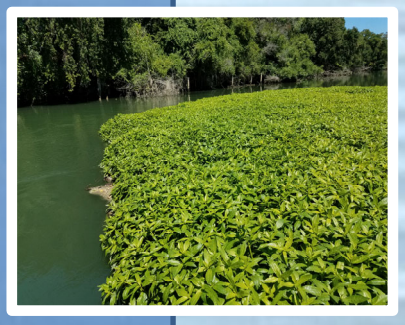
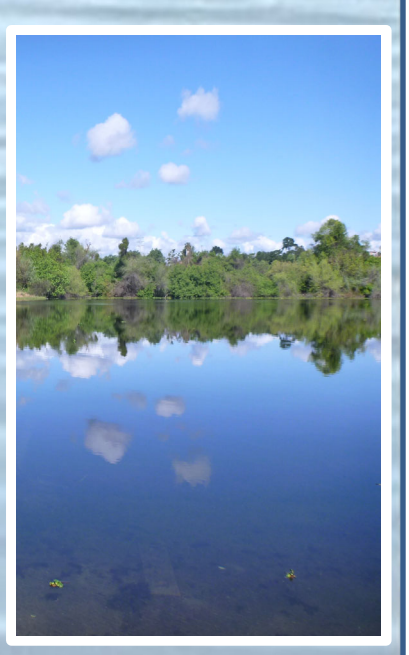
Aquatic Invasive Plant Control Program

2019 Annual Monitoring Report





California Department of Parks and Recreation
Division of Boating and Waterways
March 2020

Aquatic Invasive Plant Control Program
2019 Annual Monitoring Report

Submitted Pursuant to:

- **State Water Resources Control Board (SWRCB)**
  - Statewide General National Pollutant Discharge Elimination System (NPDES) Permit (CAG990005)
- **United States Fish and Wildlife Service Biological Opinions**
  - Service File No. 81410-2013-F-0005, effective March 13, 2013
  - Service File No. 08FBDT00-2014-F-0029, effective August 11, 2014
  - Service File No. 08FBDT00-2018-F-0029, effective April 3, 2019
- **Extensions on the Biological Opinions for:**
  - Service File No. 08FBDT00-2013-F-0015
  - Service File No. 81410-2013-F-0005
  - Service File No.08FBDT00-2014-F-0029
- **National Marine Fisheries Service (NMFS) Letters of Concurrence**
  - 2013/9443, effective February 27, 2013
  - 2014-394, effective May 28, 2014
  - 2017-8268, effective May 15, 2018

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*, Angela Calderaro, Senior Environmental Scientist (Supervisory), Patricia Gilbert (Senior Environmental Scientist Specialist), Jose Martinez (Environmental Scientist), Lydia Kenison (Environmental Scientist), and Michael Kwong (Environmental Scientist), 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.

Ramona Fernandez, Acting Deputy Director
California Department of Parks and Recreation
Division of Boating and Waterways

Date

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ACRONYMS AND ABBREVIATIONS

FRPA	Fish Restoration Program Agreement
2,4-D	2,4-dichlorophenoxyacetic acid
AB	assembly bill
AIPCP	Aquatic Invasive Plant Control Program
AIS	Aquatic Invasive Species
APAP	Aquatic Pesticide Application Plan
BAMS	BioBase Aquatic Map System
BDCW	Python scrips titled Biovolume Data Correction Workflow
BMP	Best Management Practice
BO	Biological Opinion
CDFA	Department of Food and Agriculture
CDFW	California Department of Fish and Wildlife
CDW	Change Detection Workflow
CEQA	California Environmental Quality Act
csv	comma separated value
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
CY	cubic yards
DBW	Division of Boating and Waterways
Delta	Sacramento-San Joaquin Delta, Suisun Marsh, and southern tributaries– the Tuolumne River and Merced River
DIZ	Demonstration Investigation Zone
DO	Dissolved Oxygen (measured in mg/l or ppm)
DPR	Department of Pesticide Regulation
DPS	Distinct Population Segment
DRAAWP	Delta Regional Area Wide Aquatic Weed Project
DSRS	Delta Smelt Resiliency Strategy
DWR	Department of Water Resources
EAV	emergent aquatic vegetation
EDCP	*Egeria densa* Control Program
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FAV	Floating Aquatic Vegetation
FRP	Fish Restoration Program
GC-MS-SPE	gas chromatography-mass spectrometry
GGS	Giant Garter Snake
GIS	Geographic Information System
GPS	Global Positioning System
HPLC	High Performance Liquid Chromatography
IEP	Interagency Ecology Program
MMRP	Mitigation Monitoring Reporting Program
MUN	Municipal and Domestic Supply
NASA	National Aeronautics and Space Administration
ND	No Detection/Non-detect
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollution Discharge Elimination System
NTU	Nephelometric Turbidity Units
OEHHA	Office of Environmental Health Hazard Assessment

OMP	Operations Management Plan
PCR	Pest Control Recommendation
ppb	Parts per Billion (µg/l)
QAC	Qualified Applicator Certificate
QAPP	Quality Assurance Project Plan
RMA	routine maintenance agreement
SAV	Submersed Aquatic Vegetation
SB	senate bill
SCP	Spongeplant Control Program
SWP	State Water Project
SWRCB	State Water Resources Control Board
UC	University of California
USDA-ARS	United States Department of Agriculture – Agricultural Research Service
USFWS	United States Fish and Wildlife Service
UTM	Universal Transverse Mercator
VELB	Valley Elderberry Longhorn Beetle
WHCP	Water Hyacinth Control Program
WSID	West Side Irrigation District

EXECUTIVE SUMMARY

Report Highlights: This annual report provides an overview of the activities conducted by the Aquatic Invasive Plant Control Program (AIPCP) under the Aquatic Invasive Species (AIS) Branch of the California Department of Parks and Recreation, Division of Boating and Waterways (DBW) during the 2019 calendar year in the Sacramento-San Joaquin Delta, Suisun Marsh, and southern tributaries– the Tuolumne River and Merced River (hereinafter referred to as the "Delta").

Importance of Controlling Invasive Aquatic Plants: DBW is the authorized lead agency responsible for identifying, detecting, controlling and administering programs to manage aquatic invasive plants in the Delta. It is crucial to control aquatic invasive plants in the Delta for public health, the economy, and the environment. Aquatic invasive plants can rapidly displace native species, clog water conveyance systems, form dense mats that restrict water movement, trap sediment, provide habitat for mosquitos, and cause fluctuations in water quality. Dense growth may interfere with recreational uses of a waterbody and with navigation.

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; the United States Fish and Wildlife Service (USFWS) Biological Opinions (81410-2013-F-0005 and 08FBDT00-2014-F-0029); the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) Letters of Concurrence (2013/9443, 2013/9391 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). Federal consultations were conducted with the U.S. Department of Agriculture – Agricultural Research Service (USDA-ARS) as DBW's federal nexus. The program also complies with the California Environmental Quality Act (CEQA) Environmental Impact Report (DBW January 24, 2018, Addendum April 2, 2018) and Mitigation Monitoring and Reporting Program (MMRP).

Target Species: The Aquatic Invasive Plant Control Program (AIPCP) is currently authorized to treat the species listed in Table ES-1.

Table ES-1: Target Species

Common Name	Scientific Name
Alligatorweed	*Alternanthera philoxeroides*
Brazillian waterweed or Brazilian elodea	*Egeria densa*
Coontail (or hornwort)	*Ceratophyllum demersum*
Curlyleaf pondweed	*Potamogeton crispus*
Eurasian watermilfoil	*Myriophyllum spicatum*
Fanwort	*Cabomba caroliniana*
South American spongeplant	*Limnobium laevigatum*
Uruguay water primrose	*Ludwigia hexapetala*
Water hyacinth	*Eichhornia crassipes*

Monitoring: All compliance parameters set forth in both the USFWS biological opinions and the NMFS concurrence letters were met during the 2019 treatment season. All monitoring for herbicide residue concentrations at receiving water locations were either not detected or were below receiving water limits as specified in the NPDES Permit. Any occurrences where dissolved oxygen levels, turbidity and pH exceeded limits in the Water Quality Control Plan (Basin Plan) for the Delta Basins established by the Central Valley Regional Water Quality Control Board (CVRWQCB) were expected to be temporary given the diurnal tidal movements of the Delta, varying hydrodynamics, and periodic mixing of the water column. No incidental take of threatened or endangered species occurred during the 2019 season.

2019 season program treatment metrics:

- Treatment dates: March 6, 2019 to November 30, 2019
- 4,553 acres of the 15,000 acres were treated as authorized per our permits.
    - 2,256 acres were treated for Floating Aquatic Vegetation (FAV).
    - 2439 acres were treated for Submerged Aquatic Vegetation (SAV).
    - 6.5 acres of FAV were mechanically harvested.
- Treatments occurred in 190 sites throughout the Delta.
- Collected 2,035 water samples for analysis to determine concentrations of fluridone in the water column.
- Conducted hydroacoustic mapping for 77 of the 78 SAV treatment sites.
- Conducted point sampling to identify the SAV species in all treatment sites.
- Conducted point-intercept sampling to identify the FAV species in 16 treatment sites.
- Conducted photo-point monitoring to monitor FAV growth at various sites throughout the Delta.
- The following quantities of herbicide were applied:
    - 1,433 gallons of 2,4-D
    - 633 gallons of diquat
    - 128,610 pounds of fluridone
    - 338 gallons of endothall
    - 1,736 gallons of glyphosate
    - 1,258 gallons of Imazamox

1 INTRODUCTION

The objective of the Aquatic Invasive Plant Control Program (AIPCP) is to control the growth and spread of aquatic invasive plants in the Sacramento-San Joaquin Delta, Suisun Marsh, and southern tributaries– the Tuolumne River and Merced River (hereinafter referred to as the "Delta") in support of the environment, economy, and public health. Because of the potential for spread, the long-term presence, and the persistence of aquatic invasive plants in the Delta, the AIPCP legislative mandates are for control, rather than eradication of aquatic invasive plants. The AIPCP is part of the California State Parks Division of Boating and Waterways (DBW) Aquatic Invasive Species Program. The mission of the Aquatic Invasive Species (AIS) Program is to manage aquatic invasive plants and to help prevent the introduction and establishment of Dreissenid mussels in the Sacramento-San Joaquin Delta in partnership with other state, local, and federal agencies. This document describes the program to control aquatic invasive plants in the Delta.

The AIPCP provides a comprehensive approach to aquatic invasive plant control in the Delta, and incorporates all previous Delta programs conducted by the Division of Boating and Waterways, including the Water Hyacinth Control Program (WHCP), Spongeplant Control Program (SCP) and *Egeria densa* Control Program (EDCP), and new invasive plant species incorporated through the process defined by Assembly Bill (AB) 763. The AIPCP is supported by the *Collaboration Guidelines for Delta Aquatic Invasive Plant Control* (Guidelines) (Delta Stewardship Council 2018). The Guidelines identify actions, goals, and metrics to support a comprehensive, adaptive, collaborative, flexible, practical, efficient, effective and sustainable approach to managing AIS species in the Delta. The AIPCP adheres to an adaptive management strategy with annual evaluation. This adaptive strategy allows the program to respond to changing conditions in the Delta and facilitates adaptability to changes in other elements, such as regulatory environment, public health, and the economy.

The AIPCP's adaptive management approach to aquatic invasive plant control reflects the changing nature of the Delta ecosystem and the authorization granted by AB 763. It is based on the use of a comprehensive set of treatment tools and approaches to optimize efficacy and environmental protection and is defined by increased use of monitoring, performance metrics, and treatment triggers to guide program actions and reduce risks. A comprehensive and diverse and integrated set of tools will more effectively target treatments, with the aim to control infestations before they spread. For example, implementing management actions earlier should result in fewer acres of aquatic invasive plants that require multiple herbicide applications, thus lowering seasonal herbicide use overall.

The AIPCP aims for efficacious management actions to control aquatic invasive plants while at the same time strives to minimize non-target species impacts and to prevent environmental degradation in the Delta.

DBW is the authorized lead agency for controlling nine (9) aquatic invasive plant species. According to the California Department of Fish and Wildlife (CDFW), invasive species are organisms (plants, animals, or microbes) that are not native to an environment, and once introduced, they establish, quickly reproduce and spread, and cause harm to the environment, economy, or human health (CDFW 2020).

The federal definition of "invasive species" is an alien species (any species that is not native to that ecosystem) whose introduction does or is likely to cause economic or environmental harm or harm to human health (Exec. Order No. 13112, 3 C.F.R. 1999). The nine (9) invasive floating aquatic vegetation (FAV) and submersed aquatic vegetation (SAV) species listed in **Table 1-1** are targeted for control by DBW.

Table 1-1 – Targeted Invasive Plant Species

Common Name	Scientific Name	Floating or Submersed Vegetation*
Alligatorweed	*Alternanthera philoxeroides*	FAV
Brazilian waterweed or Brazilian elodea	*Egeria densa*	SAV
Coontail or hornwort	*Ceratophyllum demersum*	SAV
Curlyleaf pondweed	*Potamogeton crispus*	SAV
Eurasian watermilfoil	*Myriophyllum spicatum*	SAV
Fanwort	*Cabomba caroliniana*	SAV
South American spongeplant	*Limnobium laevigatum*	FAV
Uruguay water primrose	*Ludwigia hexapetala*	FAV
Water hyacinth	*Eichhornia crassipes*	FAV

**Floating Aquatic Vegetation = FAV; Submersed Aquatic Vegetation = SAV*

Plants that grow under the water surface (some submersed plants may have floating leaves) are known as SAV. They grow in wetlands, marshes, shallow water bodies, slow moving waterways, lakes, reservoirs, and rivers. Some SAV are invasive, and if they are left unchecked, they can be a problem for boaters, agriculture and public safety.

Plants that grow on top of the water surface (some with some emergent characteristics) are known as FAV. They grow in wetlands, marshes, shallow water bodies, slow moving waterways, lakes, reservoirs, and rivers. FAV can be a problem for boating, agriculture, public safety, and can negatively impact the environment, industry and local economies.

Extent of Infestation

The Delta contains an estimated 101,000 water surface acres, all of which may provide habitat for FAV and SAV. Aquatic invasive plants are fast growing and have a significant impact on the shallow water habitat in the Delta ecosystem. Since these aquatic invasive plants were introduced to the region, many areas have become infested. Aquatic invasive species influence biological diversity, water conveyance, navigation, recreation and agriculture of the Delta. Aquatic invasive plants can crowd out native vegetation, provide habitat for mosquitoes, reduce water flows, entrap sediments, de-stabilize dissolved oxygen cycles, obstruct waterways and navigational channels, impede anadromous fish migration patterns, shade out crucial shallow-water fish habitat, and clog agricultural and municipal water intakes.

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, seasonal air and water temperatures, water flows, water levels, and rainfall. During the 2016-2017 winter, an increase in precipitation and water flows flushed large concentrations of water hyacinth out of the Delta and towards marine waters.

Determining the annual extent of infestation of invasive FAV and SAV in the Delta and its tributaries can be difficult because both individual plants and large mats can move with river currents, diurnal tidal movement, and winds. Historically, pre- and post-season infestations have been assessed through visual estimates conducted by DBW field staff. However, hydroacoustic mapping, and point-intercept survey efforts have assisted with tracking FAV and SAV distributions.

Through a partnership with National Aeronautics and Space Administration (NASA), as a part of the U.S. Department of Agriculture – Agricultural Research Service (USDA-ARS) Delta Regional Areawide Aquatic Weed Project (DRAAWP), NASA has provided DBW with map imagery from Landsat satellite data that depicts live water hyacinth and water primrose acreage of areas that have high probability of experiencing greater than 50 percent coverage of FAV in Delta waterways. Imagery was provided on a monthly basis to DBW, weather permitting since cloud cover can impact the satellite image.

Aerial flight imagery was also obtained through contractual efforts between DBW and Tetra Tech for various sites in the Delta. This data was primarily utilized to survey specific sites that needed more monitoring, because they were historically or presently problematic, and/or require or have received mechanical control. Tools and methodologies for further processing and analyzing this aerial flight imagery, such as vegetation classification via spectral signatures or reflectance, began in 2017 and will continue to be developed and refined for potential future use and integration into the FAV Control Program.

Setting

The AIPCP includes portions of eleven (11) counties that encompass the Delta, including Alameda, Contra Costa, Fresno, Madera, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Tuolumne, and Yolo. General boundaries for the treatment area in the Delta 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 from Clifton Court along Old River to Mossdale, and continuing along the San Joaquin River to Mendota, just east of Fresno

- East along the San Joaquin River to the City of Stockton, continuing 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 AIPCP's project area, there are 418 possible treatment sites. These sites vary in size between five (5) and 1,700 acres and may be between one and three miles in length. See **Figures A-1, A-2, and A-3** in **FAV Appendix A** and **SAV Appendix A** for maps of the AIPCP's project area and monitoring sites sampled in 2019.

2 ENABLING LEGISLATION

Both the USDA-ARS and DBW will implement the AIPCP. The AIPCP is an aquatic weed program designed to control the growth and spread of aquatic invasive plants in the Delta. The USDA-ARS is the federal nexus, providing research, and scientific expertise for AIPCP, similar to their previous federal nexus roles for the Water Hyacinth Control Program (WHCP), Spongeplant Control Program (SCP), and Egeria densa Control Program (EDCP). USDA-ARS has provided technical and programmatic advice to DBW for over thirty (30) years, prior to the WHCP's inception. In addition, within the AIPCP, USDA-ARS will manage, implement, and monitor the use of biological control methods. DBW will be the lead agency in managing and implementing herbicide and physical control methods.

The AIPCP replaces the prior WHCP, SCP, and EDCP actions with one comprehensive aquatic weed control program for the Delta. The Harbors and Navigation Code, Section 64, authorizes DBW AIS control programs. The legislature has provided authority through the following:

- Senate Bill (SB) 1344 (Garamendi, Chapter 263, Statutes of 1982) designated the then Department of Boating Waterways as the lead agency for controlling water hyacinth (*Eichhornia crassipes*) in the Delta, its tributaries, and Suisun Marsh.
- AB 2193 (Rainey, Chapter 728, Statutes of 1996) authorized DBW to develop a control program for *Egeria densa* (Brazilian waterweed) in the Delta, its tributaries, and Suisun Marsh.
- AB 1540 (Buchanan, Chapter 188, Statutes of 2012) authorized DBW to control South American spongeplant (*Limnobium laevigatum*) in the Delta, its tributaries, and Suisun Marsh.
- AB 763 (Buchanan, Chapter 330, Statutes of 2013) created a new process within Section 64.5 of the Harbors and Navigation Code for authorizing new AIS control programs in the Delta, its tributaries, and Suisun Marsh. The bill authorizes DBW, in consultation with appropriate state, local, and federal agencies, and upon concurrence from the California Department of Fish and Wildlife (CDFW), following the completion of a specified assessment described in the bill, to take such action it determines is necessary to implement control and, when feasible, eradication measures for those invasive aquatic plants.

AB 763 requires DBW to consult regularly with USDA-ARS, United States Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), the University of California, other members of the scientific and research communities, and other state agencies with authority over the control of invasive aquatic plants to determine which invasive plant species should be given the highest priority for management and to determine the best control, and, when feasible, eradication measures. To date, five species have been added to the AIPCP through AB 763 risk assessments (water primrose, curlyleaf pondweed, Eurasian watermilfoil, Carolina fanwort, and coontail/hornwort).

AB 763 also requires DBW, after consulting with appropriate state, local, and federal agencies, if it identifies a species of aquatic plant that may be invasive and needs to be controlled or eradicated, to notify CDFW of the potential threat from that aquatic plant. AB 763 requires CDFW, after receipt of that notice, in consultation with other appropriate local, state, and federal agencies, to conduct a risk assessment of that aquatic plant species to determine whether the plant species presents a threat to

the environment, economy, or human health, as determined after consideration of specified factors. AB 763 requires the risk assessment to specify whether the aquatic plant under consideration has been determined to be invasive. It requires CDFW, within 60 days after completing that assessment, to report its findings to DBW so that DBW may take any necessary action to control and, when feasible, eradicate an invasive aquatic plant, as authorized under AB 763.

Rather than being guided by the historical species-by-species approach, the AIPCP is a single, unified comprehensive program that incorporates all current and potential future aquatic invasive plant control activities. This shifts the focus from separate treatment regimens for one target plant species to a holistic and integrated multispecies treatment approach by employing the most current, appropriate, and feasible available methods.

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."

SB 1344 (Garamendi and Nielsen, Ch. 263, Statutes of 1982) amended Section 64 of the Harbors and Navigation Code 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."

Egeria densa was first introduced in Assembly Bill 2193 (Rainey, Ch. 728, Statutes of 1996), then Assembly Bill 763 expanded species jurisdiction to DBW 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."

In 2012, Assembly Bill 1540 (Buchanan, Ch. 188, Statutes of 2012) was passed to add spongeplant control to DBW's jurisdiction.

AB 763 (Buchanan, Ch. 330, Statutes of 2013) amended Section 64 of the Harbors and Navigation Code as follows:

"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)."

2.3 Risk Assessment Status

CDFW administers the risk assessment process to determine whether a species can be considered an invasive species in California. CDFW uses the U.S. Aquatic Weed Risk Assessment tool to evaluate aspects of a species' ecology, reproductive potential, dispersal mechanisms, competitive ability, actual and potential impacts (including impacts to navigation and recreation, the environment, economy, and human health as specified in Harbors and Navigation Code 64.5), and resistance to management. Based on this evaluation, CDFW, in consultation with the California Department of Water Resources (DWR), State Water Resources Control Board (SWRCB), Department of Food and Agriculture (CDFA), Department of Pesticide Regulation (DPR), and Office of Environmental Health Hazard Assessment (OEHHA), and in concurrence with DWR will make a determination whether the species is an invasive aquatic plant that causes, or is likely to cause, economic or environmental harm, or harm to human health in California. The scoring system is broken into three categories, non-invaders score less than 31, scores between 31 and 39 require further evaluation, and any species with a score greater than 39 is considered a major invader. **Table 2-1** shows the risk assessment determination for each species.

Table 2-1 – Risk Assessment Scores

Common Name	Scientific Name	Score	Date of Determination
Brazillian waterweed	*Egeria densa*	*	Not Available
Water hyacinth	*Eichhornia crassipes*	*	Not Available
South American spongeplant	*Limnobium laevigatum*	*	Not Available
Curlyleaf pondweed	*Potamogeton crispus*	66	June 12, 2015
Eurasian watermilfoil	*Myriophyllum spicatum*	76	June 28, 2016
Uruguay water primrose	*Ludwigia hexapetala*	76	July 22, 2016
Coontail	*Ceratophyllum demersum*	58	October 14, 2016
Fanwort	*Cabomba caroliniana*	75	January 25, 2018
Alligatorweed	*Alternanthera philoxeroides*	74	March 1, 2018

**Brazilian waterweed, water hyacinth, and South American spongeplant were determined to be invasive, prior to the use of this scoring tool.*

3 ENVIRONMENTAL COMPLIANCE

3.1 Summary of Regulatory Compliance Requirements

The following constitutes a summary of the environmental compliance documents required to implement the AIPCP. Each document has requirements designed to ensure avoidance or minimization of significant impacts to beneficial uses of waters of the U.S., threatened and endangered species protected by the federal 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 AIPCP from two federal agencies: United States Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS).

DBW obtained a multi-year (2018-2022) authorization from USFWS and NMFS to operate the AIPCP pursuant to Section 7 of the ESA.

- USFWS Biological Opinion (08FBDT00-2018-F-0029), effective April 3, 2019
- NMFS Biological Opinion (WCR-2017-8268, effective May 15, 2018

A National Pollutant Discharge Elimination System (NPDES) permit is required by State Water Resources Control Board (SWRCB). Coverage under this permit was obtained in December 2013 and expired in 2018. The permit 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 Routine Maintenance Agreement under the Lake or Streambed Alteration Agreement Program was entered into between DBW and CDFW for mechanical removal and harvesting efforts of FAV (Notification No. 1600-2015-0132-R3). The Agreement became effective October 23, 2015 and will expire on December 31, 2019. An extension was filed on September 24, 2019.

3.2 Reporting Requirements

3.2.1 NPDES Statewide General Permit

The NPDES Statewide General Permit for Aquatic Pesticide Use requires DBW to submit an annual report on March 1, following the AIPCP application season. Reporting per NPDES guidelines must include the following:

1) An executive summary discussing compliance or violation of this General Permit and the effectiveness of the Aquatic Pesticide Application Plan (APAP) to reduce or prevent the discharge of pollutants associated with algaecide and aquatic herbicide applications.

2) A summary of monitoring data, including the identification of water quality improvements or degradation as a result of the algaecide or aquatic pesticide application, if appropriate, and recommendations for improvements to the APAP [including proposed best management practices

(BMPs)] and monitoring program based on the monitoring results. All receiving water monitoring data shall be compared to receiving water limitations and receiving water monitoring triggers.

3) Identification of BMPs currently in use and a discussion of their effectiveness in meeting the requirements in this General Permit.

4) A discussion of BMP modifications addressing violations of this General permit.

5) A map showing the location of each treatment area (explanation of Treatment Site Selection and Prioritization on page 23).

6) Types and amounts of algaecides and aquatic herbicides used at each application event.

7) Information on surface area and/or volume of treatment areas and any other information used to calculate dosage, concentration, and quantity of each algaecide and aquatic herbicide used.

8) Sampling results shall indicate the name of the sampling agency or organization, detailed sampling location information (including latitude and longitude or township/range/section if available), detailed map or description of each sampling area (address, cross roads, etc.), collection date, name of constituent/parameter and its concentration detected, minimum levels, method detection limits for each constituent analysis, name or description of water body sampled, and a comparison with applicable water quality standards, description of analytical quality assurance/quality control plan. Sampling results shall be tabulated so that they are readily discernible.

9) Summary of algaecide and aquatic herbicide application log.

3.2.2 Biological Opinion and Letter of Concurrence

Both the USFWS Biological Opinion (BO) and NMFS Letter of Concurrence requires an annual report to be submitted January 31, following the application season. This report summarizes 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 BO. 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” (ESA; 16 U.S.C. 1532 et. Seq.). 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.

3.2.3 Statewide General NPDES Permit

RECEIVING WATERS

There are clear definitions in the NPDES Permit (No. CAG990005, Water Quality Order 2013-0002-DWQ) regarding the 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 invasive plants. It is the

responsibility of the discharger to define the treatment area for each location that it discharges to. The AIPCP treats waterways with invasive aquatic plants. Therefore, considering the NPDES definitions, the application and treatment areas are essentially the same geographic place in relation to the FAV and SAV. 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.

WATER QUALITY PARAMETERS

The AIPCP is required to monitor specific water quality parameters to ensure there are no significant impacts to beneficial waters of the United States. The physical and chemical water quality parameters monitored are temperature, salinity, electrical conductivity, turbidity, pH, and dissolved oxygen. The SAV also conducts visual inspections before, during and after applications have been made. All changes in water color, odor, and vegetative health are annotated.

Dissolved Oxygen

Dissolved oxygen (DO) limits are outlined in the Central Valley Basin Plan issued by the Central Valley Regional Water Quality Control Board (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 95th 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
- 7.0 mg/l for waters designated as cold freshwater habitat
- 7.0 mg/l for waters designated for spawning, reproduction, and development

In the locations listed in **Table 2-2**, dissolved oxygen concentrations shall not be reduced below the amount indicated during the stated time period.

Table 2-2. Specific Dissolved Oxygen Water Quality Objectives

Location	DO concentration	Time Period
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

pH and Turbidity

In addition to DO limits, basin limits for pH and turbidity are also described in the Central Valley 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.

3.2.4 USFWS Biological Opinion for AIPCP

The BO, pursuant to Section 7 of the federal ESA, imposes several measures to avoid impacts to protected species in the Delta. Primarily, DBW has been directed to implement species avoidance and habitat loss minimization. There are three main components to avoidance and habitat minimization mitigation. Components are seasonal timing of applications, species specific toxicity evaluations, and applicator education. DBW does treat during seasonal migrations for listed protected species. Species specific toxicity concentrations used by the AIPCP are well under all compliance requirements listed under BO. All applicators received worker environmental awareness training before treatment began on March 11, 2019. Personnel were informed as to the presence and life histories of endangered, threatened and other special status species such as the Valley elderberry longhorn beetle (VELB; *Desmocerus californicus dimorphus*), Delta smelt (*Hypomesus transpacificus*), and the giant garter snake (*Thamnophis gigas*); habitats associated with species; sensitive habitats and wetlands; the terms and conditions of the program's biological opinion; incidental take procedures, and the unlawful take of an animal or destruction of its habitat is a violation of the federal and/or California ESA. The briefing also included the BO as required by Section 7 of the federal ESA and concurrences from NMFS.

Delta Smelt

The BO outlines specific mitigation measures to minimize impact to Delta smelt and associated habitats. Several state and federal fish surveys are 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 conservation measures aim to reduce the potential for negative impacts on delta smelt. The BO outlines expected critical habitat and current locations of Delta smelt that must be avoided by specified treatments during the timing specified in the biological opinion. If Diquat is used it may only be applied between August 1 and November 30. For all treatments conducted between March 1 and June 30, the ability to treat aquatic invasive plants 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 as well as the expected critical habitat and current locations of Delta smelt. The goal is to significantly reduce and eliminate potential adverse effects to Delta smelt and critical habitat. 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.

The BO requires that personnel involved with the AIPCP receive 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 BO for protection, avoidance and minimization of impacts to this protected species under the federal ESA.

Valley Elderberry Longhorn Beetle

The BO outlines specific mitigation measures to minimize impacts to the Valley elderberry longhorn beetle (VELB), and associated habitat, elderberry shrubs (*Sambucus* spp.). DBW was directed by USFWS to avoid impacts to VELB by maintaining a 100-foot buffer between treatment sites and shoreline elderberry shrubs unless surveys are conducted pre- and post-treatment. Herbicide applications must occur away from and downwind of elderberry shrubs.

The BO requires that personnel involved with the AIPCP 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 elderberry shrub 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 this protected species under ESA.

Giant Garter Snake

The BO outlines specific mitigation measures to minimize impact to the giant garter snake (GGS). Restrictions regarding GGS in the BO apply to any land-based operations, which occur on Delta banks other than existing roads or boat ramps, and to mechanical removal operations in

sensitive GGS habitat. The entire AIPCP 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 (Hansen 2002).

The BO requires that personnel involved with the AIPCP receive worker environmental awareness training. Under this training program, personnel are informed about the presence of GGS 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 BO for protection, avoidance and minimization of impacts to this protected species under the federal ESA.

3.2.5 NMFS Biological Opinion for AIPCP

NMFS issued a BO (WCR-2017-8268 on May 15, 2018) in response to USDA-ARS and DBW's request for ESA Section 7 consultation. Based on the AIPCP project descriptions and supplemental material provided, and the best available scientific and commercial data, NMFS concluded that the AIPCP is not likely to jeopardize the continued existence of federally listed species or their designated critical habitats. Additionally, NMFS has included an incidental take statement, reasonable and prudent measures, and non-discretionary terms and conditions that are necessary and appropriate to avoid and minimize "take" and monitor incidental take of federally listed fish.

The AIPCP project description outlines specific mitigation measures and avoidance guidelines to minimize impact to Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), Central Valley steelhead trout (*O. mykiss*), and green sturgeon (*Acipenser medirostris*). 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-ARS included specific timing for 2,4-D (2,4-dichlorophenoxyacetic acid) 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).

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 letters of concurrence.

4 PERSONNEL, MATERIALS AND METHODS

4.1 AIPCP Personnel and Certifications

4.1.1 Application Crews

During 2019, DBW had five (5) to ten (10) full-time crews, each crew consisting of an Aquatic Pest Control Specialist and an Aquatic Pest Control Technician. DBW also had an interagency contract with the California Conservation Corps for additional personnel to assist the application crews. Each crew contains a minimum of one member possessing a Category F (Aquatics) Qualified Applicators Certificate (QAC), administered by the California Department of Pesticide Regulation. Under contract with DBW, Merced County and Fresno County Departments of Agriculture also had staff assigned to conduct surveys, and herbicide treatments or manual removal for FAV in the southern tributaries as needed.

APPLICATION EQUIPMENT

To treat SAV, crews use either a 19- or 21-foot aluminum boat powered by either an outboard engine or air driven. At the start of each treatment the application crew takes dissolved oxygen and a temperature reading using a HACH® Dissolved Oxygen Meter within the treatment site. These readings must be within the parameters outlined in the NPDES Permit and the USFWS BO before an application can be made. At the start of the application, the crew uses tablets equipped with a Global Positioning System (GPS) unit to record the beginning and ending spray lines, coordinates of the spray area and the time of treatment. Each crew uses either an Earthway Commercial spreader (30-foot spread), Hopper (50-foot to 60-foot spread), or Vortex (15-foot spread) unit with handheld blower tube to disperse herbicide to the target site.

To treat FAV, herbicide applications were conducted with handheld spray wands operated from 19-foot airboats, 21-foot outboard aluminum boats, or a ground spray rig. The boats are equipped for direct metering of herbicide, adjuvant, and water into the pump system of the spraying unit. Each application crew utilized a Hach® HQ-30 Dissolved Oxygen Meter and a tablet equipped with a GPS unit to record pre-spray and post-spray temperature, dissolved oxygen, wind speed, beginning and ending Universal Transverse Mercator (UTM) coordinates of spray area, amount of herbicide used, and the date and time of treatment.

Spray equipment were calibrated routinely, 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.

All boats are washed regularly to remove herbicide residues and all application pumps, hoses, and nozzles are inspected and, if found defective, are replaced on an as-needed basis. Boat maintenance records are available upon request.

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 on February 12, 2019 and on subsequent days for new employees. This training included the following items:

- Identification of commonly observed invasive aquatic plants in the Delta
- Species identification and impact avoidance guidelines on all threatened and endangered species associated with the AIPCP.
- 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 BOs and NMFS letters of concurrence for the FAV Program for protection, avoidance and minimization of adverse effects to protected species under the ESA.
- Avoidance and minimization measures for species of concern that are outlined in the Routine Maintenance Agreement for mechanical removal/harvesting of FAV.
- 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 Getac Tablets, Survey 123, and Collector applications take place routinely.

4.1.2 Monitoring Personnel

Environmental monitoring activities are overseen by a Senior Environmental Scientist and conducted by qualified personnel, which may include a Senior Environmental Scientist, Environmental Scientist, Associate Toxicologist, Fish and Wildlife Scientific Aids and/or Student Assistants. All water sampling events are carried out in accordance with the Quality Assurance Project Plan (QAPP) and the FAV Environmental Monitoring Protocol as approved by the SWRCB, 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 training for all monitoring personnel on environmental monitoring and field equipment protocols.

The scientists schedule and plan all field sampling events. Pictures are used to document any unusual conditions of the sampling locations, vegetation, or surrounding areas. Additional responsibilities include quality control field monitoring, laboratory analysis and reporting of findings in this annual report.

MONITORING EQUIPMENT

A 21-foot outboard motorboat (North River) was used for monitoring activities. Water samples were collected using the MasterFlex® E/S® Portable Sampler fitted with 7 to 10 feet of tubing. 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 SAV. 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 handwritten 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.

To avoid water sample contamination, boats used for environmental monitoring were never used for herbicide applications. Monitoring boats are 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.

4.2 *Materials and Methods*

4.2.1 Herbicide Application

AIPCP OPERATIONS MANAGEMENT PLAN

The AIPCP 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

The herbicide products used for AIPCP treatment include the following:

- 2,4-D (Nufarm Weedar® 64), EPA Reg. No. 71368-1-ZB
- Diquat (Reward Landscape and Aquatic Herbicide), EPA Reg. No. 100-1091
- Endothall (Aquathol K), EPA Reg. No. 70506-176
- Fluridone (Sonar Q®) - EPA Reg. No. 67690-3 (Pellets)
- Fluridone (Sonar One®) - EPA Reg. No. 67690-45 (Pellets)
- Fluridone (Sonar PR®) - EPA Reg. No. 67690-12 (Pellets)
- Glyphosate (Monsanto Round-up Custom™), EPA Reg. No. 524-343-ZG
- Imazamox (Clearcast herbicide), EPA Reg. No. 241-437-67690

Prior to the start of each fluridone treatment season, USDA-ARS and DBW (with consultative support from SePRO Corporation Aquatic Specialists) will develop a treatment protocol for each selected treatment site. The protocol will specify weekly fluridone applications at a specific parts per billion (ppb) level, by quantity and formulation, based on the size and depth of the treatment area, infestation level, presence of nearby irrigation or potable water intakes, and the extent of tidal influence at the site. This protocol will provide a baseline treatment plan that will be adjusted on a weekly basis, if necessary, based on results from water samples taken at treatment sites throughout the treatment season. The AIPCP will conduct regular water sampling per the fluridone annual monitoring protocol. Information on the AIPCP treatment sites by Delta smelt habitat level are found in **Table 4.1**.

Table 4-1. SAV Treatment Sites, Herbicides and Timing

Delta Smelt Habitat Level	USFWS Area	Legal Delta Boundary Area	Treatment Site Numbers[f]	Fish Survey Reporting Required[b,c]	Fluridone	Diquat
Primary Habitat	1	Legal Delta North of Hwy 12	200-290	March 1 to June 30	March 1 to Nov. 30	August 1 to Nov. 30
		Legal Delta South of Hwy 12	16-24b, 39-44, 69, 98a-176	March 1 to June 30	March 1 to Nov. 30	August 1 to Nov. 30
Secondary Habitat	2	Legal Delta South of Hwy 12	11-15, 33, 49-68, 78, 79, 83a-97	March 1 to June 30	March 1 to Nov. 30	August 1 to Nov. 30
Tertiary Habitat	3	Legal Delta South of Hwy 12	1-10, 25-38, 45-48, 70-77, 80-82, 291	March 1 to June 30	March 1 to Nov. 30	August 1 to Nov. 30
Non- Habitat	4	Legal Delta South of Hwy 12	300-309	March 1 to June 30	March 1 to Nov. 30	August 1 to Nov. 30
		Non-Legal Delta	370 and above	March 1 to June 30	March 1 to Nov. 30	August 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).

[b] DBW will implement a survey-based approach to conducting treatments that allows for treatments starting as early as March 1, in areas with re-growing Egeria densa when listed fish species are not present and water temperatures are rising, 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] DBW will monitor the efficacy of the new herbicides penoxsulam and imazamox (time to symptoms, plant death, and regrowth).

Table 4-2: 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.

Delta Smelt Habitat Level	USFWS Area	Legal Delta Boundary Area	Treatment Site Numbers	Fish Survey Reporting Required[b, c]	Glyphosate	2,4-D[d]	Penoxsulam[e]	Imazamox[e]	Agridex	Competitor
Primary 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 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 Habitat	3	Legal Delta South of Hwy 12	1-10, 25-38, 45-48, 70-77, 80-82, 21	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-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.

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 AIPCP requirements.

- Herbicide Handling Requirements – All personnel will be trained in herbicide handling in accordance with Food and Agriculture Code and Title 3 of California Code of Regulations pertaining to Pesticides and Pest Control Operations.
- Spray Equipment Calibration – Herbicide application equipment used for the AIPCP 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 remediated immediately. DBW applies preventative measures to reduce the potential for a serious spill.
- Annual Environmental Awareness Training – All program personnel involved in herbicidal treatments 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, State Water Project (SWP) or Central Valley Project (CVP) regarding water quality impacts.

TREATMENT SITE SELECTION AND PRIORITIZATION

Prior to the start of the treatment season, field crews visually surveyed all sites in their application region and estimated the acres infested with AIS. Hydroacoustic mapping was conducted in the areas considered by the crews to have a high infestation of submersed aquatic plants and that fell into one of DBW's high priority categories. Herbicide applications were prioritized such that nursery areas with a 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 these pre-season field surveys, combined with the staff's experience and knowledge of AIS 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 floating aquatic vegetation, and environmental considerations. Logistics, such as number of application 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 were 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 herbicide application season began on March 6, 2019 throughout the Delta where protected fish species were not likely to be present and in FAV sites within USFWS Areas 2, 3 and 4, where protected fish species were not likely to be present. At the start of the season, initial site prioritization focused FAV treatments in sections of Old River in the South Delta, Disappointment Slough, White Slough, and Fourteen Mile Slough. After June 1, sites in USFWS Area 1, such as Snodgrass Slough, Lost Slough, and Sycamore Slough, became open for herbicide treatment. All through the season, fish monitoring data were continuously reviewed to avoid treating in sites where listed fish species were likely to be present. The site selection process also considered information and concerns received from the public.

4.2.2 Environmental Monitoring

The AIPCP is responsible for collecting water quality monitoring data for the NPDES permit, as well as collecting water samples for herbicide residue testing.

AIPCP NPDES Annual Monitoring Protocol

All water quality monitoring follows the NPDES Annual Monitoring Protocol as outlined in the AIPCP Aquatic Pesticide Application Plan (APAP), which was approved in January 2014 by the SWRCB. Quality control and quality analysis measures are outlined in the Quality Assurance Project Plan (QAPP). Monitoring activities include recording FAV and SAV 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 water temperature, electrical conductivity, salinity, dissolved oxygen, pH, and turbidity. DBW also conducts physical inspections of the treated and surrounding areas to identify changes in water color and odor along with changes in vegetative health of the species within and around the treatment area.

NPDES Monitoring Site Selection

Environmental monitoring sites were selected based on requirements listed under the NPDES permit and biological opinion. The SWRCB Statewide General NPDES Permit requires that dischargers monitor a certain proportion of sites based on the total number of treated sites. 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 2019, one site, Cruiser Haven, within the Delta was designated as a monitoring site for the SAV fluridone program. There were additional Demonstration Investigation Zone (DIZ) sites that had NPDES data collected. DIZ’s are sites that serve as a study to collect data on new herbicides and methods to show that they are safe and effective. These studies are done with our federal partner, USDA-ARS. There

were 11 DIZ sites for Diquat and one site for Endothall (**Table 4-3)**. The DIZ report can be located at AIPCP's website.

Table 4-3. 2019 SAV Monitoring Sites

Site #	Site Name	Acres			NPDES
		Fluridone	Diquat	Endothall	
26	Fourteenmile Slough		16.00		X
47	Middle River - Howard			23.00	X
91a	Cruiser Haven	21.00			X
93.I	Indian Slough		8.00		X
93.D	Cabrillo Bay		15.00		X
93.M	Marina Bay		19.00		X
93.F	First & Paradise Coves		8.00		X
93.P	Princess Cove & Sand Bay		12.00		X
93.S	Shell Bay		4.00		X
107	Piper Slough		16.00		X
109	Sand Mound Slough		14.00		X
110	Taylor Slough		20.00		X
241	Long Island Slough		8.00		X
290a	Washington Lake			33.00	X

Six sites within the Delta were designated as monitoring sites for the FAV Program. Representative monitoring for the FAV Program occurred in sites with varying degrees of habitat for the following species: giant garter snake, Delta smelt, and Valley elderberry longhorn beetle. 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 elderberry shrubs in the project area (**Tables 4-4 and 4-5**). Laboratory results data can be found in **FAV Appendix D** and **SAV Appendix B.**

Table 4-4. 2019 FAV Monitoring Sites

Site #	Location	Water Body Type	Herbicide
31	Mosher Slough/Bear Creek	Tidal	2,4-D
33	Disappointment Slough	Tidal	2,4-D
17	Hayes Reach/San Joaquin River	Tidal	Imazamox
106	Fisherman's Cut	Tidal	Imazamox
102	Holland Cut	Tidal	Glyphosate
103	Old River	Tidal	Glyphosate

Table 4-5. 2019 FAV Monitoring Sites and Habitat Quality

Site #	Location	GGS Habitat Quality	Delta Smelt Habitat	VELB Habitat
31	Mosher Slough/Bear Creek	No Habitat Value to Low-Moderate	Absent	Present
33	Disappointment Slough	Low-Moderate to Moderate-High	Absent	Present
17b	Hayes Reach/San Joaquin River	Low to High	Present	Absent
106	Fisherman's Cut	Low to Low-Moderate	Present	Absent
102	Holland Cut	No Habitat Value to Low	Present	Absent
103b	Old River, East Franks Tract	Low to Moderate	Present	Absent

NPDES RESIDUE SAMPLING

For liquid herbicides, water sampling occurs on the same day of the respective 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 FAV species were 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).

For Sonar pellet applications the NPDES sampling protocol differs. For each application event, DBW takes a pre-sample and as many weekly post samples as necessary until a non-detection of fluridone is obtained. These samples are identified as A, B, and C. Sample location A is inside of the application area approximately 1/4 to 1/3 the distance from the downstream edge of the application polygon. Sample location B is located on the downstream edge of the application polygon, and sample site C is in an adjacent non-impacted area with similar hydrological conditions as the application are or receiving waters.

All water quality monitoring followed the NDPES Annual Monitoring Protocol as outlined in the APAP.

FLURIDONE ANNUAL MONITORING PROTOCOL

DBW will also take water samples at approximately three (3) feet depth and submit these samples to Dr. Pramod K. Pandey's Laboratory at the Department of Population and Health, School of Veterinary Medicine, UC Davis. The lab will determine herbicide concentrations by High Performance Liquid Chromatography (HPLC). Results will be provided within 24 hours of the time the sample was taken. This quick and regular herbicide monitoring will allow AIPCP staff to ensure that herbicide concentrations are maintained at efficacious levels, and that water quality standards are not exceeded, particularly for irrigation. Depending on the results, the treatment protocol may be adjusted to achieve an appropriate herbicide concentration.

FLURIDONE MONITORING SITE SELECTION

Each treatment polygon has at least one water sample site selected that best represents the treatment site. These sample points are generally selected at the middle and end points for sloughs and equally spaced around larger polygon areas such as Franks Tract. Each site is sampled at least every other week. Most of the sites are established at the beginning of the treatment season and remain throughout. Extra sample sites were added during the 2019 treatment season at points where information regarding the residence time of fluridone was needed. Maps of each treatment site with water sample point locations are listed in **SAV Appendix C**.

FLURIDONE RESIDUE SAMPLING

The results of the water samples were used to monitor and adjust the herbicide rate of application to ensure that the residues in the water column are conducive to attain the maximum aquatic invasive plant efficacy, preferably 1.5 to 3.5 ppb. DBW collected 2,035 fluridone water samples during the 2019 treatment season.

Table 4-6

Site #	Site Name	Acres Fluridone	Acres Diquat	Acres Endothall
	PHASE I - April 8 to 7-22, 2019			
8.A	Atherton Cove	27.00		
8.C	Calaveras River	44.00		
10.B	Buckley Cove	23.00		
10.S	Stockton Sailing Club	11.30		
10.W	Windmill Cove Marina	9.00		
12	Tiki Lagun & Turner Cut Resorts	86.00		
14.D	Delta Yacht Club	3.00		
14.H	Headreach Island	65.00		
14.P	Power Squadron	18.00		
15	St. Francis Yacht Club	19.00		
18a.K	Korth's Pirates Lair	14.00		
18a.P	Perry's Boat Harbor	9.00		
18a.W	Willow Berm Marina	19.00		
19a	Spindrift Marina	40.00		
20	Sevenmile Slough	65.00		
22.S	Brannan Island Slough	12.00		
25	Fourteenmile Slough - east	8.00		
26	Fourteenmile Slough		16.00	
26.M	Village West Marina	26.00		
30	Mosher Slough	37.74		
36	White Slough Upland	25.00		
37	White Slough	197.86		
47	Middle River - Howard			23.00
56	Middle River - Berkeley Ski Club	24.00		
58	Middle River - Bullfrog Ski Club	22.00		
78	Hammer Island	6.00		
79	Rivers End Marina	13.00		
84a.A	Old River - Salisbury Alley	3.00		
84a.C	Old River - Salisbury Cove	2.00		
84a.S	Old River - Speckman Slough	2.00		
84a/b	Old River - Coney Horseshoe	6.00		
85b	Old River - Quin's Island	33.00		
87a	Italian Slough	8.00		
87b	Italian Slough	3.00		
87b	Kings Island	2.00		
88	Lazy M Marina	5.00		
91a	Cruiser Haven	21.00		
92a/b	Old River - Diablo Ski Club	15.00		
93.I	Indian Slough		8.00	
93.D	Cabrillo Bay		15.00	
93.M	Marina Bay		19.00	
93.F	First & Paradise Coves		8.00	
93.P	Princess Cove & Sand Bay		12.00	

93.S	Shell Bay		4.00	
93	Discovery Bay	126.00		
107	Piper Slough	93.00	16.00	
109	Sand Mound Slough	56.00	14.00	
110	Taylor Slough	111.00	20.00	
111	Taylor Slough	13.00		
112	Emerson Slough	15.00		
115	Big Break	199.00		
116	Big Break	211.00		
117	Big Break	137.00		
119b.D	Driftwood Marina	8.00		
120b.L	Lloyd's Holiday Harbor	4.00		
120b.N	New Bridge Marina	7.00		
140	Delta Marina Rio Vista	8.00		
141	Das Cliff Haus	2.00		
171	Delta Coves		6.00	
176	Decker Island	36.00		
209a	B & W Resort and Marina	3.00		
214	The Meadows - Loche Slough	22.00		
216	The Meadows - NE	28.00		
241	Long Island Slough	10.00	8.00	
251a	Hidden Harbor Resort	8.00		
252a	Snug Harbor	10.00		
252b.H	Hogback	3.00		
252b.M	Morgan Slough	2.00		
267.S	Prospect Slough	27.00		
272	French Island	9.00		
286	Oxbow Marina	16.00		
290a	Washington Lake			33.00
		2,087.90	146.00	56.00

PHASE II - July 29 to November 11, 2019

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 Dr. Pramod K. Pandey's Laboratory at the Department of Population and Health, School of Veterinary Medicine, UC Davis. The method used to analyze fluridone, diquat, 2,4-D, and imazamox in surface water is HPLC. The method used to analyze glyphosate in surface waters is LCMSMS (liquid chromatography tandem mass spectrometry). For endothall, the lab analysis method used is GC-MS-SPE (gas chromatography-mass spectrometry).

ANALYTICAL TESTING VALIDATION

DBW used several methods to validate results found by contracting laboratories. These methods include collecting split (duplicate) water samples, field blanks, and equipment blanks. An equipment blank

sample (de-ionized water) was collected at every sampling event to detect potential contamination from sampling equipment.

4.2.4 Hydroacoustic Monitoring

Measuring efficacy is an important part of any treatment program. Monitoring methods need to be non-intrusive, repeatable, and show consistent and reliable results over time.

Hydroacoustic monitoring has been employed in a robust and systematic fashion. These surveys provided detailed, quantitative metrics of the change in bio-volume and percent cover in treated sites.

HYDROACOUSTICS AND BIOBASE

The sonar system used by DBW is a combination of Lowrance™ HighDefinition System (HDS®) consumer echosounders (www.lowrance.com) and a cloud-based algorithm called Biobase (www.cibiobase.com). Biobase is a geo-spatial web platform designed to process Lowrance sonar logs for mapping submerged aquatic vegetation (SAV). The software is retailed by Navico on an annual subscription basis. Biobase generates data on water depth, SAV presence/absence, SAV height, bottom hardness (composition), and biovolume. The Lowrance / Biobase combination has a distinct advantage over other sonar systems for mapping aquatic vegetation by having lower hardware and analysis costs as well as faster processing times (Radomski and Holbrook 2015). In addition, Biobase outputs are automatically adjusted to Mean Lower Low Tide for consistency across all measurements; an important feature when mapping tidal-influenced systems such as the Delta. The service provided by Biobase offers vegetation point data, interpolated vegetation grids, default maps and tabular data that can be viewed online or downloaded to the subscription holder.

Acoustic and global positioning system (GPS) data are obtained using echosounders connected to 200-Khz 20 degree, single-beam transducers mounted on the research vessels' sterns. When conducting hydroacoustic surveys, the transducer transmits sound pulses through the water column, termed pings, and the return acoustic signals are recorded by the unit. Settings for the echosounders follow those recommended by Biobase. The units are set to collect fifteen (15) acoustic pings s^{-1} and GPS coordinates every one ms^{-1}. The internal GPS units are differentially corrected using a wide-area augmented system (WAAS). The acoustic and GPS signals are logged to secure digital (SD) cards in sl2 and slg format.

Upon completion of a survey, the sonar data is uploaded to Biobase. The algorithm evaluates each ping to determine SAV presence/absence and calculates water depth and a plant height for valid features. These values are concatenated into biovolume, the proportion of plant height occupying the water column. The vegetation data points from the survey are interpolated into a raster grid format and map products are produced from this data. The original vegetation point data and the raster grids are available for download as text files in Comma Separated Values (csv) format.

PYTHON CODES, TOOLS, AND MAP PRODUCTS

Data Processing

Hydroacoustic data collected by DBW staff uses the BioBase Aquatic Map System (BAMS) to analyze data which is then converted into aquatic maps using a series of Python scrips titled Biovolume Data Correction Workflow (BDCW). The first step of the process is shown in **Figure 1**.

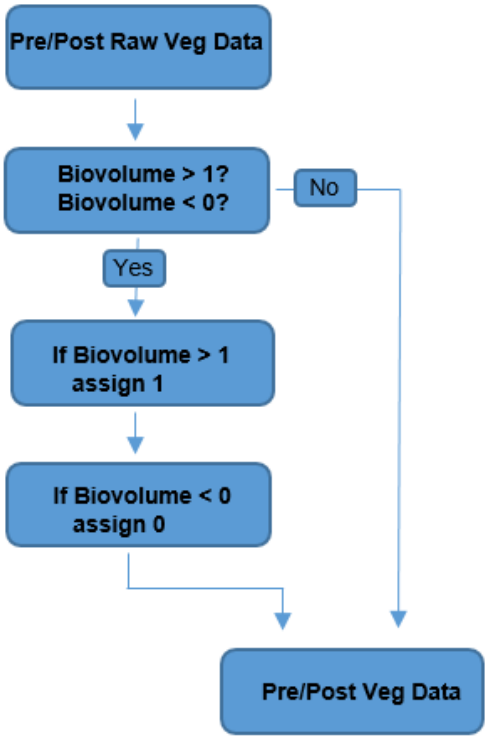

Figure 1. Biovolume Data Correction Workflow (BDCW)

Pre and Post grid data are analyzed through a series of steps that are designed to remove negative numbers and values greater than one (1) that do not satisfy the criteria for the aquatic vegetation analysis.

The next step of the process involves the Change Detection Workflow (CDW) which uses a set of geoprocessing operations, including Spline Interpolation, to generate raster surfaces and vegetation percent coverages that are then used to obtain aquatic vegetation change detection and percent cover maps respectively. The logical process is shown in **Figure 2**.

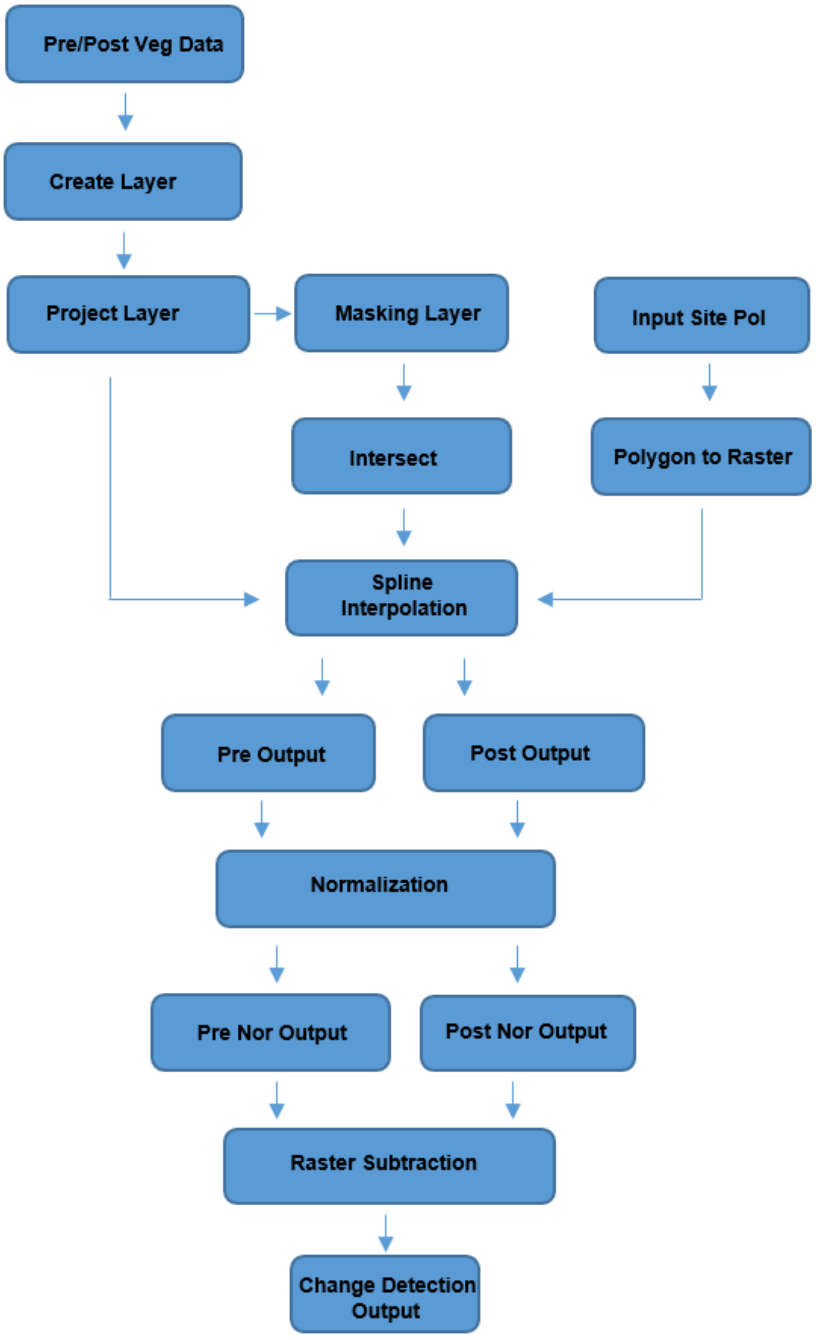

Figure 2. Change Detection Workflow (CDW)

Biovolume value is the relation between the actual height of the aquatic plant divided by the height of the water column and is ranged from zero to one. Vegetation cover is any sort of aquatic plants present in a water body which has a biovolume greater than 0.05 percent. A percent cover of this vegetation is calculated as vegetation cover divided by the total area surveyed. This parameter is used to compare both the pre- and post- treatment.

MAP PRODUCT

The final biovolume maps show SAV with color gradients: blue indicates areas with no aquatic plants, to red where aquatic plants fill the entire water column, with intermediate gradients of green to yellow to orange. A histogram accompanies each map to show the frequency of biovolume data.

The two values used are Biovolume data and vegetation cover. Biovolume value is the relation between aquatic plant height divided by the height of the water column, ranging from zero to one.

Vegetation cover is any sort of aquatic plants present in a water body which has a biovolume value greater than 0.05. A percent cover of this vegetation is calculated as vegetation cover divided by the total area surveyed. This parameter is used to compare both the pre and post treatment.

SURVEY METHODS

Hydroacoustic surveys were conducted in the legal Delta. Seventy-eight (78) sites totaling 2,439 surface acres were selected for treatment and mapped based on confirmation of visual and hydroacoustic surveys for high densities of Brazilian waterweed and other invasive SAV. Pre- and post-treatment hydroacoustic surveys were instituted to accomplish two efficacy-orientated goals. First, the pre-treatment surveys establish a measure of SAV abundance/density at these sites and the level of treatment needed. Second, the post-treatment surveys provide a current assessment of treatment efficacy and will be used to assess the program's overall efficacy on an annual basis. Surveys were completed by various DBW staff using unit research vessels. Since the Delta is comprised of sloughs, riverine areas, and large shallow waterbodies, mapping was divided into two strategic methods. Large bodies of water, such as Frank's Tract, were gridded to approximately 30-meter intervals for survey transects. In smaller slough and marina areas, transects followed the contours of the shoreline and internal structure (e.g. boat docks, tule islands) and ranged between 10 and 30 meters in width. Transects were performed in water depths ranging from 1 to 15 feet as SAV are shallow-water plants not typically found deeper than 15 feet.

4.2.5 SAV Point Sample Monitoring

Hydroacoustic mapping is a tool used to measure the abundance of submersed aquatic vegetation in an area, but does not identify the plants scanned. Therefore, a new metric was added in the 2017 treatment season – point sampling. Point sample data is gathered by using double-sided rakes that are tossed from the boat, and dragged along the bottom substrate bringing the submersed aquatic plants back to the boat. Density and health data of submersed aquatic vegetation were evaluated and rated onto field data sheets. A summary of rake pull data results is in **Table 5-3.**

Submersed Vegetation Density Scale

Rating	Range	Description
1	1-25%	A fragment to a few strands of species on rake – nothing visible other than a few plants

2	26-50%	Rake has good abundance of a species up to 50% of rake and/or visible plant coverage of approximately 25% of the area
3	52-75%	Rake has good abundance of a species up to 75% of rake and/or visible plant coverage of approximately 50% of the area
4	76-100%	Topped out dense plants – abundant rake mass and/or visible plant coverage of 75% of the area or greater

Submersed Vegetation Health Scale

Rating	Description
5	Completely healthy, green tissues
4	Leaves chlorotic or abnormal (e.g. darkened, senescent)
3	Defoliation – many leaves gone, partially defoliated along stems
2	Stem defoliated and partially necrotic (discolored)
1	Stem, any leaves necrotic, mushy, little structural integrity – easily squished; usually any roots are also necrotic, mushy or absent

The above health scale was developed for *Egeria densa* and is slightly modified for other submersed aquatic plants evaluated, such as curly leaf pondweed and fanwort. Sites with 1 to 10 acres had 5 rake pulls; 11 to 100 acres had 10 rake pulls; and sites over 100 acres had 15 rake pulls.

4.2.6 FAV Point-Intercept Sampling

Point-intercept sampling for FAV was implemented into the control program to determine change in species of floating aquatic vegetation over time throughout a subset of FAV sites in the Delta, including a subset of high-priority sites. Point-intercept data was acquired using a pole with graduated lines (gradations of 0.1 meter) placed on the water surface at thirty randomly distributed points within selected sites. Random point generation was confined to 20 feet or less of site boundaries to ensure that data was only collected close to bank and island margins (i.e. range of FAV habitat). Data on plant species, plant height (meter), water depth (meter), and plant species within vicinity (3 meters) were collected onto field data sheets.

4.2.7 Photo Point Monitoring

Photo point monitoring for FAV was implemented into the control program to monitor floating aquatic vegetation changes over a period of time. This process consists of taking repeated pictures with the same field of view of the same location (site) at multiple pre-selected locations (sites). In 2018, the FAV team took pictures twice a year, but in 2019 the team decided to take pictures three times a year. This included taking pictures in the spring (pre-growth season), mid-summer (during peak growth season of floating aquatic plants) and during the winter (when plants start their dormancy period). In addition, new sites were added to monitor to encompass the legal Delta including sites in the Suisun Marsh (**FAV Appendix A, Figure A-11** and **FAV Appendix G**).

5 MONITORING RESULTS AND DISCUSSION

5.1 *Threatened and Endangered Species*

The USFWS established incidental take for federally listed species and outlined terms and conditions necessary to minimize the impact of incidental take on listed species. No incidental take of federally listed species occurred in the 2019 season. Since NMFS concurs with USDA and DBW's determination that the proposed AIPCP 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 AIPCP.

5.2 *Infestation and Herbicide Application*

In 2019, the DBW treated a total of 2,439 acres at 78 sites of the project area for SAV, and 2,108 acres at 116 sites of the project area for FAV. The treated sites encompassed most of the Delta and can be found in **FAV Appendix A, Figures A-4 through A-7, FAV Appendix D;** and **SAV Appendix A**.

5.2.1 Summary of Herbicide Use

Each crew completed a daily treatment log to record herbicide treatment activities. The 2019 daily treatment log information can be found in **FAV Appendix B, Tables B-1 to B-9;** and **SAV Appendix D, Tables I-1 to I-7**. Number of crews available, travel time to sites, herbicide label restrictions, and environmental mitigation measures were important factors used when scheduling which sites to treat each day. No applications were made if DO concentrations were between 3.0 mg/L and the Basin Plan limits (5 mg/L to 7 mg/L, by location) as adopted by the CVRWQCB.

The SAV treatment season was conducted in two Phases in 2019. Phase I was from April 8, 2019 to July 22, 2019 with 2,088 acres at 64 sites treated with fluridone, 12 sites totaling 146 acres treated with Diquat, and 56 acres at 2 sites treated with endothall. Phase II began on July 29, 2019 and ran until November 15, 2019 with 311 acres at 4 sites. 126 acres at Discovery Bay were treated with fluridone for an extra 6 weeks. Decker Island was treated for a second 16-week session, and Winter Island and Prospect Island were treated for 16 weeks in Phase II. In 2019, the AIPCP used 128,610.4 lbs. of fluridone, 633 gallons of diquat and 338 gallons of endothall to effectively treat a total of 2,439 acres of submersed aquatic vegetation in the Delta (**Table 5-1**). Totals of herbicide usage by Sonar product for the SAV program since 2014 are found in **Figure 7**. A breakdown of the SAV acreage treated since 2014 is found in **Figure 8**.

Visible effects of the fluridone herbicide treatment were bleaching of the tips after two to three weeks, followed closely by breaking of the growing tips, then leaves falling off and gradual degradation of the plants which eventually advanced to small segments of dark husks floating in the water. Even at this late stage, new growth can form at nodes which are still viable. Observations of herbicide symptoms such as bleaching, deleaving and biomass reduction were observed as a result from all treatments.

The FAV treatment season began on March 11, 2019; however, treatments did not start until April 8, 2019 due to the weather conditions. The season continued until November 30, 2019. FAV herbicide

applications utilized glyphosate, imazamox, and 2,4-D, with the adjuvants, Agridex and Competitor. To minimize potential negative effects to salmon and steelhead, DBW and USDA-ARS 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).

The time to symptom development in FAV treated with glyphosate ranged from 1 to 3 weeks. Visible effects were gradual wilting and yellowing of the plants which eventually advanced to complete browning. For FAV treated with 2,4-D, the time to symptom development was faster, with wilting and chlorosis of the plants being observed as early as two days after treatment. 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. In some cases, treated plants remained floating for a significant amount of time, but most decomposing plants eventually sank into the water column.

In 2019, the DBW applied 1,433.25 gallons of glyphosate, 1,735.63 gallons of 2,4-D, and 1,257.69 gallons of imazamox for FAV control (**FAV Appendix A, Figures A-5 through A-9**). DBW treated approximately 2,256.15 acres of water hyacinth, spongeplant, water primrose, and/or alligatorweed in the Delta and its tributaries (**Table 5-1 and Figures 3 through 5**). Total herbicide usage and acres treated for the FAV Program varies from year to year (**Figure 6**) due to differing infestation levels, treatment start dates, regulatory restrictions, local water conditions, weather conditions, resources, and other factors.

The BO for the AIPCP states, “The proposed limit of the AIPCP is 15,000 acres per year for all SAV, EAV [emergent aquatic vegetation], and FAV during a 5-year (2018-2022) implementation period.” DBW prioritizes areas that need the most treatment, and the areas treated last year did not totaled up to the alloted 15,000 acres at this time. The alloted 15,000 acres allows DBW to use the whole amount of acres when necessary.

Table 5-1. 2019 AIPCP Herbicide Use by Month

Month	Sonar Q. Pounds	Sonar One Pounds	Sonar PR Pounds	Diquat Gallons	Endothall Gallons	2,4-D Gallons	Glyphosate Gallons	Imazamox Gallons
MARCH	0	0	0	0	0	0	0	0
APRIL	12,038	9,484	1,431	68	0	0	106	26
MAY	216	31,304	554	108	338.4	0	124.7	35
JUNE	432	29,954	213	32	0	73	65.75	187.75
JULY	653.4	17,112	15,596	36	0	432.75	42.5	386.25
AUGUST	920	1,672	426	162	0	494.75	132.5	350
SEPTEMBER	0	385	2,932	102	0	432.75	269.44	126.75
OCTOBER	0	2,172	0	124.5	0	0	513.75	97.19
NOVEMBER	0	0	1,116	0	0	0	480.99	48.75
Total	14,259.40	92,083	22,268	633	338	1,433.25	1,735.63	1,257.69

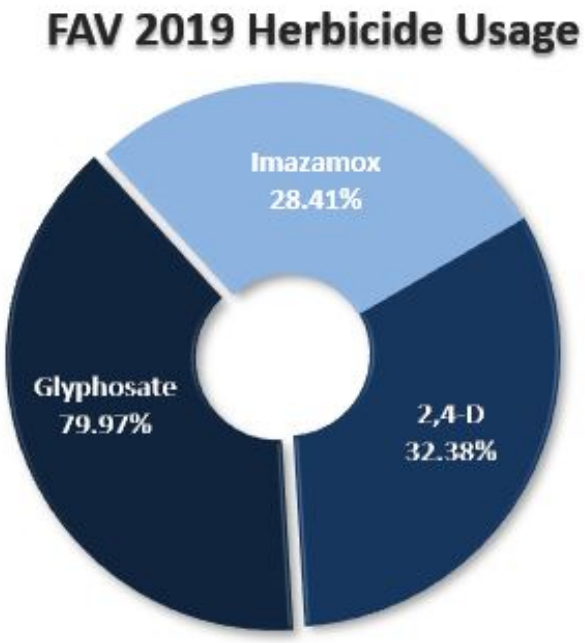

Figure 3. 2019 FAV Herbicide Use

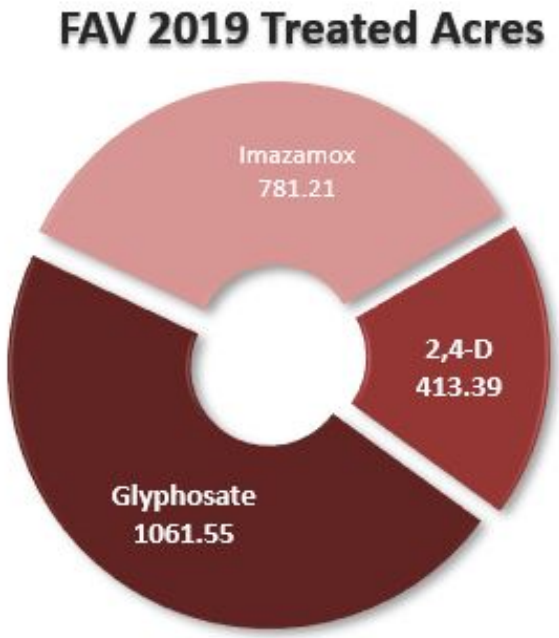

Figure 4. 2019 FAV Acreage Treated Per Herbicide

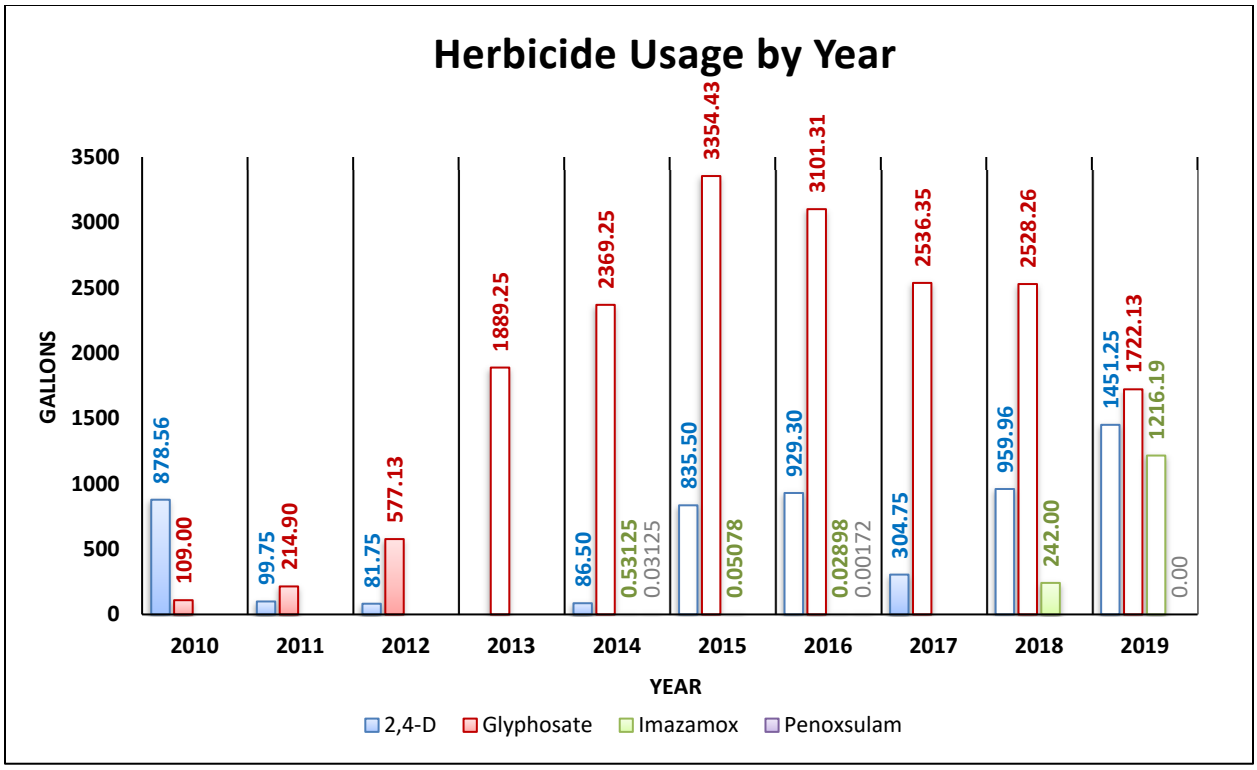

Figure 5. 2,4-D, Glyphosate, Imazamox and Penoxsulam usage by year for 2010 to 2019

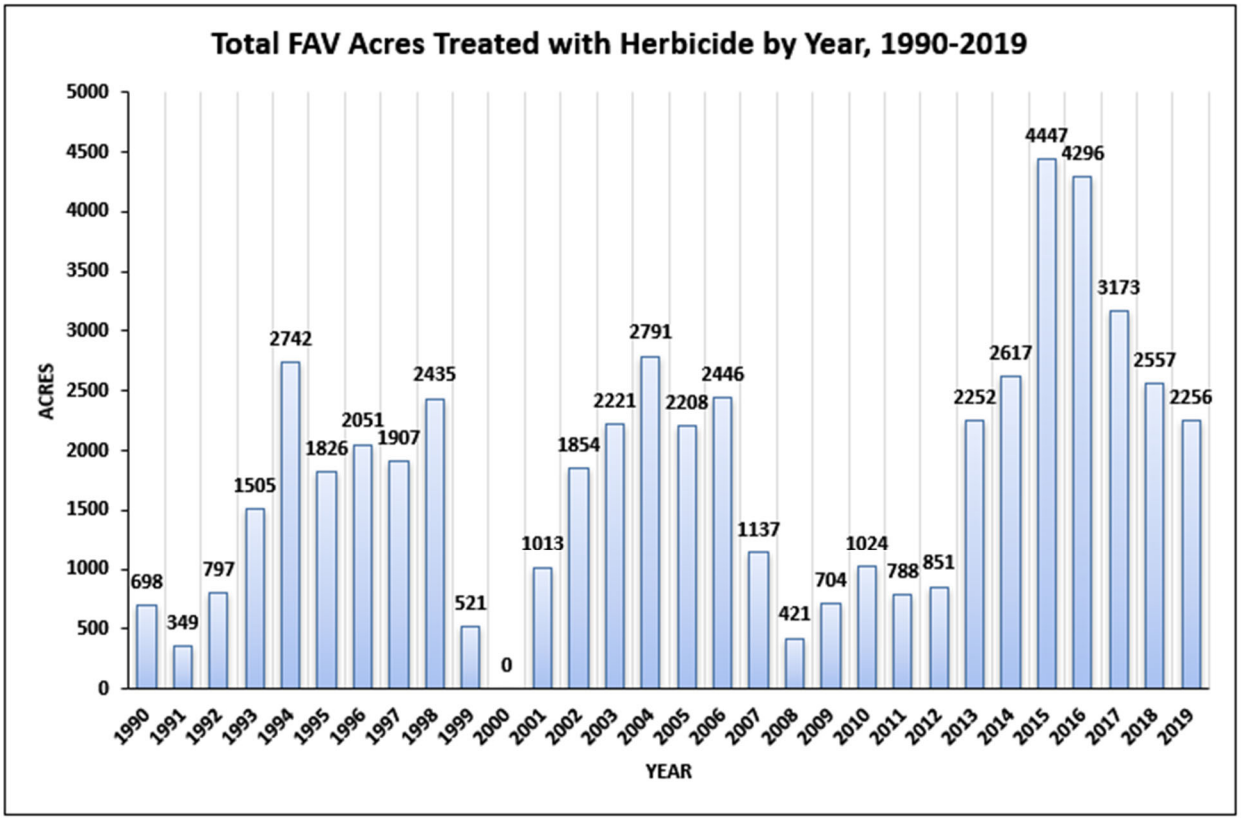

Figure 6. Total FAV Acres Treated with Herbicide by Year, 1990-2019

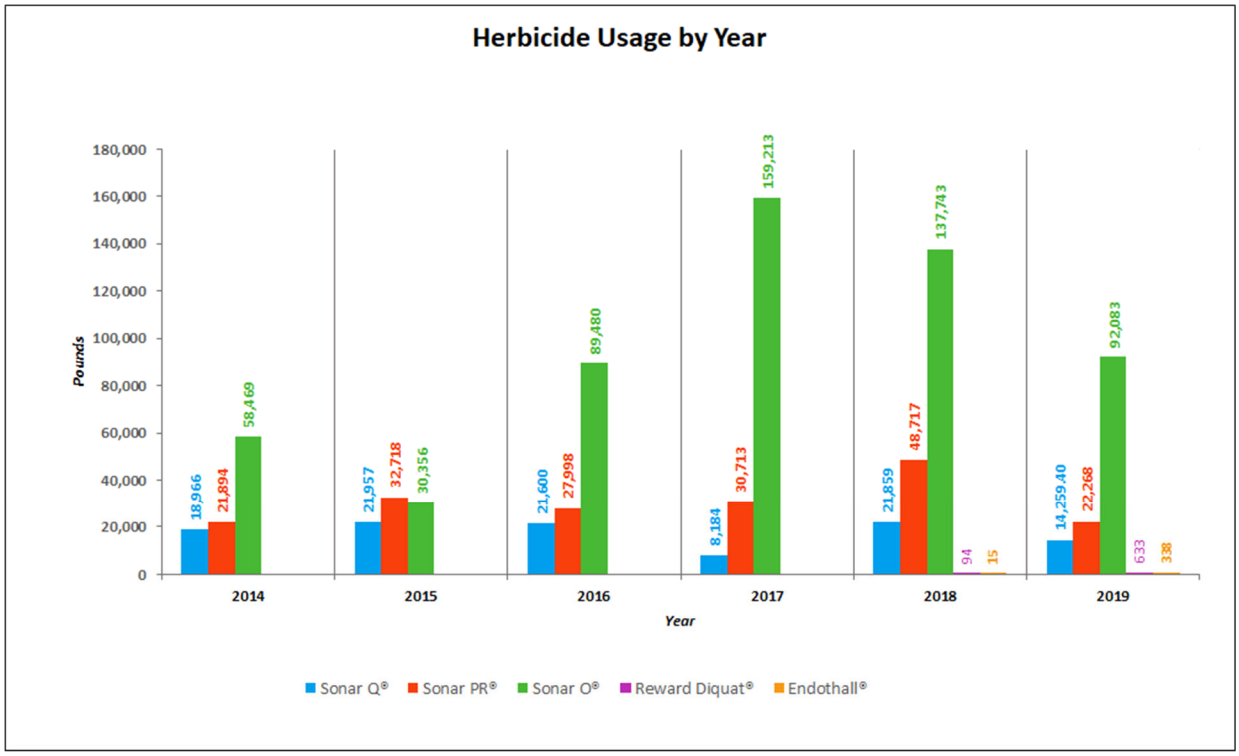

Figure 7. SAV Herbicide usage by year for 2014 to 2019

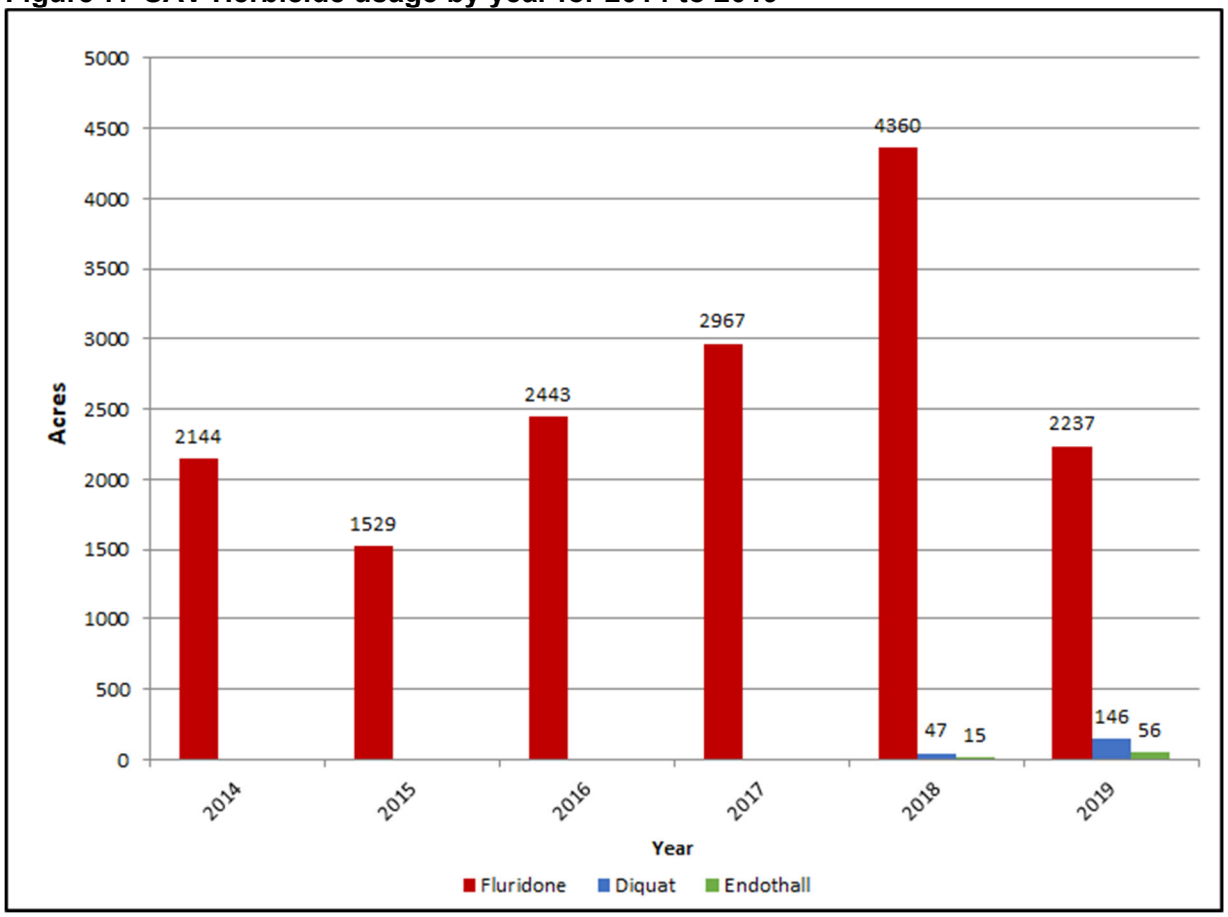

Figure 8. Number of acres treated from 2014 to 2019

5.3 *Monitoring Data and Laboratory Results*

5.3.1 NPDES Results

In 2019, a total of seven (7) sites within the legal Delta were selected as monitoring sites for the SAV and FAV Programs. Field monitoring data and lab results collected in compliance with the NPDES permit and BOs are summarized in **FAV Appendix D.** The maps with corresponding tables document the sample locations, herbicide residues and water quality data for these monitoring sampling points can be found in **FAV Appendix D** and **SAV Appendix B.** SAV NPDES sites can be found in **Table 4-3**, however, site 91 Cruiser Haven is the only Fluridone NPDES site. All other sites marked as NPDES are for Demonstration Investigation Zones (DIZ). DIZ information can be accessed on the AIPCP website in a separate DIZ report.

The NPDES permit (General Permit No. CAG990005, Water Quality Order No. 2013-0002-DWQ), 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 AIPCP maintains environmental quality measures and meets federal ESA requirements, and that monitoring provides independent statistical validity, DBW aims to maintain a more thorough monitoring plan as resources will allow.

A total of 93 samples were collected during the 2019 treatment season.

DISSOLVED OXYGEN, TURBIDITY AND PH

The average of the measurements taken at “A” (treatment area) and “C” (control site) locations on the sampling day in question will constitute an average natural against which the receiving water “B” (downstream location) measurements will be compared (refer to maps in **FAV Appendix D** and **SAV Appendix B.**

DISSOLVED OXYGEN

There were no occurrences where DO concentrations were below the basin plan limit of 5.00 mg/L during FAV NPDES monitoring. All DO levels measured during FAV NPDES monitoring and sampling efforts in 2019 were between 5.55 mg/L and 11.82 mg/L.

For SAV NPDES monitoring, one occurrence of pre-treatment DO did not meet basin plan limits with a value of 3.04 mg/L. All post sampling falls between 6.25 mg/L and 9.45 mg/L. There were no observations of injured or impacted wildlife during follow-up visits.

TURBIDITY

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 limits.

There were two (2) sampling events in two (2) FAV NPDES monitoring sites where turbidity levels exceeded Basin Plan limits (i.e. increased greater than 20 percent where natural turbidity is between 5 and 10 NTUs, or 1 NTU where natural turbidity is between 0 and 5 NTUs), including the follow-up sampling event at Site 102 (Holland Cut) on November 20, 2019 and the follow-up sampling event at Site 103b (Old River) on November 20, 2019. Furthermore, turbidity readings for samples A and B during follow-up sampling at Site 103b exceeded 50 NTUs. These increased turbidity readings may have been caused by natural waterway characteristics, propeller wash from the sampling boat, and/or strong wind conditions which pushed the sampling boat into shallow or SAV-impacted waters. Any impacts to turbidity potentially caused by the FAV Program 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. Turbidity readings of all monitoring sites were between 0.67 and 57.43 NTUs.

In 1 treatment site where SAV NPDES sampling occurred, the turbidity was lower post treatment for one sampling location. In two instances, turbidity levels exceeded Basin Plan limits (i.e. increased greater than 1 NTU where natural turbidity is between 0 and 5 NTU's post treatment levels. Turbidity readings were between 0.21 and 5.37 NTUs. High turbidity in post treatment data may have been caused by natural waterway characteristics or propeller wash from the sampling boat. For future data collection, the sampling boat will be shut off so that sediment from propeller wash or boat movement will have time to settle. If the SAV 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.

pH

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.

All pH levels in receiving waters complied with Basin Plan limits during FAV NPDES monitoring, ranging between 6.49 and 8.44. The 6.49 pH reading was collected at pre-treatment sample C at Site 17b (Hayes Reach/San Joaquin River) on September 23, 2019. The successive pH readings at samples A and B were higher than the initial reading at sample C; therefore, no depressions or exceedances occurred as a result of FAV control or monitoring activities. There were no injured or impacted species of concern observed during post-treatment follow-up monitoring.

All pH levels complied with Basin Plan limits during SAV NPDES monitoring, ranging from 6.98 to 7.93. There were no injured or impacted species of concern observed during post-treatment follow-up monitoring.

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 or Municipal and Domestic Supply (MUN) waters (**Table 4**).

Table 5-2. Receiving water limits for SAV herbicides

Herbicide Active Ingredient	Maximum Concentration (MUN)
2,4-D	70 ppb
Diquat	20 ppb
Endothall	100 ppb
Fluridone	560 ppb
Glyphosate	700 ppb
Imazamox	No receiving water limit

** Municipal and Domestic Supply = MUN*

All herbicide residue concentrations at receiving water locations were either not detected or were below receiving water limits as specified in the NPDES permit.

FLURIDONE WATER SAMPLING RESULTS

For best efficacy, the intent is to maintain a fluridone concentration in the water column at the treatment site of between 1.5 and 3.5 ppb.

DBW collected 2035 water samples during the 2019 treatment season. In each instance where the residue level exceeded the target of 5 ppb, adjustments were made to the amount of fluridone treated the following week by either skipping a week of treatment or reducing the rate of fluridone used which usually resulted in a reduction in the residue to within range limits.

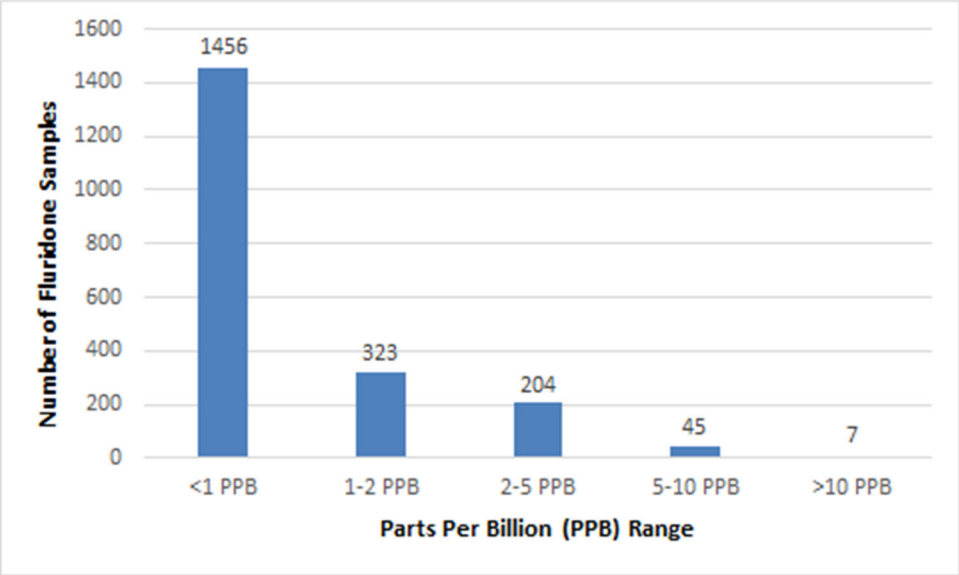

Figure 9. Number of Fluridone Samples by ppb ranges for 2019

5.3.3 Hydroacoustic Mapping

RESULTS AND CONCLUSION

77 of the 78 SAV treatment sites were mapped pre- and post-treatment. The overall mean biovolume and percent cover change between pre- and post-treatment mapping for the sites analyzed in this study are overall worse than the results seen from last season. Only 60 percent of the sites showed a decrease in overall biovolume compared to 70 percent from last year. This year only 52 percent of the treatment sites showed an overall reduction in percent cover compared to 79 percent. Even though there were fewer sites with decreases this season, the percentage of decreases were larger with half of the sites showing a decrease of 10 percent to 75 percent for change detection and 17 percent to 83 percent decrease for percent cover. Treatment sites that showed an increase this season will be reviewed and treated with Diquat next season instead of fluridone if the site is not near Delta smelt habitat.

The Egeria mapping tool proved to be an effective intermediary between exported data from Biobase and the final map products, automating and reducing the processing time. The limitation to the tool is raster cells from both pre- and post-treatment maps must overlap to provide a change value. Hydroacoustic survey protocols have been established to standardize the procedure and to assure consistency in the pre- and post-treatment mapping regime. Maps with the pre-treatment, post-treatment and mean percent biovolume can be found in **SAV Appendix E** and the mean percent cover maps are in **SAV Appendix F**.

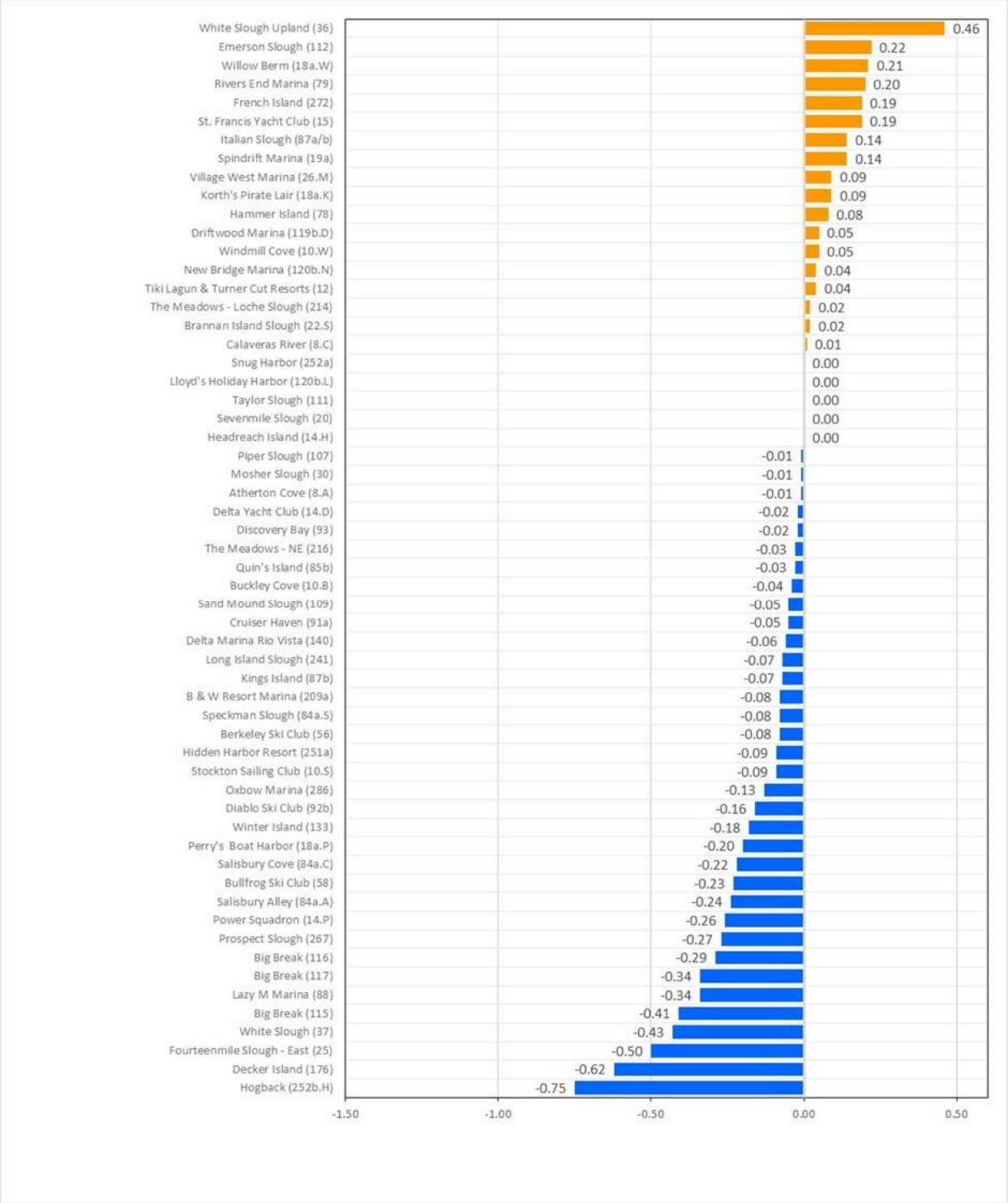

Figure 10. Graph depicting the mean percent change in biovolume between pre- and post-treatment.

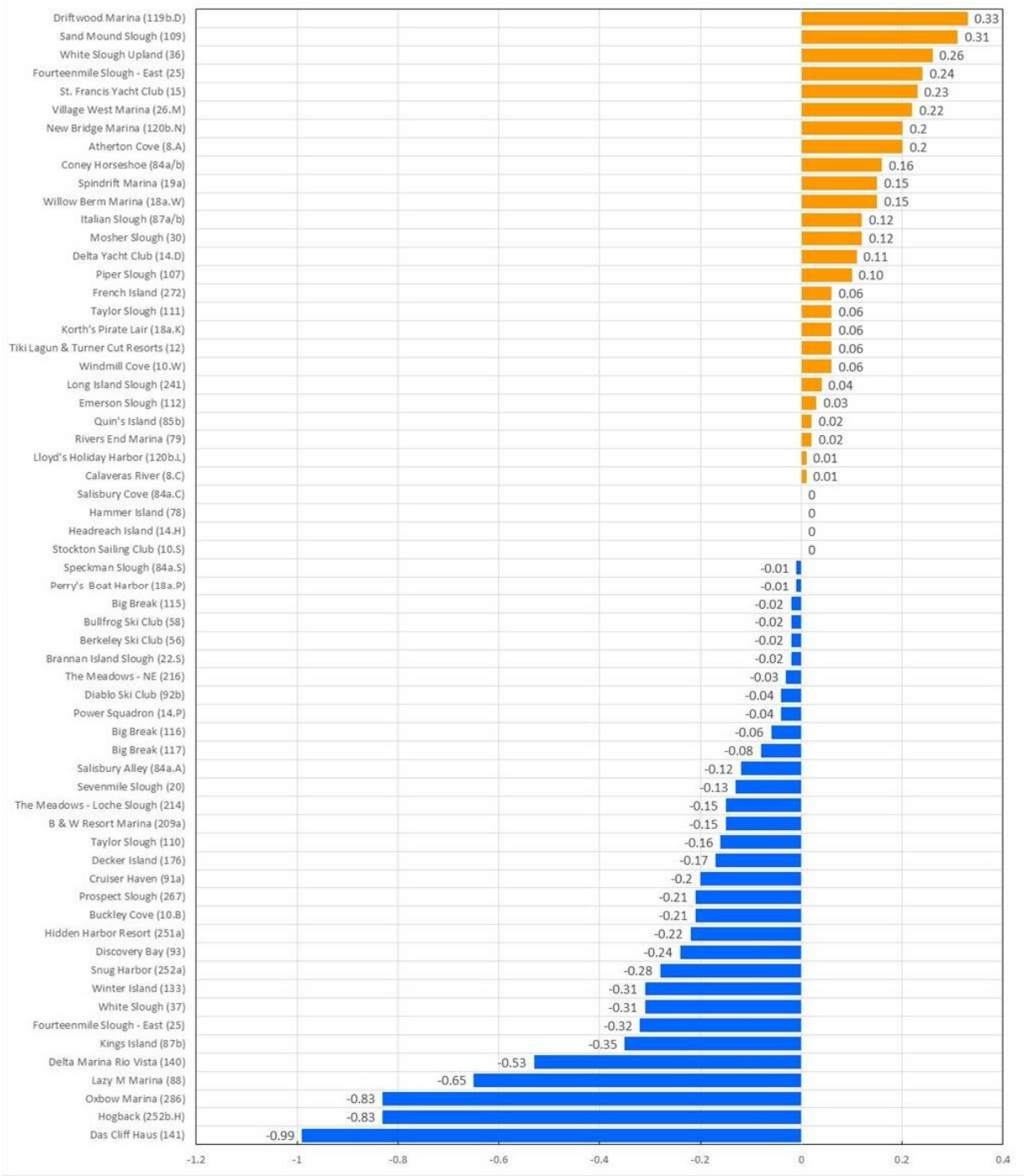

Figure 11. Graph depicting the mean percent change in SAV cover between pre- and post-treatment.

5.3.4 SAV Point Sample Monitoring

RESULTS AND CONCLUSION

Analysis was only performed for the overall percentages of each of the species collected while rake pulling. Below are the results between the rake pulls conducted pre- and post-treatment.

Table 5-3. Rake Pull Results Summary

Submersed Aquatic Plant	2019 PRE	2019 POST	Overall Difference
Egeria	14.26%	15.88%	11.31%
Curlyleaf pondweed	1.01%	0.33%	-67.36%
Coontail or Hornwort	4.21%	4.99%	18.34%
Eurasian watermilfoil	0.16%	0.07%	-56.52%
Fanwort	0.10%	0.09%	-9.52%

The largest reduction of AIPCP controlled plants with nearly 68 percent was seen in curlyleaf pondweed followed by a nearly 57 percent reduction in Eurasian watermilfoill, and a nearly 10 percent reduction in fanwort. There was an increase, less than 12 percent in Egeria and an increase, less than 19 percent, in coontail/hornwort. Environmental scientists observed a quick increase of coontail/hornwort after fluridone treatments killed vegetation and there was space for new vegetation to grow. This effect may explain the rise in coontail/hornwort biovolume. Figures with pre- and post-treatment point sample data can be found in **SAV Appendix G**.

5.3.5 FAV Point-Intercept Sampling

RESULTS AND CONCLUSION

In total, 460 point-intercept samples were collected over 16 sites (**Table 5-4 and FAV Appendix A, Figure A-11**). Point-intercept sampling points documented 6 unique species and 16 unique species within a 3-meter vicinity of the sampling points (**Table 5-5**).

Table 5-4. 2019 FAV Point-Intercept Sites Sampled

Site #	Site Name
6	French Camp Slough
15	Columbia Cut
28	Fourteen Mile Slough
32	Disappointment Slough
37	White Slough
49*	Middle River*
65	Latham Slough
92a/b	Old River
97	Rock Slough
100	Connection Slough
109	Sandmound Slough
112	Dutch Slough
203	Sycamore Slough
216	Snodgrass Slough
267	Cache Slough
300	San Joaquin River

**Only 10 out of 30 points were sampled due to inaccessibility*

Table 5-5. 2019 FAV Point-Intercept Sampling Species Documented

Species	# of Samples (out of 460)	# of Sites Present (out of 16 sites)	# of Occurences In Vicinity (3 m) (out of 460)
Bulrush *(Schoenoplectus* spp.*)*	5	2	207
Cattail *(Typha* spp.*)*	2	1	29
Pennywort *(Hydrocotyle ranunculoides)*	5	4	40
Spongeplant *(Limnobium laevigatum)*	9	5	97
Water hyacinth *(Eichhornia crassipes)*	102	15	243
Water primrose *(Ludwigia hexapetala)*	85	14	177
Giant reed *(Arundo donax)*	0	1	2
Arrowhead *(Sagittaria* spp.*)*	0	3	13
Bur marigold *(Bidens laevis)*	0	2	5
Common reed *(Phragmites australis)*	0	2	6
Woolly rose-mallow *(Hibiscus lasiocarpos* var. *occidentalis)*	0	3	3
Red sesbania *(Sesbania punicea)*	0	1	1
Smartweed *(Persicaria* spp.*)*	0	9	33
Watercress *(Nasturtium officinale)*	0	1	1
Wild taro *(Colocasia esculenta)*	0	1	2
Yellowflag iris *(Iris pseudacorus)*	0	6	12
No plant present at point or inaccessible	252	16	N/A

Water hyacinth was sampled at the highest frequency, occurring at 102 out of 460 sampling points, or 22 percent of all sampling points. Water primrose was sampled at the second highest frequency, occurring at 85 out of 460 sampling points, or 19 percent of all sampling points. These two species also occurred at almost all sampling sites, 15 out of 16 sites and 14 out of 16 sites, respectively. The most common species within the 3-meter vicinity of each sampling point were water hyacinth, bulrush, and water primrose. Additional species, some of which are invasive or rare species, did not occur at any particular sampling point, but were within vicinity of the respective sampling point (**Table 5-5** from giant reed to yellowflag iris). Maps with information on where each sampling point was located and what species was sampled can be found in **FAV Appendix A, Figure A-11**.

Any inaccessible sampling points were documented and will be moved accordingly to accessible locations for sampling efforts in 2020. Further summarization and analysis of other collected data (i.e. plant height and water depth) will occur to identify any trends from year to year, within or between species, and within or between different locations (i.e. sites or water depth ranges). Limited data was collected on a seasonal basis (i.e. late winter/early spring, mid-spring, late summer/early fall, and mid-fall) at a subset of three FAV sites; however, more data will need to be collected at a larger number of sites to become useful.

5.3.6 Aquatic Pesticide Application Plan Effectiveness

The Aquatic Pesticide Application Plan (APAP) describes aquatic pesticides and application methods used for the AIPCP. 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 (NOI) and public notification, were met. NOI were provided to County Agricultural Commissioners at least 24 hours before herbicide applications were made. The NOI included descriptions, treatment locations, and application rates for restricted use materials in addition to all other herbicides used by the AIPCP. 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, and facts, and figures on the 2019 treatments.

5.3 *Alternative Control Methods and Special Studies*

5.4.1 Non-Herbicide Control

MECHANICAL REMOVAL

On October 23, 2015, CDFW and DBW executed a Streambed Alteration Agreement (or Routine Maintenance Agreement, RMA) Notification No. 1600-2015-0132-R3, pursuant to section 1602 of the Fish and Game Code, for the mechanical removal of water hyacinth, and the agreement is valid through December 31, 2019, and pertains only to the physical and mechanical removal of FAV. The RMA contains avoidance and minimization measures for fish and wildlife species of concern. Examples of these species include giant garter snake, Delta smelt, longfin smelt, Swainson's hawk, burrowing owl and western pond turtle. Before any work can commence Environmental Scientists, approved by CDFW, conduct biological surveys in the project area to make sure that there are no species of concern. In addition to biological surveys, a biological monitor must be on site to assure that no species of concern or their habitats are being or will be significantly affected by the FAV removal operation. Furthermore, DBW provides environmental awareness training to application crews.

Under a four-year contract with the firm, Aquatic Environments, Inc. and their subcontractors, Clean Lakes, Inc. and Waterworks Industries, Inc., DBW conducted mechanical harvesting of FAV in several locations in the Delta that were identified as being a nursery site or having high infestations of water hyacinth, spongeplant and/or water primrose. Project locations included West Side Irrigation District (WSID) canal, and Fabian Tract/Rivers End/Old River (**Table 5-4** and **FAV Appendix A, Figure A-12**).

Mechanical removal utilized a combination of harvesters, transport barges, excavators, and dump trucks. DBW was able to conduct mechanical harvesting throughout the year (**Figure 12**). Approximately 10,475 cubic yards or roughly 6.49 acres of FAV were removed by mechanical means between January 2, 2019 and March 3, 2019.

Table 5-6. 2019 FAV Sites Controlled by Mechanical Harvesting

Site(s)	Location	Harvesting Date(s)	FAV Cubic Yards Removed	FAV Acres Removed
77	West Side Irrigation District (WSID) Canal	January 3, 2019 – January 11, 2019	1,800	1.12
78, 79	Old River & River's End	January 2, 2019 – March 19, 2019	8,675	5.38

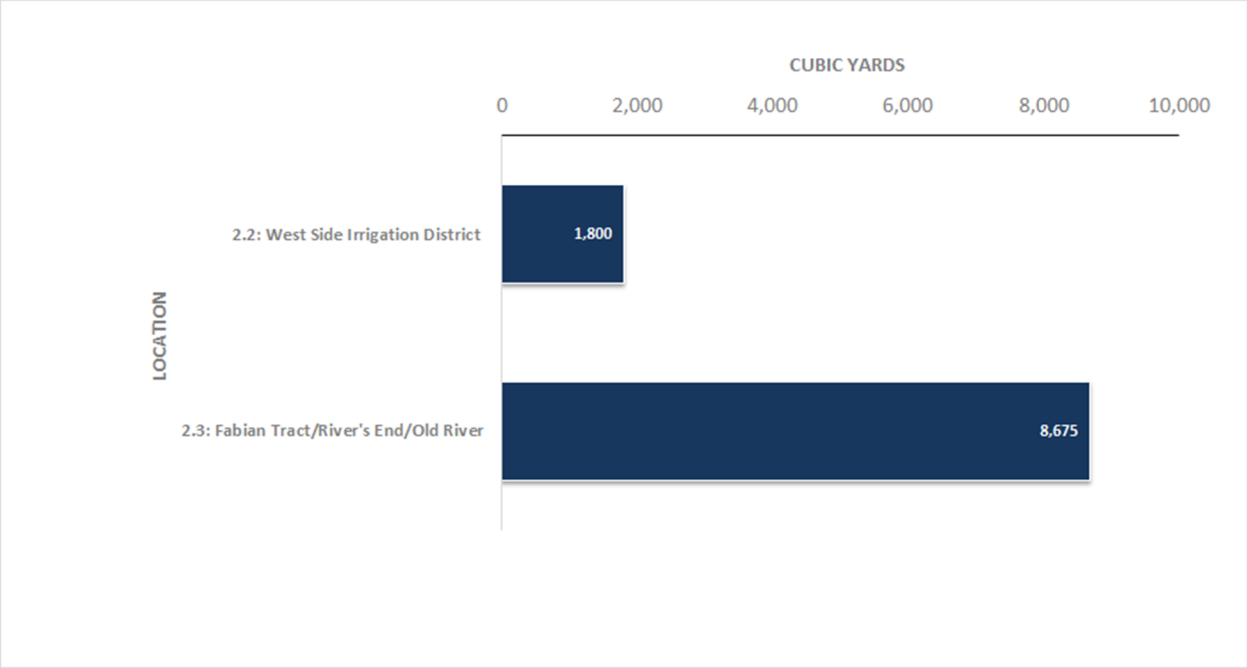

Figure 12. Cubic Yards of FAV Removed by Month

For each harvesting project, the collected FAV 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 FAV loads, plastic liners, straw wattles, and/or plywood were placed on the bank and levee where the harvester and/or excavator stockpiled water hyacinth. The loads of FAV were also allowed to drain before moving the material onshore. Once excess water was drained, plant material was removed with an excavator and moved to a dump truck, then taken to an approved spoils site. DBW coordinated and collaborated with various landowners/managers to secure right-of-entry for harvesting operations and use of land as a spoils area. These parties included WSID and the United States Bureau of Reclamation.

HERDING

In past years, DBW crews used boats to herd (push) large mats of water hyacinth out of a site or towards an awaiting excavator or conveyor for removal. This year, DBW crews did not conduct herding of FAV.

5.4.2 Delta Smelt Resiliency Strategy

The Delta Smelt Resiliency Strategy (DSRS) is a science-based document that has been prepared by the State of California to voluntarily address both immediate and near-term needs of Delta Smelt, to promote their resiliency to drought conditions as well as future variations in habitat conditions (California Natural Resource Agency 2016). The primary objective of this strategy is to improve the status of Delta smelt. One of the goals to achieve the strategy objective is to reduce the levels of invasive species, both aquatic weeds and nonnative predators (California Natural Resources Agency 2016). DBW is partnered/involved in the DSRS to help achieve this goal.

5.4.3 Fish Restoration Program

The Fish Restoration Program (FRP) is based on an agreement, signed on October 18, 2010, between CDFW and DWR that addresses regulatory requirements for habitat restoration. The primary objective of the Fish Restoration Program Agreement is to implement specific alternatives and conditions from their associated BOs and Incidental Take Permits in the Delta, Suisun Marsh, and Yolo Bypass to benefit Delta smelt, Chinook salmon, and longfin smelt. Because aquatic invasive plants have the potential to negatively impact these restoration goals, DBW is partnered with DWR to conduct control activities and monitor aquatic invasive plants at specific FRP restoration sites.

5.4.4 Alligatorweed Blitz Survey

The Alligatorweed Workgroup is comprised of various staff from federal, State, and local agencies – including DBW – and aims to spread awareness of alligatorweed, better understand alligatorweed and its distribution within and around the Delta, and support DBW in making more informed management decisions about alligatorweed. In 2019, the Alligatorweed Workgroup hosted an Alligatorweed Blitz Survey. This survey effort resulted in 305 new alligatorweed detections documented by 35 surveyors across 28 separate survey days and 33 separate DBW sites. The survey also identified areas where alligatorweed is not present, including the lower Tuolumne River, and portions of the American and Sacramento Rivers. With the addition of the blitz survey data, there are 387 total alligatorweed detections in 54 separate DBW sites since 2017 (**FAV Appendix A, Figure A-13**).

6 ACKNOWLEDGEMENTS

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California Department of Fish and Wildlife
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California Department of Food and Agriculture – Center for Analytical Chemistry
California Department of Water Resources
City of Stockton
Contra Cost Water District
County Agricultural Commissioners
County Sheriffs
County Vector Control Districts
Delta Conservancy
Delta Protection Commission
Delta Stewardship Council
Lauritzen Yacht Harbor
National Aeronautics and Space Administration
National Oceanic and Atmospheric Administration – National Marine Fisheries Service
Paradise Point Marina
Reclamation District 800
Reclamation District 1601
State Water Resources Control Board
Turlock Irrigation District
United States Bureau of Reclamation
United States Department of Agriculture – Agricultural Research Service
United States Fish and Wildlife Service
University of California, Davis
West Side Irrigation District

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Numerous Legislative Offices

7 LITERATURE CITED

BioBase. 2013. User reference guide: ciBioBase vegetation algorithm version 5.2. Contour Innovations, Minneapolis, MN.

California Department of Fish and Wildlife (CDFW). 2020. "About Invasive Species In California." Accessed on march 30, 2020 at https://wildlife.ca.gov/Conservation/Invasives/About.

California Department of Parks and Recreation Division of Boating and Waterways (DBW). 2012. Water Hyacinth Control Program Biological Assessment. California Department of Parks and Recreation, Division of Boating and Waterways, Sacramento, CA.

California Department of Parks and Recreation Division of Boating and Waterways (DBW). 2014. Spongeplant Control Program Biological Assessment. California Department of Parks and Recreation, Division of Boating and Waterways, Sacramento, CA.

California Natural Resources Agency. 2016. Delta Smelt Resiliency Strategy (DSRS). Accessed 1 July 2018. <http://resources.ca.gov/delta-smelt-resiliency-strategy/>

California Regional Water Quality Control Board. 1998. Fourth Edition of the Water Quality Control Plan (Basin Plan) for the Sacramento River and San Joaquin River Basins. California Regional Water Quality Control Board, Central Valley Region, Sacramento, CA. ESRI 2011. ArcGIS Desktop: Release 10.4.1 Redlands, CA: Environmental Systems Research Institute.

Delta Stewardship Council. 2018. Collaboration Guidelines for Delta AIP Control. Found online at https://coveredactions.deltacouncil.ca.gov/services/download.ashx?u=8df8cc2a-55f0-4f2d-bb3e-c03da0b84a1a

Hansen, Eric C. 2002. Evaluation of Giant Garter Snake (*Thamnophis gigas*) Habitat Within California' Department of Boating and Waterways Aquatic Weed Control Division's Water Hyacinth and Egeria densa Control Program Service Areas.

Lowrance high-definition system consumer echosounder, Lowrance, 12000 E. Skelly Dr., Tulsa, OK 74128. Accessed 8 January, 2020 <www.lowrance.com>

Navico BioBase, Navico Inc., 2800 Hamline Ave. N #223, Roseville, MN 55113. Accessed online at www.cibiobase.com

Radomski, Paul & Holbrook, Beth. (2015). A comparison of two hydroacoustic methods for estimating submerged macrophyte distribution and abundance: A cautionary note. Journal of Aquatic Plant Management. 53. 151-159.