbance was measured at 450 nm in 96-well plates (CoStar 3370, Corning, NY, USA) using a plate reader (Tecan Infinite M200).

Imazamox was measured by liquid chromatography with a photodiode array detector (LC-PDA) using Surveyor LC, Autosampler, and PDA (Thermo Finnigan, San Jose, USA). The imazamox stock solution was serially diluted to prepare standards with final concentrations of 50, 100, 250, 500, and 1000 µg/L. Prior to the analysis, standards and samples were filtered with 0.22 micron polyethersulfone (PES) filters (Genesee Scientific, San Diego, USA). A 3.5 µm Zorbax SB-C18 4.6 x 100 mm column (Agilent Technologies, Santa Clara, USA) was used with an injection of 15 µL and a constant flow rate of 1.0 mL/min. The mobile phases consisted of acetonitrile (Solvent A) and water with 0.1% phosphoric acid (Solvent B). The mobile phase program started with 0% Solvent A, 100% Solvent B; at 2 min 20% Solvent A, 80% Solvent B; at 6 min 50% Solvent A, 50% Solvent B; at 8 min 80% Solvent A, 20% Solvent B, and finally at 10 min 0% Solvent A, 100% Solvent B. Run time was 11 min. Imazamox was detected at 250 nm with a retention time of 4 min. The analytical software used was Xcalibur (Thermo Fisher Scientific, Waltham, MA, USA). A linear non-weighted external calibration curve was used to quantify imazamox (Figure S1).

*Hepatic 17β-estradiol (E2)*

Concentrations of hepatic 17β-estradiol (E2) were measured using commercially available ELISA kits (Product Number: K030-H5, Arbor Assay, Ann Arbor, MI, USA). Liver tissue was sonicated in 500 µL of 1XPBS then centrifuged at 13,300 × g for 10 min at 4 °C. Supernatants containing E2 and soluble proteins were transferred to clean borosilicate glass tube for E2 extraction. A small portion of liver homogenate (50 µL) was aliquoted and stored at -80 °C to measure protein concentration (DC protein assay, Bio-Rad Laboratories, Hercules, CA, USA). Supernatants in glass tubes were vortexed with 2 mL of dimethyl ether for 2 min, followed by flash freezing in dry ice-ethanol cold bath. While the bottom PBS phase was frozen, the top ether phase containing E2 was transferred into new clean borosilicate glass tube by decantation. Glass tubes were covered in foil and allowed to evaporate in a fume hood overnight. E2 was then reconstituted by adding 70 µL of autoclaved Millipore water (18.2 MΩ•cm) and samples were transferred into amber glass vials and stored at -80 °C. For the analysis, dynamic range of kit was expanded from manufacturer's range; the 100,000 pg/mL E2 stock solution provided by the ELISA kit was used to generate eight standards (0.0024, 0.0098, 0.0195, 0.0391, 0.1563, 0.6250, 2.5 and 10 ng/L). The reaction was performed following the manufacturer's instruction. Absorbance was measured at

450 nm by plate reader (Tecan Infinite M200). E2 concentrations were calculated using four parameter logistic curve fitting (4PL) (http://www.elisaanalysis.com/). E2 data were standardized by concentration of soluble protein and expressed as "pg of E2 per mg of soluble protein".

*Acetylcholinesterase*

Enzymatic activity of acetylcholinesterase (AChE) was measured following the Ellman's method (Ellman et al., 1961). Brains were homogenized by grinding at 4 °C in 0.1 M sodium phosphate buffer (pH 8.0) in a sample weight:buffer volume ratio of 1:50. The AChE assay was carried out using the supernatant resulting from a 10,000 x g centrifugation for 15 min at 4 °C. A reaction cocktail of 125 µl, containing 100 mM sodium phosphate buffer, 5.12 mM 5,5′-dithiobis(2-nitrobenzoic acid), and 25 µl of supernatant, was prepared and incubated at room temperature for 5 min. Then, 25 µl of 75 mM acetylthiocholine iodide were added, and absorbance at 412 nm was measured every 60 sec for 10 min at 25 °C by plate reader (Tecan Infinite M200) using a 96-well plate (CoStar 3370, Corning, NY, USA). AChE activity was normalized to the concentration of protein in the supernatant and reported as "units/mg protein/min". Protein concentration in the supernatants was measured by Lowry method (Lowry et al., 1951) using the Bio-Rad DC Protein Assay (Bio-Rad Laboratories, Hercules, CA, USA).

*Total glutathione*

Concentration of total glutathione (GSH) was measured following the method of Baker et al. (1990). Livers (pools of 5 per replicate) were homogenized by grinding at 4 °C in ice-cold 5% 5-sulfosalicylic acid (1:19 wet weight/vol), followed by incubation for 20 min on ice and centrifugation at 16,300 x g for 10 min at 4 °C. Supernatants were diluted 1:50 in 100 mM $Na_2HPO_4/NaH_2PO_4$ buffer at pH 7.5 containing 1 mM EDTA to obtain a concentration of 0.1% 5-sulfosalicylic acid in sample supernatants. Thereafter, absorbance at 405 nm was measured for 2 min at 15 sec intervals at 25 °C in 150 µL cocktail containing 50 µL sample supernatant, 80 mM $Na_2HPO_4/NaH_2PO_4$ buffer, 0.66 mM EDTA, 0.6 mM DTNB, 0.2 mM NADPH, and 1 unit/mL glutathione reductase. The reaction was run in a microtiter plate reader (Tecan Infinite M200) using a 96-well plate (CoStar 3370, Corning, NY, USA). Concentration of total glutathione was calculated based on a standard curve prepared with known concentrations of reduced glutathione solutions and reported as nmol/mg wet tissue.

*Statistics*

The data were checked for normality using Shapiro-Wilk W test and for homogeneity of variances by the Levene's test, and analyzed by one-way ANOVA with a *post hoc* Dunnett's test. A Welch ANOVA was run for AChE of females in glyphosate experiment since the assumption of homoscedasticity was not fulfilled. Data are shown as mean ± standard error. Significant differences were declared at $P < 0.05$.

## Results

*Chemical concentrations*

Nominal and measured concentrations of penoxsulam, fluridone, and glyphosate by ELISA and Imazamox by liquid chromatography with a photodiode array detector (LC-PDA) are shown in Table 1.

*Acute toxicity*

There were no mortality at the end of 6-hr exposure to penoxsulam, imazamox, fluridone, and glyphosate. However, both female and male fish exposed to three higher concentrations of fluridone were lethargic and swam erratically at the end of the 6 hour exposure. There were no gross anomalies in fish exposed to penoxsulam, imazamox, and glyphosate.

*Hepatic 17-β-Estradiol*

Measured hepatic 17β-Estradiol (E2) concentrations are shown in Fig 1. There were no significant effect on E2 levels in both females and males by Penoxsulam (Penoxsulam females: ANOVA, $F_{[5,12]} = 0.4238$, P=0.8235; and males: ANOVA, $F_{[5,12]} = 2.4535$, P=0.0941; figures 1A and 1B, respectively) and imazamox (Imazamox females: ANOVA, $F_{[5,12]} = 0.4973$, P=0.7726; and males: ANOVA, $F_{[5,12]} = 1.9488$, P=0.1594; figures 1C and 1D, respectively) exposure. However, fluridone exposure had a significant effect on E2 levels of both genders (Female:ANOVA, $F_{[5,12]} = 8.2118$, P = 0.0014; Male: ANOVA, $F_{[5,12]} = 7.1136$, P= 0.0026). A *post-hoc* test revealed that E2 levels of female and male fish exposed to fluridone at the concentration of 0.08 mg/L were significantly higher than that of the control, while all the other treatments showed no significant difference with the control (Dunnett's test, $\alpha = 0.05$) (Figures 1E and 1F). Significant changes on E2 levels were not observed in females after exposed to glyphosate (ANOVA, $F_{[5,12]} = 1.7555$, P = 0.1967); however, significantly increased of E2 concentrations compared with the control were observed in male fish exposed to 0.064, 0.64 and 640 mg/L of glyphosate (ANOVA, $F_{[5,12]} = 6.1678$, P = 0.0047; Dunnett's test, $\alpha = 0.05$) (Figures 1G and 1H).

*Acetylcholinesterase* (AChE)

Brain AChE activity decreased as penoxsulam concentrations increased, and statistically significant differences were observed at all the concentrations tested in females and at the two highest concentrations in males (Females: ANOVA, $F_{[5,\ 17]} = 11.4694$, P = 0.0003; Males: ANOVA, $F_{[5,\ 17]} = 5.1214$, P = 0.0096; figures 2A and 2B). Imazamox also caused a significant reduction in the brain AChE activity at all concentrations tested in females, as well as at the lowest and highest concentrations in males (females: ANOVA, $F_{[5,\ 17]} = 8.7543$, P = 0.0011; males: ANOVA, $F_{[5,\ 17]} = 3.1995$, P = 0.0459; figures 2C and 2D), but no dose-dependent effect was observed. Exposure to fluridone caused a slight inhibition of the AChE activity in female and male fish at the lowest concentration (females: ANOVA, $F_{[5,\ 17]} = 6.5770$, P = 0.0036; males: ANOVA, $F_{[5,\ 17]} = 3.8566$, P = 0.0257; figures 2E and 2F). Glyphosate exposure did not affect the AChE activity (females: ANOVA, $F_{[5,\ 4.9877]} = 3.6584$, P = 0.0907; males: ANOVA, $F_{[5,\ 4.7855]} = 2.1396$, P = 0.2172; figures 2G and 2H).

*Total glutathione*

Significant changes in concentrations of GSH were not observed in fish exposed to penoxsulam (females: ANOVA, $F_{[5,\ 17]} = 0.5370$, P = 0.7450; males: ANOVA, $F_{[5,\ 17]} = 1.2823$, P = 0.3335)

(Figures 3A and 3B) and imazamox (females: ANOVA, $F_{[5, 17]} = 0.2312$, P = 0.9415; males: ANOVA, $F_{[5, 17]} = 2.5147$, P = 0.0885) (Figures 3C and 3D). In males, total glutathione (GSH) concentration decreased as the fluridone concentration increased, and statistically significant differences were found at concentrations at or higher than 0.83 mg/L compared to the control group (ANOVA, $F_{[5, 17]} = 10.9193$, P = 0.0004; figure 3F). Similar dose response trend was observed in females, however the results were not statistically significant (ANOVA, $F_{[5, 17]} = 2.2534$, P = 0.1156; figure 3E). Exposure to glyphosate did not affect the total GSH concentration in females (ANOVA, $F_{[5, 17]} = 1.3986$, P = 0.2926; figure 3G); however, a significant decrease in AChE activity was observed in males exposed to 0.64 mg/L glyphosate (ANOVA, $F_{[5, 17]} = 3.3224$, P = 0.0410; figure 3H).

## Discussion

Herbicides can enter into aquatic systems through accidental overspray, surface runoff and transport through air, and can be detected extensively in water in many countries (Zhang et al., 2016). For instance, Coupe et al. have reported that 0.009–0.86 % of glyphosate enters the surface water after application (Coupe et al., 2012) and glyphosate has an aquatic half-life of 7-14 days (Giesy et al., 2000). Therefore, the application of herbicides in the field may adversely affect health of aquatic organisms. The present work evaluated the hepatic concentrations of E2 and glutathione and the activity of brain acetylcholinesterase after acute 6h exposure to penoxsulam, imazamox, fluridone and glyphosate, which are actively sprayed in the SFE for controlling invasive aquatic plants.

Penoxsulam and imazamox exhibited no estrogenic effects on Delta Smelt since 17β-estradiol (E2) concentration in the liver was not altered by the 6 h exposure to these two chemicals. In contrast, Fluridone and Glyphosate elevated 17β-estradiol levels in liver after 6 h exposure. Elevation of E2 production is a strong evidence of endocrine disruption, since E2 is a primary sex hormone which regulates maturation of female Delta Smelt (Kurobe et al., 2016). In our study, increased E2 level was observed in both female and male fish exposed to 0.08 mg/L of fluridone and male fish exposed to 0.064, 0.64 and 640 mg/L of glyphosate, indicating the potential estrogenic effect of fluridone and glyphosate on Delta Smelt at the environmentally relevant concentration. In accordance with the current study, previous studies have reported that glyphosate has endocrine disruption effect and showed reproductive toxicity in Jundia (*Rhamdia quelen*) (Soso et al., 2007) and Zebrafish (*Danio rerio*) (Uren Webster et al., 2014). Elevation of E2 is particularly concerning, as it can disturb the balance of endocrine system thus leading to the impairment of reproductive performance, including decreased fecundity and fertility, suppressive sexual behavior, and altered the sexual differentiation. Such adverse effects on reproductive system by EDCs have been increasingly reported recently. Aravindakshan et al. (2004) reported that spottail shiner (*Notropis hudsonius*) in the river contaminated by xenoestrogen showed decreased sperm concentrations and motility parameters, and displayed intersex. Sária et al. (2013) and Depiereux et al. (2014) reported that chronically exposed to environmentally relevant concentrations of ethynylestradiol (EE2) induced misplaced oocytes and decreased oocyte volume in pipefish (Sária et al., 2013), caused intersex gonad (ova-testis) development and sexual inversion in Rainbow Trout (Depiereux et al. 2014). Similar reproductive system disruption caused by EDCs was also observed in Japanese Medaka (*Oryzias latipes*) (Gronen et al., 1999; Kang et al., 2002; Scholz et

al., 2000). Therefore, as widely applied in the field, the potential reproductive toxicity caused by fluridone and glyphosate should draw an attention, and need to be thoroughly understood.

It is interesting that the pattern of E2 level by fluridone exposure showed an non-monotonic dose response effect which was consistent with a study on rare minnow (*Gobiocypris rarus*) (Zhang et al., 2016), where U-shaped or inverted U-shaped dose response effects were observed on whole body sex hormone (17β-estradiol, testosterone and 11-Ketotestosterone) and vitellogenin (Vtg) levels after exposed to bisphenol A (BPA), typical of many hormones and toxic compounds (Calabrese, 2008; Gentilcore et al., 2013; Zhang et al., 2014). Non-monotonic dose responses are not unusual in studies involving endocrine disrupting effects (Vandenberg et al. 2012). This may be because of the dual actions as an estrogen agonist and antagonist of fluridone. The mechanisms of competing and interacting pathways of environmentally produced estrogen-like pollutants are more complex than expected (Hiroi et al., 1999). Chemicals can directly and indirectly affect estrogen levels by direct binding to and activate various hormone receptors (Mnif et al., 2011), or through interfering estrogen breakdown or synthesis pathways. Negative feedback regulation of production could also affect E2 level, which can cause 17β-estradiol levels to decrease at higher levels of chemical exposure (Lagarde et al. 2015). This may also interpret that E2 level in male Delta Smelt was also non-monotonic dose responses by glyphosate exposure where elevated E2 level was only observed in 0.064, 0.64 and 640 mg/L of glyphosate treated fish.

Penoxsulam, imazamox, and fluridone but not glyphosate caused inhibition of brain AChE activities. AChE is an enzyme that catalyzes the breakdown of acetylcholine, an important neurotransmitter in the central and peripheral nervous systems. Levels of brain neurotransmitters correlate with behavioral states, therefore it is likely that pollutant-induced neurological dysfunction results in behavioral changes in fish (Scott and Sloman, 2004). Sandahl et al. (2005) reported that exposure of Coho Salmon to chlorpyrifos caused a significant inhibition of brain AChE activity, which was significantly correlated to reduction of spontaneous swimming and feeding activities. Changes in swimming and feeding behavior were found at AChE inhibition as low as 23 % (Sandahl et al., 2005). Similarly, Beauvais et al. (2000) showed that inhibition of brain AChE at levels similar or higher than the ones observed in this study (20-40%) negatively affected swimming speed and distance in larval Rainbow Trout (*Oncorhynchus mykiss*) by exposure to Diazinon and Malathion. In Japanese Medaka, exposure to Chlorpyrifos significantly inhibited brain AChE activity (~50-80%), which was highly correlated to decreased swimming speed (Khalil et al., 2013). Although abnormal behavior was not observed in the penoxsulam and imazamox treatment groups during the 6 h exposure, consequences of Delta Smelt exposure to these herbicides, particularly by extended exposure (e.g. chronic exposure), are still unknown and may impair swimming performance or feeding behavior of Delta Smelt.

It is noteworthy that we observed more pronounced inhibition of AChE activity in females than males exposed to penoxsulam and imazamox. AChE activity was decreased 20.1-38.3% in females in all the penoxsulam concentrations, while in males the activity of AChE decreased (reduction of 28.1-28.4%) only at the two highest concentrations. Imazamox exposure also decreased the activity of AChE in females at all the concentrations tested, while in males the enzyme activity was significantly affected only at the lowest and highest concentrations. Sex differences of AChE activity in response to pollutants have been reported. In Japanese Medaka, El-Alfy et al (2001) showed that muscular AChE was more strongly inhibited in females than males after exposure to

Aldicarb. Additionally, in *Carassius auratus*, it was shown that AChE from females was considerably more sensitive to inhibition by carbamates, and that its activity was recovered more quickly than in males (Yi et al 2006). These results suggest that sex difference could play a role in the response of Delta Smelt to neurotoxic substances that inhibit AChE activity. However, further studies are needed to elucidate the mechanisms behind the gender differences observed in this study.

The acute exposure to fluridone and glyphosate caused a consumption of hepatic glutathione (GSH) while such response was not observed in exposure to penoxsulam and imazamox. The depletion of GSH content can result in cell degeneration, differentiation, and proliferation leads to an increase susceptibility to oxidative stress implicated in the progression of cancer (Zhang et al., 2008). GSH not only play a crucial role in antioxidant defense by free radical scavenging, but also severs as a cofactor for glutathione s-transferase which facilitates the removal of certain chemicals. Thus, the change in GSH level has been widely used as an important indicator of detoxification ability of organisms (Cheung et al., 2001; Stara et al., 2012). GSH level in aquatic organisms can be altered by pollutants in different tissues which have been reported in numerous studies. 30-50% reductions of glutathione were found in Blue Mussel (*Mytilus edulis*) from fields and mesocosms (Suteau et al., 1988), and in *M. galloprovincialis* exposed to copper (Viarengo et al., 1990). Zhang et al reported that GSH content showed a reduction in brain in Chinese rare minnow (*Gobiocypris rarus*) exposed to hexabromocyclododecane (HBCDD) (Zhang et al., 2008). After exposed to 100ug/L of atrazine, the GSH level decreased in liver of Catfish (*Rhamdia quelen*) (Mela et al., 2013). In the present study, the GSH content declined in female Delta Smelt exposed to fluridone at or higher than 0.83 mg/L and glyphosate at 0.64 mg/L. The depletion of GSH may be caused by consumption in detoxication processes of fluridone and glyphosate or by increased production of ROS as GSH scavenges free radicals (Bamela and Richard, 1994). To sum up, our results indicate that GSH depletion caused by fluridone and glyphosate may compromise detoxification of other pollutants and endobiotics that require conjugation with glutathione in the second phase of biotransformation, and that fish may be more prone to oxidative damage by other pollutants or environmental factors since GSH is the main non-enzymatic antioxidant.

***Summary***

According to our results of hepatic E2 and GSH concentrations in adult Delta Smelt, penoxsulam and imazamox seem to be safer, and less likely to cause severe adverse effects on the reproductive performance and concentration of glutathione of Delta Smelt, compared to fluridone and glyphosate, since increased levels of hepatic E2 and depletion of GSH were observed in Delta Smelt by glyphosate and fluridone, even after just 6 hour exposure. However, the present results indicate that penoxsulam, imazamox and fluridone are potential neurotoxicants which may negatively affect swimming ability of Delta Smelt by chronic exposure because activity of brain acetylcholinesterase (AChE) was reduced by these herbicides. Although abnormal behavior was not observed in adult Delta Smelt by the 6 h acute exposure study, it is possible that fish may behave differently by extended exposure period. The present study helps to establish cause–effect relationships and consequently to detect a biologically relevant and statistically significant difference among herbicides toxicities for the successful management of chemical pollution to protect the endangered Delta Smelt in the San Francisco Estuary. However, to thorough understanding the

sublethal effects of penoxsulam, imazamox, fluridone and glyphosate, the fate of Delta Smelt by chronically exposure and the application volume and period of the herbicides may need to be somehow evaluated, since endocrine disruption and any other adverse effects can be enhanced by extended exposure period.

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Table 1. Nominal and measured concentrations of penoxsulam, imazamox, fluridone, and glyphosate.

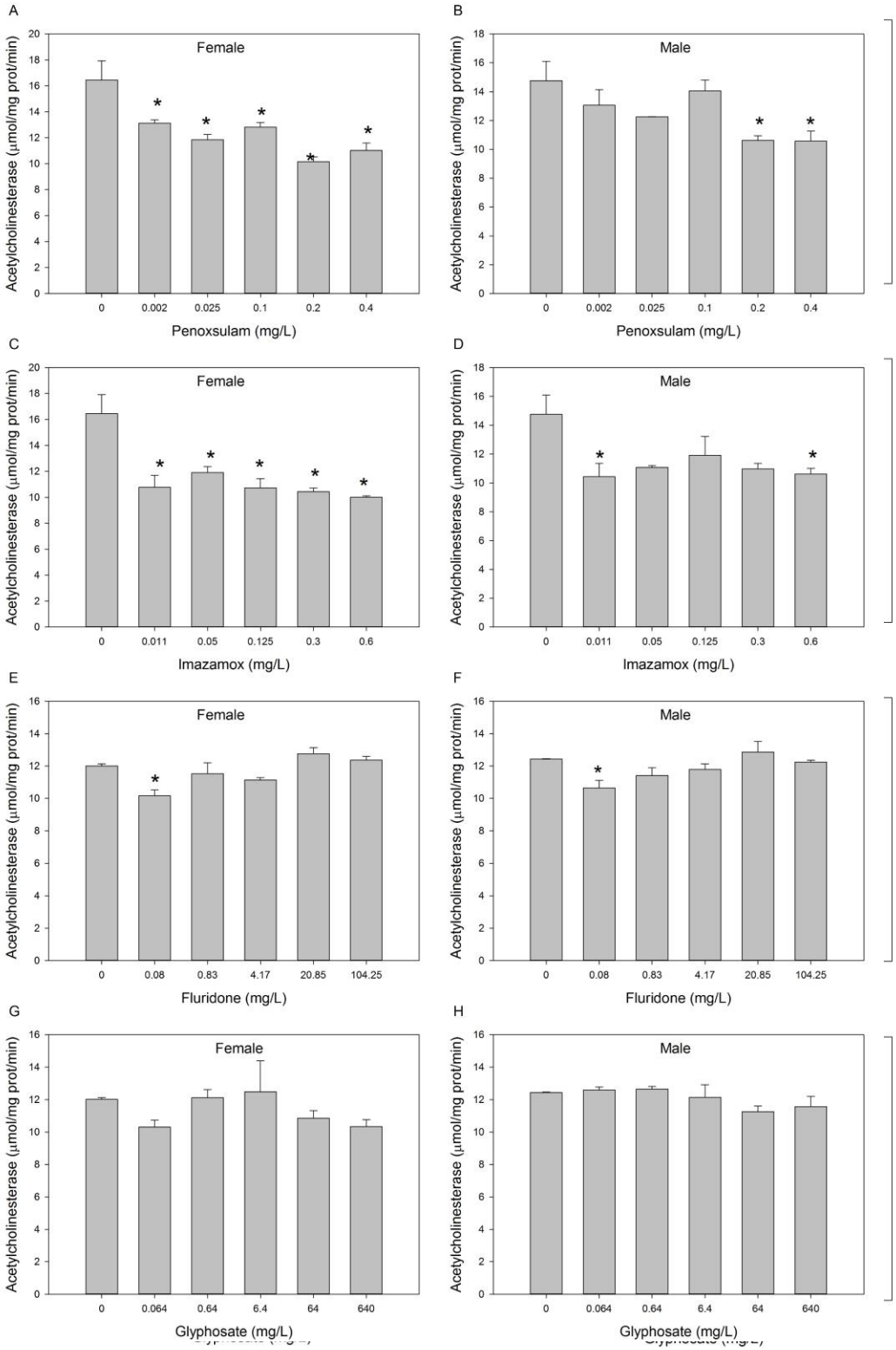
| Herbicide/Treatment | Nominal concentration (mg/L) | Measured concentration (mg/L) | Standard deviation |
|---|---|---|---|
| *Penoxsulam* | | | |
| Control | 0 | 0.000384 | 0.00027 |
| 1 | 0.002 | 0.00307 | 0.00076 |
| 2 | 0.025 | 0.0436 | 0.0132 |
| 3 | 0.1 | 0.132 | 0.0226 |
| 4 | 0.2 | 0.22 | 0.0141 |
| 5 | 0.4 | 0.425 | 0.0177 |
| *Imazamox* | | | |
| Control | 0 | Below LOQ* | Below LOQ |
| 1 | 0.011 | Below LOQ | Below LOQ |
| 2 | 0.05 | 0.0457 | 0.0056 |
| 3 | 0.125 | 0.1283 | 0.0197 |
| 4 | 0.3 | 0.2266 | 0.0202 |
| 5 | 0.6 | 0.6456 | 0.0087 |
| *Fluridone* | | | |
| Control | 0 | 0 | 0 |
| 1 | 0.08 | 0.0665 | 0.012 |
| 2 | 0.83 | 0.7285 | 0.0746 |
| 3 | 4.17 | 2.045 | 1.503 |

| | | | |
|---|---|---|---|
| 4 | 20.85 | 9.70** | 7.88 |
| 5 | 104.25 | 27.9** | 54 |
| *Glyphosate* | | | |
| Control | 0 | 0.000399 | 0.00028 |
| 1 | 0.064 | 0.11 | 0.0325 |
| 2 | 0.64 | 0.755 | 0.0813 |
| 3 | 6.4 | 9.31 | 2.06 |
| 4 | 64 | 104 | 28.3 |
| 5 | 640 | 831 | 135 |

* The concentrations of imazamox were below detection limit of quantification (LOQ) by the LC-PDA.

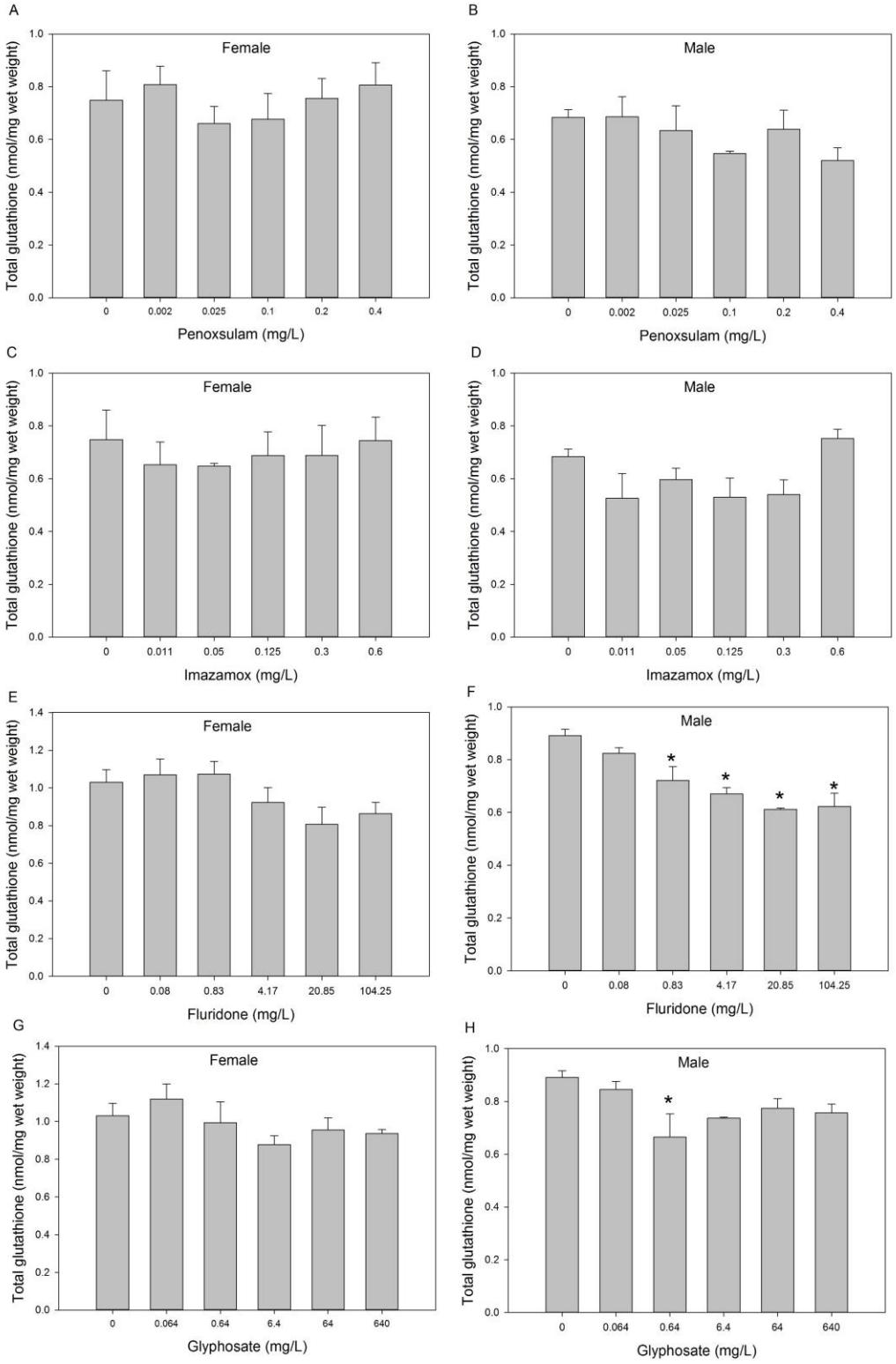
** Measured fluridone concentrations were not reliable because of precipitated.

Figure 1. Hepatic 17β-Estradiol (E2) concentration of females (A, C, E, and G) and males (B, D, F, and H) adult Delta Smelt exposed to penoxsulam (A and B), imazamox (C and D), fluridone (E




and F), and glyphosate (G and H) for 6 h. Each bar represents the mean ± SE of three replicates. The data were collected from 5 fish per replicate. Asterisks (*) indicate statistical differences from control group by one-way ANOVA with a post hoc Dunnett's test ($P < 0.05$).

Figure 2. Brain acetylcholinesterase activity in females (A, C, E, and G) and males (B, D, F, and H) Delta Smelt exposed to penoxsulam (A and B), imazamox (C and D), fluridone (E and F), and glyphosate (G and H) for 6 h. Each bar represents the mean ± SE of three replicates. Data were




collected from 5 fish per replicate. Asterisks (*) indicate statistical differences from control group (0 mg/L) by one-way ANOVA with a post hoc Dunnett's test ($P < 0.05$).

Figure 3. Concentration of total glutathione in liver of females (A, C, E, and G) and males (B, D, F, and H) adult Delta Smelt exposed to penoxsulam (A and B), imazamox (C and D), fluridone (E and F), and glyphosate (G and H) for 6 h. Each bar represents the mean ± SE of three replicates.

The data were collected from 5 fish per replicate. Asterisks (*) indicate statistical differences from control group by one-way ANOVA with a post hoc Dunnett's test ($P < 0.05$).

Table S1. Dynamic ranges of ELISA kits for penoxsulam, fluridone, and glyphosate.

| Herbicide | Dynamic range (mg/L) | Product number* |
|---|---|---|
| Penoxsulam | 0.0025 - 0.010 | 500501 |
| Fluridone | 0.0005 - 0.015 | 50051 |
| Glyphosate | $0.075 \times 10^{-3}$ - 0.004 | 500086 |

* Abraxis, Inc (http://www.abraxiskits.com/)

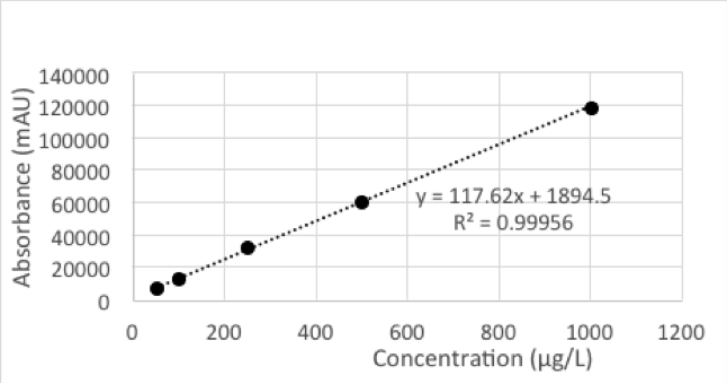



Figure S1. Standard curve for imazamox quantification by LC-PDA.

# 2017 TOXICITY STUDY

## Draft Final Report to the Department of Parks and Recreation, Division of Boating and Waterways

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September 22, 2017

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# Contents


List of Tables and Figures ..... 2
Tables ..... 2
Figures ..... 3
Executive Summary ..... 4
Toxicity Study ..... 4
Carfentrazone-ethyl (Stingray EW) ..... 4
Fluridone (Sonar AS) ..... 4
Endothall (Aquathol K) ..... 5
Glyphosate (Roundup Custom) ..... 5
Imazamox (Clearcast) ..... 5
Flumioxazin (Clipper) ..... 5
Imazapyr (Habitat) ..... 6
Topramezone (Oasis) ..... 6
SX-1552 (Procellacor/SLF-9522) ..... 6
Cygnet Plus non-ionic surfactant ..... 6
Tank Mixes ..... 7
Feeding Study ..... 7
Introduction ..... 9
Materials and Methods ..... 9
Toxicity Study ..... 9
Chemicals ..... 9
Water Quality ..... 10
Inland Silverside ..... 10
Rainbow Trout ..... 11
Fathead Minnow ..... 12
*Ceriodaphnia dubia* ..... 12
Statistics ..... 13
Feeding Study ..... 13
Biocontrol Agents ..... 13
Delta Smelt ..... 14
Rainbow Trout ..... 15
RNA/DNA Analysis ..... 15

Results ..... 15
Toxicity Study ..... 16
Inland Silverside ..... 16
Rainbow Trout ..... 17
Fathead Minnow ..... 19
*Ceriodaphnia dubia* ..... 20
Feeding Study ..... 22
Delta Smelt ..... 22
Rainbow Trout ..... 23
Discussion, Conclusions, and Recommendations ..... 25
Toxicity Study ..... 25
Carfentrazone-ethyl (Stingray EW) ..... 25
Fluridone (Sonar AS) ..... 25
Endothall (Aquathol K) ..... 26
Glyphosate (Roundup Custom) ..... 27
Imazamox (Clearcast) ..... 28
Flumioxazin (Clipper) ..... 28
Imazapyr (Habitat) ..... 30
Topramezone (Oasis) ..... 30
SX-1552 (Procellacor/SLF-9522) ..... 30
Cygnet Plus non-ionic surfactant ..... 30
Tank Mixes ..... 31
Feeding study ..... 32
Literature Cited ..... 33

## List of Tables and Figures

### Tables

Table 1. Herbicides, adjuvants and tank mixes ..... 9
Table 2. Feeding study test treatments ..... 14
Table 3. Summary of results for acute 96-hour Inland Silverside toxicity tests examining the toxicity of herbicides and adjuvants ..... 16

Table 4. Summary of survival and associated effect concentration data for chronic 7-day Inland Silverside toxicity tests examining the toxicity of herbicides and adjuvants..... 16

Table 5. Summary of growth and associated effect concentration data for chronic 7-day Inland Silverside toxicity tests examining the toxicity of herbicides and adjuvants..... 17

Table 6. Summary of results for acute 96-hour Rainbow Trout toxicity tests examining the toxicity of herbicides and adjuvants..... 17

Table 7. Summary of survival and associated effect concentration data for chronic 7-day Rainbow Trout toxicity tests examining the toxicity of herbicides and adjuvants..... 18

Table 8. Summary of growth and associated effect concentration data for chronic 7-day Rainbow Trout toxicity tests examining the toxicity of herbicides and adjuvants..... 18

Table 9. Summary of results for acute 96-hour Fathead Minnow toxicity tests examining the toxicity of herbicides and adjuvants..... 19

Table 10. Summary of survival and associated effect concentration data for chronic 7-day Fathead Minnow toxicity tests examining the toxicity of herbicides and adjuvants..... 19

Table 11. Summary of growth and associated effect concentration data for chronic 7-day Fathead Minnow toxicity tests examining the toxicity of herbicides and adjuvants..... 20

Table 12. Summary of results for acute 96-hour *Ceriodaphnia dubia* toxicity tests examining the toxicity of herbicides and adjuvants..... 20

Table 13. Summary of survival and associated effect concentration data for chronic 6-8 day *Ceriodaphnia dubia* toxicity tests examining the toxicity of herbicides and adjuvants.... 21

Table 14. Summary of reproduction and associated effect concentration data for chronic 6-8 day *Ceriodaphnia dubia* toxicity tests examining the toxicity of herbicides and adjuvants..... 21

## Figures

Figure 1. Photo of adult Weevil, and larval and adult Planthoppers used in the Feeding Study..... 14

Figure 2. 240 DPH Delta Smelt with empty stomach (arrow) and large amount of abdominal fat (arrowheads)..... 22

Figure 3. Many planthoppers in intestine (arrows) of juvenile Rainbow Trout..... 23

Figure 4. Weevil in stomach (arrow) and intestine (arrowheads) of juvenile Rainbow Trout..... 24

Figure 5. Graph depicting RNA/DNA ratios of Rainbow Trout in the Feeding Study..... 24

# Executive Summary

In order to support the upcoming Biological Opinion, the Department of Parks and Recreation, Division of Boating and Waterways (DBW) has contracted with the Aquatic Health Program Laboratory to conduct toxicity testing. The goals of this project are two-fold: 1) Conduct toxicity testing using Inland Silverside (*Menidia beryllina*), Rainbow Trout (*Oncorhynchus mykiss*), Fathead Minnow (*Pimephales promelas*) and the water flea *Ceriodaphnia dubia*, for new herbicides and adjuvants for the Floating Aquatic Vegetation Control Program (FAV) and Submersed Aquatic Vegetation Control Program (SAV).; and 2) Conduct feeding studies using Rainbow Trout and Delta Smelt (*Hypomesus transpacificus*) for the biocontrol agents mottled water hyacinth weevil (*Neochetina eichorniae*) and planthopper (*Megamelus scutellaris*).

## Toxicity Study

Toxicity evaluations were conducted on nine herbicides, one non-ionic surfactant, and three tank mixes. Herbicide and adjuvants were tested in formulation, with test concentrations calculated from the percent active ingredient of each formulation. Tank mixes were tested at maximum label application concentrations, and for those used with FAV, the non-ionic surfactant Agridex was added at maximum concentration (2.5% vol/vol) per mix. Chemical toxicity testing was conducted using a 50% serial dilution series, with a maximum test concentration of 100,000 ppb. Generally, herbicide and adjuvant test evaluations were conducted on the pure formulated product without dilution. Tank mixes utilized the formulations diluted with distilled water in order to match the lowest concentrations tested; in addition these stock solutions were used in instances where test concentrations were too low to use the formulated product without dilution. Certificates of analyses and chemical concentration confirmations were obtained for all formulated products prior to testing. At test initiation, sub-samples of all chemical concentrations for each test were collected and archived for future chemical analyses. Thus, the data provided herein is based on nominal values.

Toxicity tests with Inland Silverside, Rainbow Trout, Fathead Minnow, and Ceriodaphnia dubia, followed acute and chronic protocols outlined in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (5th ed., USEPA 2002), *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms* (3rd ed., USEPA 2002), *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (4th ed., USEPA 2002), and "Rainbow Trout (*Oncorhynchus mykiss*) and Brook Trout (*Salvelinus fontinalis*) 7-day Survival and Growth Test Method" (Lazorchak and Smith 2007) with modifications.

### Carfentrazone-ethyl (Stingray EW)

This herbicide elicited the most toxic effects across all species tested. LC50 data ranged from 276.3 ppb (acute 96-hr *C. dubia*) to 2,819 ppb (chronic 7-day Inland Silverside). Moreover, the chronic sac-fry stage Rainbow Trout had an LC50 of <195.3 ppb, which was the lowest concentration tested.

### Fluridone (Sonar AS)

LC50s generated differed among species, with *C. dubia* being the most sensitive to this herbicide. Conversely, the Fathead Minnow exhibited far less sensitivity, with a chronic 7-day LC50 of 29,440 (23750-42810) ppb and an acute 96-hour LC50 of >31,250, the highest concentration tested. The chronic sac-fry Rainbow Trout 7-day LC50 also exceeded the highest test concentration, 62,500 ppb.

## Endothall (Aquathol K)

Test organisms were relatively insensitive to this herbicide The exception to this is the Inland Silversides, which had an acute 96-hour LC50 of 15,350 (13830-15840) ppb, and a chronic 7-day LC50 of 15,360 (13710-15840) ppb. Acute 96-hour *C. dubia* LC50 of 38,560 (33440-56870) ppb and chronic LC50 of 33,760 (32070-53180) were similar to those of Inland Silversides, however the *C. dubia* reproductive endpoint was very sensitive to endothall, with a calculated EC25 of 13.94 (11.93-18.05) ppb, as the NOEC was below 3,125 ppb, the lowest concentration tested.

## Glyphosate (Roundup Custom)

This particular formulation of Roundup contains a mixture of glyphosate and water, with no adjuvant added to the product. Inland Silversides were the only test organism to exhibit adverse effects with this herbicide, with an acute 96-hr LC50 of 42,610 (32040-64230) ppb, a chronic LC50 of 71,540 (68700-76580), and a growth EC25 of 57,800 (28580-NA) ppb.

## Imazamox (Clearcast)

Test organism sensitivity varied across species and test protocol. Acute and chronic Inland Silverside, acute Rainbow Trout, acute Fathead Minnow, and the chronic *C. dubia* tests all had LC50s greater than the highest test concentration of 100,000 ppb. Chronic Inland Silversides had a growth EC25 of 58,740 (28580-NA), and chronic *C. dubia* had a reproduction EC25 of 16,080 (10650-19490) ppb, which is the lowest response observed in any species. LC50 sensitivities ranged from 71,630 (46330-108100) ppb for acute 96-hr *C. dubia*, to 33,210 (30470-35050) ppb for the chronic Fathead Minnow. The chronic LC50 for the chronic sac-fry Rainbow Trout was 83,310 (4252-129000) ppb; however the growth EC25 was greater than 100,000 ppb, the highest concentration tested.

## Flumioxazin (Clipper)

All of the organisms tested exhibited reduced responses with this herbicide. The sub-lethal endpoints of growth and reproduction were a more sensitive indicator than the survival endpoint. Interestingly, acute and chronic survival LC50s were generally similar to each other within the same species tested. For instance, acute and chronic survival LC50s for the Fathead Minnow were 58,670 (42170-65590) ppb and 56,610 (43440-64030) ppb, respectively. However, in comparison, the Fathead Minnow growth EC25 dropped dramatically to 8,780 (NA-13450) ppb. A similar pattern was observed with the acute and chronic Rainbow Trout survival LC50s, of 27,230 (10800-16940) ppb and 17,810 (7603-42030) ppb, respectively, with a chronic growth EC25 of 642.8 (NA-41330) ppb. Less so, the acute and chronic Inland Silversides had survival LC50s of 60,960 (53230-67180) ppb and 44,160 (39320-49560) ppb, respectively, with a growth EC25 of 27,970 (NA-39000) ppb. *C. dubia* exhibited an inverse dose response in the chronic toxicity tests. This inverse dose response pattern was absent from the acute test (96-hr LC50 of 87,060 ppb), which is noteworthy as the test waters were batched and split between acute and chronic tests. Test organisms in the chronic test exhibited 100% mortality in all flumioxazin test treatments except the top two highest concentrations of 50,000 and 100,000 ppb, which had 80% and 90% survival, respectively. However, animals in those test concentrations did not produce any neonates, which generated an EC25 of <3,125 ppb, the lowest concentration tested. Although the dominant route of flumioxazin for *C. dubia* is likely through direct uptake from water column, *C. dubia* may also be exposed to toxic levels of flumioxazin via food ingestion. At this time we do not have a definitive explanation for this response. Our results could possibly be due to the differences in acute and chronic *C. dubia* protocols. Acute protocols have a reduction in feeding, where test organisms are fed prior to test

initiation, and again two hours before water renewal at the 48-hr time point. This reduces the chances of chemicals binding to food during the test. In comparison, organisms in the chronic *C. dubia* test are exposed to food daily, as food is added to the test renewal waters. Flumioxazin is listed as having 'moderate mobility' with a mean $K_{oc}$ of 557, and is expected to bind moderately to soil with more organic material (Thurston County Health Department 2014). It is possible that the food (a mixture of green algae, trout chow, alfalfa, and yeast) added to the test chambers of the chronic test acted as organic material that the flumioxazin could then bind to, becoming more bioavailable to the test organisms as they feed. If this were the case, *C. dubia* in the lower test concentrations may have eaten more food than those in the higher test concentrations, and therefore exhibited higher mortality by being further exposed to the flumioxazin. Test organisms in the higher test treatment concentrations could have already been weakened by the higher flumioxazin test concentrations or have sensed the presence of the chemical in the water, which may have reduced their ability to feed, or avoid the food, and thus be exposed to less flumioxazin in the water column if it were bound to the food particles. However, we were unable to find any supporting evidence for this in the literature.

### Imazapyr (Habitat)

Imazapyr was one of the least toxic to all species tested, as we were unable to generate any effect concentration data for any survival LC50 endpoint, as all test organisms did not exhibit any reduced responses up to and including the highest test concentration of 100,000 ppb. The only sub-lethal response was observed in the chronic *C. dubia* test, with a reproduction EC25 of 67,190 (25160-72730) ppb.

### Topramezone (Oasis)

Topramezone was the other least toxic herbicide tested during this study. There were no adverse effects observed in any species in any endpoint. All effect concentration data exceeded the highest test concentration of 100,000 ppb.

### SX-1552 (Procellacor/SLF-9522)

*C. dubia* was the species most sensitive to SX-1552, as all fish species tested had effect concentration data that exceeded the highest test concentration of 100,000 ppb. The 96-hr LC50 for *C. dubia* is 68,040 (62920-70270) ppb, while the chronic LC50 was > 100,000 ppb, with a reproductive EC25 of 20,100 (14170-26010) ppb.

### Cygnet Plus non-ionic surfactant

Test organisms were generally sensitive to this adjuvant, more so than most of the herbicides evaluated in this study. Acute and chronic Inland Silverside survival LC50s were 8,839 (8839-8839) ppb and 8,505 (7865-9039) ppb, respectively, with a growth EC25 of >6,250 ppb, indicating that fish in concentrations above 6,250 ppb exhibited 100% mortality prior to 96-hr, and that surviving Inland Silversides did not exhibit a reduction in weight. Acute and chronic Fathead Minnow survival LC50s were similar as well, with 58,670 (42170-65590) ppb and 12,380 (11050-13860) ppb, respectively, with a growth EC25 of 7,640 (6208-10340) ppb. The acute 96-hr Rainbow Trout LC50 is 8,800 (8672-8862) ppb, however we were only able to generate a 48-hr LC50 in the chronic sac-fry Rainbow Trout test, as all test organisms exposed to Cygnet Plus NIS exhibited 100% mortality prior to 96-hr. That 48-hr survival LC50 is 9,396 (8504-13140), and its associated EC25 is >3,125 due to the high mortality of test organisms by 96-hr. *C. dubia* exhibited 100% mortality prior to 96-hr in both the acute and chronic test protocols. We were able to generate a 24-hr acute LC50 of 3,125 (NA-5196) ppb, with an associated 24-hr NOEC of 3,125

ppb and a LOEC of 6,250 ppb. In the chronic *C. dubia* test, organisms exhibited 100% mortality within 24-hr of test initiation, therefore we are unable to generate effect concentration, as it is < 3,125 ppb, the lowest concentration tested.

### Tank Mixes

The herbicide concentrations of imazamox, carfentrazone, glyphosate, and flumioxazin used in the Tank Mixes are lower than the LC50 concentrations determined in current study. The exception to this is Endothall, where the maximum application concentration is 5,000 ppb. This concentration had little effect on the survival effect concentration for the majority of the species tested. However, it should be noted that 5,000 ppb was the NOEC for both acute and chronic Inland Silversides, as well as the growth EC25 threshold for the chronic Inland Silversides. The growth NOEC for the Fathead Minnows was 3,125 ppb, which is lower than the 5,000 ppb endothall included in the tank mixes. Moreover, the chronic *C. dubia* reproductive EC25 was 31.94 ppb for this chemical, which is well below the concentration of endothall added to the tank mixes. The results of current study indicate that survival of Inland Silverside, Rainbow Trout, and Fathead Minnow were not negatively affected by the Tank Mixes in the acute and chronic tests. These Tank Mixes also did not have any negative effects on Inland Silverside and Rainbow Trout growth. In comparison, the Fathead Minnow growth endpoint was sensitive to the Tank Mixes of [fluridone + endothall], as well as [glyphosate + flumioxazin + Agridex NIS], where we saw statistically significant reductions in this endpoint when Fathead Minnows were exposed to these Tank Mixes.

*C. dubia* were the most sensitive to the Tank Mixes, with statistically significant reductions in 96-hr survival in organisms exposed to [Imazamox + carfentrazone + Agridex NIS] and [glyphosate + flumioxazin + Agridex NIS], yet this endpoint was unaffected by the [fluridone + endothall] mix. The *C. dubia* chronic reproductive endpoint was the most susceptible to the Tank Mixes, as this endpoint was statistically significantly reduced in response to all the Tank Mixes tested.

While surfactants are usually suggested as the most toxic component of herbicide tank mixes than the active ingredient (Giesy et al. 2000), we cannot definitively make that same claim with the current study, as the addition or absence of the adjuvant had little impact on the toxicity of the Tank Mixes tested. In instances where we saw statistically significant reductions in a sub-lethal endpoint, such as growth and/or reproduction, these generally occurred regardless of whether an adjuvant was included in the mix. Despite limited information from the tank mixes study, results of the current study suggest no additive effects of [500 ppb imazamox + 74 ppb carfentrazone-ethyl + Agridex NIS], [90 ppb fluridone + 5,000 ppb endothall], and [90 ppb glyphosate + 45 ppb flumioxazin + Agridex NIS] on the three fish species, but there may possibly be an additive or synergistic effect on *C. dubia,* since this species was most affected by these mixes. Currently, at this time there is limited information for us to draw further conclusions on the tank mixes. As these Tank Mixes were set at the maximum field application limits, and not at the concentrations currently in place with DBW SAV and FAV control programs, the data provided herein can be considered as a 'worst case scenario' if maximum field concentrations are reached. However, as there is such limited information regarding tank mix toxicity, as well as mixture effects and adjuvant synergism in the literature, we recommend additional studies to further examine Tank Mix mixture effects at environmentally relevant concentrations.

## Feeding Study

Feeding studies using biocontrol agents *Megamelus scutellaris* (Planthopper) and *Neochetina* spp. (Weevil) for Delta Smelt and Rainbow Trout consisted of four test treatments. Fish were fed 1.5% of

their respective body weights of 1) formulated diet (control), 2) Planthopper, 3) Weevil, and 4) a fasting treatment was included as a comparison. Delta Smelt feeding study tests were conducted on-site at the UC Davis Fish Culture and Conservation Laboratory in Byron, CA, and Rainbow Trout feeding studies were conducted on-site at UC Davis. Fish were evaluated for survival, success of feeding, and growth determinations by RNA/DNA analysis. Gut content analysis indicates that Delta Smelt did not consume Planthopper or Weevil during the 96-hour feeding study. Since there is no evidence of Delta Smelt consuming Planthopper or Weevil biocontrol agents, RNA/DNA analysis was not conducted. However, gut content analysis indicates Rainbow trout did consume the Planthopper and Weevil. There was no significant effects in RNA/DNA analysis (an indicator of short-term growth) among all treatments.

A recent study conducted in FCCL indicates that adult Delta Smelt consume insects (e.g., beetles, bees, moths, and mosquitos) and worms when raised ex-situ for 6 months in ambient field water pumped from the river (Hung et al., unpublished data). Therefore, it is very likely Delta Smelt will feed on Planthopper and Weevil in the wild when food availability is limited. To further confirm whether Delta Smelt will consume Planthopper and Weevil biocontrol agents we would like to propose a 10 day feeding study (4 days starvation followed by 6 days exposure to Planthopper and Weevil).

Results of this study confirmed that juvenile Rainbow trout are feeding on Planthopper and Weevil and there are no significant differences in RNA/DNA analysis between control and treatment groups. It should be noted that the short-term 96-hr study is insufficient to evaluate the nutritional status of Planthopper and Weevil of Rainbow Trout.

# Introduction

In order to support the upcoming Biological Opinion, the Department of Parks and Recreation, Division of Boating and Waterways (DBW) has contracted with the Aquatic Health Program Laboratory to conduct toxicity testing. The goals of this project are two-fold:

1. Conduct toxicity testing using Inland Silverside (*Menidia beryllina*), Rainbow Trout (*Oncorhynchus mykiss*), Fathead Minnow (*Pimephales promelas*) and the water flea *Ceriodaphnia dubia*, for new herbicides and adjuvants for the Floating Aquatic Vegetation Control Program (FAV) and Submersed Aquatic Vegetation Control Program (SAV).
2. Conduct feeding studies using Rainbow Trout and Delta Smelt (*Hypomesus transpacificus*) for the biocontrol agents mottled water hyacinth weevil (*Neochetina eichorniae*) and planthopper (*Megamelus scutellaris*).

# Materials and Methods

## Toxicity Study

### Chemicals

Toxicity evaluations were conducted on nine herbicides, one non-ionic surfactant, and three tank mixes (see Table 1). Herbicide and adjuvants were tested in formulation, with test concentrations calculated from the percent active ingredient of each formulation. Tank mixes were tested at maximum label application concentrations, and for those used with FAV, the non-ionic surfactant Agridex was added at maximum concentration (2.5% vol/vol) per mix. Agridex was chosen as the non-ionic surfactant in the tank mix because toxicity evaluations have been conducted previously on this chemical. Toxicity testing evaluating Fluridone was conducted with the liquid formulation of Sonar AS, rather than the time-release pellet form of Sonar Q, due to the complexities associated with the chemical quantification of the time-release pellets. This report will reference these chemicals by their active ingredient rather than their trade name, with the exception of the adjuvants Cygnet Plus non-ionic surfactant (NIS) and Agridex NIS.

Table 1. Herbicides, adjuvants and tank mixes

| Trade Name | Active Ingredient |
|---|---|
| **Stingray EW** | Carfentrazone-ethyl |
| **Sonar AS** | Fluridone |
| **Aquathol K** | Endothall |
| **Round up Custom** | Glyphosate |
| **Clearcast** | Imazamox |
| **Clipper** | Flumioxazin |
| **Habitat** | Imazapyr |
| **Oasis** | Topramezone |
| **Procellacor / SLF-9522** | SX-1552 |
| **Cygnet Plus non-ionic surfactant** | D-limonene, vegetable (seed) oil ethoxylate, alcohol ethoxylate |
| **Agridex non-ionic surfactant*** | Heavy range paraffinic oil, polyol fatty acid esters, polyethoxylated derivatives |
| **Tank mix:** 500 ppb Imazamox + 74 ppb Carfentrazone-ethyl + Agridex non-ionic surfactant | |

| |
|---|
| **Tank mix:** 90 ppb Fluridone + 5,000 ppb Endothall |
| **Tank mix:** 90 ppb Glyphosate + 45 ppb Flumioxazin + Agridex non-ionic surfactant |

* Used in tank mix only. A separate Agridex-only treatment was also included with each toxicity test that evaluated a tank mix.

Chemical toxicity testing was conducted using a 50% serial dilution series, with a maximum test concentration of 100,000 ppb. One exception to this was Endothall, which in one case was tested up to 500,000 ppb. Instances in which test concentrations were either too high or too low to elicit an organism response were repeated when time allowed and based on test organism availability.

Generally, herbicide and adjuvant test evaluations were conducted on the pure formulated product without dilution. Tank mixes utilized the formulations diluted with distilled water in order to match the lowest concentrations tested; in addition these stock solutions were used in instances where test concentrations were too low to use the formulated product without dilution. No solvents were required for this project.

Certificates of analyses and chemical concentration confirmations were obtained for all formulated products prior to testing. At test initiation, sub-samples of all chemical concentrations for each test were collected and archived for future chemical analyses. Thus, the data provided herein is based on nominal values.

## Water Quality

All toxicity study tests were conducted in moderately hard synthetic water, as outlined in USEPA (2002 a,b,c). Synthetic water used in the Inland Silverside tests were made according to USEPA, and then adjusted to 8 ppt salinity using Crystal Sea® Marine Mix (Marine Enterprises International, Baltimore, MD), which may have brought these specific waters out of the moderately hard range, as hardness is positively correlated with salinity. Physiological parameters of ammonia-nitrogen, hardness (as $CaCO_3$), alkalinity (as $CaCO_3$), dissolved oxygen, pH, electrical conductivity, salinity, and temperature, were all kept within the optimum ranges for the test organisms. There were in some cases, instances where the dissolved oxygen levels were below the minimum level recommended by USEPA in the 24-hr waste water in some toxicity tests. However, these reduced dissolved oxygen levels did not have any significant impact on the test organisms, as there was no mortality observed in those test concentrations which exhibited the reduced dissolved oxygen measurements. Those herbicides with acid bases (e.g., glyphosate, carfentrazone-ethyl, imazamox) were tested at concentrations which did not negatively influence pH; thus no adjustments were required.

## Inland Silverside

Inland silversides (*Menidia beryllina*) were obtained from Aquatic Biosystems (Fort Collins, CO). Inland Silversides were slowly acclimated down to 8 ppt salinity over the course of three days prior to test initiation. Eight parts per thousand was selected as a testing salinity for this marine fish species, as it is representative of the different salinities present in the Delta, and is the same salinity that was used for prior DBW herbicide/adjuvant investigations with the marine diatom *Thalassiosira pseudonana*. Inland Silversides were nine days old at test initiation, allowing for the same batch of fish to be used in both acute and chronic testing protocols. Inland Silverside toxicity tests were conducted at 25 ± 2 °C.

Acute 96-hour testing protocols followed those outlined in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (5$^{th}$ ed., USEPA 2002) and

consisted of four 250 mL replicates with 200 mL sample per replicate and 10 fish each. Test solutions were renewed at the 48-hour time point, at which time detritus was removed. Inland Silversides were fed *Artemia* nauplii during culture prior to test initiation, and two hours prior to water renewal at 48-hours. Fish were observed daily and deceased organisms were removed when present. At test termination, surviving fish were euthanized with an overdose of buffered methane tricaine sulfonate. The test acceptability criterion for the acute 96-hour testing protocol requires 90% control survival.

Chronic 7-day testing protocols followed those outlined in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms* (3rd ed., USEPA 2002) and consisted of four 600 mL replicates with 500 mL sample per replicate and 10 fish each. Test solutions were renewed daily, at which time detritus and deceased organisms were removed. Inland Silversides were fed *Artemia* nauplii daily. At test termination, surviving fish were euthanized with an overdose of methane tricaine sulfonate, dried to a constant temperature and used for weight determinations. Test acceptability criteria for the chronic 7-day test protocol require 80% control survival and an average of 0.50 mg or greater dry weight of control larvae.

### Rainbow Trout

Rainbow Trout (*Oncorhynchus mykiss*) were obtained from Thomas Fish Company (Anderson, CA) and were initiated in toxicity tests the day of arrival. Two different life stages were used for acute and chronic protocols. Rainbow Trout toxicity tests were conducted at 12 ± 2 °C.

Acute 96-hour testing protocols followed those outlined in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (5th ed., USEPA 2002) and consisted of four 4L replicates with 4L of sample per replicate and 10 fish each. Rainbow Trout in the swim-up or "button up" stage (15-30 days) were applied in acute toxicity test protocols; Rainbow Trout were approximately 18 days old at test initiation. Test solutions were renewed at the 48-hour time point, at which time detritus was removed. Rainbow Trout were fed Trout Chow Crumble #1 during culture prior to test initiation, and two hours prior to water renewal at 48-hours. Fish were observed daily and deceased organisms were removed when present. At test termination, surviving fish were euthanized with an overdose of buffered methane tricaine sulfonate. The test acceptability criterion for the acute 96-hour testing protocol requires 90% control survival.

Chronic 7-day testing protocols followed those outlined in "Rainbow Trout (*Oncorhynchus mykiss*) and Brook Trout (*Salvelinus fontinalis*) 7-day Survival and Growth Test Method" (Lazorchak and Smith 2007) with modifications. The method recommended using five 15-30 day old Rainbow Trout each in four 1L replicates with 400 mL sample. This method was attempted several times, and we observed high mortality in several test treatments, including the control, due to reduced dissolved oxygen levels. We determined that oxygen consumption by the fish was greater than the dissolved oxygen available in the water column. While it's possible that the lack of dissolved oxygen could have been ameliorated by the application of aeration to test replicates for the duration of the test, we were concerned that aeration could volatilize the herbicides and adjuvants and reduce overall test concentrations. We were limited logistically by space and hazardous waste generation, precluding our ability to increase test solution volumes. We therefore used a younger life-stage Rainbow Trout, the larval sac-fry stage, approximately 4-8 days post hatch. Rainbow Trout have a large exposed yolk sac that is used as a food source (i.e., no additional feeding), and fish at this stage do not swim but remain at the bottom of the water column until the swim bladder inflates. We anticipated that these Rainbow Trout would have less of an oxygen

demand than the swim-up stage and would be better suited for this test method. Additionally, since the yolk sac is used as its only food source, overall weight changes with these fish over the duration of the test would be minimal. The method suggested a minimum acceptable growth factor of 1.5 times the initial mean dry fish weight. However, given the feeding differences between the two life stages we determined that this growth factor could not be reasonably attained and instead considered a test acceptable when there was no significant difference between the initial mean dry fish weight and the final mean dry fish weight. Therefore, test protocols consisted of four 1L replicates with 400 mL of sample and five sac-fry Rainbow Trout each. No additional food was given. Test solutions were renewed daily, with detritus and deceased fish removed when observed. At test termination, surviving fish were euthanized with an overdose of buffered methane tricaine sulfonate and dried at a constant temperature for weight determinations. Additionally, a subset of 20 fish were euthanized and weighed at the start of the test in order to make weight comparisons. Test acceptability criteria for this protocol was set as 80% control survival and no significant difference in weight between initial fish at test initiation, and those at test termination.

### Fathead Minnow

Fathead minnows (*Pimephales promelas*) were obtained from AquaTox Inc. (Hot Springs, AK) and were initiated in toxicity tests the day of arrival. Larval Fathead Minnows used in toxicity tests were less than 48-hours old at initiation. In the USEPA manuals, Fathead Minnow acute and chronic toxicity test protocols allow use of the same age of fish, replicate number and size, as well as number of test organisms per replicate. We therefore utilized the chronic toxicity protocol for all toxicity investigations, and derived the 96-hour toxicity data from the chronic test protocol.

Chronic 7-day testing protocols followed those outlined in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* ($4^{th}$ ed., USEPA 2002) and consisted of four 600 mL replicates with 250 mL of sample and 10 fish each. Toxicity tests were conducted at 25 ± 2 °C. Test solutions were renewed daily, at which time detritus and deceased organisms were removed. Fathead Minnows were fed *Artemia* nauplii daily. At test termination, surviving fish were euthanized with an overdose of methane tricaine sulfonate, dried to a constant temperature and used for weight determinations. Test acceptability criteria for the chronic 7-day test protocol require 80% control survival and an average of 0.25 mg or greater dry weight of control larvae.

### *Ceriodaphnia dubia*

Organisms originally obtained from Aquatic Research Organisms (Hampton, NH) were cultured in-house at UCD AHP. *Ceriodaphnia dubia* (*C. dubia*) were less than 24-hours old at test initiation for acute and chronic protocols. Toxicity tests were conducted at 25 ± 2 °C.

Acute 96-hour testing protocols followed those outlined in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* ($5^{th}$ ed., USEPA 2002) and consisted of four 20 mL replicates with 18 mL of sample and 5 *C. dubia* each. *C. dubia* were born within a 20 hour window and were initiated in toxicity tests at less than 24-hours old. Test solutions were renewed at the 48-hour time point. *C. dubia* were fed a mixture of YCT (yeast, organic alfalfa, and trout chow) and *Selenastrum capricornutum* (a green freshwater alga) during culture and 2 hours prior to test solution renewal at 48-hours. *C. dubia* were observed daily, at which time deceased organisms were removed. Test acceptability for the acute 96-hour test protocol requires 90% control survival.

Chronic 6-8 day testing protocols followed those outlined in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms* (4th ed., USEPA 2002) and consisted of ten 20 mL replicates with 15 mL of sample and one *C. dubia* each. *C. dubia* were born within an 8-hour window and were initiated in tests using blocking by known parentage when organisms were less than 24-hours old. Blocking by known parentage utilizes 10 gravid *C. dubia*, with offspring from one gravid applied to each replicate number for all test treatments. For example, one gravid *C. dubia* will supply offspring for all 1-replicates, a second gravid *C. dubia* will supply offspring for all 2-replicates, and so-on. This method reduces variability due to stressed organisms, and allows for more accurate data interpretation in the case of observations of males (the test acceptability criterion for the reproduction endpoint applies only to surviving female *C. dubia*). *C. dubia* were fed a mixture of YCT and *Selenastrum capricornutum* added to new test solutions daily. Test solutions were renewed daily, where deceased organisms were removed when present. Test acceptability criteria for the chronic 6-8 day test protocol require 80% control survival, with 60% of surviving females having an average of 15 neonates or greater.

### Statistics

Each test was characterized by descriptive statistics, including the mean response and variation among replicates. Lethal and sub-lethal effect concentrations were calculated using CETIS v. 1.8.7.2 (Tidepool Scientific Software, McKinleyville, CA). NOEC and LOEC values were calculated using USEPA standard statistical protocols (USEPA 2002). LC50 and EC25 data were calculated using linear regression, non-linear regression, or linear interpolation methods.

Additional comparisons were made to determine the toxicity of a chemical concentration or tank mix, separate from the effect concentration data. In this case, toxicity is defined as a statistically significant reduction in test organism performance in a test treatment compared to a laboratory control. Test organism performance (control vs. individual chemical concentration or tank mixture) was evaluated in terms of significant differences in test organism performance by a one-tailed heteroscedastic t-test ($\alpha$ = 0.05) and a categorization of the performance of organisms exposed to the chemical concentration as either greater to or less than 80% of the control performance. Test treatments were considered toxic only when both a significant t-test result and organism performance below 80% of the control was observed.

## Feeding Study

### Biocontrol Agents

Biocontrol agents *Megamelus scutellaris* (Planthopper) and *Neochetina* spp. (Weevil) were obtained from Dr. Patrick Moran, Dr. Julie Hopper, and Dr. Paul Pratt of the US Department of Agriculture, Agricultural Research Unit (USDA-ARS), from in-house colonies. Biocontrol agents were flash frozen and delivered to UCD AHPL on dry ice. Biocontrol agents were kept frozen at -80°C until their use in the feeding studies (Figure 1).

Feeding studies for Delta Smelt and Rainbow Trout consisted of four test treatments, as outlined in Table 2 below. Fish were fed 1.5% of their respective body weights of 1) formulated diet (control), 2) Planthopper, 3) Weevil, and 4) a fasting treatment was included as a comparison.

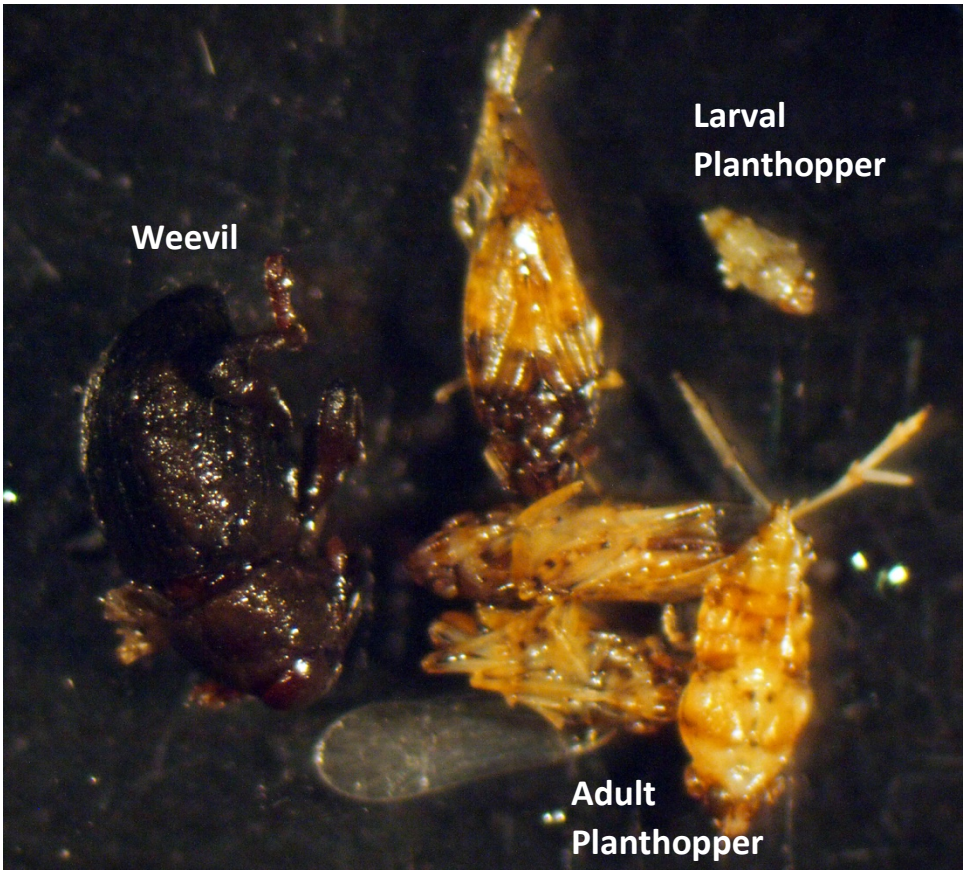


Figure 1. Photo of adult Weevil, and larval and adult Planthoppers used in the Feeding Study.

Table 2. Feeding study test treatments

| Treatment | Delta Smelt | | Rainbow Trout | |
|---|---|---|---|---|
| | Feeding | Test Duration | Feeding | Test Duration |
| **Control** | 0.042 g formulated diet | 96 hours | 0.005 g formulated diet | 96 hours |
| **Fasting** | No food | | No food | |
| **Planthopper** | 0.042 g Planthopper | | 0.005 g Planthopper | |
| **Weevil** | 0.042 g Weevil | | 0.005 g Weevil | 48 hours |

## Delta Smelt

Sub-adult Delta Smelt (240 dph) were raised at the UC Davis Fish Conservation and Control Laboratory (FCCL, Byron CA). At the FCCL, ambient water from the California Aqueduct was used for fish culture and testing matrix after basic water treatment processes (including solids removal and UV disinfection). The Delta Smelt feeding study was conducted on-site at the FCCL.

Flow-through exposures consisted of three 20 L black replicate High Density Polyethylene (HDPE) buckets with 15 L of sample and five Delta Smelt each. Replicates were continuously aerated and the temperature maintained at 15.7 °C by placing the replicate buckets in large circular water tanks (five feet in diameter with 869 L of working volume for temperature control). Exposures consisted of four

feeding treatments (Table 2); Delta Smelt were fed 1.5% of their body weight daily (mean body weight 2.81 g) over the course of 96-hours for both Weevil and Planthopper species. Delta Smelt were observed daily, with deceased fish removed when present. At termination, surviving Delta Smelt were euthanized with an overdose of tricaine methane sulfonate, flash frozen in liquid nitrogen for preservation, and then stored in liquid nitrogen until dissection. Fish were dissected at UCD AHP, following the method outlined in Teh et al. (2016). Intestinal tracts were removed and used for gut content analysis, and dorsal muscle tissues were partitioned for measuring short-term growth of fish using RNA/DNA ratio analysis.

### Rainbow Trout

Juvenile Rainbow Trout (37 days old) were obtained from Thomas Fish Company (Anderson, CA) and were kept in culture at UCD AHP prior to their use in a test. Ambient well water from the Center for Aquatic Biology and Aquaculture (CABA) was used for fish culture and testing matrix. The Rainbow Trout feeding study was conducted on-site at CABA.

Flow-through exposures consisted of three 20 L blue replicate HDPE buckets with 15 L of sample and five Rainbow Trout each. Replicates were continuously aerated and the temperature maintained at 14.2°C by placing the replicate buckets in large circular water tanks (five feet in diameter with 869 L of working volume for temperature control, connected to a recirculating chiller unit). Rainbow Trout were fed 1.5% of their body weight daily (mean body weight 0.353 g) over the course of 96-hours for Planthoppers and 48-hours for Weevils (preference was given to the Delta Smelt feeding study, and there was concern that there was not enough Weevil biomass to conduct both studies for 96-hours). Rainbow Trout were observed daily, with deceased fish removed when present. At termination, surviving Rainbow Trout were euthanized with an overdose of tricaine methane sulfonate, flash frozen in liquid nitrogen for preservation, and then stored in liquid nitrogen until dissection. Fish were dissected at UCD AHP, following the method outlined in Teh et al. (2016). Intestinal tracts were removed and used for gut content analysis, and dorsal muscle tissues were partitioned for measuring of short-term fish growth usiing RNA/DNA ratio analysis.

### RNA/DNA Analysis

Short-term growth was evaluated by measuring the RNA/DNA ratio. Growing involves synthesis of molecules to build up tissue which is manifested in higher synthesis of RNA for synthesis of protein, e.g. muscle. As the quantity of DNA per cell remains relatively constant, changes in the quantity of RNA per cell indicates different growth rate. RNA/DNA ratio is a sensitive indicator of growth rate after short exposure to adverse conditions such as contaminants (Bisbal & Bengston, 1995; McLaughlin et al., 1995; Chicharo et al. 1998). RNA-DNA ratio in muscle was measured using the ethidium bromide fluorometric technique (Caldarone et al., 2001). Briefly, sample protein from muscle was dissociated from nucleic acid and the fluorophore ethidium bromide (DNA staining dye) was used to measure total nucleic acids. RNAse is added to digest RNA to differentiate RNA from DNA.

## Results

Survival LC50 and growth/reproductive EC25 and the respective NOEC and LOEC values are outlined below in Tables 3 –14.

## Toxicity Study

### Inland Silverside

Table 3. Summary of results for acute 96-hour Inland Silverside toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Survival LC50 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl** | 2,549 (2476-3228) | 781.25 | 1,563 |
| **Fluridone** | 8,887 (5790-12430) | 3,910 | 7,815 |
| **Endothall** | 15,350 (13830-15840) | 5,000 | 50,000 |
| **Glyphosate** | 42,610 (32040-64230) | 25,000 | 50,000 |
| **Imazamox** | >100,000 | 25,000 | 50,000 |
| **Flumioxazin** | 60,950 (53230-67180) | 25,000 | 50,000 |
| **Imazapyr** | >50,000 | 50,000 | >50,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | >100,000 | 100,000 | >100,000 |
| **Cygnet Plus non-ionic surfactant** | 8,839 (8839-8839) | 6,250 | 12,500 |
| **Agridex non-ionic surfactant** | No significant effects | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | No significant effects | | |
| **Tank Mix**: Fluridone + Endothall | No significant effects | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | No significant effects | | |

Table 4. Summary of survival and associated effect concentration data for chronic 7-day Inland Silverside toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Survival LC50 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl** | 2,819 (2041-2301) | 781.25 | 1,562.5 |
| **Fluridone** | 6,007 (5244-6791) | 3,910 | 7,815 |
| **Endothall** | 15,360 (13710-15840) | 5,000 | 50,000 |
| **Glyphosate** | 71,540 (68700-76580) | 50,000 | 100,000 |
| **Imazamox** | >100,000 | 100,000 | >100,000 |
| **Flumioxazin** | 44,160 (39320-49560) | 25,000 | 50,000 |
| **Imazapyr** | >100,000 | 100,000 | >100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | >100,000 | 100,000 | >100,000 |
| **Cygnet Plus non-ionic surfactant** | 8,505 (7865-9039) | 6,250 | 12,500 |
| **Agridex non-ionic surfactant** | No significant effects | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | No significant effects | | |
| **Tank Mix**: Fluridone + Endothall | No significant effects | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | No significant effects | | |

Table 5. Summary of growth and associated effect concentration data for chronic 7-day Inland Silverside toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Growth EC25 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl** | 1,841 (1675-1964) | 1,562.5 | 3,125 |
| **Fluridone** | 4,991 (3549-5968) | 3,910 | 7,815 |
| **Endothall** | >5,000 | 5,000 | >5,000 |
| **Glyphosate** | 57,800 (50370-61340) | 50,000 | 100,000 |
| **Imazamox** | 58,740 (28,580-NA) | 25,000 | 50,000 |
| **Flumioxazin** | 27,970 (NA-39000) | 25,000 | 50,000 |
| **Imazapyr** | >100,000 | 100,000 | >100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | >100,000 | 100,000 | >100,000 |
| **Cygnet Plus non-ionic surfactant** | >6,250 | 6,250 | >6,250 |
| **Agridex non-ionic surfactant** | No significant effects | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | No significant effects | | |
| **Tank Mix**: Fluridone + Endothall | No significant effects | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | No significant effects | | |

## Rainbow Trout

Table 6. Summary of results for acute 96-hour Rainbow Trout toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Survival LC50 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl** | 1,101 (1086-1134) | 781.25 | 1,563 |
| **Fluridone** | 7,204 (6434-45680) | 3,910 | 7,815 |
| **Endothall** | >500,000 | 500,000 | >500,000 |
| **Glyphosate** | >100,000 | 100,000 | >100,000 |
| **Imazamox** | >100,000 | 100,000 | >100,000 |
| **Flumioxazin** | 27,230 (10800-96940) | <3,125 | 3,125 |
| **Imazapyr** | >100,000 | 100,000 | >100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | >100,000 | 100,000 | >100,000 |
| **Cygnet Plus non-ionic surfactant** | 8,800 (8672-8862) | 6,250 | 12,500 |
| **Agridex non-ionic surfactant** | No significant effects | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | No significant effects | | |
| **Tank Mix**: Fluridone + Endothall | No significant effects | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | No significant effects | | |

Table 7. Summary of survival and associated effect concentration data for chronic 7-day Rainbow Trout toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Survival LC50 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl*** | 984.4 (401.6-1117) | 781.25 | 1,562.5 |
| **Fluridone** | >62,500 | 62,500 | >62,500 |
| **Endothall** | >100,000 | 100,000 | >100,000 |
| **Glyphosate** | >100,000 | 100,000 | >100,000 |
| **Imazamox** | 83,310 (4252-129000) | 50,000 | 100,000 |
| **Flumioxazin** | 17,810 (7603-42030) | 25,000 | 50,000 |
| **Imazapyr** | >100,000 | 100,000 | >100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | >100,000 | 100,000 | >100,000 |
| **Cygnet Plus non-ionic surfactant*** | 9,396 (8504-13140) | 6,250 | 12,500 |
| **Agridex non-ionic surfactant** | No significant effects | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | No significant effects | | |
| **Tank Mix**: Fluridone + Endothall | No significant effects | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | No significant effects | | |

*48-hour LC50, NOEC and LOEC values. Test organisms exhibited 100% mortality prior to 96 hours.

Table 8. Summary of growth and associated effect concentration data for chronic 7-day Rainbow Trout toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Growth EC25 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl*** | >195.3 | <195.3 | 195.3 |
| **Fluridone** | >62,500 | 62,500 | >62,500 |
| **Endothall** | >100,000 | 100,000 | >100,000 |
| **Glyphosate** | >100,000 | 100,000 | >100,000 |
| **Imazamox** | >100,000 | 50,000 | 100,000 |
| **Flumioxazin** | 642.8 (NA-41330) | 25,000 | 50,000 |
| **Imazapyr** | >100,000 | 100,000 | >100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | >100,000 | 50,000 | >100,000 |
| **Cygnet Plus non-ionic surfactant*** | >3,125 | <3,125 | 3,125 |
| **Agridex non-ionic surfactant** | *Statistically significant reduction in Imazamox + Carfentrazone + Agridex mix* | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | No significant effects | | |
| **Tank Mix**: Fluridone + Endothall | No significant effects | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | No significant effects | | |

*48-hour EC25, NOEC and LOEC values. Test organisms exhibited 100% mortality prior to 96 hours.

## Fathead Minnow

Table 9. Summary of results for acute 96-hour Fathead Minnow toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Survival LC50 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl** | 2,075 (1767-2207) | 1,562.5 | 3,125 |
| **Fluridone** | >31,250 | 31,250 | >31,250 |
| **Endothall** | >100,000 | 100,000 | >100,000 |
| **Glyphosate** | >100,000 | 100,000 | >100,000 |
| **Imazamox** | >100,000 | 100,000 | >100,000 |
| **Flumioxazin** | 58,670 (42170-65590) | 25,000 | 50,000 |
| **Imazapyr** | >100,000 | 100,000 | >100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | >100,000 | 100,000 | >100,000 |
| **Cygnet Plus non-ionic surfactant** | 13,310 (7434-19790) | 12,500 | 25,000 |
| **Agridex non-ionic surfactant** | No significant effects | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | No significant effects | | |
| **Tank Mix**: Fluridone + Endothall | No significant effects | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | No significant effects | | |

Table 10. Summary of survival and associated effect concentration data for chronic 7-day Fathead Minnow toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Survival LC50 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl** | 2,075 (1767-2207) | 1,562.5 | 3,125 |
| **Fluridone** | 29,440 (23750-42810) | 7,812 | 15,625 |
| **Endothall** | >100,000 | 100,000 | >100,000 |
| **Glyphosate** | >100,000 | 100,000 | >100,000 |
| **Imazamox** | 33,210 (30470-35050) | 25,000 | 50,000 |
| **Flumioxazin** | 56,610 (43440-64030) | 25,000 | 50,000 |
| **Imazapyr** | >100,000 | 100,000 | >100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | >100,000 | 100,000 | >100,000 |
| **Cygnet Plus non-ionic surfactant** | 12,380 (11050-13860) | 12,500 | 25,000 |
| **Agridex non-ionic surfactant** | No significant effects | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | No significant effects | | |
| **Tank Mix**: Fluridone + Endothall | No significant effects | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | No significant effects | | |

Table 11. Summary of growth and associated effect concentration data for chronic 7-day Fathead Minnow toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Growth EC25 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl** | 1,562.5 | 781.25 | 1,562.5 |
| **Fluridone** | 10,500 (8306-14000) | 3,906 | 7,812 |
| **Endothall** | 58,840 (NA-110,700) | 3,125 | 6,250 |
| **Glyphosate** | >100,000 | 100,000 | >100,000 |
| **Imazamox** | 23,780 (48310-NA) | 12,500 | 25,000 |
| **Flumioxazin** | 8,780 (NA-13450) | 6,250 | 12,500 |
| **Imazapyr** | >100,000 | 100,000 | >100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | >100,000 | 50,000 | >100,000 |
| **Cygnet Plus non-ionic surfactant** | 7,640 (6208-10340) | 6,250 | 12,500 |
| **Agridex non-ionic surfactant** | *Statistically significant reduction in Glyphosate + Flumioxazin + Agridex mix* | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | No significant effects | | |
| **Tank Mix**: Fluridone + Endothall | *Statistically significant reduction* | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | *Statistically significant reduction* | | |

### *Ceriodaphnia dubia*

Table 12. Summary of results for acute 96-hour *Ceriodaphnia dubia* toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Survival LC50 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl** | 276.3 (276.3-276.3) | 195.31 | 390.63 |
| **Fluridone** | >3,906 | 1,953 | 3,906 |
| **Endothall** | 38,560 (33440-56870) | 25,000 | 50,000 |
| **Glyphosate** | >100,000 | 100,000 | >100,000 |
| **Imazamox** | 71,360 (46330-108100) | 50,000 | 100,000 |
| **Flumioxazin** | 87,060 (59410-NA) | 50,000 | 100,000 |
| **Imazapyr** | >100,000 | 100,000 | >100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | 68,040 (62920-70270) | 50,000 | 100,000 |
| **Cygnet Plus non-ionic surfactant*** | 3,125 (NA-5196) | 3,125 | 6,250 |
| **Agridex non-ionic surfactant** | *Statistically significant reduction* | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | *Statistically significant reduction* | | |
| **Tank Mix**: Fluridone + Endothall | No significant effects | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | *Statistically significant reduction* | | |

*24-hr LC50, NOEC and LOEC values. Test organisms exhibited 100% mortality prior to 96-hours.

Table 13. Summary of survival and associated effect concentration data for chronic 6-8 day *Ceriodaphnia dubia* toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Survival LC50 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl** | 1,205 (1105-1563) | 781.25 | 1,562.5 |
| **Fluridone** | 113 (43.2-551.6) | <1,953 | 1,953 |
| **Endothall** | 33,760 (32070-53180) | 25,000 | 50,000 |
| **Glyphosate** | >100,000 | 100,000 | >100,000 |
| **Imazamox** | >100,000 | 100,000 | >100,000 |
| **Flumioxazin** | Inverse dose response | <3,125 | <3,125 |
| **Imazapyr** | >100,000 | 100,000 | >100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | >100,000 | 100,000 | >100,000 |
| **Cygnet Plus non-ionic surfactant** | <3,125 | <3,125 | 3,125 |
| **Agridex non-ionic surfactant** | No significant effects | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | No significant effects | | |
| **Tank Mix**: Fluridone + Endothall | No significant effects | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | No significant effects | | |

Table 14. Summary of reproduction and associated effect concentration data for chronic 6-8 day *Ceriodaphnia dubia* toxicity tests examining the toxicity of herbicides and adjuvants.

| Chemical | Reproduction EC25 | NOEC | LOEC |
|---|---|---|---|
| | ppb | | |
| **Carfentrazone-ethyl** | 502.3 (410-519.7) | 390.63 | 781.25 |
| **Fluridone** | 5.6 (5.649-5.649) | <1,953 | 1,953 |
| **Endothall** | 13.94 (11.93-18.05) | <3,125 | 3,125 |
| **Glyphosate** | 24,030 (17430-28200) | 12,500 | 25,000 |
| **Imazamox** | 16,080 (10650-19490) | 12,500 | 25,000 |
| **Flumioxazin** | Inverse dose response | <3,125 | 3,125 |
| **Imazapyr** | 67,190 (25160-72730) | 50,000 | 100,000 |
| **Topramezone** | >100,000 | 100,000 | >100,000 |
| **SX-1552** | 20,100 (14170-26010) | 25,000 | 50,000 |
| **Cygnet Plus non-ionic surfactant** | <3,125 | <3,125 | 3,125 |
| **Agridex non-ionic surfactant** | *Statistically significant reduction* | | |
| **Tank Mix**: Imazamox + Carfentrazone + Agridex NIS | *Statistically significant reduction* | | |
| **Tank Mix**: Fluridone + Endothall | *Statistically significant reduction* | | |
| **Tank Mix**: Glyphosate + Flumioxazin + Agridex NIS | *Statistically significant reduction* | | |

## Feeding Study

### Delta Smelt

Gut content analysis indicates that Delta Smelt did not consume Planthopper or Weevil during the 96-hour feeding study. Figure 2 shows 240 DPH Delta Smelt with empty stomach (arrow) and large amount of abdominal fat (arrowheads). Since there is no evidence of Delta Smelt consuming Planthopper or Weevil biocontrol agents, RNA/DNA analysis was not conducted.

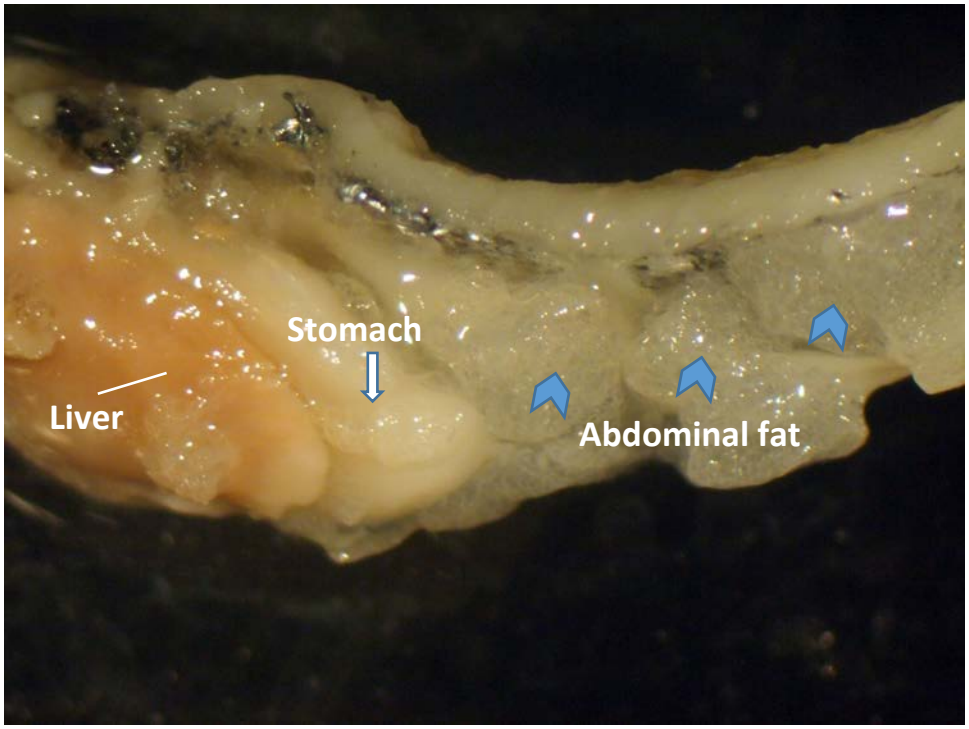


Figure 2. 240 DPH Delta Smelt with empty stomach (arrow) and large amount of abdominal fat (arrowheads).

## Rainbow Trout

Gut content analysis indicates Rainbow trout did consume the Planthopper (Figure. 3) and Weevil (Figure 4). However, there is no significant effects in RNA/DNA analysis (an indicator of short-term growth) among all treatments (Figure 5).

Figure 3. Many Planthoppers in intestine (arrows) of juvenile Rainbow Trout.

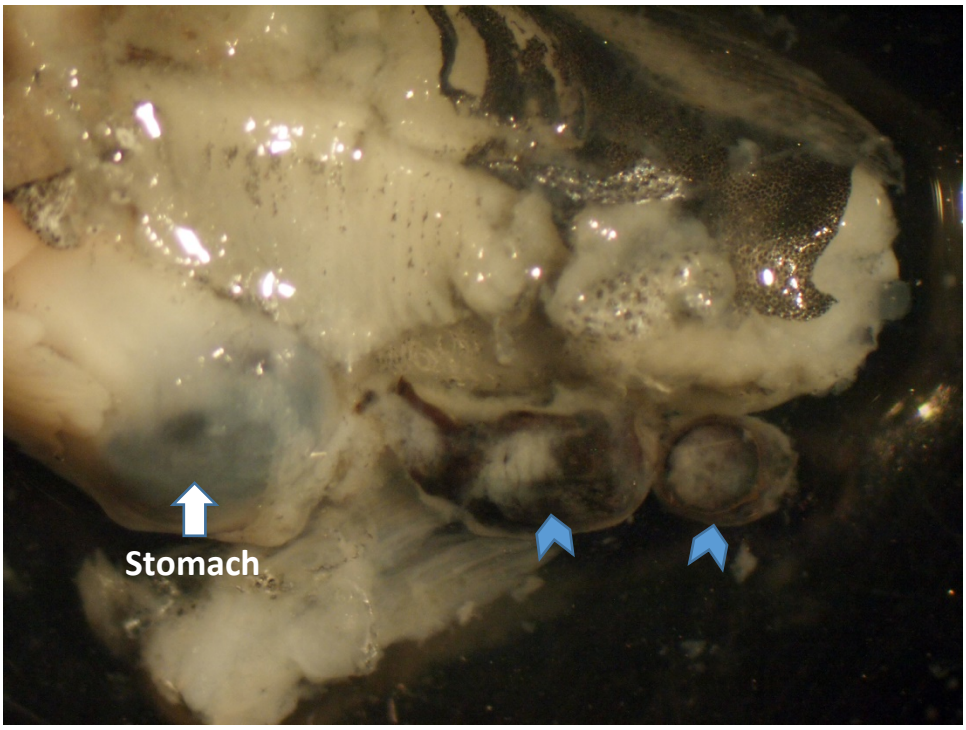


Figure 4. Weevil in stomach (arrow) and intestine (arrowheads) of juvenile Rainbow Trout.

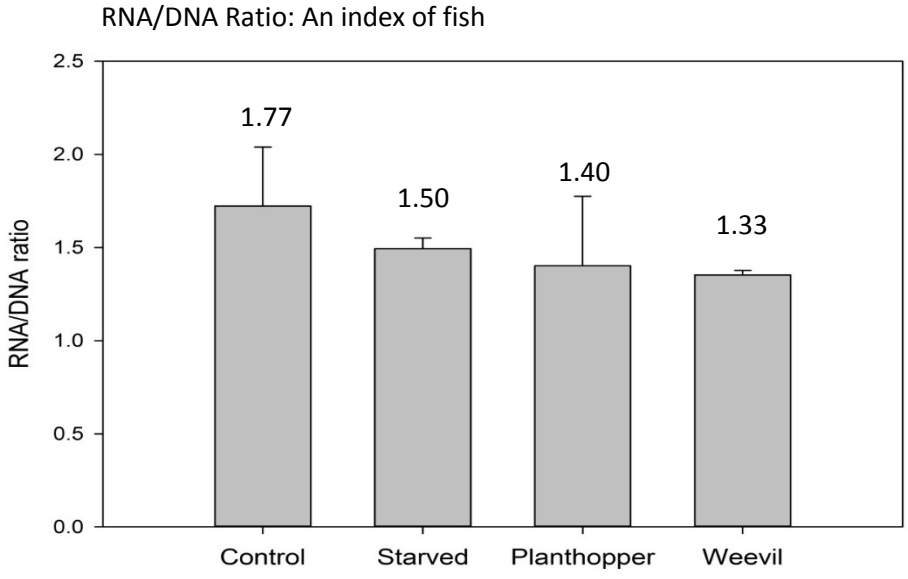


Figure 5. Graph depicting RNA/DNA ratios of Rainbow Trout in the Feeding Study.

# Discussion, Conclusions, and Recommendations

## Toxicity Study

This study examined the sensitivity of three fish species and one invertebrate species to multiple herbicides, both singly and in mixture together with a non-ionic surfactant. For single herbicide toxicity tests, maximum test concentrations were held at 100 ppm (100,000 ppb); with the exception of Endothall, which was tested with acute Rainbow Trout with a max concentration of 500 ppm (500,000 ppb). Tests were conducted using a 50% serial dilution series, with chemical concentrations based on the active ingredient in each herbicide formulation.

It is well known that toxicity differs between a formulated product versus the technical grade active ingredient, as several investigators have demonstrated (Yi et al. 2010; Mayer and Ellersieck, 1986; Hamelink et al. 1986). This is typically due to the inert, often proprietary ingredients that make up the formulated product, which may include emulsifiers and/or surfactants. Moreover, several studies have demonstrated higher toxicity with adjuvants when compared to formulations without adjuvants, or the technical grade active ingredient (Folmar et al. 1979; Tsui and Chiu 2003; Cuhra et al. 2012). With that in mind, we acknowledge that the toxicity data provided herein may have been enhanced by using the formulated product rather than the technical grade active ingredient itself. However, for the scope of this study, we believe that evaluating the toxicity of these formulated products has more environmental relevance than the technical product alone.

### Carfentrazone-ethyl (Stingray EW)

This herbicide elicited the most toxic effects across all species tested. LC50 data ranged from 276.3 ppb (acute 96-hr *C. dubia*) to 2,819 ppb (chronic 7-day Inland Silverside). Moreover, the chronic sac-fry stage Rainbow Trout had an LC50 of <195.3 ppb, which was the lowest concentration tested. As test organisms exhibited 100% mortality prior to 96-hours, we are unable to provide a 96-hour LC50 for this herbicide. However, we were able to calculate the 48-hr LC50 for carfentrazone-ethyl, which was 984.4 (401.6-1177) ppb, with a NOEC of 781.25 ppb and a LOEC of 1,562.5 ppb. These values are lower than what has been previously reported. Although limited information exists in the literature for this herbicide, the ECOTOX Knowledgebase (https://cfpub.epa.gov/ecotox) has reported a 96-hour LC50 for Rainbow Trout at 1,600 ppb for flow-through and >99,200 ppb in a 96-hour static toxicity test (USEPA 1992). These values were derived using the technical grade product of carfentrazone-ethyl of approximately 99% purity, which may account for the differences in sensitivity between species, as our 96-hour acute (swim-up stage) Rainbow Trout exhibited a 96-hour LC50 of 1,101 ppb when using the formulated product Stingray EW, which is 21.3% active ingredient (a.i.) and 78.7% “other ingredients”. We were unable to find any additional supporting literature for the other species tested in this study. However, the Safety Data Sheet (SDS) of Stingray EW lists a 96-hour LC50 for Rainbow Trout (*Salmo gairdneri*) of 1,600 ppb and a 48-hour EC50 of >9,800 ppb for *Daphnia magna* (SePRO 2017). In comparison, toxicity evaluations in the current study with *C. dubia* elicited a 96-hour LC50 of 276.3 ppb and a 7-day LC50 of 1,205 ppb, both of which are below those listed in the SDS.

### Fluridone (Sonar AS)

Fluridone was tested using the liquid formulation of Sonar AS, rather than the time-release pellet form of Sonar Q, which is currently being used with the SAV control program; therefore these toxicity values may differ from what is actually being used in the field. LC50s generated for this herbicide in our study differed among species, with *C. dubia* being the most sensitive to this herbicide. The 96-hour acute LC50

was greater than 3,906 ppb, which was the highest concentration tested; test organisms in this concentration exhibited 65% survival at 96-hrs. However in the chronic test, we observed 100% mortality in this concentration within the first 24 hours of test initiation. Test organisms in the lowest concentration of 1,953 ppb fluridone, had only 20% survival, and time precluded a retest using lower concentrations. Calculated chronic LC50 values for fluridone was 113 (43.2-551.6) ppb, and a reproduction EC25 of 5.6 (5.649-5.649) ppb. In comparison, Hamelink et al. (1986) reported *D. magna* 48-hr EC50s of 6,300 (95% CI 5400-7400) ppb for the technical grade fluridone, and 3,600 (3200-4000) ppb for the fluridone liquid formulation (48% a.i.). These values are higher than those reported in the current study with *C. dubia*. Yi et al. (2010) investigated the sensitivity of male water mites (Hydrachnidiae: Arrenurus: *Megaluracarus*) to both liquid formulation and technical grade fluridone, with 96-hour EC50s of <10 ppb (70% mortality was observed at 10 ppb, the lowest concentration tested), and 631 ppb, respectively. Filizadeh et al. (2003) reported <48-hr LC50s of 100 ppb for *D. magna*. The authors did not specify whether they used technical grade or liquid formulation of fluridone.

Hamelink et al. (1986) reports effect concentration data of liquid formulation of fluridone for several fish species, including a 96-hour acute LC50 of 8,100 (7900-8300) ppb for Rainbow Trout, 13,200 (10300-17000) ppb for Catfish, and 12,000 (8200-17500) ppb for Bluegill Sunfish. Hamelink's fish LC50 values fall in between those that were observed in the current study. Inland Silversides exhibited an acute 96-hour LC50 of 8,887 (5790-12430) ppb and a 7-day chronic LC50 of 6,007 (5244-6791) ppb. Similarly, our acute 96-hour LC50 for Rainbow Trout was 7,204 (6434-45680) ppb (the upper limit of the 95% CI is due to Rainbow Trout in the higher test concentrations above 7,815 ppb exhibiting similar mortality patterns and did not follow the typical dose response of increased response to increased dose).

Conversely, the Fathead Minnow exhibited far less sensitivity to this herbicide, with a chronic 7-day LC50 of 29,440 (23750-42810) ppb and an acute 96-hour LC50 of >31,250, the highest concentration tested. The chronic sac-fry Rainbow Trout 7-day LC50 also exceeded the highest test concentration, 62,500 ppb. Mayer and Ellersieck (1986) reported similar values for the Fathead Minnow, with 96-hour LC50s of 41,000 (32000-52000) ppb for the liquid formulation of fluridone, and 22,000 (17000-28000) ppb for the technical grade fluridone. Mayer and Ellersieck also reported similar values for Rainbow Trout, as their 96-hour LC50 for formulated fluridone was 7,100 (5600-9100) ppb and 4,250 (3350-5390) ppb for the technical grade fluridone.

Paul et al. (2011) evaluated the sensitivity of several other fish species to the liquid formulation of fluridone in static, non-renewal tests, with a similar variance of responses. The Walleye (*Stizostedion vitreum*) exhibited a 96-hour LC50 of 1,800 (1400-2000) ppb; 7,600 (6900-8700) ppb for the Largemouth Bass (*Micropterus salmoides*), and 13,000 (12000-15000) ppb for Smallmouth Bass (*Micropterus dolomieu*).

### Endothall (Aquathol K)

Test organisms were relatively insensitive to this herbicide, as in many cases LC50 values could not be determined because they were higher than the highest concentration tested. The majority of tests included a max concentration of 100,000 ppb, except for the acute Rainbow Trout test, in which we went up to 500,000 ppb. In both cases, LC50s could not be obtained. The exception to this is the Inland Silversides, which had an acute 96-hour LC50 of 15,350 (13830-15840) ppb, and a chronic 7-day LC50 of 15,360 (13710-15840) ppb. Interestingly, we were unable to obtain a chronic EC25 for growth, because

fish in concentrations of 5,000 ppb and above died before weight determinations could be made, and those fish alive in concentrations below 5,000 did not exhibit any significant reductions in growth. Our *C. dubia* tests also elicited LC50 values for both acute and chronic test durations. Acute 96-hour *C. dubia* LC50 of 38,560 (33440-56870) ppb and chronic LC50 of 33,760 (32070-53180) were similar to those of Inland Silversides, however the reproductive endpoint was very sensitive to endothall, with a calculated EC25 of 13.94 (11.93-18.05) ppb, as the NOEC was below 3,125 ppb, the lowest concentration tested.

Other researchers have reported similar results. Nelson and Roline (1998) reported 48-hr *C. dubia* LC50 of 48,280 (40230-57930) ppb for the technical grade endothall. Williams et al. (1984) exposed the amphipod *Hyalella azteca* to concentrations up to 1,000 ppb, with no mortality observed in any test concentrations. In Williams et al. (1984), previous studies were mentioned, such as Serns (1974), who found zooplankton populations of two ponds to be unaffected by endothall applications. Walker (1963) did not observe any toxic effects on pond invertebrates exposed to 5,000-10,000 ppb endothall, and who also tested nine species of fish that were unaffected by endothall concentrations of 95,000-150,000 ppb. In Berry (1984), Goldfish (*Carassius auratus*) had a Tolerance Limit ($TL_m$) of 372,000 (340000-406000) ppb in static, non-renewal 96-hr tests, and gill hypertrophy was observed in those fish exposed to 80,000 ppb and above. Paul et al. (2011) reported 96-hr LC50s for static non-renewal toxicity tests with 8-10 day-old Walleye LC50 of 16,000 (11000-21000) ppb; 41-43 day-old Walleye LC50 of 54,000 (42000-68000) ppb; larval Smallmouth Bass LC50 of 47,000 (42000-54000) ppb; and 9-13 day-old Largemouth Bass LC50 of 130,000 (120000-150000) ppb. In Serdar's literature review (1993), he found that most fish species' tolerance for endothall in 96-hr exposures had LC50s ranging between 100,000 and 200,000 ppb; with Fathead Minnows 96-hr LC50 ranging from 320,000-610,000 ppb; an LC50 of 213,000 ppb for Rainbow Trout (swim-up stage); 150,000 ppb for Rainbow Trout sac-fry stage, and an LC50 of 136,000 ppb for Chinook Salmon.

Liguori et al. (1983) exposed Chinook Salmon in two 14-day flow-through tests and reported a 14-d LC50 of 62,500 ppb. These researchers then conducted a follow-up study with those Salmon smolts exposed to the lowest test concentrations of endothall (1,500 and 3,000 ppb) which were then placed in seawater to determine the fish's ability to travel to the sea. Fish exposed to 3,000 ppb and above for 96-hrs prior, died when placed into seawater. Thus, while these concentrations of endothall may not have direct acute effects, it is possible that they may affect anadromous fishes' ability to transition to seawater habitats.

### Glyphosate (Roundup Custom)

This particular formulation of Roundup contains a mixture of glyphosate and water, with no adjuvant added to the product. Individual test concentrations were evaluated without the addition of an adjuvant. Inland Silversides were the only test organism to exhibit adverse effects with this herbicide, with an acute 96-hr LC50 of 42,610 (32040-64230) ppb, a chronic LC50 of 71,540 (68700-76580), and a growth EC25 of 57,800 (28580-NA) ppb. It is interesting that the acute LC50 is lower than the chronic LC50, especially because the test waters were made in one batch, and then split between acute and chronic protocols, and Inland Silversides used in both protocols were the same age. It is possible that the protocol itself may account for the differences in sensitivity. There was a shortage of fish available at test initiation, thus the chronic test was initiated with ten fish in each of four replicates, whereas the acute protocol was initiated with five fish in each of four replicates. Also, the size of the test chambers differed between test protocols, with 600 mL glass beakers used for the chronic protocol, and 250 mL glass beakers used for the acute protocol. The differences between replicate chamber surface area and

water volume may have allowed for the possibility of more glyphosate binding to the test chambers and being unavailable to the test organisms; however with a $Log_{Kow}$ of -3.5 (Schuette 1998), that potential seems unlikely.

Anton et al. (1994) tested a formulation of glyphosate containing 54.9% a.i. and reported a 96-hr static non-renewal LC50 for Rainbow Trout of 7,815.67 ppm, which is a calculated LC50 of 4,290.8 ppm a.i. of glyphosate. Folmar et al. (1979) evaluated the technical grade of glyphosate, the isopropylamine salt of glyphosate, and Roundup containing surfactant, on a number of test organisms. The technical grade glyphosate was the least toxic to all test species, with acute 96-hr LC50s ranging from 97,000 (79000-120000) ppb for Fathead Minnow, to 140,000 (110000-170000) ppb for Rainbow Trout and Bluegill Sunfish. These values drop considerably when test organisms are exposed to the formulation of Roundup, with LC50s as low as 2,300 (1900-2800) ppb for Fathead Minnow; 5,000 (3800-6600) ppb for Bluegill; and 8,300 (7000-9900) ppb for Rainbow Trout. Noteworthy are the Rainbow Trout sac-fry values in the Folmar et al. study, where Rainbow Trout sac fry survival was statistically significantly reduced at 5,000 ppb, and elicited a 96-hr LC50 of 3,400 (2200-5300) ppb. In comparison, the Rainbow Trout sac-fry in the present study did not exhibit any negative effects up to and including the highest test concentration of 100,000 ppb.

### Imazamox (Clearcast)

Test organism sensitivity varied across species and test protocol in response to this herbicide. Acute and chronic Inland Silverside, acute Rainbow Trout, acute Fathead Minnow, and the chronic *C. dubia* all had LC50s greater than the highest test concentration of 100,000 ppb. Of those species which had LC50s greater than 100,000 ppb, the chronic Inland Silversides had a growth EC25 of 58,740 (28580-NA), and the chronic *C. dubia* had a reproduction EC25 of 16,080 (10650-19490) ppb, which is the lowest response observed in any species for this herbicide. LC50 sensitivities ranged from 71,630 (46330-108100) ppb for acute 96-hr *C. dubia*, to 33,210 (30470-35050) ppb for the chronic Fathead Minnow. The chronic LC50 for the chronic sac-fry Rainbow Trout was 83,310 (4252-129000) ppb; however the growth EC25 was greater than 100,000 ppb, the highest concentration tested. Thus, all Rainbow Trout which survived the 7-day chronic test duration did not exhibit any reductions in weight.

Very little information exists in the literature regarding imazamox effects on non-target animals. Di Lorenzo et al. (2015) evaluated the toxicity of a commercial formulation of imazamox on the cyclopoid copepod (*Eucyclops serrulatus*), and tested two different life stages at two different temperatures. They report median 96-hr LC50s of 235,760 (± 19.22 SD) ppb for adult *E. serrulatus* at 15 °C and 230,740 (± 25.64 SD) at 18 °C. Juvenile *E. serrulatus* 96-hr LC50s were 139,300 (± 43.78 SD) ppb and 111,900 (± 20.35 SD) ppb at 15 °C and 18 °C, respectively. We were unable to find any additional supporting literature for the other species tested in this study. However, the Safety Data Sheet (SDS) of Clearcast lists a 96-hr LC50 for Bluegill (*Lepomis macrochirus*) of >199,000 ppb (SePRO, 2015).

### Flumioxazin (Clipper)

All of the organisms tested exhibited reduced responses with this herbicide. The sub-lethal endpoints of growth and reproduction were a more sensitive indicator than the survival endpoint. Interestingly, acute and chronic survival LC50s were generally similar to each other within the same species tested. For instance, acute and chronic survival LC50s for the Fathead Minnow were 58,670 (42170-65590) ppb and 56,610 (43440-64030) ppb, respectively. However, in comparison, the Fathead Minnow growth EC25 dropped dramatically to 8,780 (NA-13450) ppb. A similar pattern was observed with the acute and

chronic Rainbow Trout survival LC50s, of 27,230 (10800-16940) ppb and 17,810 (7603-42030) ppb, respectively, with a chronic growth EC25 of 642.8 (NA-41330) ppb. Less so, the acute and chronic Inland Silversides had survival LC50s of 60,960 (53230-67180) ppb and 44,160 (39320-49560) ppb, respectively, with a growth EC25 of 27,970 (NA-39000) ppb. In general, fish responses in the present study are higher than those in the literature, with the exception of the 96-hr LC50 for Bluegill, of >21,000 ppb (ECOTOX Knowledgebase). The ECOTOX Knowledgebase also lists 96-hr LC50 for Sheepshead Minnow (*Cyprinodon variegatus*) as >4,700 ppb, and a 96-hr LC50 for Rainbow Trout of 2,300 (1700-2900) ppb with an associated NOEC of 920 ppb.

*C. dubia* did not follow this pattern and instead exhibited an inverse dose response in the chronic toxicity tests. This test was repeated, having the same organism response. This inverse dose response pattern was absent from the acute test (96-hr LC50 of 87,060 ppb), which is noteworthy as the test waters were batched and split between acute and chronic tests. Test organisms in the chronic test exhibited 100% mortality in all flumioxazin test treatments except the top two highest concentrations of 50,000 and 100,000 ppb, which had 80% and 90% survival, respectively. However, animals in those test concentrations did not produce any neonates, which generated an EC25 of <3,125 ppb, the lowest concentration tested. Although the dominant route of flumioxazin for *C. dubia* is likely through direct uptake from water column, *C. dubia* may also be exposed to toxic levels of flumioxazin via food ingestion. At this time we do not have a definitive explanation for this response. The only mention of an observed inverse dose response in the literature was in Olson et al. (1987), where the researchers administered the carbamate insecticide Aldicarb, to mice via drinking water for 14 days at 10, 100, and 1,000 ppb, or for 34 days at 1, 10, 100, and 1,000 ppb. Their results significantly and repeatedly suppressed cell response in red blood cells at the lowest concentration, and found that 1 ppb elicited a greater suppression of plaque forming cells and other immune factors than did 1,000 ppb Aldicarb (Olsen et al. 1987). The authors did not extrapolate the mechanisms behind those responses. Our results could possibly be due to the differences in acute and chronic *C. dubia* protocols. Acute protocols have a reduction in feeding, where test organisms are fed prior to test initiation, and again two hours before water renewal at the 48-hr time point. This reduces the chances of chemicals binding to food during the test. In comparison, organisms in the chronic *C. dubia* test are exposed to food daily, as food is added to the test renewal waters. Flumioxazin is listed as having 'moderate mobility' with a mean $K_{oc}$ of 557, and is expected to bind moderately to soil with more organic material (Thurston County Health Department 2014). It is possible that the food (a mixture of green algae, trout chow, alfalfa, and yeast) added to the test chambers of the chronic test acted as organic material that the flumioxazin could then bind to, becoming more bioavailable to the test organisms as they feed. If this were the case, *C. dubia* in the lower test concentrations may have eaten more food than those in the higher test concentrations, and therefore exhibited higher mortality by being further exposed to the flumioxazin. Test organisms in the higher test treatment concentrations could have already been weakened by the higher flumioxazin test concentrations or have sensed the presence of the chemical in the water, which may have reduced their ability to feed, or avoid the food, and thus be exposed to less flumioxazin in the water column if it were bound to the food particles. However, we were unable to find any supporting evidence for this in the literature.

The information available in the literature indicate Daphnia sensitivity to this herbicide. The Australian Pesticides and Veterinary Medicines Authority (APVMA 2003) evaluation of flumioxazin in the formulation Pledge 500 WG generated *D. magna* 48-hr EC50 values for both the soluble fraction of

flumioxazin, centrifuged from the test water samples, as well as the non-centrifuged water samples. The 48-hr EC50 in the centrifuged water samples was 5,900 (5400-6500) ppb, compared to 17,000 (14000-22000) ppb in the non-centrifuged water samples. *D. magna* exposed to the non-centrifuged samples had an NOEC of 8,400 ppb. These researchers also conducted a *D. magna* life-cycle study, in which they report a NOEC of 57 ppb and a LOEC of 105 ppb.

### Imazapyr (Habitat)

Imazapyr was one of the least toxic to all species tested, as we were unable to generate any effect concentration data for any survival LC50 endpoint, as all test organisms did not exhibit any reduced responses up to and including the highest test concentration of 100,000 ppb. The only sub-lethal response was observed in the chronic *C. dubia* test, with a reproduction EC25 of 67,190 (25160-72730) ppb. Our findings concur with those in the literature. The Weed Society of America (WSSA 1994) lists 96-hr LC50s >100,000 ppb for Rainbow Trout, Bluegill Sunfish, Channel Catfish, and *D. magna.* Forbis (1984) reported a static 48-hr EC50 for *D. manga* of 350,000 (300000-410000) ppb, with a LOAEC of 180,000 ppb and a LOAEC of 320,000 ppb.

### Topramezone (Oasis)

Topramezone was the least toxic herbicide tested during this study. There were no adverse effects observed in any species in any endpoint. All effect concentration data exceeded the highest test concentration of 100,000 ppb. Although there is limited information available in the literature, the EPA ECOTOX Knowledgebase lists 96-hr LC50 of >239,400 ppb for Bluegill, and >119,000 ppb for Sheepshead Minnow, for the technical grade topramezone, and for a static 96-hr Rainbow Trout LC50 of >94,600 ppb for liquid formulation of topramezone and >97,400 ppb for technical grade topramezone.

### SX-1552 (Procellacor/SLF-9522)

*C. dubia* was the species most sensitive to SX-1552, as all fish species tested had effect concentration data that exceeded the highest test concentration of 100,000 ppb. The 96-hr LC50 for *C. dubia* is 68,040 (62920-70270) ppb, while the chronic LC50 was > 100,000 ppb, with a reproductive EC25 of 20,100 (14170-26010) ppb. As this herbicide is relatively new, no information exists in the literature outside of aquatic vegetation sensitivities. The RSDS lists 96-hr LC50s on the formulated product for Carp (*Cyprinus carpio*) of >1,920 ppb, >80,000 ppb for *D. magna*, and >1,880 ppb for the eastern oyster (*Crassostrea virginica*) (SePRO 2016).

### Cygnet Plus non-ionic surfactant

Test organisms were generally sensitive to this adjuvant, more so than most of the herbicides evaluated in this study. As was observed with flumioxazin, acute and chronic survival LC50s were generally similar to each other within the same species tested. Acute and chronic Inland Silverside survival LC50s were 8,839 (8839-8839) ppb and 8,505 (7865-9039) ppb, respectively, with a growth EC25 of >6,250 ppb, indicating that fish in concentrations above 6,250 ppb exhibited 100% mortality prior to 96-hr, and that surviving Inland Silversides did not exhibit a reduction in weight. Acute and chronic Fathead Minnow survival LC50s were similar as well, with 58,670 (42170-65590) ppb and 12,380 (11050-13860) ppb, respectively, with a growth EC25 of 7,640 (6208-10340) ppb. The acute and chronic Rainbow Trout survival LC50s were similar, however we were only able to generate a 48-hr LC50 in the chronic sac-fry Rainbow Trout test, as all test organisms exposed to Cygnet Plus NIS exhibited 100% mortality prior to 96-hr. That 48-hr survival LC50 is 9,396 (8504-13140), and its associated EC25 is >3,125 due to the high mortality of test organisms by 96-hr. The acute 96-hr Rainbow Trout LC50 is 8,800 (8672-8862) ppb. *C.*

*dubia* were also sensitive to this adjuvant, as test organisms exhibited 100% mortality prior to 96-hr in both the acute and chronic test protocols. We were able to generate a 24-hr acute LC50 of 3,125 (NA-5196) ppb, with an associated 24-hr NOEC of 3,125 ppb and a LOEC of 6,250 ppb. In the chronic *C. dubia* test, organisms exhibited 100% mortality within 24-hr of test initiation, therefore we are unable to generate effect concentration, as it is < 3,125 ppb, the lowest concentration tested. Test organisms in both the acute and chronic *C. dubia* test protocols exhibited similar time to mortality, as 50% of the organisms in the acute protocol exhibited mortality, and all were deceased by 48-hr.

There is limited information available in the literature regarding Cygnet Plus NIS specifically. Haller and Stocker (2003) examined the toxicity of 19 adjuvants to Bluegill Sunfish, and reported a 96-hr LC50 of 30,200 (29000-31500) ppb to Cygnet Plus. There is, however, a plethora of information citing the toxicity of adjuvants in comparison to herbicide and/or pesticide formulations, or the technical products themselves. Folmar et al. (1979) evaluated various formulations of glyphosate with and without adjuvants and found that the surfactant used in many glyphosate formulations are more toxic than the active ingredient, with LC50s ranging from 1,000 (1200-1700) ppb for the Fathead Minnow, to 3,000 (2500-3700) ppb for Bluegill Sunfish. Tatum et al. (2012) evaluated several herbicides, adjuvants, and tank mixtures and reported the adjuvant Entry II elicited 47% mortality in 96-hr Fathead Minnow and 60% in 48-hr *C. dubia* acute toxicity tests at the highest concentration tested (100%). Haller and Stocker (2003) reported that the toxicity of the 19 adjuvants studied ranged from 1 to over 200 ppm, but that results generally were similar to the proprietary data from the manufacturers and other values reported in the literature. Tsui and Chiu (2003) generated 48-hr LC50s for *D. magna* for two technical grades of glyphosate as well as the adjuvant used in some Roundup formulations, POEA, and found that Daphnia sensitivity to the adjuvant was an order of magnitude higher than to glyphosate alone (LC50 of POEA 1,150 ppb compared to 147,000 ppb for glyphosate acid and 415,000 ppb IPA salt of glyphosate).

### Tank Mixes

Tank mixes were made based on the label's maximum application rates for either FAV or SAV control, depending on the herbicide mixture. Tank mixes containing herbicides used for FAV control included the addition of the non-ionic surfactant Agridex at the maximum application rate of 2.5% (v/v). Tank mixes tested during this investigation were:

1) 90 ppb glyphosate (Roundup Custom) + 45 ppb flumioxazin (Clipper) + Agridex NIS
2) 74 ppb carfentrazone (Stingray EW) + 500 ppb Imazmox (Clearcast) + Agridex NIS
3) 90 ppb fluridone (SonarAS) + 5,000 ppb endothall (Aquathol K)

The third tank mix is used with SAV control and thus did not include an adjuvant, as these herbicides are injected directly into the water column during application.

It should be noted that the herbicide concentrations of imazamox, carfentrazone, glyphosate, and flumioxazin used in the Tank Mixes are lower than the LC50 concentrations determined in current study. The exception to this is endothall, where the maximum application concentration is 5,000 ppb. This concentration had little effect on the survival effect concentration for the majority of the species tested. However, it should be noted that 5,000 ppb was the NOEC for both acute and chronic Inland Silversides, as well as the growth EC25 threshold for the chronic Inland Silversides. The growth NOEC for the Fathead Minnows was 3,125 ppb, which is lower than the 5,000 ppb endothall included in the tank

mixes. Moreover, the chronic *C. dubia* reproductive EC25 was 31.94 ppb for this chemical, which is well below the concentration of endothall added to the tank mixes.

The results of current study indicate that survival of Inland Silverside, Rainbow Trout, and Fathead Minnow were not negatively affected by the Tank Mixes in the acute and chronic tests. These Tank Mixes also did not have any negative effects on Inland Silverside and Rainbow Trout growth. In comparison, the Fathead Minnow growth endpoint was sensitive to the Tank Mixes of [fluridone + endothall], as well as [glyphosate + flumioxazin + Agridex NIS], where we saw statistically significant reductions in this endpoint when Fathead Minnows were exposed to these Tank Mixes.

*C. dubia* were the most sensitive to the Tank Mixes, with statistically significant reductions in 96-hr survival in organisms exposed to [imazamox + carfentrazone + Agridex NIS] and [glyphosate + flumioxazin + Agridex NIS], yet this endpoint was unaffected by the [fluridone + endothall] mix. The *C. dubia* chronic reproductive endpoint was the most susceptible to the Tank Mixes, as this endpoint was statistically significantly reduced in response to all the Tank Mixes tested.

While surfactants are usually suggested as the most toxic component of herbicide tank mixes than the active ingredient (Giesy et al. 2000), we cannot definitively make that same claim with the current study, as the addition or absence of the adjuvant had little impact on the toxicity of the Tank Mixes tested. In instances where we saw statistically significant reductions in a sub-lethal endpoint, such as growth and/or reproduction, these generally occurred regardless of whether an adjuvant was included in the mix.

Despite limited information from the tank mixes study, results of the current study suggest no additive effects of [500 ppb imazamox + 74 ppb carfentrazone-ethyl + Agridex NIS], [90 ppb fluridone + 5,000 ppb endothall], and [90 ppb glyphosate + 45 ppb flumioxazin + Agridex NIS] on the three fish species, but there may possibly be an additive or synergistic effect on *C. dubia,* since this species was most affected by these mixes. Currently, at this time there is limited information for us to draw further conclusions on the tank mixes. As these Tank Mixes were set at the maximum field application limits, and not at the concentrations currently in place with DBW SAV and FAV control programs, the data provided herein can be considered as a 'worst case scenario' if maximum field concentrations are reached. However, as there is such limited information regarding tank mix toxicity, as well as mixture effects and adjuvant synergism in the literature, we recommend additional studies to further examine Tank Mix mixture effects at more environmentally relevant concentrations.

## Feeding study

During this feeding study, Delta Smelt did not consume Planthopper or Weevil biocontrol agents. Despite the pre-test fasting period and empty stomachs, Delta Smelt exposed to Planthopper and Weevil feeding treatments possessed a large amount of reserved energy (i.e. abdominal fats) to sustain a 96-hr starvation period without feeding. In fact, we have found that a 6-day starvation period has no detrimental effects on adult Delta Smelt survival. These results indicate that FCCL adult Delta Smelt are in excellent health condition and have abundant reserved energy necessary for reproduction.

In addition, a recent study conducted in FCCL indicates that adult Delta Smelt consume insects (e.g., beetles, bees, moths, and mosquitos) and worms when raised ex-situ for 6 months in ambient field water pumped from the river (Hung et al., unpublished data). Therefore, it is very likely Delta Smelt will feed on Planthopper and Weevil in the wild when food availability is limited. To further confirm whether

Delta Smelt will consume Planthopper and Weevil biocontrol agents we would like to propose a 10 day feeding study (4 days starvation followed by a 6-day exposure to Planthopper and Weevil).

Results of this study confirmed that juvenile Rainbow trout are feeding on Planthopper and Weevil and there are no significant differences in RNA/DNA analysis between control and treatment groups. It should be noted that the short-term 96-hr study is insufficient to evaluate the nutritional status of Planthopper and Weevil consumption on Rainbow Trout.

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Section 4

# Draft Collaboration Guidelines

## Collaboration Guidelines for Delta AIS Control

The purpose of the Collaboration Guidelines for Delta Aquatic Invasive Species[1] (AIS) Control (Guidelines) is to support a comprehensive, flexible, practical, inclusive, efficient, and effective approach to managing aquatic invasive species in the Delta. A primary goal of the Guidelines is to ensure that they provide specificity and follow-through, particularly as related to roles and responsibilities of AIS Control in the Delta. The Guidelines are compatible with the Program Description in the Biological Assessment (BA) and Programmatic Environmental Impact Report (PEIR), and will be incorporated into the Endangered Species Act (ESA) consultation process and PEIR. The Guidelines identify actions, implementation guidelines, and defines roles and responsibilities across nine objective areas. These areas are consistent with the Aquatic Invasive Plant Control Program's (AIPCP) comprehensive programmatic approach that balances the needs of the environment, public health, and the economy.

The Guidelines fit within a framework of numerous plans that affect the Sacramento-San Joaquin Delta and surrounding areas. The Guidelines should be considered within the framework of six associated plans, as described below. The actions described in the Guidelines are intended to be compatible with, and support, related plan actions. **Exhibit 1** provides an illustration of the area of focus for each of the six plans, as well as the Guidelines. Several plans are focused on California water, including the Delta. Others cover water and land, including the Delta. The California Wildlife Action Plan focuses on species in both land and water. The California AIS plan covers invasive species in waters of all California, including the Delta. The graphic illustrates the significant overlap across plans. **Exhibit 2** provides a high level summary of each of the plans, and their relationships to the Guidelines and the AIPCP.

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[1] These Collaboration Guidelines apply to California State Parks Division of Boating and Waterways (DBW) Aquatic Invasive Plant Control Program (AIPCP) and to the broader Aquatic Invasive Species Control Program. The focus of the Collaboration Guidelines is the Sacramento-San Joaquin Delta, tributaries, and Suisun March, as defined in Harbors and Navigation Code Section 64.

**Exhibit 1**
**Relationship of Six Key California Water, Delta, and AIS Planning Efforts Related to the Collaboration Guidelines**

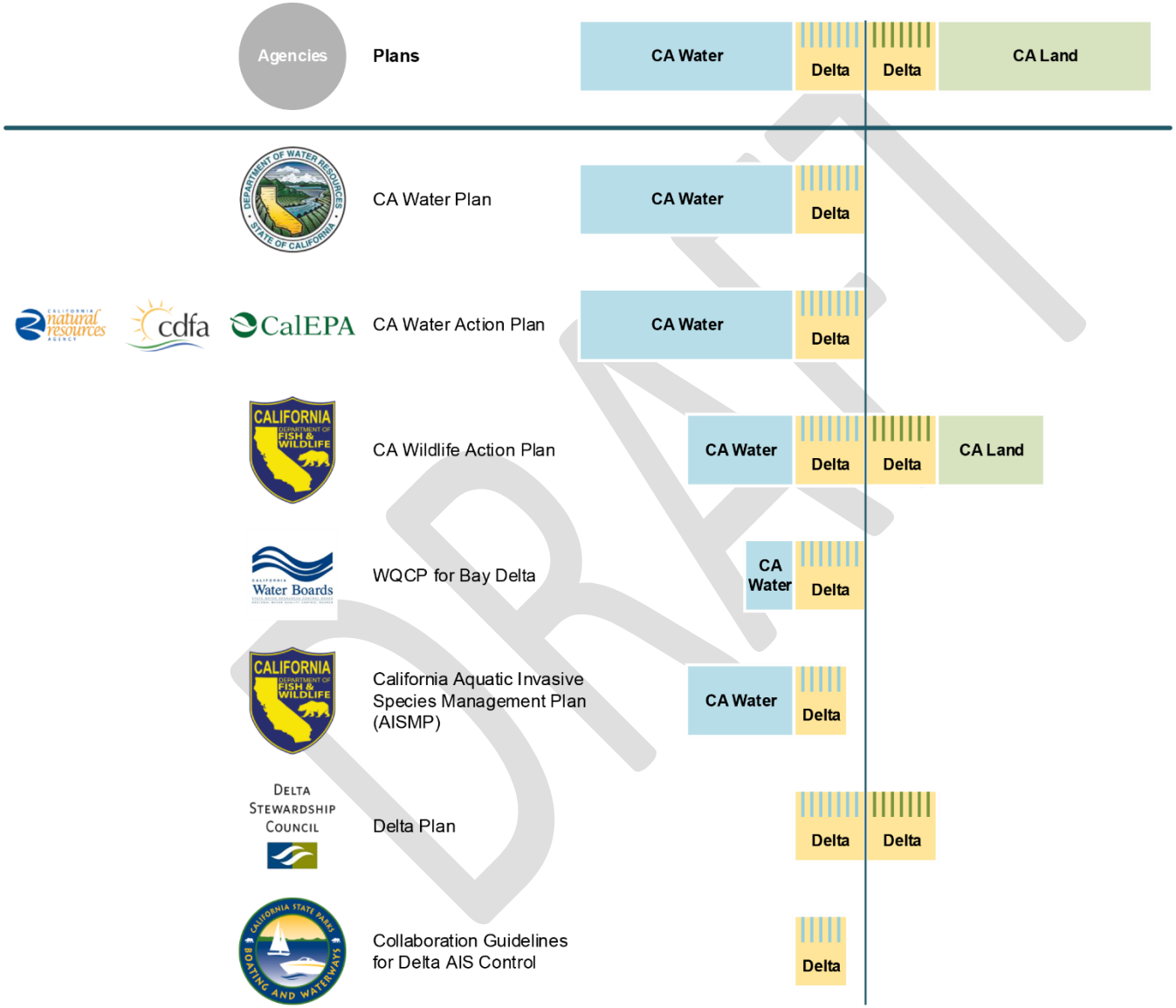


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**Exhibit 2**
**Overview of Six Key California Water, Delta, and AIS Planning Efforts Related to the Collaboration Guidelines**



| Plan and Agency | Description | Relationship to AIPCP and Collaboration Guidelines |
|---|---|---|
| California Water Plan Update 2013 (DWR) | DWR's long-standing commitment to regularly assess the state's water management challenges and opportunities; solution oriented strategies for sustainable management of water resources. Complements Water Action Plan.<br><br>Critical themes:<br>• Commit to Integrated Water Management – includes improved water quality, better flood management, restored and enhanced ecosystems, more reliable water supplies<br>• Strengthen government agency alignment – includes increased coordination, leveraging existing networks, better alignment of planning, policies, regulations<br>• Invest in innovation and infrastructure – includes development of analytical tools, structures and facilities to support human activities and natural infrastructure.<br><br>Delta-specific components: among the Plan's 10 essential actions are: achieve the coequal goals for the Delta; protect and restore important ecosystems. | Water quality<br><br>Habitat enhancements<br><br>Connection to aid players to achieve their goals<br><br>Not degrading water quality<br><br>Avenue to meet habitat enhancement goals<br><br>Water supply reliability |
| California Water Action Plan 2016 Update (Natural Resources Agency, CDFA, CalEPA) | First released in January 2014, this plan is a roadmap to put California on a path to sustainable water management. The solutions in the plan are intended to strike a balance between the need to provide for public health and safety, protect the environment, and support a stable California economy. The plan supports collaboration between federal, state, local and tribal governments, industry, and NGOs. The plan has three broad objectives: more reliable water supplies, the restoration of important species and habitat, and a more resilient, sustainable managed water resource system. The plan includes ten actions, including two directly related to the AIPCP (achieve the co-equal goals for the Delta and protect and restore important ecosystems).<br><br>The Delta Conservation Framework, incorporated into the California Water Action Plan, will guide long-term implementation of strategies and related actions for Delta conservation and stakeholder integration and the protection, enhancement, restoration, and adaptive management of Delta ecosystems and their ecological functions to benefit human and natural communities. The Delta Conservation Framework will continue the efforts of California EcoRestore over the long-term. | Balances public health, environment, economy<br><br>Promotes collaboration, including a coordinated approach to managing the Delta.<br><br>Develops and implements plans to recover threatened and endangered species in the Delta<br><br>Accelerates and implements habitat restoration through California EcoRestore through 15 restoration projects and 30,000 acres.<br><br>Supports implementation of near-term Delta ecosystem improvement projects (Yolo Bypass and others)<br><br>Supports restoring flows to the San Joaquin River and reintroducing Chinook salmon via the San Joaquin River Restoration Program.<br><br>Supports long-range planning (2017 to 2050) through the Delta Conservation Framework. |

**Exhibit 2**
**Overview of Six Key California Water, Delta, and AIS Planning Efforts Related to the Collaboration Guidelines** *(continued)*



| Plan and Agency | Description | Relationship to AIPCP and Collaboration Guidelines |
|---|---|---|
| Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Basin Plan) (SWRCB) | Authorized under the Porter-Cologne Water Quality Control Act, establishes beneficial uses and includes a program of implementation to achieve water quality objectives.<br><br>The State Water Board is in the process of developing and implementing updates to the Bay-Delta Plan to protect beneficial uses in the Bay-Delta watershed. Phase I of this work involves updating San Joaquin River flow and southern Delta water quality requirements included in the Bay-Delta Plan. The proposed Phase II changes to the Bay-Delta Plan include: new inflow requirements for the Sacramento River, its tributaries, and eastside tributaries to the Delta (the Mokelumne, Calaveras and Cosumnes rivers); new and modified Delta outflow requirements; new requirements for cold water habitat; new and modified interior Delta flow requirements; recommendations for complementary ecosystem protection actions that others should take; and adaptive management, monitoring, evaluation, special study, and reporting provisions. The updates are expected to be adopted in late 2017. | Establishes water quality objectives to achieve defined beneficial uses for the Bay-Delta. Based on the NPDES general permit, the Water Quality Control Plan defines dissolved oxygen and other water quality objectives and monitoring requirements for the AIPCP. |
| California Wildlife Action Plan (CDFW) | Updated in 2015, this was the first major revision to the 2005 State Wildlife Action Plan (SWAP). The SWAP was mandated by Congress to receive funding for a State and Tribal Wildlife Grant Program. The plan includes conservation actions that respond to current and future challenges. Strategies focus on restoring ecological function and processes capable of withstanding the stresses imposed by a changing environment. The SWAP employs an ecosystem approach, sets three statewide goals (abundance and richness, enhance ecosystem conditions, and enhance ecosystem functions and processes. It considers species of greatest conservation needs, climate change, and prioritizes conservation targets (seven regions, including the Bay Delta and Central Coast). | Supports collaboration and partnerships<br><br>Invasive plants/animals are identified as one of the pressures (stressors). There are strategies in ten categories that address invasives.<br><br>Identifies species of greatest concern in the Bay Delta<br><br>Conservation Strategy 4 (Direct Management) includes “Manage invasive species”<br><br>Specific conservation target includes: “By 2025, miles of freshwater emergent wetland where native species are dominant are increased by at least 5% from 2015 miles. |

**Exhibit 2**
**Overview of Six Key California Water, Delta, and AIS Planning Efforts Related to the Collaboration Guidelines** *(continued)*



| Plan and Agency | Description | Relationship to AIPCP and Collaboration Guidelines |
|---|---|---|
| Delta Plan (Delta Stewardship Council) | Finalized in 2013, the Delta Plan was developed by the Delta Stewardship Council (DSC), established in 2009 with the Delta Reform Act. The Act also established the co-equal goals (providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem), and directed that 'covered actions' – plans, programs, and/or projects must be consistent with the Delta Plan.<br><br>The Plan includes 73 Recommendations and 14 Policies (legal requirements).<br><br>Next edition of the plan will be completed in 2018.<br><br>The Plan remains in place, pending conclusion of legal appeals.<br><br>Performance measures for the Delta Plan were published in September 2016, and include four measures for Strategy 4.4: Prevent Introduction of and Manage Nonnative Species Impacts.<br><br>The DSC operates the Delta Plan Interagency Implementation Committee to coordinate and oversee DPC's activities as required by the Delta Reform Act, and facilitate work on the Delta Plan. | Designates six high priority locations in the Delta and Suisun Marsh to protect, restore, and enhance to recover endangered species, rebuild salmon runs, and enhance wildlife habitat.<br><br>Ecosystem Restoration policies and recommendations call for habitat restoration, prohibits actions that could bring in new exotic species or improve conditions for existing species, and supports prioritization and implementation of actions to control nonnative invasive species.<br><br>Performance Measures include:<br>• CDFW and other appropriate agencies prioritize the list of "Stage 2 Actions for Nonnative Invasive Species."<br>• CDFW and other appropriate agencies fully implement the 2014 Ecosystem Restoration Program "Conservation Strategy" list or Strategic Goal 5. |
| California Aquatic Invasive Species Management Plan Update (2017) (CDFW) | The CAISMP was first released on 2008 and currently being updated by CDFW. The update is intended to identify areas of improved coordination among agencies, address actions that will make the most impact combatting invasive species, identify priorities to support budget requests, and help obtain federal funding. The intent is to develop realistic recommendations with measurable targets, providing more focus than the initial plan. The current draft of the plan includes 66 actions in 8 objective categories, identifies lead agencies, budgets, and funding sources. CDFW has been leading the effort since late 2016, bringing together and coordinating numerous state agencies. The final plan is expected to be completed in January 2018. | DBW and USDA-ARS have been involved in the CAISMP planning effort. Several proposed plan actions are directly related to DBW and/or USDA-ARS efforts in the Delta, including:<br>• Use online portal to track projects with locations and control methods<br>• Increase programs to monitor sites where AIS are likely to spread both for species new to state and for monitoring spread of existing species to new sites<br>• Develop list of species likely to be introduced and experts on their management<br>• Develop a framework for long-term monitoring of aquatic vegetation in the Delta and beyond areas currently under management<br>• Develop proactive actions that will be helpful with development and implementation of rapid response<br>• Expand acreage DBW is allowed to treat in the Delta as they add more aquatic plant species<br>• Implement aquatic weed control action from the Delta Smelt Resiliency Strategy |

For AIS management nationwide, the Aquatic Nuisance Species (ANS) Task Force has provided a well-defined structure that includes eight required plan objectives. The California AIS Management plan (CAISMP) that CDFW is currently drafting follows the ANS Task Force structure. The Guidelines are not a formal plan in the regulatory sense, but generally follow the approach specified by the ANS Task Force. Several of the Guideline actions listed below are modified from the CAISMP to be specific to the Delta. There are also additional actions for the Delta that do not have parallel actions in the CAISMP. The Guideline actions are organized by the eight required AIS plan objectives. In addition, the Guidelines includes a ninth objective: Ecosystem Restoration.

The remainder of the document provides Guideline activities and actions (left column), organized by the required AIS plan objectives. The middle column of the table provides performance metrics and approximate timeframes for each action. The right column identifies any related actions from the Draft CAISMP (April 2017). The California plan numbering ties to the nine objectives. The numbers in parenthesis below provide the current number of Guidelines actions for each objective. There are 25 actions in total. These Guidelines are meant to be a fluid document, with actions added or removed over time to reflect the current needs of the DBW's aquatic invasive species control programs.

The nine objectives are as follows:

1. Coordination and Collaboration – Improve coordination and collaboration among the people, agencies, and activities involved with AIS (3)
2. Prevention – Minimize and prevent the introduction and spread of AIS into and throughout California waters (2)
3. Early Detection and Monitoring – Develop and maintain programs that ensure the early detection of new AIS and the monitoring of existing AIS (3)
4. Rapid Response and Eradication – Establish and manage systems for rapid response and eradication (2)
5. Long-Term Control and Management – Control the spread of AIS and minimize their impacts on native habitats and species (5)
6. Education and Outreach – Develop a comprehensive education and outreach program to ensure awareness of AIS threats and management priorities (1)
7. Research – Increase research on the baseline biology of AIS, the ecological and economic impacts of invasions, and options for control to improve management (4)
8. Laws and Regulations – Ensure state laws and regulations promote the prevention and management of AIS introductions (3)
9. Ecosystem Restoration – Protect areas of special ecological significance and support AIS control efforts in restoration areas (2)

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**Exhibit 3**
**Delta Aquatic Invasive Species Collaboration Guidelines**



| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| **Objective 1: Coordination and Collaboration** | | |
| 1. Implement a coordinated approach for the Delta AIS program.<br>DBW will identify and meet with appropriate state, federal, and local agency partners to discuss program approach for each upcoming year. The partners will also discuss applicable roles within the overall Delta AIS program, including the roles of: USDA-ARS, UC Davis, DWR, CDFW, CDFA, CVRWQCB, the Port of Stockton, counties, Reclamation districts, vector control, USDA-ARS, USFWS, NMFS, USBR, USACE, and USCG. | • Distribute monthly or quarterly email communication on program status, starting in 2018<br>• Conduct annual meeting in January or February to describe program approach for upcoming treatment season, starting in 2018 | 1B1. Improve communications on AIS control methods and related research (Agencies, research institutions, stakeholders) |
| 2. Where applicable, collaborate and coordination weed control management activities by specific agencies and specific locations, considering varying priorities and resource constraints. | • Develop ongoing agreements to meet program needs | |
| 3. Improve communication about effective control methods among practitioners of aquatic plant management.<br>a. Continue the Delta Interagency Team's annual workshop and posting talks online (meet early in the treatment season (February))<br>b. Continue working with collaborative groups such as the Interagency Ecology Program (IEP) Working Group on AIS plants<br>c. Improve online portal to track projects within the Delta (UC Davis/USDA-ARS/DRAAWP)<br>d. Re-establish Weed Management Area program (a concept utilized historical by CDFA) in the Delta to improve county-level coordination among multiple organizations.<br>Through DRAAWP or the UC Weed RIC (Research and Information Center), prepare and maintain a living document that summarizes control methods, procedures, and results in order to support adaptive management approaches. Ensure that this document is available to practitioners for real-time information. | • Identify lead entity to maintain document by January 2018<br>• Prepare initial draft by June 2018<br>• Continue to develop and promote document as a repository of effective control methods | 1B1. Improve communications on AIS control methods and related research (Agencies, research institutions, stakeholders) |

**Exhibit 3**
**Delta Aquatic Invasive Species Collaboration Guidelines** *(continued)*



| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| **Objective 2: Prevention** | | |
| 1. Educate the public about aquatic weed species and decontamination at Delta boat ramps and marinas<br><br>DBW will build on existing documents to develop posters and fliers on aquatic weed species and decontamination methods. The AIS program will coordinate with the Boating Facilities and Outreach programs. | • Prepare documents and place at various Delta boat ramps and marinas by May 2018<br><br>• Distribute updated documents when applicable | 2B3. Develop Best Management Practices for cleaning recreational vessels (Sea Grant) |
| 2. Educate nurseries, aquarium stores and farmer's markets in the Delta to educate them on AIS vectors and reduce their spread in the Delta<br><br>DBW will coordinate with existing initiatives, including CDFW's AIS outreach efforts, Sea Grant, Habitattitude, and County Agricultural Commissioners to provide educational materials on AIS species to nurseries, farmer's markets, and aquarium stores in and around the Delta and surrounding areas.<br><br>• Join Habitattitude (www.habitattitude.net/), a national initiative working in coordination the pet, aquarium, and nursery industries to prevent the release of fish and aquatic plants in the environment<br><br>• Utilize educational materials from Habitattitude and other entities | • Identify nurseries (CDFA has a list of certified nurseries) and aquarium stores in the Delta region and surrounding areas by May 2018<br><br>• Obtain and distribute materials by July 2018<br><br>• Obtain updated documents annually, or as requested by owners | 6A6. Provide information to be distributed to ornamental buyers about risk of releasing aquarium species (University of California Cooperative Extension (UCCE) and Sea Grant) |

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| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| **Objective 3: Early Detection and Monitoring** | | |
| 1. Prepare and compile comprehensive maps of aquatic vegetation in the Delta<br>As part of the coordinated effort, multiple entities will regularly (annually or more frequently) prepare a variety of maps of aquatic vegetation, including:<br>a. IEP Working Group's monitoring plan for all AIS plants in Delta (DWR) (in planning phase)<br>b. DRAAWP/NASA monitoring, in coordination with DBW, that may include satellite and fly over imagery<br>c. Coordinated DBW ground-truthing with flights<br>d. DBW hydro-acoustic monitoring of SAV treatment sites | • DBW will seek to obtain photogrammetry images on a to support program needs<br>• DBW will conduct annual hydro-acoustic monitoring of selected SAV treatment sites | 3A1. Increase programs to monitor sites where AIS are likely to spread both for species new to state and for monitoring spread of existing species to new sites (None identified)<br>3B1. Develop a framework for long-term monitoring of aquatic vegetation in the Delta beyond areas currently under treatment (DWR/IEP, CDFW, Delta Conservancy, DBW) |
| 2. Develop and implement a coordinated effort for DBW crews to conduct early detection and monitoring by supporting their ability to monitor sites where AIS are likely to spread, both for species new to state and for monitoring spread of existing species to new sites. | • Work with USDA-ARS to prepare a "watch list" of potential invading species by February 2018<br>• Develop protocol for field crew monitoring by February 2018<br>• Provide training to field crews by March 2018 | 3A1. Increase programs to monitor sites where AIS are likely to spread both for species new to state and for monitoring spread of existing species to new sites (None identified) |
| 3. Expand the use of citizen science and information from the Delta's network of marinas, boaters, and residents to report on infestations<br>DBW will continue to publicize its "Report a Sighting" procedures online and in outreach materials. In addition, DBW will develop a smart phone application that will allow the public to easily submit sighting information to DBW (including submitting photos and coordinates of where the photo was taken), and for DBW to track, evaluate, and respond to the information. DBW will promote the application through DBW's email network, web page, social media, marinas, program stakeholders<br>DBW will continue to publicize and track information obtained through "Report a Sighting". | • Develop a smart phone application for Delta AIS sightings by end of 2018<br>• Monitor and report on information obtained through the application, with pilot testing by the end of 2018 | 3B2. Incorporate AIS monitoring into existing citizen science programs (Sea Grant, UCCE, CDFW, CDFA) |

| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| **Objective 4: Rapid Response and Eradication** | | |
| 1. Develop a proactive regulatory agreement between DBW and CDFA to facilitate rapid response in the near term, including "emergency projects", if and when applicable. | • Meet with CDFA by March 2018 to develop rapid response agreement in the event of new weed invasion in the Delta under CDFA's existing authorization | 4A1. Develop framework for when to use rapid response and eradication vs. long-term control (None listed)<br>4A3. Develop proactive regulatory agreements between agencies to facilitate rapid response (CDFA) |
| 2. Evaluate the need for DBW to seek authority to conduct rapid response in the Delta.<br>DBW will evaluate, and if applicable work with the legislature to obtain authority to conduct rapid response in the Delta for new AIS outbreaks. DBW and its partners will develop criteria and procedures for implementing a rapid response in the Delta. | • Develop criteria and procedures for rapid response by March 2018 (to be used by CDFA initially) | 4A1. Develop framework for when to use rapid response and eradication vs. long-term control (None listed)<br>4A2. Develop structure for rapid response for species other than mussels (CDFW)<br>4A4. Develop proactive actions that one can take that will be helpful with development and implementation of rapid response (Sea Grant and CDFW and DBW) |

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| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| **Objective 5: Long-term Control & Management** | | |
| 1. Identify best management practices (BMPs) for AIS plants in the Delta. BMPs will outline the preferred treatment types (chemical, physical, biological), locations, and timing for FAVs, EAVs, and SAVs. | • Develop summary of key actions, priorities, approaches for each species found in the Delta, building on the BA, by March 2018; include discussion of how the life cycle of plant relates to treatment options<br>• Update this document annually based on results of prior treatment season in January of each year | 5A1. Expand acreage Boating and Waterways is allowed to treat in the Delta as they add more aquatic plant species (DBW)<br>5A2. Work with regulatory agencies to identify opportunities for programmatic permits in place of individual project permits (DBW) |
| 2. Develop structured prioritization approach that is based on established criteria, minimizing the need for reactive treatment of sites<br>DBW will define treatment zones based on each site's characteristics, uses, and nursery status. For each zone, DBW will develop control method best practices. In addition, DBW will develop prioritization criteria that can be utilized in developing the control approach for each treatment season.<br>DBW will develop treatment protocols and prioritization methodologies to be implemented prior to each treatment season. | • Define treatment zones, preferred approach/BMPs, and prioritization for each treatment zone by June 2017 as part of the BA<br>• Expand on the existing prioritization framework to create comprehensive prioritization documents for FAV, EAV, and SAV by December 2017 and update annually based on results of prior treatment season (in December of each year) | |
| 3. Implement an integrated adaptive management approach to AIS treatment in the Delta. Build on the treatment zones developed in item #2, and incorporate chemical, physical, and biological treatment methods to maximize treatment efficacy. Evaluate results on an annual basis and incorporate learning from the prior year and ongoing research into the next year's planning efforts. | • Incorporate an integrated adaptive management approach into the BA Program Description by June 2017<br>• Continue to implement adaptive management during in current and future treatment seasons | 5A1. Expand acreage Boating and Waterways is allowed to treat in the Delta as they add more aquatic plant species (DBW)<br>5A2. Work with regulatory agencies to identify opportunities for programmatic permits in place of individual project permits (DBW) |

| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| 4. Work with USDA-ARS to implement biocontrol in the Delta.<br><br>Incorporate biocontrols into the Programmatic Consultation and program approach, with USDA-ARS leading implementation and monitoring efforts.<br><br>Include *Neochetina bruchi*, *N. eichhorniae*, and *Megamelus scutellaris* in the AIPCP Program Description. | • Obtain authorization to introduce these species in the Delta | 5A5. Expand availability of biocontrols agents (primarily for invasive plants) (CDFA (USDA), DBW) |

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| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| **Objective 6: Education and Outreach** | | |
| 1. Conduct outreach to various audiences in the Delta to educate them about AIS vectors, best practices, treatment locations, and related matters, utilizing existing materials to the extent possible.<br>a. Continue email lists – expand information provided<br>b. Partner with groups that may have additional communication pathways, including but not limited to: USDA-ARS, UC Cooperative Extension, the Western Aquatic Plant Management Society (WAPMS), and the California Weed Science Society<br>c. Provide AIS education for those that have a lease for docks, marinas<br>d. Provide educational materials for non-motorized vessel owners and at launch sites<br>e. Utilize non-profits (water clubs, kayak groups, aquatic centers, etc.) for education/outreach<br>f. Social media | • Continue current outreach efforts on an ongoing basis<br>• Prepare an integrated communication strategy by November 2017<br>• Begin implementation of the communication strategy in March 2018<br>• Review and update communication strategy as needed | 6A2. Provide information to citizen science groups on ways to avoid introducing or moving AIS (UCCE)<br>6A3. Provide information to water recreationists about AIS ((UCCE, Sea Grant, UC Davis)<br>6A8. Develop outreach messages in other commonly used languages including Spanish, Chinese, Tagalog, etc.(UCCE, Sea Grant, UC Davis) |

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| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| **Objective 7: Research** | | |
| 1. With the USDA-ARS, Aquatic Plant Management Society (APMS), Aquatic Ecosystem Restoration Foundation (AERF), Center for Aquatic and Invasive Plants at University of Florida (U of F), the IEP Aquatic Vegetation Project Work Team, and others as applicable, develop a list of research questions and research priorities that will support the AIPCP, which may include the areas below. Note that this item is an effort to identify data gaps. The prioritization of research efforts and responsible entities or lead agencies for conducting the research will be identified through a collaborative effort.<br>a. Identify effective species-specific control methods for the Delta environment<br>b. Biocontrols (USDA-ARS)<br>e. Dissolved Oxygen<br>f. Turbidity<br>g. Fish locations and migration<br>h. Effects on critical habitats, including food web, and integration of AIP treatments with ecosystem restoration projects<br>i. Effects of climate change on Delta AIS species<br>j. Toxicity studies for new herbicides and adjuvants<br>k. Quantify costs of prevention, management, and AIS impacts in the Delta<br>l. Herbicide fate in bottom sediment<br>Reach out to nationally recognized aquatic plant management experts (APMS, AERF, U of F, and others) to obtain and provide input on aquatic plant management research and methods. | • Develop a working list of research questions in collaboration with the, USDA –ARS, DRAAWP, and others including project outlines and priorities, by December 2017<br>• Encourage research that will support DBW operations | 7A1. Develop a list of research questions together with regional researchers (Research institutions + agencies)<br>7A5. Evaluate how climate change will affect range expansion, impacts, and control effectiveness for particular invasive species (Research institutions)<br>7A6. Develop models or maps of potential range expansion, including considerations of climate change, to inform early detection and prioritization of control (Research institutions)<br>7B2. Develop a framework for quantifying the costs of prevention and vector management with costs of AIS impacts (Research institutions)<br>7C3. Identify potential targets for biocontrol (CDFA (USDA)) |

**Exhibit 3**
**Delta Aquatic Invasive Species Collaboration Guidelines** *(continued)*



| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| 2. Improve practitioners' and researchers' understanding of invasive species:<br>a. Evaluate and quantify the detrimental impacts of invasive species on ecosystems, special status species<br>b. Develop a thorough understanding of biology and ecology of target invasive species to inform future treatment method selection<br>Compile research and data on biology and ecology of invasive plant species found in the Delta (led by USDA-ARS). | • Identify key research questions on the impact of invasive species on Delta habitats by December 2017 (led by USDA-ARS) | 7A4. Improve information on the biology of particular AIS for the purposes of targeting management (Research institutions)<br>7B2. Develop a framework for quantifying the costs of prevention and vector management with costs of AIS impacts (Research institutions) |
| 3. Evaluate the efficacy of control methods for each target invasive species; gather data and case studies about effective and ineffective controls. Utilize Research Investigation Zones (RIZs) to support field research on an ongoing basis.<br>Prepare a list of key management questions; these operational needs may inform the research questions and priorities described above. Key questions may be related to:<br>a. Overspray and drift quantification<br>b. Herbicide concentrations in the water during and following treatments<br>c. Effectiveness of selected treatment methods (herbicides, adjuvants, physical, biological) | • Develop and begin to implement a research plan to address control methods, starting in the 2017 treatment season (overspray and drift)<br>• Incorporate RIZs into the AIPCP Biological Assessment and annual planning process | 7A4. Improve information on the biology of particular AIS for the purposes of targeting management (Research institutions)<br>7C2. Evaluate effectiveness of control methods for particular species (Research institutions, UCCE)<br>74C. Develop a decision tree for assessing which steps (eradication, control, reduction, no action) are needed for a new or existing introduction (Research institutions) |
| 4. Conduct proactive risk assessments in the Delta to identify which invasive plant species a) are already in the Delta will likely become problems and b) which species are likely to invade the Delta to create a "watch list". | • As applicable, support USDA-ARS in implementing proactive invasive species risk assessments starting in 2019 (led by USDA-ARS) | 74C. Develop a decision tree for assessing which steps (eradication, control, reduction, no actin) are needed for a new or existing introduction (Research institutions) |

| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| **Objective 8: Laws and Regulations** | | |
| 1. See Rapid Response and Eradication #2 – Evaluate the need for DBW to seek authority to conduct rapid response in the Delta | • Evaluate the need for legislation, and if applicable, work with CA Parks Legislative Affairs to develop legislative language during 2019 session | 4A3. Develop proactive regulatory agreements between agencies to facilitate rapid response (CDFA) |
| 2. Clarify definition and approach to non-native invasive species, working with USDA-ARS, CDFW, and CDFA to develop a definition that could be incorporated into policy or regulatory language related to non-native invasive species (addressing inconsistency between AB 763 and definition of invasive species). | • Address definition related to non-native invasive species by December 2018 | |
| 3. Work with CDFA to classify significant Delta aquatic invasive plants such as water hyacinth and *Egeria densa* as “noxious weeds”.<br>See: https://www.cdfa.ca.gov/plant/ipc/encycloweedia/winfo_weedlaws.html<br>5004. "Noxious weed" means any species of plant that is, or is liable to be, troublesome, aggressive, intrusive, detrimental, or destructive to agriculture, silviculture, or important native species, and difficult to control or eradicate, which the director, by regulation, designates to be a noxious weed. In determining whether or not a species shall be designated a noxious weed for the purposes of protecting silviculture or important native plant species, the director shall not make that designation if the designation will be detrimental to agriculture. | • Coordinate with CDFA and develop the regulatory case to classify water hyacinth and *Egeria densa* as noxious weeds by March 2019 | 6A6. Provide information to be distributed to ornamental buyers about risk of releasing aquarium species (UCCE and Sea Grant) |

| Collaboration Guidelines Activity/Action Descriptions | DBW Performance Metrics/ Time Frames | Related California AISMP Actions (Lead Agency(s)) |
|---|---|---|
| **Objective 9: Ecosystem Restoration** | | |
| 1. Provide support to the Delta Smelt Resiliency Strategy (DSRS) through invasive weed control at strategic locations<br><br>Starting in 2017, work with DWR, CDFW, and USFWS to identify and quantify selective treatment of aquatic invasive planet to support the DSRS. | • Acres treated in support of DSRS per year | 5B1. Implement Aquatic Weed Control action from the Delta Smelt Resiliency Strategy (DWR, DBW) |
| 2. Formalize the role of AIS treatments within Delta ecosystem restoration projects, addressing issues such as the following:<br>a. Should DBW develop a standard MOU template for DBW support of restoration projects?<br>b. What is the amount and frequency of treatment needed to support a given ecosystem restoration project? What are the research needs?<br>c. How should those treatments be funded?<br>d. How should the impact of those treatments be monitored? By whom<br>e. Can DBW obtain mitigation credit for treatments that are expressly to benefit habitat and species? | • Develop a structured but adaptive approach to AIS treatments in ecosystem restoration sites, working with key stakeholders (DWR/IEP Working Group, CDFW, USFWS, NMFS) during 2018<br>• # of restoration sites supported | 5B2. Research techniques to prevent establishment of invasive species in restoration projects (DWR, UC Davis) |

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**Acronyms and Abbreviations**

AERF - Aquatic Ecosystem Restoration Foundation

AIPCP – Aquatic Invasive Plant Control Program

AIS – Aquatic Invasive Species

ANS– Aquatic Nuisance Species

APMS – Aquatic Plant Management Society

BA – Biological Assessment

Basin Plan – Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary

BMP – Best Management Practice

CAISMP – California Aquatic Invasive Species Management Plan

CalEPA – California Environmental Protection Agency

CDFA – California Department of Food and Agriculture

CDFW – California Department of Fish and Wildlife

CVRWQCB – Central Valley Regional Water Quality Control Board

DBW – Division of Boating and Waterways

Delta – Sacramento-San Joaquin Delta

DPC – Delta Protection Commission

DRAAWP – Delta Region Areawide Aquatic Weed Project

DSC – Delta Stewardship Council

DSRS – Delta Smelt Resiliency Strategy

DWR – Department of Water Resources

EAV – Emergent Aquatic Vegetation

ESA – Endangered Species Act

FAV – Floating aquatic vegetation

HABs – Harmful Algal Blooms

IEP – Interagency Ecology Program

MOU – Memorandum of Understanding

NASA – National Aeronautical and Space Administration

NGO – Non-Governmental Organization

NMFS – National Marine Fisheries Service

PEIR – Programmatic Environmental Impact Report

RIC – Regional Information Center

SAV – Submersed aquatic vegetation

SWAP – State Wildlife Action Plan

SWRCB – State Water Resources Control Board

UCCE – University of California Cooperative Extension

UC Davis – University of California, Davis

U of F – University of Florida

USACE – United States Army Corp of Engineers

USBR – United States Bureau of Reclamation

USDA – United States Department of Agriculture

USDA-ARS – USDA Agricultural Research Service

USFWS – United States Fish and Wildlife Service

WAPMS – Western Aquatic Plant Management Society

WQCP – Water Quality Control Plan

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