

Floating Aquatic Vegetation Control Program Water Hyacinth and Spongeplant Control Projects 2015 Annual Monitoring Report



Floating Aquatic Vegetation Control Program 2015 Annual Report

Submitted Pursuant to:
Statewide General NPDES Permit (CAG990005)
USFWS Biological Opinion (81410-2013-F-0005)
USFWS Biological Opinion (08FBDT00-2014-F-0029)
NMFS Letter of Concurrence (2013/9443)
NMFS Letter of Concurrence (2014-394)

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 information submitted. Based on my inquiry of the persons who manage the program, Edward Hard – *Environmental Program Manager*, Leandro Ramos – *Senior Environmental Scientist (Supervisory)*, or those persons directly responsible for gathering the information, Angela Llaban – *Senior Environmental Scientist (Specialist)*, 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.



Lynn Sadler, Deputy Director



Date

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ACRONYMS AND ABBREVIATIONS

1. 2,4-D – 2,4-dichlorophenoxyacetic acid
2. AHP – Aquatic Health Program
3. ANOVA – Analysis of Variance
4. APAP – Aquatic Pesticide Application Plan
5. BMP – Best Management Practices
6. BO or BiOp – Biological Opinion
7. CDEC – California Data Exchange Center
8. CDFA-CAC – California Department of Food and Agriculture – Center for Analytical Chemistry
9. CDFW – California Department of Fish and Wildlife
10. CDPR – California Department of Pesticide Regulation
11. CF – Condition Factor
12. COLD – Cold Freshwater Habitat (Basin Plan beneficial use)
13. CVRWQB – Central Valley Regional Water Quality Control Board
14. DBW – California Department of Boating and Waterways
15. Delta – Sacramento-San Joaquin Delta
16. DO – Dissolved Oxygen (measured in mg/l or ppm)
17. DPF – Days Post Fertilization
18. DPH – Days Post Hatch
19. DPS – Distinct Population Segment
20. DWR – California Department of Water Resources
21. EPA – United States Environmental Protection Agency

22. ESA – Endangered Species Act (federal)
23. FAO – Food and Agriculture Organization of the United Nations
24. FAV – Floating Aquatic Vegetation
25. GC/MS – Gas Chromatography/Mass Spectrometry
26. GGS – Giant Garter Snake
27. HDPE – High Density Polyethylene
28. HPLC – High Performance Liquid Chromatography
29. IEP – Interagency Ecology Program
30. LOQ – Limit of Quantitation
31. NASA – National Aeronautics and Space Administration
32. NMFS – National Marine Fisheries Service
33. NOAA-Fisheries – National Oceanic and Atmospheric Administration-Fisheries
34. NPDES – National Pollution Discharge Elimination System
35. NTU – Nephelometric Turbidity Units
36. OGA – Oil Globule Area
37. OH – Owl Harbor Marina
38. OMP – Operations Management Plan
39. PCR – Pest Control Recommendation
40. PME – Precision Measurement Engineering, Inc.
41. ppb – Parts per Billion ($\mu\text{g/l}$)
42. QAC – Qualified Applicator Certificate
43. QAPP – Quality Assurance Project Plan
44. SAV – Submersed Aquatic Vegetation
45. SCA – Specific Cooperative Agreement

46. SCP – Spongeplant Control Program
47. SDWC – Stockton Deep Water Channel
48. SM – Seven Mile Slough
49. SPWN – Spawning, Reproduction, and/or Early Development (Basin Plan beneficial use)
50. SWRCB – State Water Resources Control Board
51. TS – Trapper Slough
52. UCD – University of California, Davis
53. UP – Union Point
54. USBR – United States Bureau of Reclamation
55. USDA-ARS – United States Department of Agriculture – Agricultural Research Service
56. USFWS – United States Fish and Wildlife Service
57. UTC – Coordinated Universal Time
58. UTM – Universal Transverse Mercator
59. VELB – Valley Elderberry Longhorn Beetle
60. WARM – Warm Freshwater Habitat (Basin Plan beneficial use)
61. WHCP – Water Hyacinth Control Program
62. WS – Whiskey Slough

EXECUTIVE SUMMARY

Water hyacinth (*Eichhornia crassipes*) and South American spongeplant (*Limnobium laevigatum*) are non-native, free-floating, invasive aquatic plants. They grow in wetlands, marshes, shallow water bodies, slow moving waterways, lakes, reservoirs, and rivers. Water hyacinth and spongeplant can have negative navigational, agricultural, public safety, environmental, or industrial impacts. These plants can de-stabilize dissolved oxygen cycles, crowd out native plants, shade out important shallow water fish habitat, obstruct waterways and navigational channels, and block agricultural and municipal water intakes.

In 1982, Senate Bill 1344 (Garamendi and Nielsen), Chapter 2, Article 2, Section 64 amended the statutes of the California Harbors and Navigation Code to designate the California Department of Parks and Recreation Division of Boating and Waterways (DBW) as the lead agency for controlling water hyacinth in the Sacramento-San Joaquin Delta (Delta), its tributaries, and the Suisun Marsh. In 2012, Assembly Bill 1540 (Buchanan) was passed to add spongeplant to DBW's aquatic weed control programs. In 2013, Assembly Bill 763 (Buchanan) was passed to address the need for a holistic approach to manage aquatic weeds in the Delta. This bill changed the overall strategic approach towards invasive aquatic plant management for the Division of Boating and Waterways. This bill mandated greater coordination among local, state, federal and private boating interests in the Delta to identify new plant species through a risk assessment based process to manage invasive aquatic plants.

This program operates under the regulations imposed by the National Pollutant Discharge Elimination System (NPDES) Statewide General Permit (CAG990005), issued by the State Water Resources Control Board (SWRCB); the U.S. Fish and Wildlife Service (USFWS) Biological Opinions (81410-2013-F-0005 and 08FBDT00-2014-F-0029); the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) Letter of Concurrence (2013/9443 and 2014-394) pursuant to Section 7 of the Endangered Species Act (ESA); and the California Department of Fish and Wildlife (CDFW) Streambed Alteration Agreement (1600-2015-0132-R3). As part of these regulations a monitoring program was developed to evaluate impacts of two floating aquatic vegetation (FAV) programs, the Water Hyacinth Control Program (WHCP) and Spongeplant Control Program (SCP), on water quality and federally listed threatened and endangered species.

All WHCP and SCP water quality monitoring follow the WHCP and SCP NPDES Annual Monitoring Protocol as outlined in the WHCP and SCP Aquatic Pesticide Application Plan (APAP), which was approved in 2014 by the SWRCB. Monitoring activities include recording WHCP and SCP impacts on beneficial waters of the United States, observations of federally listed threatened or endangered species, and associated listed species habitats. DBW monitored 18 sites within the legal Delta and San Joaquin River. Herbicide residues were analyzed in receiving waters and water quality parameters such as dissolved oxygen, temperature, conductivity, salinity, pH, and turbidity were measured at representative locations. During 2015, there were several occurrences where dissolved oxygen levels, turbidity and pH exceeded limits in the Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin River Basins established by the Central Valley Regional Water Quality Control Board. Water samples were collected per the NPDES monitoring requirements. There was no field evidence to suggest a correlation of these exceedances with DBW's FAV control program operations. These occurrences were expected to be temporary given the diurnal tidal movements of the Delta, varying hydrodynamics, and

periodic mixing of the water column. There were no observations of injured or impacted species of concern during follow up site surveys.

All herbicide (and adjuvants) residue concentrations at receiving water locations were either not detected or were below receiving water limits as specified in the NPDES permit. For all glyphosate water samples, herbicide residues were not detected. Residue concentrations for 2,4-D water samples were either not detected or ranged between 0.1 ppb to 2.27 ppb.

In 2015, the DBW applied 3,354 gallons of glyphosate, 836 gallons of 2,4-D, 7 gallons of imazamox, 1,855 gallons of Agridex, and 102 gallons Competitor for water hyacinth and spongeplant control. Herbicide treatments of the 2015 season began on March 4, 2015 and continued through November 30, 2015.

DBW treated the most acres in the history of the program (see Figure 3, page 28). DBW successfully treated 4,447 acres of water hyacinth and spongeplant (approximately 7 acres) in the Delta and its surrounding tributaries. The hard work performed during the 2015 season will serve as a springboard for the 2016 season and beyond.

The WHCP in 2015 treated more acreage than any other time in the history of the program. The USFWS Biological Opinion for the WHCP states, "From years 2014 to 2017 DBW may treat up to 3,500 acres of water hyacinth within the 350 treatment sites." In October, DBW expected to exceed the 3,500 acre limit for 2015 and submitted a request to USFWS and NMFS for a change in action for the WHCP. The change in action requested to treat up to 1,000 additional acres of water hyacinth for a maximum of 4,500 acres for 2015. The USFWS reviewed the request and "concurred that the increase in the amount of acres treated for 2015 with implementation of the conservation measures is not likely to adversely affect the valley elderberry longhorn beetle and giant garter snake." The USFWS biological opinion for the WHCP was amended as appropriate. NMFS reviewed the request and concurred that "the requested change in action is not likely to expose listed species, their designated critical habitat and essential fish habitat to herbicide levels that may affect the species and their habitat beyond those that were previously considered in the informal consultation that was conducted for the WHCP."

In January 2015, DBW acquired contracted services with the Department of Water Resources (DWR) to mechanically harvest water hyacinth from Old River near Fabian Tract in the South Delta. It was estimated that a total of 36,907 cubic yards of water hyacinth were removed between January 16, 2015 and March 12, 2015. Also in 2015, DBW acquired a 4-year contract with a mechanical harvesting firm to mechanically harvest water hyacinth from waterways of the Delta that were identified as being a nursery site or having high infestations of water hyacinth and/or spongeplant. These sites included a section of the Stockton Deep Water Channel from Weber Point to Buckley Cove, the Calaveras River, and Whiskey Slough. The contractor used a combination of harvesting equipment, excavators, and dump trucks to harvest and remove plants from the water and to take plants to an approved spoils site for drying and decay. Approximately 24,202 cubic yards of water hyacinth were controlled by mechanical means between November 13, 2015 and December 31, 2015.

1 INTRODUCTION

1.1 Extent of Infestation

The California Department of Parks and Recreation, Division of Boating and Waterways (DBW) is the designated lead state department for controlling water hyacinth (*Eichhornia crassipes*) and South American spongeplant (*Limnobiium laevigatum*), which are non-native, invasive, floating, aquatic weeds that can potentially grow in approximately 67,779 water surface acres of the Sacramento-San Joaquin Delta and its tributaries (San Joaquin River, Tuolumne River and Merced River). Water hyacinth coverage estimates in the Delta since 1981 have ranged from less than 500 acres, up to approximately 2,500 acres (DBW 2012). This wide range of annual water hyacinth acreage in the Delta is dependent upon many factors including: acreage treated, timing of treatments, winter air and water temperatures, summer air and water temperatures, water flows, water levels, and rainfall.

In 2007, spongeplant was identified in the Delta near Antioch and found again in following years, spreading to several other locations within the Delta. In 2015, spongeplant distribution expanded throughout the Delta and was observed in 45 sites in the Delta that contained either small amounts of individual plants or larger infestations ranging from approximately less than 25 square feet to 20,000 square feet.

Determining the annual extent of infestation of water hyacinth and spongeplant in the Delta and its tributaries can be difficult because both individual plants and large mats move with river currents, diurnal tidal movement and winds. Historically, pre- and post-season infestations have been assessed through visual estimates conducted by field crews.

Through a partnership with National Aeronautics and Space Administration (NASA) as a part of the US Department of Agriculture (USDA) Area-Wide Pest Management Project, NASA has provided DBW map imagery from Landsat satellite data that depicts live water hyacinth acreage of areas that have high probability of experiencing > 50% coverage of water hyacinth in Delta waterways. With this remote sensing tool, DBW and partners have been able to track water hyacinth distributions.

1.2 Setting

The two FAV programs, the WHCP and SCP, include portions of eleven counties that encompass the Delta and its upland tributaries. The eleven counties include Alameda, Contra Costa, Fresno, Madera, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Tuolumne, and Yolo. General boundaries for the treatment area in the Delta and its tributaries are as follows:

- West up to and including Sherman Island, at the confluence of the Sacramento and San Joaquin Rivers
- West up to the Sacramento Northern Railroad to include water bodies north of the southern confluence of the Sacramento River and Sacramento River Deep Water Ship Channel
- North to the northern confluence of the Sacramento River and Sacramento River Deep Water Ship Channel, plus waters within Lake Natoma

- South along the San Joaquin River to Mendota, just east of Fresno
- East along the San Joaquin River to Friant Dam on Millerton Lake
- East along the Tuolumne River to La Grange Reservoir below Don Pedro Reservoir
- East along the Merced River to Merced Falls, below Lake McClure

Within the 2015 WHCP and SCP project area, there are 418 possible treatment sites. These sites vary in size (between 5 and 1,700 acres) and may be between one and three miles in length. See Figure A-1 in Appendix A for a map of the WHCP and SCP project area and monitoring sites sampled in 2015.

2 SENATE BILL 1344 & ASSEMBLY BILLS 1540 AND 763

2.1 Section 64 of the Harbors and Navigation Code

Section 64 of the Harbors and Navigation Code is amended to read as follows:

“(a) The Legislature hereby finds and declares that the growth of water hyacinth (*Eichhornia crassipes*), Brazilian elodea (*Egeria densa*), and South American spongeplant (*Limnobium laevigatum*) in the Sacramento-San Joaquin Delta, its tributaries, and the Suisun Marsh has occurred at an unprecedented level and that the resulting accumulations of water hyacinth, *Egeria densa*, and South American spongeplant obstruct navigation, impair other recreational uses of waterways, have the potential for damaging manmade facilities, and may threaten the health and stability of fisheries and other ecosystems within the delta and marsh. Accordingly, it is necessary that the state, in cooperation with agencies of the United States, undertake an aggressive program for the effective control of water hyacinth, *Egeria densa*, and South American spongeplant in the delta, its tributaries, and the marsh.”

“(b) The Division is designated as the lead agency of the state for the purpose of cooperating with agencies of the United States and other public agencies in controlling water hyacinth, *Egeria densa*, and South American spongeplant in the delta, its tributaries, and the marsh.”

AB 763 (Passed in 2013)

“This bill would additionally designate the Division as the lead agency of the state for the purpose of cooperating with other state, local, and federal agencies in identifying, detecting, controlling, and administering programs to manage invasive aquatic plants, as defined, in the Sacramento-San Joaquin Delta, its tributaries, and the Suisun Marsh.”

2.2 Section 64.5 of the Harbors and Navigation Code

Section 64.5 of the Harbors and Navigation Code is amended to read as follows:

“(a) The Division is designated as the lead agency of the state for the purpose of cooperating with other state, local, and federal agencies in identifying, detecting, controlling, and administering programs to manage invasive aquatic plants in the Sacramento-San Joaquin Delta, its tributaries, and the Suisun Marsh. The Division, in consultation with appropriate state, local, and federal agencies, may take such action it determines is necessary, upon concurrence from the Department of Fish and Wildlife following the completion of the risk assessment described in subdivision (c), to implement control and,

when feasible, eradication measures for invasive aquatic plants. Any actions taken to control invasive aquatic plants shall be in compliance with all applicable laws and regulations and conducted in an environmentally sound manner.”

“(b) The Division shall regularly consult with the United States Department of Agriculture, the United States Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, the University of California, and other members of the scientific and research communities, as well as other state agencies with authority over the control of invasive aquatic plants to determine which species of those plants should be given the highest priority for management and determine the best control and, when feasible, eradication measures.”

“(c) (1) After consulting with the various entities as required in subdivision (b), if the Division identifies a species of aquatic plant that may be invasive and need to be controlled or eradicated, the division shall notify the Department of Fish and Wildlife of the potential threat from that aquatic plant species. After receipt of that notice, the Department of Fish and Wildlife, in consultation with other appropriate local, state, and federal agencies, including, but not limited to, the Department of Food and Agriculture, the Department of Water Resources, the State Water Resources Control Board, the Department of Pesticide Regulation, and the Office of Environmental Health Hazard Assessment, shall conduct a risk assessment of the aquatic plant species identified by the Division to determine whether the plant species is invasive and presents a threat to the environment, economy, or human health. In making that determination, the Department of Fish and Wildlife shall take prompt action to minimize detrimental impacts and costs of management, and shall consider all of the following:

(A) Whether the aquatic plant species may obstruct navigation and recreational uses of waterways.

(B) Whether the aquatic plant species may cause environmental damage, including threats to the health and stability of fisheries, impairment to birds’ access to waterways and nesting, roosting, and foraging areas, deterioration of water quality resulting from plant decay, and harm to native plants.

(C) Whether the aquatic plant species may cause harm to the state’s economy, infrastructure, or manmade facilities such as state water storage facilities and pumping operations, by increasing flood risk, threatening water supplies by blocking pumps, canals, and dams necessitating early control efforts.

(2) Based on factors specified in subparagraphs (A), (B), and (C) of paragraph (1) and any other environmental, economic, or human health impacts, the risk assessment shall specify whether the plant species under consideration has been determined to be an invasive aquatic plant. Findings from the risk assessment shall be documented in a way that clearly describes the severity and types of impacts caused by a plant species determined to be an invasive aquatic plant.

(3) Within 60 days after completing the risk assessment required by paragraph (1), the Department of Fish and Wildlife shall report its findings to the division so that the division may take any necessary action to control and, when feasible, eradicate an invasive aquatic plant, as authorized under subdivision (a).

(d) For purposes of this section, “invasive aquatic plant” means an aquatic plant or algae species, including its seeds, fragments, and other biological materials capable of propagating that species, whose proliferation or dominant colonization of an area causes or is likely to cause economic or environmental harm or harm to human health.

(e) Aquatic plants shall be determined to be invasive through the risk assessment required to be completed by the Department of Fish and Wildlife in consultation with the division and other state, local, and federal agencies pursuant to subdivision (c).”

3 ENVIRONMENTAL COMPLIANCE

3.1 Summary of Regulatory Compliance Requirements

The following constitutes a summary of the environmental compliance documents required to implement the two FAV programs, the WHCP and SCP. Each document has requirements designed to ensure avoidance or minimization of significant impacts to beneficial uses of waters of the U.S., federally threatened and endangered species, or state threatened and endangered species protected by the Endangered Species Act (ESA). DBW partners with the US Department of Agriculture-Agricultural Research Service (USDA-ARS) as a federal nexus to obtain required approvals to operate the WHCP and SCP from two federal agencies: U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS).

DBW obtained a multi-year (2013-2017) authorization from USFWS and NMFS to operate the WHCP and SCP pursuant to Section 7 of the Endangered Species Act (ESA).

- USFWS Biological Opinion (81410-2013-F-0005), effective March 13, 2013
- USFWS Biological Opinion (08FBTD00-2014-F-0029), effective August 11, 2014
- NMFS Letter of Concurrence (2013/9443), effective February 27, 2013
- NMFS Letter of Concurrence (2014-394), effective May 28, 2014

A National Pollutant Discharge Elimination System (NPDES) permit is required by the State Water Resources Control Board (SWRCB). Coverage under this permit was obtained in January 2014 and expires in 2018, and is referenced as the Statewide General NPDES Permit for the Discharge of Aquatic Pesticides for Aquatic Weed Control in Waters of the United States (Permit No.CAG990005, Water Quality Order 2013-0002-DWQ).

In addition, a Streambed Alteration Agreement (or Routine Maintenance Agreement) was entered into between DBW and CDFW for the mechanical removal/harvesting of water hyacinth (Notification No. 1600-2015-0132-R3). The Agreement became effective October 23, 2015 and shall expire on December 31, 2019.

3.1.1 Reporting Requirements

The NPDES Statewide General Permit for Aquatic Pesticide Use requires DBW to submit an annual report March 1 following the WHCP and SCP application season. Reporting per NPDES guidelines must include the following: 1) an executive summary discussing permit compliance or violation of permit terms and conditions to beneficial waters of the U.S. (Page 3); 2) the effectiveness of the WHCP/SCP Aquatic Pesticide Application Plan (APAP)

(Section 5.3.3); 3) the discharge of pollutants associated with aquatic pesticide applications (Sections 4.2 and 5.3.2); 4) a summary of monitoring data, including changes to water quality, and violations of compliance with water quality objectives as outlined in the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins issued by the Central Valley Regional Water Quality Control Board (CVRWQCB) (Section 5.3); 5) identification of Best Management Practices (BMPs) and their effectiveness in meeting permit requirements (Section 4); 6) a discussion of modifications or management corrections for any violations that occurred (Section 5.3); 7) maps showing application area, acreage and sampling locations, types and amounts of aquatic pesticides used during each application event, information on surface area, volume and rate of application (Appendices A - C), and 8) sampling results for all required monitoring (Appendix D).

Both the USFWS Biological Opinions (BO) and the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) Letters of Concurrence require annual reports to be submitted January 31, following the application season. These reports summarize compliance with the terms and conditions which include species and habitat protection, water quality monitoring, and any additional monitoring and studies that may have been conducted as part of regulatory requirements from other participating state or federal agencies. Additional reporting requirements are on a case-by-case basis in the event an incidental take should occur with any of the species discussed in the USFWS BOs. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Reporting of take begins with immediate notification to the USFWS biologist (based on jurisdiction) in charge of administering the BO and requires documentation of information, such as location of take, number of species, water quality conditions, chain of custody, and prescriptive action for preventing future occurrences.

3.1.2 Statewide General NPDES Permit

RECEIVING WATERS

There are clear definitions in the NPDES Permit (No. CAG990005) regarding application area, treatment area, and receiving waters. In the NPDES Permit, an *application area* is defined as the area in which aquatic pesticides are directly applied. The *treatment area* is the area treated with an aquatic herbicide to control aquatic weeds. It is the responsibility of the discharger to define the treatment area for each location that it discharges to. The WHCP/SCP sprays herbicide onto water hyacinth and/or spongeplant and does not inject herbicides into the water column to treat submerged plants. Therefore, considering the NPDES definitions, the application and treatment areas are essentially the same geographic place in relation to the WHCP/SCP. Receiving waters are defined in two manners: 1) waters directly down flow of the treatment area, and 2) waters within the treatment area after completion of the treatment event when herbicide residue levels fall below minimum effective concentrations. Herbicides applied to aquatic plants are not considered a pollutant until residues reach receiving waters. This is because an herbicide designed to treat aquatic plants and approved by the U.S. Environmental Protection Agency (EPA) cannot also be a pollutant under the Clean Water Act when the herbicide is doing what it was designed and approved to do under federal pesticide use regulations.

NUMERIC LIMITS

Dissolved Oxygen

Dissolved oxygen (DO) limits are outlined in the Central Valley Basin Plan issued by the CVRWQCB and subsequently required under the NPDES permit. Within the legal boundaries of the Delta, the DO concentration shall not be reduced below:

- 7.0 mg/l in the Sacramento River (below the I Street Bridge) and in all Delta waters west of the Antioch Bridge
- 6.0 mg/l in the San Joaquin River (between Turner Cut and Stockton, 1 September through 30 November)
- 5.0 mg/l in all other Delta waters

For surface water bodies outside the legal boundaries of the Delta, the monthly median of the mean daily DO concentration shall not fall below 85 percent of saturation in the main water mass, and the 95 percentile concentration shall not fall below 75 percent of saturation. To protect beneficial uses of water, the dissolved oxygen concentrations shall not be reduced below the following minimum levels at any time:

- 5.0 mg/l for waters designated as warm freshwater habitat (WARM)
- 7.0 mg/l for waters designated as cold freshwater habitat (COLD)
- 7.0 mg/l for waters designated for spawning, reproduction, and development (SPWN)

In the locations listed in Table 1, dissolved oxygen concentrations shall not be reduced below the amount indicated during the stated time period.

Table 1. Specific Dissolved Oxygen Water Quality Objectives

Location	DO concentration	Time Period
Sacramento River from Keswick Dam to Hamilton City	9.0 mg/l*	1 June to 31 August
Feather River from Fish Barrier Dam at Oroville to Honcut Creek	8.0 mg/l	1 September to 31 May
Merced River from Cressy to New Exchequer Dam	8.0 mg/l	All year
Tuolumne River from Waterford to La Grange	8.0 mg/l	15 October to 15 June

* When natural conditions lower dissolved oxygen below this level, the concentration shall be maintained at or above 95 percent of saturation.

pH and Turbidity

In addition to DO limits, basin limits for pH and turbidity are also described in the Basin Plan and required under the NPDES permit. The discharge shall not cause the ambient pH to fall below 6.5 or exceed 8.5, and/or cause turbidity to increase as follows:

- More than 1 Nephelometric Turbidity Units (NTU) where natural turbidity is between 0 and 5 NTUs
- More than 20 percent where natural turbidity is between 5 and 50 NTUs
- More than 10 NTUs where natural turbidity is between 50 and 100 NTUs
- More than 10 percent where natural turbidity is over 100 NTUs

The Basin Plan also outlines general turbidity objectives for Delta waters: except for periods of storm runoff, the turbidity of Delta waters shall not exceed 50 NTUs in the waters of the Central Delta and 150 NTUs in other Delta waters.

3.1.3 USFWS Biological Opinions for WHCP & SCP

The USFWS issued biological opinions (BO) (Service file No. 81410-2013-F-0005 and 08FBDT00-2014-F-0029) on the effects of DBW's WHCP and SCP on delta smelt (*Hypomesus transpacificus*) and its critical habitat, giant garter snake (*Thamnophis gigas*) and the valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*). The WHCP and SCP comply with the USFWS BO terms and conditions which include implementation of conservation measures identified in the WHCP and SCP project description. Below is a summary of the terms and conditions required under the biological opinion.

DELTA SMELT

The USFWS BO outlines specific mitigation measures to minimize impact to *H. transpacificus* (delta smelt) and associated habitats. Interagency Ecological Program (IEP) fish monitoring data is used to determine the presence or absence of delta smelt within or near herbicide application areas. Timing and location requirements specified in the USFWS BO aim to reduce the potential for negative impacts on delta smelt. The WHCP/SCP program area is divided into four USFWS Areas (Figures A-2 and A-3 in Appendix A on pages 39 and 41): Area 1 (primary delta smelt habitat), Area 2 (secondary delta smelt habitat), Area 3 (tertiary delta smelt habitat) and Area 4 (non-delta smelt habitat). Herbicide applications in Areas 2, 3 and 4 may begin on March 1 and continue through November 30. Herbicide applications in Area 1 may begin June 1 and continue until November 30. For all treatments conducted between March 1 and June 30, the ability to treat water hyacinth depends on the presence of listed fish species, which is determined by a review of available fish monitoring data and by species surveys on the day of the planned treatment. Herbicide applications will be suspended in the immediate treatment area in the event that delta smelt are identified, harmed or killed in the action area.

In 2001, DBW was directed by the USFWS to determine the level of impact that WHCP herbicides might have on the delta smelt. These impacts were to be determined for critical life stages only. Originally, the USFWS BO required egg and larvae 96-hr. definitive toxicity tests and "live-car" exposure studies. It was later determined by the USFWS that only 96-hr. definitive studies on larvae were necessary. It was also determined that 96-hr. acute toxicity tests using application-exposed field water from treatment sites was acceptable in lieu of live car studies. Both studies for delta smelt were completed and submitted to the USFWS in March 2004. After evaluation of these reports in the spring of 2004, the USFWS determined that acute exposure from 2,4-D, glyphosate and Agridex® does not cause significant impacts and, issued new terms and conditions for use of these herbicides and adjuvant.

The USFWS BO requires that personnel involved with the WHCP and SCP receive USFWS-approved worker environmental awareness training. Under this training program, personnel are informed about the presence of delta smelt and its associated habitat. Training includes 1) species identification, 2) the life history of delta smelt, 3) the importance of Delta migratory routes, and 4) all terms and conditions of the USFWS BO for protection, avoidance and minimization of impacts to protected species under ESA.

VALLEY ELDERBERRY LONGHORN BEETLE

The USFWS BO outlines specific mitigation measures to minimize impact to *Desmocerus californicus dimorphus*, the valley elderberry longhorn beetle (VELB), and associated elderberry shrub (*Sambucus* sp.) habitat. DBW was directed by USFWS to avoid impact to VELB by surveying for *Sambucus* spp. (elderberry shrub), and maintaining a 100-foot buffer between treatment sites and shoreline elderberry shrubs. In areas where treatment cannot occur away from VELB habitat, and where a 100-foot buffer would preclude DBW's ability to treat water hyacinth, DBW will use a 50-foot buffer when winds are less than 3 mph. In addition, wind speed and direction are also factors as to whether or not a treatment could occur in these areas. Herbicide applications occur away from and downwind of elderberry shrubs.

The USFWS BO requires that personnel involved with the WHCP and SCP receive worker environmental awareness training taught by a USFWS-approved biologist. Under this training program, personnel are informed about the presence of VELB and its habitat. Training includes 1) species identification, 2) the life history of VELB, 3) the importance of elderberry shrubs as habitat, and 4) all terms and conditions of the USFWS BO for protection, avoidance and minimization of impacts to protected species under ESA.

GIANT GARTER SNAKE

The USFWS BO outlines specific mitigation measures to minimize impact to *Thamnophis gigas* (giant garter snake, GGS). Restrictions regarding GGS in the USFWS BO apply to any land based operations, which occur on Delta banks other than existing roads or boat ramps, and to mechanical removal of water hyacinth in sensitive GGS habitat. Disturbance of upland GGS habitat will be conducted between May 1 and October 1 to lessen direct effects during the active season, because GGS are actively moving and avoiding danger.

Mechanical harvesters will maintain a speed of 2 to 2.5 knots in areas outside of sensitive GGS, or areas where GGS has been sighted in the past, making it likely for any present GGS to move out of the area. Additionally, the mechanical harvester will stop and/or reverse the harvester if a snake is seen within water hyacinth during removal. Disposal of water hyacinth following handpicking or mechanical removal outside of the active season (May 1 – October 1) will be disposed of at an approved spoils area with low to no value GGS habitat to ensure no hibernating GGS are buried under piles of collected water hyacinth.

The entire WHCP and SCP project area has been evaluated for GGS habitat. This evaluation has been incorporated into the GIS technology utilized by application crews. The application crews were also provided with a set of maps of previously surveyed and sensitive areas for GGS to minimize impact where GGS are most likely to be found.

The USFWS BO requires that personnel involved with the WHCP and SCP receive USFWS approved worker environmental awareness training. Under this training program, personnel are informed about the presence of GGS (*T. gigas*) and habitat associated with the species. Training includes: 1) species identification, 2) the life history of the GGS, 3) the importance of irrigation canals, marshes/wetlands, and seasonally flooded areas as habitat, and 4) all terms and conditions of the USFWS BO for protection, avoidance and minimization of impacts to protected species under ESA.

3.1.4 NMFS Letter of Concurrence for WHCP and SCP

NMFS issued Letters of Concurrence (2013/9443 and 2014-394) in response to USDA-ARS and DBW's request for ESA Section 7 consultation. Based on the WHCP and SCP project descriptions and supplemental material provided, and the best available scientific and commercial data, NMFS concurs with USDA-ARS and DBW's determination that the proposed use of herbicide products, adjuvants, physical removal, or mechanical methods is not likely to adversely affect federally listed Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), Central Valley steelhead trout (*O. mykiss*), or the Southern distinct population segment (DPS) of North American green sturgeon (*Acipenser medirostris*) or any of their designated critical habitats.

The WHCP and SCP project description outlines specific mitigation measures and avoidance guidelines to minimize impact to Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead trout, and green sturgeon. Dependent upon the type of water-year and in-stream flows, juvenile Chinook salmon and steelhead may be present in the Delta through June. The DBW proposed to begin herbicide applications as early as March 1 in sites where listed fish species are not likely to be present. The remainder of the action area may be treated provided that the available fish monitoring data indicates that salmonids are not likely present or that the pulse of juvenile Chinook salmon has migrated through the Delta. To minimize potential negative effects to chinook salmon and steelhead, DBW and USDA included specific timing for 2,4-D applications as a part of the proposed project. The proposed time frame for 2,4-D applications is consistent with the 2011 NMFS Biological Opinion for EPA registration of 2,4-D (for Pacific Salmonids). This biological opinion limits 2,4-D applications from June 15 through September 15 within the legal Delta and from July 15 through August 15 in the San Joaquin River (southern sites).

Specific guidelines were proposed by DBW and USDA, and thus concurred upon by NMFS to ensure fish are not impacted by WHCP/SCP applications. The following practices are incorporated into the WHCP and SCP protocols to avoid oxygen depletion due to decaying vegetation and ensure fish passage: In slow-moving and back-end sloughs infested with water hyacinth, applicators may only treat up to 30% of the water hyacinth mat at one time. In Delta tidal waters, applicators may only treat up to 50% of the water hyacinth mat at one time. Mats will be treated up to 3-acre strips, leaving at least 100 foot buffer strips between treated areas. Applicators must maintain buffer zones, treat at specific dissolved oxygen levels, and never block escape routes. Each WHCP/SCP crew received a copy of the protocol and refresher training on Fish Passage Protocol prior to the 2015 treatment season.

DBW continues to require herbicide applicators to be informed about the presence of Chinook salmon, steelhead, and green sturgeon and their associated habitat. Training includes: 1) species identification, 2) salmonid and sturgeon life history, 3) importance of migratory routes and identification of associated habitat, 4) impact avoidance guidelines and 5) the terms and conditions of the NMFS concurrence letter.

4 PERSONNEL, MATERIALS AND METHODS

4.1 FAV Personnel

4.1.1 Application Crews

During 2015, the DBW had five to six full-time crews, with each crew consisting of either an Aquatic Pest Control Specialist and an Aquatic Pest Control Technician, or two Specialists for herbicide application activities. Each crew contains a minimum of one member possessing a Qualified Applicators Certificate (QAC), category “F” (aquatics), administered by the California Department of Pesticide Regulation (CDPR). Under contract with DBW, Merced and Fresno County Department of Agriculture also had staff available to conduct surveys and herbicide treatments for water hyacinth as needed.

APPLICATION PERSONNEL EDUCATION AND TRAINING

Qualified Applicator Certificate

Application crews receive continuing education credits in pesticide training to keep their QACs current. Continuing education covers pesticide laws and regulations which may include topics such as federal and state pesticide regulations, pesticide and worker safety, surface and ground water protection, pesticide labeling and label interpretation, and pesticide effects on the environment. Category F QACs are renewed every two years upon completion of the continued education credit requirements.

Environmental Awareness Training

Environmental awareness training was conducted in February 2015. This training included the following items:

- Species identification and impact avoidance guidelines on all threatened and endangered species associated with the WHCP/SCP
- Identification and protection of elderberry shrubs and protocol for monitoring species during an application season
- Identification and protection of the giant garter snake, including life history; importance of irrigation canals, marshes, wetlands, and seasonally flooded areas as habitat
- Identification and protection of Delta smelt, longfin smelt, Chinook salmon, steelhead, green sturgeon, and associated protected habitats, fishery closure dates, and other regulatory agency requirements
- Terms and conditions of the USFWS biological opinions and NMFS letters of concurrence for the WHCP and SCP for protection, avoidance and minimization of adverse effects to protected species under the ESA
- Protocol for “take,” including reviewing the “Incidental Take Statement,” collection and handling of dead species, completion of chains of custody, and notification to USFWS.

Equipment Training

Refresher training on the use and calibration of the dissolved oxygen meters and use of Motion F5t Tablet PC and ArcPad application took place in February 2015.

4.1.2 Monitoring Personnel

Monitoring activities are overseen by an environmental scientist and conducted by qualified personnel, which may include an environmental scientist and scientific aids. All water sampling events are carried out in accordance with the WHCP Quality Assurance Project Plan (QAPP) and the WHCP/SCP Environmental Monitoring Protocol as approved by the State Water Resources Control Board, NMFS, and USFWS.

Environmental scientists are responsible for understanding and adhering to the regulatory permits and biological opinion terms and conditions. They are also responsible for training other monitoring crew members on monitoring protocols, water sampling techniques, and the calibration and use of field equipment necessary to collect accurate data. Environmental scientists conducted monitoring training for all monitoring personnel during 2015 on environmental monitoring and field equipment protocols.

4.2 Materials and Methods

4.2.1 Herbicide Application

WHCP/SCP OPERATIONS MANAGEMENT PLAN

The WHCP/SCP Operations Management Plan (OMP) details general requirements, the scope of program activities, a pre-application planning protocol, application/monitoring coordination protocol, herbicide application protocol; Best Management Practices (BMP) for herbicide handling, spray equipment maintenance and calibration, spill avoidance and contingency plan, listed species avoidance and habitat evaluation; dissolved oxygen/temperature measurement, fish passage protocol, and agricultural and water intake coordination.

HERBICIDES AND ADJUVANTS

The herbicides and adjuvants used in 2015 by the WHCP and SCP include the following:

Herbicides

- Glyphosate (Roundup Custom™), EPA Reg. No. 524-343-ZG
- 2,4-D (Weedar® 64), EPA Reg. No. 71368-1-ZB
- Imazamox (Clearcast®), EPA Reg. No. 241-437-AA-67690

Adjuvant

- Agridex® (paraffin base petroleum oil and polyoxyethylate polyol fatty acid esters), CA Reg. No. 5905-50017-AA
- Competitor® (ethyl oleate, Sorbitan alkylpolyethoxylate ester, dialkyl polyoxyethylene glycol), CA Reg. No. 2935-50173-AA

DBW acquired restricted materials permits from the County Agricultural Commissioners for utilizing 2,4-D within the authorized time frame from June 15 to September 15 (Table 2). Penoxsulam was not used during the 2015 treatment season since it is currently pending label amendment approval from California Department of Pesticide Regulation and/or the EPA.

Table 2. WHCP Treatment Sites, Herbicides and Timing

Delta smelt (DS) Habitat Level	USFWS Area	Delta Boundary Area	Treatment Site Numbers	Fish Survey Reporting Required ^{b,c}	Glyphosate	2,4-D ^d	Penoxsulam ^e	Imazamox ^e	Agridex	Competitor
Primary DS Habitat	1	Legal Delta North of Hwy 12	200- 290	June 1 to June 30	June 1 to Nov. 30	No	No	No	June 1 to Nov. 30	No
		Legal Delta South of Hwy 12	16-24b, 39-44, 69, 98a-176	June 1 to June 30	June 1 to Nov. 30	June 15 to Sept. 15	No	No	June 1 to Nov. 30	No
Secondary DS Habitat	2	Legal Delta South of Hwy 12	11-15, 33, 49-68, 78, 79, 83a-97	March 1 to June 30	Mar. 1 to Nov. 30	June 15 to Sept. 15	No	No	Mar. 1 to Nov. 30	No
Tertiary DS Habitat	3	Legal Delta South of Hwy 12	1-10, 25-38, 45-48, 70-77, 80-82, 291	March 1 to June 30	Mar. 1 to Nov. 30	June 15 to Sept. 15	Mar. 1 to Nov. 30	Mar. 1 to Nov. 30	Mar. 1 to Nov. 30	Mar. 1 to Nov. 30
Non-DS Habitat	4	Legal Delta South of Hwy 12	300-309	March 1 to June 30	Mar. 1 to Nov. 30	June 15 to Sept. 15	Mar. 1 to Nov. 30	Mar. 1 to Nov. 30	Mar. 1 to Nov. 30	Mar. 1 to Nov. 30
		Non-Legal Delta	310 and above	March 1 to June 30	Mar. 1 to Nov. 30	July 15 to Aug. 15	Mar. 1 to Nov. 30	Mar. 1 to Nov. 30	Mar. 1 to Nov. 30	Mar. 1 to Nov. 30

^a DBW may not treat in any site if DO is between 3 ppm and Basin Plan limits (5 ppm to 8 ppm, by location). DBW may not treat if winds are >10 mph (or >7 mph in Contra Costa County).

^b DBW will implement a survey-based approach to conducting treatments that allows for treatments from March through June in areas with re-growing water hyacinth when listed fish species are not present, as reported to NMFS and USFWS.

^c DBW environmental scientists will continue to monitor fish surveys and avoid treating in sites where listed fish species are present; however, formal weekly reporting to NMFS and USFWS is not required after July 1.

^d The 2,4-D time and location restrictions are specified in the NMFS BO for the Environmental Protection Agency registration of pesticides in order to protect listed salmonid species.

^e DBW will monitor the efficacy of the new herbicides penoxsulam and imazamox (time to symptoms, plant death, and regrowth).

BEST MANAGEMENT PRACTICES

The DBW developed a series of BMPs that outline methods or techniques that have been found to be the most effective and a practical means of achieving a particular objective and/or to comply with FAV Program requirements.

- Herbicide Handling Requirements – All personnel will be trained in herbicide handling in accordance with Food and Agriculture Code and Title 3 Code of Regulations pertaining to Pesticides and Pest Control Operations.
- Spray Equipment Calibration – Herbicide application equipment used for the FAV Program is to be calibrated on at least a monthly basis during the treatment season.
- Spill Avoidance and Contingency Plan – All herbicide spills are treated as emergencies and need to be treated immediately. DBW applies preventative measures to reduce the potential for a serious spill.
- Annual Environmental Awareness Training – All Program personnel receive required Annual Environmental Awareness training
- Endangered Species Avoidance Measures – Implement avoidance measures to reduce or eliminate potential impacts of the programs on endangered species.
- Agricultural and Water Intake Coordination – Specific measures are implemented to ensure herbicide treatments do not negatively impact water intakes. All herbicide label requirements are followed as they related to use of treated water for irrigation or drinking purposes. DBW also coordinates with county, water districts, SWP or CVP regarding water quality impacts.

APPLICATION EQUIPMENT

Herbicide applications in 2015 were conducted with hand held spray wands operated from 16 to 21-foot airboats, outboard aluminum boats, or a ground spray rig. The boats are equipped for direct metering of herbicides, adjuvant and water into the pump system of the spraying unit. Each application crew utilized a Hach® HQ-30 Dissolved Oxygen Meter and a Motion F5t Tablet PC to record pre-spray and post-spray temperature, dissolved oxygen, wind speed, beginning and ending UTM coordinates of spray area, amount of herbicide used, and the date and time of treatment.

Spray equipment was calibrated on at least a weekly basis, after changing injection pumps or whenever problems with the equipment occurred. Injection systems were cleaned daily and hoses were cleaned as needed. Pump oil was changed every 50 hours. Boat maintenance was also conducted on a regular basis.

SITE SELECTION AND PRIORITIZATION

Prior to the start of the 2015 treatment season, field crew visually surveyed all sites in their application region and estimated the amount of acres infested with water hyacinth and/or spongeplant. Herbicide applications were prioritized such that nursery areas with high amount of growth and areas that are critical to public, agricultural, municipal, industrial, recreational or navigational use were treated first. DBW prioritized treatment sites based on results of pre-season field surveys, combined with the staff's experience and knowledge of water hyacinth and spongeplant growth patterns and distribution. Each site was ranked on several factors including: (1) whether or not the site was a nursery area, (2) current infestation levels, (3) potential for infestation, and (4) whether the site is important for navigation, public safety, recreation, and/or

commercial use. Initial plans indicated the general priority for site treatment, and treatment plans were modified during the season due to weather conditions, growth and movement of water hyacinth, and environmental considerations. Logistics such as number of crews available, travel time to sites, herbicide label restrictions, environmental mitigations measures, and daily tidal conditions are also factored into daily site selections for treatment.

Following the terms and conditions specified in the NPDES permit, biological opinions, and concurrence letters, a number of sites were available for treatment starting in March, with the remainder of sites open for treatment after June 1. During the March to June time period when delta smelt, winter-run Chinook, spring-run Chinook, and/or steelhead juveniles are entering and/or present in the Delta, site selection depended on available Interagency Ecological Program (IEP) monitoring data showing the absence of special status fish species in treatment sites. Between March 1 and June 30, weekly fish survey and planned treatment site summaries were reported to USFWS and NMFS.

The 2015 herbicide application season began on March 4, 2015 in sites within USFWS Areas 2, 3 and 4, where protected fish species were not likely to be present. After June 1, sites in USFWS Area 1 became open for herbicide treatment. Throughout the season, fish monitoring data were continuously reviewed to avoid treating in sites where listed fish species were likely to be present. Sites selected for treatment were based on the level of impacts to navigation, public safety, recreation and/or commercial use, threats to agricultural water pumping facilities, and high degrees of hyacinth infestation. During the 2015 the site selection process also considered information and concerns received via email and phone from the public.

4.2.2 Environmental Monitoring

WHCP AND SCP NPDES ANNUAL MONITORING PROTOCOL

All water quality monitoring follows the NPDES Annual Monitoring Protocol as outlined in the WHCP and SCP Aquatic Pesticide Application Plan (APAP), which was approved in January 2014 by the State Water Resources Control Board. Quality control and quality analysis measures are outlined in the Quality Assurance Project Plan (QAPP). Monitoring activities include recording WHCP and SCP impacts on beneficial waters of the United States, federally listed threatened and endangered species, and associated threatened or endangered species habitats. DBW is required to document herbicide residues in receiving waters and monitor water quality parameters such as dissolved oxygen, temperature, conductivity, pH, turbidity, and waterway appearance at representative monitoring locations.

MONITORING EQUIPMENT

A 19-21 foot aluminum air boat or a 22 foot outboard motorboat was used for monitoring activities. Water samples were collected using the MasterFlex[®] E/S[®] Portable Sampler fitted with 7-10 feet of tubing. Water samples were stored on ice in 1000 mL amber glass bottles. Water quality parameters were measured with a Hydrolab[®] Model MS5 mini datasonde. Water quality parameters included water temperature, electrical conductivity, salinity, dissolved oxygen, pH and turbidity. Parameters measured by the Hydrolab[®] were geographically referenced with GPS coordinates with a Motion F5t Tablet PC and ArcPad application. Data were captured electronically using Hydroplus[®] software specifically modified for the WHCP/SCP. In the event of datasonde malfunction, a Hach[®] HQ-30 Dissolved Oxygen Meter was used as a backup to measure temperature and dissolved oxygen within monitoring sites. In addition, all data was hand written on datasheets as a backup copy. These datasheets were

subsequently used for data quality control purposes. A digital camera was used to provide visual records of sampling locations and other notable factors that may affect water quality, species of concern, or the condition of the surrounding environment. Several monitoring sites were marked with flagging tape for quick identification for follow-up visits.

To avoid water sample contamination, boats used for environmental monitoring were never used for herbicide applications. Monitoring boats were also periodically washed. To ensure that water quality data is reliable, Hydrolabs[®] and Hach[®] DO meters were calibrated on a regular basis based on the manufacturer's requirements.

MONITORING SITE SELECTION

Environmental monitoring sites were selected based on requirements listed under the NPDES permit and biological opinions. The SWRCB Statewide General NPDES Permit requires that dischargers monitor a certain proportion of sites based on the total number of treated sites. DBW monitors a minimum of six application events for each active ingredient in each environmental setting (flowing water and non-flowing water) per year. Since DBW does not conduct herbicide applications in non-flowing water and tidal and riverine water body types are considered flowing water, all monitoring took place only in the "flowing water" environmental setting category. In 2015, a total of 18 sites within the Delta and the San Joaquin River were designated as monitoring sites (Table 3). Locations of the sites monitored in 2015 are mapped in Appendix A, Figure A-1.

Representative monitoring occurred in sites with varying degrees of habitat for the following species (Table 4): giant garter snake (*T. gigas*), delta smelt (*H. transpacificus*), and valley elderberry longhorn beetle (VELB) (*D. californicus dimorphus*). Giant garter snake habitat has been rated as low, medium or high, while VELB and Delta smelt habitat are classified as being absent or present based on the known distribution of Delta smelt and the known locations of valley elderberry shrubs in the project area.

RESIDUE SAMPLING

Water sampling occurs on the same day of herbicide application, in addition to follow-up sampling at the same locations within a week after treatment. All sampling stations at representative locations are identified as "A", "B", and "C". Sampling station "A" represents the treatment area where water hyacinth was treated. Sampling station "B" represents receiving water that is downstream from the treatment area. Sampling station "C" represents a control site that is sampled before herbicide treatment, typically upstream of the treatment area. Sampling times are identified as "1", "2", and "3". Sampling time "1" indicates pre-treatment. Sampling time "2" indicates immediately post-treatment. Sampling time "3" indicates within seven days after treatment. Thus, sample 1A is taken before a treatment, within the treatment area. Likewise, sample 3C is taken within one week after treatment, upstream of the treatment area (i.e. control site). All water quality monitoring followed the NDPEs Annual Monitoring Protocol as outlined in the APAP.

Table 3. 2015 FAV Monitoring Sites

Site #	Location	Water Body Type	Herbicide and Adjuvant
6	French Camp Slough	Tidal	Imazamox/Competitor
10	Buckley Cove	Tidal	Imazamox/Competitor
28	14 Mile Slough	Tidal	2,4-D/Agridex
29	14 Mile Slough	Tidal	2,4-D/Agridex
37	White Slough	Tidal	Imazamox/Agridex
38	Honker Cut	Tidal	Imazamox/Agridex
42	Little Connection Slough	Tidal	2,4-D/Agridex
44	Potato Slough	Tidal	2,4-D/Agridex
56	Middle River	Tidal	Glyphosate/Agridex
58	Middle River	Tidal	Glyphosate/Agridex
61	Whiskey Slough	Tidal	Glyphosate/Competitor
68	Middle River	Tidal	Glyphosate/Competitor
98A	Old River	Tidal	2,4-D/Agridex
101B	Old River	Tidal	2,4-D/Agridex
102	Holland Cut	Tidal	Glyphosate/Agridex
104B	Old River	Tidal	Glyphosate/Agridex
311	San Joaquin River	Riverine	Imazamox/Agridex
312	San Joaquin River	Riverine	Imazamox/Agridex

Table 4. 2015 FAV Monitoring Sites and Habitat Quality

Site #	Location	GGs Habitat Quality	Smelt Habitat	VELB Habitat
6	French Camp Slough	Low-Moderate to Moderate-High	Absent	Present
10	Buckley Cove	Low	Absent	Present
28	14 Mile Slough	High	Absent	Present
29	14 Mile Slough	Low	Absent	Absent
37	White Slough	No habitat to High	Absent	Absent
38	Honker Cut	Low	Present	Absent
42	Little Connection Slough	Low	Present	Absent
44	Potato Slough	Low to Moderate	Present	Absent
56	Middle River	Low to Moderate	Present	Absent
58	Middle River	Low-Moderate	Present	Absent
61	Whiskey Slough	Low	Absent	Absent
68	Middle River	No habitat to Moderate-High	Present	Absent
98A	Old River	Moderate to High	Present	Absent
101B	Old River	Low	Present	Absent
102	Holland Cut	Low	Present	Absent
104B	Old River	Moderate	Present	Absent
311	San Joaquin River	Low-Moderate	Absent	Absent
312	San Joaquin River	Low-Moderate	Absent	Absent

4.2.3 Contract Laboratory Standard Operating Procedures

The analytical methods used by contract laboratories are published in the EPA Test Methods for Evaluating Solid Waste Physical/Chemical SW 846 or EPA Method for Chemical Analysis of Water and Waste. Analysis of water samples was conducted by the California Department of Food and Agriculture, Center for Analytical Chemistry (CDFA-CAC). The method used to analyze 2,4-D in surface water is gas chromatography/mass spectrometry (GC/MS). Analysis of glyphosate in surface water was done by high performance liquid chromatography (HPLC). Analysis of imazamox and penoxsulam was done by HPLC-MS.

For the 2,4-D GC/MS analysis, a linear calibration with options of using an average response factor or a linear regression is specified. An initial five-point calibration curve is completed, where the low-level standard concentration is less than or equal to the analyte quantitation limits. The limit of quantitation (LOQ) for this analysis is 0.1 parts per billion (ppb). Glyphosate samples undergo liquid chromatographic analysis with a standard 5 point calibration curve. The LOQ for glyphosate analysis is 20 ppb. The Agridex and Competitor analysis is run with a standard 3 point calibration curve with an LOQ of 100 ppb. Imazamox and penoxsulam analyses were run with a 4 point calibration curve with an LOQ of 10 ppb. The 2,4-D results are also compared to percent recovery of the surrogate chemical 3,4-D to ensure accuracy of results. There are no comparable surrogates for glyphosate, Agridex, imazamox or penoxsulam at this time.

ANALYTICAL TESTING VALIDATION

DBW used several methods to validate results found by contracting laboratories. These methods include collecting split (duplicate) water samples, field spikes, field blanks and equipment blanks. An equipment blank sample (de-ionized water collected using the sampling device) was collected at every sampling event to detect potential contamination from sampling equipment.

5 MONITORING RESULTS AND DISCUSSION

5.1 Threatened and Endangered Species

The USFWS have established incidental take for ESA listed species and outlined terms and conditions necessary to minimize the impact of incidental take on threatened and endangered species. No incidental take of threatened or endangered species occurred in the 2015 season. Since NMFS concurs with USDA and DBW's determination that the proposed WHCP and SCP is not likely to adversely affect federally listed salmonids or green sturgeon, or their habitat, there is no incidental take provided by NMFS in implementing the WHCP and SCP.

5.2 Infestation and Herbicide Application

In 2015, the WHCP conducted a total of 1,042 herbicide applications within 215 sites of the project area (Figure A-4, Figure A-5, and Appendix C). The treated sites encompassed most of the Delta, in addition to the San Joaquin River, Tuolumne River, Merced River and Salt Slough. There were several locations in the Delta and tributaries that were identified to having high water hyacinth infestations and were considered high priority areas. These sites included the Tuolumne River, reaches of the San Joaquin River, Stockton area waterways (Fourteen Mile Slough and the Deep Water Ship Channel), Snodgrass Slough, Lost Slough, Hog Slough, Sycamore Slough, Whiskey Slough, and reaches of the south Delta in Old and Middle Rivers. Several of these areas had water hyacinth infestations that blocked entire sections of the waterways, preventing navigation. For example the San Joaquin River downstream of Highway 132 (Site 310) had about a 0.6 mile long blockage of water hyacinth.

DBW was successful keeping water hyacinth under control in the Central and Southern Delta throughout spring and summer and with some success in regions of the Northern Delta such as Snug Harbor and the Delta Meadows. However, some locations in the Northern Delta, such as Lost Slough, Hog Slough, and Sycamore Slough, had increased growth of water hyacinth because 1) these regions could not be treated until June 1, and 2) 2,4-D, the faster acting herbicide could not be used in the northern Delta (refer to Table 2).

Herbicide treatments were effective in stopping growth and killing water hyacinth. Observations of herbicide symptoms such as wilting, yellowing and browning were observed from all treatments. Water hyacinth reached its peak biomass in late-summer/fall and individual plants broke apart from larger mats along channel margins and moved into different sites. It is likely that the sudden movement and change in water hyacinth distribution was due to a combination of tidal movement, seasonal changes in wind patterns, and disturbance from high boating activity during Labor Day weekend. After completion of the herbicide treatment season, both treated and untreated water hyacinth continued to float and move with winds, currents, and tides, which posed a hazard to navigation in some locations. Waterways with high infestations/coverage of water hyacinth were identified for implementation of mechanical harvesting. Use of mechanical control is further discussed in Section 5.4.1.

In 2015, both the Sacramento and San Joaquin Valley were classified to have critical water year types (California Data Exchange Center (CDEC), 2016). This year's drought conditions may have favored increased growth and infestation of water hyacinth due to low water levels causing increased sediment exposure to sunlight, which may have promoted seed germination, and low water flows which can contribute to accumulation of hyacinth in shallow and slow-moving waterways. This year warm water and air temperatures during summer favored fast growth of

water hyacinth. Water hyacinth grows best in warm, high-nutrient waters (DiTomaso and Healy, 2003). Both vegetative and sexual reproduction occur in water hyacinth and have the potential for production of large numbers of individuals in a short amount of time (Barrett, 1980b). Optimal growth of water hyacinth occurs at temperatures of 28-30°C and plants can reproduce rapidly through vegetative reproduction (daughter plants) and can double plant numbers under suitable conditions between 1 to 2 weeks (Gopal, 1987; Harley et al, 1996). Elevated nutrient levels in the Delta from agricultural and urban runoff as well as wastewater discharges may also contribute to the prolific growth of water hyacinth. Plant growth is directly correlated with nutrient concentrations, and as nitrogen and phosphorous increase, so too does water hyacinth biomass (Gopal, 1987).

5.2.1 Summary of Herbicide Use

Each crew completed a daily treatment log to record herbicide treatment activities. The 2015 WHCP and SCP daily log information can be found in Appendix B, Tables B-1 to B-9. Herbicide applications were made only when dissolved oxygen (DO) levels were either above the Basin Plan limit adopted by the Central Valley Regional Water Quality Control Board or below 3.0 mg/L. No applications were made if DO concentrations were between 3.0 mg/L and the Basin Plan limits (5 mg/L to 8 mg/L, by location).

The herbicide treatment season began on March 4, 2015 and continued to November 30, 2015. Herbicide applications utilized glyphosate, 2,4-D, and imazamox with the adjuvants Agridex or Competitor. To minimize potential negative effects to salmon and steelhead, DBW and USDA included specific timing for 2,4-D applications as a part of the proposed project. The proposed time frame for 2,4-D applications is consistent with the 2011 NMFS Biological Opinion for EPA registration of 2,4-D (for Pacific Salmonids), which limits 2,4-D applications from June 15 through September 15 within the legal Delta, and from July 15 through August 15 in the San Joaquin River (southern sites).

Glyphosate is a slow-acting herbicide, and time to symptom development in treated water hyacinth plants ranged from 1 to 3 weeks. Visible effects were gradual wilting and yellowing of the plants which eventually advanced to complete browning. Observations of herbicide symptoms such as wilting, yellowing and browning were observed from all treatments. However, as temperatures decreased during the fall months, herbicide symptoms were slower to appear due to decreased plant growth rates, which caused a decrease in herbicide uptake and translocation rates. Although water hyacinth plants were effectively treated, in several cases plants continued to float and moves with the wind and water flows of the Delta. Treated plants remained floating for a significant amount of time, but most decomposing plants eventually sank in to the water column. In 2015, the WHCP and SCP used 3,354 gallons of glyphosate, 836 gallons of 2,4-D, 7 gallons of imazamox, 1,855 gallons of Agridex, and 102 gallons Competitor to effectively treat a total of 4,447 acres of water hyacinth and spongeplant (approximately 7 acres) in the Delta and its tributaries (Table 5, Figures 1 and 2).

Most noteworthy in 2015, was that the WHCP treated more acreage than any other time in the history of the program (Figure 3). The USFWS Biological Opinion for the WHCP states, “In 2013, California State Parks may treat up to 5,000 acres of water hyacinth within the 350 treatment sites. From years 2014 to 2017 DBW may treat up to 3,500 acres of water hyacinth within the 350 treatment sites.” In October, DBW expected to exceed the 3,500 acre limit for 2015 and submitted a request to USFWS and NMFS for a change in action for WHCP. The change in action requested to treat up to 1,000 additional acres of water hyacinth for a maximum of 4,500 acres for 2015. The USFWS reviewed the request and “concurred that the

increase in the amount of acres treated for 2015 with implementation of the conservation measures is not likely to adversely affect the valley elderberry longhorn beetle and giant garter snake.” The USFWS biological opinion for the WHCP was amended as appropriate. NMFS reviewed the request and concurred that “the requested change in action is not likely to expose listed species, their designated critical habitat and essential fish habitat to herbicide levels that may affect the species and their habitat beyond those that were previously considered in the informal consultation that was conducted for the WHCP.”

The total acreage of water hyacinth each year between 1990 and 2015 (Figure 3) varies since the number of acres treated in a given year can reflect the magnitude of infestation; however, other factors can also affect the amount of treatment that occurs (treatment start dates, regulatory restrictions, local water conditions, weather, staff levels, etc.). Water hyacinth was not treated in 2000 as the control program was not implemented in response to legal action from Delta Keepers, where they claimed that DBW should obtain an NPDES permit under the 9th Circuit Court’s *Headwaters Inc. v. Talent Irrigation District* decision.

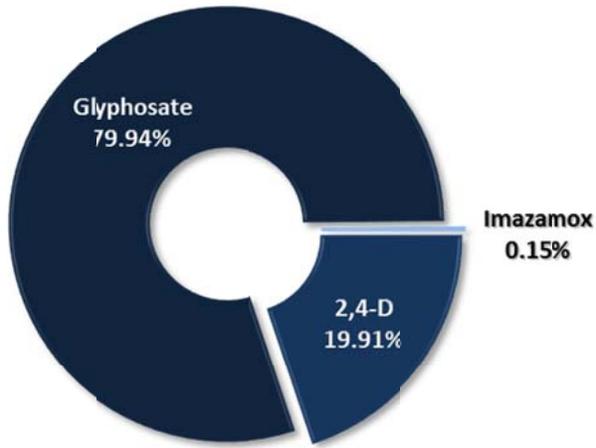
In addition to beginning herbicide treatments in early March, DBW application crews were allowed to work overtime which could explain why the WHCP/SCP was successful in treating a higher number of acres of water hyacinth and spongeplant in the Delta and southern tributaries compared to previous years.

Table 5. 2015 FAV Herbicide Use and Acreage Treated by Month

Month	2,4-D		Glyphosate		Imazamox		Penoxsulam		Agridex	Competitor
	gallons	acres	gallons	acres	ounces	acres	ounces	acres	gallons	gallons
MARCH	0	0	159.75	170.40	0	0	0	0	16.50	44.75
APRIL	0	0	223.50	238.40	0.60	2.40	0	0	76.00	24.00
MAY	0	0	332.41	3548.88	1.40	5.60	0	0	115.84	27.00
JUNE	92.00	92.00	392.41	420.08	1.50	6.00	0	0	214.08	6.50
JULY	211.75	211.75	314.45	337.53	0	0	0	0	261.21	0
AUGUST	335.25	335.25	264.23	282.97	0	0	0	0	294.82	0
SEPTEMBER	196.50	196.50	436.70	466.95	1.00	4.00	0	0	303.50	0
OCTOBER	0	0	790.43	844.17	2.00	8.00	0	0	368.64	0
NOVEMBER	0	0	440.55	470.33	0	0	0	0	204.27	0
Total	835.50	835.50	3354.43	3585.72	6.50	26.00	0	0	1854.86	102.25

Figure 1. 2015 FAV Herbicide and Adjuvant Use

a) FAV 2015 Herbicide Usage



b) FAV 2015 Adjuvant Usage

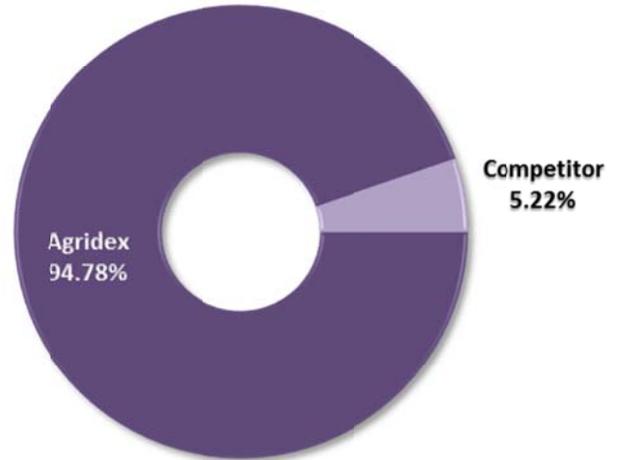
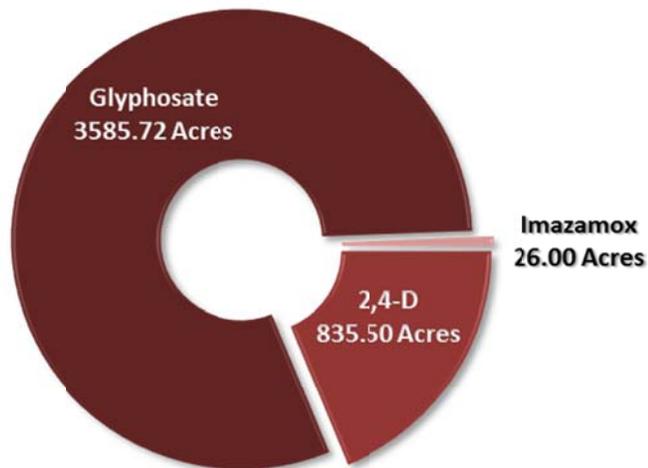


Figure 2. 2015 FAV Acreage Treated Per Herbicide

FAV 2015 Treated Acres



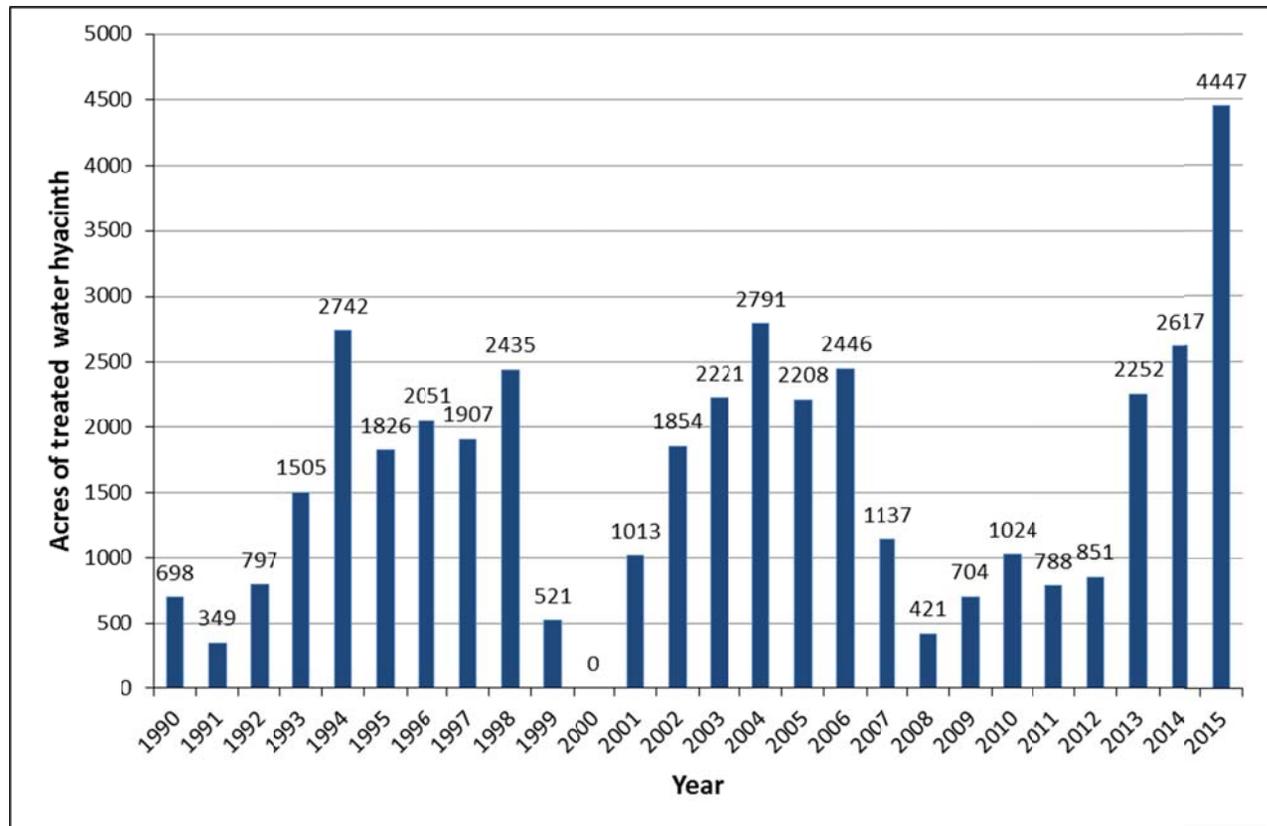


Figure 3. Total water hyacinth acres chemically treated by year, 1990-2015. Beginning in 2013, spongeplant was concurrently treated with water hyacinth.

5.3 Monitoring Data and Laboratory Results

In 2015, a total of 18 sites within the Delta and along the San Joaquin River were designated as monitoring sites (Table 3 and Figure A-1, Appendix A). Field monitoring data and lab results collected in compliance with the NPDES permit and BOs are summarized in Appendix D. Figures and tables found within Appendix D document the sample locations, chemical residues and water quality data for these 18 monitoring sites.

The NPDES permit (General Permit No. CAG990005, Water Quality Order No. 2013-0002-DWQ), that became effective on December 1, 2013, contains sampling requirements that are materially less than what has been historically measured, in terms of frequency of measurement. To ensure that the WHCP and SCP maintain environmental quality measures and meet federal Endangered Species Act requirements, and that monitoring provides independent statistical validity, DBW aims to maintain a more thorough monitoring plan as resources will allow.

5.3.1 Dissolved Oxygen, Turbidity and pH

There were two occurrences where DO concentrations were below the basin plan limit of 5 mg/L. In site 28 (Fourteen Mile Slough), 25 feet downflow of the treatment area the DO concentration was 4.65 mg/L. The measured DO was below the basin limit on July 6. However, DO measurements taken during a follow up evaluation of the monitoring site on July 10 indicated that DO levels returned above basin limits (6.55 mg/L). In site 6 (French Camp

Slough), the DO concentration within the treatment area, one week post-herbicide treatment was 4.91 mg/L on June 11. However, DO measurements taken by the application crew after this date indicated that DO levels returned above basin limits (> 5 mg/L). The reduced DO was shown to be temporary in both sites, likely due to periodic mixing of water due to tidal movement. All fish passage protocols were followed and there were no observations of injured or impacted wildlife during follow-up visits. All other DO levels measured during NPDES monitoring and sampling efforts in 2015 were between 5.05 mg/L and 11.91 mg/L.

As per Basin Plan standards for turbidity, waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases in turbidity attributable to controllable water quality factors shall not exceed the following limits listed in Section 3.1.2. The average of the turbidity measurements taken at “A” and “C” locations on the sampling day in question will constitute an average natural turbidity against which the receiving water (“B” location) measurements will be compared. There were 11 occasions in 10 different sites, where turbidity levels exceeded Basin Plan limits (i.e. increased greater than 20%). Nine of these exceedances occurred on the day of herbicide application. However, in eight of these cases the turbidity levels were again within the basin limits during follow up sampling within 7 days after the herbicide treatment. Two of the turbidity exceedances were measured during post-treatment sampling within 7 days of the treatment. High turbidity may have been caused by natural waterway characteristics or propeller wash from the sampling boat. If the WHCP/SCP was responsible for the turbidity violations, the effects were expected to be temporary due to the tidal nature of the Delta, varying hydrodynamics and periodic mixing of the water column. There were no injured or impacted species of concern observed during post-treatment follow-up monitoring. For all monitoring sites within the Delta, turbidity readings were between 0.8 and 96.3 NTUs. Turbidity in monitoring sites on the upper San Joaquin River (Stanislaus County) ranged from 4.6 to 63.9 NTUs.

The Basin Plan Limit for pH shall not cause the ambient pH in the receiving water to fall below 6.5 or exceed 8.5. During 2015, there were three treatment sites which had a receiving water pH levels that exceeded the basin plan limit of 8.5. In site 102 (Holland Cut) the pH was 9.24 and 8.52 in receiving waters immediately post-treatment and one week post-treatment, respectively. In site 104B (Old River) pH was 9.64, and in site 38 (Honker Cut) pH was 8.68. These were measured immediately post-treatment, downstream of the treatment area. The pre-treatment pH measurements taken in the control sampling location and within the treatment area, in the same sites mentioned above, were also greater than 8.5. This suggests that higher pH levels already existed in the surrounding area prior to herbicide applications. Elevated pH levels were likely a result from other environmental factors and not necessarily a result of herbicide application activity. All other pH levels in receiving waters complied with basin plan limits and ranged between 7.27 and 8.50.

5.3.2 Herbicide Residue Concentrations

Maximum residue limits are based on EPA municipal drinking water standards. Herbicide residue shall not exceed the following concentrations in receiving waters (Table 6). The NPDES General Permit does not have receiving water limitations for imazamox or penoxsulam. However, it requires data collection for receiving water monitoring, which will provide information on whether the use of imazamox and penoxsulam has water quality impacts.

Table 6. Receiving water limits for WHCP and SCP herbicides

Herbicide Active Ingredient	Maximum Concentration
2,4-D	70 µg/L
Glyphosate	700 µg/L
Imazamox	No receiving water limit
Penoxsulam	No receiving water limit

During 2015, all herbicide (and adjuvant) residue concentrations at receiving water locations were either not detected or were below receiving water limits as specified in the NPDES permit (Appendix D). For all glyphosate and imazamox water samples, herbicide residues were not detected. Residue concentrations for 2,4-D water samples were either not detected or ranged between 0.1 ppb to 2.27 ppb.

5.3.3 APAP Effectiveness

The APAP describes aquatic pesticides, adjuvants and application methods used for the FAV control program. The selected herbicide and adjuvants were effective on water hyacinth and spongeplant as described in Section 5.2 above. Herbicide application methods and BMPs were effective in maintaining herbicide residues in receiving water below the maximum concentration limits. In addition, all reporting requirements described in the APAP such as providing a Pest Control Recommendation (PCR), notice of intent and public notification, were met. Notices of intent were provided to County Agricultural Commissioner’s at least 24 hours before herbicide applications were made. The notice of intent included descriptions treatment locations and application rates for restricted use materials such as 2,4-D, in addition to all other herbicides used by the FAV programs. To improve public notifications, DBW developed a new outreach tool in the form of a weekly email notification, available to anyone who subscribes to the distribution list. Updates provided planned treatment areas, facts, and figures on the 2015 treatments.

5.4 Alternative Control Methods and Special Studies

5.4.1 Non-Chemical Control

Handpicking

Due to time restrictions and treatment limitations for the chemical application of water hyacinth, manual removal (handpicking) methods have been implemented as part of the WHCP’s Integrated Pest Management Plan. In some cases during 2015, small individual plants of spongeplant were observed floating near the bases of water hyacinth plants; these plants were immediately removed from the water by hand. No handpicking of water hyacinth occurred in 2015. Instead, DBW elected to conduct mechanical removal of water hyacinth.

Mechanical Removal

In January 2015, it was estimated that about 5 miles of Old River in the south Delta were covered solid with water hyacinth. DBW initiated an interagency agreement with the Department of Water Resources (DWR) and also partnered with the U.S. Bureau of Reclamation (USBR)

and their water contractors in harvesting and removing water hyacinth from Old River near The USBR Tracy Fish Facility and Fabian Tract. Mechanical harvesting at this site utilized a large capacity mechanical harvester and two Aquamogs to collect and move hyacinth in the river, 2-5 long reach excavators that were placed on the west levee of Fabian Tract to remove hyacinth from the river, dump trucks to relocate hyacinth from the levee to the spoils area on Fabian Tract (USBR property), and a small track loader/excavator to load dump trucks with hyacinth. Between January 16, 2015 and March 12, 2015, approximately 36,907 cubic yards of water hyacinth were mechanically removed.

DBW also acquired a 4-year contract with the firm, Aquatic Environments, Inc. to conduct mechanical harvesting in the Delta. The initial work under this contract began on November 13, 2015 and focused water hyacinth harvesting and removal on a section of the Stockton Deep Water Channel (SDWC) from Weber Point to Buckley Cove (sites 8 and 10), the Calaveras River (site 8), and Whiskey Slough (sites 61 and 62). Mechanical removal utilized a combination of harvesters, transport barge, excavators and dump trucks. Approximately 24,202 cubic yards of water hyacinth were removed by mechanical means in the aforementioned sites between November 13, 2015 and December 31, 2015.

For the harvesting projects located at Fabian Tract and the SDWC, the hyacinth was temporarily stockpiled on the water side of the banks or levees before being further removed by an excavator. To prevent possible disturbance to the levee bank and minimize erosion from water runoff from hyacinth loads, plastic liners, straw wattles, and/or plywood were placed on the bank and levee where the harvester and/or excavator stockpiled water hyacinth. Unloading operations at Whiskey Slough were staged at the marina's concrete launch ramp and therefore erosion avoidance measures described above were not applied. Water hyacinth loads were also allowed to drain before moving the material onshore. Once excess water was drained, the plant material was removed with an excavator and moved to an awaiting dump truck, and taken to an approved spoils site. The Port of Stockton gave permission to DBW to utilize a portion of their property on Roberts Island, adjacent to the SDWC, for hyacinth removal and spoils. For Whiskey Slough, the Whiskey Slough Marina authorized DBW to use their launch ramp and a portion of their property behind the Marina for spoils.

Herding

DBW crews used boats to herd (push) large mats of water hyacinth to the long-reach excavators staged at Fabian Tract. DBW also assisted USBR in removing a buildup of water hyacinth at the Tracy Fish Facility fish screen. DBW crews used boats to herd large mats of water hyacinth to the mechanical arm and conveyor system operated by USBR where the plants were loaded into trucks and disposed of in the spoils site adjacent to the Tracy Fish Facility.

5.4.2 Dissolved Oxygen Monitoring Study

In 2015, a dissolved oxygen monitoring study was conducted during the treatment season. Dissolved oxygen and water temperature were measured before and after herbicide applications in locations with water hyacinth and in adjacent open water. The 2015 study included two locations in the Delta infested with water hyacinth with different characteristics: one in a dead-end waterway (Seven Mile Slough, site 20) and one with stronger tidal influence (Middle River at Union Point, site 52). Both of these locations receive herbicide (glyphosate) treatments during the study to evaluate impacts of the treatment on DO levels. A third location with water hyacinth infestation was selected in Trapper and Whiskey Sloughs (sites 62 and 63) as a control site and was not treated with herbicide. Data loggers were deployed about one

week prior to herbicide treatments and were left deployed for about three weeks after herbicide treatments.

Comparison of DO data between locations with water hyacinth and locations of open water confirmed DO concentrations are reduced underneath water hyacinth, and support the findings of other studies that DO levels underneath water hyacinth are lower. Refer to Appendix E for the complete report.

5.4.3 Toxicological Fishery Impact Study

To meet the terms and conditions of the USFWS Biological Opinions, DBW contracted with the University of California, Davis (UCD) to conduct a multi-year toxicological study, using delta smelt (*Hypomesus transpacificus*), for herbicides and adjuvants used in the FAV and Submersed Aquatic Vegetation (SAV) control programs (WHCP, SCP, and *Egeria densa* Control Program). Program herbicides and adjuvants for toxicity evaluation included fluridone, 2,4-D, glyphosate, penoxsulam, imazamox, Agridex, and Competitor. To ensure that delta smelt in the San Francisco Estuary and Sacramento-San Joaquin Delta are not directly affected by program herbicides and adjuvants the USFWS has requested that DBW assess their effects through a series of acute (96 hour survival) and chronic (growth and reproduction) toxicity tests on early life stages of delta smelt (eggs and newly hatched larvae). Additionally, a food web investigation was conducted in which the objective was to evaluate toxic (lethal and sublethal) effects of program herbicides and adjuvants on one copepod species (*Eurytemora affinis*) and one diatom species (*Thalassiosira pseudonana*).

In 2014, UCD completed toxicity testing with early life-stage delta smelt (embryos and larvae) for imazamox, penoxsulam, and their mixture with Agridex. Toxicity testing included range finder exposures, definitive LC50 tests, and mixture-interaction analyses. Survival, hatching success, and sublethal responses (i.e. weight, condition factor, oil globule area, yolk + oil globule area, and yolk perimeter) of delta smelt embryos and larvae were evaluated. Initial findings indicate that the environmental risks of imazamox and penoxsulam to delta smelt are very low.

In 2015, UCD completed further herbicide toxicity comparisons to evaluate effects of glyphosate, 2,4-D, fluridone and a mixture of imazamox + Competitor on delta smelt embryos and early stage larvae. Analysis of sub-lethal effects from fluridone, glyphosate and 2,4-D have not yet been completed. However, there were sub-lethal responses observed during fluridone testing in both embryo and larval stages such as deformities of hatched fish and reduced swimming ability. In glyphosate tests, embryos appeared underdeveloped for the first 96-hr exposure, but eventually recovered once moved into clean water. All toxicity endpoints were orders of magnitude above the expected concentrations resulting from program herbicide application rates. In addition, further studies evaluated the toxicity of penoxsulam, imazamox, Agridex and their mixtures, via 96-hr assays to the calanoid copepod (*E. affinis*) survival as a part of the food web investigation. Complete results of all contracted work tasks will be presented in a final report which is expected in summer of 2016. Refer to Appendix F for the most recent progress report.

5.4.4 Delta Area-Wide Pest Management Project

The USDA Area-Wide Pest Management Project was initiated in 2014 to enhance and transform the unsustainable management approach of the past 30 years. The project will aim to

increase implementation of aquatic invasive plant assessment, management, and decision support tools to improve Delta-wide integrated management of multiple aquatic and riparian weeds and associated pests (i.e. mosquitos) of non-crop areas. The Project's purpose is to bring local, state and federal agencies together for a common mission to achieve aquatic and riparian weed control that minimizes inputs and impacts while maximizing ecological and economic benefits. One of the goals of the Area-Wide Project is to demonstrate how to reduce aquatic weed populations to low levels by combining strategic herbicide applications with biological control agent releases. Other objectives include: 1) development of weed growth models, 2) integration of remote sensing and modeling tools to track weed distributions, 3) assessment of control efficacy, and 4) assessment of target and non-target effects of control operations on aquatic weeds, mosquitos, and other organisms. DBW's role and objectives for the Area-Wide Project includes researching enhanced weed control methods, assessment of aquatic weed abundance, diversity and concentration, and enhanced nutrient and pesticide monitoring. Refer to Appendix G for DBW's 2015 Annual Performance Report.

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APPENDIX A

FAV Maps

Figure A- 1. 2015 WHCP/SCP Project Area and Sampling Sites

Figure A- 2. WHCP/SCP Northern Sites and USFWS Areas

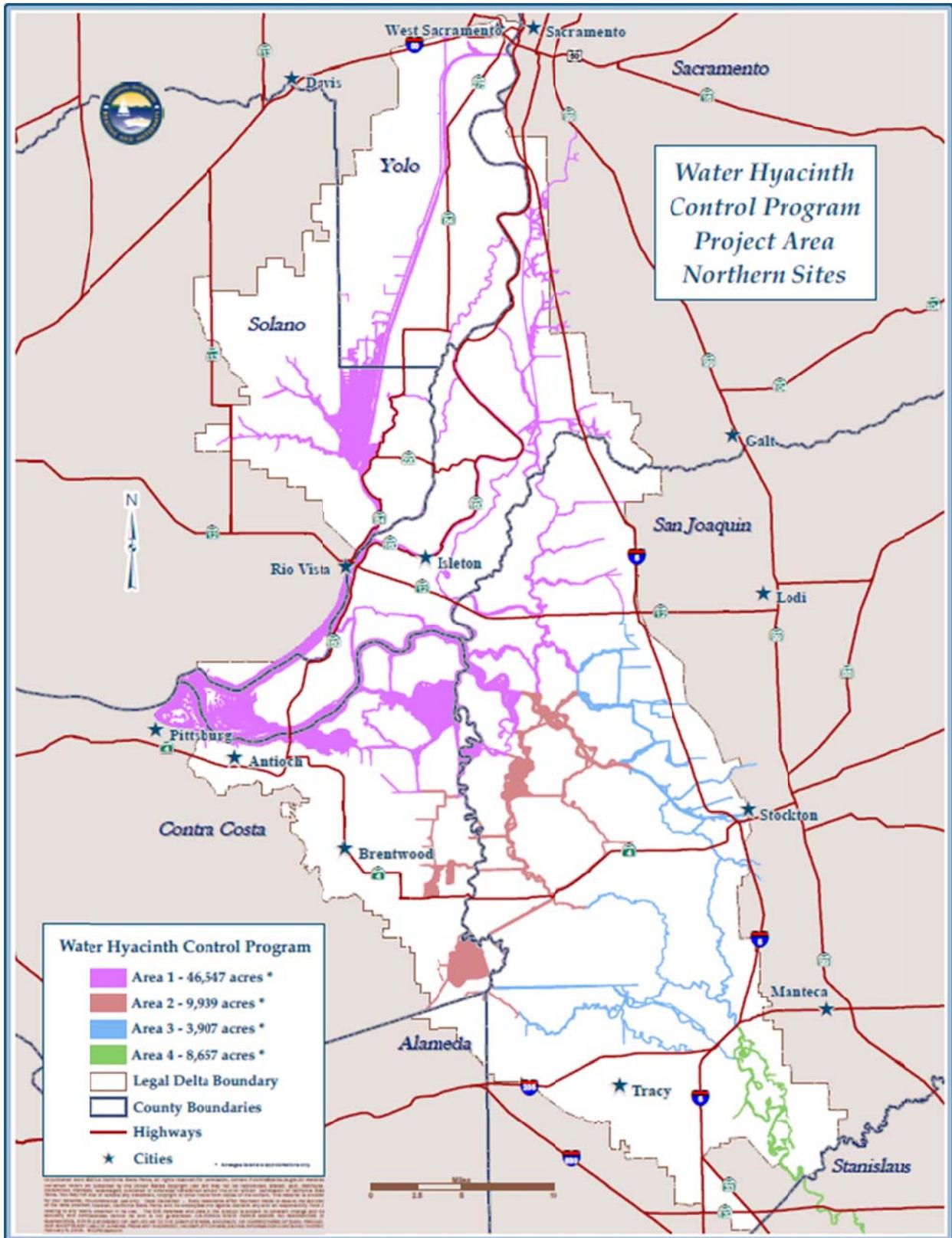


Figure A- 3. WHCP/SCP Southern Sites and USFWS Areas

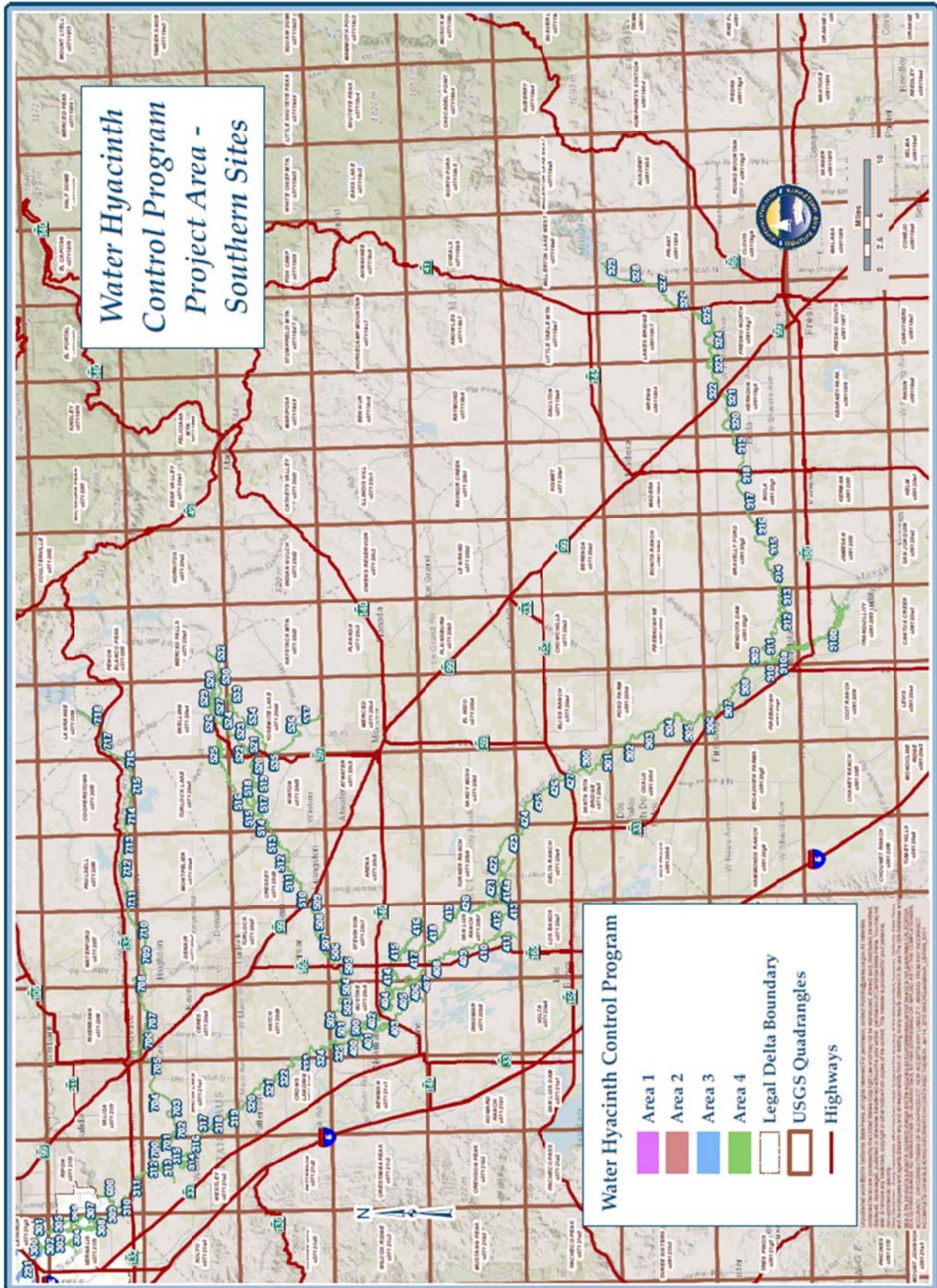


Figure A- 4. Treatment Count in 2015: Northern Sites

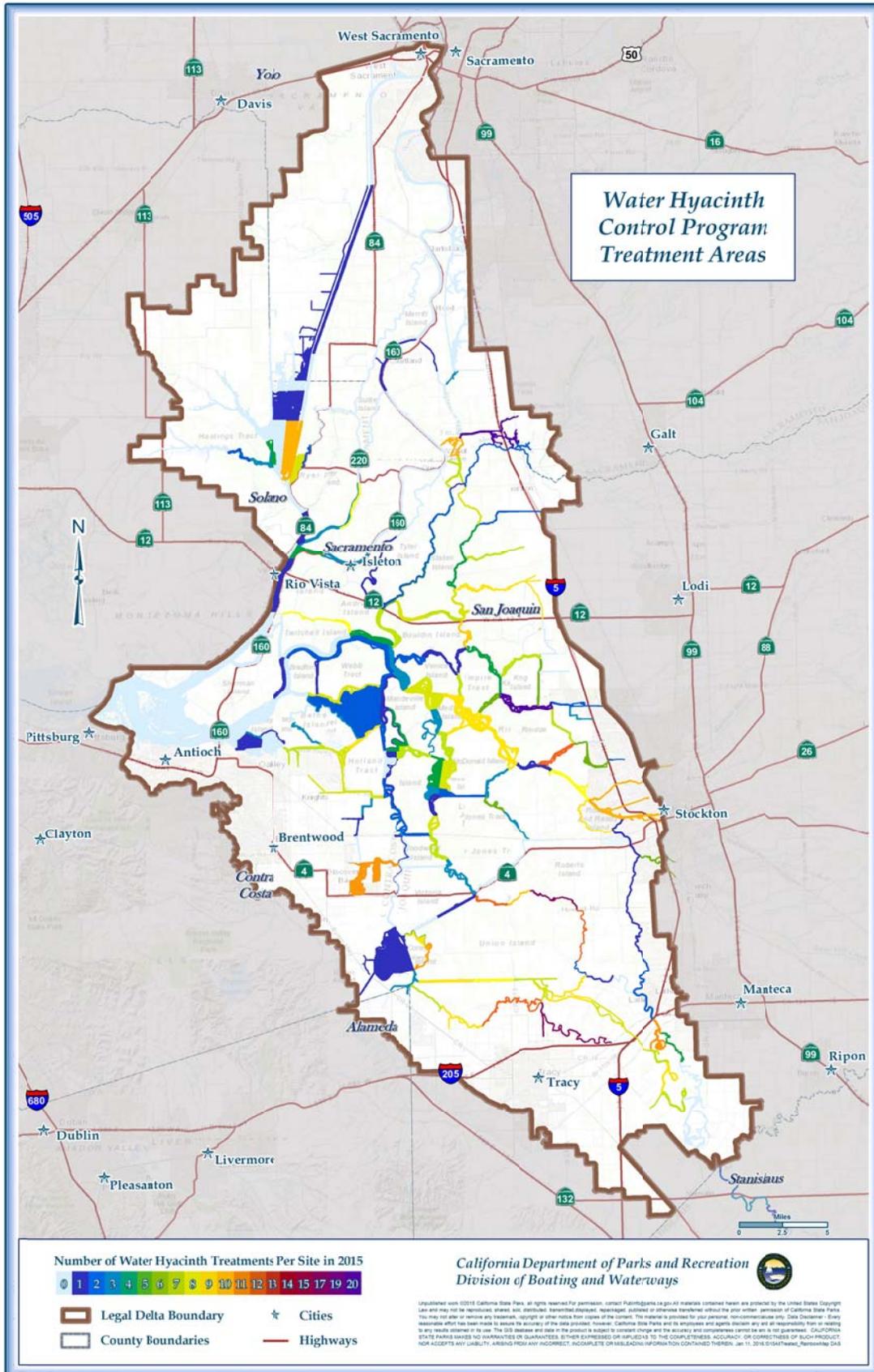


Figure A- 5. Treatment Count in 2015: Southern Sites

APPENDIX B

2015 Herbicide Application Daily Logs

Table B- 1. March 2015 Herbicide and Adjuvant Use

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed	
3/4/2015	3738	28	San Joaquin	15.70	15.20	800	1100	8.40	9.20	0.00	5.00	0.00	0.00	0.00	2.50	120	0.00	5.33	0.00	0.00	0-2	
3/4/2015	3738	32	San Joaquin	15.20	15.30	1200	1600	8.30	8.60	0.00	2.00	0.00	0.00	0.00	1.00	120	0.00	2.13	0.00	0.00	0-2	
3/4/2015	8835	300	San Joaquin	13.70	14.20	1000	1330	8.21	8.33	0.00	2.50	0.00	0.00	0.00	1.25	120	0.00	2.67	0.00	0.00	2-4	
3/4/2015	8835	301	San Joaquin	13.20	13.70	830	1000	8.13	8.21	0.00	2.50	0.00	0.00	0.00	1.25	120	0.00	2.67	0.00	0.00	0-2	
3/4/2015	8929	48	San Joaquin	13.40	14.50	900	1230	8.60	8.70	0.00	4.00	0.00	0.00	0.00	1.50	120	0.00	4.27	0.00	0.00	2-4	
3/4/2015	9122	74	San Joaquin	14.30	14.30	1130	1300	12.10	10.50	0.00	2.50	0.00	0.00	0.00	1.00	120	0.00	2.67	0.00	0.00	2-4	
3/4/2015	9122	75	San Joaquin	12.90	14.90	830	1130	11.70	12.10	0.00	5.00	0.00	0.00	0.00	1.50	120	0.00	5.33	0.00	0.00	0-2	
3/5/2015	3738	32	San Joaquin	15.10	15.30	800	1630	8.30	9.10	0.00	8.00	0.00	0.00	0.00	4.00	120	0.00	8.53	0.00	0.00	0-2	
3/5/2015	8789	85	Contra Costa	13.80	14.00	830	1500	8.70	8.30	0.00	7.50	0.00	0.00	3.75	0.00	120	0.00	8.00	0.00	0.00	2-4	
3/5/2015	8835	319	Stanislaus	14.00	16.60	930	1330	10.15	10.65	0.00	7.00	0.00	0.00	0.00	3.25	120	0.00	7.47	0.00	0.00	2-4	
3/5/2015	9122	73	San Joaquin	13.80	14.10	1230	1430	13.50	12.50	0.00	3.50	0.00	0.00	0.00	0.75	120	0.00	3.73	0.00	0.00	2-4	
3/5/2015	9122	74	San Joaquin	13.10	13.80	830	1230	12.30	13.50	0.00	6.50	0.00	0.00	0.00	2.50	120	0.00	6.93	0.00	0.00	2-4	
3/6/2015	8789	85	Contra Costa	13.90	14.20	1000	1500	8.50	8.10	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4	
3/6/2015	9122	81	San Joaquin	13.80	14.40	830	1430	12.50	12.90	0.00	2.75	0.00	0.00	0.00	0.75	120	0.00	2.93	0.00	0.00	2-4	
3/6/2015	9122	82	San Joaquin	13.80	14.40	900	1230	12.40	12.90	0.00	7.25	0.00	0.00	0.00	1.25	120	0.00	7.73	0.00	0.00	2-4	
3/9/2015	9122	80	San Joaquin	14.40	14.80	1030	1330	9.90	9.80	0.00	7.50	0.00	0.00	0.00	2.75	120	0.00	8.00	0.00	0.00	2-4	
3/10/2015	3738	37	San Joaquin	15.70	16.00	900	1300	8.50	9.10	0.00	4.50	0.00	0.00	0.00	2.25	120	0.00	4.80	0.00	0.00	0-2	
3/12/2015	9371	56	San Joaquin	14.80	15.30	1000	1100	8.50	9.90	0.00	0.75	0.00	0.00	0.00	0.25	120	0.00	0.80	0.00	0.00	4-6	
3/13/2015	8789	93	Contra Costa	14.30	14.80	830	1530	8.60	8.80	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4	
3/13/2015	9371	56	San Joaquin	17.30	17.90	1230	1500	8.90	8.80	0.00	7.00	0.00	0.00	0.00	1.50	120	0.00	7.47	0.00	0.00	0-2	
3/13/2015	9371	66	San Joaquin	15.10	15.30	930	1030	8.10	8.30	0.00	1.25	0.00	0.00	0.00	0.25	120	0.00	1.33	0.00	0.00	2-4	
3/13/2015	9371	67	San Joaquin	15.80	17.00	1030	1200	8.50	8.10	0.00	1.00	0.00	0.00	0.00	0.25	120	0.00	1.07	0.00	0.00	2-4	
3/16/2015	9371	80	San Joaquin	17.40	17.60	1230	1430	8.50	9.80	0.00	3.50	0.00	0.00	0.00	1.25	120	0.00	3.73	0.00	0.00	2-4	
3/17/2015	9371	74	San Joaquin	18.90	19.00	1430	1530	9.10	8.00	0.00	2.00	0.00	0.00	0.00	0.25	120	0.00	2.13	0.00	0.00	4-6	
3/17/2015	9371	75	San Joaquin	18.20	18.80	900	1400	8.40	8.50	0.00	8.75	0.00	0.00	0.00	1.25	120	0.00	9.33	0.00	0.00	2-4	
3/18/2015	3738	28	San Joaquin	16.80	16.90	900	1030	9.00	8.20	0.00	0.75	0.00	0.00	0.00	0.25	120	0.00	0.80	0.00	0.00	2-4	
3/19/2015	3738	10	San Joaquin	16.70	16.90	800	930	9.30	9.00	0.00	0.50	0.00	0.00	0.00	0.25	120	0.00	0.53	0.00	0.00	2-4	
3/19/2015	3738	25	San Joaquin	16.90	16.20	1000	1130	9.00	9.50	0.00	2.00	0.00	0.00	0.00	1.00	120	0.00	2.13	0.00	0.00	2-4	
3/19/2015	3738	26	San Joaquin	16.20	16.90	1200	1500	8.10	9.10	0.00	3.50	0.00	0.00	0.00	1.50	120	0.00	3.73	0.00	0.00	2-4	
3/19/2015	8835	304	San Joaquin	16.80	18.20	900	1430	8.87	10.13	0.00	5.75	0.00	0.00	0.00	2.75	120	0.00	6.13	0.00	0.00	2-4	
3/19/2015	9371	61	San Joaquin	17.70	18.80	1000	1100	7.70	7.60	0.00	1.75	0.00	0.00	0.00	0.75	120	0.00	1.87	0.00	0.00	4-6	
3/19/2015	9371	68	San Joaquin	17.70	18.90	1130	1230	8.30	8.30	0.00	2.25	0.00	0.00	0.00	0.75	120	0.00	2.40	0.00	0.00	2-4	
3/20/2015	9371	84	Contra Costa	17.30	19.20	1030	1130	7.90	6.80	0.00	2.03	0.00	0.00	0.95	0.00	120	0.00	2.17	0.00	0.00	2-4	
3/20/2015	9371	84	San Joaquin	17.30	19.20	930	1030	7.90	6.80	0.00	1.24	0.00	0.00	0.58	0.00	120	0.00	1.32	0.00	0.00	2-4	
3/20/2015	9371	85	San Joaquin	19.20	19.70	1130	1200	6.80	7.30	0.00	1.01	0.00	0.00	0.47	0.00	120	0.00	1.08	0.00	0.00	2-4	
3/20/2015	9371	85	Contra Costa	19.70	23.60	1200	1430	7.30	9.20	0.00	4.22	0.00	0.00	2.00	0.00	120	0.00	4.50	0.00	0.00	0-2	
3/26/2015	3738	14	San Joaquin	17.20	17.40	930	1500	9.00	9.20	0.00	6.50	0.00	0.00	0.00	2.50	120	0.00	6.93	0.00	0.00	0-2	
3/27/2015	8835	49	San Joaquin	18.20	21.40	800	1300	8.30	8.30	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6	
3/27/2015	9371	93	Contra Costa	18.20	21.30	1100	1430	9.90	10.90	0.00	6.00	0.00	1100	0.00	1.25	0.00	120	0.00	6.40	0.00	0.00	0-2
3/27/2015	9607	709	Stanislaus	20.00	21.20	930	1400	7.04	8.07	0.00	5.00	0.00	0.00	0.00	2.50	120	0.00	5.33	0.00	0.00	0-2	
										0.00	159.75	0.00	0.00	16.50	44.75		0.00	170.40	0.00	0.00		

Table B- 2. April 2015 Herbicide and Adjuvant Use

Date	Vessel ID	Site ID	County	Before Temp (-C)	After Temp (-C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
4/1/2015	9371	76	San Joaquin	18.70	20.30	1230	1430	5.80	5.60	0.00	4.00	0.00	0.00	1.00	0.00	120	0.00	4.27	0.00	0.00	4-6
4/2/2015	9371	291	San Joaquin	18.70	19.30	930	1230	7.20	7.00	0.00	5.00	0.00	0.00	1.25	0.00	120	0.00	5.33	0.00	0.00	8-10
4/3/2015	8835	46	San Joaquin	15.40	15.90	730	1400	0.62	0.86	0.00	9.00	0.00	0.00	4.25	0.00	120	0.00	9.60	0.00	0.00	2-4
4/3/2015	9371	81	San Joaquin	18.10	20.20	800	1300	9.50	9.80	0.00	11.00	0.00	0.00	0.75	2.50	120	0.00	11.73	0.00	0.00	0-2
4/6/2015	8789	61	San Joaquin	17.00	17.20	1200	1330	11.60	11.00	0.00	0.50	0.00	0.00	0.25	0.00	120	0.00	0.53	0.00	0.00	4-6
4/6/2015	8789	62	San Joaquin	16.90	17.00	1030	1200	9.55	11.60	0.00	1.00	0.00	0.00	0.50	0.00	120	0.00	1.07	0.00	0.00	2-4
4/9/2015	8789	708	Stanislaus	14.40	14.90	1000	1400	10.20	10.50	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
4/9/2015	8835	709	Stanislaus	14.40	15.60	1000	1430	10.20	10.31	0.00	6.50	0.00	0.00	0.00	3.25	120	0.00	6.93	0.00	0.00	2-4
4/9/2015	9122	76	San Joaquin	16.10	18.30	1000	1430	5.90	5.80	0.00	8.00	0.00	0.00	0.00	3.00	120	0.00	8.53	0.00	0.00	2-4
4/10/2015	8789	708	Stanislaus	14.30	15.00	1000	1400	10.10	10.30	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
4/10/2015	9122	77	San Joaquin	16.00	20.40	900	1430	6.70	8.60	0.00	11.25	0.00	0.00	3.25	0.00	120	0.00	12.00	0.00	0.00	0-2
4/14/2015	9122	74	San Joaquin	16.90	17.20	900	1100	5.60	5.60	0.00	4.00	0.00	0.00	0.00	1.50	120	0.00	4.27	0.00	0.00	4-6
4/14/2015	9122	291	San Joaquin	15.30	15.90	1230	1400	0.98	1.30	0.00	5.00	0.00	0.00	0.00	1.75	120	0.00	5.33	0.00	0.00	6-8
4/15/2015	9122	291	San Joaquin	15.80	17.30	930	1130	5.30	6.80	0.00	2.00	0.00	0.00	0.75	0.75	120	0.00	2.13	0.00	0.00	4-6
4/16/2015	8789	708	Stanislaus	17.40	17.90	930	1400	9.80	9.90	0.00	4.50	0.00	0.00	2.25	0.00	120	0.00	4.80	0.00	0.00	2-4
4/16/2015	8834	47	San Joaquin	16.90	23.50	1100	1430	9.60	8.60	0.00	7.00	0.00	0.00	4.00	0.00	120	0.00	7.47	0.00	0.00	2-4
4/16/2015	8834	49	San Joaquin	14.90	16.80	800	900	8.40	11.80	0.00	0.50	0.00	0.00	0.25	0.00	120	0.00	0.53	0.00	0.00	2-4
4/16/2015	8835	311	Stanislaus	15.40	17.20	1000	1100	8.25	8.17	0.00	0.00	0.40	0.00	1.00	0.00	32	0.00	0.00	1.60	0.00	2-4
4/16/2015	8835	312	Stanislaus	18.50	19.50	1130	1230	8.16	8.21	0.00	0.00	0.20	0.00	0.50	0.00	32	0.00	0.00	0.80	0.00	2-4
4/16/2015	9122	78	San Joaquin	16.60	17.40	830	1130	11.70	11.50	0.00	7.25	0.00	0.00	2.50	0.00	120	0.00	7.73	0.00	0.00	4-6
4/16/2015	9122	80	San Joaquin	17.60	20.20	1230	1430	9.60	9.00	0.00	3.00	0.00	0.00	1.00	0.00	120	0.00	3.20	0.00	0.00	2-4
4/16/2015	9339	29	San Joaquin	17.40	18.10	930	1230	9.90	10.40	0.00	3.25	0.00	0.00	0.00	1.50	120	0.00	3.47	0.00	0.00	0-2
4/17/2015	8834	49	San Joaquin	15.90	20.30	630	1330	11.10	11.10	0.00	7.50	0.00	0.00	5.75	0.00	120	0.00	8.00	0.00	0.00	2-4
4/17/2015	9371	93	Contra Costa	18.00	21.10	830	1400	11.40	11.30	0.00	11.00	0.00	0.00	3.00	0.00	120	0.00	11.73	0.00	0.00	2-4
4/20/2015	9371	85	San Joaquin	18.40	21.30	1230	1430	10.90	11.40	0.00	6.00	0.00	0.00	3.50	0.00	120	0.00	6.40	0.00	0.00	2-4
4/23/2015	3738	31	San Joaquin	18.40	19.00	1030	1430	12.00	9.60	0.00	7.50	0.00	0.00	0.00	3.00	120	0.00	8.00	0.00	0.00	0-2
4/23/2015	8834	47	San Joaquin	20.10	21.40	1230	1530	7.20	7.00	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	2-4
4/23/2015	8834	48	San Joaquin	17.00	22.10	800	1230	7.30	6.00	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
4/23/2015	8835	303	San Joaquin	19.80	20.30	930	1430	6.88	6.75	0.00	6.25	0.00	0.00	3.00	0.00	120	0.00	6.67	0.00	0.00	4-6
4/23/2015	9371	84	Contra Costa	19.00	22.10	900	1300	6.50	7.90	0.00	10.27	0.00	0.00	4.11	0.00	120	0.00	10.95	0.00	0.00	2-4
4/23/2015	9371	84	San Joaquin	19.00	22.10	1300	1430	6.50	7.90	0.00	2.23	0.00	0.00	0.89	0.00	120	0.00	2.38	0.00	0.00	2-4
4/24/2015	3738	709	Stanislaus	20.80	22.80	1130	1400	10.20	10.20	0.00	4.50	0.00	0.00	0.00	3.00	120	0.00	4.80	0.00	0.00	2-4
4/24/2015	8834	310	Stanislaus	19.00	20.40	830	1000	7.80	7.30	0.00	1.50	0.00	0.00	1.00	0.00	120	0.00	1.60	0.00	0.00	4-6
4/24/2015	8834	311	Stanislaus	21.40	23.00	1030	1300	7.50	6.20	0.00	4.75	0.00	0.00	2.00	0.00	120	0.00	5.07	0.00	0.00	6-8
4/24/2015	9371	82	San Joaquin	17.30	17.60	930	1100	5.80	5.70	0.00	3.75	0.00	0.00	1.50	0.00	120	0.00	4.00	0.00	0.00	8-10
4/27/2015	3738	30	San Joaquin	21.60	22.10	1230	1500	9.90	8.90	0.00	3.50	0.00	0.00	0.00	2.00	120	0.00	3.73	0.00	0.00	2-4
4/29/2015	3738	9	San Joaquin	22.60	23.60	830	930	9.10	8.70	0.00	1.00	0.00	0.00	0.00	0.25	120	0.00	1.07	0.00	0.00	4-6
4/29/2015	8834	47	San Joaquin	17.80	19.70	730	1030	7.10	7.80	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	2-4
4/29/2015	8834	48	San Joaquin	19.70	21.20	1030	1130	7.80	7.00	0.00	1.50	0.00	0.00	1.00	0.00	120	0.00	1.60	0.00	0.00	4-6
4/29/2015	8834	49	San Joaquin	19.60	22.00	1130	1430	7.00	7.50	0.00	1.50	0.00	0.00	1.00	0.00	120	0.00	1.60	0.00	0.00	6-8
4/29/2015	8835	303	San Joaquin	20.20	23.90	900	1430	6.83	8.25	0.00	5.75	0.00	0.00	2.50	0.00	120	0.00	6.13	0.00	0.00	2-4
4/29/2015	9371	84	San Joaquin	19.80	21.70	900	1330	7.80	5.90	0.00	11.25	0.00	0.00	5.00	0.00	120	0.00	12.00	0.00	0.00	2-4
4/30/2015	3738	303	San Joaquin	21.50	22.50	900	1330	6.50	6.50	0.00	3.50	0.00	0.00	0.00	1.50	120	0.00	3.73	0.00	0.00	0-2

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
4/30/2015	8789	92	Contra Costa	20.90	21.40	1030	1430	8.60	8.90	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6
4/30/2015	8834	47	San Joaquin	20.30	19.80	800	1030	7.20	7.10	0.00	3.25	0.00	0.00	2.00	0.00	120	0.00	3.47	0.00	0.00	2-4
4/30/2015	8835	303	San Joaquin	20.10	21.80	930	1330	6.80	6.50	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6
4/30/2015	9122	56	San Joaquin	20.80	21.80	1030	1130	7.10	6.90	0.00	0.50	0.00	0.00	0.25	0.00	120	0.00	0.53	0.00	0.00	6-8
4/30/2015	9122	58	San Joaquin	19.80	20.10	900	1000	7.60	6.70	0.00	1.25	0.00	0.00	0.50	0.00	120	0.00	1.33	0.00	0.00	2-4
										0.00	223.50	0.60	0.00	76.00	24.00		0.00	238.40	2.40	0.00	

Table B- 3. May 2015 Herbicide and Adjuvant Use

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
5/1/2015	8789	92	San Joaquin	20.80	21.60	900	1500	7.10	7.90	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
5/1/2015	8834	47	San Joaquin	20.20	21.40	630	930	7.80	6.50	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
5/1/2015	8834	48	San Joaquin	22.30	22.50	930	1100	7.00	7.00	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	4-6
5/1/2015	9371	93	Contra Costa	19.30	25.50	830	1530	7.80	7.20	0.00	15.75	0.00	0.00	5.25	0.00	120	0.00	16.80	0.00	0.00	0-2
5/6/2015	8789	26	San Joaquin	23.20	23.50	900	1200	7.90	8.10	0.00	4.00	0.00	0.00	2.00	0.00	120	0.00	4.27	0.00	0.00	2-4
5/6/2015	8789	28	San Joaquin	23.40	23.60	1230	1530	8.30	8.10	0.00	6.00	0.00	0.00	3.00	0.00	120	0.00	6.40	0.00	0.00	2-4
5/6/2015	8816	46	San Joaquin	19.70	21.30	1000	1230	1.10	2.40	0.00	3.00	0.00	0.00	1.50	0.00	120	0.00	3.20	0.00	0.00	4-6
5/6/2015	8816	47	San Joaquin	17.40	17.80	730	1000	8.40	8.00	0.00	3.00	0.00	0.00	1.50	0.00	120	0.00	3.20	0.00	0.00	2-4
5/6/2015	8816	48	San Joaquin	21.90	22.70	1230	1400	6.80	2.70	0.00	1.50	0.00	0.00	0.50	0.00	120	0.00	1.60	0.00	0.00	4-6
5/6/2015	8835	300	San Joaquin	17.40	19.10	900	1400	6.88	7.23	0.00	6.00	0.00	0.00	2.75	0.00	120	0.00	6.40	0.00	0.00	2-4
5/6/2015	9371	52	San Joaquin	22.00	22.00	1300	1400	7.70	7.70	0.00	1.56	0.00	0.00	0.39	0.00	120	0.00	1.66	0.00	0.00	6-8
5/6/2015	9371	53	San Joaquin	20.20	22.00	930	1300	6.50	7.70	0.00	4.44	0.00	0.00	1.11	0.00	120	0.00	4.74	0.00	0.00	4-6
5/7/2015	3738	29	San Joaquin	23.80	23.90	1300	1500	8.90	8.60	0.00	2.50	0.00	0.00	0.00	1.00	120	0.00	2.67	0.00	0.00	4-6
5/8/2015	8789	92	Contra Costa	19.70	20.90	830	1530	6.80	7.30	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	4-6
5/8/2015	8834	46	San Joaquin	14.80	17.80	630	1000	7.20	2.10	0.00	5.50	0.00	0.00	4.00	0.00	120	0.00	5.87	0.00	0.00	2-4
5/8/2015	8834	47	San Joaquin	17.90	18.20	1000	1200	6.80	7.40	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	2-4
5/8/2015	9371	93	Contra Costa	19.30	23.40	800	1500	8.10	9.30	0.00	11.50	0.00	0.00	3.00	0.00	120	0.00	12.27	0.00	0.00	0-2
5/11/2015	9339	33	San Joaquin	21.10	21.80	1100	1400	8.13	8.10	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	4-6
5/12/2015	3738	710	Stanislaus	22.40	23.10	1030	1400	11.80	10.60	0.00	5.00	0.00	0.00	0.00	2.00	120	0.00	5.33	0.00	0.00	4-6
5/13/2015	3738	32	San Joaquin	23.60	23.80	800	1300	9.80	9.60	0.00	7.50	0.00	0.00	0.00	3.00	120	0.00	8.00	0.00	0.00	2-4
5/13/2015	9339	706	Stanislaus	19.80	22.10	1000	1400	8.06	8.50	0.00	5.50	0.00	0.00	2.50	0.00	120	0.00	5.87	0.00	0.00	2-4
5/14/2015	3738	32	San Joaquin	20.10	21.10	830	1400	8.40	9.50	0.00	7.50	0.00	0.00	4.00	3.00	120	0.00	8.00	0.00	0.00	2-4
5/14/2015	8835	302	San Joaquin	19.50	21.20	830	1130	14.68	12.35	0.00	2.25	0.00	0.00	0.75	0.00	120	0.00	2.40	0.00	0.00	2-4
5/14/2015	8835	303	San Joaquin	21.20	21.80	1200	1400	12.35	12.75	0.00	2.75	0.00	0.00	0.75	0.00	120	0.00	2.93	0.00	0.00	4-6
5/14/2015	9371	14	San Joaquin	19.00	20.60	930	1330	6.80	7.40	0.00	7.00	0.00	0.00	2.50	0.00	120	0.00	7.47	0.00	0.00	4-6
5/15/2015	8834	46	San Joaquin	16.80	17.10	630	1100	7.50	1.20	0.00	6.00	0.00	0.00	3.00	0.00	120	0.00	6.40	0.00	0.00	2-4
5/15/2015	8834	47	San Joaquin	17.50	18.40	1100	1330	6.80	6.50	0.00	3.00	0.00	0.00	2.50	0.00	120	0.00	3.20	0.00	0.00	4-6
5/15/2015	8835	712	Stanislaus	17.90	18.10	700	1400	7.30	8.20	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	0-2
5/15/2015	9371	14	San Joaquin	19.50	20.20	830	1200	7.90	7.00	0.00	4.00	0.00	0.00	1.25	0.00	120	0.00	4.27	0.00	0.00	2-4
5/15/2015	9371	28	San Joaquin	21.20	21.40	1230	1300	7.50	7.30	0.00	0.75	0.00	0.00	0.75	0.00	120	0.00	0.80	0.00	0.00	6-8
5/15/2015	9371	33	San Joaquin	19.30	19.30	700	800	7.60	7.20	0.00	2.00	0.00	0.00	0.25	0.00	120	0.00	2.13	0.00	0.00	0-2
5/18/2015	MERCED	528	Merced	18.40	20.30	1140	1530	10.27	10.14	0.00	0.03	0.00	0.00	0.02	0.00	96	0.00	0.04	0.00	0.00	6-8
5/19/2015	3738	9	San Joaquin	20.10	20.30	900	1230	8.90	7.90	0.00	6.00	0.00	0.00	0.00	3.00	120	0.00	6.40	0.00	0.00	2-4
5/19/2015	3738	28	San Joaquin	22.00	22.00	1330	1530	7.60	7.50	0.00	6.00	0.00	0.00	3.00	0.00	120	0.00	6.40	0.00	0.00	4-6
5/19/2015	MERCED	410	Merced	20.60	24.00	1130	1530	8.28	10.30	0.00	0.02	0.00	0.00	0.01	0.00	96	0.00	0.03	0.00	0.00	6-8
5/20/2015	3738	9	San Joaquin	19.70	20.00	830	1400	7.40	7.70	0.00	10.00	0.00	0.00	0.00	4.00	120	0.00	10.67	0.00	0.00	4-6
5/20/2015	8835	300	San Joaquin	17.70	18.20	1030	1245	6.48	7.54	0.00	4.00	0.00	0.00	1.75	0.00	120	0.00	4.27	0.00	0.00	4-6
5/20/2015	8835	301	San Joaquin	19.30	19.50	900	1015	10.70	10.14	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	2-4
5/20/2015	9339	709	Stanislaus	21.10	21.40	1030	1330	9.60	9.70	0.00	4.00	0.00	0.00	0.00	2.50	120	0.00	4.27	0.00	0.00	4-6
5/20/2015	9371	65	San Joaquin	21.40	21.60	1400	1530	8.40	8.00	0.00	2.50	0.00	0.00	0.75	0.00	120	0.00	2.67	0.00	0.00	6-8
5/20/2015	9371	68	San Joaquin	17.50	21.20	830	1330	8.80	8.20	0.00	7.00	0.00	0.00	3.00	0.00	120	0.00	7.47	0.00	0.00	4-6
5/20/2015	MERCED	409	Merced	19.70	21.00	1000	1430	8.37	10.33	0.00	0.02	0.00	0.00	0.01	0.00	96	0.00	0.03	0.00	0.00	0-2
5/21/2015	3738	30	San Joaquin	19.80	20.00	830	1300	9.10	8.70	0.00	2.50	0.00	0.00	1.50	0.00	120	0.00	2.67	0.00	0.00	4-6

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
5/21/2015	9339	32	San Joaquin	20.60	21.10	830	1230	8.12	9.00	0.00	5.00	0.00	0.00	0.00	2.50	120	0.00	5.33	0.00	0.00	4-6
5/21/2015	9371	65	San Joaquin	21.00	22.80	830	1530	7.80	7.50	0.00	12.25	0.00	0.00	4.75	0.00	120	0.00	13.07	0.00	0.00	4-6
5/21/2015	MERCED	526	Merced	17.80	20.50	1000	1400	9.33	9.84	0.00	0.05	0.00	0.00	0.03	0.00	96	0.00	0.07	0.00	0.00	6-8
5/22/2015	8834	47	San Joaquin	19.20	20.30	900	1230	7.50	7.00	0.00	3.00	0.00	0.00	1.50	0.00	120	0.00	3.20	0.00	0.00	2-4
5/22/2015	8835	709	Stanislaus	20.60	20.70	800	1330	8.21	8.70	0.00	6.50	0.00	0.00	2.50	0.00	120	0.00	6.93	0.00	0.00	4-6
5/22/2015	9371	53	San Joaquin	17.80	22.50	830	1430	8.80	7.90	0.00	10.25	0.00	0.00	3.00	0.00	120	0.00	10.93	0.00	0.00	2-4
5/22/2015	MERCED	522	Merced	20.40	22.50	1300	1500	10.44	10.49	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	4-6
5/22/2015	MERCED	523	Merced	17.20	20.40	1000	1300	9.27	10.44	0.00	0.06	0.00	0.00	0.03	0.00	96	0.00	0.08	0.00	0.00	4-6
5/22/2015	MERCED	524	Merced	17.10	17.20	920	1000	8.64	9.27	0.00	0.01	0.00	0.00	0.01	0.00	96	0.00	0.01	0.00	0.00	4-6
5/23/2015	9371	15	San Joaquin	19.30	21.50	630	1230	6.60	7.50	0.00	9.50	0.00	0.00	4.00	0.00	120	0.00	10.13	0.00	0.00	2-4
5/25/2015	8835	714	Stanislaus	17.30	17.30	830	1030	8.91	9.00	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	4-6
5/25/2015	8835	715	Stanislaus	17.30	17.60	1030	1330	9.00	8.70	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6
5/26/2015	3738	32	San Joaquin	20.20	20.60	900	1100	8.70	9.40	0.00	5.00	0.00	0.00	0.00	2.50	120	0.00	5.33	0.00	0.00	4-6
5/26/2015	MERCED	520	Merced	21.60	24.70	1200	1400	9.39	9.85	0.00	0.08	0.00	0.00	0.04	0.00	96	0.00	0.11	0.00	0.00	2-4
5/26/2015	MERCED	521	Merced	20.10	21.60	1000	1200	10.24	9.39	0.00	0.06	0.00	0.00	0.03	0.00	96	0.00	0.08	0.00	0.00	2-4
5/27/2015	8834	49	San Joaquin	18.10	18.50	700	930	7.10	7.00	0.00	4.50	0.00	0.00	2.00	0.00	120	0.00	4.80	0.00	0.00	2-4
5/27/2015	8834	50	San Joaquin	22.30	22.60	930	1230	9.10	9.50	0.00	5.00	0.00	0.00	3.00	0.00	120	0.00	5.33	0.00	0.00	2-4
5/27/2015	9371	74	San Joaquin	21.80	22.90	1100	1500	7.60	7.80	0.00	7.00	0.00	0.00	2.50	0.00	120	0.00	7.47	0.00	0.00	4-6
5/27/2015	MERCED	518	Merced	20.60	25.70	1300	1500	9.25	11.76	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	2-4
5/27/2015	MERCED	519	Merced	20.10	20.60	900	1300	8.05	9.25	0.00	0.23	0.00	0.00	0.12	0.00	96	0.00	0.31	0.00	0.00	2-4
5/28/2015	8835	300	San Joaquin	21.10	22.50	930	1130	9.93	9.67	0.00	0.00	0.40	0.00	1.25	0.00	32	0.00	0.00	1.60	0.00	2-4
5/28/2015	8835	302	San Joaquin	22.50	22.80	1200	1400	9.67	9.75	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	4-6
5/28/2015	8835	303	San Joaquin	22.80	24.10	1400	1600	9.75	8.68	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6
5/28/2015	9371	84	San Joaquin	20.90	21.30	1430	1500	7.80	7.90	0.00	0.95	0.00	0.00	0.28	0.00	120	0.00	1.01	0.00	0.00	4-6
5/28/2015	9371	84	Contra Costa	19.80	20.90	930	1430	6.50	7.80	0.00	9.05	0.00	0.00	2.72	0.00	120	0.00	9.65	0.00	0.00	2-4
5/28/2015	964121	46	San Joaquin	20.30	21.40	930	1230	2.00	1.30	0.00	0.00	0.50	0.00	0.50	0.00	32	0.00	0.00	2.00	0.00	2-4
5/28/2015	MERCED	515	Merced	23.00	23.60	1300	1300	10.07	9.95	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	2-4
5/28/2015	MERCED	517	Merced	21.30	23.00	1000	1300	9.02	10.07	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	2-4
5/29/2015	8835	310	Stanislaus	24.50	25.20	1000	1200	11.13	11.61	0.00	2.50	0.00	0.00	2.00	0.00	120	0.00	2.67	0.00	0.00	4-6
5/29/2015	8835	311	Stanislaus	25.20	26.50	1200	1600	11.61	10.11	0.00	10.00	0.00	0.00	5.50	0.00	120	0.00	10.67	0.00	0.00	4-6
5/29/2015	9123	13	San Joaquin	21.30	21.60	700	1400	9.10	8.60	0.00	7.50	0.00	0.00	0.00	3.50	120	0.00	8.00	0.00	0.00	0-2
5/29/2015	9371	84	Contra Costa	20.00	20.80	1030	1230	7.70	7.50	0.00	3.75	0.00	0.00	1.25	0.00	120	0.00	4.00	0.00	0.00	4-6
5/29/2015	9371	84	San Joaquin	19.60	20.00	900	1030	7.90	7.70	0.00	2.75	0.00	0.00	0.50	0.00	120	0.00	2.93	0.00	0.00	2-4
5/29/2015	9371	85	Contra Costa	20.80	22.30	1230	1530	7.60	8.30	0.00	4.50	0.00	0.00	0.75	0.00	120	0.00	4.80	0.00	0.00	0-2
5/29/2015	964121	46	San Joaquin	19.40	20.60	600	900	7.50	2.10	0.00	0.00	0.50	0.00	0.50	0.00	32	0.00	0.00	2.00	0.00	2-4
5/29/2015	MERCED	514	Merced	23.00	24.60	1200	1400	8.79	10.99	0.00	0.13	0.00	0.00	0.06	0.00	96	0.00	0.17	0.00	0.00	0-2
5/29/2015	MERCED	515	Merced	21.00	23.00	900	1100	8.35	8.79	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	0-2
5/30/2015	9371	65	San Joaquin	20.60	22.20	630	1130	7.90	8.60	0.00	8.00	0.00	0.00	2.50	0.00	120	0.00	8.53	0.00	0.00	2-4
5/30/2015	9371	68	San Joaquin	22.20	22.40	1130	1230	8.60	8.80	0.00	0.75	0.00	0.00	0.25	0.00	120	0.00	0.80	0.00	0.00	2-4
										0.00	332.41	1.40	0.00	115.84	27.00		0.00	354.88	5.60	0.00	

Table B- 4. June 2015 Herbicide and Adjuvant Use

Date	Vessel ID	Site ID	County	Before Temp (-C)	After Temp (-C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
6/1/2015	8834	46	San Joaquin	21.20	21.80	900	1200	2.60	2.00	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	4-6
6/1/2015	8834	47	San Joaquin	20.30	21.20	700	900	7.00	6.80	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	2-4
6/1/2015	8929	203	San Joaquin	20.20	22.30	730	1400	8.81	9.60	0.00	10.00	0.00	0.00	3.75	0.00	120	0.00	10.67	0.00	0.00	2-4
6/1/2015	9123	37	San Joaquin	22.10	21.90	700	1130	9.10	9.60	0.00	4.00	0.00	0.00	0.00	2.00	120	0.00	4.27	0.00	0.00	2-4
6/1/2015	9123	38	San Joaquin	21.20	21.30	1230	1400	8.70	9.10	0.00	2.00	0.00	0.00	0.00	1.50	120	0.00	2.13	0.00	0.00	4-6
6/1/2015	MERCED	512	Merced	24.70	26.30	1200	1400	9.81	9.31	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	4-6
6/1/2015	MERCED	513	Merced	21.70	24.70	930	1200	8.16	9.81	0.00	0.13	0.00	0.00	0.06	0.00	96	0.00	0.17	0.00	0.00	4-6
6/2/2015	8835	37	San Joaquin	20.20	20.40	700	1300	9.80	8.30	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	4-6
6/2/2015	8929	204	San Joaquin	20.80	21.90	1200	1430	8.38	8.52	0.00	6.25	0.00	0.00	2.25	0.00	120	0.00	6.67	0.00	0.00	4-6
6/2/2015	8929	206	San Joaquin	18.70	20.40	730	1130	8.71	8.90	0.00	6.25	0.00	0.00	2.25	0.00	120	0.00	6.67	0.00	0.00	2-4
6/2/2015	964121	46	San Joaquin	18.50	20.20	600	900	7.60	7.40	0.00	0.00	0.50	0.00	0.50	0.00	32	0.00	0.00	2.00	0.00	4-6
6/2/2015	964121	47	San Joaquin	20.90	20.90	1000	1200	7.20	7.20	0.00	0.00	0.50	0.00	0.50	0.00	32	0.00	0.00	2.00	0.00	4-6
6/3/2015	8834	47	San Joaquin	20.80	21.20	630	930	1.20	6.70	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6
6/3/2015	8834	48	San Joaquin	20.70	21.40	930	1130	7.20	7.00	0.00	2.50	0.00	0.00	1.50	0.00	120	0.00	2.67	0.00	0.00	4-6
6/3/2015	8929	205	San Joaquin	21.80	23.70	1130	1400	8.26	8.51	0.00	4.00	0.00	0.00	1.25	0.00	120	0.00	4.27	0.00	0.00	4-6
6/3/2015	8929	207	San Joaquin	18.90	21.10	730	1030	8.56	8.93	0.00	3.00	0.00	0.00	0.75	0.00	120	0.00	3.20	0.00	0.00	2-4
6/3/2015	9012	109	Contra Costa	22.70	22.90	1000	1500	6.40	6.90	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6
6/3/2015	9607	6	San Joaquin	22.40	22.10	830	1000	7.40	7.90	0.00	0.00	0.25	0.00	0.13	0.00	32	0.00	0.00	1.00	0.00	2-4
6/3/2015	9607	10	San Joaquin	22.40	22.60	1030	1130	9.20	7.80	0.00	0.00	0.25	0.00	0.13	0.00	32	0.00	0.00	1.00	0.00	2-4
6/3/2015	MERCED	410	Merced	25.30	26.30	1330	1400	9.40	8.90	0.00	0.01	0.00	0.00	0.01	0.00	96	0.00	0.01	0.00	0.00	4-6
6/3/2015	MERCED	411	Merced	18.90	21.60	900	1000	6.05	5.16	0.00	0.02	0.00	0.00	0.01	0.00	96	0.00	0.03	0.00	0.00	0-2
6/3/2015	MERCED	412	Merced	21.60	22.80	1000	1100	5.16	11.51	0.00	0.03	0.00	0.00	0.01	0.00	96	0.00	0.04	0.00	0.00	0-2
6/3/2015	MERCED	413	Merced	22.80	23.20	1100	1200	11.51	9.80	0.00	0.02	0.00	0.00	0.01	0.00	96	0.00	0.03	0.00	0.00	0-2
6/4/2015	8834	48	San Joaquin	18.30	18.60	630	830	7.00	7.10	0.00	1.50	0.00	0.00	0.50	0.00	120	0.00	1.60	0.00	0.00	4-6
6/4/2015	8834	49	San Joaquin	18.60	23.80	830	1230	7.30	7.40	0.00	6.00	0.00	0.00	2.50	0.00	120	0.00	6.40	0.00	0.00	2-4
6/4/2015	8929	215	Sacramento	20.70	22.70	930	1430	7.52	7.96	0.00	8.00	0.00	0.00	4.50	0.00	120	0.00	8.53	0.00	0.00	2-4
6/4/2015	9012	112	Contra Costa	22.70	22.90	1100	1500	6.30	6.60	0.00	7.50	0.00	0.00	2.50	0.00	120	0.00	8.00	0.00	0.00	2-4
6/4/2015	9607	8	San Joaquin	22.30	22.50	700	1400	8.20	8.40	0.00	9.50	0.00	0.00	4.00	0.00	120	0.00	10.13	0.00	0.00	0-2
6/4/2015	MERCED	511	Merced	25.60	27.60	1200	1500	9.10	9.56	0.00	0.08	0.00	0.00	0.04	0.00	96	0.00	0.11	0.00	0.00	2-4
6/4/2015	MERCED	512	Merced	22.80	25.60	1000	1100	8.46	9.10	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	0-2
6/5/2015	9371	215	Sacramento	22.10	23.30	830	1330	7.20	7.60	0.00	10.00	0.00	0.00	3.75	0.00	120	0.00	10.67	0.00	0.00	0-2
6/5/2015	MERCED	528	Merced	19.00	20.50	930	1430	9.25	8.11	0.00	0.30	0.00	0.00	0.15	0.00	96	0.00	0.40	0.00	0.00	0-2
6/8/2015	9607	39	San Joaquin	23.10	23.80	800	1430	9.50	7.70	0.00	9.00	0.00	0.00	0.00	3.00	120	0.00	9.60	0.00	0.00	0-2
6/8/2015	MERCED	510	Merced	27.30	30.60	1000	1400	7.40	8.86	0.00	0.08	0.00	0.00	0.04	0.00	96	0.00	0.11	0.00	0.00	0-2
6/9/2015	8929	202	San Joaquin	23.70	23.50	730	1030	8.50	8.43	0.00	2.00	0.00	0.00	0.75	0.00	120	0.00	2.13	0.00	0.00	4-6
6/9/2015	9123	42	San Joaquin	22.10	22.40	630	930	9.10	8.70	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	0-2
6/9/2015	9371	13	San Joaquin	22.80	22.80	1030	1200	8.10	8.00	0.00	1.50	0.00	0.00	0.75	0.00	120	0.00	1.60	0.00	0.00	10+
6/9/2015	9371	16	San Joaquin	21.80	22.10	800	1000	7.90	8.30	0.00	3.25	0.00	0.00	1.50	0.00	120	0.00	3.47	0.00	0.00	2-4
6/9/2015	MERCED	509	Merced	27.50	29.00	1000	1430	7.19	7.78	0.00	0.23	0.00	0.00	0.12	0.00	96	0.00	0.31	0.00	0.00	0-2
6/10/2015	8929	216	Sacramento	23.70	23.50	900	1130	6.30	6.42	0.00	4.00	0.00	0.00	1.50	0.00	120	0.00	4.27	0.00	0.00	2-4
6/10/2015	9123	29	San Joaquin	22.10	22.40	930	1130	9.60	9.10	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	2-4
6/10/2015	9371	215	Sacramento	23.70	23.80	900	1100	6.30	6.80	0.00	3.00	0.00	0.00	0.50	0.00	120	0.00	3.20	0.00	0.00	2-4
6/10/2015	MERCED	508	Merced	25.90	27.70	1000	1400	7.35	19.65	0.00	0.28	0.00	0.00	0.14	0.00	96	0.00	0.37	0.00	0.00	0-2

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
6/11/2015	8929	216	Sacramento	22.60	26.00	830	1400	7.15	8.05	0.00	11.50	0.00	0.00	5.00	0.00	120	0.00	12.27	0.00	0.00	2-4
6/11/2015	9012	110	Contra Costa	22.40	22.60	730	930	6.10	6.40	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	4-6
6/11/2015	9012	112	Contra Costa	22.50	22.80	930	1500	6.30	6.20	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	4-6
6/11/2015	9371	215	Sacramento	21.00	21.80	830	1030	5.10	6.20	0.00	3.75	0.00	0.00	1.25	0.00	120	0.00	4.00	0.00	0.00	0-2
6/11/2015	9371	217	Sacramento	26.10	27.40	1100	1430	11.50	6.30	0.00	4.75	0.00	0.00	1.25	0.00	120	0.00	5.07	0.00	0.00	2-4
6/11/2015	9607	42	San Joaquin	22.80	23.00	630	930	8.60	8.70	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
6/11/2015	9607	100	San Joaquin	22.80	22.90	1030	1300	9.30	8.10	0.00	4.00	0.00	0.00	2.00	0.00	120	0.00	4.27	0.00	0.00	2-4
6/11/2015	MERCED	507	Merced	27.60	29.00	1230	1400	8.62	10.89	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	2-4
6/11/2015	MERCED	508	Merced	25.00	27.60	900	1230	7.31	8.62	0.00	0.23	0.00	0.00	0.12	0.00	96	0.00	0.31	0.00	0.00	2-4
6/12/2015	9012	93	Contra Costa	24.70	25.10	800	1500	9.60	9.80	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
6/12/2015	9123	40	San Joaquin	23.20	23.60	630	1430	8.20	9.50	0.00	7.50	0.00	0.00	3.50	0.00	120	0.00	8.00	0.00	0.00	0-2
6/12/2015	MERCED	507	Merced	25.80	28.70	930	1400	7.11	7.43	0.00	0.27	0.00	0.00	0.13	0.00	96	0.00	0.36	0.00	0.00	0-2
6/15/2015	3548	300	San Joaquin	23.10	24.70	900	1300	7.83	7.65	3.00	0.00	0.00	0.00	1.00	0.00	64	3.00	0.00	0.00	0.00	2-4
6/15/2015	9123	43	San Joaquin	22.00	22.40	630	1400	9.50	8.70	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	2-4
6/15/2015	9371	16	San Joaquin	20.60	23.30	900	1500	7.90	7.70	0.00	11.50	0.00	0.00	5.75	0.00	120	0.00	12.27	0.00	0.00	4-6
6/15/2015	MERCED	507	Merced	23.30	27.70	900	1430	7.20	9.64	0.00	0.33	0.00	0.00	0.16	0.00	96	0.00	0.44	0.00	0.00	0-2
6/16/2015	3548	304	San Joaquin	23.60	23.80	900	1200	7.30	7.70	4.00	0.00	0.00	0.00	2.00	0.00	64	4.00	0.00	0.00	0.00	4-6
6/16/2015	8929	200	San Joaquin	21.80	24.20	730	1330	7.19	9.85	0.00	10.00	0.00	0.00	4.25	0.00	120	0.00	10.67	0.00	0.00	2-4
6/16/2015	9012	107	Contra Costa	23.80	24.10	830	1530	6.60	7.10	7.50	0.00	0.00	0.00	3.50	0.00	64	7.50	0.00	0.00	0.00	4-6
6/16/2015	9123	44	San Joaquin	22.60	22.80	630	1400	8.40	8.70	0.00	7.50	0.00	0.00	3.25	0.00	120	0.00	8.00	0.00	0.00	2-4
6/16/2015	9371	203	San Joaquin	23.40	23.90	800	1400	6.20	7.90	0.00	10.00	0.00	0.00	4.00	0.00	120	0.00	10.67	0.00	0.00	8-10
6/16/2015	MERCED	506	Merced	23.70	29.60	900	1500	7.60	9.53	0.00	0.50	0.00	0.00	0.25	0.00	96	0.00	0.67	0.00	0.00	0-2
6/17/2015	9371	52	San Joaquin	23.60	24.10	800	1100	6.30	6.50	0.00	6.00	0.00	0.00	2.25	0.00	120	0.00	6.40	0.00	0.00	2-4
6/17/2015	9371	56	San Joaquin	25.50	25.90	1100	1400	5.50	5.20	0.00	3.50	0.00	0.00	1.25	0.00	120	0.00	3.73	0.00	0.00	2-4
6/17/2015	964121	20	Sacramento	23.10	23.40	700	1100	7.10	7.60	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
6/17/2015	MERCED	505	Merced	25.70	30.70	1000	1430	7.18	9.09	0.00	0.28	0.00	0.00	0.14	0.00	96	0.00	0.37	0.00	0.00	0-2
6/17/2015	MERCED	506	Merced	24.80	25.70	900	1000	7.02	7.18	0.00	0.06	0.00	0.00	0.03	0.00	96	0.00	0.08	0.00	0.00	0-2
6/18/2015	9012	108	Contra Costa	23.60	24.00	800	1500	6.30	6.70	7.50	0.00	0.00	0.00	3.00	0.00	64	7.50	0.00	0.00	0.00	4-6
6/18/2015	9371	20	Sacramento	20.10	21.30	800	1400	8.30	7.90	0.00	7.25	0.00	0.00	4.75	0.00	120	0.00	7.73	0.00	0.00	2-4
6/18/2015	MERCED	504	Merced	26.70	30.50	1100	1400	8.64	11.37	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	0-2
6/18/2015	MERCED	505	Merced	25.50	26.70	1000	1100	7.82	8.64	0.00	0.10	0.00	0.00	0.05	0.00	96	0.00	0.13	0.00	0.00	0-2
6/19/2015	8835	709	Stanislaus	21.50	23.70	830	1000	7.80	8.00	0.00	2.25	0.00	0.00	1.50	0.00	120	0.00	2.40	0.00	0.00	4-6
6/19/2015	8835	715	Stanislaus	23.80	23.80	1130	1200	1.50	1.50	0.00	1.80	0.00	0.00	1.25	0.00	120	0.00	1.92	0.00	0.00	4-6
6/19/2015	8835	716	Stanislaus	23.80	21.90	1200	1330	1.50	7.50	0.00	4.70	0.00	0.00	3.25	0.00	120	0.00	5.01	0.00	0.00	4-6
6/19/2015	9012	108	Contra Costa	23.30	23.60	730	900	6.00	6.50	2.50	0.00	0.00	0.00	1.50	0.00	64	2.50	0.00	0.00	0.00	4-6
6/19/2015	9012	109	Contra Costa	23.70	24.10	900	1500	6.30	6.70	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	4-6
6/19/2015	MERCED	529	Merced	19.50	21.10	930	1300	8.00	8.14	0.00	0.31	0.00	0.00	0.16	0.00	96	0.00	0.41	0.00	0.00	2-4
6/20/2015	9371	214	Sacramento	22.50	24.10	830	1500	8.90	8.40	0.00	11.75	0.00	0.00	5.25	0.00	120	0.00	12.53	0.00	0.00	2-4
6/22/2015	9012	109	Contra Costa	23.00	23.60	730	1530	6.10	6.50	7.50	0.00	0.00	0.00	3.00	0.00	64	7.50	0.00	0.00	0.00	4-6
6/22/2015	9123	69	San Joaquin	22.50	23.10	800	1400	9.50	8.10	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	2-4
6/22/2015	9339	301	San Joaquin	23.10	24.00	900	1230	7.80	8.20	1.50	0.00	0.00	0.00	0.50	0.00	64	1.50	0.00	0.00	0.00	4-6
6/22/2015	9339	302	San Joaquin	24.20	24.10	1300	1430	7.90	7.20	0.25	0.00	0.00	0.00	0.00	0.00	64	0.25	0.00	0.00	0.00	2-4
6/22/2015	9371	84	Contra Costa	24.60	25.20	1200	1430	5.50	5.10	0.00	3.00	0.00	0.00	1.75	0.00	120	0.00	3.20	0.00	0.00	2-4
6/22/2015	9371	84	San Joaquin	23.30	24.60	900	1200	5.90	5.50	0.00	9.00	0.00	0.00	3.25	0.00	120	0.00	9.60	0.00	0.00	2-4

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
6/22/2015	964121	42	San Joaquin	21.40	22.30	900	1100	7.50	7.40	0.00	1.75	0.00	0.00	1.00	0.00	120	0.00	1.87	0.00	0.00	2-4
6/22/2015	MERCED	503	Merced	27.50	28.00	1330	1500	11.97	14.98	0.00	0.17	0.00	0.00	0.09	0.00	96	0.00	0.23	0.00	0.00	2-4
6/22/2015	MERCED	504	Merced	21.90	27.50	930	1330	7.86	11.97	0.00	0.30	0.00	0.00	0.15	0.00	96	0.00	0.40	0.00	0.00	0-2
6/23/2015	8929	202	San Joaquin	19.70	22.40	730	1330	7.67	7.82	0.00	9.25	0.00	0.00	3.75	0.00	120	0.00	9.87	0.00	0.00	2-4
6/23/2015	9012	112	Contra Costa	24.30	24.50	1300	1530	6.60	6.50	2.50	0.00	0.00	0.00	1.00	0.00	64	2.50	0.00	0.00	0.00	6-8
6/23/2015	9012	117	Contra Costa	24.10	24.40	1000	1230	6.60	6.40	2.50	0.00	0.00	0.00	1.00	0.00	64	2.50	0.00	0.00	0.00	6-8
6/23/2015	9122	93	Contra Costa	24.20	24.40	1230	1400	8.50	8.40	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	2-4
6/23/2015	9123	14	San Joaquin	23.60	24.10	630	1430	8.10	8.60	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	0-2
6/23/2015	9339	304	San Joaquin	23.00	23.30	1000	1200	7.14	7.40	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	4-6
6/23/2015	964121	203	San Joaquin	22.90	23.40	800	1230	6.40	6.00	0.00	5.75	0.00	0.00	3.50	0.00	120	0.00	6.13	0.00	0.00	2-4
6/23/2015	MERCED	503	Merced	23.70	28.80	930	1430	8.77	15.02	0.00	0.16	0.00	0.00	0.08	0.00	96	0.00	0.21	0.00	0.00	2-4
6/24/2015	8929	209	Sacramento	23.70	23.70	900	930	8.40	8.40	0.00	1.00	0.00	0.00	0.75	0.00	120	0.00	1.07	0.00	0.00	4-6
6/24/2015	8929	209	San Joaquin	18.10	23.70	730	900	9.75	8.40	0.00	1.50	0.00	0.00	1.00	0.00	120	0.00	1.60	0.00	0.00	2-4
6/24/2015	8929	210	San Joaquin	23.70	25.00	930	1200	8.40	7.20	0.00	4.25	0.00	0.00	2.25	0.00	120	0.00	4.53	0.00	0.00	4-6
6/24/2015	8929	210	Sacramento	25.00	25.00	1200	1230	7.20	7.20	0.00	0.75	0.00	0.00	0.25	0.00	120	0.00	0.80	0.00	0.00	2-4
6/24/2015	8929	211	San Joaquin	25.00	23.50	1230	1330	7.20	8.27	0.00	2.00	0.00	0.00	1.25	0.00	120	0.00	2.13	0.00	0.00	2-4
6/24/2015	9123	100	San Joaquin	24.00	24.30	630	1430	8.40	9.10	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	0-2
6/24/2015	9339	302	San Joaquin	23.10	23.70	900	1200	7.20	7.40	3.50	0.00	0.00	0.00	1.75	0.00	64	3.50	0.00	0.00	0.00	4-6
6/24/2015	9371	80	San Joaquin	24.80	25.30	1300	1530	8.30	8.50	2.25	0.00	0.00	0.00	2.00	0.00	64	2.25	0.00	0.00	0.00	4-6
6/24/2015	9371	81	San Joaquin	23.00	24.80	830	1300	6.10	8.10	3.50	0.00	0.00	0.00	2.25	0.00	64	3.50	0.00	0.00	0.00	4-6
6/24/2015	964121	203	San Joaquin	22.70	22.60	600	1200	7.10	7.00	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	2-4
6/24/2015	MERCED	520	Merced	23.80	26.40	1130	1430	8.02	8.82	0.00	0.20	0.00	0.00	0.10	0.00	96	0.00	0.27	0.00	0.00	2-4
6/24/2015	MERCED	521	Merced	22.10	23.80	930	1130	8.83	8.02	0.00	0.11	0.00	0.00	0.05	0.00	96	0.00	0.15	0.00	0.00	2-4
6/25/2015	9012	109	Contra Costa	23.90	24.20	730	1200	8.40	7.90	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	6-8
6/25/2015	9371	52	San Joaquin	24.00	24.80	900	1130	7.90	7.90	2.50	0.00	0.00	0.00	1.25	0.00	64	2.50	0.00	0.00	0.00	2-4
6/25/2015	9371	57	San Joaquin	25.30	26.50	1200	1500	8.70	8.70	2.50	0.00	0.00	0.00	1.00	0.00	64	2.50	0.00	0.00	0.00	4-6
6/25/2015	9607	100	San Joaquin	24.10	24.60	700	1200	8.10	8.90	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	0-2
6/25/2015	964121	74	San Joaquin	24.50	26.50	1130	1230	7.40	6.20	0.00	1.00	0.00	0.00	0.50	0.00	120	0.00	1.07	0.00	0.00	2-4
6/25/2015	964121	291	San Joaquin	24.10	24.10	900	1000	2.10	2.10	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	2-4
6/26/2015	9012	114	Contra Costa	23.70	24.00	730	1200	7.00	7.50	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	6-8
6/26/2015	9339	303	San Joaquin	25.50	24.30	800	1200	7.93	7.40	3.00	0.00	0.00	0.00	1.50	0.00	64	3.00	0.00	0.00	0.00	2-4
6/26/2015	9371	57	San Joaquin	24.60	25.50	830	1100	7.20	6.80	1.75	0.00	0.00	0.00	1.00	0.00	64	1.75	0.00	0.00	0.00	2-4
6/26/2015	9371	58	San Joaquin	25.50	26.90	1100	1430	6.60	7.50	2.25	0.00	0.00	0.00	1.25	0.00	64	2.25	0.00	0.00	0.00	2-4
6/26/2015	9607	40	San Joaquin	24.10	24.60	700	1430	8.50	9.20	0.00	8.50	0.00	0.00	4.00	0.00	120	0.00	9.07	0.00	0.00	0-2
6/26/2015	964121	74	San Joaquin	24.00	26.20	600	1230	6.40	2.50	0.00	6.00	0.00	0.00	3.00	0.00	120	0.00	6.40	0.00	0.00	2-4
6/26/2015	MERCED	518	Merced	28.40	29.10	1430	1530	8.39	9.50	0.00	0.13	0.00	0.00	0.06	0.00	96	0.00	0.17	0.00	0.00	2-4
6/26/2015	MERCED	519	Merced	26.10	28.40	1130	1430	8.80	8.39	0.00	0.38	0.00	0.00	0.19	0.00	96	0.00	0.51	0.00	0.00	2-4
6/29/2015	8835	219	Sacramento	24.20	27.30	900	1330	7.15	7.24	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	4-6
6/29/2015	9339	714	Stanislaus	22.10	22.60	930	1400	8.02	8.10	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6
6/29/2015	9371	83	San Joaquin	22.60	27.80	830	930	6.90	6.80	1.25	0.00	0.00	0.00	0.75	0.00	64	1.25	0.00	0.00	0.00	4-6
6/29/2015	9371	83	Contra Costa	23.50	23.50	930	1030	7.00	7.00	0.75	0.00	0.00	0.00	0.25	0.00	64	0.75	0.00	0.00	0.00	2-4
6/29/2015	9371	84	Contra Costa	24.30	24.80	1130	1400	6.20	6.80	1.00	0.00	0.00	0.00	1.00	0.00	64	1.00	0.00	0.00	0.00	2-4
6/29/2015	964121	267	Solano	21.50	21.50	1000	1230	7.40	7.40	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	4-6
6/29/2015	MERCED	518	Merced	24.00	27.70	900	1400	8.08	9.33	0.00	0.31	0.00	0.00	0.16	0.00	96	0.00	0.41	0.00	0.00	0-2

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
6/30/2015	8835	215	Sacramento	24.10	27.20	930	1230	7.85	7.82	0.00	3.50	0.00	0.00	2.25	0.00	120	0.00	3.73	0.00	0.00	2-4
6/30/2015	9339	714	Stanislaus	22.40	22.10	930	1330	8.00	7.90	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	0-2
6/30/2015	9371	80	San Joaquin	25.70	28.10	800	1230	5.80	8.90	0.00	10.00	0.00	0.00	1.25	0.00	120	0.00	10.67	0.00	0.00	0-2
6/30/2015	9607	32	San Joaquin	24.20	25.10	600	1330	9.10	9.10	3.50	0.00	0.00	0.00	1.50	0.00	64	3.50	0.00	0.00	0.00	0-2
6/30/2015	964121	49	San Joaquin	25.10	25.10	830	930	6.80	6.80	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	2-4
6/30/2015	964121	58	San Joaquin	22.80	22.80	600	630	7.30	7.30	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	2-4
6/30/2015	964121	97	Contra Costa	23.70	23.70	730	800	6.40	6.40	0.50	0.00	0.00	0.00	0.50	0.00	64	0.50	0.00	0.00	0.00	2-4
6/30/2015	MERCED	515	Merced	28.20	28.40	1400	1430	9.26	9.36	0.00	0.06	0.00	0.00	0.03	0.00	96	0.00	0.08	0.00	0.00	0-2
6/30/2015	MERCED	517	Merced	25.40	28.20	1030	1400	8.03	9.26	0.00	0.22	0.00	0.00	0.11	0.00	96	0.00	0.29	0.00	0.00	0-2
6/30/2015	MERCED	518	Merced	25.60	25.40	1000	1030	8.07	8.03	0.00	0.03	0.00	0.00	0.02	0.00	96	0.00	0.04	0.00	0.00	0-2
										92.00	392.41	1.50	0.00	214.08	6.50		92.00	420.08	6.00	0.00	

Table B- 5. July 2015 Herbicide and Adjuvant Use

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
7/1/2015	8835	215	Sacramento	25.10	27.60	800	1330	7.32	7.22	0.00	9.75	0.00	0.00	3.50	0.00	120	0.00	10.40	0.00	0.00	2-4
7/1/2015	9371	73	San Joaquin	28.00	29.60	1300	1500	7.50	6.30	1.25	0.00	0.00	0.00	1.00	0.00	64	1.25	0.00	0.00	0.00	2-4
7/1/2015	9371	82	San Joaquin	26.90	28.00	900	1300	7.80	7.60	0.00	10.00	0.00	0.00	2.50	0.00	120	0.00	10.67	0.00	0.00	0-2
7/1/2015	9607	6	San Joaquin	26.10	25.40	730	1230	1.40	6.90	2.50	1.50	0.00	0.00	2.00	0.00	64	2.50	1.60	0.00	0.00	0-2
7/1/2015	964121	46	San Joaquin	25.50	27.40	1100	1300	7.60	2.20	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	2-4
7/1/2015	MERCED	515	Merced	27.00	29.20	1130	1500	8.17	8.42	0.00	0.38	0.00	0.00	0.19	0.00	96	0.00	0.51	0.00	0.00	2-4
7/2/2015	8835	217	Sacramento	24.30	26.10	800	1300	7.18	6.60	0.00	8.25	0.00	0.00	4.00	0.00	120	0.00	8.80	0.00	0.00	4-6
7/2/2015	9371	73	San Joaquin	26.90	27.60	830	1430	7.90	7.50	5.00	0.00	0.00	0.00	4.00	0.00	64	5.00	0.00	0.00	0.00	2-4
7/2/2015	9607	6	San Joaquin	25.70	25.30	700	1230	7.90	8.10	4.00	0.00	0.00	0.00	2.00	0.00	64	4.00	0.00	0.00	0.00	0-2
7/2/2015	9607	9	San Joaquin	25.00	25.00	1230	1500	8.00	8.00	0.00	2.50	0.00	0.00	0.75	0.00	120	0.00	2.67	0.00	0.00	0-2
7/2/2015	964121	203	San Joaquin	25.00	25.10	930	1230	7.50	7.30	0.00	1.50	0.00	0.00	1.50	0.00	120	0.00	1.60	0.00	0.00	2-4
7/2/2015	964121	252	Sacramento	25.10	25.10	600	730	6.50	6.50	0.00	1.00	0.00	0.00	0.50	0.00	120	0.00	1.07	0.00	0.00	2-4
7/2/2015	MERCED	413	Merced	24.80	27.40	1000	1430	6.48	5.58	0.00	0.41	0.00	0.00	0.20	0.00	96	0.00	0.55	0.00	0.00	0-2
7/3/2015	8835	20	Sacramento	21.00	23.90	700	1400	6.70	6.90	0.00	11.00	0.00	0.00	3.00	0.00	120	0.00	11.73	0.00	0.00	4-6
7/3/2015	9371	72	San Joaquin	26.50	28.40	830	1300	7.80	7.10	4.50	0.00	0.00	0.00	1.50	0.00	64	4.50	0.00	0.00	0.00	2-4
7/3/2015	9371	75	San Joaquin	28.20	29.50	1300	1430	7.60	6.80	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	2-4
7/3/2015	964121	47	San Joaquin	24.70	24.70	900	1230	6.20	6.20	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	2-4
7/6/2015	8835	217	Sacramento	24.70	28.10	900	1400	7.09	8.14	0.00	9.00	0.00	0.00	5.50	0.00	120	0.00	9.60	0.00	0.00	4-6
7/6/2015	9122	28	San Joaquin	25.00	25.00	1000	1100	8.20	8.60	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	2-4
7/6/2015	9122	29	San Joaquin	24.60	24.70	830	930	7.40	8.10	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	2-4
7/6/2015	9371	75	San Joaquin	25.30	26.80	930	1500	5.90	5.80	4.75	0.00	0.00	0.00	3.75	0.00	64	4.75	0.00	0.00	0.00	4-6
7/6/2015	964121	18	Sacramento	24.40	24.40	1000	1100	7.30	7.30	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	4-6
7/6/2015	MERCED	410	Merced	28.30	29.10	1350	1445	7.93	8.87	0.00	0.08	0.00	0.00	0.04	0.00	96	0.00	0.11	0.00	0.00	6-8
7/6/2015	MERCED	412	Merced	24.10	28.30	1020	1350	2.35	7.93	0.00	0.31	0.00	0.00	0.16	0.00	96	0.00	0.41	0.00	0.00	6-8
7/6/2015	MERCED	413	Merced	23.60	24.10	940	1020	5.14	2.35	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	2-4
7/7/2015	9122	31	San Joaquin	25.00	25.10	730	1430	8.30	8.60	2.50	0.00	0.00	0.00	1.25	0.00	64	2.50	0.00	0.00	0.00	2-4
7/7/2015	9371	74	San Joaquin	25.90	26.10	830	1000	6.50	7.20	1.50	0.00	0.00	0.00	1.00	0.00	64	1.50	0.00	0.00	0.00	2-4
7/7/2015	9371	291	San Joaquin	24.40	25.30	1030	1500	8.20	8.60	3.00	0.00	0.00	0.00	2.75	0.00	64	3.00	0.00	0.00	0.00	8-10
7/7/2015	MERCED	409	Merced	25.40	28.80	1130	1430	5.77	8.86	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	4-6
7/7/2015	MERCED	410	Merced	24.00	24.50	940	1130	6.02	5.77	0.00	0.11	0.00	0.00	0.05	0.00	96	0.00	0.15	0.00	0.00	4-6
7/8/2015	9122	15	San Joaquin	25.40	25.70	1230	1430	9.10	8.70	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	0-2
7/8/2015	9122	67	San Joaquin	25.10	25.30	700	1200	8.70	10.70	4.00	0.00	0.00	0.00	2.00	0.00	64	4.00	0.00	0.00	0.00	2-4
7/8/2015	9371	74	San Joaquin	23.30	24.50	930	1500	6.50	6.20	2.75	0.00	0.00	0.00	2.50	0.00	64	2.75	0.00	0.00	0.00	6-8
7/8/2015	MERCED	409	Merced	23.80	29.10	935	1345	6.04	8.98	0.00	0.13	0.00	0.00	0.06	0.00	96	0.00	0.17	0.00	0.00	2-4
7/9/2015	8835	216	Sacramento	23.10	23.50	930	1530	7.34	7.61	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6
7/9/2015	8835	217	Sacramento	22.80	23.20	730	930	7.33	7.06	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	4-6
7/9/2015	9371	74	San Joaquin	24.20	25.30	800	1500	6.60	6.30	6.00	1.75	0.00	0.00	3.25	0.00	64	6.00	1.87	0.00	0.00	4-6
7/9/2015	964121	46	San Joaquin	20.80	22.50	630	1030	6.30	6.20	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	4-6
7/9/2015	MERCED	408	Merced	22.80	23.20	935	955	8.49	9.00	0.00	0.01	0.00	0.00	0.01	0.00	96	0.00	0.01	0.00	0.00	4-6
7/9/2015	MERCED	505	Merced	25.50	28.70	1135	1500	7.93	8.89	0.00	0.27	0.00	0.00	0.13	0.00	96	0.00	0.36	0.00	0.00	2-4
7/9/2015	MERCED	506	Merced	24.80	25.50	1100	1135	7.31	7.93	0.00	0.07	0.00	0.00	0.03	0.00	96	0.00	0.09	0.00	0.00	2-4
7/10/2015	8834	18	San Joaquin	21.00	22.40	600	1130	7.30	8.80	3.50	0.00	0.00	0.00	1.50	0.00	64	3.50	0.00	0.00	0.00	4-6
7/10/2015	8834	18	Sacramento	22.30	24.20	1200	1500	8.60	9.30	2.00	0.00	0.00	0.00	1.50	0.00	64	2.00	0.00	0.00	0.00	4-6

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
7/10/2015	8835	215	Sacramento	22.80	26.50	730	1430	7.27	7.82	0.00	12.50	0.00	0.00	6.50	0.00	120	0.00	13.33	0.00	0.00	4-6
7/10/2015	9122	66	San Joaquin	25.20	25.50	700	1400	8.10	9.60	4.00	0.00	0.00	0.00	2.00	0.00	64	4.00	0.00	0.00	0.00	2-4
7/10/2015	9371	74	San Joaquin	23.40	25.30	1100	1500	5.70	6.30	5.00	0.00	0.00	0.00	1.25	0.00	64	5.00	0.00	0.00	0.00	4-6
7/10/2015	MERCED	514	Merced	22.60	25.30	1110	1500	8.25	9.17	0.00	0.47	0.00	0.00	0.23	0.00	96	0.00	0.63	0.00	0.00	2-4
7/10/2015	MERCED	515	Merced	22.20	22.60	1000	1110	8.18	8.25	0.00	0.11	0.00	0.00	0.05	0.00	96	0.00	0.15	0.00	0.00	2-4
7/11/2015	9371	79	Alameda	25.40	25.50	1330	1430	7.20	7.80	0.75	0.00	0.00	0.00	1.00	0.00	64	0.75	0.00	0.00	0.00	2-4
7/11/2015	9371	84	Contra Costa	25.20	26.10	1130	1300	6.20	7.80	1.25	0.00	0.00	0.00	1.00	0.00	64	1.25	0.00	0.00	0.00	2-4
7/11/2015	9371	84	San Joaquin	25.20	25.20	1000	1130	6.20	6.20	1.25	0.00	0.00	0.00	1.00	0.00	64	1.25	0.00	0.00	0.00	2-4
7/13/2015	8835	215	Sacramento	23.20	26.10	900	1430	7.13	6.89	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	2-4
7/13/2015	9122	26	San Joaquin	25.10	25.20	700	1400	10.10	10.80	3.00	0.00	0.00	0.00	1.50	0.00	64	3.00	0.00	0.00	0.00	0-2
7/13/2015	9371	75	San Joaquin	23.50	24.60	800	1430	6.80	6.20	5.75	0.00	0.00	0.00	2.25	0.00	64	5.75	0.00	0.00	0.00	4-6
7/13/2015	MERCED	512	Merced	26.40	29.10	1145	1530	9.00	9.26	0.00	0.44	0.00	0.00	0.22	0.00	96	0.00	0.59	0.00	0.00	4-6
7/13/2015	MERCED	513	Merced	23.90	26.40	910	1145	8.05	9.00	0.00	0.25	0.00	0.00	0.13	0.00	96	0.00	0.33	0.00	0.00	4-6
7/14/2015	3420	26	San Joaquin	25.60	25.90	700	1430	9.10	8.70	3.00	0.00	0.00	0.00	1.50	0.00	64	3.00	0.00	0.00	0.00	0-2
7/14/2015	8816	20	Sacramento	22.30	25.80	830	1230	7.30	7.80	3.00	0.00	0.00	0.00	1.00	0.00	64	3.00	0.00	0.00	0.00	2-4
7/14/2015	8835	217	Sacramento	22.70	27.20	800	1430	6.98	9.80	0.00	12.50	0.00	0.00	6.00	0.00	120	0.00	13.33	0.00	0.00	4-6
7/14/2015	9012	110	Contra Costa	22.70	23.10	730	1530	9.60	8.90	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	4-6
7/14/2015	9122	76	San Joaquin	23.50	24.60	830	1300	6.80	6.50	2.50	0.00	0.00	0.00	0.25	0.00	64	2.50	0.00	0.00	0.00	8-10
7/14/2015	MERCED	512	Merced	26.50	28.20	1130	1510	8.92	9.31	0.00	0.33	0.00	0.00	0.16	0.00	96	0.00	0.44	0.00	0.00	4-6
7/14/2015	MERCED	513	Merced	24.30	26.50	945	1130	8.04	8.92	0.00	0.17	0.00	0.00	0.09	0.00	96	0.00	0.23	0.00	0.00	4-6
7/15/2015	3420	100	San Joaquin	25.60	25.70	600	1330	10.10	9.90	5.50	0.00	0.00	0.00	2.75	0.00	64	5.50	0.00	0.00	0.00	0-2
7/15/2015	8816	18	Sacramento	24.60	25.70	1130	1230	7.80	8.20	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	2-4
7/15/2015	8816	18	San Joaquin	22.50	22.90	1000	1130	7.20	7.00	1.50	0.00	0.00	0.00	1.00	0.00	64	1.50	0.00	0.00	0.00	4-6
7/15/2015	8816	20	Sacramento	21.90	22.40	600	930	7.50	7.10	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	2-4
7/15/2015	8816	201	San Joaquin	26.60	28.30	1300	1330	9.60	9.80	0.00	1.50	0.00	0.00	0.25	0.00	120	0.00	1.60	0.00	0.00	2-4
7/15/2015	8835	246	Sacramento	20.80	28.10	800	1330	1.42	6.35	0.00	8.50	0.00	0.00	4.00	0.00	120	0.00	9.07	0.00	0.00	2-4
7/15/2015	9012	110	Contra Costa	22.50	23.30	730	1530	9.00	9.30	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	4-6
7/15/2015	9122	76	San Joaquin	23.30	23.80	830	1430	7.10	6.60	6.00	0.00	0.00	0.00	1.75	0.00	64	6.00	0.00	0.00	0.00	2-4
7/15/2015	MERCED	512	Merced	25.90	28.70	1010	1500	8.03	9.18	0.00	0.55	0.00	0.00	0.27	0.00	96	0.00	0.73	0.00	0.00	2-4
7/16/2015	8816	12	San Joaquin	24.70	25.10	630	1300	6.90	7.20	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	0-2
7/16/2015	9122	76	San Joaquin	23.10	23.30	800	930	7.90	7.90	1.25	0.00	0.00	0.00	0.50	0.00	64	1.25	0.00	0.00	0.00	6-8
7/16/2015	9122	77	San Joaquin	23.20	23.60	930	1200	7.70	7.30	3.75	0.00	0.00	0.00	0.75	0.00	64	3.75	0.00	0.00	0.00	4-6
7/16/2015	MERCED	511	Merced	27.10	30.80	1100	1515	9.26	9.88	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	0-2
7/16/2015	MERCED	512	Merced	25.30	27.10	930	1100	8.08	9.26	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	0-2
7/17/2015	9012	114	Contra Costa	22.90	23.10	800	1400	9.20	8.90	4.00	0.00	0.00	0.00	2.00	0.00	64	4.00	0.00	0.00	0.00	4-6
7/17/2015	9122	84	Contra Costa	24.30	24.30	830	1100	7.90	7.90	2.25	0.00	0.00	0.00	1.50	0.00	64	2.25	0.00	0.00	0.00	2-4
7/17/2015	9122	84	San Joaquin	24.30	25.10	1100	1400	7.90	7.20	2.25	0.00	0.00	0.00	1.75	0.00	64	2.25	0.00	0.00	0.00	2-4
7/17/2015	9122	85	Contra Costa	25.20	25.20	1430	1530	5.90	5.80	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	2-4
7/17/2015	MERCED	413	Merced	27.30	27.40	1400	1500	5.62	9.21	0.00	0.03	0.00	0.00	0.00	0.00	96	0.00	0.04	0.00	0.00	0-2
7/20/2015	3420	59	San Joaquin	25.50	26.00	700	1130	9.20	9.40	2.50	0.00	0.00	0.00	1.25	0.00	64	2.50	0.00	0.00	0.00	0-2
7/20/2015	8816	19	Sacramento	23.40	26.00	630	1130	7.20	7.10	3.50	0.00	0.00	0.00	2.00	0.00	64	3.50	0.00	0.00	0.00	2-4
7/20/2015	8835	214	Sacramento	27.60	27.60	1330	1400	7.54	7.54	0.00	0.75	0.00	0.00	0.25	0.00	120	0.00	0.80	0.00	0.00	4-6
7/20/2015	8835	216	Sacramento	25.10	27.60	730	1330	7.49	7.54	0.00	10.75	0.00	0.00	4.75	0.00	120	0.00	11.47	0.00	0.00	0-2
7/20/2015	9012	112	Contra Costa	24.90	25.30	730	1430	10.40	10.60	2.50	1.50	0.00	0.00	2.50	0.00	64	2.50	1.60	0.00	0.00	6-8

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
7/20/2015	MERCED	510	Merced	28.20	30.90	940	1420	8.04	8.68	0.00	0.08	0.00	0.00	0.04	0.00	96	0.00	0.11	0.00	0.00	0-2
7/21/2015	3420	8	San Joaquin	25.80	25.90	730	1300	9.10	9.60	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	0-2
7/21/2015	8816	19	Contra Costa	23.70	25.40	630	1200	7.60	7.20	5.00	0.00	0.00	0.00	3.50	0.00	64	5.00	0.00	0.00	0.00	4-6
7/21/2015	8835	214	Sacramento	25.00	27.40	1030	1430	7.44	8.21	0.00	5.75	0.00	0.00	2.25	0.00	120	0.00	6.13	0.00	0.00	4-6
7/21/2015	8835	216	Sacramento	25.00	25.00	730	1030	7.44	7.44	0.00	4.25	0.00	0.00	1.75	0.00	120	0.00	4.53	0.00	0.00	4-6
7/21/2015	9012	113	Contra Costa	24.80	24.90	730	1530	10.10	9.90	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	6-8
7/21/2015	9122	77	San Joaquin	23.80	24.60	900	1330	2.60	5.80	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	6-8
7/21/2015	MERCED	529	Merced	26.30	25.30	1400	1530	1.50	8.32	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	2-4
7/22/2015	3738	34	San Joaquin	26.00	26.10	1030	1230	8.70	9.90	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	4-6
7/22/2015	8816	17	San Joaquin	23.20	25.30	800	1200	7.60	7.50	2.00	0.00	0.00	0.00	1.50	0.00	64	2.00	0.00	0.00	0.00	2-4
7/22/2015	8835	215	Sacramento	23.40	27.20	730	1430	8.46	8.11	0.00	10.00	0.00	0.00	4.50	0.00	120	0.00	10.67	0.00	0.00	4-6
7/22/2015	9012	92	Contra Costa	26.10	26.90	1330	1530	8.90	9.40	0.00	1.00	0.00	0.00	1.43	0.00	120	0.00	1.07	0.00	0.00	4-6
7/22/2015	9012	92	San Joaquin	26.10	26.90	800	1330	8.90	9.40	6.00	0.00	0.00	0.00	4.57	0.00	64	6.00	0.00	0.00	0.00	4-6
7/22/2015	9122	58	San Joaquin	25.70	26.80	830	1400	6.40	7.30	5.00	1.75	0.00	0.00	4.00	0.00	64	5.00	1.87	0.00	0.00	0-2
7/22/2015	MERCED	508	Merced	28.00	29.20	1000	1240	7.13	7.01	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	0-2
7/22/2015	MERCED	509	Merced	27.20	30.10	900	1415	7.41	8.39	0.00	0.24	0.00	0.00	0.12	0.00	96	0.00	0.32	0.00	0.00	0-2
7/23/2015	3738	8	San Joaquin	26.10	26.30	700	1200	9.50	10.10	3.50	0.00	0.00	0.00	1.50	0.00	64	3.50	0.00	0.00	0.00	0-2
7/23/2015	8816	252	Sacramento	23.80	23.40	630	1000	6.40	7.20	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6
7/23/2015	8835	219	Sacramento	23.70	27.10	730	1330	7.41	7.30	0.00	7.50	0.00	0.00	3.25	0.00	120	0.00	8.00	0.00	0.00	4-6
7/23/2015	9012	112	Contra Costa	24.30	24.60	1100	1330	9.90	10.10	0.00	1.50	0.00	0.00	0.75	0.00	120	0.00	1.60	0.00	0.00	4-6
7/23/2015	9012	114	Contra Costa	24.10	24.50	800	1030	9.90	10.20	0.00	1.50	0.00	0.00	0.75	0.00	120	0.00	1.60	0.00	0.00	4-6
7/23/2015	9122	56	San Joaquin	23.60	24.50	830	1330	6.10	7.20	5.00	0.00	0.00	0.00	3.50	0.00	64	5.00	0.00	0.00	0.00	2-4
7/23/2015	MERCED	508	Merced	26.00	31.50	1015	1530	7.00	7.05	0.00	0.53	0.00	0.00	0.27	0.00	96	0.00	0.71	0.00	0.00	2-4
7/24/2015	8816	40	San Joaquin	25.00	25.30	900	1430	8.50	7.80	3.00	0.00	0.00	0.00	2.00	0.00	64	3.00	0.00	0.00	0.00	2-4
7/24/2015	8835	217	Sacramento	23.00	25.70	730	1400	6.85	6.36	0.00	10.00	0.00	0.00	4.75	0.00	120	0.00	10.67	0.00	0.00	4-6
7/24/2015	9012	99	San Joaquin	24.50	26.00	830	1330	7.70	7.40	5.50	0.00	0.00	0.00	2.50	0.00	64	5.50	0.00	0.00	0.00	0-2
7/24/2015	9122	93	Contra Costa	24.20	26.40	900	1500	7.30	8.10	3.00	0.00	0.00	0.00	1.75	0.00	64	3.00	0.00	0.00	0.00	2-4
7/24/2015	MERCED	508	Merced	24.70	28.50	935	1415	7.17	8.60	0.00	0.42	0.00	0.00	0.21	0.00	96	0.00	0.56	0.00	0.00	4-6
7/25/2015	9122	77	San Joaquin	23.80	25.50	900	1500	5.60	6.30	7.00	0.00	0.00	0.00	3.75	0.00	64	7.00	0.00	0.00	0.00	6-8
7/25/2015	964121	47	San Joaquin	28.30	28.30	1100	1400	7.20	7.20	1.00	0.00	0.00	0.00	1.00	0.00	64	1.00	0.00	0.00	0.00	2-4
7/25/2015	964121	49	San Joaquin	27.20	27.20	730	1100	6.80	6.80	1.50	0.00	0.00	0.00	1.50	0.00	64	1.50	0.00	0.00	0.00	2-4
7/27/2015	3738	9	San Joaquin	26.10	26.50	630	1400	8.40	9.20	1.00	5.00	0.00	0.00	3.00	0.00	64	1.00	5.33	0.00	0.00	2-4
7/27/2015	8816	18	San Joaquin	23.10	28.10	730	1230	7.10	8.00	2.50	0.00	0.00	0.00	2.00	0.00	64	2.50	0.00	0.00	0.00	2-4
7/27/2015	8816	18	Sacramento	24.40	23.10	630	730	7.10	7.10	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	2-4
7/27/2015	8835	214	Sacramento	27.60	27.60	1130	1430	6.59	6.59	0.00	4.50	0.00	0.00	1.75	0.00	120	0.00	4.80	0.00	0.00	4-6
7/27/2015	8835	216	Sacramento	23.40	27.60	700	1130	6.95	6.59	0.00	8.00	0.00	0.00	2.75	0.00	120	0.00	8.53	0.00	0.00	2-4
7/27/2015	9122	78	San Joaquin	23.60	25.60	930	1430	6.30	6.10	2.50	2.00	0.00	0.00	5.50	0.00	64	2.50	2.13	0.00	0.00	0-2
7/27/2015	MERCED	507	Merced	23.70	29.30	940	1440	7.53	10.11	0.00	0.42	0.00	0.00	0.21	0.00	96	0.00	0.56	0.00	0.00	4-6
7/28/2015	3738	32	San Joaquin	25.00	25.40	700	1230	10.10	9.70	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	0-2
7/28/2015	8816	17	San Joaquin	23.40	23.40	800	900	8.00	8.00	0.25	0.00	0.00	0.00	0.13	0.00	64	0.25	0.00	0.00	0.00	2-4
7/28/2015	8816	17	Contra Costa	22.10	22.10	700	800	8.40	8.40	0.25	0.00	0.00	0.00	0.13	0.00	64	0.25	0.00	0.00	0.00	2-4
7/28/2015	8816	20	Sacramento	23.90	24.20	930	1100	6.60	7.30	1.50	0.00	0.00	0.00	1.00	0.00	64	1.50	0.00	0.00	0.00	4-6
7/28/2015	8835	214	Sacramento	29.10	29.10	1400	1430	7.15	7.15	0.00	0.75	0.00	0.00	0.50	0.00	120	0.00	0.80	0.00	0.00	4-6
7/28/2015	8835	216	Sacramento	25.20	29.10	1000	1400	7.49	7.15	0.00	7.25	0.00	0.00	4.25	0.00	120	0.00	7.73	0.00	0.00	2-4

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed
7/28/2015	8835	217	Sacramento	23.40	25.20	700	1000	8.84	7.49	0.00	4.50	0.00	0.00	1.75	0.00	120	0.00	4.80	0.00	0.00	2-4
7/28/2015	9012	98	San Joaquin	25.00	25.30	1030	1130	6.70	6.30	1.25	0.00	0.00	0.00	0.75	0.00	64	1.25	0.00	0.00	0.00	2-4
7/28/2015	9012	101	San Joaquin	24.80	24.90	900	1000	5.10	5.50	1.25	0.00	0.00	0.00	0.75	0.00	64	1.25	0.00	0.00	0.00	2-4
7/28/2015	9122	84	San Joaquin	23.60	24.10	830	1130	5.90	5.70	0.00	6.50	0.00	0.00	2.25	0.00	120	0.00	6.93	0.00	0.00	2-4
7/28/2015	9122	85	San Joaquin	25.30	26.80	1200	1430	5.50	6.20	0.00	7.00	0.00	0.00	1.75	0.00	120	0.00	7.47	0.00	0.00	4-6
7/28/2015	MERCED	507	Merced	24.20	28.40	925	1415	7.96	13.40	0.00	0.38	0.00	0.00	0.19	0.00	96	0.00	0.51	0.00	0.00	2-4
7/29/2015	3738	32	San Joaquin	25.40	25.60	1000	1330	9.90	9.80	0.00	4.00	0.00	0.00	2.00	0.00	120	0.00	4.27	0.00	0.00	2-4
7/29/2015	8816	267	Solano	25.50	25.80	1100	1300	7.20	7.40	0.00	3.75	0.00	0.00	2.50	0.00	120	0.00	4.00	0.00	0.00	2-4
7/29/2015	8816	270	Solano	22.80	25.30	700	1100	6.80	7.10	0.00	4.25	0.00	0.00	2.25	0.00	120	0.00	4.53	0.00	0.00	2-4
7/29/2015	8835	215	Sacramento	23.60	29.20	730	1400	8.22	8.10	0.00	8.50	0.00	0.00	5.50	0.00	120	0.00	9.07	0.00	0.00	0-2
7/29/2015	9122	83	San Joaquin	24.60	24.80	900	1100	7.30	6.90	0.00	4.50	0.00	0.00	1.25	0.00	120	0.00	4.80	0.00	0.00	0-2
7/29/2015	9122	85	Contra Costa	28.10	28.60	1330	1430	6.50	7.20	0.00	2.50	0.00	0.00	0.50	0.00	120	0.00	2.67	0.00	0.00	2-4
7/29/2015	9122	86	San Joaquin	25.90	28.10	1200	1300	7.10	6.90	0.00	2.45	0.00	0.00	0.46	0.00	120	0.00	2.61	0.00	0.00	2-4
7/29/2015	9122	86	Contra Costa	25.90	28.10	1130	1200	7.10	6.90	0.00	1.55	0.00	0.00	0.29	0.00	120	0.00	1.65	0.00	0.00	2-4
7/29/2015	9339	300	San Joaquin	25.90	26.30	1000	1230	9.60	9.40	2.50	0.00	0.00	0.00	1.25	0.00	64	2.50	0.00	0.00	0.00	2-4
7/29/2015	MERCED	506	Merced	27.40	29.80	1250	1450	10.38	11.66	0.00	0.17	0.00	0.00	0.09	0.00	96	0.00	0.23	0.00	0.00	0-2
7/29/2015	MERCED	507	Merced	24.40	27.40	930	1250	7.70	10.38	0.00	0.20	0.00	0.00	0.10	0.00	96	0.00	0.27	0.00	0.00	0-2
7/30/2015	3738	9	San Joaquin	25.40	25.60	630	1200	8.00	8.10	1.50	4.00	0.00	0.00	2.50	0.00	64	1.50	4.27	0.00	0.00	0-2
7/30/2015	8835	214	Sacramento	24.20	28.80	700	1430	6.67	7.13	0.00	13.25	0.00	0.00	5.75	0.00	120	0.00	14.13	0.00	0.00	4-6
7/30/2015	9122	85	San Joaquin	25.60	26.40	900	1200	7.90	7.80	0.00	5.00	0.00	0.00	2.25	0.00	120	0.00	5.33	0.00	0.00	0-2
7/30/2015	9122	85	Contra Costa	26.50	27.80	1200	1430	7.80	7.50	0.00	5.00	0.00	0.00	2.75	0.00	120	0.00	5.33	0.00	0.00	2-4
7/30/2015	MERCED	506	Merced	23.80	30.80	930	1445	8.30	11.06	0.00	0.47	0.00	0.00	0.23	0.00	96	0.00	0.63	0.00	0.00	0-2
7/31/2015	8816	262	Solano	24.30	24.60	930	1200	6.60	7.00	0.00	3.00	0.00	0.00	1.25	0.00	120	0.00	3.20	0.00	0.00	4-6
7/31/2015	8816	267	Solano	23.00	22.70	700	900	7.30	7.50	0.00	1.50	0.00	0.00	0.75	0.00	120	0.00	1.60	0.00	0.00	4-6
7/31/2015	8929	200	San Joaquin	24.20	27.40	730	1130	7.66	7.90	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6
7/31/2015	9122	84	San Joaquin	26.30	27.90	830	1400	7.50	6.40	0.00	10.75	0.00	0.00	5.00	0.00	120	0.00	11.47	0.00	0.00	4-6
7/31/2015	MERCED	506	Merced	25.40	29.50	925	1310	8.39	10.18	0.00	0.23	0.00	0.00	0.12	0.00	96	0.00	0.31	0.00	0.00	0-2
										211.75	314.45	0.00	0.00	261.21	0.00		211.75	337.53	0.00	0.00	

Table B- 6. August 2015 Herbicide and Adjuvant Use

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
8/1/2015	8816	72	San Joaquin	24.00	27.90	900	1200	6.20	7.00	4.00	0.00	0.00	0.00	1.50	0.00	64	4.00	0.00	0.00	0.00	4-6
8/1/2015	9122	71	San Joaquin	24.80	25.30	1230	1400	6.50	7.20	2.25	0.00	0.00	0.00	1.50	0.00	64	2.25	0.00	0.00	0.00	2-4
8/1/2015	9122	72	San Joaquin	24.20	24.80	900	1200	5.90	6.30	4.50	0.00	0.00	0.00	2.75	0.00	64	4.50	0.00	0.00	0.00	2-4
8/3/2015	3738	37	San Joaquin	25.60	25.80	1030	1330	9.10	8.90	2.50	0.00	0.00	0.00	1.25	0.00	64	2.50	0.00	0.00	0.00	0-2
8/3/2015	9122	76	San Joaquin	24.80	25.50	1030	1430	6.30	6.00	8.25	0.00	0.00	0.00	2.75	0.00	64	8.25	0.00	0.00	0.00	0-2
8/3/2015	MERCED	412	Merced	26.60	26.90	1345	1455	6.02	5.03	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	0-2
8/3/2015	MERCED	413	Merced	23.80	26.60	920	1345	5.45	6.02	0.00	0.23	0.00	0.00	0.12	0.00	96	0.00	0.31	0.00	0.00	0-2
8/4/2015	8816	75	San Joaquin	21.50	22.60	700	1300	6.60	6.00	3.00	0.00	0.00	0.00	1.50	0.00	64	3.00	0.00	0.00	0.00	4-6
8/4/2015	8929	217	Sacramento	21.40	22.80	700	1230	8.44	7.06	0.00	8.25	0.00	0.00	3.25	0.00	120	0.00	8.80	0.00	0.00	4-6
8/4/2015	MERCED	410	Merced	24.40	24.60	1300	1415	5.73	6.78	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	6-8
8/4/2015	MERCED	412	Merced	23.10	24.40	935	1300	5.90	5.73	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	2-4
8/5/2015	3738	13	San Joaquin	25.70	26.00	600	1400	9.90	9.10	6.00	0.00	0.00	0.00	3.00	0.00	64	6.00	0.00	0.00	0.00	0-2
8/5/2015	8816	252	Solano	21.20	22.40	630	1100	8.40	8.00	0.00	2.50	0.00	0.00	1.50	0.00	120	0.00	2.67	0.00	0.00	2-4
8/5/2015	8929	213	Sacramento	23.70	26.40	1000	1430	8.80	8.21	0.00	9.00	0.00	0.00	4.75	0.00	120	0.00	9.60	0.00	0.00	2-4
8/5/2015	8929	213	San Joaquin	22.80	23.70	630	1000	6.80	8.80	0.00	6.00	0.00	0.00	3.25	0.00	120	0.00	6.40	0.00	0.00	0-2
8/5/2015	9012	97	Contra Costa	25.80	26.10	1100	1500	8.93	8.78	4.50	0.00	0.00	0.00	2.25	0.00	64	4.50	0.00	0.00	0.00	4-6
8/5/2015	9122	87	Contra Costa	21.50	23.80	1100	1430	5.30	6.20	4.25	0.00	0.00	0.00	2.75	0.00	64	4.25	0.00	0.00	0.00	2-4
8/5/2015	9122	87	Contra Costa	23.80	23.80	1430	1500	6.20	6.20	0.75	0.00	0.00	0.00	0.50	0.00	64	0.75	0.00	0.00	0.00	2-4
8/5/2015	9122	88	Contra Costa	21.30	21.50	830	1100	5.10	5.30	2.50	0.00	0.00	0.00	0.75	0.00	64	2.50	0.00	0.00	0.00	0-2
8/5/2015	9339	709	Stanislaus	21.10	22.40	830	1330	0.50	7.80	5.50	0.00	0.00	0.00	2.75	0.00	64	5.50	0.00	0.00	0.00	2-4
8/5/2015	MERCED	411	Merced	20.10	25.60	930	1430	7.34	6.15	0.00	0.21	0.00	0.00	0.10	0.00	96	0.00	0.28	0.00	0.00	2-4
8/6/2015	3738	13	San Joaquin	25.10	25.20	630	1330	9.10	9.00	3.50	0.00	0.00	0.00	1.50	0.00	64	3.50	0.00	0.00	0.00	0-2
8/6/2015	8816	252	Sacramento	24.70	24.50	1200	1300	7.50	7.20	0.00	1.00	0.00	0.00	0.50	0.00	120	0.00	1.07	0.00	0.00	2-4
8/6/2015	8816	267	Solano	20.50	24.50	730	1130	7.70	7.00	0.00	7.50	0.00	0.00	4.00	0.00	120	0.00	8.00	0.00	0.00	2-4
8/6/2015	8929	212	Sacramento	22.90	25.20	630	1400	6.98	7.50	0.00	12.50	0.00	0.00	7.50	0.00	120	0.00	13.33	0.00	0.00	0-2
8/6/2015	9012	97	Contra Costa	24.30	27.10	830	1530	8.24	7.33	6.00	0.00	0.00	0.00	3.00	0.00	64	6.00	0.00	0.00	0.00	2-4
8/6/2015	9339	708	Stanislaus	21.20	22.00	900	1330	7.80	6.40	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	0-2
8/7/2015	3738	709	Stanislaus	25.10	25.70	800	1300	7.30	6.50	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	2-4
8/7/2015	8816	75	San Joaquin	21.20	24.30	700	1100	7.50	6.00	1.50	0.00	0.00	0.00	1.00	0.00	64	1.50	0.00	0.00	0.00	2-4
8/7/2015	8816	77	San Joaquin	21.30	21.00	1130	1300	6.80	6.40	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	4-6
8/7/2015	9122	75	San Joaquin	25.30	27.50	900	1430	6.20	5.80	7.75	1.50	0.00	0.00	3.50	0.00	64	7.75	1.60	0.00	0.00	2-4
8/7/2015	9339	709	Stanislaus	25.10	25.70	800	1300	7.30	6.50	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	0-2
8/7/2015	MERCED	528	Merced	20.70	23.90	940	1440	9.11	8.97	0.00	0.26	0.00	0.00	0.13	0.00	96	0.00	0.35	0.00	0.00	2-4
8/8/2015	9122	61	San Joaquin	23.70	24.10	1100	1400	6.10	6.70	3.00	0.00	0.00	0.00	1.00	0.00	64	3.00	0.00	0.00	0.00	4-6
8/8/2015	9122	62	San Joaquin	23.70	24.80	730	1000	6.30	6.90	3.25	0.00	0.00	0.00	1.00	0.00	64	3.25	0.00	0.00	0.00	2-4
8/8/2015	9339	709	Stanislaus	25.00	25.40	830	1300	7.80	8.20	5.50	0.00	0.00	0.00	2.75	0.00	64	5.50	0.00	0.00	0.00	2-4
8/10/2015	3738	708	Stanislaus	26.50	26.70	900	1300	8.60	8.20	3.00	0.00	0.00	0.00	1.50	0.00	64	3.00	0.00	0.00	0.00	0-2
8/10/2015	8816	241	Sacramento	22.90	22.30	730	1000	6.90	6.50	0.00	3.50	0.00	0.00	1.50	0.00	120	0.00	3.73	0.00	0.00	6-8
8/10/2015	8835	217	Sacramento	22.20	25.40	830	1430	7.83	8.19	0.00	10.00	0.00	0.00	3.50	0.00	120	0.00	10.67	0.00	0.00	4-6
8/10/2015	9122	72	San Joaquin	24.70	24.90	930	1130	6.60	6.10	4.00	0.00	0.00	0.00	2.50	0.00	64	4.00	0.00	0.00	0.00	4-6
8/10/2015	9122	291	San Joaquin	24.90	25.50	1200	1430	6.10	5.70	5.00	0.00	0.00	0.00	3.25	0.00	64	5.00	0.00	0.00	0.00	6-8
8/10/2015	9339	708	Stanislaus	24.70	25.10	900	1300	8.70	7.80	3.00	0.00	0.00	0.00	1.50	0.00	64	3.00	0.00	0.00	0.00	2-4
8/10/2015	MERCED	512	Merced	25.60	28.90	1000	1445	8.21	8.95	0.00	0.45	0.00	0.00	0.23	0.00	96	0.00	0.60	0.00	0.00	4-6
8/11/2015	3738	28	San Joaquin	25.40	25.80	630	1300	11.60	9.60	3.50	0.00	0.00	0.00	1.50	0.00	64	3.50	0.00	0.00	0.00	0-2

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
8/11/2015	8835	206	San Joaquin	22.30	25.70	700	1400	7.40	7.88	0.00	10.50	0.00	0.00	6.00	0.00	120	0.00	11.20	0.00	0.00	4-6
8/11/2015	9122	73	San Joaquin	24.20	24.40	1230	1430	6.40	5.90	2.00	2.00	0.00	0.00	1.00	0.00	64	2.00	2.13	0.00	0.00	6-8
8/11/2015	9122	74	San Joaquin	22.90	23.30	800	1200	6.20	6.00	5.50	0.00	0.00	0.00	3.25	0.00	64	5.50	0.00	0.00	0.00	6-8
8/11/2015	9339	715	Stanislaus	21.60	21.90	930	1300	7.60	7.40	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	0-2
8/11/2015	MERCED	409	Merced	23.50	26.50	1050	1400	5.91	6.55	0.00	0.08	0.00	0.00	0.00	0.00	96	0.00	0.11	0.00	0.00	0-2
8/11/2015	MERCED	410	Merced	22.40	23.50	940	1100	6.23	5.91	0.00	0.05	0.00	0.00	0.00	0.00	96	0.00	0.07	0.00	0.00	0-2
8/12/2015	8816	262	Solano	21.60	22.30	830	1030	6.70	6.50	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	6-8
8/12/2015	8816	263	Solano	22.30	23.20	1030	1230	6.50	7.00	0.00	3.00	0.00	0.00	2.00	0.00	120	0.00	3.20	0.00	0.00	6-8
8/12/2015	8835	208	San Joaquin	23.90	25.80	900	1400	8.10	8.28	0.00	7.50	0.00	0.00	4.25	0.00	120	0.00	8.00	0.00	0.00	4-6
8/12/2015	9012	97	Contra Costa	24.10	26.00	900	1300	8.58	11.15	3.25	0.00	0.00	0.00	1.38	0.00	64	3.25	0.00	0.00	0.00	2-4
8/12/2015	9122	16	San Joaquin	24.30	25.70	800	1500	7.80	7.50	7.50	0.00	0.00	0.00	4.50	0.00	64	7.50	0.00	0.00	0.00	6-8
8/12/2015	9339	713	Stanislaus	22.20	22.70	900	1330	7.00	6.70	5.50	0.00	0.00	0.00	3.00	0.00	64	5.50	0.00	0.00	0.00	2-4
8/13/2015	9122	16	San Joaquin	23.80	24.50	800	1430	7.30	6.80	6.50	0.00	0.00	0.00	4.50	0.00	64	6.50	0.00	0.00	0.00	6-8
8/14/2015	8929	210	San Joaquin	22.50	22.40	830	1000	7.30	7.10	0.00	2.50	0.00	0.00	1.50	0.00	120	0.00	2.67	0.00	0.00	4-6
8/14/2015	8929	211	San Joaquin	22.30	22.50	1000	1200	7.20	7.30	0.00	3.50	0.00	0.00	1.00	0.00	120	0.00	3.73	0.00	0.00	4-6
8/14/2015	8929	211	Sacramento	22.50	23.00	1200	1300	7.30	7.00	0.00	1.25	0.00	0.00	0.50	0.00	120	0.00	1.33	0.00	0.00	2-4
8/14/2015	9012	91	Contra Costa	25.70	27.30	1030	1430	8.79	7.98	3.00	0.00	0.00	0.00	1.75	0.00	64	3.00	0.00	0.00	0.00	2-4
8/14/2015	9122	84	San Joaquin	24.60	25.80	830	1130	7.90	6.60	3.50	0.00	0.00	0.00	2.50	0.00	64	3.50	0.00	0.00	0.00	6-8
8/14/2015	9122	84	Contra Costa	25.80	25.80	1130	1330	6.60	6.60	2.00	0.00	0.00	0.00	1.50	0.00	64	2.00	0.00	0.00	0.00	4-6
8/14/2015	9339	712	Stanislaus	23.50	24.10	1000	1230	7.80	6.70	3.00	0.00	0.00	0.00	1.50	0.00	64	3.00	0.00	0.00	0.00	2-4
8/15/2015	9122	84	Contra Costa	24.50	25.20	1130	1300	6.60	6.50	2.00	0.00	0.00	0.00	0.50	0.00	64	2.00	0.00	0.00	0.00	8-10
8/15/2015	9122	85	Contra Costa	25.20	27.30	1300	1530	6.50	6.10	2.00	0.00	0.00	0.00	0.75	0.00	64	2.00	0.00	0.00	0.00	6-8
8/15/2015	9122	85	San Joaquin	24.30	24.50	900	1130	6.80	6.50	3.50	0.00	0.00	0.00	2.00	0.00	64	3.50	0.00	0.00	0.00	6-8
8/15/2015	9339	304	San Joaquin	25.70	26.10	830	1330	7.50	6.80	6.00	0.00	0.00	0.00	3.00	0.00	64	6.00	0.00	0.00	0.00	2-4
8/17/2015	3738	68	San Joaquin	25.30	24.60	630	1400	10.20	9.80	5.50	2.00	0.00	0.00	3.50	0.00	64	5.50	2.13	0.00	0.00	0-2
8/17/2015	8929	204	San Joaquin	23.70	27.90	800	1430	7.32	8.05	0.00	12.75	0.00	0.00	6.25	0.00	120	0.00	13.60	0.00	0.00	0-2
8/17/2015	9122	47	San Joaquin	25.30	27.50	830	1230	1.19	1.13	4.75	0.00	0.00	0.00	2.50	0.00	64	4.75	0.00	0.00	0.00	2-4
8/17/2015	MERCED	526	Merced	24.50	25.80	1110	1445	8.33	9.07	0.00	0.07	0.00	0.00	0.03	0.00	96	0.00	0.09	0.00	0.00	2-4
8/17/2015	MERCED	528	Merced	21.80	24.50	920	1110	8.29	8.33	0.00	0.12	0.00	0.00	0.06	0.00	96	0.00	0.16	0.00	0.00	0-2
8/18/2015	3738	42	San Joaquin	25.60	25.70	800	1000	8.90	11.70	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	6-8
8/18/2015	8929	205	San Joaquin	25.30	26.20	1300	1430	7.61	7.35	0.00	2.50	0.00	0.00	1.75	0.00	120	0.00	2.67	0.00	0.00	6-8
8/18/2015	8929	206	San Joaquin	25.30	25.40	1000	1300	7.19	7.52	0.00	5.00	0.00	0.00	2.75	0.00	120	0.00	5.33	0.00	0.00	2-4
8/18/2015	8929	208	San Joaquin	23.40	25.30	700	1000	6.78	7.19	0.00	5.25	0.00	0.00	3.00	0.00	120	0.00	5.60	0.00	0.00	2-4
8/18/2015	9012	96	Contra Costa	24.90	27.30	1000	1400	11.69	11.55	4.00	0.00	0.00	0.00	2.13	0.00	64	4.00	0.00	0.00	0.00	4-6
8/18/2015	9122	45	San Joaquin	23.20	23.20	830	1000	5.30	5.10	1.75	0.00	0.00	0.00	0.75	0.00	64	1.75	0.00	0.00	0.00	2-4
8/18/2015	9122	72	San Joaquin	23.10	24.60	1030	1430	6.40	6.80	6.50	0.00	0.00	0.00	4.75	0.00	64	6.50	0.00	0.00	0.00	4-6
8/18/2015	9339	300	San Joaquin	25.00	25.50	830	1330	9.86	9.80	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
8/18/2015	MERCED	522	Merced	26.70	28.40	1300	1455	9.38	10.03	0.00	0.13	0.00	0.00	0.06	0.00	96	0.00	0.17	0.00	0.00	2-4
8/18/2015	MERCED	523	Merced	23.80	26.70	1015	1300	8.33	9.38	0.00	0.12	0.00	0.00	0.06	0.00	96	0.00	0.16	0.00	0.00	2-4
8/18/2015	MERCED	524	Merced	22.40	23.80	920	1015	8.05	8.33	0.00	0.02	0.00	0.00	0.01	0.00	96	0.00	0.03	0.00	0.00	0-2
8/19/2015	3738	10	San Joaquin	25.50	25.60	630	800	11.60	10.10	2.00	0.00	0.00	0.00	1.50	0.00	64	2.00	0.00	0.00	0.00	2-4
8/19/2015	3738	11	San Joaquin	25.40	25.50	830	1000	10.00	9.90	1.50	0.00	0.00	0.00	0.75	0.00	64	1.50	0.00	0.00	0.00	4-6
8/19/2015	3738	25	San Joaquin	25.70	25.80	1030	1200	8.60	8.10	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	2-4
8/19/2015	3738	26	San Joaquin	25.70	25.80	1230	1400	8.60	8.00	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	0-2
8/19/2015	9012	97	Contra Costa	23.70	25.30	830	1100	8.49	8.10	2.25	0.00	0.00	0.00	1.50	0.00	64	2.25	0.00	0.00	0.00	2-4
8/19/2015	9122	77	San Joaquin	24.30	26.20	900	1500	5.60	7.40	9.00	0.00	0.00	0.00	3.50	0.00	64	9.00	0.00	0.00	0.00	2-4

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)	
8/19/2015		9339	712	Stanislaus	23.20	23.00	900	1400	7.60	7.80	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
8/19/2015	MERCED	520	Merced	24.70	28.30	1155	1445	8.13	8.85	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	2-4	
8/19/2015	MERCED	521	Merced	23.40	24.70	955	1155	8.59	8.13	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	0-2	
8/20/2015		3738	33	San Joaquin	25.70	25.80	630	830	9.90	10.00	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	6-8
8/20/2015		3738	39	San Joaquin	25.20	25.10	1200	1400	11.40	10.80	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	4-6
8/20/2015		3738	40	San Joaquin	25.00	25.10	900	1100	9.20	9.40	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	6-8
8/20/2015		8929	203	San Joaquin	22.60	25.40	630	1430	7.60	7.64	0.00	12.75	0.00	0.00	7.50	0.00	120	0.00	13.60	0.00	0.00	4-6
8/20/2015		9012	95	Contra Costa	24.80	25.40	1200	1300	10.26	10.08	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	4-6
8/20/2015		9012	96	Contra Costa	23.90	24.60	730	1130	7.58	9.31	2.25	0.00	0.00	0.00	1.00	0.00	64	2.25	0.00	0.00	0.00	2-4
8/20/2015		9122	73	San Joaquin	23.70	25.50	900	1500	5.70	6.80	8.00	0.00	0.00	0.00	2.50	0.00	64	8.00	0.00	0.00	0.00	4-6
8/20/2015		9339	712	Stanislaus	23.20	23.00	900	1400	7.40	7.10	0.00	8.00	0.00	0.00	4.00	0.00	120	0.00	8.53	0.00	0.00	2-4
8/21/2015		3738	28	San Joaquin	25.10	26.70	630	1400	9.90	8.30	7.50	0.00	0.00	0.00	3.25	0.00	64	7.50	0.00	0.00	0.00	0-2
8/21/2015		8929	240	Sacramento	22.30	22.00	930	1130	7.20	7.80	0.00	3.50	0.00	0.00	1.50	0.00	120	0.00	3.73	0.00	0.00	4-6
8/21/2015		8929	241	Sacramento	22.50	22.40	630	930	7.80	7.50	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	4-6
8/21/2015		9122	75	San Joaquin	23.40	23.60	800	1430	9.30	8.10	6.75	0.00	0.00	0.00	3.75	0.00	64	6.75	0.00	0.00	0.00	0-2
8/21/2015		9339	300	San Joaquin	25.10	26.40	830	1030	8.50	7.20	1.50	0.00	0.00	0.00	0.75	0.00	64	1.50	0.00	0.00	0.00	4-6
8/21/2015		9339	302	San Joaquin	26.60	26.90	1030	1330	7.70	8.10	3.50	0.00	0.00	0.00	1.75	0.00	64	3.50	0.00	0.00	0.00	2-4
8/21/2015	MERCED	519	Merced	23.40	26.70	940	1445	8.04	9.06	0.00	0.36	0.00	0.00	0.18	0.00	96	0.00	0.48	0.00	0.00	4-6	
8/22/2015		9122	76	San Joaquin	23.70	24.60	700	1500	8.10	9.30	7.00	0.00	0.00	0.00	4.00	0.00	64	7.00	0.00	0.00	0.00	0-2
8/22/2015		9339	303	San Joaquin	24.20	24.70	800	1000	8.60	7.80	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	4-6
8/22/2015		9339	304	San Joaquin	25.00	25.80	1030	1300	7.60	7.40	3.00	0.00	0.00	0.00	1.50	0.00	64	3.00	0.00	0.00	0.00	2-4
8/24/2015		3738	12	San Joaquin	25.20	25.40	700	1230	8.90	9.40	4.00	0.00	0.00	0.00	2.00	0.00	64	4.00	0.00	0.00	0.00	2-4
8/24/2015		8834	252	Sacramento	22.20	23.40	630	930	7.80	7.50	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	4-6
8/24/2015		8929	201	San Joaquin	22.60	24.90	930	1430	8.22	7.76	0.00	11.00	0.00	0.00	5.50	0.00	120	0.00	11.73	0.00	0.00	6-8
8/24/2015		8929	202	San Joaquin	22.40	22.40	830	930	7.55	8.60	0.00	1.25	0.00	0.00	0.75	0.00	120	0.00	1.33	0.00	0.00	4-6
8/24/2015		8929	209	San Joaquin	22.40	22.60	700	800	8.75	8.65	0.00	0.75	0.00	0.00	0.25	0.00	120	0.00	0.80	0.00	0.00	2-4
8/24/2015	MERCED	518	Merced	24.40	27.90	1205	1310	8.00	9.07	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	0-2	
8/24/2015	MERCED	519	Merced	23.00	24.40	945	1205	8.18	8.00	0.00	0.23	0.00	0.00	0.12	0.00	96	0.00	0.31	0.00	0.00	0-2	
8/25/2015		3738	44	San Joaquin	7.80	8.50	900	1000	23.40	23.50	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	0-2
8/25/2015		8929	200	San Joaquin	23.10	24.80	1030	1430	7.90	7.84	0.00	7.25	0.00	0.00	3.25	0.00	120	0.00	7.73	0.00	0.00	4-6
8/25/2015		8929	201	San Joaquin	22.30	23.10	830	1030	8.44	7.90	0.00	4.00	0.00	0.00	2.00	0.00	120	0.00	4.27	0.00	0.00	2-4
8/25/2015		8929	202	San Joaquin	21.90	22.30	700	830	8.64	8.44	0.00	1.25	0.00	0.00	0.50	0.00	120	0.00	1.33	0.00	0.00	2-4
8/25/2015		9012	96	Contra Costa	23.20	24.80	800	1130	8.44	9.96	3.75	0.00	0.00	0.00	2.00	0.00	64	3.75	0.00	0.00	0.00	4-6
8/25/2015		9012	98	Contra Costa	24.80	24.90	1230	1430	9.86	10.32	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	4-6
8/25/2015		9339	711	Stanislaus	23.50	24.00	830	1330	8.50	8.10	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
8/25/2015		9371	79	Alameda	23.80	24.10	900	1100	8.10	6.90	0.25	0.00	0.00	0.00	0.25	0.00	64	0.25	0.00	0.00	0.00	2-4
8/25/2015		9371	80	San Joaquin	25.80	27.80	1230	1500	6.80	7.20	3.75	0.00	0.00	0.00	1.25	0.00	64	3.75	0.00	0.00	0.00	2-4
8/25/2015	MERCED	517	Merced	23.60	26.80	1025	1420	8.15	8.95	0.00	0.17	0.00	0.00	0.09	0.00	96	0.00	0.23	0.00	0.00	2-4	
8/25/2015	MERCED	518	Merced	23.30	23.60	950	1025	8.26	8.15	0.00	0.02	0.00	0.00	0.01	0.00	96	0.00	0.03	0.00	0.00	0-2	
8/26/2015		3420	32	San Joaquin	24.00	24.10	800	1430	9.90	10.60	4.50	0.00	0.00	0.00	2.00	0.00	64	4.50	0.00	0.00	0.00	0-2
8/26/2015		8834	251	Solano	23.40	23.50	1000	1100	7.40	7.30	0.00	1.50	0.00	0.00	0.50	0.00	120	0.00	1.60	0.00	0.00	4-6
8/26/2015		8834	251	Sacramento	22.20	23.80	800	1000	7.50	7.40	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	2-4
8/26/2015		8834	252	Solano	23.50	23.70	1100	1230	7.30	7.40	0.00	1.50	0.00	0.00	0.50	0.00	120	0.00	1.60	0.00	0.00	4-6
8/26/2015		8834	252	Sacramento	21.60	22.20	630	800	7.20	7.50	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	2-4
8/26/2015		8929	213	San Joaquin	22.40	23.70	700	1000	7.28	7.15	0.00	5.25	0.00	0.00	3.75	0.00	120	0.00	5.60	0.00	0.00	0-2

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
8/26/2015	8929	213	Sacramento	23.70	25.40	1000	1430	7.15	7.61	0.00	6.75	0.00	0.00	4.25	0.00	120	0.00	7.20	0.00	0.00	2-4
8/26/2015	9339	711	Stanislaus	24.70	25.20	830	1030	8.10	8.00	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	0-2
8/26/2015	9371	82	San Joaquin	24.30	25.40	930	1530	7.90	7.70	5.25	0.00	0.00	0.00	3.00	0.00	64	5.25	0.00	0.00	0.00	2-4
8/26/2015	MERCED	515	Merced	23.40	27.00	920	1425	8.07	9.04	0.00	0.30	0.00	0.00	0.15	0.00	96	0.00	0.40	0.00	0.00	0-2
8/27/2015	3420	32	San Joaquin	24.00	24.60	630	1430	9.90	8.10	7.00	1.50	0.00	0.00	4.00	0.00	64	7.00	1.60	0.00	0.00	0-2
8/27/2015	8929	200	San Joaquin	24.90	27.20	1300	1430	7.33	8.14	0.00	3.00	0.00	0.00	1.50	0.00	120	0.00	3.20	0.00	0.00	2-4
8/27/2015	8929	205	San Joaquin	23.70	26.60	930	1230	7.25	7.50	0.00	5.75	0.00	0.00	3.00	0.00	120	0.00	6.13	0.00	0.00	0-2
8/27/2015	8929	208	San Joaquin	22.30	23.40	700	900	7.94	7.71	0.00	2.25	0.00	0.00	1.00	0.00	120	0.00	2.40	0.00	0.00	0-2
8/27/2015	9371	72	San Joaquin	23.60	24.80	830	1430	6.50	7.30	6.25	0.00	0.00	0.00	3.00	0.00	64	6.25	0.00	0.00	0.00	2-4
8/27/2015	MERCED	514	Merced	24.00	28.70	950	1500	8.38	8.85	0.00	0.42	0.00	0.00	0.24	0.00	96	0.00	0.56	0.00	0.00	2-4
8/28/2015	3420	8	San Joaquin	23.60	23.70	1000	1430	8.10	8.40	2.25	0.00	0.00	0.00	1.25	0.00	64	2.25	0.00	0.00	0.00	0-2
8/28/2015	3420	9	San Joaquin	23.70	24.00	630	930	10.10	8.10	3.50	0.00	0.00	0.00	1.50	0.00	64	3.50	0.00	0.00	0.00	0-2
8/28/2015	9122	77	San Joaquin	23.70	24.30	730	1500	8.50	7.90	7.50	0.00	0.00	0.00	3.00	0.00	64	7.50	0.00	0.00	0.00	0-2
8/28/2015	9339	301	San Joaquin	22.40	22.30	730	1000	2.85	7.10	2.50	0.00	0.00	0.00	1.25	0.00	64	2.50	0.00	0.00	0.00	2-4
8/28/2015	9339	302	San Joaquin	22.40	23.10	1030	1200	7.20	7.10	1.50	0.00	0.00	0.00	0.75	0.00	64	1.50	0.00	0.00	0.00	2-4
8/28/2015	9339	303	San Joaquin	23.10	23.10	1200	1230	7.10	7.10	1.00	0.00	0.00	0.00	0.50	0.00	64	1.00	0.00	0.00	0.00	2-4
8/28/2015	9371	212	San Joaquin	25.10	25.10	1400	1430	6.20	6.20	0.00	1.00	0.00	0.00	0.50	0.00	120	0.00	1.07	0.00	0.00	2-4
8/28/2015	9371	212	Sacramento	23.20	25.10	700	1400	5.20	6.20	0.00	10.00	0.00	0.00	6.00	0.00	120	0.00	10.67	0.00	0.00	2-4
8/28/2015	MERCED	513	Merced	25.40	29.30	940	1400	8.04	8.91	0.00	0.23	0.00	0.00	0.12	0.00	96	0.00	0.31	0.00	0.00	0-2
8/29/2015	9012	101	Contra Costa	23.70	25.40	900	1500	7.26	8.36	7.50	0.00	0.00	0.00	1.50	0.00	64	7.50	0.00	0.00	0.00	2-4
8/29/2015	9339	102	Contra Costa	23.80	24.10	1030	1330	8.50	8.90	2.50	0.00	0.00	0.00	1.25	0.00	64	2.50	0.00	0.00	0.00	4-6
8/29/2015	9339	103	Contra Costa	23.70	23.90	830	1030	8.60	8.40	2.50	0.00	0.00	0.00	1.25	0.00	64	2.50	0.00	0.00	0.00	2-4
8/31/2015	3420	15	San Joaquin	24.00	24.30	630	1400	9.90	8.70	9.00	0.00	0.00	0.00	4.00	0.00	64	9.00	0.00	0.00	0.00	2-4
8/31/2015	8929	40	San Joaquin	22.20	24.70	700	1430	8.36	7.70	0.00	12.25	0.00	0.00	4.50	0.00	120	0.00	13.07	0.00	0.00	0-2
8/31/2015	9012	97	Contra Costa	23.50	25.10	900	1430	9.10	9.50	3.75	0.00	0.00	0.00	1.75	0.00	64	3.75	0.00	0.00	0.00	2-4
8/31/2015	9371	81	San Joaquin	24.30	24.80	1200	1430	6.40	6.20	1.50	0.00	0.00	0.00	0.50	0.00	64	1.50	0.00	0.00	0.00	0-2
										335.25	264.23	0.00	0.00	294.82	0.00		335.25	282.97	0.00	0.00	

Table B- 7. September 2015 Herbicide and Adjuvant Use

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
9/1/2015	3420	42	San Joaquin	24.00	24.10	700	1400	9.90	8.10	8.00	0.00	0.00	0.00	4.00	0.00	64	8.00	0.00	0.00	0.00	0-2
9/1/2015	8834	267	Solano	22.10	23.40	730	1230	7.30	7.60	0.00	12.00	0.00	0.00	5.00	0.00	120	0.00	12.80	0.00	0.00	2-4
9/1/2015	8929	40	San Joaquin	23.60	24.80	1000	1300	8.94	7.75	0.00	5.00	0.00	0.00	3.75	0.00	120	0.00	5.33	0.00	0.00	2-4
9/1/2015	8929	200	San Joaquin	25.10	25.30	1300	1430	8.10	8.23	0.00	1.50	0.00	0.00	0.75	0.00	120	0.00	1.60	0.00	0.00	2-4
9/1/2015	8929	202	San Joaquin	22.10	23.50	730	930	7.82	6.73	0.00	4.50	0.00	0.00	2.50	0.00	120	0.00	4.80	0.00	0.00	0-2
9/1/2015	9339	709	Stanislaus	23.50	23.10	830	1330	7.80	8.40	0.00	7.00	0.00	0.00	3.00	0.00	120	0.00	7.47	0.00	0.00	2-4
9/1/2015	9371	78	San Joaquin	22.60	23.90	900	1200	7.50	7.70	4.50	0.00	0.00	0.00	1.75	0.00	64	4.50	0.00	0.00	0.00	0-2
9/1/2015	9371	83	San Joaquin	23.90	25.60	1330	1500	7.90	7.50	2.00	0.00	0.00	0.00	0.63	0.00	64	2.00	0.00	0.00	0.00	4-6
9/1/2015	9371	83	Contra Costa	23.90	25.60	1200	1330	7.90	7.50	2.00	0.00	0.00	0.00	0.63	0.00	64	2.00	0.00	0.00	0.00	2-4
9/2/2015	3420	15	San Joaquin	24.60	24.20	900	1400	9.40	10.60	4.50	0.00	0.00	0.00	2.00	0.00	64	4.50	0.00	0.00	0.00	2-4
9/2/2015	3420	32	San Joaquin	24.10	24.20	730	830	8.40	8.10	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	0-2
9/2/2015	3420	34	San Joaquin	24.00	24.10	630	730	8.20	8.60	0.50	0.00	0.00	0.00	0.25	0.00	64	0.50	0.00	0.00	0.00	0-2
9/2/2015	8834	262	Solano	22.30	22.60	930	1100	7.50	7.50	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	4-6
9/2/2015	8834	263	Solano	22.40	22.50	830	930	7.70	7.70	0.00	0.50	0.00	0.00	0.25	0.00	120	0.00	0.53	0.00	0.00	4-6
9/2/2015	8929	214	Sacramento	23.00	23.40	700	1300	7.15	8.19	0.00	7.50	0.00	0.00	5.00	0.00	120	0.00	8.00	0.00	0.00	2-4
9/2/2015	8929	215	Sacramento	23.40	23.50	1300	1430	8.19	7.64	0.00	2.75	0.00	0.00	1.75	0.00	120	0.00	2.93	0.00	0.00	4-6
9/2/2015	9339	105	Contra Costa	23.30	23.40	830	1330	7.85	8.10	7.50	0.00	0.00	0.00	3.50	0.00	64	7.50	0.00	0.00	0.00	2-4
9/2/2015	9371	75	San Joaquin	22.10	23.50	930	1400	6.90	6.00	3.50	0.00	0.00	0.00	2.50	0.00	64	3.50	0.00	0.00	0.00	4-6
9/2/2015	MERCED	512	Merced	24.40	26.50	940	1255	8.03	8.68	0.00	0.52	0.00	0.00	0.26	0.00	96	0.00	0.69	0.00	0.00	0-2
9/3/2015	3420	39	San Joaquin	24.20	24.30	630	1430	8.80	8.10	7.00	0.00	0.00	0.00	3.50	0.00	64	7.00	0.00	0.00	0.00	0-2
9/3/2015	9371	46	San Joaquin	21.70	21.50	1100	1200	5.20	5.50	1.00	0.00	0.00	0.00	0.25	0.00	64	1.00	0.00	0.00	0.00	4-6
9/3/2015	9371	47	San Joaquin	20.30	22.10	930	1330	5.10	6.20	2.00	0.00	0.00	0.00	0.75	0.00	64	2.00	0.00	0.00	0.00	2-4
9/3/2015	MERCED	529	Merced	22.40	23.90	1330	1500	10.55	11.22	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	0-2
9/4/2015	3420	39	San Joaquin	26.10	26.40	630	1430	7.80	9.20	7.50	0.00	0.00	0.00	3.50	0.00	64	7.50	0.00	0.00	0.00	0-2
9/4/2015	8834	267	Solano	22.10	22.50	700	900	7.60	7.40	0.00	2.50	0.00	0.00	1.50	0.00	120	0.00	2.67	0.00	0.00	2-4
9/4/2015	9371	74	San Joaquin	17.60	22.00	830	1430	5.30	6.40	8.50	0.00	0.00	0.00	2.50	0.00	64	8.50	0.00	0.00	0.00	6-8
9/4/2015	MERCED	512	Merced	23.10	25.80	925	1440	8.03	8.82	0.00	0.42	0.00	0.00	0.21	0.00	96	0.00	0.56	0.00	0.00	0-2
9/5/2015	9371	74	San Joaquin	18.10	20.50	800	1500	5.10	5.30	10.00	0.00	0.00	0.00	2.50	0.00	64	10.00	0.00	0.00	0.00	2-4
9/7/2015	3420	65	San Joaquin	21.20	26.00	700	1400	5.70	7.10	6.50	0.00	0.00	0.00	3.00	0.00	64	6.50	0.00	0.00	0.00	0-2
9/7/2015	8834	251	Sacramento	23.20	23.20	1300	1330	7.80	7.80	0.00	0.25	0.00	0.00	0.25	0.00	120	0.00	0.27	0.00	0.00	2-4
9/7/2015	8834	252	Sacramento	23.20	23.50	1330	1530	7.80	7.50	0.00	4.75	0.00	0.00	2.25	0.00	120	0.00	5.07	0.00	0.00	2-4
9/7/2015	8834	262	Solano	22.30	22.50	800	1230	7.30	7.70	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
9/7/2015	9371	49	San Joaquin	21.50	21.70	830	1030	7.60	7.10	1.50	0.00	0.00	0.00	0.50	0.00	64	1.50	0.00	0.00	0.00	2-4
9/8/2015	8834	267	Solano	21.30	23.40	800	1330	7.60	7.10	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
9/8/2015	8929	216	Sacramento	25.70	26.80	1100	1430	8.10	7.86	0.00	4.00	0.00	0.00	1.75	0.00	120	0.00	4.27	0.00	0.00	0-2
9/8/2015	8929	217	Sacramento	22.40	25.70	700	1100	8.46	8.10	0.00	5.50	0.00	0.00	2.50	0.00	120	0.00	5.87	0.00	0.00	2-4
9/8/2015	9339	105	Contra Costa	23.60	24.10	830	1300	7.90	8.30	7.50	0.00	0.00	0.00	3.00	0.00	64	7.50	0.00	0.00	0.00	2-4
9/8/2015	MERCED	508	Merced	27.50	27.20	1425	1530	8.55	9.43	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	0-2
9/9/2015	3420	60	San Joaquin	26.10	26.50	1130	1400	8.00	7.00	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	0-2
9/9/2015	3420	65	San Joaquin	25.10	25.50	630	1100	8.90	8.10	4.00	0.00	0.00	0.00	2.00	0.00	64	4.00	0.00	0.00	0.00	0-2
9/9/2015	8834	65	San Joaquin	22.60	23.40	630	1230	8.20	7.40	6.50	0.00	0.00	0.00	3.50	0.00	64	6.50	0.00	0.00	0.00	2-4
9/9/2015	8835	207	San Joaquin	24.10	27.80	1000	1430	7.35	7.14	0.00	7.50	0.00	0.00	4.25	0.00	120	0.00	8.00	0.00	0.00	2-4
9/9/2015	9123	49	San Joaquin	23.10	24.30	900	1430	6.10	5.20	8.50	0.00	0.00	0.00	2.25	0.00	64	8.50	0.00	0.00	0.00	0-2
9/9/2015	MERCED	511	Merced	24.00	27.40	1030	1515	9.11	8.96	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	0-2
9/9/2015	MERCED	512	Merced	22.20	24.00	940	1030	8.00	9.11	0.00	0.03	0.00	0.00	0.02	0.00	96	0.00	0.04	0.00	0.00	0-2

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxxulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxxulam Acres	Wind Speed (mph)
9/10/2015	3420	16	San Joaquin	25.50	26.20	730	1200	9.70	8.80	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	2-4
9/10/2015	3420	69	San Joaquin	26.20	26.30	1230	1400	8.70	8.50	2.50	0.00	0.00	0.00	1.25	0.00	64	2.50	0.00	0.00	0.00	2-4
9/10/2015	8834	20	Sacramento	22.60	23.50	700	1230	7.50	7.00	3.50	0.00	0.00	0.00	1.50	0.00	64	3.50	0.00	0.00	0.00	2-4
9/10/2015	8835	217	Sacramento	22.60	24.70	700	1430	10.20	9.41	0.00	10.75	0.00	0.00	5.00	0.00	120	0.00	11.47	0.00	0.00	2-4
9/10/2015	9123	48	San Joaquin	23.30	24.70	830	1400	6.20	5.80	8.25	0.00	0.00	0.00	6.25	0.00	64	8.25	0.00	0.00	0.00	2-4
9/10/2015	9339	105	Contra Costa	24.10	24.30	930	1300	7.60	8.10	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	2-4
9/11/2015	3420	60	San Joaquin	26.30	26.60	830	1130	8.60	9.10	2.50	0.00	0.00	0.00	1.25	0.00	64	2.50	0.00	0.00	0.00	2-4
9/11/2015	3420	61	San Joaquin	26.40	26.70	1200	1430	9.20	8.10	3.50	0.00	0.00	0.00	1.75	0.00	64	3.50	0.00	0.00	0.00	2-4
9/11/2015	8835	215	Sacramento	22.50	24.20	700	1430	9.90	7.30	0.00	16.00	0.00	0.00	8.00	0.00	120	0.00	17.07	0.00	0.00	2-4
9/11/2015	9123	48	San Joaquin	23.20	23.50	830	1500	5.90	5.30	7.25	0.00	0.00	0.00	4.50	0.00	64	7.25	0.00	0.00	0.00	2-4
9/11/2015	MERCED	506	Merced	24.80	27.70	1140	1420	8.03	12.43	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	0-2
9/14/2015	3420	32	San Joaquin	25.00	25.70	630	1630	11.00	8.60	8.50	0.00	0.00	0.00	4.00	0.00	64	8.50	0.00	0.00	0.00	2-4
9/14/2015	3548	173	Contra Costa	24.20	24.60	1100	1430	7.30	7.60	5.00	0.00	0.00	0.00	2.50	0.00	64	5.00	0.00	0.00	0.00	2-4
9/14/2015	8834	18	San Joaquin	21.30	21.80	630	1200	8.50	7.90	5.00	0.00	0.00	0.00	3.00	0.00	64	5.00	0.00	0.00	0.00	4-6
9/14/2015	8834	48	San Joaquin	23.40	23.70	1330	1530	7.10	7.20	1.50	0.00	0.00	0.00	1.00	0.00	64	1.50	0.00	0.00	0.00	2-4
9/14/2015	8835	214	Sacramento	23.10	24.70	1130	1530	7.82	7.39	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	4-6
9/14/2015	8835	216	Sacramento	21.90	23.20	700	1130	7.32	7.75	0.00	8.00	0.00	0.00	3.75	0.00	120	0.00	8.53	0.00	0.00	2-4
9/14/2015	9123	58	San Joaquin	23.40	24.70	830	1430	6.90	6.60	8.00	0.00	0.00	0.00	4.75	0.00	64	8.00	0.00	0.00	0.00	0-2
9/14/2015	MERCED	510	Merced	24.60	24.20	1000	1340	8.15	9.43	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	0-2
9/15/2015	3420	8	San Joaquin	25.80	26.10	1200	1600	8.50	8.10	4.00	0.00	0.00	0.00	2.00	0.00	64	4.00	0.00	0.00	0.00	2-4
9/15/2015	3420	10	San Joaquin	24.00	24.20	630	1100	8.20	8.70	3.50	0.00	0.00	0.00	1.50	0.00	64	3.50	0.00	0.00	0.00	0-2
9/15/2015	3548	105	Contra Costa	21.90	22.20	830	1030	8.10	8.00	3.00	0.00	0.00	0.00	1.50	0.00	64	3.00	0.00	0.00	0.00	2-4
9/15/2015	3548	173	Contra Costa	22.00	22.60	1100	1400	8.40	7.90	2.00	0.00	0.00	0.00	1.00	0.00	64	2.00	0.00	0.00	0.00	2-4
9/15/2015	8834	8	San Joaquin	23.80	23.40	1000	1530	7.80	7.00	4.50	0.00	0.00	0.00	2.50	0.00	64	4.50	0.00	0.00	0.00	2-4
9/15/2015	8834	18	Sacramento	20.40	21.00	630	830	8.70	8.40	1.50	0.00	0.00	0.00	1.00	0.00	64	1.50	0.00	0.00	0.00	4-6
9/15/2015	8835	214	Sacramento	23.10	24.40	1400	1530	6.91	6.82	0.00	2.75	0.00	0.00	1.50	0.00	120	0.00	2.93	0.00	0.00	4-6
9/15/2015	8835	216	Sacramento	22.20	22.80	1030	1400	7.16	7.27	0.00	6.50	0.00	0.00	3.25	0.00	120	0.00	6.93	0.00	0.00	4-6
9/15/2015	8835	217	Sacramento	22.00	22.20	730	1030	7.88	7.16	0.00	4.75	0.00	0.00	2.25	0.00	120	0.00	5.07	0.00	0.00	2-4
9/15/2015	9123	49	San Joaquin	23.00	24.30	800	1400	5.90	5.20	9.00	0.00	0.00	0.00	5.75	0.00	64	9.00	0.00	0.00	0.00	2-4
9/15/2015	MERCED	411	Merced	22.50	23.40	1130	1340	6.89	6.36	0.00	0.03	0.00	0.00	0.02	0.00	96	0.00	0.04	0.00	0.00	2-4
9/15/2015	MERCED	412	Merced	21.90	22.50	1105	1130	5.11	6.89	0.00	0.02	0.00	0.00	0.01	0.00	96	0.00	0.03	0.00	0.00	2-4
9/15/2015	MERCED	413	Merced	20.60	21.90	1020	1105	5.53	5.11	0.00	0.02	0.00	0.00	0.01	0.00	96	0.00	0.03	0.00	0.00	2-4
9/16/2015	8834	215	Sacramento	19.50	21.50	700	1530	8.40	7.60	0.00	10.00	0.00	0.00	4.50	0.00	120	0.00	10.67	0.00	0.00	2-4
9/16/2015	8835	212	Sacramento	20.80	23.00	700	1500	8.08	9.36	0.00	15.75	0.00	0.00	7.50	0.00	120	0.00	16.80	0.00	0.00	2-4
9/16/2015	9123	49	San Joaquin	22.80	23.50	730	1430	5.60	6.30	0.00	10.75	0.00	0.00	4.75	0.00	120	0.00	11.47	0.00	0.00	2-4
9/16/2015	MERCED	528	Merced	18.90	21.40	1000	1435	9.64	8.49	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	4-6
9/17/2015	8834	262	Solano	18.90	19.30	730	1130	8.40	7.70	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
9/17/2015	8835	204	San Joaquin	21.40	23.20	1200	1430	7.12	7.34	0.00	6.50	0.00	0.00	3.25	0.00	120	0.00	6.93	0.00	0.00	4-6
9/17/2015	8835	206	San Joaquin	21.00	21.40	900	1130	6.98	7.12	0.00	4.75	0.00	0.00	2.00	0.00	120	0.00	5.07	0.00	0.00	2-4
9/17/2015	8835	208	San Joaquin	20.80	21.00	700	900	6.60	6.98	0.00	3.50	0.00	0.00	1.75	0.00	120	0.00	3.73	0.00	0.00	2-4
9/17/2015	9012	174	Contra Costa	25.00	25.10	1000	1200	7.50	12.40	0.00	2.20	0.00	0.00	0.75	0.00	120	0.00	2.35	0.00	0.00	2-4
9/17/2015	9012	175	Contra Costa	25.30	25.10	1200	1400	10.00	9.10	0.00	1.00	0.00	0.00	0.50	0.00	120	0.00	1.07	0.00	0.00	4-6
9/17/2015	9123	49	San Joaquin	22.80	23.90	800	1330	7.30	7.50	0.00	6.75	0.00	0.00	5.25	0.00	120	0.00	7.20	0.00	0.00	6-8
9/17/2015	MRCDBP	512	Merced	21.30	22.80	1035	1420	8.85	9.57	0.00	0.25	0.00	0.00	0.13	0.00	96	0.00	0.33	0.00	0.00	4-6
9/18/2015	3548	174	Contra Costa	21.70	22.00	800	1030	8.00	7.90	0.00	3.00	0.00	0.00	1.50	0.00	120	0.00	3.20	0.00	0.00	2-4

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxxulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxxulam Acres	Wind Speed (mph)
9/18/2015	3548	175	Contra Costa	22.00	22.30	1030	1330	8.10	8.30	0.00	4.50	0.00	0.00	2.25	0.00	120	0.00	4.80	0.00	0.00	2-4
9/18/2015	8835	40	San Joaquin	20.80	23.70	1230	1430	7.96	7.82	0.00	2.50	0.00	0.00	1.50	0.00	120	0.00	2.67	0.00	0.00	4-6
9/18/2015	8835	201	San Joaquin	20.30	20.80	1030	1200	7.18	7.96	0.00	3.25	0.00	0.00	2.25	0.00	120	0.00	3.47	0.00	0.00	0-2
9/18/2015	8835	202	San Joaquin	19.80	20.30	700	1000	7.36	7.18	0.00	3.75	0.00	0.00	2.75	0.00	120	0.00	4.00	0.00	0.00	0-2
9/18/2015	9123	75	San Joaquin	23.50	23.70	1200	1400	6.20	6.10	0.00	3.50	0.00	0.00	1.25	0.00	120	0.00	3.73	0.00	0.00	2-4
9/18/2015	9123	76	San Joaquin	23.30	23.70	800	1130	6.70	6.90	0.00	6.50	0.00	0.00	2.75	0.00	120	0.00	6.93	0.00	0.00	2-4
9/18/2015	MRCDBP	518	Merced	21.60	24.20	1203	1415	8.22	10.09	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	2-4
9/18/2015	MRCDBP	519	Merced	20.90	21.60	930	1203	8.04	8.22	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	2-4
9/19/2015	3548	104	Contra Costa	21.30	21.30	800	830	7.24	7.24	0.00	0.77	0.00	0.00	0.36	0.00	120	0.00	0.82	0.00	0.00	0-2
9/19/2015	3548	105	Contra Costa	21.30	21.50	830	1300	7.24	7.60	0.00	6.73	0.00	0.00	3.14	0.00	120	0.00	7.18	0.00	0.00	0-2
9/21/2015	3420	67	San Joaquin	25.60	26.10	900	1400	8.10	9.20	0.00	8.00	0.00	0.00	4.00	0.00	120	0.00	8.53	0.00	0.00	2-4
9/21/2015	3548	107	Contra Costa	21.60	22.70	930	1330	8.10	7.50	0.00	6.00	0.00	0.00	3.00	0.00	120	0.00	6.40	0.00	0.00	2-4
9/21/2015	8834	267	Solano	18.60	21.10	800	1230	8.00	7.60	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	2-4
9/21/2015	8835	200	San Joaquin	21.80	25.80	630	1430	7.33	7.93	0.00	15.50	0.00	0.00	6.50	0.00	120	0.00	16.53	0.00	0.00	2-4
9/21/2015	9012	103	San Joaquin	22.80	26.20	1130	1600	9.30	12.70	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	0-2
9/22/2015	3420	14	San Joaquin	24.60	25.00	700	1400	8.40	11.70	0.00	6.52	0.00	0.00	3.26	0.00	120	0.00	6.95	0.00	0.00	0-2
9/22/2015	3420	15	San Joaquin	25.00	25.00	1400	1430	11.70	11.70	0.00	0.48	0.00	0.00	0.24	0.00	120	0.00	0.51	0.00	0.00	0-2
9/22/2015	8835	285	Sacramento	20.40	20.40	700	900	9.12	7.77	0.00	2.25	0.00	0.00	0.75	0.00	120	0.00	2.40	0.00	0.00	4-6
9/22/2015	8835	286	Sacramento	20.40	20.70	930	1100	7.77	7.84	0.00	1.50	0.00	0.00	0.50	0.00	120	0.00	1.60	0.00	0.00	6-8
9/22/2015	8835	287	Sacramento	20.70	20.80	1100	1230	7.84	8.55	0.00	0.50	0.00	0.00	0.25	0.00	120	0.00	0.53	0.00	0.00	4-6
9/22/2015	9012	102	Contra Costa	22.50	22.50	930	1030	8.60	8.80	0.00	2.25	0.00	0.00	1.25	0.00	120	0.00	2.40	0.00	0.00	6-8
9/22/2015	9012	104	San Joaquin	22.70	23.30	1100	1230	10.60	9.90	0.00	2.75	0.00	0.00	0.75	0.00	120	0.00	2.93	0.00	0.00	6-8
9/22/2015	MRCDBP	508	Merced	23.20	27.30	940	1515	7.83	8.47	0.00	0.39	0.00	0.00	0.20	0.00	96	0.00	0.52	0.00	0.00	0-2
9/23/2015	3420	38	San Joaquin	25.00	25.10	700	1330	10.10	9.90	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
9/23/2015	8835	203	San Joaquin	20.90	23.50	1030	1500	7.86	8.45	0.00	8.75	0.00	0.00	5.00	0.00	120	0.00	9.33	0.00	0.00	4-6
9/23/2015	8835	204	San Joaquin	20.30	20.90	900	1030	8.17	7.86	0.00	2.25	0.00	0.00	1.25	0.00	120	0.00	2.40	0.00	0.00	4-6
9/23/2015	8835	208	San Joaquin	19.80	20.10	700	830	8.88	8.22	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	2-4
9/23/2015	MRCDBP	507	Merced	28.80	24.40	1200	1400	8.73	9.57	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	6-8
9/23/2015	MRCDBP	508	Merced	21.30	28.80	930	1200	7.44	8.73	0.00	0.23	0.00	0.00	0.12	0.00	96	0.00	0.31	0.00	0.00	4-6
9/24/2015	3420	10	San Joaquin	24.80	24.90	700	1000	11.40	8.60	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	0-2
9/24/2015	3548	106	Contra Costa	22.10	23.40	830	1330	8.00	8.40	0.00	7.50	0.00	0.00	4.00	0.00	120	0.00	8.00	0.00	0.00	2-4
9/24/2015	8835	215	Sacramento	20.80	25.50	700	1400	1.79	10.72	0.00	10.75	0.00	0.00	5.50	0.00	120	0.00	11.47	0.00	0.00	2-4
9/24/2015	9012	16	San Joaquin	22.70	24.20	1000	1400	10.10	9.80	0.00	7.50	0.00	0.00	1.25	0.00	120	0.00	8.00	0.00	0.00	2-4
9/24/2015	MRCDBP	507	Merced	20.20	23.50	930	1440	7.20	9.97	0.00	0.28	0.00	0.00	0.00	0.00	96	0.00	0.37	0.00	0.00	0-2
9/25/2015	8834	262	Solano	19.20	23.10	830	1200	7.80	7.30	0.00	5.00	0.00	0.00	3.00	0.00	120	0.00	5.33	0.00	0.00	2-4
9/25/2015	8835	215	Sacramento	25.30	25.80	1530	1730	8.54	8.33	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	4-6
9/25/2015	8835	216	Sacramento	21.80	25.10	930	1530	6.97	8.90	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	2-4
9/25/2015	8835	217	Sacramento	20.10	21.80	700	930	7.31	6.97	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
9/25/2015	9012	6	San Joaquin	22.40	24.50	800	1300	9.10	8.80	0.00	6.50	0.00	0.00	2.00	0.00	120	0.00	6.93	0.00	0.00	2-4
9/25/2015	9012	7	San Joaquin	24.50	24.80	1300	1530	8.80	9.00	0.00	3.00	0.00	0.00	0.75	0.00	120	0.00	3.20	0.00	0.00	2-4
9/25/2015	MRCDBP	506	Merced	22.50	25.00	1330	1430	7.95	10.86	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	0-2
9/25/2015	MRCDBP	507	Merced	20.80	22.50	920	1330	7.57	7.95	0.00	0.16	0.00	0.00	0.08	0.00	96	0.00	0.21	0.00	0.00	0-2
9/26/2015	9012	13	San Joaquin	23.10	23.30	700	1100	9.30	9.30	0.00	1.00	0.00	0.00	0.25	0.00	120	0.00	1.07	0.00	0.00	2-4
9/28/2015	8835	217	Sacramento	20.40	22.20	930	1100	8.17	8.19	0.00	1.25	0.00	0.00	0.75	0.00	120	0.00	1.33	0.00	0.00	0-2
9/28/2015	8835	219	Sacramento	22.20	24.20	1100	1400	8.19	7.23	0.00	5.75	0.00	0.00	3.25	0.00	120	0.00	6.13	0.00	0.00	2-4
9/28/2015	MRCDBP	505	Merced	23.60	22.80	1340	1450	8.74	7.86	0.00	0.16	0.00	0.00	0.08	0.00	96	0.00	0.21	0.00	0.00	0-2
9/28/2015	MRCDBP	506	Merced	22.20	23.60	1000	1340	7.25	8.74	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	0-2
9/29/2015	3420	8	San Joaquin	25.20	25.30	1030	1400	9.40	8.20	0.00	6.00	0.00	0.00	2.25	0.00	120	0.00	6.40	0.00	0.00	0-2
9/29/2015	3420	10	San Joaquin	24.20	25.00	700	1000	10.40	9.10	0.00	6.00	0.00	0.00	2.25	0.00	120	0.00	6.40	0.00	0.00	0-2
9/29/2015	3548	108	Contra Costa	21.20	21.50	930	1030	7.16	7.70	0.00	1.50	0.00	0.00	0.75	0.00	120	0.00	1.60	0.00	0.00	4-6
9/29/2015	9123	291	San Joaquin	21.80	23.70	1000	1500	5.90	5.50	0.00	7.50	0.00	0.00	1.00	0.00	120	0.00	8.00	0.00	0.00	6-8

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
9/29/2015	MRCDBP	504	Merced	20.70	21.50	1145	1435	7.87	8.07	0.00	0.22	0.00	0.00	0.11	0.00	96	0.00	0.29	0.00	0.00	4-6
9/29/2015	MRCDBP	505	Merced	20.10	20.70	1000	1145	7.79	7.87	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	2-4
9/30/2015	3420	8	San Joaquin	22.10	22.50	730	1430	8.80	8.10	0.00	6.50	0.00	0.00	3.50	0.00	120	0.00	6.93	0.00	0.00	0-2
9/30/2015	3548	709	Stanislaus	22.20	22.60	1000	1330	7.50	7.80	0.00	0.00	1.00	0.00	0.75	0.00	32	0.00	0.00	4.00	0.00	2-4
9/30/2015	8816	241	Sacramento	20.00	20.40	830	1030	7.80	8.20	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	4-6
9/30/2015	8816	251	Solano	19.60	19.50	1030	1130	7.70	7.70	0.00	1.00	0.00	0.00	0.50	0.00	120	0.00	1.07	0.00	0.00	2-4
9/30/2015	9123	75	San Joaquin	20.60	21.30	930	1500	1.60	1.80	0.00	10.75	0.00	0.00	6.00	0.00	120	0.00	11.47	0.00	0.00	2-4
9/30/2015	MRCDBP	529	Merced	19.50	19.70	900	1140	8.05	8.16	0.00	0.16	0.00	0.00	0.08	0.00	96	0.00	0.21	0.00	0.00	0-2
										196.50	436.70	1.00	0.00	303.50	0.00		196.50	466.95	4.00	0.00	

Table B- 8. October 2015 Herbicide and Adjuvant Use

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
10/2/2015	8816	272	Solano	19.00	22.90	800	1100	7.70	7.60	0.00	6.50	0.00	0.00	4.00	0.00	120	0.00	6.93	0.00	0.00	2-4
10/2/2015	8929	215	Sacramento	18.80	25.90	700	1430	8.66	7.11	0.00	13.00	0.00	0.00	6.00	0.00	120	0.00	13.87	0.00	0.00	2-4
10/2/2015	9123	76	San Joaquin	20.80	22.50	830	1600	2.50	5.50	0.00	14.50	0.00	0.00	6.50	0.00	120	0.00	15.47	0.00	0.00	2-4
10/2/2015	MRCDBP	503	Merced	21.30	22.40	1305	1445	9.50	8.37	0.00	0.13	0.00	0.00	0.06	0.00	96	0.00	0.17	0.00	0.00	6-8
10/2/2015	MRCDBP	504	Merced	18.70	21.30	930	1305	8.41	9.50	0.00	0.28	0.00	0.00	0.14	0.00	96	0.00	0.37	0.00	0.00	6-8
10/3/2015	9123	13	San Joaquin	21.30	23.50	900	1430	6.40	7.10	0.00	12.50	0.00	0.00	3.50	0.00	120	0.00	13.33	0.00	0.00	2-4
10/5/2015	3420	33	San Joaquin	23.10	23.50	1000	1500	9.90	8.50	0.00	7.50	0.00	0.00	3.50	0.00	120	0.00	8.00	0.00	0.00	0-2
10/5/2015	3548	709	Stanislaus	21.90	22.20	900	1430	8.10	8.30	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
10/5/2015	8816	19	Sacramento	19.90	21.30	800	1200	7.20	7.50	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
10/5/2015	8929	203	San Joaquin	19.60	21.70	730	1300	8.42	8.71	0.00	9.50	0.00	0.00	4.75	0.00	120	0.00	10.13	0.00	0.00	2-4
10/5/2015	8929	205	San Joaquin	21.80	23.20	1330	1430	7.88	7.90	0.00	1.25	0.00	0.00	0.50	0.00	120	0.00	1.33	0.00	0.00	2-4
10/5/2015	9123	52	San Joaquin	22.20	22.50	930	1130	6.40	6.30	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
10/5/2015	9123	53	San Joaquin	22.50	22.80	1130	1300	6.30	6.50	0.00	2.75	0.00	0.00	1.00	0.00	120	0.00	2.93	0.00	0.00	2-4
10/5/2015	9123	56	San Joaquin	23.20	23.50	1300	1500	6.90	7.60	0.00	2.25	0.00	0.00	0.50	0.00	120	0.00	2.40	0.00	0.00	2-4
10/5/2015	MRCDBP	503	Merced	18.60	20.80	945	1420	7.57	8.38	0.00	0.20	0.00	0.00	0.10	0.00	96	0.00	0.27	0.00	0.00	0-2
10/6/2015	3420	14	San Joaquin	21.00	21.00	1100	1400	11.80	10.30	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
10/6/2015	3420	32	San Joaquin	20.10	20.20	630	830	9.90	8.80	0.00	3.50	0.00	0.00	1.50	0.00	120	0.00	3.73	0.00	0.00	0-2
10/6/2015	3420	33	San Joaquin	20.10	20.20	830	1100	9.90	8.10	0.00	3.50	0.00	0.00	1.50	0.00	120	0.00	3.73	0.00	0.00	0-2
10/6/2015	8816	61	San Joaquin	21.40	21.80	1300	1500	7.90	8.30	0.00	2.25	0.00	0.00	1.00	0.00	120	0.00	2.40	0.00	0.00	2-4
10/6/2015	8816	62	San Joaquin	20.70	21.50	930	1300	7.60	7.90	0.00	5.25	0.00	0.00	2.00	0.00	120	0.00	5.60	0.00	0.00	2-4
10/6/2015	8929	210	San Joaquin	21.70	23.60	1200	1400	8.77	8.20	0.00	1.75	0.00	0.00	1.00	0.00	120	0.00	1.87	0.00	0.00	4-6
10/6/2015	8929	211	San Joaquin	18.80	21.70	730	1130	7.82	8.77	0.00	5.00	0.00	0.00	3.50	0.00	120	0.00	5.33	0.00	0.00	2-4
10/6/2015	9123	45	San Joaquin	22.70	22.80	900	1330	7.50	8.20	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	0-2
10/6/2015	9123	72	San Joaquin	22.70	26.00	1330	1530	7.20	11.50	0.00	3.25	0.00	0.00	1.50	0.00	120	0.00	3.47	0.00	0.00	2-4
10/6/2015	MRCDBP	501	Merced	19.70	22.20	1200	1445	7.47	10.13	0.00	0.11	0.00	0.00	0.05	0.00	96	0.00	0.15	0.00	0.00	2-4
10/6/2015	MRCDBP	502	Merced	18.70	19.70	930	1200	7.50	7.47	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	0-2
10/7/2015	3420	13	San Joaquin	20.20	20.30	700	830	10.10	9.70	0.00	1.50	0.00	0.00	0.75	0.00	120	0.00	1.60	0.00	0.00	0-2
10/7/2015	3420	14	San Joaquin	20.30	21.30	830	930	9.50	9.30	0.00	0.50	0.00	0.00	0.25	0.00	120	0.00	0.53	0.00	0.00	0-2
10/7/2015	3420	68	San Joaquin	20.50	21.10	1000	1400	9.10	9.30	0.00	8.00	0.00	0.00	4.00	0.00	120	0.00	8.53	0.00	0.00	0-2
10/7/2015	8816	13	San Joaquin	20.40	25.00	900	1500	7.60	7.00	0.00	10.00	0.00	0.00	4.00	0.00	120	0.00	10.67	0.00	0.00	0-2
10/7/2015	8929	209	Sacramento	18.80	19.90	700	930	8.35	7.16	0.00	3.00	0.00	0.00	1.75	0.00	120	0.00	3.20	0.00	0.00	2-4
10/7/2015	8929	209	San Joaquin	23.90	24.20	1430	1500	8.13	7.97	0.00	1.50	0.00	0.00	1.25	0.00	120	0.00	1.60	0.00	0.00	2-4
10/7/2015	8929	210	San Joaquin	23.80	23.90	1330	1430	8.11	8.13	0.00	0.75	0.00	0.00	0.50	0.00	120	0.00	0.80	0.00	0.00	2-4
10/7/2015	8929	210	Sacramento	20.00	21.10	930	1130	7.19	8.17	0.00	3.00	0.00	0.00	2.00	0.00	120	0.00	3.20	0.00	0.00	2-4
10/7/2015	8929	211	Sacramento	21.10	22.80	1130	1300	8.17	7.90	0.00	2.75	0.00	0.00	1.75	0.00	120	0.00	2.93	0.00	0.00	2-4
10/7/2015	9123	93	Contra Costa	23.10	23.80	830	1400	9.30	7.80	0.00	4.25	0.00	0.00	1.50	0.00	120	0.00	4.53	0.00	0.00	0-2
10/7/2015	MRCDBP	500	Merced	19.50	21.70	1000	1300	7.00	8.61	0.00	0.05	0.00	0.00	0.03	0.00	96	0.00	0.07	0.00	0.00	0-2
10/7/2015	MRCDBP	501	Merced	18.00	19.50	900	1000	7.88	7.00	0.00	0.06	0.00	0.00	0.03	0.00	96	0.00	0.08	0.00	0.00	0-2
10/8/2015	3420	15	San Joaquin	20.40	20.40	900	915	8.60	8.60	0.00	0.37	0.00	0.00	0.17	0.00	120	0.00	0.39	0.00	0.00	0-2
10/8/2015	3420	32	San Joaquin	20.10	20.40	630	830	10.10	9.90	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	0-2
10/8/2015	3420	42	San Joaquin	20.40	21.00	915	1430	8.60	9.10	0.00	7.13	0.00	0.00	3.33	0.00	120	0.00	7.61	0.00	0.00	0-2
10/8/2015	3548	107	Contra Costa	20.30	20.80	730	1430	8.80	8.30	0.00	8.00	0.00	0.00	4.00	0.00	120	0.00	8.53	0.00	0.00	2-4
10/8/2015	3738	15	San Joaquin	20.90	21.80	1008	1510	6.90	7.30	0.00	4.00	0.00	0.00	5.00	0.00	120	0.00	4.27	0.00	0.00	2-4
10/8/2015	8929	40	San Joaquin	20.30	21.20	1030	1400	8.54	7.44	0.00	5.75	0.00	0.00	3.25	0.00	120	0.00	6.13	0.00	0.00	2-4
10/8/2015	8929	201	San Joaquin	20.10	20.30	900	1030	7.43	8.54	0.00	0.75	0.00	0.00	0.25	0.00	120	0.00	0.80	0.00	0.00	2-4

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
10/8/2015	8929	209	San Joaquin	19.70	19.80	700	830	6.90	7.16	0.00	2.25	0.00	0.00	1.00	0.00	120	0.00	2.40	0.00	0.00	2-4
10/8/2015	9122	90	Contra Costa	21.60	22.30	800	1310	8.20	7.60	0.00	6.50	0.00	0.00	2.50	0.00	120	0.00	6.93	0.00	0.00	0-2
10/8/2015	9122	93	Contra Costa	23.50	23.80	1320	1510	9.80	8.30	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	2-4
10/8/2015	MRCDBP	508	Merced	22.10	27.20	1115	1500	7.79	8.00	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	0-2
10/8/2015	MRCDBP	509	Merced	22.20	22.10	935	1115	7.61	7.79	0.00	0.06	0.00	0.00	0.03	0.00	96	0.00	0.08	0.00	0.00	0-2
10/9/2015	3420	32	San Joaquin	20.20	23.50	700	1400	6.80	8.20	0.00	12.50	0.00	0.00	6.00	0.00	120	0.00	13.33	0.00	0.00	0-2
10/9/2015	3548	108	Contra Costa	20.90	21.30	830	1300	8.40	8.10	0.00	7.00	0.00	0.00	3.00	0.00	120	0.00	7.47	0.00	0.00	4-6
10/9/2015	3738	29	Sacramento	20.80	23.00	815	1500	5.80	7.70	0.00	13.50	0.00	0.00	7.00	0.00	120	0.00	14.40	0.00	0.00	4-6
10/9/2015	9122	93	Contra Costa	22.50	23.80	800	1500	9.80	10.60	0.00	6.00	0.00	0.00	2.00	0.00	120	0.00	6.40	0.00	0.00	0-2
10/12/2015	3420	37	San Joaquin	20.70	20.80	800	900	8.90	8.60	0.00	0.00	0.50	0.00	0.25	0.00	120	0.00	0.00	0.53	0.00	0-2
10/12/2015	3420	38	San Joaquin	21.20	21.40	900	1000	8.50	8.70	0.00	0.00	0.50	0.00	0.25	0.00	120	0.00	0.00	0.53	0.00	0-2
10/12/2015	3548	108	Contra Costa	20.60	21.00	730	1430	8.60	8.20	0.00	7.50	0.00	0.00	3.50	0.00	120	0.00	8.00	0.00	0.00	2-4
10/12/2015	3738	28	San Joaquin	21.40	23.30	850	1531	5.60	6.80	0.00	13.75	0.00	0.00	5.50	0.00	120	0.00	14.67	0.00	0.00	2-4
10/12/2015	8929	216	Sacramento	18.90	23.90	700	1430	7.40	7.88	0.00	13.00	0.00	0.00	4.50	0.00	120	0.00	13.87	0.00	0.00	0-2
10/12/2015	9122	76	San Joaquin	22.40	22.90	730	1430	7.40	8.30	0.00	11.50	0.00	0.00	5.00	0.00	120	0.00	12.27	0.00	0.00	0-2
10/13/2015	3420	8	San Joaquin	20.10	21.40	700	1430	9.70	8.50	0.00	17.50	0.00	0.00	8.50	0.00	120	0.00	18.67	0.00	0.00	0-2
10/13/2015	3548	108	Contra Costa	21.30	21.80	730	1430	8.40	8.00	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
10/13/2015	8929	215	Sacramento	19.10	22.60	730	1430	6.84	8.41	0.00	9.75	0.00	0.00	5.00	0.00	120	0.00	10.40	0.00	0.00	0-2
10/13/2015	9122	77	San Joaquin	22.10	22.90	1230	1530	10.20	9.70	0.00	6.00	0.00	0.00	2.50	0.00	120	0.00	6.40	0.00	0.00	2-4
10/13/2015	9122	78	San Joaquin	21.20	21.80	730	1200	7.40	8.30	0.00	6.50	0.00	0.00	2.50	0.00	120	0.00	6.93	0.00	0.00	0-2
10/13/2015	MRCDBP	508	Merced	22.90	25.20	1320	1510	8.46	9.39	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	0-2
10/14/2015	3420	41	San Joaquin	20.70	23.60	700	1430	10.00	11.30	0.00	10.50	0.00	0.00	5.25	0.00	120	0.00	11.20	0.00	0.00	0-2
10/14/2015	3738	28	San Joaquin	21.30	23.80	830	1409	5.80	7.50	0.00	6.75	0.00	0.00	3.00	0.00	120	0.00	7.20	0.00	0.00	4-6
10/14/2015	8929	215	Sacramento	20.80	21.90	730	1430	8.44	8.53	0.00	14.00	0.00	0.00	7.50	0.00	120	0.00	14.93	0.00	0.00	0-2
10/14/2015	9122	74	San Joaquin	20.90	21.30	800	1400	6.20	7.80	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	0-2
10/14/2015	MRCDBP	522	Merced	22.70	24.30	1255	1500	9.86	9.67	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	0-2
10/14/2015	MRCDBP	523	Merced	21.40	22.70	1000	1255	8.92	9.86	0.00	0.08	0.00	0.00	0.04	0.00	96	0.00	0.11	0.00	0.00	0-2
10/14/2015	MRCDBP	524	Merced	21.30	21.40	930	1000	8.26	8.92	0.00	0.02	0.00	0.00	0.01	0.00	96	0.00	0.03	0.00	0.00	0-2
10/15/2015	3420	30	San Joaquin	22.40	21.10	1130	1400	8.60	8.90	0.00	7.50	0.00	0.00	3.50	0.00	120	0.00	8.00	0.00	0.00	0-2
10/15/2015	3420	34	San Joaquin	20.30	20.60	700	1100	11.00	9.70	0.00	7.50	0.00	0.00	3.50	0.00	120	0.00	8.00	0.00	0.00	0-2
10/15/2015	8929	212	Sacramento	19.80	22.10	700	1430	8.02	8.32	0.00	6.00	0.00	0.00	3.00	0.00	120	0.00	6.40	0.00	0.00	2-4
10/15/2015	MRCDBP	508	Merced	22.00	23.90	1000	1505	8.33	9.26	0.00	0.33	0.00	0.00	0.16	0.00	96	0.00	0.44	0.00	0.00	0-2
10/16/2015	3420	14	San Joaquin	20.80	22.40	630	1400	7.00	7.70	0.00	12.50	0.00	0.00	6.00	0.00	120	0.00	13.33	0.00	0.00	2-4
10/16/2015	3548	108	Contra Costa	21.60	22.00	800	1007	7.50	8.40	0.00	2.59	0.00	0.00	1.29	0.00	120	0.00	2.76	0.00	0.00	2-4
10/16/2015	3548	109	Contra Costa	21.60	22.00	1008	1330	7.50	8.40	0.00	5.41	0.00	0.00	2.41	0.00	120	0.00	5.77	0.00	0.00	2-4
10/16/2015	3738	32	San Joaquin	21.40	21.40	630	1430	9.90	10.10	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	0-2
10/16/2015	8929	40	San Joaquin	22.50	22.80	1140	1325	8.20	8.10	0.00	2.00	0.00	0.00	0.75	0.00	120	0.00	2.13	0.00	0.00	2-4
10/16/2015	8929	212	Sacramento	19.90	18.90	835	1013	7.50	7.80	0.00	3.00	0.00	0.00	1.25	0.00	120	0.00	3.20	0.00	0.00	2-4
10/16/2015	MRCDBP	518	Merced	8.67	9.53	1355	1450	0.00	0.00	0.00	0.08	0.00	0.00	0.04	0.00	96	0.00	0.11	0.00	0.00	0-2
10/16/2015	MRCDBP	519	Merced	8.11	8.67	940	1355	0.00	0.00	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	0-2
10/19/2015	3548	109	Contra Costa	20.10	20.80	730	1430	7.30	7.10	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	4-6
10/19/2015	8929	205	San Joaquin	19.60	19.80	930	1230	7.48	8.22	0.00	6.00	0.00	0.00	3.50	0.00	120	0.00	6.40	0.00	0.00	4-6
10/19/2015	8929	209	San Joaquin	18.50	19.10	730	900	7.54	7.86	0.00	1.00	0.00	0.00	0.50	0.00	120	0.00	1.07	0.00	0.00	2-4
10/19/2015	9122	47	San Joaquin	19.30	20.20	900	1500	9.20	11.70	0.00	6.00	0.00	0.00	2.50	0.00	120	0.00	6.40	0.00	0.00	0-2
10/19/2015	9339	109	Contra Costa	20.10	20.40	830	1230	7.10	7.50	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	4-6

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
10/19/2015	MRCDBP	518	Merced	20.00	20.70	1405	1520	9.13	9.38	0.00	0.06	0.00	0.00	0.03	0.00	96	0.00	0.08	0.00	0.00	0-2
10/19/2015	MRCDBP	520	Merced	18.90	20.40	1125	1350	8.39	9.03	0.00	0.03	0.00	0.00	0.02	0.00	96	0.00	0.04	0.00	0.00	2-4
10/19/2015	MRCDBP	521	Merced	18.40	18.90	940	1125	8.82	8.39	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	2-4
10/20/2015	3420	32	San Joaquin	20.60	20.70	800	1100	10.60	9.20	0.00	4.00	0.00	0.00	2.00	0.00	120	0.00	4.27	0.00	0.00	2-4
10/20/2015	3420	34	San Joaquin	20.30	20.20	630	800	8.90	9.90	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	0-2
10/20/2015	3420	65	San Joaquin	20.00	20.20	1130	1430	12.00	11.40	0.00	6.00	0.00	0.00	3.00	0.00	120	0.00	6.40	0.00	0.00	4-6
10/20/2015	8929	201	San Joaquin	18.90	19.20	945	1200	7.53	8.16	0.00	0.50	0.00	0.00	0.25	0.00	120	0.00	0.53	0.00	0.00	6-8
10/20/2015	8929	202	San Joaquin	18.30	18.70	730	930	8.31	7.48	0.00	2.50	0.00	0.00	1.75	0.00	120	0.00	2.67	0.00	0.00	2-4
10/20/2015	9122	72	San Joaquin	19.80	20.10	920	1120	7.20	8.40	0.00	4.00	0.00	0.00	2.00	0.00	120	0.00	4.27	0.00	0.00	4-6
10/20/2015	9122	82	San Joaquin	20.80	21.20	1145	1510	7.90	10.30	0.00	2.50	0.00	0.00	1.50	0.00	120	0.00	2.67	0.00	0.00	2-4
10/20/2015	9339	300	San Joaquin	21.40	22.00	900	1300	7.20	7.60	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
10/20/2015	MRCDBP	506	Merced	21.00	21.60	1315	1515	7.76	7.93	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	4-6
10/21/2015	3420	10	San Joaquin	20.20	21.50	630	1430	8.80	9.90	0.00	12.50	0.00	0.00	6.00	0.00	120	0.00	13.33	0.00	0.00	0-2
10/21/2015	8929	200	San Joaquin	18.40	19.80	730	1115	8.47	7.55	0.00	4.75	0.00	0.00	2.25	0.00	120	0.00	5.07	0.00	0.00	2-4
10/21/2015	8929	203	San Joaquin	19.80	20.20	1130	1430	7.55	7.13	0.00	4.50	0.00	0.00	2.50	0.00	120	0.00	4.80	0.00	0.00	4-6
10/21/2015	9122	78	San Joaquin	20.90	21.20	1215	1530	8.10	9.70	0.00	6.50	0.00	0.00	2.00	0.00	120	0.00	6.93	0.00	0.00	4-6
10/21/2015	9122	79	Alameda	19.20	20.10	900	1130	9.30	10.70	0.00	3.50	0.00	0.00	1.50	0.00	120	0.00	3.73	0.00	0.00	0-2
10/21/2015	9123	269	Yolo	20.00	21.30	1030	1300	7.50	7.70	0.00	6.50	0.00	0.00	3.00	0.00	120	0.00	6.93	0.00	0.00	4-6
10/21/2015	9339	300	San Joaquin	21.10	22.30	830	1130	7.50	7.40	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
10/21/2015	9339	304	San Joaquin	22.70	22.40	1130	1430	7.60	7.10	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
10/21/2015	9371	16	San Joaquin	19.60	20.00	1005	1512	7.50	8.60	0.00	11.75	0.00	0.00	0.00	0.00	120	0.00	12.53	0.00	0.00	2-4
10/21/2015	MRCDBP	514	Merced	18.40	19.90	1105	1420	8.17	8.69	0.00	0.13	0.00	0.00	0.06	0.00	96	0.00	0.17	0.00	0.00	2-4
10/21/2015	MRCDBP	515	Merced	18.20	18.40	920	1105	8.20	8.17	0.00	0.11	0.00	0.00	0.05	0.00	96	0.00	0.15	0.00	0.00	0-2
10/22/2015	8929	66	San Joaquin	20.10	20.40	700	930	7.90	8.10	0.00	3.00	0.00	0.00	1.50	0.00	120	0.00	3.20	0.00	0.00	0-2
10/22/2015	8929	67	San Joaquin	20.40	21.80	1000	1400	7.90	9.50	0.00	9.50	0.00	0.00	4.75	0.00	120	0.00	10.13	0.00	0.00	0-2
10/22/2015	9122	76	San Joaquin	18.60	19.60	900	1500	7.20	9.30	0.00	10.00	0.00	0.00	4.00	0.00	120	0.00	10.67	0.00	0.00	0-2
10/22/2015	9123	251	Sacramento	20.10	20.20	1230	1330	7.90	7.80	0.00	1.50	0.00	0.00	1.00	0.00	120	0.00	1.60	0.00	0.00	2-4
10/22/2015	9123	260	Solano	17.60	18.40	900	1200	8.50	8.30	0.00	6.50	0.00	0.00	2.50	0.00	120	0.00	6.93	0.00	0.00	2-4
10/22/2015	9371	15	San Joaquin	19.80	20.00	1000	1138	7.50	7.60	0.00	0.00	0.19	0.00	0.19	0.00	32	0.00	0.00	0.75	0.00	2-4
10/22/2015	9371	37	San Joaquin	20.80	21.60	1209	1524	7.50	9.60	0.00	0.00	0.81	0.00	0.81	0.00	32	0.00	0.00	3.25	0.00	0-2
10/22/2015	MRCDBP	506	Merced	18.70	20.10	920	1430	7.55	7.53	0.00	0.10	0.00	0.00	0.04	0.00	96	0.00	0.13	0.00	0.00	0-2
10/22/2015	MRCDBP	507	Merced	18.70	19.00	950	1345	7.48	7.90	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	0-2
10/23/2015	3420	100	San Joaquin	20.60	21.50	800	1400	8.60	10.10	0.00	7.50	0.00	0.00	3.75	0.00	120	0.00	8.00	0.00	0.00	0-2
10/23/2015	9122	73	San Joaquin	19.60	20.70	1200	1430	10.10	4.40	0.00	3.50	0.00	0.00	1.50	0.00	120	0.00	3.73	0.00	0.00	2-4
10/23/2015	9122	74	San Joaquin	19.30	19.70	800	1200	8.90	7.30	0.00	6.50	0.00	0.00	2.50	0.00	120	0.00	6.93	0.00	0.00	0-2
10/23/2015	9123	281	Solano	17.50	19.40	830	1330	8.30	7.50	0.00	9.00	0.00	0.00	5.50	0.00	120	0.00	9.60	0.00	0.00	2-4
10/23/2015	9339	300	San Joaquin	18.80	19.30	830	1330	7.10	7.40	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	0-2
10/23/2015	9371	69	San Joaquin	20.10	23.60	955	1618	7.10	7.50	0.00	11.00	0.00	0.00	5.00	0.00	120	0.00	11.73	0.00	0.00	3-5
10/23/2015	MRCDBP	513	Merced	18.60	19.00	855	1200	8.42	8.29	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	0-2
10/24/2015	8929	281	Solano	17.70	19.40	730	1330	8.70	8.00	0.00	11.00	0.00	0.00	5.75	0.00	120	0.00	11.73	0.00	0.00	2-4
10/24/2015	9371	15	San Joaquin	19.30	19.80	735	1505	7.00	7.50	0.00	8.50	0.00	0.00	4.50	0.00	120	0.00	9.07	0.00	0.00	2-4
10/26/2015	3420	100	San Joaquin	19.50	20.20	630	1400	8.50	8.60	0.00	12.00	0.00	0.00	6.00	0.00	120	0.00	12.80	0.00	0.00	0-2
10/26/2015	8929	251	Solano	18.80	19.60	1300	1430	8.32	9.62	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	2-4
10/26/2015	8929	252	Sacramento	17.20	18.20	730	1115	7.16	8.44	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	0-2
10/26/2015	8929	252	Solano	18.30	18.80	1130	1300	8.46	8.32	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	2-4
10/26/2015	9122	76	San Joaquin	17.40	20.30	800	1500	8.20	6.70	0.00	12.50	0.00	0.00	5.00	0.00	120	0.00	13.33	0.00	0.00	0-2
10/26/2015	9123	281	Solano	17.40	17.80	900	1100	8.40	8.00	0.00	3.50	0.00	0.00	1.50	0.00	120	0.00	3.73	0.00	0.00	2-4
10/26/2015	9123	282	Solano	20.10	21.50	1100	1530	8.70	8.10	0.00	9.00	0.00	0.00	4.50	0.00	120	0.00	9.60	0.00	0.00	4-6
10/26/2015	9339	709	Stanislaus	17.20	17.10	900	1400	8.40	8.60	0.00	10.00	0.00	0.00	4.00	0.00	120	0.00	10.67	0.00	0.00	0-2
10/26/2015	9371	15	San Joaquin	18.20	19.80	832	1515	1.30	7.60	0.00	10.75	0.00	0.00	5.25	0.00	120	0.00	11.47	0.00	0.00	2-4
10/26/2015	MRCDBP	512	Merced	20.40	20.10	1325	1535	8.35	8.76	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	0-2
10/27/2015	8929	214	Sacramento	19.20	19.80	1300	1430	7.56	7.22	0.00	0.50	0.00	0.00	0.25	0.00	120	0.00	0.53	0.00	0.00	2-4
10/27/2015	8929	216	Sacramento	18.60	19.20	1015	1300	8.31	7.56	0.00	3.75	0.00	0.00	2.25	0.00	120	0.00	4.00	0.00	0.00	2-4
10/27/2015	8929	217	Sacramento	18.10	18.60	730	1000	8.20	8.31	0.00	2.75	0.00	0.00	1.75	0.00	120	0.00	2.93	0.00	0.00	2-4

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
10/27/2015	9122	76	San Joaquin	7.30	19.90	800	1030	19.80	9.70	0.00	3.00	0.00	0.00	1.50	0.00	120	0.00	3.20	0.00	0.00	0-2
10/27/2015	9122	77	San Joaquin	20.20	19.50	1100	1500	8.60	6.10	0.00	7.00	0.00	0.00	2.50	0.00	120	0.00	7.47	0.00	0.00	2-4
10/27/2015	9123	282	Solano	17.50	18.30	830	1230	8.70	8.00	0.00	6.00	0.00	0.00	3.00	0.00	120	0.00	6.40	0.00	0.00	2-4
10/27/2015	9339	1	San Joaquin	19.40	19.70	1130	1430	8.50	8.00	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	2-4
10/27/2015	9339	300	San Joaquin	19.00	19.20	900	1000	8.45	8.60	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	2-4
10/27/2015	9371	58	San Joaquin	19.20	19.40	940	1503	6.60	7.10	0.00	6.25	0.00	0.00	2.75	0.00	120	0.00	6.67	0.00	0.00	2-4
10/27/2015	MRCDBP	504	Merced	18.70	18.70	1420	1445	8.10	7.83	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	4-6
10/27/2015	MRCDBP	505	Merced	18.50	18.80	1325	1530	8.24	8.25	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	0-2
10/28/2015	MRCDBP	511	Merced	19.20	20.00	1140	1450	8.32	9.57	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	0-2
10/28/2015	MRCDBP	512	Merced	18.40	19.20	1000	1140	8.23	8.32	0.00	0.11	0.00	0.00	0.05	0.00	96	0.00	0.15	0.00	0.00	0-2
10/29/2015	8929	40	San Joaquin	18.30	18.60	745	1300	6.73	7.17	0.00	7.75	0.00	0.00	5.00	0.00	120	0.00	8.27	0.00	0.00	4-6
10/29/2015	MRCDBP	511	Merced	19.10	19.60	1240	1500	9.11	9.93	0.00	0.03	0.00	0.00	0.02	0.00	96	0.00	0.04	0.00	0.00	4-6
10/29/2015	MRCDBP	512	Merced	18.10	19.10	1000	1240	8.50	9.11	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	6-8
10/30/2015	3420	8	San Joaquin	19.10	19.30	830	1400	8.80	8.60	0.00	9.00	0.00	0.00	4.75	0.00	120	0.00	9.60	0.00	0.00	0-2
10/30/2015	3420	10	San Joaquin	19.10	19.00	730	830	9.10	9.30	0.00	0.50	0.00	0.00	0.25	0.00	120	0.00	0.53	0.00	0.00	0-2
10/30/2015	9122	72	San Joaquin	18.50	19.80	1130	1430	7.50	8.60	0.00	10.00	0.00	0.00	4.00	0.00	120	0.00	10.67	0.00	0.00	0-2
10/30/2015	9339	1	San Joaquin	16.90	17.60	800	1200	8.15	7.80	0.00	7.00	0.00	0.00	3.00	0.00	120	0.00	7.47	0.00	0.00	2-4
10/30/2015	9339	2	San Joaquin	7.80	17.80	1200	1400	17.60	7.60	0.00	3.00	0.00	0.00	1.50	0.00	120	0.00	3.20	0.00	0.00	2-4
10/30/2015	9371	12	San Joaquin	18.40	18.20	810	1444	7.40	7.80	0.00	8.75	0.00	0.00	4.25	0.00	120	0.00	9.33	0.00	0.00	2-4
10/30/2015	MRCDBP	504	Merced	17.40	18.60	1030	1400	7.34	7.49	0.00	0.28	0.00	0.00	0.14	0.00	96	0.00	0.37	0.00	0.00	4-6
										0.00	790.43	2.00	0.00	368.64	0.00		0.00	844.17	5.07	0.00	

Table B- 9. November 2015 Herbicide and Adjuvant Use

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
11/3/2015	3420	38	San Joaquin	17.80	18.10	700	1300	7.80	8.30	0.00	7.50	0.00	0.00	3.50	0.00	120	0.00	8.00	0.00	0.00	4-6
11/3/2015	8929	216	Sacramento	17.10	17.50	1200	1530	9.89	9.68	0.00	5.00	0.00	0.00	3.25	0.00	120	0.00	5.33	0.00	0.00	4-6
11/3/2015	8929	217	Sacramento	16.20	16.90	800	1130	7.81	10.12	0.00	6.00	0.00	0.00	3.75	0.00	120	0.00	6.40	0.00	0.00	2-4
11/3/2015	9122	81	San Joaquin	16.60	17.10	730	1030	7.00	8.20	0.00	3.00	0.00	0.00	1.00	0.00	120	0.00	3.20	0.00	0.00	2-4
11/3/2015	9122	84	San Joaquin	18.40	18.30	1045	1430	7.80	9.70	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	4-6
11/3/2015	9123	252	Sacramento	14.70	16.20	930	1100	8.60	8.00	0.00	3.50	0.00	0.00	1.50	0.00	120	0.00	3.73	0.00	0.00	2-4
11/3/2015	9339	2	San Joaquin	16.50	16.60	800	1030	7.90	8.20	0.00	2.50	0.00	0.00	1.50	0.00	120	0.00	2.67	0.00	0.00	2-4
11/3/2015	MERCED	503	Merced	16.60	17.40	1000	1420	7.31	8.21	0.00	0.28	0.00	0.00	0.14	0.00	96	0.00	0.37	0.00	0.00	4-6
11/4/2015	8929	216	Sacramento	16.80	17.30	800	1115	7.88	8.29	0.00	3.25	0.00	0.00	1.75	0.00	120	0.00	3.47	0.00	0.00	4-6
11/4/2015	9123	240	Sacramento	14.90	15.20	800	915	8.40	7.80	0.00	1.25	0.00	0.00	0.42	0.00	120	0.00	1.33	0.00	0.00	4-6
11/4/2015	9123	241	Sacramento	14.90	15.20	916	930	8.40	7.80	0.00	0.25	0.00	0.00	0.25	0.00	120	0.00	0.27	0.00	0.00	4-6
11/5/2015	3420	34	San Joaquin	17.30	17.60	700	1230	10.10	9.40	0.00	6.50	0.00	0.00	3.25	0.00	120	0.00	6.93	0.00	0.00	0-2
11/5/2015	3548	97	Contra Costa	15.50	16.00	830	1330	9.20	9.40	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	0-2
11/5/2015	8929	215	Sacramento	14.80	15.90	800	1500	6.93	7.75	0.00	12.75	0.00	0.00	6.50	0.00	120	0.00	13.60	0.00	0.00	2-4
11/5/2015	9122	81	San Joaquin	15.80	16.20	1310	1500	7.60	7.50	0.00	3.50	0.00	0.00	1.75	0.00	120	0.00	3.73	0.00	0.00	2-4
11/5/2015	9122	82	San Joaquin	14.20	14.90	830	1250	7.70	8.30	0.00	6.00	0.00	0.00	2.50	0.00	120	0.00	6.40	0.00	0.00	0-2
11/5/2015	9123	272	Solano	10.30	12.50	900	1230	8.50	8.00	0.00	6.50	0.00	0.00	4.00	0.00	120	0.00	6.93	0.00	0.00	2-4
11/5/2015	MRCDBP	501	Merced	14.80	15.70	1130	1520	8.24	9.14	0.00	0.11	0.00	0.00	0.05	0.00	96	0.00	0.15	0.00	0.00	2-4
11/5/2015	MRCDBP	502	Merced	14.40	14.80	1000	1130	8.01	8.24	0.00	0.14	0.00	0.00	0.07	0.00	96	0.00	0.19	0.00	0.00	2-4
11/5/2015	MRCDBP	503	Merced	14.20	14.40	930	1000	7.87	8.01	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	2-4
11/6/2015	3420	8	San Joaquin	17.10	18.20	700	1500	8.50	9.70	0.00	12.50	0.00	0.00	6.00	0.00	120	0.00	13.33	0.00	0.00	0-2
11/6/2015	9122	80	San Joaquin	15.20	15.80	1030	1445	9.70	10.70	0.00	6.50	0.00	0.00	3.00	0.00	120	0.00	6.93	0.00	0.00	2-4
11/6/2015	9122	81	San Joaquin	14.50	14.90	730	1020	7.50	8.30	0.00	3.50	0.00	0.00	1.50	0.00	120	0.00	3.73	0.00	0.00	0-2
11/6/2015	9123	240	Sacramento	11.00	16.00	800	1300	8.40	9.00	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
11/6/2015	9339	98	Contra Costa	15.50	16.20	830	1330	8.60	8.20	0.00	10.00	0.00	0.00	4.50	0.00	120	0.00	10.67	0.00	0.00	2-4
11/6/2015	MRCDBP	529	Merced	15.20	16.30	925	1400	8.51	8.60	0.00	0.25	0.00	0.00	0.13	0.00	96	0.00	0.33	0.00	0.00	0-2
11/7/2015	9123	272	Solano	13.70	13.30	800	1300	10.00	9.00	0.00	7.50	0.00	0.00	4.00	0.00	120	0.00	8.00	0.00	0.00	2-4
11/9/2015	MRCDBP	502	Merced	13.80	13.70	940	1130	8.38	7.92	0.00	0.06	0.00	0.00	0.03	0.00	96	0.00	0.08	0.00	0.00	2-4
11/10/2015	3548	108	Contra Costa	14.20	14.70	730	1300	11.50	10.10	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	6-8
11/10/2015	9371	221	Contra Costa	15.20	15.10	1055	1448	7.10	7.40	0.00	2.75	0.00	0.00	1.25	0.00	120	0.00	2.93	0.00	0.00	2-4
11/10/2015	MRCDBP	500	Merced	13.40	13.50	1215	1300	9.71	10.50	0.00	0.05	0.00	0.00	0.03	0.00	96	0.00	0.07	0.00	0.00	8-10
11/10/2015	MRCDBP	501	Merced	13.00	13.40	1030	1215	8.86	9.71	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	6-8
11/10/2015	MRCDBP	502	Merced	12.90	13.00	935	1030	8.65	8.86	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	6-8
11/11/2015	9122	80	San Joaquin	14.80	14.70	1230	1440	8.10	8.50	0.00	4.50	0.00	0.00	2.00	0.00	120	0.00	4.80	0.00	0.00	0-2
11/11/2015	9122	81	San Joaquin	12.90	14.20	1000	1230	8.80	7.50	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	0-2
11/11/2015	9371	13	San Joaquin	15.30	15.10	1045	1501	8.10	8.30	0.00	5.00	0.00	0.00	1.00	0.00	120	0.00	5.33	0.00	0.00	2-4
11/12/2015	8816	272	Solano	9.70	15.60	1030	1330	9.00	9.40	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	2-4
11/12/2015	9122	80	San Joaquin	12.30	14.10	830	1400	8.90	8.70	0.00	8.00	0.00	0.00	3.25	0.00	120	0.00	8.53	0.00	0.00	0-2
11/12/2015	9339	3	San Joaquin	12.50	13.10	900	1400	9.80	9.90	0.00	8.75	0.00	0.00	4.00	0.00	120	0.00	9.33	0.00	0.00	0-2
11/12/2015	9371	18	Sacramento	13.30	13.30	850	1430	8.50	8.50	0.00	6.50	0.00	0.00	1.75	0.00	120	0.00	6.93	0.00	0.00	4-6
11/12/2015	9371	18	San Joaquin	15.40	15.40	1430	1502	8.10	8.10	0.00	1.00	0.00	0.00	1.25	0.00	120	0.00	1.07	0.00	0.00	6-8
11/12/2015	MRCDBP	410	Merced	13.50	13.90	1355	1435	7.49	8.36	0.00	0.05	0.00	0.00	0.02	0.00	96	0.00	0.07	0.00	0.00	6-8
11/12/2015	MRCDBP	411	Merced	12.10	13.50	940	1355	7.39	7.49	0.00	0.19	0.00	0.00	0.09	0.00	96	0.00	0.25	0.00	0.00	2-4
11/13/2015	8816	267	Solano	9.80	15.60	930	1330	9.60	11.00	0.00	6.00	0.00	0.00	3.00	0.00	120	0.00	6.40	0.00	0.00	2-4
11/13/2015	9122	183	San Joaquin	12.80	12.60	900	1055	9.50	8.70	0.00	1.50	0.00	0.00	0.50	0.00	120	0.00	1.60	0.00	0.00	0-2

Date	Vessel ID	Site ID	County	Before Temp (°C)	After Temp (°C)	Time Arrived	Time Departed	DO Before (mg/L)	DO After (mg/L)	2,4-D (gal)	Glyphosate (gal)	Imazamox (gal)	Penoxsulam (gal)	Agridex (gal)	Competitor (gal)	Chem Rate (oz/Ac)	2,4-D Acres	Glyphosate Acres	Imazamox Acres	Penoxsulam Acres	Wind Speed (mph)
11/13/2015	9122	184	San Joaquin	13.20	14.50	1000	1435	9.30	7.20	0.00	8.50	0.00	0.00	4.00	0.00	120	0.00	9.07	0.00	0.00	2-4
11/13/2015	9371	218	San Joaquin	11.80	15.40	850	1510	5.80	9.90	0.00	9.50	0.00	0.00	3.00	0.00	120	0.00	10.13	0.00	0.00	0-2
11/13/2015	MRCDBP	409	Merced	11.70	13.10	1140	1350	6.66	8.05	0.00	0.06	0.00	0.00	0.03	0.00	96	0.00	0.08	0.00	0.00	0-2
11/13/2015	MRCDBP	410	Merced	11.60	11.70	1010	1140	7.93	6.66	0.00	0.08	0.00	0.00	0.04	0.00	96	0.00	0.11	0.00	0.00	0-2
11/14/2015	9371	217	Contra Costa	14.10	15.50	915	1446	9.50	9.40	0.00	8.00	0.00	0.00	2.50	0.00	120	0.00	8.53	0.00	0.00	0-2
11/17/2015	8816	262	Solano	9.00	14.30	850	1300	9.60	8.50	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
11/17/2015	9339	4	San Joaquin	10.90	11.10	830	1230	10.80	10.50	0.00	7.50	0.00	0.00	4.00	0.00	120	0.00	8.00	0.00	0.00	2-4
11/17/2015	9339	5	San Joaquin	10.50	10.70	1230	1430	11.10	11.40	0.00	2.50	0.00	0.00	1.00	0.00	120	0.00	2.67	0.00	0.00	2-4
11/17/2015	9371	219	Contra Costa	12.80	13.90	851	1428	10.00	10.10	0.00	9.25	0.00	0.00	3.00	0.00	120	0.00	9.87	0.00	0.00	2-4
11/17/2015	MRCDBP	528	Merced	13.50	13.90	925	1430	10.87	10.79	0.00	0.09	0.00	0.00	0.05	0.00	96	0.00	0.12	0.00	0.00	0-2
11/17/2015	none	93	Contra Costa	11.30	12.50	730	1420	10.70	7.60	0.00	5.00	0.00	0.00	2.00	0.00	120	0.00	5.33	0.00	0.00	0-2
11/18/2015	9339	28	San Joaquin	11.50	11.90	830	1400	12.20	11.00	0.00	7.50	0.00	0.00	3.50	0.00	120	0.00	8.00	0.00	0.00	0-2
11/18/2015	9371	221	Contra Costa	13.60	14.60	915	1506	9.70	9.30	0.00	8.00	0.00	0.00	3.00	0.00	120	0.00	8.53	0.00	0.00	2-4
11/18/2015	none	46	San Joaquin	11.80	12.90	900	1430	7.30	8.60	0.00	7.50	0.00	0.00	3.50	0.00	120	0.00	8.00	0.00	0.00	0-2
11/19/2015	3420	101	San Joaquin	14.50	15.00	730	1430	7.90	9.20	0.00	8.50	0.00	0.00	3.75	0.00	120	0.00	9.07	0.00	0.00	0-2
11/19/2015	3548	105	Contra Costa	12.00	12.40	730	1430	11.90	11.10	0.00	7.50	0.00	0.00	3.00	0.00	120	0.00	8.00	0.00	0.00	2-4
11/19/2015	8929	208	San Joaquin	10.80	12.20	800	1300	9.58	9.47	0.00	4.00	0.00	0.00	2.50	0.00	120	0.00	4.27	0.00	0.00	0-2
11/19/2015	9339	28	San Joaquin	10.30	11.90	830	1430	7.60	8.10	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	0-2
11/19/2015	9371	119	Sacramento	12.10	12.70	830	1500	9.20	9.50	0.00	9.75	0.00	0.00	4.00	0.00	120	0.00	10.40	0.00	0.00	2-4
11/19/2015	none	46	San Joaquin	12.80	13.20	1100	1500	7.50	8.10	0.00	7.50	0.00	0.00	4.00	0.00	120	0.00	8.00	0.00	0.00	0-2
11/20/2015	3420	101	San Joaquin	15.30	16.00	730	1500	8.50	8.50	0.00	10.00	0.00	0.00	5.00	0.00	120	0.00	10.67	0.00	0.00	0-2
11/20/2015	9339	28	San Joaquin	11.20	12.20	830	1200	11.80	10.80	0.00	4.00	0.00	0.00	2.00	0.00	120	0.00	4.27	0.00	0.00	0-2
11/20/2015	9371	104	San Joaquin	9.60	9.60	1412	1503	9.00	9.60	0.00	0.33	0.00	0.00	0.23	0.00	120	0.00	0.35	0.00	0.00	2-4
11/20/2015	9371	104	Contra Costa	12.60	9.60	1155	1412	9.00	9.60	0.00	5.42	0.00	0.00	3.77	0.00	120	0.00	5.78	0.00	0.00	2-4
11/20/2015	9371	117	Contra Costa	12.40	12.60	1005	1133	8.80	9.10	0.00	1.75	0.00	0.00	0.75	0.00	120	0.00	1.87	0.00	0.00	4-6
11/20/2015	9371	119	Sacramento	12.20	12.20	835	952	8.90	8.90	0.00	1.50	0.00	0.00	0.75	0.00	120	0.00	1.60	0.00	0.00	2-4
11/21/2015	8929	212	Sacramento	11.50	11.70	822	1014	9.30	9.50	0.00	3.00	0.00	0.00	1.50	0.00	120	0.00	3.20	0.00	0.00	0-2
11/21/2015	8929	214	Sacramento	12.50	13.60	1101	1503	9.80	10.50	0.00	7.75	0.00	0.00	2.00	0.00	120	0.00	8.27	0.00	0.00	2-4
11/23/2015	3420	29	San Joaquin	15.80	15.90	1330	1530	8.60	9.30	0.00	2.50	0.00	0.00	1.25	0.00	120	0.00	2.67	0.00	0.00	0-2
11/23/2015	3548	105	Contra Costa	13.20	14.10	930	1400	13.20	10.80	0.00	6.50	0.00	0.00	3.00	0.00	120	0.00	6.93	0.00	0.00	0-2
11/23/2015	8816	267	Solano	12.50	14.60	1000	1400	9.90	8.70	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	2-4
11/23/2015	8929	215	Sacramento	11.20	12.80	1115	1500	10.14	10.78	0.00	6.00	0.00	0.00	2.75	0.00	120	0.00	6.40	0.00	0.00	2-4
11/23/2015	8929	216	Sacramento	10.60	10.90	800	1100	8.31	8.75	0.00	4.25	0.00	0.00	2.00	0.00	120	0.00	4.53	0.00	0.00	0-2
11/23/2015	9371	20	Sacramento	12.50	13.50	855	1428	9.70	9.90	0.00	8.25	0.00	0.00	3.50	0.00	120	0.00	8.80	0.00	0.00	0-2
11/25/2015	9371	32	San Joaquin	11.20	11.60	835	1441	10.70	9.80	0.00	13.75	0.00	0.00	8.00	0.00	120	0.00	14.67	0.00	0.00	2-4
11/27/2015	9371	14	San Joaquin	11.10	9.50	850	1543	11.70	10.40	0.00	7.75	0.00	0.00	5.25	0.00	120	0.00	8.27	0.00	0.00	6-8
11/28/2015	9371	123	Sacramento	10.30	10.70	1100	1428	10.90	10.80	0.00	5.25	0.00	0.00	1.75	0.00	120	0.00	5.60	0.00	0.00	8-10
11/28/2015	9371	140	Solano	10.20	10.30	955	1034	11.50	11.50	0.00	1.25	0.00	0.00	0.75	0.00	120	0.00	1.33	0.00	0.00	6-8
11/30/2015	3420	101	San Joaquin	9.20	9.10	730	1400	11.00	10.60	0.00	5.00	0.00	0.00	2.50	0.00	120	0.00	5.33	0.00	0.00	0-2
11/30/2015	3548	108	Contra Costa	9.50	9.80	900	1400	14.20	13.70	0.00	8.50	0.00	0.00	4.00	0.00	120	0.00	9.07	0.00	0.00	0-2
11/30/2015	8816	267	Solano	5.30	10.10	1000	1330	12.90	10.20	0.00	4.00	0.00	0.00	1.00	0.00	120	0.00	4.27	0.00	0.00	2-4
11/30/2015	8929	205	San Joaquin	9.20	9.80	1100	1400	10.79	10.32	0.00	7.25	0.00	0.00	3.75	0.00	120	0.00	7.73	0.00	0.00	2-4
11/30/2015	8929	208	San Joaquin	8.40	9.00	815	1030	9.76	10.91	0.00	2.75	0.00	0.00	1.50	0.00	120	0.00	2.93	0.00	0.00	0-2
11/30/2015	9371	141	Sacramento	9.40	8.60	900	1146	10.90	10.60	0.00	3.25	0.00	0.00	1.50	0.00	120	0.00	3.47	0.00	0.00	2-4
11/30/2015	9371	240	Sacramento	8.60	8.30	1152	1405	10.60	10.60	0.00	2.00	0.00	0.00	1.00	0.00	120	0.00	2.13	0.00	0.00	2-4
										0.00	440.55	0.00	0.00	204.27	0.00		0.00	470.33	0.00	0.00	

APPENDIX C

2015 Treatment Count Per Site

2015 Hyacinth Treatment Count (Glyphosate, 2,4-D, and Imazamox)																				As of 11/30/2015	
Site ↓	Count ↓	Site ↓	Count ↓	Site ↓	Count ↓	Site ↓	Count ↓	Site ↓	Count ↓	Site ↓	Count ↓	Site ↓	Count ↓	Site ↓	Count ↓	Site ↓	Count ↓	Site ↓	Count ↓	Site ↓	Count ↓
1	2	34	5	73	7	101A	1	134	0	222	0	255	0	290B	0	411	4	521	4	902	0
2	2	35	0	74	17	101B	4	135	0	223	0	256A	0	291	7	412	5	522	3	903	0
3	1	36	0	75	13	102	2	136	0	224	0	256B	0	300	12	413	6	523	3	904	0
4	1	37	6	76	13	103A	1	137	0	225	0	257A	0	301	4	414	0	524	3	905	0
5	1	38	4	77	9	103B	1	138	0	226	0	257B	0	302	6	414A	0	525	0	906	0
6	5	39	4	78	6	104A	2	139	0	230	0	258A	0	303	9	415	0	526	2	907	0
7	1	40	10	79	3	104B	1	140	1	231	0	258B	0	304	6	416	0	527	0	908	0
8	11	41	1	80	9	105	7	141	1	232	0	259	0	305	0	417	0	528	6	909	0
9	9	42	6	81	8	106	1	173	2	233	0	260	1	306	0	418	0	529	5	910A	0
10	8	43	1	82	6	107	3	174	2	234	0	261	0	307	0	419	0	530	0	910B	0
11	1	44	2	83A	3	108	9	175	2	235	0	262	7	308	0	420	0	531	0	911	0
12	3	45	2	83B	3	109	7	176	0	236	0	263	2	309	0	421	0	532	0	912	0
13	9	46	13	84A	11	110	3	200	7	237	0	264	0	310	2	422	0	533	0	913	0
14	9	47	17	84B	12	111	0	201	6	238	0	265	0	311	3	423	0	534	0	914	0
15	9	48	10	85A	4	112	6	202	7	239	0	266	0	312	1	424	0	535	0	915	0
16	7	49	13	85B	9	113	1	203	9	240A	0	267	11	313	0	425	0	536	0	916	0
17A	2	50	1	86A	1	114	3	204	4	240B	4	268	0	314	0	426	0	537	0	917	0
17B	3	51	0	86B	1	115	0	205	6	241	3	269	1	315	0	427	0	600	0	918	0
18A	6	52	3	87A	1	116	0	206	4	242	0	270	1	316	0	500	2	700	0	919	0
18B	6	53	3	87B	1	117	1	207	2	243	0	271	0	317	0	501	4	701	0	920	0
19A	4	54	0	88	1	118	0	208	7	244	0	272	4	318	0	502	4	702	0	921	0
19B	2	55	0	89A	0	119A	0	209A	2	245	0	273	0	319	1	503	6	703	0	922	0
20	8	56	6	89B	0	119B	0	209B	5	246A	0	274	0	320	0	504	6	704	0	923	0
21A	0	57	2	90A	1	120A	0	210A	2	246B	1	275	0	321	0	505	6	705	0	924	0
21B	2	58	7	90B	0	120B	0	210B	4	247A	0	276	0	322	0	506	11	706	1	925	0
22	0	59	1	91A	1	121A	0	211A	2	247B	0	277	0	323	0	507	10	707	0	926	0
23A	1	60	2	91B	0	121B	0	211B	3	248A	0	278	0	324	0	508	12	708	6	927	0
23B	0	61	5	92A	3	122	0	212A	6	248B	0	279	0	325	0	509	4	709	14	928	0
24A	0	62	3	92B	2	123	0	212B	1	249A	0	280	0	400	0	510	3	710	1	929	0
24B	0	63	0	93	12	124	0	213A	2	249B	0	281	3	401	0	511	5	711	2	Sites Treated	
25	2	64	0	94	0	125	0	213B	2	250A	0	282	2	402	0	512	14	712	4		
26	5	65	7	95	1	126	0	214	11	250B	0	283	0	403	0	513	5	713	1	Treatment Count	
27	0	66	3	96	3	127	0	215	20	251A	3	284	0	404	0	514	4	714	3		
28	13	67	4	97	7	128	0	216	16	251B	3	285	1	405	0	515	7	715	3	1042	
29	6	68	6	98A	1	129	0	217	16	252A	3	286	1	406	0	516	0	716	1		
30	3	69	3	98B	2	130	0	218	0	252B	8	287	1	407	0	517	3	717	0	Tidal	
31	2	70	0	99A	0	131	0	219	3	253A	0	288	0	408	1	518	9	718	0	163	782
32	20	71	1	99B	1	132	0	220	0	253B	0	289	0	409	5	519	6	900	0	Riverine	
33	5	72	9	100	6	133	0	221	0	254	0	290A	0	410	8	520	4	901	0	52	260
Less Treatments		→→→													→→→			More Treatments			

APPENDIX D
Monitoring and Laboratory Data

Monitoring Results – Site 6, French Camp Slough

Imazamox Residue

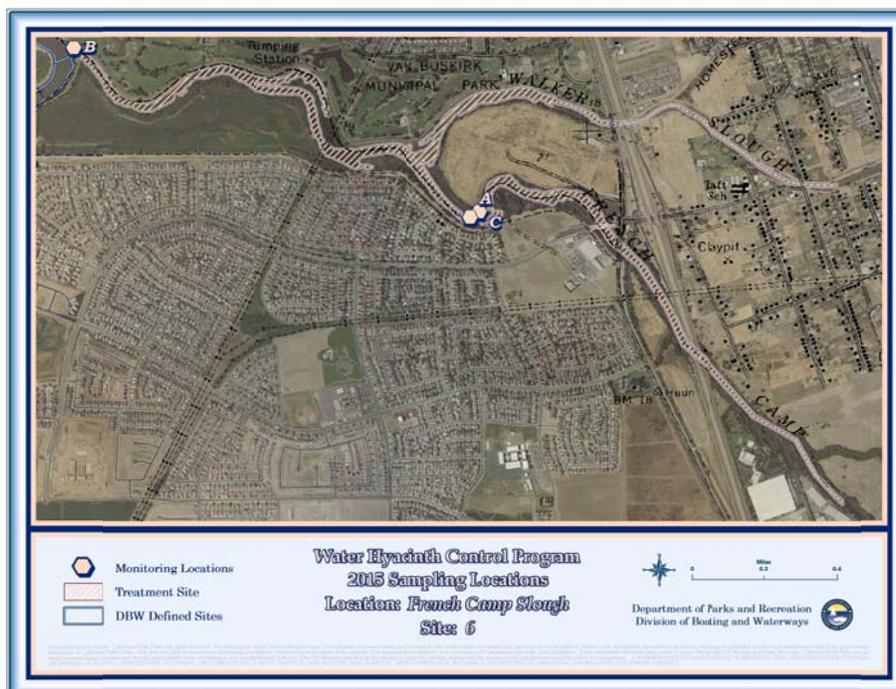
Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Imazamox (ppb)
1A	2015-4461	H06-060315-3	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
1C	2015-4460	H06-060315-2	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
2B	2015-4463	H06-060315-5	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
3A	2015-4761	H06-061115-3	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND
3B	2015-4760	H06-061115-2	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND
3C	2015-4763	H06-061115-5	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND

Competitor Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Competitor (ppb)
1A	2015-4461	H06-060315-3	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
1C	2015-4460	H06-060315-2	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
2B	2015-4463	H06-060315-5	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
3A	2015-4761	H06-061115-3	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND
3B	2015-4760	H06-061115-2	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND
3C	2015-4763	H06-061115-5	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H06-060315-3	6/3/2015	649544	4197553	8:48	22.65	0.771	0.40	6.96	7.36	16.5	ebb
1C	H06-060315-2	6/3/2015	649584	4197575	8:38	22.45	0.793	0.41	6.71	7.51	20.9	ebb
2B	H06-060315-5	6/3/2015	647789	4198306	10:08	22.83	1.019	0.53	7.49	7.55	39.6	ebb
3A	H06-061115-3	6/11/2015	-	-	9:10	23.29	0.205	0.09	4.91	7.61	25.9	ebb/low slack
3B	H06-061115-2	6/11/2015	-	-	9:02	23.32	0.304	0.15	6.19	7.73	26.3	ebb/low slack
3C	H06-061115-5	6/11/2015	647798	4198290	9:25	23.98	0.506	0.26	5.05	7.41	18.5	ebb/low slack



Monitoring Results – Site 10, Buckley Cove

Imazamox Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Imazamox (ppb)
1A	2015-4467	H10-060315-3	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
1C	2015-4466	H10-060315-2	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
2B	2015-4469	H10-060315-5	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
3A	2015-4767	H10-061115-3	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND
3B	2015-4766	H10-061115-2	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND
3C	2015-4769	H10-061115-5	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND

Competitor Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Competitor (ppb)
1A	2015-4467	H10-060315-3	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
1C	2015-4466	H10-060315-2	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
2B	2015-4469	H10-060315-5	6/3/2015	6/3/2015	6/16/2015	6/16/2015	ND
3A	2015-4767	H10-061115-3	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND
3B	2015-4766	H10-061115-2	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND
3C	2015-4769	H10-061115-5	6/11/2015	6/11/2015	6/16/2015	6/16/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H10-060315-3	6/3/2015	642396	4204616	10:38	22.66	0.997	0.52	7.54	7.64	6.1	ebb
1C	H10-060315-2	6/3/2015	642300	4204517	10:30	22.81	0.967	0.50	7.38	7.51	4.9	ebb
2B	H10-060315-5	6/3/2015	642144	4204678	11:30	22.77	0.970	0.51	7.18	7.53	5.8	ebb
3A	H10-061115-3	6/11/2015	642465	4204595	9:59	23.74	0.974	0.51	8.51	7.84	8.7	low slack
3B	H10-061115-2	6/11/2015	642311	4204489	9:53	23.98	1.013	0.53	7.11	7.59	4.4	low slack
3C	H10-061115-5	6/11/2015	642250	4204632	10:05	23.91	1.004	0.53	6.88	7.76	5.6	low slack



Monitoring Results – Site 28, Fourteen Mile Slough

2,4-D Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	2,4-D (ppb)
1A	2015-0062	H28-070615-3	7/6/2015	7/6/2015	7/7/2015	7/8/2015	0.156
1C	2015-0061	H28-070615-2	7/6/2015	7/6/2015	7/7/2015	7/8/2015	0.273
2B	2015-0064	H28-070615-5	7/6/2015	7/6/2015	7/7/2015	7/8/2015	1.29
3A	2015-0115	H28-071015-3	7/10/2015	7/10/2015	7/13/2015	7/14/2015	0.433
3B	2015-0114	H28-071015-2	7/10/2015	7/10/2015	7/13/2015	7/14/2015	0.344
3C	2015-0117	H28-071015-5	7/10/2015	7/10/2015	7/13/2015	7/14/2015	0.468

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-0062	H28-070615-3	7/6/2015	7/6/2015	7/7/2015	7/8/2015	ND
1C	2015-0061	H28-070615-2	7/6/2015	7/6/2015	7/7/2015	7/8/2015	ND
2B	2015-0064	H28-070615-5	7/6/2015	7/6/2015	7/7/2015	7/8/2015	ND
3A	2015-0115	H28-071015-3	7/10/2015	7/10/2015	7/13/2015	7/14/2015	ND
3B	2015-0114	H28-071015-2	7/10/2015	7/10/2015	7/13/2015	7/14/2015	ND
3C	2015-0117	H28-071015-5	7/10/2015	7/10/2015	7/13/2015	7/14/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H28-070615-3	7/6/2015	641848	4208477	10:10	25.96	0.738	0.38	6.53	7.72	20.2	Ebb
1C	H28-070615-2	7/6/2015	641946	4208557	10:08	25.70	0.613	0.31	7.07	7.79	1.1	Ebb
2B	H28-070615-5	7/6/2015	641005	4207919	11:12	25.21	0.795	0.41	4.65	7.58	5.5	Ebb
3A	H28-071015-3	7/10/2015	641847	4208474	9:53	24.38	0.736	0.38	6.64	7.90	55.6	Flood
3B	H28-071015-2	7/10/2015	641951	4208544	9:49	24.70	0.751	0.39	6.53	7.84	5.4	Flood
3C	H28-071015-5	7/10/2015	641004	4207935	10:03	24.50	0.737	0.38	6.55	7.87	4.3	flood



Monitoring Results – Site 29, Fourteen Mile Slough

2,4-D Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	2,4-D (ppb)
1A	2015-0068	H29-070615-3	7/6/2015	7/6/2015	7/7/2015	7/8/2015	0.513
1C	2015-0067	H29-070615-2	7/6/2015	7/6/2015	7/7/2015	7/8/2015	0.538
2B	2015-0070	H29-070615-5	7/6/2015	7/6/2015	7/7/2015	7/8/2015	0.319
3A	2015-0120	H29-071015-3	7/10/2015	7/10/2015	7/13/2015	7/14/2015	0.924
3B	2015-0119	H29-071015-2	7/10/2015	7/10/2015	7/13/2015	7/14/2015	1.06
3C	2015-0122	H29-071015-5	7/10/2015	7/10/2015	7/13/2015	7/14/2015	0.464

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-0068	H29-070615-3	7/6/2015	7/6/2015	7/7/2015	7/8/2015	ND
1C	2015-0067	H29-070615-2	7/6/2015	7/6/2015	7/7/2015	7/8/2015	ND
2B	2015-0070	H29-070615-5	7/6/2015	7/6/2015	7/7/2015	7/8/2015	ND
3A	2015-0120	H29-071015-3	7/10/2015	7/10/2015	7/13/2015	7/14/2015	ND
3B	2015-0119	H29-071015-2	7/10/2015	7/10/2015	7/13/2015	7/14/2015	ND
3C	2015-0122	H29-071015-5	7/10/2015	7/10/2015	7/13/2015	7/14/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H29-070615-3	7/6/2015	639936	4211511	8:38	24.68	0.524	0.27	6.10	7.55	3.2	Flood
1C	H29-070615-2	7/6/2015	639946	4211616	8:33	24.77	0.523	0.27	5.98	7.43	3.6	High slack
2B	H29-070615-5	7/6/2015	641664	4208885	10:00	25.38	0.551	0.28	7.39	7.84	3.5	Ebb
3A	H29-071015-3	7/10/2015	639943	4211474	9:06	23.12	0.520	0.26	5.21	7.53	14.6	Low slack
3B	H29-071015-2	7/10/2015	639953	4211603	9:00	23.25	0.520	0.26	5.83	7.54	10.7	Low slack
3C	H29-071015-5	7/10/2015	641663	4208885	9:28	24.27	0.736	0.38	6.35	7.66	4.1	Low slack



Monitoring Results – Site 37, White Slough

Imazamox Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Imazamox (ppb)
1A	2015-1325	H37-101215-3	10/12/2015	10/12/2015	10/21/2015	10/22/2015	ND
1C	2015-1324	H37-101215-2	10/12/2015	10/12/2015	10/21/2015	10/22/2015	ND
2B	2015-1327	H37-101215-5	10/12/2015	10/12/2015	10/21/2015	10/22/2015	ND
3A	2015-1427	H37-101915-3	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND
3B	2015-1426	H37-101915-2	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND
3C	2015-1429	H37-101915-5	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-1325	H37-101215-3	10/12/2015	10/12/2015	10/14/2015	10/14/2015	ND
1C	2015-1324	H37-101215-2	10/12/2015	10/12/2015	10/14/2015	10/14/2015	ND
2B	2015-1327	H37-101215-5	10/12/2015	10/12/2015	10/14/2015	10/14/2015	ND
3A	2015-1427	H37-101915-3	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND
3B	2015-1426	H37-101915-2	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND
3C	2015-1429	H37-101915-5	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H37-101215-3	10/12/2015	638889	4216265	8:27	21.76	0.227	0.11	8.04	8.96	5.0	Ebb
1C	H37-101215-2	10/12/2015	638931	4216214	8:24	21.79	0.235	0.11	8.29	9.08	14.4	Ebb
2B	H37-101215-5	10/12/2015	638154	4216471	9:36	21.60	0.224	0.10	8.56	8.44	8.0	Ebb
3A	H37-101915-3	10/19/2015	638886	4216272	9:38	20.36	0.221	0.10	8.23	8.29	96.3	Flood
3B	H37-101915-2	10/19/2015	638938	4216195	9:31	20.38	0.221	0.10	7.94	8.34	9.6	Flood
3C	H37-101915-5	10/19/2015	638145	4216471	9:50	20.39	0.217	0.10	8.29	8.36	13.3	Flood



Monitoring Results – Site 38, Honker Cut

Imazamox Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Imazamox (ppb)
1A	2015-1331	H38-101215-3	10/12/2015	10/12/2015	10/21/2015	10/22/2015	ND
1C	2015-1330	H38-101215-2	10/12/2015	10/12/2015	10/21/2015	10/22/2015	ND
2B	2015-1333	H38-101215-5	10/12/2015	10/12/2015	10/21/2015	10/22/2015	ND
3A	2015-1433	H38-101915-3	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND
3B	2015-1432	H38-101915-2	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND
3C	2015-1435	H38-101915-5	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-1331	H38-101215-3	10/12/2015	10/12/2015	10/14/2015	10/14/2015	ND
1C	2015-1330	H38-101215-2	10/12/2015	10/12/2015	10/14/2015	10/14/2015	ND
2B	2015-1333	H38-101215-5	10/12/2015	10/12/2015	10/14/2015	10/14/2015	ND
3A	2015-1433	H38-101915-3	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND
3B	2015-1432	H38-101915-2	10/19/2015	10/19/2015	10/21/2015	10/22/2015	ND
3C	2015-1435	H38-101915-5	10/19/2015	10/19/2015	10/21/2015	10/22/2015 </tr	

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H38-101215-3	10/12/2015	635227	4214506	10:06	21.48	0.194	0.09	9.00	8.61	2.2	Ebb
1C	H38-101215-2	10/12/2015	635254	4214576	10:02	21.56	0.195	0.09	9.05	8.79	4.7	Ebb
2B	H38-101215-5	10/12/2015	635163	4213464	11:03	21.69	0.204	0.09	9.17	8.68	8.1	Ebb
3A	H38-101915-3	10/19/2015	635231	4214470	10:30	20.49	0.193	0.09	7.72	8.17	5.4	Flood
3B	H38-101915-2	10/19/2015	635272	4214603	10:24	20.47	0.185	0.08	7.94	8.36	7.4	Flood
3C	H38-101915-5	10/19/2015	635169	4213464	10:43	20.65	0.308	0.15	7.53	8.17	5.6	Flood



Monitoring Results – Site 42, Little Connection Slough

2,4-D Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	2,4-D (ppb)
1A	2015-0768	H42-081815-3	8/18/2015	8/18/2015	8/26/2015	9/2/2015	ND
1C	2015-0767	H42-081815-2	8/18/2015	8/18/2015	8/26/2015	9/2/2015	ND
2B	2015-0770	H42-081815-5	8/18/2015	8/18/2015	8/26/2015	9/2/2015	2.27
3A	2015-0829	H42-082515-3	8/25/2015	8/25/2015	8/26/2015	9/9/2015	0.179
3B	2015-0828	H42-082515-2	8/25/2015	8/25/2015	8/26/2015	9/9/2015	0.164
3C	2015-0831	H42-082515-5	8/25/2015	8/25/2015	8/26/2015	9/9/2015	0.165

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-0768	H42-081815-3	8/18/2015	8/18/2015	8/25/2015	8/25/2015	ND
1C	2015-0767	H42-081815-2	8/18/2015	8/18/2015	8/25/2015	8/25/2015	ND
2B	2015-0770	H42-081815-5	8/18/2015	8/18/2015	8/25/2015	8/25/2015	ND
3A	2015-0829	H42-082515-3	8/25/2015	8/25/2015	8/25/2015	8/25/2015	ND
3B	2015-0828	H42-082515-2	8/25/2015	8/25/2015	8/25/2015	8/25/2015	ND
3C	2015-0831	H42-082515-5	8/25/2015	8/25/2015	8/25/2015	8/25/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H42-081815-3	8/18/2015	631651	4212889	8:20	24.69	0.256	0.12	9.87	7.65	3.8	Ebb
1C	H42-081815-2	8/18/2015	631649	4212827	8:26	24.07	0.254	0.12	8.95	7.67	3.5	Ebb
2B	H42-081815-5	8/18/2015	631677	4213910	9:37	24.72	0.238	0.11	9.95	8.07	3.4	Ebb
3A	H42-082515-3	8/25/2015	631631	4212932	10:31	23.47	0.556	0.28	10.77	7.94	3.4	Low slack
3B	H42-082515-2	8/25/2015	631642	4212843	10:27	22.75	0.557	0.28	9.80	7.96	1.0	Low slack
3C	H42-082515-5	8/25/2015	631689	4213863	10:10	23.17	0.530	0.27	11.91	7.81	1.4	Low slack



Monitoring Results – Site 44, Potato Slough

2,4-D Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	2,4-D (ppb)
1A	2015-0835	H44-082515-3	8/25/2015	8/25/2015	8/26/2015	9/9/2015	0.115
1C	2015-0834	H44-082515-2	8/25/2015	8/25/2015	8/26/2015	9/9/2015	0.119
2B	2015-0837	H44-082515-5	8/25/2015	8/25/2015	8/26/2015	9/9/2015	0.102
3A	2015-0938	H44-090115-3	9/1/2015	9/1/2015	9/3/2015	9/10/2015	ND
3B	2015-0937	H44-090115-2	9/1/2015	9/1/2015	9/3/2015	9/10/2015	ND
3C	2015-0940	H44-090115-5	9/1/2015	9/1/2015	9/3/2015	9/10/2015	ND

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-0835	H44-082515-3	8/25/2015	8/25/2015	8/27/2015	8/31/2015	ND
1C	2015-0834	H44-082515-2	8/25/2015	8/25/2015	8/27/2015	8/31/2015	ND
2B	2015-0837	H44-082515-5	8/25/2015	8/25/2015	8/27/2015	8/31/2015	ND
3A	2015-0938	H44-090115-3	8/25/2015	8/25/2015	8/27/2015	8/31/2015	ND
3B	2015-0937	H44-090115-2	8/25/2015	8/25/2015	8/27/2015	8/31/2015	ND
3C	2015-0940	H44-090115-5	8/25/2015	8/25/2015	8/27/2015	8/31/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H44-082515-3	8/25/2015	628168	4216026	8:32	23.29	0.225	0.10	7.80	7.70	1.9	Ebb
1C	H44-082515-2	8/25/2015	628237	4216077	8:29	23.36	0.222	0.10	7.76	7.31	2.2	Ebb
2B	H44-082515-5	8/25/2015	627533	4216380	9:38	23.35	0.230	0.11	7.80	7.76	2.8	Ebb
3A	H44-090115-3	9/1/2015	628158	4216021	9:00	23.61	0.342	0.17	7.61	8.16	5.0	Ebb
3B	H44-090115-2	9/1/2015	628247	4216104	8:55	23.74	0.286	0.14	8.11	8.01	5.0	Ebb
3C	H44-090115-5	9/1/2015	627536	4216399	9:15	23.51	0.429	0.21	7.51	8.21	4.7	Ebb



Monitoring Results – Site 56, Middle River

Glyphosate Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Glyphosate (ppb)
1A	2015-3758	H56-043015-3	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
1C	2015-2757	H56-043015-2	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
2B	2015-3760	H56-043015-5	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
3A	2015-3864	H56-050715-3	5/7/2015	5/7/2015	5/13/2015	5/13/2015	ND
3B	2015-3863	H56-050715-2	5/7/2015	5/7/2015	5/13/2015	5/13/2015	ND
3C	2015-3866	H56-050715-5	5/7/2015	5/7/2015	5/13/2015	5/13/2015	ND

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-3758	H56-043015-3	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
1C	2015-2757	H56-043015-2	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
2B	2015-3760	H56-043015-5	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
3A	2015-3864	H56-050715-3	5/7/2015	5/7/2015	5/8/2015	5/8/2015	ND
3B	2015-3863	H56-050715-2	5/7/2015	5/7/2015	5/8/2015	5/8/2015	ND
3C	2015-3866	H56-050715-5	5/7/2015	5/7/2015	5/8/2015	5/8/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H56-043015-3	4/30/2015	630252	4198062	9:26	20.40	0.539	0.27	6.05	7.77	7.4	Ebb
1C	H56-043015-2	4/30/2015	630310	4198035	9:22	20.40	0.539	0.27	6.28	7.86	7.1	Ebb
2B	H56-043015-5	4/30/2015	629726	4198207	11:20	20.52	0.538	0.27	6.11	7.54	7.0	Ebb
3A	H56-050715-3	5/7/2015	630251	4198061	9:15	20.78	0.573	0.29	6.42	8.04	6.0	Ebb
3B	H56-050715-2	5/7/2015	630334	4198037	9:12	20.78	0.572	0.29	6.41	8.05	3.1	Ebb
3C	H56-050715-5	5/7/2015	629742	4198203	9:24	20.75	0.572	0.29	6.64	7.94	10.6	Ebb



Monitoring Results – Site 58, Middle River

Glyphosate Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Glyphosate (ppb)
1A	2015-3763	H58-043015-3	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
1C	2015-3762	H58-043015-2	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
2B	2015-2765	H58-043015-5	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
3A	2015-3870	H58-050715-3	5/7/2015	5/7/2015	5/13/2015	5/13/2015	ND
3B	2015-3869	H58-050715-2	5/7/2015	5/7/2015	5/13/2015	5/13/2015	ND
3C	2015-3872	H58-050715-5	5/7/2015	5/7/2015	5/13/2015	5/13/2015	ND

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-3763	H58-043015-3	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
1C	2015-3762	H58-043015-2	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
2B	2015-2765	H58-043015-5	4/30/2015	4/30/2015	5/5/2015	5/5/2015	ND
3A	2015-3870	H58-050715-3	5/7/2015	5/7/2015	5/8/2015	5/8/2015	ND
3B	2015-3869	H58-050715-2	5/7/2015	5/7/2015	5/8/2015	5/8/2015	ND
3C	2015-3872	H58-050715-5	5/7/2015	5/7/2015	5/8/2015	5/8/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H58-043015-3	4/30/2015	628930	4200816	8:38	20.41	0.534	0.27	6.11	7.82	6.2	Ebb
1C	H58-043015-2	4/30/2015	628873	4200746	8:35	20.40	0.534	0.27	5.83	7.76	5.9	Ebb
2B	H58-043015-5	4/30/2015	629581	4201252	10:25	20.58	0.538	0.27	6.06	7.61	5.6	Ebb
3A	H58-050715-3	5/7/2015	628925	4200831	9:57	20.65	0.574	0.29	6.69	7.77	10.9	Ebb
3B	H58-050715-2	5/7/2015	628893	4200713	9:51	20.70	0.574	0.29	6.88	8.01	1.8	Ebb
3C	H58-050715-5	5/7/2015	629621	4201209	10:10	20.34	0.572	0.29	6.57	7.73	7.4	Ebb



Monitoring Results – Site 61, Whiskey Slough

Glyphosate Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Glyphosate (ppb)
1A	2015-2900	H61-031915-3	3/19/2015	3/19/2015	4/10/2015	4/10/2015	ND
1C	2015-2899	H61-031915-2	3/19/2015	3/19/2015	4/10/2015	4/10/2015	ND
2B	2015-2901	H61-031915-5	3/19/2015	3/19/2015	4/10/2015	4/10/2015	ND
3A	2015-2986	H61-032615-3	3/26/2015	3/26/2015	4/10/2015	4/10/2015	ND
3B	2015-2985	H61-032615-2	3/26/2015	3/26/2015	4/10/2015	4/10/2015	ND
3C	2015-2988	H61-032615-5	3/26/2015	3/26/2015	4/10/2015	4/10/2015	ND

Competitor Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Competitor (ppb)
1A	2015-2900	H61-031915-3	3/19/2015	3/19/2015	4/16/2015	4/16/2015	ND
1C	2015-2899	H61-031915-2	3/19/2015	3/19/2015	4/16/2015	4/16/2015	ND
2B	2015-2901	H61-031915-5	3/19/2015	3/19/2015	4/16/2015	4/16/2015	ND
3A	2015-2986	H61-032615-3	3/26/2015	3/26/2015	4/17/2015	4/20/2015	ND
3B	2015-2985	H61-032615-2	3/26/2015	3/26/2015	4/17/2015	4/20/2015	ND
3C	2015-2988	H61-032615-5	3/26/2015	3/26/2015	4/17/2015	4/20/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H61-031915-3	3/19/2015	635270	4202503	9:43	17.71	0.760	0.39	7.72	7.62	6.9	Ebb
1C	H61-031915-2	3/19/2015	635448	4202384	9:30	17.65	0.776	0.40	8.20	7.59	4.1	Ebb
2B	H61-031915-5	3/19/2015	634445	4202795	11:54	18.12	0.718	0.37	7.85	7.62	9.5	Ebb
3A	H61-032615-3	3/26/2015	635360	4202463	10:24	17.97	0.701	0.36	8.04	7.65	7.4	Flood
3B	H61-032615-2	3/26/2015	635404	4202412	10:18	17.93	0.704	0.36	7.84	7.64	12.4	Flood
3C	H61-032615-5	3/26/2015	634447	4202794	10:39	18.05	0.496	0.25	9.03	7.91	4.5	flood



Monitoring Results – Site 68, Middle River

Glyphosate Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Glyphosate (ppb)
1A	2015-2903	H68-031915-3	3/19/2015	3/19/2015	4/10/2015	4/10/2015	ND
1C	2015-2902	H68-031915-2	3/19/2015	3/19/2015	4/10/2015	4/10/2015	ND
2B	2015-2904	H68-031915-5	3/19/2015	3/19/2015	4/10/2015	4/10/2015	ND
3A	2015-2986	H68-032615-3	3/26/2015	3/26/2015	4/10/2015	4/10/2015	ND
3B	2015-2985	H68-032615-2	3/26/2015	3/26/2015	4/10/2015	4/10/2015	ND
3C	2015-2988	H68-032615-5	3/26/2015	3/26/2015	4/10/2015	4/10/2015	ND

Competitor Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Competitor (ppb)
1A	2015-2903	H68-031915-3	3/19/2015	3/19/2015	4/16/2015	4/16/2015	ND
1C	2015-2902	H68-031915-2	3/19/2015	3/19/2015	4/16/2015	4/16/2015	ND
2B	2015-2904	H68-031915-5	3/19/2015	3/19/2015	4/16/2015	4/16/2015	ND
3A	2015-2986	H68-032615-3	3/26/2015	3/26/2015	4/17/2015	4/20/2015	ND
3B	2015-2985	H68-032615-2	3/26/2015	3/26/2015	4/17/2015	4/20/2015	ND
3C	2015-2988	H68-032615-5	3/26/2015	3/26/2015	4/17/2015	4/20/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H68-031915-3	3/19/2015	630685	4207318	10:17	17.09	0.323	0.16	8.88	7.83	12.9	Ebb
1C	H68-031915-2	3/19/2015	630678	4207254	10:13	17.11	0.324	0.16	9.03	7.95	5.7	Ebb
2B	H68-031915-5	3/19/2015	630953	4207987	12:05	17.41	0.326	0.16	9.69	7.54	6.4	Ebb
3A	H68-032615-3	3/26/2015	630685	4207320	9:35	17.63	0.333	0.16	9.88	8.03	5.9	Flood
3B	H68-032615-2	3/26/2015	630684	4207257	9:26	17.60	0.332	0.16	9.95	7.96	5.7	Flood
3C	H68-032615-5	3/26/2015	630951	4207994	9:47	18.08	0.331	0.16	10.13	8.04	5.7	Flood



Monitoring Results – Site 98A, Old River

2,4-D Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	2,4-D (ppb)
1A	2015-0328	H98-072815-3	7/28/2015	7/28/2015	7/29/2015	7/30/2015	0.476
1C	2015-0327	H98-072815-2	7/28/2015	7/28/2015	7/29/2015	7/30/2015	0.421
2B	2015-0330	H98-072815-5	7/28/2015	7/28/2015	7/29/2015	7/30/2015	0.529
3A	2015-0409	H98-080315-3	8/3/2015	8/3/2015	8/4/2015	8/5/2015	0.376
3B	2015-0408	H98-080315-2	8/3/2015	8/3/2015	8/4/2015	8/5/2015	0.394
3C	2015-0411	H98-080315-5	8/3/2015	8/3/2015	8/4/2015	8/5/2015	0.384

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-0328	H98-072815-3	7/28/2015	7/28/2015	7/29/2015	7/29/2015	ND
1C	2015-0327	H98-072815-2	7/28/2015	7/28/2015	7/29/2015	7/29/2015	ND
2B	2015-0330	H98-072815-5	7/28/2015	7/28/2015	7/29/2015	7/29/2015	ND
3A	2015-0409	H98-080315-3	8/3/2015	8/3/2015	8/5/2015	8/5/2015	ND
3B	2015-0408	H98-080315-2	8/3/2015	8/3/2015	8/5/2015	8/5/2015	ND
3C	2015-0411	H98-080315-5	8/3/2015	8/3/2015	8/5/2015	8/5/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H98-072815-3	7/28/2015	624693	4204137	10:25	25.03	0.719	0.37	6.78	7.67	4.5	Low slack
1C	H98-072815-2	7/28/2015	624758	4204211	10:20	25.25	0.723	0.37	6.90	7.74	4.5	Low slack
2B	H98-072815-5	7/28/2015	625242	4203768	11:28	25.33	0.723	0.37	7.43	7.79	5.5	Low slack
3A	H98-080315-3	8/3/2015	624785	4204222	12:13	24.87	0.714	0.37	6.42	7.88	6.6	Ebb
3B	H98-080315-2	8/3/2015	624671	4204209	12:09	24.96	0.715	0.37	6.37	7.63	6.6	Ebb
3C	H98-080315-5	8/3/2015	625245	4203778	12:26	25.07	0.715	0.37	6.25	7.70	1.7	Ebb



Monitoring Results – Site 101A, Old River

2,4-D Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	2,4-D(ppb)
1A	2015-0334	H101-072815-3	7/28/2015	7/28/2015	7/29/2015	7/30/2015	0.237
1C	2015-0333	H101-072815-2	7/28/2015	7/28/2015	7/29/2015	7/30/2015	0.250
2B	2015-0336	H101-072815-5	7/28/2015	7/28/2015	7/29/2015	7/30/2015	0.222
3A	2015-0415	H101-080315-3	8/3/2015	8/3/2015	8/4/2015	8/5/2015	0.274
3B	2015-0414	H101-080315-2	8/3/2015	8/3/2015	8/4/2015	8/5/2015	0.257
3C	2015-0417	H101-080315-5	8/3/2015	8/3/2015	8/4/2015	8/5/2015	0.229

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-0334	H101-072815-3	7/28/2015	7/28/2015	7/29/2015	7/29/2015	ND
1C	2015-0333	H101-072815-2	7/28/2015	7/28/2015	7/29/2015	7/29/2015	ND
2B	2015-0336	H101-072815-5	7/28/2015	7/28/2015	7/29/2015	7/29/2015	ND
3A	2015-0415	H101-080315-3	8/3/2015	8/3/2015	8/5/2015	8/5/2015	ND
3B	2015-0414	H101-080315-2	8/3/2015	8/3/2015	8/5/2015	8/5/2015	ND
3C	2015-0417	H101-080315-5	8/3/2015	8/3/2015	8/5/2015	8/5/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H101-072815-3	7/28/2015	624816	4207898	8:45	25.65	0.667	0.34	5.12	7.64	2.8	Ebb
1C	H101-072815-2	7/28/2015	624737	4207727	8:35	24.80	0.674	0.35	6.45	7.58	4.0	Ebb
2B	H101-072815-5	7/28/2015	625476	4208598	9:50	24.64	0.644	0.33	7.28	7.65	10.5	Ebb
3A	H101-080315-3	8/3/2015	624819	4207912	12:51	24.49	0.680	0.35	6.81	7.77	3.6	Ebb
3B	H101-080315-2	8/3/2015	624763	4207738	12:45	24.58	0.681	0.35	6.96	7.81	3.7	Ebb
3C	H101-080315-5	8/3/2015	625496	4208589	1:05	25.11	0.647	0.33	8.62	7.98	3.4	Ebb



Monitoring Results – Site 102, Old River

Glyphosate Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Glyphosate (ppb)
1A	2015-1169	H102-092215-3	9/22/2015	9/22/2015	9/28/2015	9/28/2015	ND
1C	2015-1168	H102-092215-2	9/22/2015	9/22/2015	9/28/2015	9/28/2015	ND
2B	2015-1171	H102-092215-5	9/22/2015	9/22/2015	9/28/2015	9/28/2015	ND
3A	2015-1243	H102-092915-3	9/29/2015	9/29/2015	9/30/2015	9/30/2015	ND
3B	2015-1242	H102-092915-2	9/29/2015	9/29/2015	9/30/2015	9/30/2015	ND
3C	2015-1245	H102-092915-5	9/29/2015	9/29/2015	9/30/2015	9/30/2015	ND

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-1169	H102-092215-3	9/22/2015	9/22/2015	9/23/2015	9/23/2015	ND
1C	2015-1168	H102-092215-2	9/22/2015	9/22/2015	9/23/2015	9/23/2015	ND
2B	2015-1171	H102-092215-5	9/22/2015	9/22/2015	9/23/2015	9/23/2015	ND
3A	2015-1243	H102-092915-3	9/29/2015	9/29/2015	10/1/2015	10/1/2015	ND
3B	2015-1242	H102-092915-2	9/29/2015	9/29/2015	10/1/2015	10/1/2015	ND
3C	2015-1245	H102-092915-5	9/29/2015	9/29/2015	10/1/2015	10/1/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H102-092215-3	9/22/2015	624500	4209149	9:18	22.61	0.665	0.34	6.95	8.00	5.8	Flood
1C	H102-092215-2	9/22/2015	624493	4209226	9:13	22.69	0.647	0.33	6.29	7.62	5.8	Flood
2B	H102-092215-5	9/22/2015	624621	4208050	10:28	22.64	0.652	0.33	7.27	9.24	6.2	Flood
3A	H102-092915-3	9/29/2015	624500	4209148	9:18	21.55	0.648	0.33	7.57	8.56	1.6	Ebb
3B	H102-092915-2	9/29/2015	624493	4209241	9:15	21.54	0.644	0.33	7.69	8.39	5.7	Ebb
3C	H102-092915-5	9/29/2015	624621	4208054	9:32	21.77	0.703	0.36	7.26	8.52	0.8	Ebb



Monitoring Results – Site 104B, Old River

Glyphosate Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Glyphosate (ppb)
1A	2015-1175	H104-092215-3	9/22/2015	9/22/2015	9/28/2015	9/28/2015	ND
1C	2015-1174	H104-092215-2	9/22/2015	9/22/2015	9/28/2015	9/28/2015	ND
2B	2015-1177	H104-092215-5	9/22/2015	9/22/2015	9/28/2015	9/28/2015	ND
3A	2015-1249	H104-092915-3	9/29/2015	9/29/2015	9/30/2015	9/30/2015	ND
3B	2015-1248	H104-092915-2	9/29/2015	9/29/2015	9/30/2015	9/30/2015	ND
3C	2015-1251	H104-092915-5	9/29/2015	9/29/2015	9/30/2015	9/30/2015	ND

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-1175	H104-092215-3	9/22/2015	9/22/2015	9/23/2015	9/23/2015	ND
1C	2015-1174	H104-092215-2	9/22/2015	9/22/2015	9/23/2015	9/23/2015	ND
2B	2015-1177	H104-092215-5	9/22/2015	9/22/2015	9/23/2015	9/23/2015	ND
3A	2015-1249	H104-092915-3	9/29/2015	9/29/2015	10/1/2015	10/1/2015	ND
3B	2015-1248	H104-092915-2	9/29/2015	9/29/2015	10/1/2015	10/1/2015	ND
3C	2015-1251	H104-092915-5	9/29/2015	9/29/2015	10/1/2015	10/1/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H104-092215-3	9/22/2015	624869	4214543	11:00	22.47	0.552	0.28	7.64	8.30	18.3	Flood
1C	H104-092215-2	9/22/2015	624881	4214570	10:58	22.47	0.554	0.28	7.86	9.62	7.3	Flood
2B	H104-092215-5	9/22/2015	624707	4213891	12:00	22.59	0.587	0.30	8.56	9.64	15.6	Flood
3A	H104-092915-3	9/29/2015	624872	4214546	10:18	21.46	0.663	0.34	7.28	8.32	2.5	Ebb
3B	H104-092915-2	9/29/2015	624937	4214616	10:13	21.50	0.682	0.35	7.46	8.50	8.2	Ebb
3C	H104-092915-5	9/29/2015	624777	4213914	10:31	21.60	0.620	0.32	7.63	8.40	7.9	Ebb



Monitoring Results – Site 311, San Joaquin River

Imazamox Residue

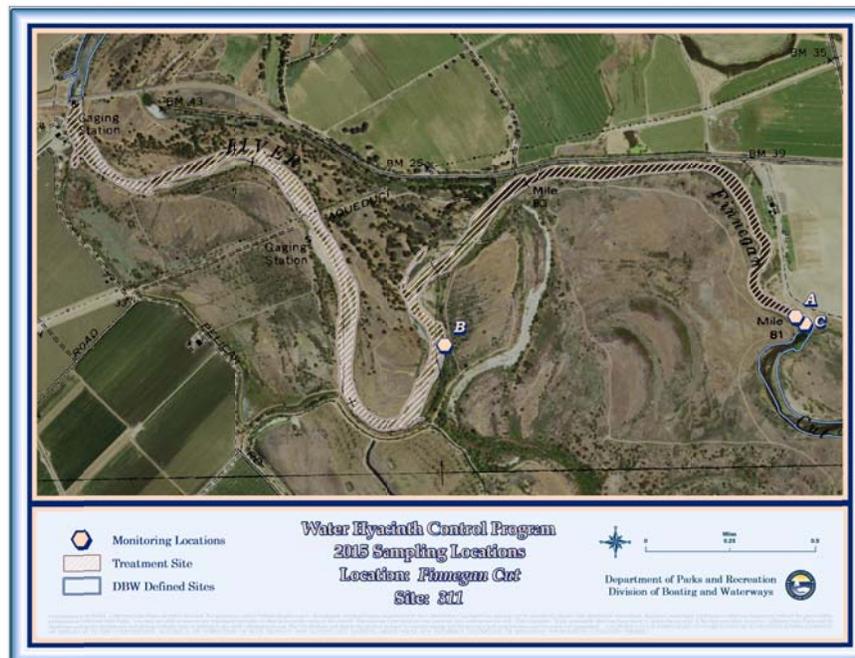
Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Imazamox (ppb)
1A	2015-3434	H311-041615-3	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND
1C	2015-3433	H311-041615-2	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND
2B	2015-3436	H311-041615-5	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND
3A	2015-3607	H311-042315-3	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND
3B	2015-3606	H311-042315-2	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND
3C	2015-3609	H311-042315-5	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)
1A	2015-3434	H311-041615-3	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND
1C	2015-3433	H311-041615-2	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND
2B	2015-3436	H311-041615-5	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND
3A	2015-3607	H311-042315-3	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND
3B	2015-3606	H311-042315-2	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND
3C	2015-3609	H311-042315-5	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H311-041615-3	4/16/2015	659687	4166451	10:05	15.45	0.230	0.11	8.25	7.55	13.1	none
1C	H311-041615-2	4/16/2015	659729	4166418	9:48	15.54	0.231	0.11	8.91	7.57	9.8	none
2B	H311-041615-5	4/16/2015	658022	4166319	11:25	16.62	0.237	0.11	8.38	7.25	17.7	none
3A	H311-042315-3	4/23/2015	659678	4166455	9:37	19.44	0.430	0.22	6.91	7.73	12.8	none
3B	H311-042315-2	4/23/2015	659738	4166400	9:28	19.46	0.426	0.21	7.60	7.75	17.7	none
3C	H311-042315-5	4/23/2015	658029	4166306	10:05	21.30	0.441	0.22	7.24	7.66	16.2	none



Monitoring Results – Site 312, San Joaquin River

Imazamox Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Imazamox (ppb)
1A	2015-3440	H312-041615-3	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND
1C	2015-3439	H312-041615-2	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND
2B	2015-3442	H312-041615-5	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND
3A	2015-3612	H312-042315-3	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND
3B	2015-3611	H312-042315-2	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND
3C	2015-3614	H312-042315-5	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND

Agridex Residue

Sample Location	Lab Sample ID	DBW ID	Date Sample Taken	Date Sample Received	Date Sample Extracted	Date Sample Analyzed	Agridex (ppb)							
1A	2015-3440	H312-041615-3	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND							
1C	2015-3439	H312-041615-2	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND							
2B	2015-3442	H312-041615-5	4/16/2015	4/17/2015	4/23/2015	4/23/2015	ND							
3A	2015-3612	H312-042315-3	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND							
3B	2015-3611	H312-042315-2	4/23/2015	4/23/2015	4/24/2015	4/24/2015 </tr <tr> <td>3C</td> <td>2015-3614</td> <td>H312-042315-5</td> <td>4/23/2015</td> <td>4/23/2015</td> <td>4/24/2015</td> <td>4/24/2015</td> <td>ND</td> </tr>	3C	2015-3614	H312-042315-5	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND
3C	2015-3614	H312-042315-5	4/23/2015	4/23/2015	4/24/2015	4/24/2015	ND							

Water Quality Data

Sample Location	Sample ID	Date	UTM Easting	UTM Northing	Time	Water Temp (°C)	Conductivity (mS/cm)	Salinity (ppt)	DO (mg/L)	pH	Turbidity (NTU)	Tide Cycle
1A	H312-041615-3	4/16/2015	661359	4163997	10:43	17.01	0.139	0.06	8.09	7.44	19.6	none
1C	H312-041615-2	4/16/2015	661324	4163870	10:25	16.80	0.134	0.06	8.14	7.46	4.6	none
2B	H312-041615-5	4/16/2015	661032	4164507	12:26	18.74	0.174	0.08	8.12	7.27	24.2	none
3A	H312-042315-3	4/23/2015	661351	4163995	11:02	21.60	0.246	0.12	7.83	7.65	41.6	none
3B	H312-042315-2	4/23/2015	661349	4163931	10:51	21.40	0.238	0.11	7.70	7.73	63.9	none
3C	H312-042315-5	4/23/2015	661033	4164507	11:17	21.93	0.273	0.13	7.98	7.70	20.8	none



APPENDIX E

2015 Dissolved Oxygen Monitoring Study

2015 Dissolved Oxygen Monitoring Study for the Water Hyacinth Control Program

Introduction

Chemical treatment of aquatic weeds with certain herbicides can result in a faster than natural decaying of plant biomass that may create a large biological oxygen demand, resulting in decreases in dissolved oxygen. The California State Parks, Division of Boating and Waterways (DBW) recognizes that decaying water hyacinth has the potential to temporarily reduce dissolved oxygen (DO) levels. The low DO following herbicide treatment may be amplified by the fact that large patches of water hyacinth on its own can cause low DO levels (Toft 2000), particularly in slower-moving waters and dead-end sloughs. Toft found average spot DO measurements below 5 mg/l for water hyacinth and above 5 mg/l for pennywort (Toft 2000). In a similar study of DO in aquatic weeds in Texas, water hyacinth was found to have the lowest DO levels as compared to milfoil, hydrilla, pondweed, and a mix of native species, and was the only plant to have DO levels below 5 mg/l (Madsen 1997 in Toft). For every herbicide application conducted under DBW's Water Hyacinth Control Program (WHCP), DBW crews measure DO concentrations immediately prior to treating, and approximately one hour post-treatment to evaluate impacts. DBW has several years of pre- and post-treatment DO data for the WHCP; however there is limited availability of data sets with continuous DO measurements in water hyacinth impacted waterways.

In the 2013-2017 USFWS Biological Opinion (81410-2013-F-0005), a DO monitoring study was included as a part of the WHCP conservation measures. In 2013, a one month pilot DO monitoring study was conducted by DBW in Middle River at Union Point Marina in order to evaluate the study design, equipment operation and project feasibility. To assess impacts of water hyacinth and water hyacinth treatments on DO, DBW conducted a full-scale DO monitoring study in the Sacramento-San Joaquin Delta (Delta) during the 2014 WHCP treatment season. DO and water temperature were measured before and after herbicide applications, in locations with water hyacinth and in adjacent open water. Greater fluctuations and ranges of DO were observed underneath water hyacinth, compared to open water. However, the data collected during the 2014 study resulted in inconclusive information regarding herbicide treatment impacts on DO levels. In 2015, DBW attempted a second full-scale DO monitoring study in the Delta. DO and temperature measurements were collected from Delta locations including Middle River at Union Point, Whiskey Slough, Trapper Slough, and Seven Mile Slough.

Materials and Methods

The 2015 study included two locations in the Delta that were infested with water hyacinth and/or spongeplant with different characteristics: 1) in a dead-end slough with slow moving water and 2) in a main channel with stronger tidal influence. Both of these locations received herbicide treatments during the study to evaluate impacts of the treatment and plant decomposition on DO levels. A third location, with a water hyacinth infestation was selected as a control site and was not treated with herbicide. In order to eliminate any seasonal temperature effects on DO, the study was conducted during the summer when water and air temperatures remained relatively stable.

MiniDOT loggers from Precision Measurement Engineering, Inc. (PME) were used to collect temperature and DO measurements. The data loggers were fitted with two AA Lithium batteries

and set to measure and record DO in milligrams per liter, DO saturation (%), temperature in Celsius, date, and time data at 30 minutes intervals. Data were automatically stored on an internal SD card.

On June 10, 2015, a total of six miniDOT DO and temperature loggers were deployed in Seven Mile Slough (Site 20), Trapper Slough (Site 63), Whiskey Slough (Site 62), and Middle River at Union Point (Site 52) (Figures 1 - 4). Two data loggers were deployed within the Union Point Marina on Middle River, which represented a more tidally influenced location, with one underneath water hyacinth and one in open water (herein referred to as UP-WH and UP-O; WH = water hyacinth and O= open water). Within Seven Mile Slough, two data loggers were deployed underneath water hyacinth and spongeplant (SM-WH) and another in the adjacent open waters (SM-O). Seven Mile Slough represented a dead-end slough location. Unfortunately, during a follow up visit on June 23, 2015, the SM-O data logger was missing from the study site and could not be found. It was suspected that the data logger was stolen. As a result, on June 20, 2015 another data logger was deployed at a more secure location at the adjacent Owl Harbor Marina in open water (OH-O). A third pair of data loggers was deployed in adjacent Trapper Slough and Whiskey Slough (TS-WH and WS-O), which are connected by a gate and culverts near Lower Jones Road. These two sites were designated as a control (no herbicide treatment) location.

Data loggers were hung from floating docks, or anchored to rip rap and/or nearby pilings using nylon rope and were positioned about 2 feet below the water surface. For the three pair locations, one data logger was placed in open water with no water hyacinth present and the other data logger placed underneath a water hyacinth mat and/or spongeplant. GPS coordinates (in Universal Transverse Mercator (UTM)) of the data logger locations were recorded using a PC tablet with ArcPad. The study site and data logger locations were photographed on a weekly basis during the study.

Data loggers were deployed one week prior to the application of herbicide onto the water hyacinth. On June 17, 2015, DBW field staff applied glyphosate with the adjuvant Agridex onto the water hyacinth and/or spongeplant at the study sites within Seven Mile Slough and Union Point Marina. Water hyacinth in Trapper Slough was left untreated for the duration of the study. The data loggers were left to record data in the study sites for approximately four weeks after the herbicide treatments. The study sites were visited once a week during the study period to download data, check data loggers for fouling, conduct equipment maintenance as necessary, observe site and environmental conditions (i.e. ensure loggers remain under water hyacinth), and monitor herbicide impacts on water hyacinth and/or spongeplant. Weekly maintenance included removing debris, cleaning biofoul and checking equipment security. To download data, the miniDOT loggers were turned off for a brief period of time in order to change the SD cards. After a new SD card was installed, the data loggers were turned on for continued data collection. Data loggers were removed from the study locations on July 14, 2015.

Data were downloaded to a PC computer via a USB card reader and were viewed using the miniDOTPlot software provided by PME. Since the miniDOT Logger is set to record time in Coordinated Universal Time (UTC), the time zone was offset by -7 hours. The miniDOTPlot software calculated oxygen saturation and was set to adjust the data based on air pressure of 1014.2 mbar and a salinity of 0.34 – 0.45 ppt. The mean, standard deviation and range was calculated for water temperature, DO and percent saturation for each location. DO and temperature data were compared between pair-locations (water hyacinth vs. open water) using a one-way analysis of variance (ANOVA).

Results

The time-series data (June 10, 2015 to July 14, 2015) for DO and water temperature are depicted in Figures 5 - 10. Data that was captured by the SM-O data logger before it went missing was of poor quality. Therefore, water quality in Owl Harbor (OH-O) was used for analysis and comparison. Diel changes in DO were observed, generally with lower DO levels mostly occurring at night or early morning and the highest concentrations occurring in the afternoon. Diel changes in water temperature were also observed. Mean water temperature (\pm standard deviation) was $25.55 \pm 0.81^\circ\text{C}$ at UP-WH, $25.05 \pm 0.78^\circ\text{C}$ at UP-O (Figure 11a), $23.75 \pm 0.64^\circ\text{C}$ at SM-WH, and $23.16 \pm 0.99^\circ\text{C}$ at SM-O (Figure 11b), and $25.26 \pm 1.64^\circ\text{C}$ at TS-WH, $26.68 \pm 1.02^\circ\text{C}$ at WH-O (Figure 11c).

There were significant differences in DO concentrations between the water hyacinth location and open water for each study site ($p < 0.05$). The mean DO levels were lower underneath water hyacinth compared to open water in each study site. For Union Point on Middle River, mean DO was 5.67 ± 0.79 mg/L (mean \pm standard deviation; $n=1,345$) at UP-WH and 6.39 ± 0.46 mg/L ($n=1,632$) at UP-O (Figure 12a). In Seven Mile Slough, mean DO was 1.32 ± 1.12 mg/L ($n=1,629$) at SM-WH and 6.82 ± 1.15 mg/L ($n=665$) at OH-O (Figure 12b). Lastly, in Trapper and Whiskey Sloughs the mean DO was 3.76 ± 2.90 mg/L at TS-WH ($n=1,621$) and 7.81 ± 1.99 mg/L ($n=1,634$) at WS-O (Figure 12c). For the Union Point site, the range of DO concentrations was relatively similar between the water hyacinth and open water locations. For Seven Mile Slough and Trapper/Whiskey Slough, the range of DO levels was lower underneath water hyacinth compared to open water (Table 1).

Similar trends were observed with DO percent saturation between water hyacinth locations and open water sites (Figure 13). There was a significant difference in DO saturation between the water hyacinth location and open water ($p < 0.05$), where the mean and the range for DO saturation were lower when water hyacinth was present. Underneath water hyacinth, the mean DO saturation was $69.36 \pm 9.93\%$ at UP-WH, $15.63 \pm 13.29\%$ at SM-WH, and $45.86 \pm 35.10\%$ at TS-WH. In open water locations, mean DO saturation was $78.20\% \pm 5.97\%$ at UP-O, $79.88\% \pm 14.20\%$ at OH-O, and $97.87\% \pm 26.18\%$ at WS-O.

For each location, there were several occasions where DO levels fell below 5 mg/L which is considered to be a critical level for fish and other aquatic life. Under water hyacinth in Trapper Slough, Seven Mile Slough and Union Point, there were a total of 2,929 records where DO levels were below 5 mg/L (Table 2); 2,231 of those records had DO levels ≤ 3 mg/L. For all sites in open water, there were 138 records with DO levels < 5 mg/L; zero of those records had DO levels ≤ 3 mg/L.

Herbicide symptoms were observed in treated water hyacinth during a follow up visit on June 23, 2015, six days after the initial treatment. These symptoms included wilted leaves and chlorosis, where some plants had turned light yellow. During a follow up visit on June 30, 2015, 13 days after treatment, water hyacinth and spongeplant plants were still floating but were mostly brown with some yellow plants.

Discussion

Lower ranges of DO were observed underneath water hyacinth mats (UP-WH, SM-WH, and TS-WH), compared to open water (UP-O, OH-O, and WS-O). Underneath water hyacinth mats, DO

levels fluctuated throughout the day. In general, DO levels increased during the day and peaked in the afternoon, and decreased at night. This suggests that oxygen was produced via photosynthesis during daylight hours by floating vegetation, submersed vegetation, and/or phytoplankton and biological respiration caused a reduction in DO concentrations at night.

There were several instances where DO concentrations were below 5 mg/L both under water hyacinth and in open water. There were also a number of occurrences where DO concentrations were below 3 mg/L. Most of these events of low DO concentrations were temporary, followed by an increase in DO levels. However, in Seven Mile Slough, low DO concentrations below 3 mg/L were sustained for significant amounts of time, from days to weeks. The high water surface coverage of water hyacinth and spongeplant at the east end of Seven Mile Slough prevented gas exchange between the surface water and air causing reduced levels of DO. In addition, Seven Mile Slough, at the dead-end where the study was conducted, has slow moving waters with high residence times and reduced influence of tidal waters. Long periods of sustained DO readings at 0 mg/L in Seven Mile Slough could be explained by the possibility that the data logger bottomed out during low tide and was buried in sediment. The Sacramento and San Joaquin basin plan limits established by the Central Valley Regional Water Quality Control Board has water quality standards for DO in order to protect beneficial uses of water. The basin plan limits for DO depend on location and time of year, and range from 5 mg/L to 8 mg/L. Per the Basin Plan, in the Delta study locations (Seven Mile Slough, Trapper Slough, Whiskey Slough, and Middle River at Union Point) the DO concentration shall not be reduced below 5.0 mg/L. Generally, low DO concentrations may be detrimental to fish species and other aquatic life. Fish begin to experience oxygen stress or exhibit avoidance at levels below 5 mg/L. Salmonids have been reported to actively avoid areas with low DO concentrations (Davis 1975 in Carter 2005).

There were varying impacts from the herbicide treatments on DO levels in Middle River at Union Point versus Seven Mile Slough. At Union Point, there was only a slight decreasing trend in DO concentrations after the herbicide treatment, when herbicide symptoms became visible. Whereas, in Seven Mile Slough there was a noticeable decrease in DO, where concentrations remained below 3 mg/L after herbicide symptoms became visible six days after the treatment.

Absence of significant treatment effects on DO concentrations at Union Point may have been influenced by the slow acting nature of the herbicide glyphosate as compared to a faster acting herbicide, such as 2,4-D; wind; diurnal tides; and higher water flows in Middle River. Flowing water, such as the tidal water in the Delta, dissolves more oxygen than still water. Occurrences of sustained levels of decreased DO resulting treated and decaying water hyacinth are more likely to be observed in a slow-moving, dead end slough, as was observed in Seven Mile Slough. Several acres of mostly water hyacinth and some spongeplant covering the water surface in Seven Mile Slough prevented effective gas exchange between air and water surface. In addition, there is minimal water flow and likely a high resident time of water in Seven Mile Slough, which resulted in minimal mixing and renewal of oxygen rich waters.

Data collected from this study support the findings of other studies where DO levels underneath water hyacinth were lower. Average DO measurements were below 5 mg/L in water hyacinth and above 5 mg/L in pennywort (*Hydrocotyle ranunculoides*). A study conducted by the University of California Davis found DO levels as low as 0 mg/L below a solid water hyacinth mat (Toft 2000). Additionally, DO levels under the roots of water hyacinth mats in the Parana River floodplain in Argentina were a maximum 2.3 mg/L within the first meter, and typically only 1 mg/L, with even lower DO levels deeper in the river (Petr 2000). DO measured in the Sudd River in Sudan were 1.8 mg/L at 30 cm below the water hyacinth mat (Petr 2000).

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Petr, T. 2000. Interactions between fish and aquatic macrophytes in inland waters. Food and Agriculture Organization of the United Nations (FAO), Fisheries and Aquaculture Department. Rome. FAO Fisheries Technical paper 396.

Toft, J.D. 2000. Community effects of the non-indigenous aquatic plant water hyacinth (*Eichhornia crassipes*) in the Sacramento/San Joaquin Delta, California. University of Washington.

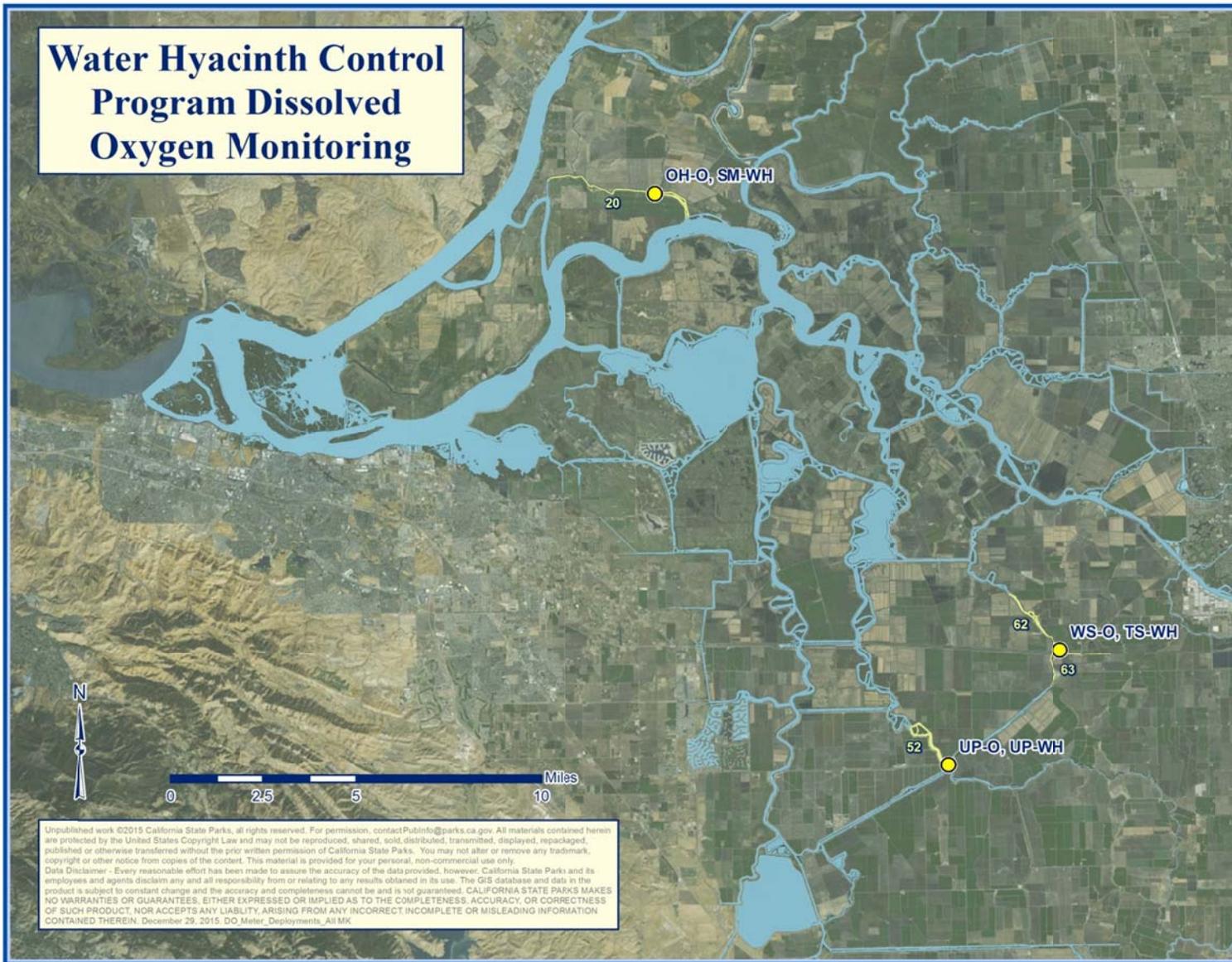


Figure 1. 2015 Dissolved oxygen monitoring study sites in the Delta



Figure 2. Data logger locations in Middle River at Union Point

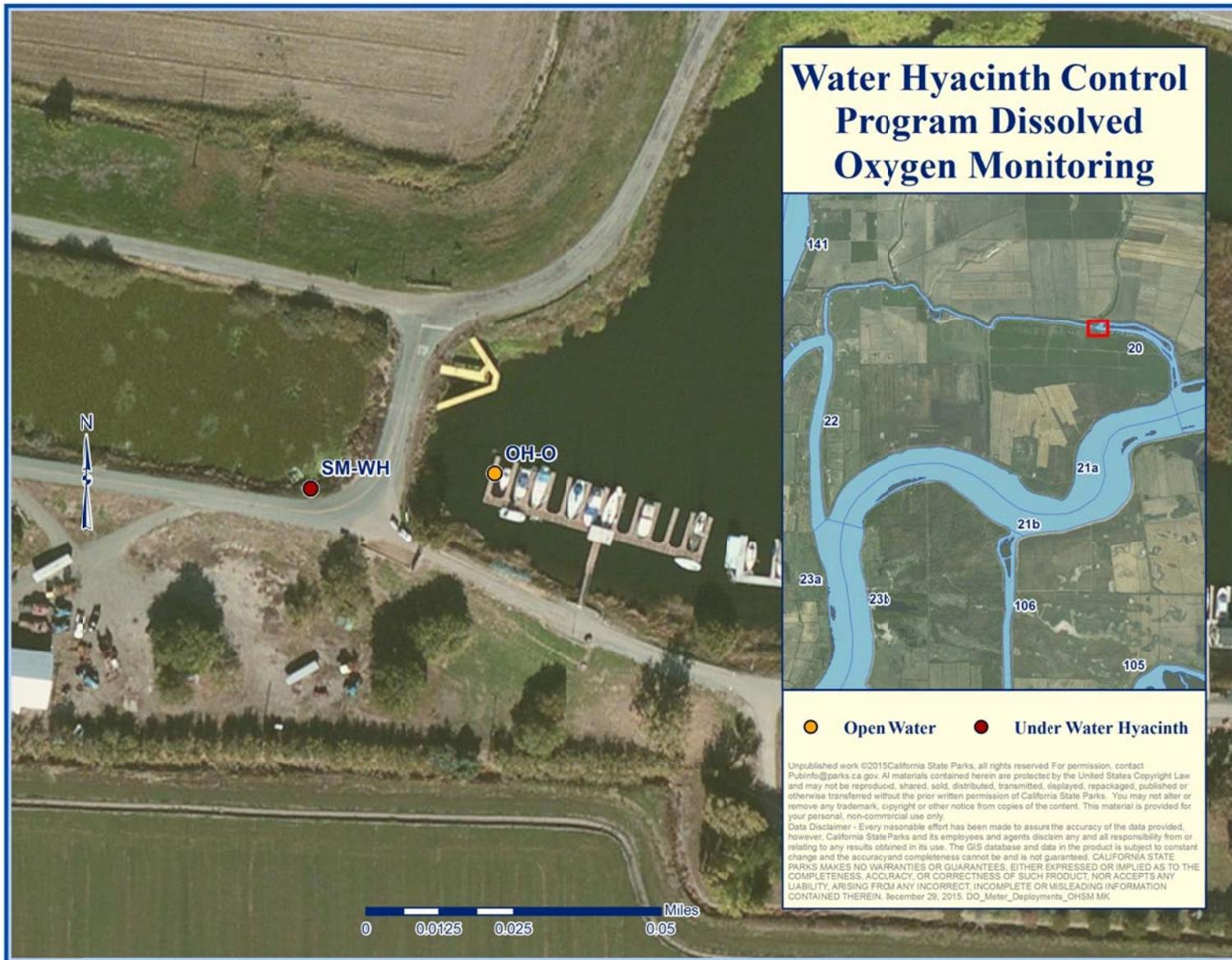


Figure 3. Data logger locations in Seven Mile Slough and Owl Harbor

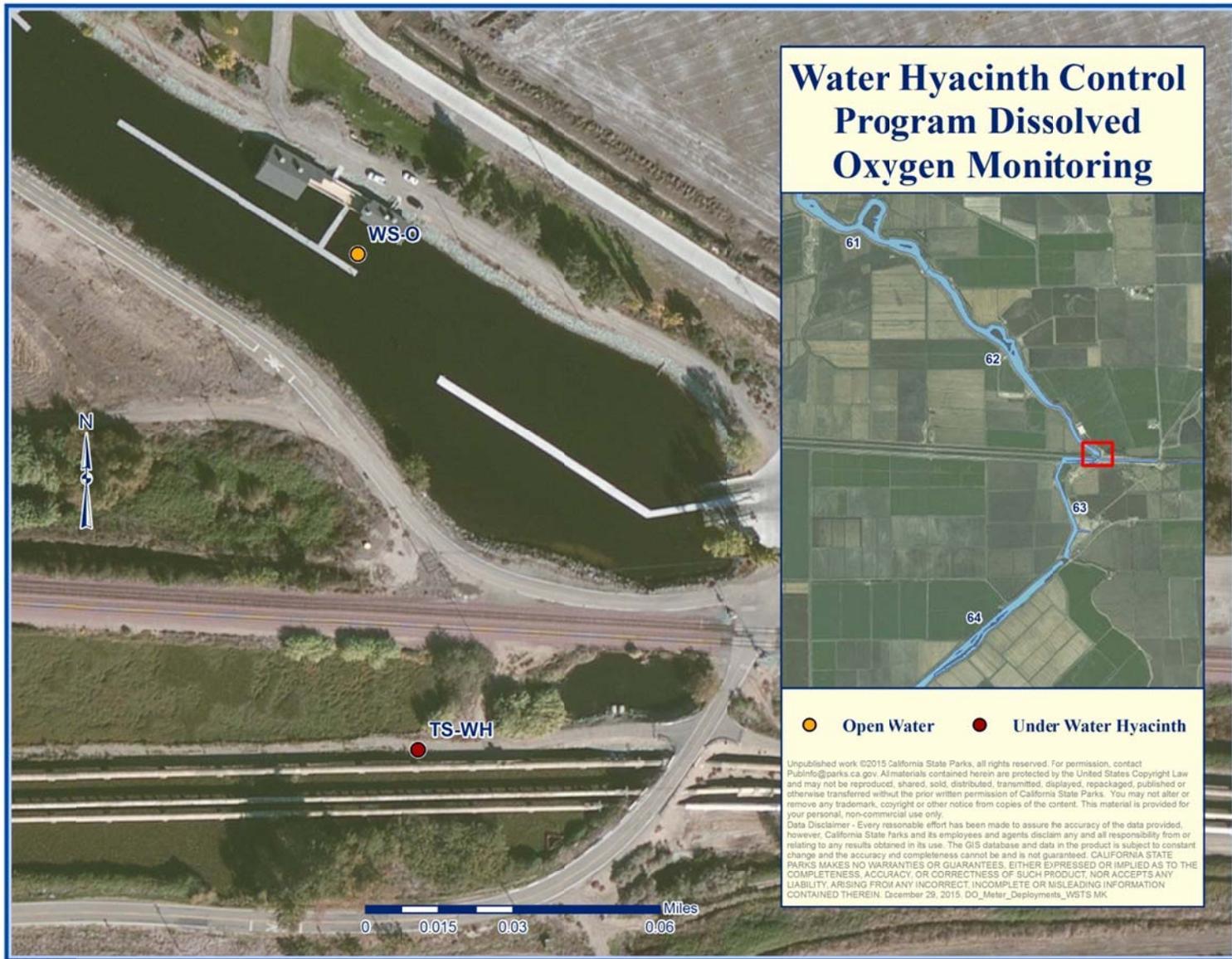


Figure 4. Data logger locations in Trapper Slough and Whiskey Slough

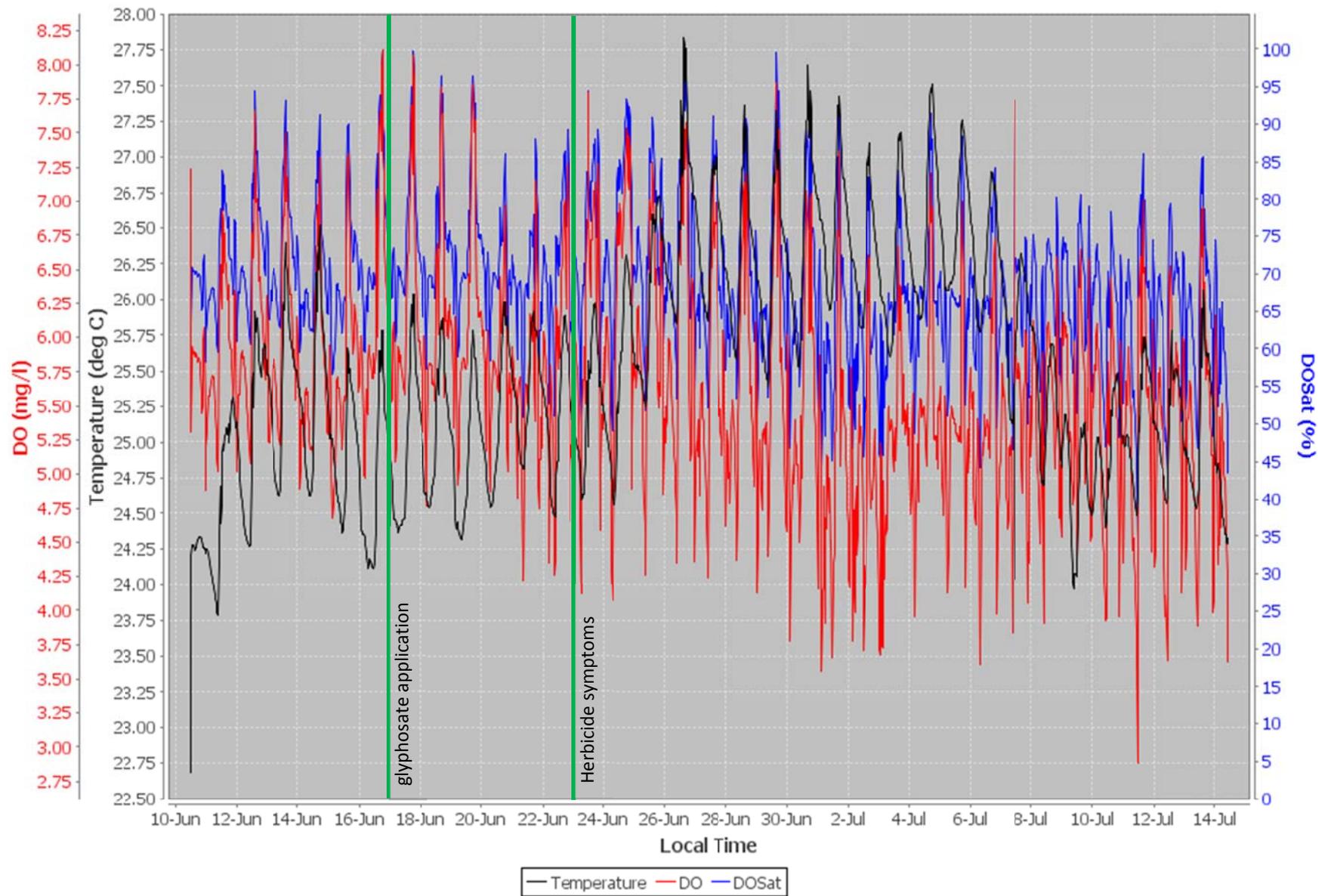


Figure 5. Dissolved Oxygen and Water Temperature at Union Point, under water hyacinth (treated with herbicide)

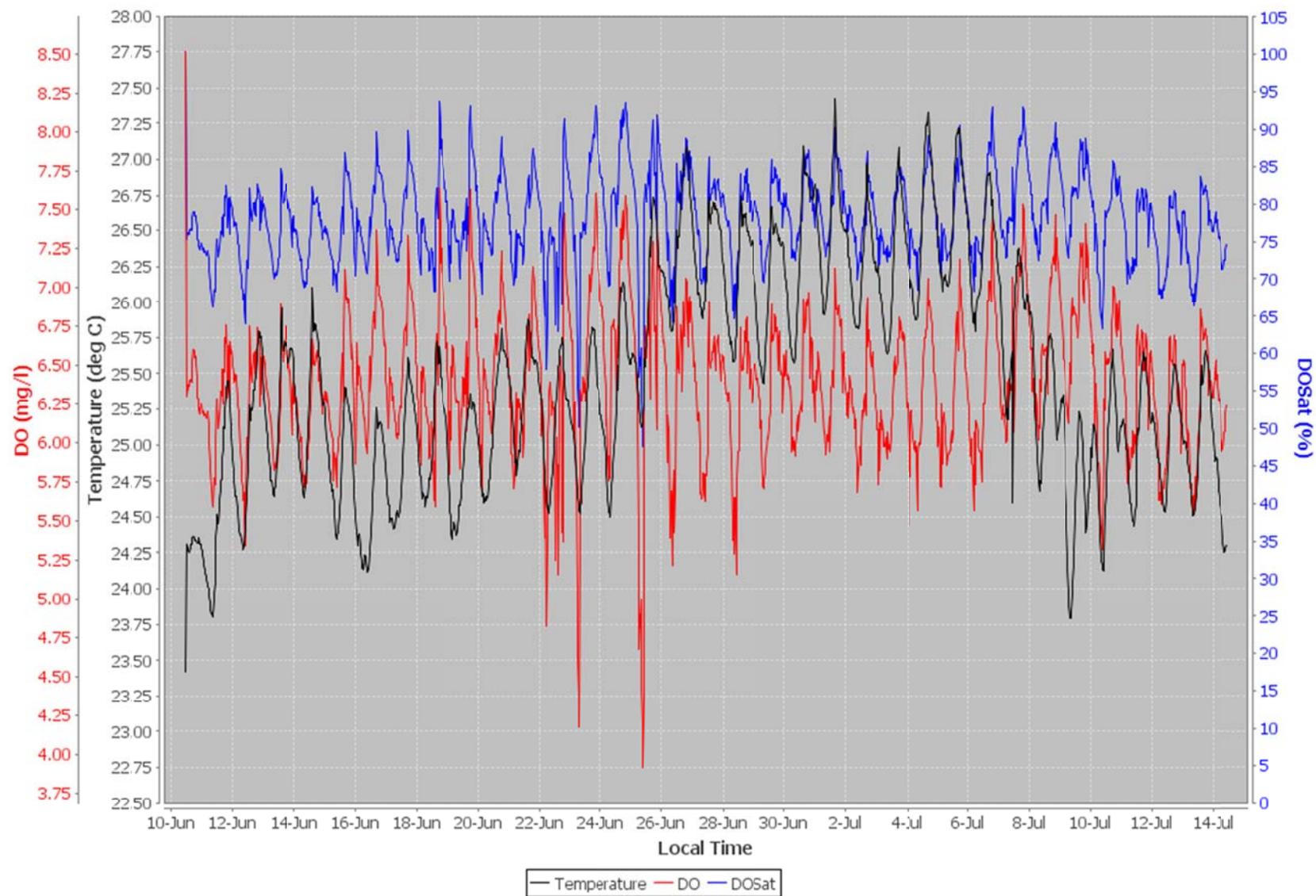


Figure 6. Dissolved Oxygen and Water Temperature at Union Point in open water

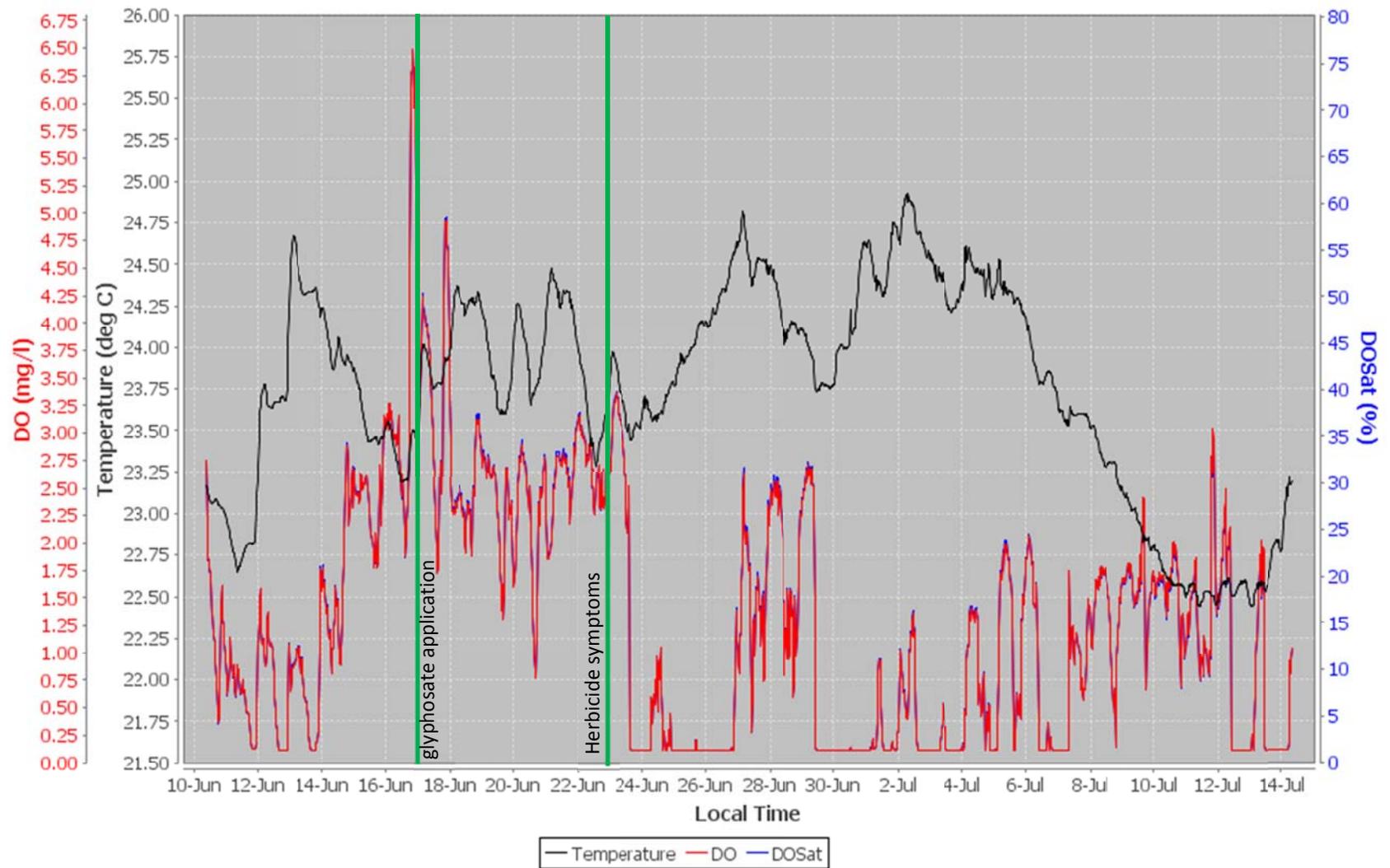


Figure 7. Dissolved Oxygen and Water Temperature in Seven Mile Slough, under water hyacinth and spongeplant (treated with herbicide)

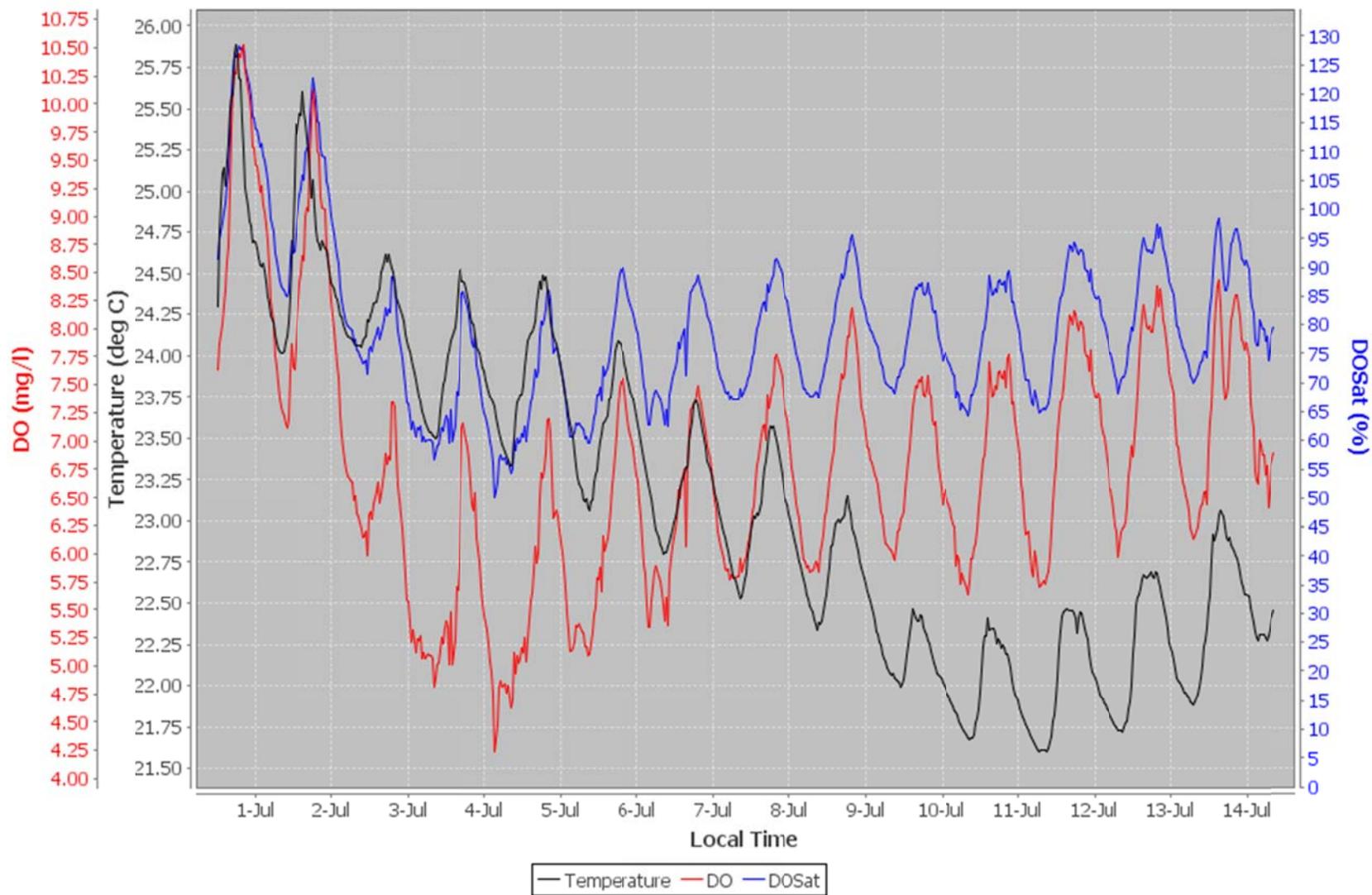


Figure 8. Dissolved Oxygen and Water Temperature in Owl Harbor in open water

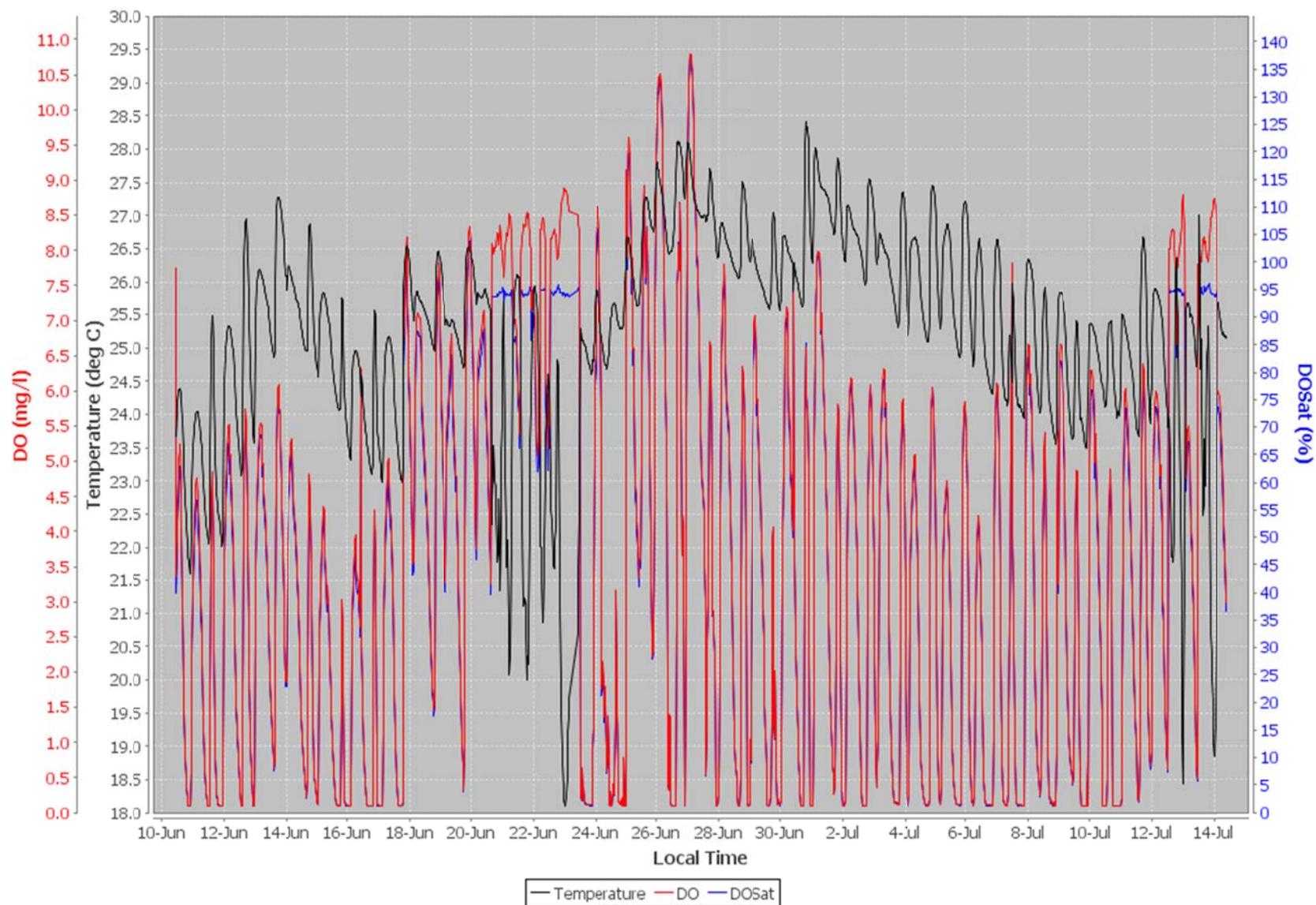


Figure 9. Dissolved Oxygen and Water Temperature in Trapper Slough, under water hyacinth (untreated, control site)

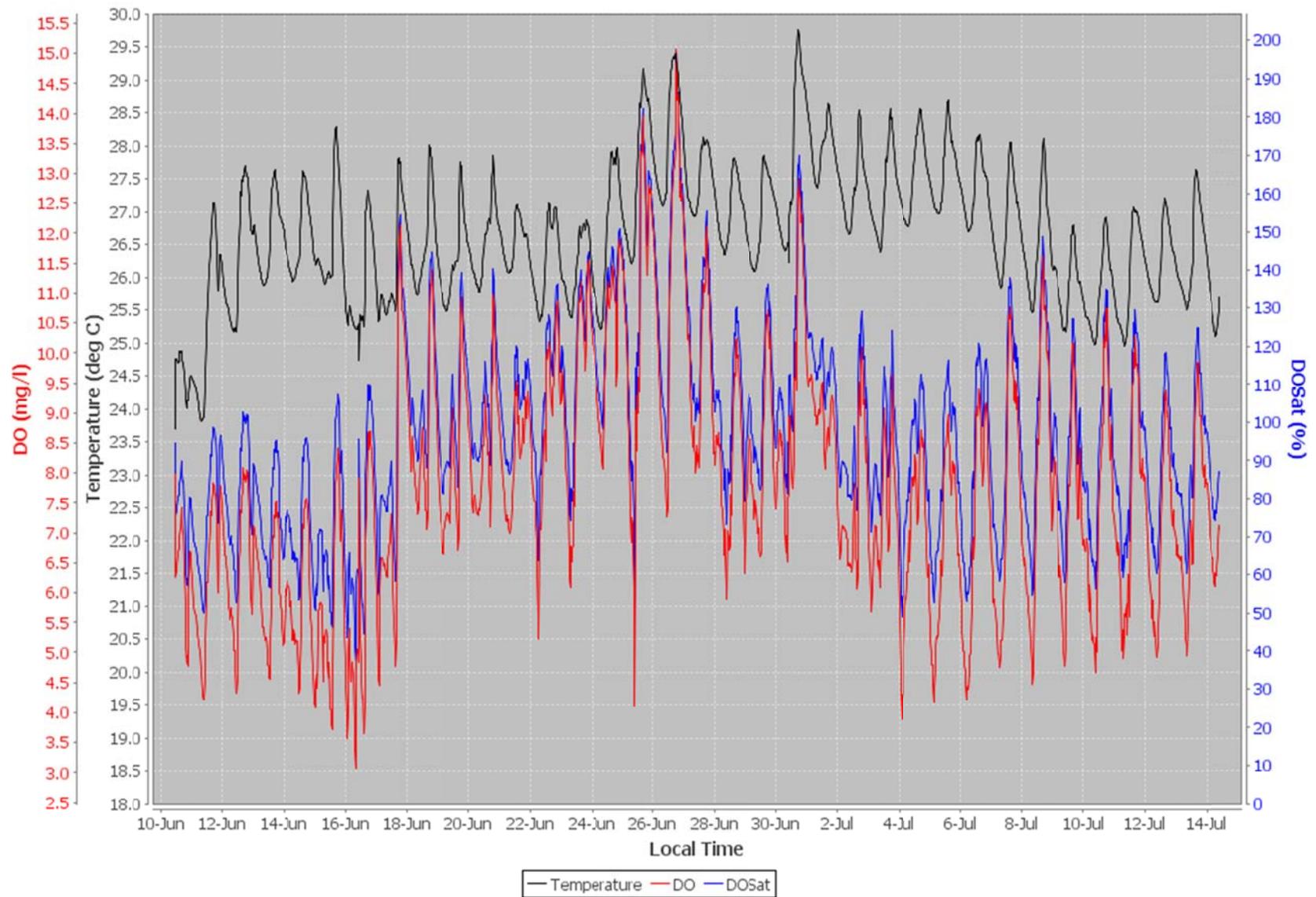


Figure 10. Dissolved Oxygen and Water Temperature in Whiskey Slough in open water

Table 1. Ranges of temperature, DO concentration, and DO saturation in study locations

Location		Sample Size	Water Temperature (°C)		Dissolved Oxygen (mg/L)		DO Saturation (%)	
			Min	Max	Min	Max	Min	Max
Under Water Hyacinth	UP-WH	1632	22.68	27.83	2.88	8.11	34.67	99.66
	SM-WH	1629	22.44	24.92	0.11	6.48	1.30	76.38
	TS-WH	1621	18.11	28.40	0.11	10.80	1.23	137.78
Open Water	UP-O	1632	23.42	27.42	3.91	8.51	47.58	100.13
	OH-O	665	21.60	25.88	4.24	10.52	50.11	128.19
	WS-O	1634	23.71	29.75	3.08	15.06	37.44	197.14

Table 2. Occurrences of low DO concentrations under water hyacinth and in open water

Location		# Data records with DO levels < 5 mg/L	# Data records with DO levels ≤ 3 mg/L
Under Water Hyacinth	UP-WH	285	1
	SM-WH	1618	1537
	TS-WH	1026	693
Open Water	OH-O	17	0
	UP-O	11	0
	WS-O	110	0

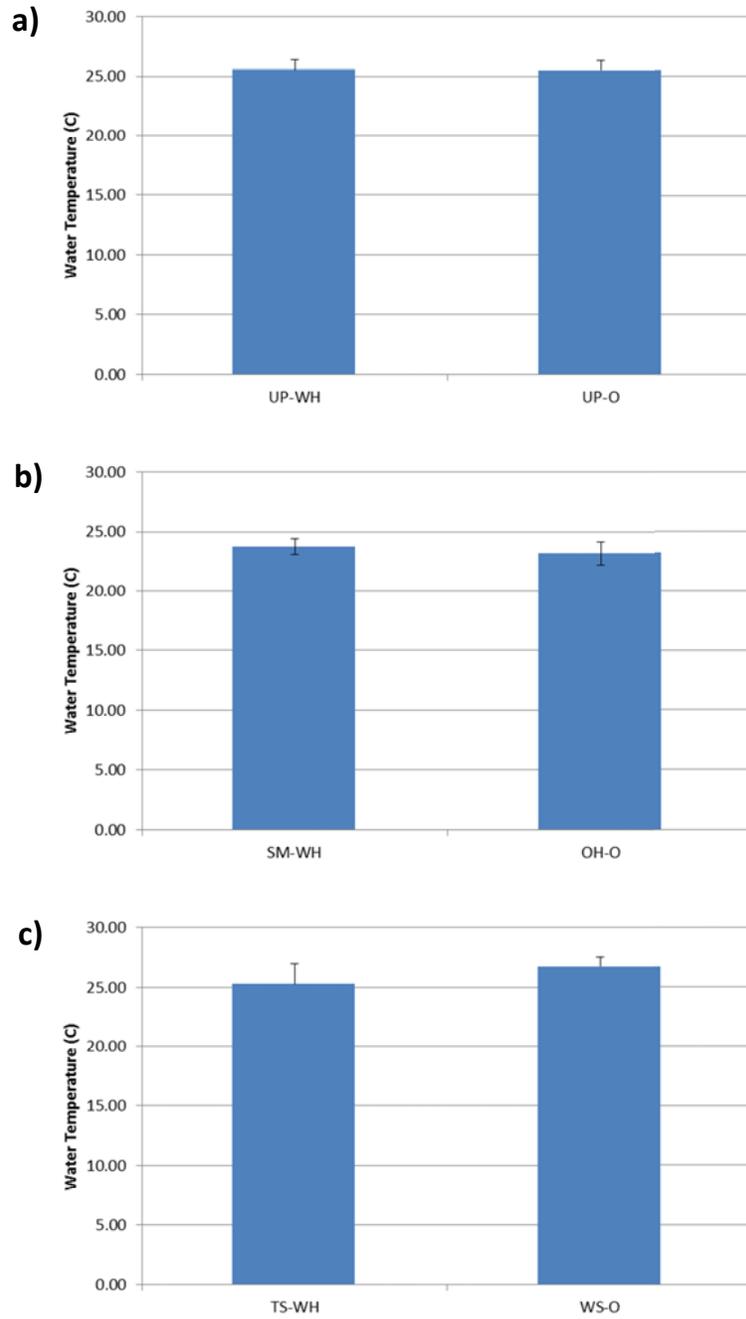


Figure 11. Water temperature under water hyacinth vs. open water, mean \pm SD; a) Union Point, b) Seven Mile Slough, and c) Trapper and Whiskey Sloughs

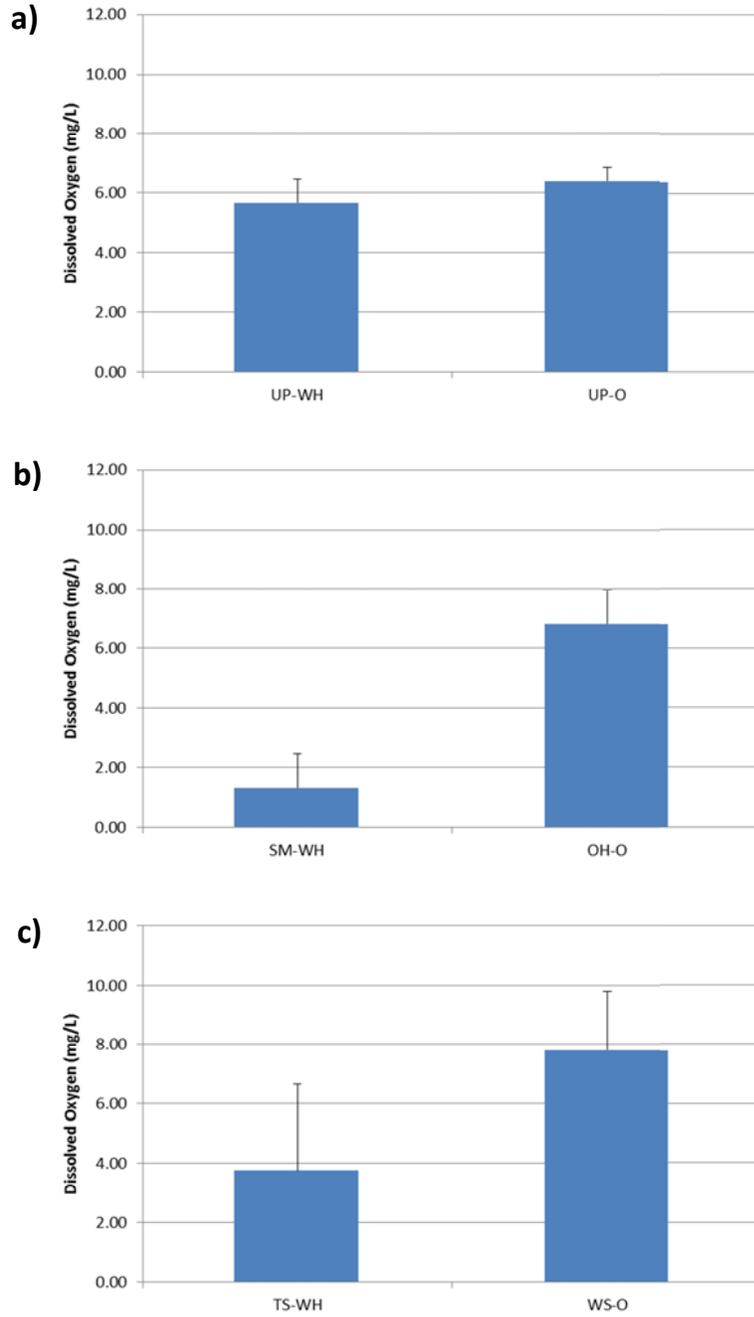


Figure 12. Dissolved oxygen concentration under water hyacinth vs. open water, mean \pm SD; a) Union Point, b) Seven Mile Slough, and c) Trapper and Whiskey Sloughs

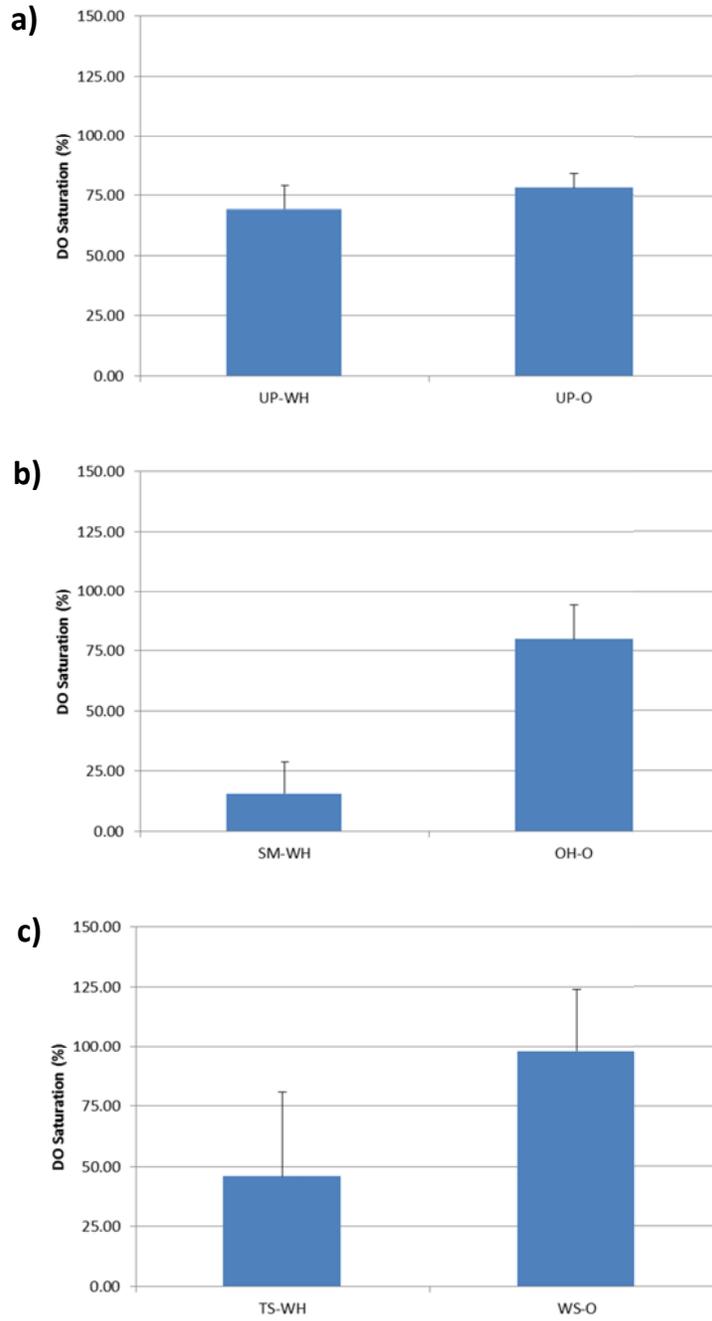


Figure 13. Dissolved oxygen saturation under hyacinth vs. open water, mean \pm SD; a) Union Point, b) Seven Mile Slough, and c) Trapper and Whiskey Sloughs

APPENDIX F

UC Davis Progress Report 2

Acute and Chronic Toxicity Testing of New Herbicides and Adjuvants on
Delta Smelt, *Hypomesus transpacificus*

Contract Progress Report

Progress Report # 2

Reporting Period: Jan. 1, 2015 to Aug. 30, 2015

Submittal Date October 20, 2015

Contract No: California Department of Boating and Waterways Contract No. C1370030
Project Name: Acute and Chronic Toxicity Testing of New Herbicides and Adjuvants on Delta Smelt, *Hypomesus transpacificus*
Contractor Name: UC Davis Aquatic Health Program Laboratory

I certify under penalty of law that this document and all attachments were prepared by me or under my direction in accordance with the terms and conditions of each Contract Task. Based on my inquiry of the persons or persons who manage the project or those directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. All information submitted in this document and all attachments conform to and are in accordance with the state and federal laws and I so here certify with my signature. I am aware that there are significant penalties for submitting false or misleading information.

Project Director: Dr. Swee Teh 
Printed Name Signature

Funding for this project has been provided in full or in part through an agreement with the California Department of Boating and Waterways. The contents of this document do not necessarily reflect the views and policies of the California Department of Boating and Waterways, nor does mention of trade names or commercial products constitute endorsement or recommendation for use (Gov. Code, § 7550, 40 C.F.R. § 31.20)

Table 1. Summary of Work Completed To Date

Work Item	Items for Review #	Due Date	% Of Work Complete
Task 1	1: Acute and Chronic Effects of herbicides and adjuvants	July, 2014	
	1.1 Establish optimum culture conditions		100%
	1.2 Range-finder studies		100%
	1.3 96-hr LC50 testing: embryo stage		100%
	1.4 96-hr LC50 testing: larval stage		100%
	1.5 Chemical analyses		100%
Task 2	1.6 Gross examination for deformity		100%
	2: Interactive effects of herbicide + adjuvant mixtures	September, 2014	
	2.1 Mixture toxicity testing: embryo stage		100%
	2.2 Mixture toxicity testing: larval stage		100%
2.3 Chemical Analyses	100%		
Task 3a	2.4 Gross examination for deformity		100%
	3a: Herbicide Toxicity Comparison	July, 2015	
	3.1 Range-finder studies: embryo/hatchling stage		100%
	3.2 96-hr LC50 testing: embryo/larval stage		100%
	3.3 Mixture analysis: embryo/hatchling stage		100%
3.4 Chemical Analyses	100%		
	3.5 Morphology		ongoing

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Work Item	Items for Review #	Due Date	% Of Work Complete
Task 3b	3b: Food Web Investigation	November, 2015	
	3.1 Range-finder studies: copepod		100%
	3.2 96-hr LC50 testing: copepod		100%
	3.3 Mixture Analyses: copepod		100%
	3.4 Chemical Analyses: copepod		100%
	3.5 Establish optimum culture conditions: diatom		0%
	3.6 Range-finder studies: diatom		0%
	3.7 96-hr LC50 testing: diatom		0%
	3.8 Mixture analysis: diatom		0%
	3.9 Chemical Analyses		0%
Task 4	4: Final report and publication in peer-reviewed journal	July, 2016	
	4.1 Draft Project Report		0%
	4.2 Draft Project Report Review		0%
	4.3 Final Project Report		0%
	4.4 Submission to Peer-reviewed Journal		0%

Progress Report Narrative

Introduction

The Department of Boating and Waterways (DBW) 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 in 2014; however these chemicals are relatively new and have not been extensively field tested. The sensitivity of non-target aquatic organisms, including sensitive delta fish (Delta Smelt), zooplankton (*Eurytemora affinis*) and phytoplankton (diatoms) to these herbicides and adjuvants has not been well established.

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. To summarize, 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. In the Imazamox + Agridex exposure to larval Delta Smelt, Agridex significantly affected larval survival at both time points measured (96h LC₅₀ = 36.5 mg/L, 7d LC₅₀ = 28.6 mg/L), while Imazamox had a significant effect on larval survival after 7d only (LC₅₀ = 69.5 mg/L), but not 96h. In the Penoxsulam + Agridex exposure to larval Delta Smelt, neither chemical significantly affected larval survival through the 8d test period. Antagonistic interactions between Agridex and Imazamox were detected at the 96h and 8d time point, and also detected between Agridex and Penoxsulam at the 8d time point.

In the embryo exposures, Agridex caused significant reductions in most sub-lethal endpoints including: weight, condition factor, length, oil globule area, yolk + oil globule area, and yolk perimeter. Only oil globule perimeter and yolk area were not affected by increasing concentrations of this chemical. Imazamox alone had significant increases in yolk area, yolk + oil globule area, and yolk perimeter in Delta Smelt embryos. Agridex + Imazamox in mixture exhibited synergistic interactions, resulting in an

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even greater increase in oil globule area, yolk area, yolk + oil globule area, and yolk perimeter. In contrast, antagonistic interactions were seen in length and condition factor endpoints. Treatments with Penoxsulam alone generally had a statistically significant increase in response in the majority of sub-lethal endpoints, and interactions between Penoxsulam and Agridex were significant. These synergistic effects resulted in significant negative effects on condition factor and hatchling length, but positive effects on the average size of hatchling oil globule and yolk sac. In the larval tests with Imazamox, there was a significant reduction in length in treatments testing Imazamox and Agridex individually. Condition factor and weight endpoints were significantly reduced in mixture treatments due to an antagonistic effect. Imazamox, when tested alone, had significant increases in oil globule area and oil globule perimeter. In the larval tests with Penoxsulam, Agridex had a negative effect on weight and condition factor endpoints, but a positive effect on oil globule area. Penoxsulam, when tested alone, had significant increases in weight and condition factor.

Herbicides and adjuvants caused minimal effects on embryo hatching success and larvae survival (Figures 1, 2), but toxic responses were prevalent among the sub-lethal 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 41 mg/L, which is over 400 (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.

Sub-lethal effects from herbicide and adjuvant mixtures were variable, and some effects occurred at low, environmentally relevant concentrations. Condition factor (CF) 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 (OGA) 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 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 (Hageraars 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 2

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summarizes the inferred mechanisms of toxicity for each herbicide, adjuvant, and mixture based on their combined effects on CF and OGA.

Neither herbicide tested, Imazamox or Penoxsulam, caused deleterious sub-lethal 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 2). 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 these data 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 times 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

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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.

Summary of Activities

Year two of this project evaluated the toxicity of Penoxsulam, Imazamox, Agridex, and their mixtures, to the calanoid copepod *Eurytemora affinis* as part of the Food Web Investigation, in 96-hr assays. Additionally, the Toxicity Comparison portion of this study evaluated the current-use herbicides, Fluridone as Sonar AS, glyphosate as Roundup Custom, and 2,4-D as Weedar 64, as well as the current-use adjuvant Competitor, to early life stages of Delta Smelt.

Materials and Methods

Eurytemora affinis

Eurytemora 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. The copepod culture is raised at 20 °C with a 16:8-h light: dark cycle and continuous aeration. Copepods are 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 is filtered and refreshed with clean reconstituted water to maintain optimal water quality. To reduce density-dependent effects, mass cultures are maintained at a density of ~100 adults/L.

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 24h 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 distilled water amended with inorganic salts to USEPA moderately hard standards [USEPA, 2002]) and gently aerated until their use in a test, or until fully hatched.

Chemical Solutions

Imazamox, Penoxsulam and Fluridone were obtained from SePRO Corporation (Carmel, IN, USA) in original formulation (Clearcast, Galleon SC, and Sonar AS, respectively). Test concentrations were calculated from the percent active ingredient, either Imazamox, Penoxsulam or Fluridone. Agridex, Weedar 64, and Roundup Custom was obtained from Helena Chemical Company (Collierville, TN, USA), and Competitor was obtained from Wilbur Ellis Company (San Francisco, CA, USA). Test concentrations of Agridex/Competitor were based on total Agridex/Competitor concentration, given that the solution is a mixture of oils with no one specific active ingredient. Penoxsulam, Imazamox and Agridex was tested with *E. affinis*, where Fluridone, 2,4-D and Glyphosate were tested with delta smelt.

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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. All toxicity tests were conducted in UC Davis reverse osmosis water amended with inorganic salts to USEPA moderately hard specifications (hardness: 88 mg/L as CaCO₃; alkalinity: 56 mg/L as CaCO₃; total ammonia as nitrogen, 0.0 mg/L; USEPA, 2002).

Toxicity Tests

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 for 96h. 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 alive copepods were used in calculations.

Embryo-stage Delta Smelt

Embryo-stage toxicity tests consisted of four 600mL replicates containing 500mL treatment water and 20 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 (peak hatching at 11-12 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 on renewal days, and dissolved oxygen, pH and temperature were measured on the 48-h wastewater. 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 morphologic analyses.

Larval-stage Delta Smelt

Larval-stage toxicity tests consisted of four 600mL replicates with 500mL sample. Tests were initiated with 20 smelt. Chemical exposure duration lasted 96h with an 80% renewal at 48h. Less water was removed in order to keep enough remaining in test chambers to avoid stress on the fish. For the first two larval tests, waters were renewed via siphon connected to a screened funnel, to reduce the velocity of water siphoned through the screen and to avoid damaging the smelt (as was used in Hoffmann et al. 2014). However we changed the method from siphoning to pouring off treatment water during renewal after we observed high rates of mortality in some treatments the day after siphoning, leading us to believe that smelt were becoming negatively affected by the velocity of the siphon, even with the funnel. After 96h, smelt were held in clean water with every other day renewals for an additional 4 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 on renewal days, and dissolved oxygen, pH and temperature were measured on the 48-h wastewater. 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 morphologic analyses.

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Morphologic Analyses

Preserved smelt will be recorded via photo-microscopy. Micrographs will be analyzed using ImageJ software from the National Institute of Health (<http://rsbweb.nih.gov/ij/>). The resultant coordinate data will be exported and used to calculate total body length and yolk sac oil globulin area.

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) in which fish and copepod were distributed. All models were fit using the program R (R Core Team).

Chemical Analyses

Multiple treatment water samples were collected over the duration of the experiments. For the *E. affinis* exposure, initial water samples were collected at test initiation on Day 0 and test renewal on Day 2 and 4. For the 11d embryo exposures, initial water samples were collected at test initiation on Day 0 and test renewal on Day 4. Final water samples (collected prior to renewal) were collected on Day 4, Day 6 and on the day of test take down, Day 11. For the 8d larval exposures, initial water samples were collected at test initiation on Day 0 and at test renewal on Day 4. Final water samples were collected on Day 4 and Day 6. Samples were collected in 4oz High Density Polyethylene (HDPE) brown plastic bottles and immediately stored at 4°C until shipped. Sample temperature was maintained between 0-6°C during overnight transport. Imazamox and Penoxsulam concentrations were measured using standardized FasTEST methods (SePRO Research and Technology Campus, Whitakers, NC). Measured concentrations are summarized in Figures 15-20.

Results

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 is outlined in Figures 3-7.

Delta Smelt embryo hatching success

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

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herbicides (Fluridone LC₅₀ = 326.6 mg/L, Glyphosate LC₅₀ = 3490.4 mg/L, 2,4-D LC₅₀ = 715.5 mg/L). Interestingly, there were no significant effects observed with Imazamox in either life stage. Competitor also did not exhibit any significant effects on embryo survival or hatching success. Delta Smelt embryo data are outlined in Figures 8-10. Water quality for these tests is outlined in Tables 4-6.

Delta Smelt larval survival

Significant effects were observed at 96h and 8d for both Glyphosate (96h LC₅₀ = 1619.2 mg/L, 8d LC₅₀ = 946.3 mg/L) and 2,4-D (96h LC₅₀ = 521.3, 8d LC₅₀ = 285.1 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. Concentrations selected for Competitor were too high for this life stage and we were unable to obtain an LC₅₀ (data not reported). Delta smelt larval data are outlined in Figures 11-14. Water quality measurements are outlined in Tables 7-8. We were unable to obtain an LC₅₀ for Fluridone, however there were several observed sub-lethal effects, as described in more detail below.

Sub-lethal observations

Morphological endpoints such as length, weight and condition factor have not yet been completed. Sub-lethal responses outlined in this section refer to those observed during testing. Fluridone had the highest rate of observed sub-lethal effects in both life stages. In the embryo exposures, sub-lethal effects were observed as low as 31.25 mg/L, and included major deformities of hatched fish, inability of hatched fish to swim, unsuccessful hatching (mortality) and larvae mortality after hatch. Although we were unable to obtain an LC₅₀ for Fluridone in the larval stage, Delta Smelt exhibited negative sub-lethal effects at the lowest concentration tested (0.25 mg/L) and included twitching, erratic swimming patterns, inability to swim, deformities of the vertebrate causing circular swimming patterns and strained movement. In larval tests with 2,4-D, fish exhibited signs of twitching, erratic swimming patterns or an inability to swim in concentrations of 250 and 500 mg/L. In Glyphosate tests, embryos appeared underdeveloped for the first part of the exposure (96 h), but eventually recovered once moved into clean water.

Next Steps

Morphological analysis of embryo- and larval-stage Delta Smelt to current-use herbicides is currently in progress. Research and development is being conducted on the diatom *Thalassiosira pseudonana* under task 3b.

Task 1 - Acute and Chronic Effects of herbicides and adjuvants (Cumulative 100% complete)

- 1.1 Determining optimum culture conditions are complete
- 1.2 Range finder studies are complete
- 1.3 Embryo-stage LC50 testing is complete
- 1.4 Larval-stage LC50 testing is complete
- 1.5 Chemical analyses are complete
- 1.6 Gross examination for deformity is complete

Task 2 – Interactive Effects of herbicide + adjuvant mixtures (Cumulative 100% complete)

- 2.1 Embryo-stage mixture studies are complete
- 2.2 Larval-stage mixture studies are complete
- 2.3 Chemical analyses on mixture studies are complete
- 2.4 Gross examination for deformity is complete

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Task 3a – Herbicide Toxicity Comparison (Cumulative 80% complete)

- 3.1 Range-finder studies for embryo/hatchling stage are complete
- 3.2 96-hr LC50 testing of embryo/larval stage are complete
- 3.3 Mixture analysis of embryo/hatchling stage are complete
- 3.4 Chemical Analyses on mixture studies are complete
- 3.5 Morphology is ongoing.

Task 3b – Food Web Investigation (Cumulative 50% complete)

- 3.1 Range-finder studies with copepods is complete.
- 3.2 96-hr LC50 testing with copepods is complete.
- 3.3 Mixture Analyses with copepod is complete.
- 3.4 Chemical Analyses for copepod studies is complete.

Task 4 – Final report and publication in peer-reviewed journal (Cumulative 0% complete)

- 4.1 No work performed during this reporting period.

Embryo Hatching Success

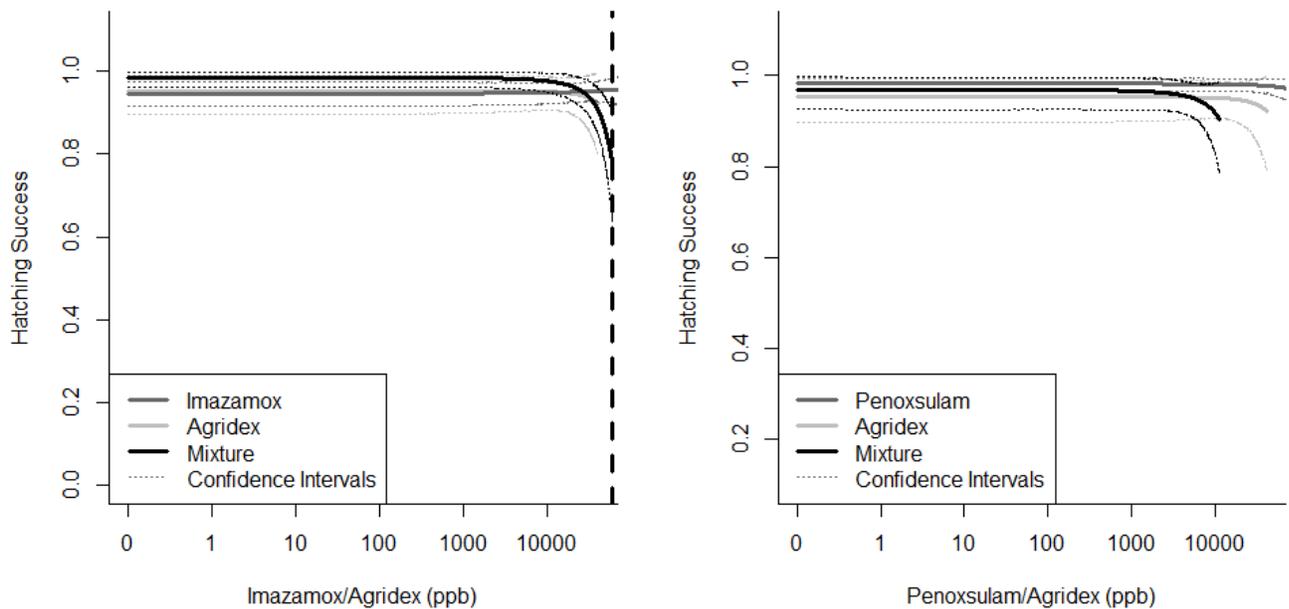


Figure 1. Chart shows herbicide, adjuvant, and herbicide-adjuvant mixture effects on embryo hatching success conducted in 2014. As noted in the key, Imazamox or Penoxsulam (herbicide) = dark grey line, Agridex (adjuvant) = light grey, and the mixture = black. Confidence intervals around the models are shown as dotted lines, where a vertical dotted line denotes a significant effect at that concentration (color coded to key).

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Larvae Survival

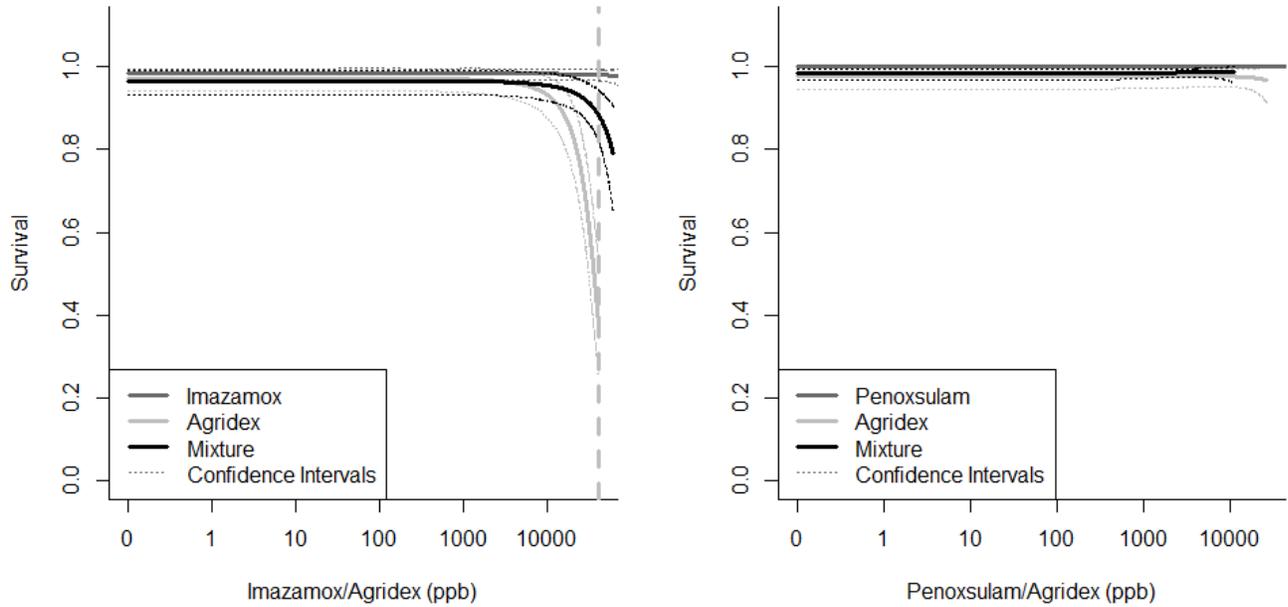


Figure 2. Chart shows herbicide, adjuvant, and herbicide-adjuvant mixture effects on larval survival conducted in 2014. Agridex alone caused larvae smelt mortality at the highest test concentration (Max effect = Average of 39% survival at the highest Agridex test concentration of 41 mg/L relative to control of 100%). Mixture with Imazamox mitigated the toxicity (antagonistic mixture interaction) – resulting in an average of 79% survival in the mixture.

Table 2. 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

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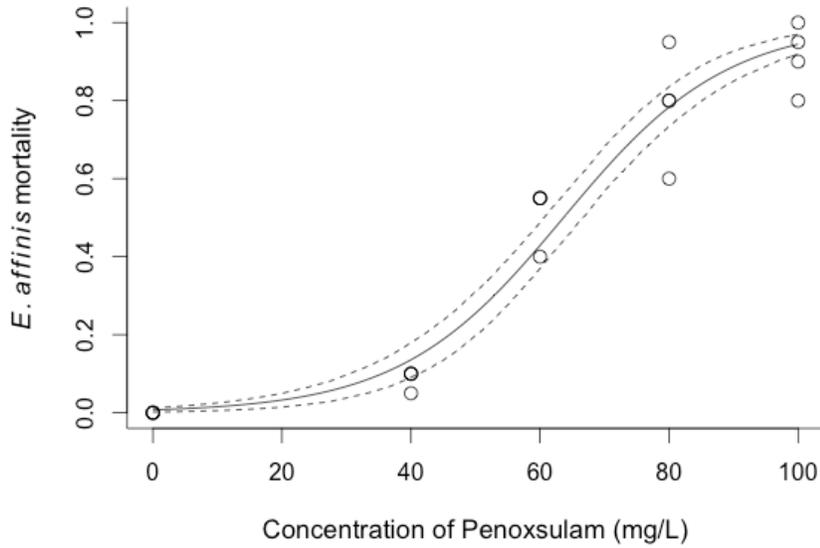


Figure 3. *Eurytemora affinis* mortality data with Penoxsulam. LC_{50} : 63.7 mg/L (dotted line 95% CI: 60.6, 66.6), LC_{10} : 35.6 mg/L (dotted line 95% CI: 30.1, 41.1).

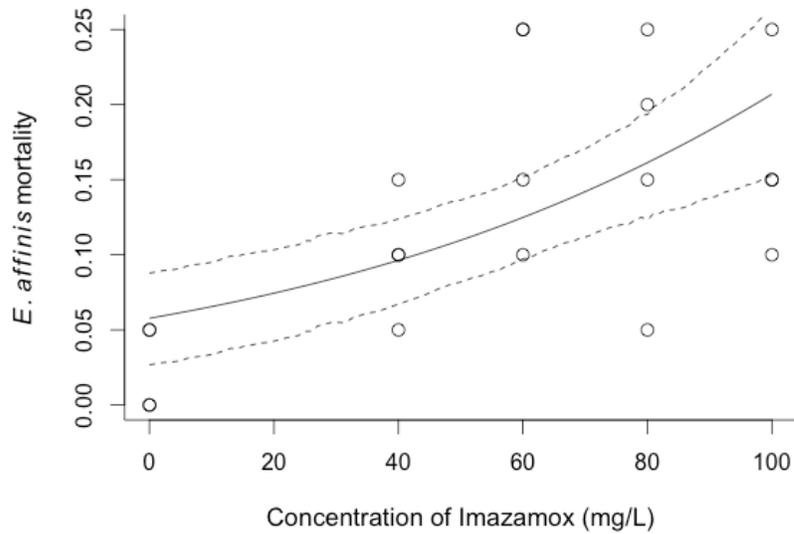


Figure 4. *Eurytemora affinis* mortality data with Imazamox. LC_{50} : none; LC_{10} : 56.6 mg/L (dotted line 95% CI: 17.4, 65.2).

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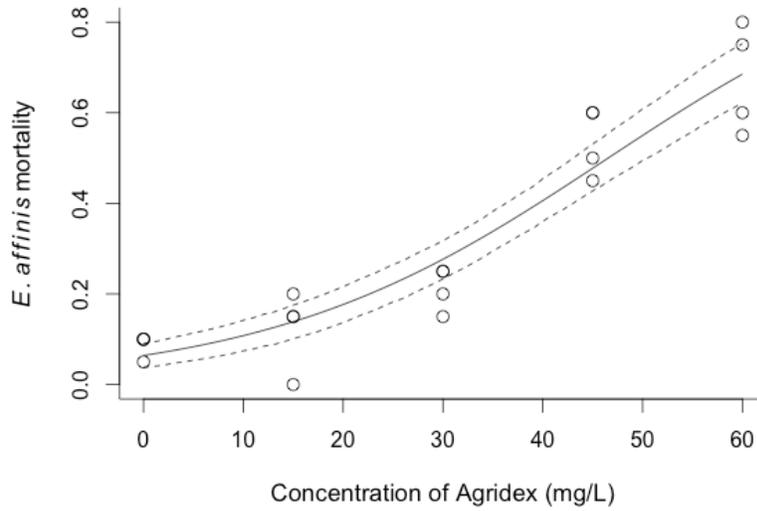


Figure 5. *Eurytemora affinis* mortality data with Agridex. LC₅₀: 46.7 mg/L (dotted line 95% CI: 42.8, 50.4); LC₁₀: 8.5 mg/L (dotted line 95% CI: 2.3, 15.1).

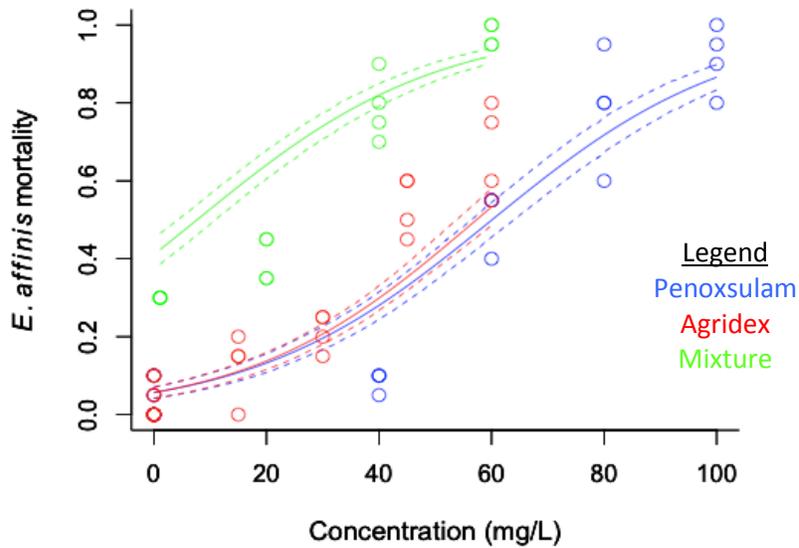


Figure 6. *Eurytemora affinis* mortality data: Penoxsulam + Agridex mixture. Mixture LC₅₀: 24.4 mg/L, (dotted line 95% CI: 22.0, 26.8); Mixture LC₁₀: 0.5 mg/L (dotted line 95% CI: -2.3, 3.6). Penoxsulam + Agridex has a significant additive effect.

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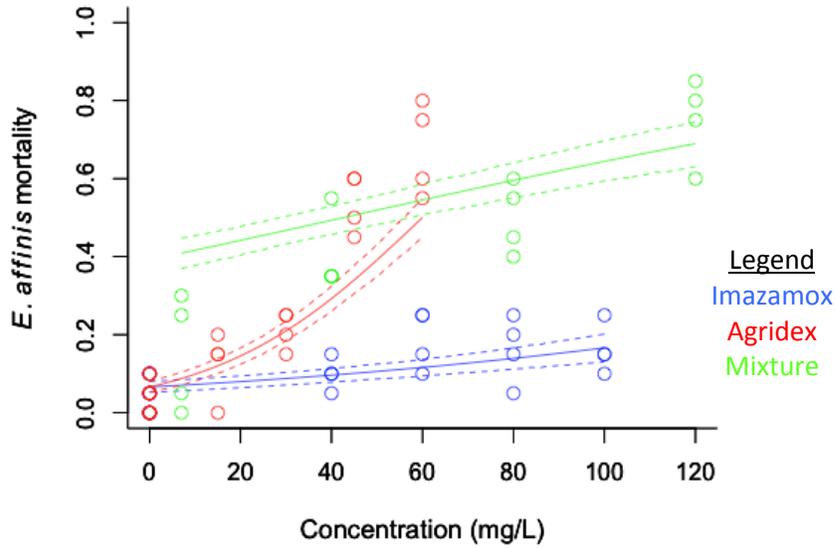


Figure 7. *Eurytemora affinis* mortality data: Imazamox + Agridex mixture. Mixture LC₅₀: 77.0 mg/L (dotted line 95% CI: 70.0, 84.0); Mixture LC₁₀: 4.5 mg/L (dotted line 95% CI: -4.2 13.4). Imazamox + Agridex has a significant additive effect.

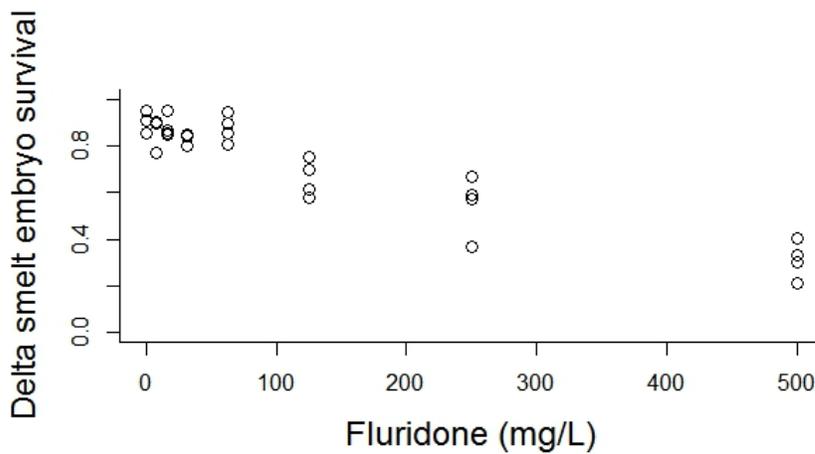


Figure 8. Delta Smelt embryo survival data with Fluridone. Fluridone 12d LC₅₀: 326.5 mg/L (95% CI: 278.6, 376.6).

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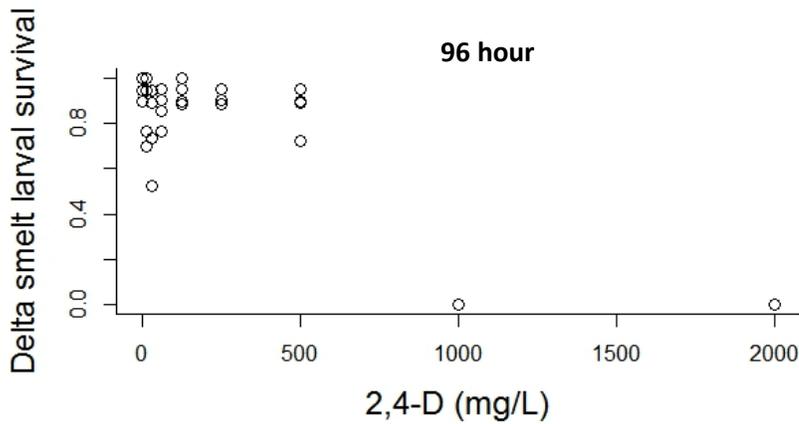


Figure 13. Delta Smelt larval 96h survival data with 2,4-D. 96h LC₅₀: 521.3 mg/L (95% CI: 400.9, 649.9).

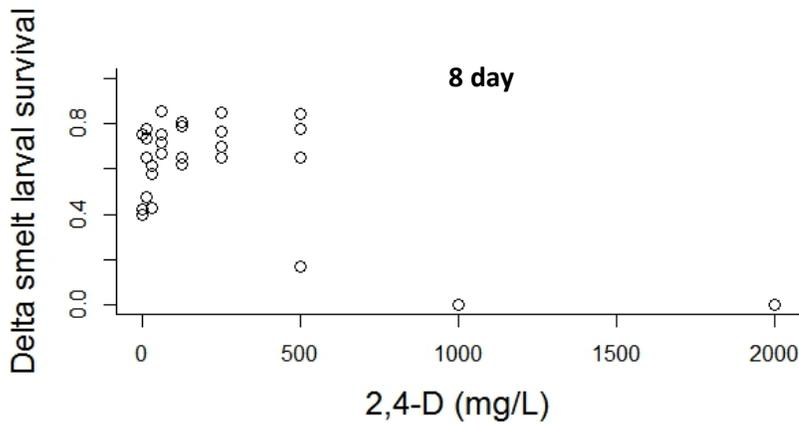


Figure 14. Delta Smelt larval 8d survival data with 2,4-D. 8d LC₅₀: 285.1 mg/L (95% CI: 169.3, 409.9).

Table 3. 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*

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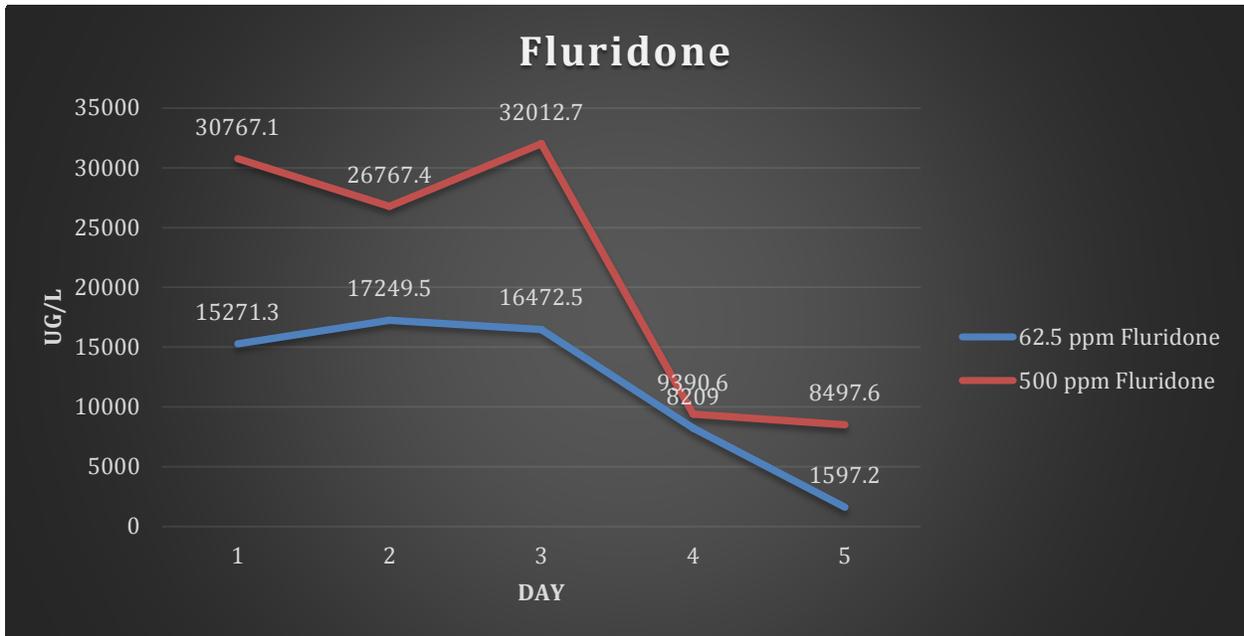


Figure 15. Graph of chemical analysis results for Fluridone in a 12d Delta Smelt embryo exposure.

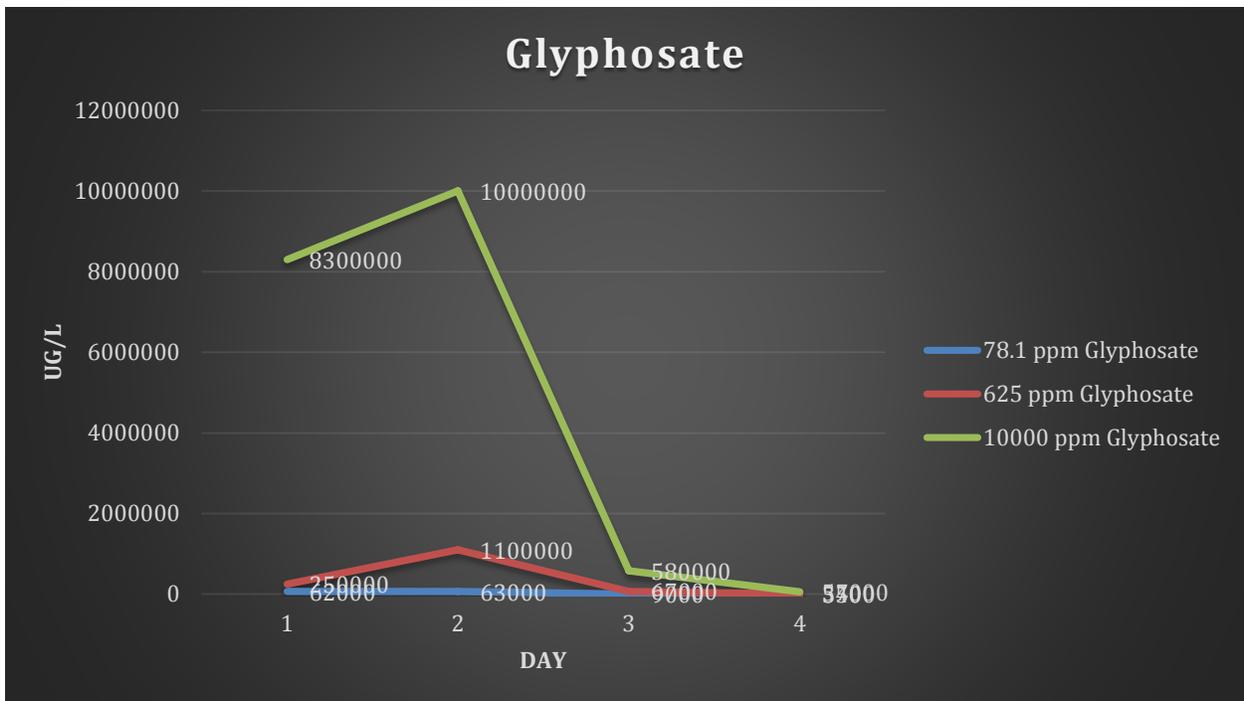


Figure 16. Graph of chemical analysis results for Glyphosate in a 12d Delta Smelt embryo exposure.

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Figure 17. Graph of chemical analysis results for 2,4-D in a 12d Delta Smelt embryo exposure.

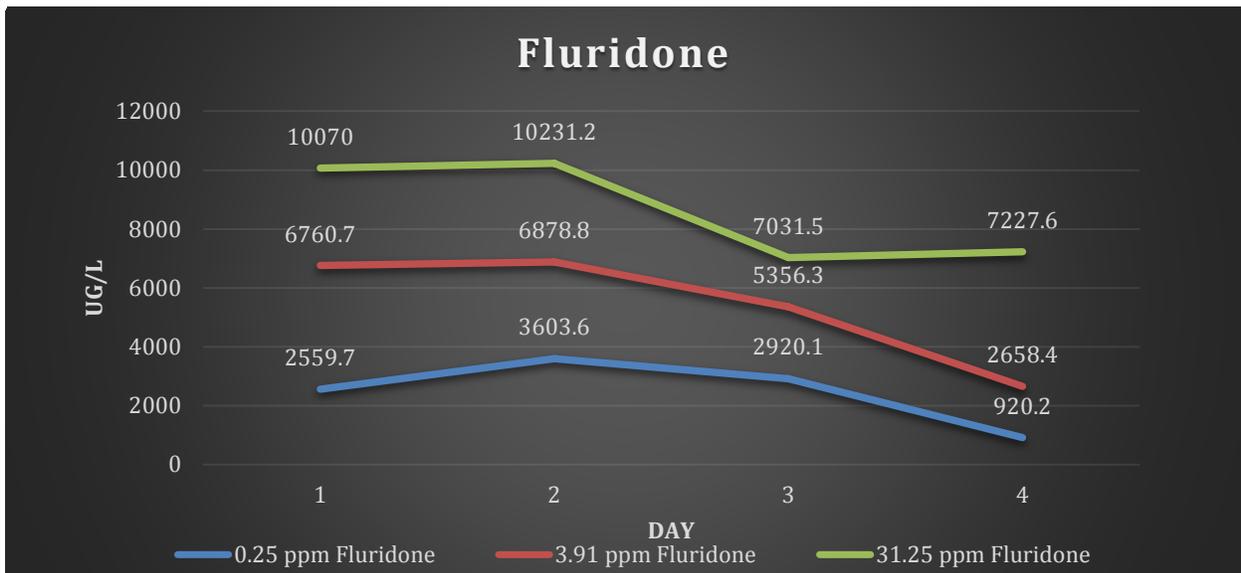


Figure 18. Graph of chemical analysis results for Fluridone in an 8d Delta Smelt larval exposure.

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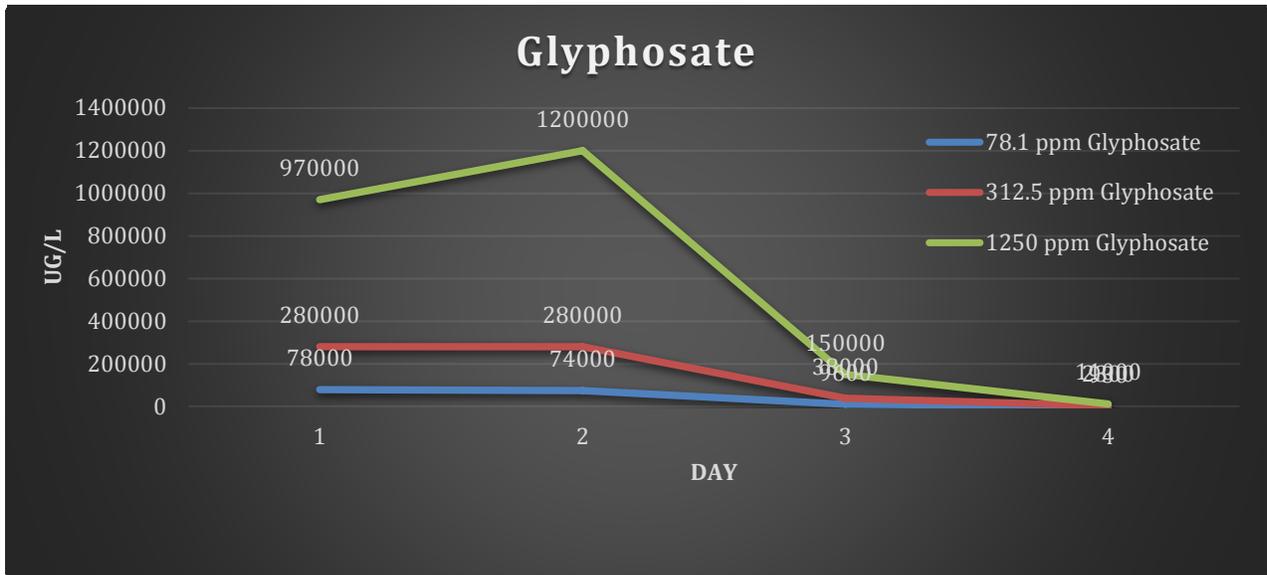


Figure 19. Graph of chemical analysis results for Glyphosate in an 8d Delta Smelt larval exposure.

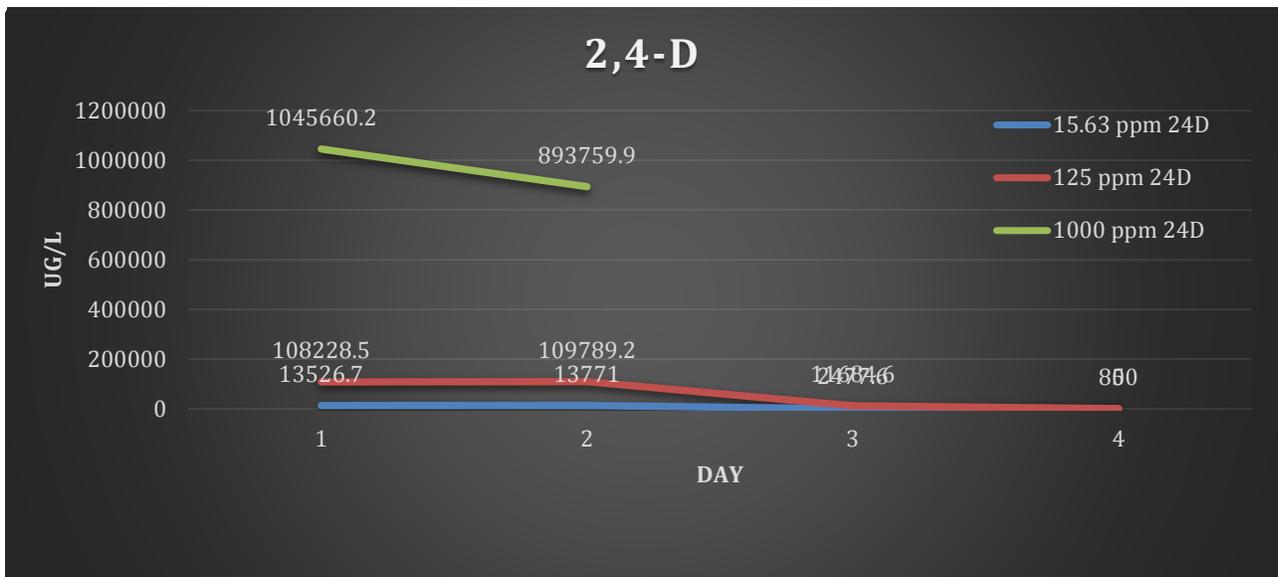


Figure 20. Graph of chemical analysis results for 2,4-D in an 8d Delta Smelt larval exposure. There are only two data points for 1000 ppm, as that concentration exhibited 100% mortality prior to the next sampling.

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Table 4. Summary of water quality measurements taken during an 12-day delta smelt embryo toxicity test initiated on April 1, 2015, evaluating the effects of Fluridone as Sonar AS.

Treatment	Temp (°C)			EC (µS)			DO (mg/L)			pH		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Control	14.3	16.5	15.5	165	252	196	8.9	10.2	9.3	7.92	8.25	8.08
8 ppm Fluridone	14.3	16.1	15.3	166	253	209	9.0	10.2	9.5	7.86	8.10	7.98
16 ppm Fluridone	14.4	16.1	15.3	168	228	198	9.2	10.2	9.6	7.88	8.06	7.98
31.25 ppm Fluridone	14.4	16.3	15.2	160	166	163	9.2	10.4	9.6	7.82	8.28	8.03
62.5 ppm Fluridone	14.3	16.1	15.3	161	166	163	9.0	10.4	9.5	7.79	8.29	8.00
125 ppm Fluridone	14.2	15.9	15.2	160	170	165	9.1	10.2	9.5	7.77	8.28	8.00
250 ppm Fluridone	14.1	16.0	15.2	165	176	171	9.3	10.1	9.4	7.73	8.19	7.96
500 ppm Fluridone	14.3	15.9	15.2	174	179	176	9.2	9.6	9.4	7.64	8.06	7.91

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Table 5. Summary of water quality measurements taken during an 12-day delta smelt embryo toxicity test initiated on April 22, 2015, evaluating the effects of Glyphosate as Roundup Custom, and 2,4-D as Weedar 64.

Treatment	Temp (°C)			EC (µS)			DO (mg/L)			pH		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Control	15.0	17.7	16.3	237	265	247	8.6	10.4	9.5	7.98	8.20	8.07
pH-adjusted Control: Glyphosate	15.8	18.8	17.3	318	360	339	8.9	10.3	9.6	7.47	8.09	7.81
7.81 ppm Glyphosate	15.0	16.7	16.1	270	340	305	8.8	10.4	9.6	7.47	8.06	7.81
15.63 ppm Glyphosate	15.0	16.7	16.0	304	399	352	8.9	10.5	9.6	7.52	8.07	7.80
31.25 ppm Glyphosate	15.0	16.9	16.2	353	510	432	8.9	10.6	9.6	7.50	8.03	7.79
62.5 ppm Glyphosate	15.1	17.3	16.2	441	698	569	8.9	10.5	9.6	7.45	8.05	7.77
125 ppm Glyphosate	15.0	17.1	16.4	607	1099	853	9.2	10.6	9.7	7.48	8.03	7.76
250 ppm Glyphosate	15.0	17.3	16.4	962	2067	1515	8.8	10.5	9.5	7.47	7.96	7.75
500 ppm Glyphosate	14.7	17.8	16.3	1606	3466	2536	8.8	10.6	9.6	7.49	8.02	7.75
1000 ppm Glyphosate	14.7	16.7	16.2	2771	6240	4506	8.9	10.8	9.7	7.46	8.07	7.77
15.63 ppm 2,4-D	15.1	16.7	16.1	251	366	308	8.8	10.5	9.6	7.74	8.05	7.92
31.25 ppm 2,4-D	14.9	17.2	16.2	250	294	272	8.9	10.6	9.6	7.86	8.08	7.97
62.5 ppm 2,4-D	15.1	17.5	16.5	265	280	273	9.0	10.6	9.8	7.37	8.05	7.90
125 ppm 2,4-D	15.5	17.7	16.6	283	318	301	8.9	10.6	9.6	7.91	8.09	8.00
250 ppm 2,4-D	15.4	17.5	16.5	311	348	330	8.8	10.6	9.6	7.90	8.11	7.99
500 ppm 2,4-D	15.4	17.2	16.5	370	415	393	8.9	10.3	9.6	7.77	8.12	7.95
1000 ppm 2,4-D	15.4	17.4	16.6	503	575	539	8.9	10.5	9.6	7.67	8.13	7.93
2000 ppm 2,4-D	15.4	17.8	16.8	726	813	770	9.0	10.5	9.6	7.49	8.16	7.85

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Table 6. Summary of water quality measurements taken during an 12-day delta smelt embryo toxicity test initiated on May 28 2015, evaluating the effects of Imazamox, Competitor and their mixture.

	Treatment	Temp (°C)			EC (µS)			DO (mg/L)			pH		
		Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
1	Control	15.1	16.9	16.0	234	292	258	9.3	9.5	9.4	7.85	8.09	7.99
2	12 ppb Imazamox	15.3	16.7	15.8	231	239	235	9.2	9.8	9.5	7.84	8.07	7.98
3	50 ppb Imazamox	15.3	16.7	15.8	230	236	233	9.3	9.8	9.5	7.88	8.07	7.98
4	500 ppb Imazamox	15.3	17.2	15.9	233	243	238	9.2	9.8	9.5	7.85	8.08	7.96
5	5000 ppb Imazamox	15.4	17.2	16.0	230	240	235	9.2	9.8	9.5	7.87	8.04	7.95
6	50000 ppb Imazamox	15.3	17.2	15.9	244	253	248	8.1	9.8	9.3	7.65	7.93	7.84
7	12 ppb Imazamox + 86 ppb Competitor	15.1	17.6	15.8	235	238	236	9.3	9.8	9.5	7.84	8.12	7.96
8	50 ppb Imazamox + 353 ppb Competitor	15.2	17.4	15.8	240	243	242	9.3	9.6	9.4	7.87	8.16	7.97
9	500 ppb Imazamox + 3550 ppb Competitor	15.2	16.1	15.6	234	240	237	9.1	9.7	9.4	7.85	8.16	7.96
10	5000 ppb Imazamox + 35550 ppb Competitor	15.4	16.2	15.8	234	245	239	6.7	9.6	8.9	7.33	8.11	7.81
11	50000 ppb Imazamox + 35550 ppb Competitor	15.1	16.0	15.7	244	255	250	3.5	9.6	8.1	7.02	7.91	7.66
12	0.277 ppb Competitor	15.2	16.1	15.7	230	240	235	9.0	9.7	9.4	7.85	8.13	7.96
13	0.550 ppb Competitor	15.2	16.9	15.8	227	239	233	9.1	9.8	9.5	7.90	8.15	7.98
14	1.1 ppb Competitor	15.0	16.5	15.7	226	240	233	9.2	9.8	9.5	7.87	8.13	7.97
15	2.2 ppb Competitor	14.7	16.7	15.8	223	242	232	9.1	9.9	9.5	7.86	8.11	7.97
16	4.4 ppb Competitor	14.9	16.7	15.8	229	241	235	9.1	9.8	9.5	7.83	8.12	7.96
17	8.8 ppb Competitor	14.7	16.6	15.7	226	241	234	9.1	9.8	9.5	7.82	8.14	7.95
18	17.6 ppb Competitor	14.6	17.1	16.0	227	242	234	9.0	9.8	9.4	7.91	8.15	7.98
19	35550 ppb Competitor	14.2	17.7	15.9	222	243	233	9.1	9.8	9.5	7.85	8.13	7.96

Contract Progress Report

Table 7. Summary of water quality measurements taken during a 8-day delta smelt larval toxicity test initiated on May 20, 2015, evaluating the toxicity of Glyphosate, 2,4-D, and Fluridone.

No.	Details	Temperature (°C)			EC (µS)			DO (mg/L)			pH ¹		
		Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
1	Control	14.6	17.3	15.8	218	286	245	8.9	9.5	9.2	8.03	8.20	8.10
2	pH-adjusted Control (Glyphosate)	13.0	16.8	15.3	215	310	255	9.0	9.7	9.3	7.45	8.18	7.87
3	78.1 ppm Glyphosate	12.8	16.2	15.3	163	261	221	8.9	10.0	9.4	7.53	8.18	7.88
4	156.3 ppm Glyphosate	12.9	16.9	15.5	240	327	285	8.9	10.0	9.4	7.45	8.18	7.84
5	312.5 ppm Glyphosate	12.9	16.7	15.5	240	437	358	9.1	10.1	9.5	7.46	8.18	7.83
6	625 ppm Glyphosate	12.9	18.3	15.9	240	592	459	8.5	10.2	9.4	7.51	8.18	7.81
7	1250 ppm Glyphosate	12.9	19.9	16.0	240	996	737	8.8	9.9	9.4	7.51	8.18	7.83
8	2500 ppm Glyphosate	12.8	16.5	15.4	240	1698	1148	9.2	10.1	9.6	7.54	8.18	7.72
9	5000 ppm Glyphosate	15.3	16.2	15.8	240	3046	1643	9.1	9.9	9.4	7.55	8.18	7.79
10	15.63 ppm 2,4-D	14.7	16.6	15.8	240	242	241	9.0	9.7	9.3	7.96	8.18	8.05
11	31.25 ppm 2,4-D	14.8	16.5	15.9	240	245	242	9.1	9.9	9.3	7.96	8.18	8.06
12	62.5 ppm 2,4-D	14.7	16.6	15.9	240	250	245	9.2	10.1	9.4	7.90	8.18	8.04
13	125 ppm 2,4-D	14.6	16.8	15.9	240	267	253	9.0	10.1	9.3	7.89	8.18	8.04
14	250 ppm 2,4-D	14.8	17.4	16.2	240	296	268	8.9	10.2	9.3	7.90	8.18	8.01
15	500 ppm 2,4-D	14.6	16.7	15.9	240	348	312	8.7	10.3	9.3	7.85	8.18	7.98
16	1000 ppm 2,4-D	14.7	16.2	15.6	240	462	386	8.9	10.3	9.3	7.74	8.18	7.90
17	2000 ppm 2,4-D	14.7	16.2	15.6	240	680	460	9.2	10.3	9.6	7.64	8.18	7.90
18	0.25 ppm Fluridone	14.9	19.8	16.4	232	269	247	8.7	10.4	9.4	7.87	8.18	8.04
19	0.49 ppm Fluridone	14.7	19.0	16.5	231	240	236	8.9	10.3	9.3	7.85	8.18	8.03
20	0.98 ppm Fluridone	14.6	18.4	16.3	233	240	235	8.9	10.3	9.3	7.89	8.18	8.03
21	1.95 ppm Fluridone	14.7	18.5	16.3	231	240	235	8.8	10.3	9.3	7.93	8.18	8.04
22	3.91 ppm Fluridone	14.8	17.1	16.1	235	240	237	8.9	10.3	9.3	7.93	8.18	8.04
23	7.81 ppm Fluridone	14.7	17.0	16.1	236	249	241	8.8	10.3	9.3	7.95	8.18	8.04
24	15.63 ppm Fluridone	14.7	16.9	16.2	235	240	237	8.7	10.3	9.2	7.92	8.18	8.03
25	31.25 ppm Fluridone	14.6	17.3	16.3	230	240	235	8.8	10.3	9.2	7.97	8.18	8.04

1: Glyphosate samples were pH-adjusted to 7.5 (± 0.5) during chemical exposure at 24- and 48-h timepoints.

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Table 8. Summary of water quality measurements taken during a 8-day delta smelt larval toxicity test initiated on June 10 2015, evaluating the toxicity of Imazamox, and the mixture of Imazamox + Competitor.

No.	Details	Temperature (°C)			EC (µS)			DO (mg/L)			pH		
		Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
1	Control	13.8	15.9	14.7	223	240	230	9.3	10.1	9.7	7.93	8.19	8.06
2	12 ppb Imazamox	13.7	16.0	14.7	225	237	231	9.3	10.4	9.8	7.88	8.05	8.01
3	50 ppb Imazamox	13.5	16.4	14.8	233	241	237	9.4	10.3	9.8	7.86	8.14	8.02
4	500 ppb Imazamox	13.5	16.1	14.9	236	239	238	9.5	10.3	9.8	7.86	8.11	8.01
5	5000 ppb Imazamox	13.7	16.3	15.1	235	237	236	9.5	10.3	9.8	7.83	8.12	7.99
6	50000 ppb Imazamox	13.7	16.1	15.2	248	255	252	6.6	10.1	9.1	7.37	8.03	7.81
7	12 ppb Imazamox + 86 ppb Competitor	13.9	16.9	15.4	238	246	242	9.3	10.3	9.7	7.80	8.11	8.00
8	50 ppb Imazamox + 353 ppb Competitor	14.1	16.9	15.5	241	248	245	9.2	10.2	9.6	7.86	8.12	8.03
9	500 ppb Imazamox + 3.55 ppm Competitor	14.2	17.2	15.7	118	240	179	9.1	9.6	9.4	7.82	8.16	8.02
10	5000 ppb Imazamox + 35.55 ppm Competitor	14.4	17.4	15.9	238	243	240	7.1	10.0	9.0	7.46	8.10	7.84
11	50000 ppb Imazamox + 35.55 ppm Competitor	14.3	17.7	16.7	252	257	255	3.5	9.3	7.1	7.18	7.88	7.56

APPENDIX G

2015 DBW Annual Performance Report
for Delta Area-Wide Project

**2015
Annual Performance Report**

Cooperator Name: Division of Boating and Waterways
Principal Investigator Name: Edward Hard, Environmental Program Manager
ARS Agreement Number: 58-5325-4-027
Reporting period covered: 07/31/2015 – 12/31/2015

Assess Aquatic Weed Growth under Field Conditions Objective

One of the objectives of the Specific Cooperative Agreement (SCA) is to assess weed growth under field conditions such as low water as is the current condition throughout the Delta.

California State Parks, Division of Boating and Waterways (DBW) has worked with the National Aeronautics and Space Administration (NASA) throughout the federal fiscal year to retrieve timely composite spatial and temporal images that depict potential concentrations of invasive aquatic plants in the Delta. This assessment tool has required both DBW and NASA to ground truth those potential concentrations of vegetation on several occasions to determine the validity of concentration, abundance, and speciation to be enable control of the vegetation. Operational constraints from NASA include the presence of cloud cover on imagery that will prevent the timely delivery of the composite map to DBW. This particular constraint is being adaptively managed to better allow for information expectations on behalf of DBW and NASA is working diligently to evaluate other technical options to provide more timely products to DBW. There is much investment needed to further enhance this objective to ensure some real-time advantages of this type of technique through the next funding cycle.

Implement and Assess Improved Weed Control Methodologies Objective

One of the objectives of the SCA is to implement and assess improved weed control methodologies as designed by the Area-wide task force. DBW had experimentally treated certain acreage in the southern and western Delta as a pilot demonstration study. To meet the objectives of the SCA, DBW contributed to testing new herbicides (imazamox and penoxsulam), identified nursery sites for water hyacinth in the Sacramento-San Joaquin Delta, and implemented more mechanical control during the winter (December 2014-February 2015). DBW staff participated several meetings with the Area-wide meetings task force which included planning and execution of chemical control measures, and identification of potential sites for

mosquito population/vector study. Part of the discussion was a plan to release biocontrol agents in 20-30 areas in the Delta in 2015.

DBW staff conducted experimental treatments of water hyacinth in the Delta using the herbicides imazamox (Clearcast) and penoxsulam (Galleon). Each herbicide was applied to quarter acre plots at both low and high rates to evaluate treatment efficacy. The treated test plots were observed on a weekly basis for one month. Although slow acting, imazamox and penoxsulam were found to be thorough in their impact on water hyacinth growth. It was observed that penoxsulam had better performance compared to imazamox. Additionally, DBW contracted with University of California Davis to conduct toxicity testing on early life stages of delta smelt for imazamox and penoxsulam. Acute and chronic toxicity tests on herbicides alone and interactive effects of herbicide and adjuvant mixtures evaluated 96-hour LC50 for delta smelt embryos and larvae, in addition to evaluation of sub lethal effects. Initial findings indicate that penoxsulam and imazamox may be less toxic to delta smelt than current-use herbicides (2,4-D and glyphosate). Complete results will be presented in a final report which is expected in summer of 2016.

Monitoring Environmental Characteristics Objective

DBW is working with the Central Valley Regional Water Quality Control Board to prepare and begin implementing a study plan to develop nutrient objectives for the Delta in Chapter 6 of the Delta Stewardship Council's Delta Plan. In 2014 Water Board staff wrote a Strategic Work Plan that includes tasks, deliverables and a timeline to develop the study plan and determine if nutrient objectives are needed. DBW is working with this Stakeholder and Technical Advisory Group to accomplish in part a better understanding of the nutrient loading inputs into the Delta that may be impacting the weed growth of the weed populations. DBW is involved in the Macrophyte Workgroup.