Summary Report on the Transactions of the Smelt Working Group in Water Year 2014

Prepared for the Delta Science Program Independent Review
By Bay-Delta Fish and Wildlife Office
U.S. Fish and Wildlife Service, Sacramento, California
August 2014

Acronyms and Abbreviations

BDFWO	Bay-Delta Fish and Wildlife Office
BiOp	Central Valley Project/State Water Project Long-term Operations Biological Opinion
Board	State Resources Control Board
CDEC	California Data Exchange Center
cfs	cubic feet per second
CVP	Central Valley Project
DAT	Data Assessment Team
DFW	California Department of Fish and Wildlife
DWR	California Department of Water Resources ESA Endangered Species Act
FMWT	Fall Mid-Water Trawl
IEP	Interagency Ecological Program
NMFS	National Marine Fisheries Service
OMR	Old and Middle River Flow (combined, in cubic feet per second)
Project(s)	Central Valley Project and State Water Project
Reclamation	U.S. Bureau of Reclamation
RPA	Reasonable and Prudent Alternative
Service	U.S. Fish and Wildlife Service
SKT	Spring Kodiak Trawl Survey
SLS	Smelt Larva Survey
STNS	Summer Townet Survey
SWG	Smelt Working Group
SWP	State Water Project
TUCP	Temporary Urgency Change Petition, issued by State Resources Control Board
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WOMT	Water Operations Management Team
WY	Water Year (October 1 – September 30)
X_2	Distance from Golden Gate Bridge to the two parts per thousand isohaline

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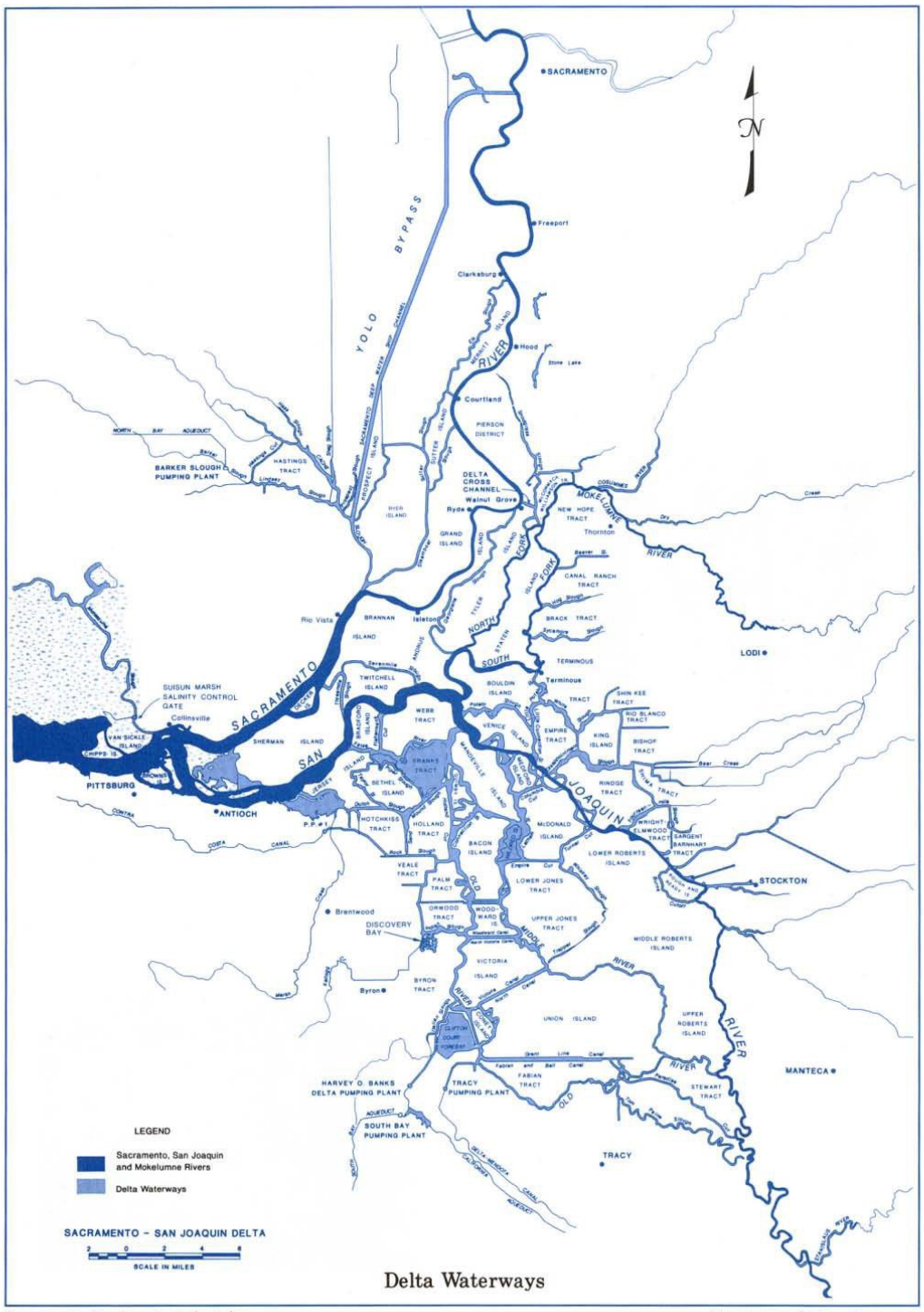

Figure 1. Map of the Sacramento-San Joaquin Delta

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Introduction

The Bay-Delta Fish and Wildlife Office (BDFWO) has prepared this report to summarize the implementation the U.S. Fish and Wildlife Service's (Service) biological opinion on the Central Valley Project (CVP) and State Water Project (SWP) Long-term Operations (BiOp) in Water Year (WY) 2014. In addition to background information pertinent to implementation of the BiOp , this report provides a summary of the transactions of the Smelt Working Group (SWG), as well as water operations and during WY 2014. The SWG is a technical team that evaluates biological and technical issues regarding Delta Smelt (*Hypomesus transpacificus*) and develops recommendations for consideration by the Service during implementation of the BiOp's Reasonable and Prudent Alternative (RPA) actions.

During WY 2014 the SWG made no recommendations for more restrictive water operations and the Service issued no determinations to reduce water exports.

Chapter 1. Background

1.1 Consultation Background

The Federal Endangered Species Act (ESA) is primarily administered by the National Marine Fisheries Service (NMFS) and the Service. A biological opinion is the product of an interagency formal consultation under section 7 of the ESA, which provides that "each Federal agency shall, in consultation with and with the assistance of the Secretary, insure that any action authorized, funded or carried out by such agency… is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [critical] habitat…"

In the December 2008 BiOp to the U.S. Bureau of Reclamation (Reclamation), the Service determined that the coordinated operations of the CVP and SWP, as proposed, would likely to jeopardize the continued existence of the Delta Smelt and adversely modify its critical habitat. The BiOp identified three factors that affect the population resilience and long-term viability of Delta Smelt: 1) direct mortality associated with entrainment of pre-spawning adult Delta Smelt by CVP/SWP operations; 2) direct mortality of larval and early juvenile Delta Smelt associated with entrainment by CVP/SWP operations; and 3) indirect mortality and reduced fitness through reductions to and degradation of Delta habitats by CVP/SWP operations, with the fall as a particular concern (BiOp, p 325). The risk of entrainment increases with increased reverse flows on the Old and Middle rivers (OMR), which occur as a result of Project export pumping. Reverse OMR flows are a proximal cause of entrainment; the position of the two-parts-per-thousand isohaline (termed "$X2$"and measured as kilometers from the Golden Gate Bridge) is a distal cause of entrainment.

In collaboration with Reclamation and the California Department of Water Resources (DWR), the Service developed an RPA to the proposed action. The Service's BiOp for Delta Smelt includes five RPA components to protect all Delta Smelt life stages and minimize impacts to critical habitat. The primary components affecting CVP and SWP operations are Components 1 and 2 (Table 1). Component 1 protects adult Delta Smelt by reducing OMR flows to a range of -1,250 to -5,000 cubic feet per second (cfs) at times when the fish are most vulnerable to entrainment at Project diversions, which can occur as early as December and continue until spawning has begun. Component 2 protects larval and juvenile Delta Smelt by reducing OMR flows to a range of -1,250 to -5,000 cfs at times when these life stages are vulnerable to entrainment. Component 2 is implemented from the onset of spawning to June 30, or when water temperatures reach 25° Celsius, whichever occurs first. Components 1 and 2 are implemented through an adaptive decision process described in the BiOp and the SWG. More specific information about the implementation of Actions 1 through 3 can be found in Chapter 2. Summary of SWG Discussion and Advice

Table 1. Component 1 (Actions 1 and 2) and Component 2 (Action 3) of the BiOp's RPA

		Objective	Trigger	Timing	OMR Flows
Component 1	**Action 1 (a)**	A fixed duration action to protect pre-spawning adult Delta Smelt from entrainment during the first flush and to provide advantageous hydrodynamic conditions early in the migration period.	SWG may recommend a start date	Dec 1 to Dec 20	-2,000 cfs
	Action 1 (b)		Turbidity or Salvage	Dec 20 to Action 2	
	Action 2	An action implemented using an adaptive process to tailor protection to changing environmental conditions after Action 1. As in Action 1, the intent is to protect pre-spawning adults from entrainment and, to the extent possible, from adverse hydrodynamic conditions	The end of Action 1 or (if Action 1 is not triggered), the SWG may recommend a start date	Immediately following Action 1	-1250 to -5000 cfs
Component 2	**Action 3**	Minimize the number of larval Delta Smelt entrained at the facilities by managing hydrodynamics in the central Delta flow levels pumping rates spanning a time sufficient for protection of larval Delta Smelt. The action is adaptive and flexible within appropriate constraints	Temperature or Onset of Spawning	Upon meeting trigger criteria	

1.2 Adaptive Decision Process

Real-time decision making to assist fishery management is a process that promotes flexible decision making and can be adjusted as new data are collected, and as outcomes from management actions and other events become better understood. Sources of uncertainty relative to CVP and SWP operations include hydrologic conditions and the biology and ecology of species. The adaptive decision process allows for minimized impacts to water deliveries and minimized adverse effects to listed species. Decisions regarding CVP and SWP operations to avoid and minimize adverse effects on listed species must consider factors that include public health, safety, water supply reliability, and water quality.

To facilitate these water operations decisions, the Project agencies and the Service, NMFS, and the California Department of Fish and Wildlife (DFW) have developed and refined a process to collect data, disseminate information, develop recommendations, make decisions, and provide transparency. This process consists of three types of groups that meet on a recurring basis. Management teams (e.g. the Water Operations Management Team [WOMT]) are made up of management staff from Reclamation, DWR, the Service, NMFS, the U.S. Environmental Protection Agency (USEPA) and DFW. Information teams (e.g. the Data Assessment Team [DAT]) are teams whose role is to disseminate and coordinate information among agencies and stakeholders. Fisheries and Operations Technical Teams (e.g. SWG) are made up of technical staff from state and Federal agencies. These teams review the most up-to-date information on fish status and Delta conditions, and develop recommendations that fishery agencies' management can use in identifying actions to protect listed species.

The process to identify actions for protection of listed species varies to some degree among species but follows this general outline: a Fisheries or Operations Technical Team compiles and assesses current information regarding species, such as stages of reproductive development, geographic distribution, relative abundance, and physical habitat conditions. The team then provides a recommendation to the agency having the statutory obligation to enforce protection of the species in question. The agency's staff and management then review the recommendation, and in cooperation with Reclamation and DWR, use it as a basis for developing a protective action to minimize adverse effects to listed species by the Projects. The fishery agency with the statutory authority makes the final determination on the protective action. The outcomes of any protective actions that are implemented are monitored and documented, and this information informs future recommended actions (BiOp, pp 27-29).

1.3 Smelt Working Group

The SWG is one of several fisheries technical teams that provide guidance and recommendations on resource management issues. The SWG consists of representatives from the Service, NMFS, DFW, DWR, and Reclamation. The Service chairs the group, and members are assigned by each agency.

The SWG evaluates biological and technical issues regarding Delta Smelt and develops recommendations for consideration by the Service. When the Longfin Smelt (*Spirinchus thaleichthys*) became a California candidate species in 2008, the SWG also began developing recommendations for DFW to minimize adverse effects to Longfin Smelt. The SWG meets regularly during December through June, which is historically when Delta Smelt salvage has occurred. In addition, the Delta Smelt Risk Assessment Matrix (Attachment 1) outlines the conditions when the SWG will convene to evaluate the necessity of protective actions and provide the Service with a recommendation. The SWG will also convene to review Longfin Smelt entrainment risk at the request of DFW (BiOp, pp 30-31).

When the data indicate that smelt may be at risk for entrainment, the SWG may recommend OMR flows within the ranges in the BiOp's RPA to the Service. The Service's staff and managers review the recommendation and, if warranted, use it to develop a determination for modification of water operations that will minimize adverse effects caused by Project operations. This adaptive process continues throughout the winter and spring until smelt are no longer vulnerable to entrainment. SWG meeting notes are made public on the BDFWO website at http://www.fws.gov/sfbaydelta/cvp-swp/smelt_working_group.cfm.

1.4 Delta Smelt Monitoring Data

Most research and monitoring in the Bay-Delta are coordinated through the Interagency Ecological Program (IEP). The IEP is led by state and Federal agencies, and includes university and private partners. There are several monitoring programs that are implemented each year throughout estuary. Each study has the potential to capture Delta Smelt to some degree; four are commonly used to index the abundance and distribution of Delta Smelt (Figure 2).

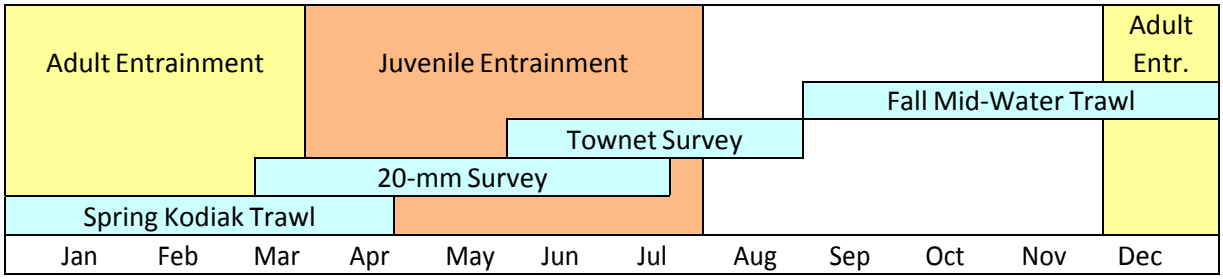


Figure 2. Approximate timetable of the primary surveys used to assess relative abundance and distribution of Delta Smelt

The Fall Mid-Water Trawl (FMWT) and the Summer Townet Survey (STNS) are the two longest-running IEP fish monitoring programs that are used to index Delta Smelt abundance. Two more recent surveys, the 20-mm survey and the Spring Kodiak Trawl (SKT) survey, were specifically designed to sample Delta Smelt relative abundance and distribution. Each of these four sampling programs targets different life stages and encompasses the entire life cycle and distribution. Data from the FMWT (September – December) are used to calculate a relative index of abundance, which is used in the BiOp to calculate allowable incidental take for the Projects. Data from the SKT (January – May) are used to monitor distribution and spawning readiness of adults. Data from the 20-mm survey (March – June) are used to monitor the distribution and relative abundance of post-larval Delta Smelt. Data from the STNS (June – August) are used to monitor the distribution and relative abundance of juvenile Delta Smelt.

Both the state and Federal water Projects utilize behavioral-barrier fish screens designed to route fish away from export water and into a fish salvage facility where they are collected, counted, and trucked to a release site in the Delta. The salvage process was designed for young Chinook Salmon and Striped Bass; Delta Smelt that enter the facility are thought to not survive the release process and are counted as mortality. The fish salvage facilities report Delta Smelt and Longfin Smelt salvage to the Service and publish the data on a public website. (BiOp, pp 143-145, http://www.usbr.gov/mp/cvo/).

Chapter 2. Summary of SWG Discussion and Advice in WY 2014

After an initial organizational meeting on November 25, 2013, the SWG began distributing data in December and held regular meetings beginning January 6, 2014; the last meeting was on June 9, 2014. At least one representative from each agency was able to participate on most calls.

Weekly discussion topics included fish salvage at the Projects' fish salvage facilities, DFW and Service biological field surveys, Delta hydrology, expected Project operations for the coming week, status of NMFS biological opinion actions and risk of entrainment for Delta Smelt and Longfin Smelt. Periodic discussion topics included applicable sections of the Service BiOp for Delta Smelt, updates for ongoing field studies, historical survey results, hydrology patterns, water quality requirements, status of emergency drought actions, Delta turbidity modeling results, and the status of temporary Delta barriers.

2.1 Component 1: Adult Entrainment

Adult Incidental Take
The adult Delta Smelt incidental take authorized in the BiOp is based on historical take from the Projects and also uses the FMWT index to scale allowable take to apparent abundance (BiOp, pp 285-288). The FMWT index for Delta Smelt for 2013 was 18. Therefore, using the equation in the BiOp, authorized incidental take for adult Delta Smelt in WY 2014 was 155 fish for both Projects; the BiOp's Concern Level was 116 fish.

Action 1
Adult Delta Smelt entrainment generally occurs when pre-spawning migrants enter the central and southern Delta following the first winter pulse of precipitation in the watershed. This event is characterized by the first substantial flow increase of the winter and is generally coincident with an increase in turbidity, also referred to as "first flush". Flow and turbidity are believed to serve as cues for adult Delta Smelt migration.

Action 1 requires OMR flow be managed to no more negative than -2,000 cfs for 14 days. This decrease in reverse OMR flow results in the draw of little to no Sacramento River water into the central and southern Delta and typically allows some portion of the San Joaquin River flow to reach the confluence area. Action 1 is intended to decrease the risk of entrainment of pre-spawning adult Delta Smelt, and improve habitat conditions for the species. Additionally, Action 1 is intended to decrease the risk of entrainment of larval and juvenile Delta Smelt later in the season by allowing environmental cues to encourage the species to spawn in the northern Delta.

In WY 2014, the SWG monitored turbidity and Delta hydrology as indicators of the occurrence of the first winter pulse flow in an effort to assess the entrainment risk. Additionally, the SWG monitored salvage and survey results as an indicator of relative species abundance and distribution. Action 1 was not implemented in WY 2014 because the criteria for implementation were not met.

Action 2
Action 2 encompasses the period when OMR prescriptions (-1,250 to -5,000 cfs) for pre-spawning adult Delta Smelt are required to protect parental stock prior to reproduction; however, such controls may be relaxed if the main pulse of fish migration has already occurred and adults are maintaining position near selected spawning areas. Action 2 may also be needed to extend protections, consistent with Action 1, in years when the spawning migration period is longer or due to changing environmental conditions. Because conditions are highly variable both between and within years, the SWG monitors environmental conditions including turbidity, flow, and water temperature, as well as relative fish abundance, distribution and spawning readiness, and salvage at the export facilities, to assess the risk of entrainment. The RPA describes a variety of potential recommendations, according to the assessed level of risk (BiOp, pp 354-356).

Action 2 commences automatically following Action 1; however, as Action 1 was not implemented in WY 2014, Action 2 can begin when either the Service or SWG determine that protective OMR flows are necessary. In WY 2014, restrictions under Action 2 were not implemented. No adult Delta Smelt were salvaged at either the CVP or SWP fish facilities for the December-through-March period.

2.2 Component 2: Juvenile Entrainment

Juvenile Incidental Take
Incidental take for juvenile Delta Smelt is based upon historic observed take as well as upon apparent abundance (BiOp, pp 289-293) similar to the adult take calculation. Because of the difficulty in identifying larval smelts to species, only Delta Smelt greater than 20 mm in length are counted in salvage. Juvenile take is estimated by month for the April-through-July period. Authorized take for WY 2014 is provided in Table 2.

Table 2. Incidental take for juvenile Delta Smelt at least 20 mm in size, WY 2014, cumulative by month

	Concern Level	Authorized Take	Actual Project Take*
April	6	9	24
May	231	347	78
June	591	887	78
July	671	1007	78

*Actual Take numbers are the final combined, cumulative salvage data published on California Department of Fish and Wildlife's Salvage Monitoring website at ftp://ftp.delta.dfg.ca.gov/salvage/Daily_Smelt_Summary/SMELT_SALVAGE_TABLES_2014_%2007012014.pdf

Action 3.
Implementation of Action 3 begins when the SWG determines that spawning has begun and larval fish are present in the Delta, following the guidance in the BiOp. It is likely that Delta conditions (primarily water temperature) will be appropriate for the presence of larvae before larvae are detected by routine survey sampling. The SWG monitors water temperature, adult spawning condition (i.e., gonad development based on Delta Smelt collected in field surveys or at the salvage facilities), larval occurrence and distribution to assess the relative risk of entrainment. Action 3 concludes when Delta water temperatures reach a daily average of 25° Celsius at Clifton Court Forebay for three consecutive days, or until June 30, whichever occurs first (BiOp pp 357- 359).

In WY 2014, the SWG monitored Delta hydrology and juvenile distribution as indicated by the Smelt Larval Survey (SLS) and 20-mm Survey. No Delta Smelt were collected until SLS surveys #5 and #6. Distribution of Delta Smelt larvae indicated that presence was predominately in the Sacramento River system. Delta Smelt larvae were detected in all 20-mm Surveys in WY2014. While distribution of Delta Smelt larvae in the 20-mm Survey shifted throughout the season, the majority of the catch occurred at Sacramento River stations.

To review all SWG meeting notes from WY 2014, please visit http://www.fws.gov/sfbaydelta/cvp-swp/smelt_working_group.cfm.

Chapter 3. Water Operations Summary for Water Year 2014

Hydrologic year types in both the Sacramento and San Joaquin river basins were classified as critical in WY 2014. Throughout January, exports were controlled by the State Water Resources Control Board (Board) monthly water quality standards in D-1641. To address extreme drought conditions, a Temporary Urgency Change Petition (TUCP) was approved by the Board on January 31, 2014. The TUCP allowed for the relaxation of some D-1641water quality standards, and controlled exports some of the time from February through June. The OMR flow restriction of -5000 cfs in both the Service and NMFS RPAs partly controlled exports in March. Exports from April through May were subsequently controlled by the export to inflow

ratio of 1:1 for April 15-May 15 (NMFS RPA Stanislaus River/Vernalis pulse flows). By early May, D-1641 water quality standards controlled Project operations, and continued to through the end of the SWG season. On June 10, 2014, the temperature off-ramp conditions for RPA Component 2, Action 3 were met.

Please refer to Figure 3 for sections 3.1 through 3.3.

3.1 Export Pumping

The combined Projects export rate averaged approximately 2,500 cfs in December, 1,500 cfs in January, 2,500 cfs in February, and 4,200 cfs in March. The remainder of the spring saw a continued lower export rate, with April averaging 3,600 cfs, May averaging 1,300 cfs, and June averaging 800 cfs.

3.2 River Flows

December 2013 and January 2014 were marked by a lack of the storms which typically bring rainfall to contribute to river flow. Sacramento River flow at Freeport remained fairly steady during the 2013/2014 winter, with daily average flows generally remaining between 5,000 and 8,000 cfs. A few smaller storms in February and March resulted in minor increases in river flow. The storm in early February resulted in a peak flow of approximately 24,000 cfs at Freeport. An additional storm in March resulted in a peak at Freeport of approximately 28,000 cfs, and resulted in increased flows for a little more than two weeks. A smaller storm in early April resulted in a smaller peak of approximately 19,000 cfs. After this storm, the Sacramento River at Freeport did not again rise above 10,000 cfs until reservoir releases were increased in June to support Delta water quality standards and Delta exports.

The San Joaquin River did not receive storm-driven flow from December 2013 through June 2014, and did not rise above 1,200 cfs from December through mid-April. On April 16, flows at Vernalis began to increase in response to reservoir releases upstream to comply with the NMFS Biological Opinion RPA. By May 19, flow at Vernalis dropped below 1,000 cfs and continued to decrease until reaching a relatively steady flow of approximately 250 cfs by the end of June.

3.3 Delta Outflow and Winter Pulse

Delta outflow generally parallels Sacramento River flows, depending on the rainfall and snowfall patterns throughout the water year. Delta outflow did not rise above 10,000 cfs until February 8. This pulse peaked at approximately 27,000 cfs and declined rapidly to flows below 10,000 cfs by mid-February. The abrupt change in turbidity and flow commonly associated with the “first flush” did not occur in December of 2013 (BiOp p 146). Another pulse with a peak of approximately 26,000 cfs outflow moved through the system in early March. A final pulse with a peak of approximately 22,000 cfs moved quickly through the system in early April. Subsequent to this April peak, outflow declined through the remainder of the month. Average outflows in May and June were approximately 3,800 and 4,800 cfs, respectively.

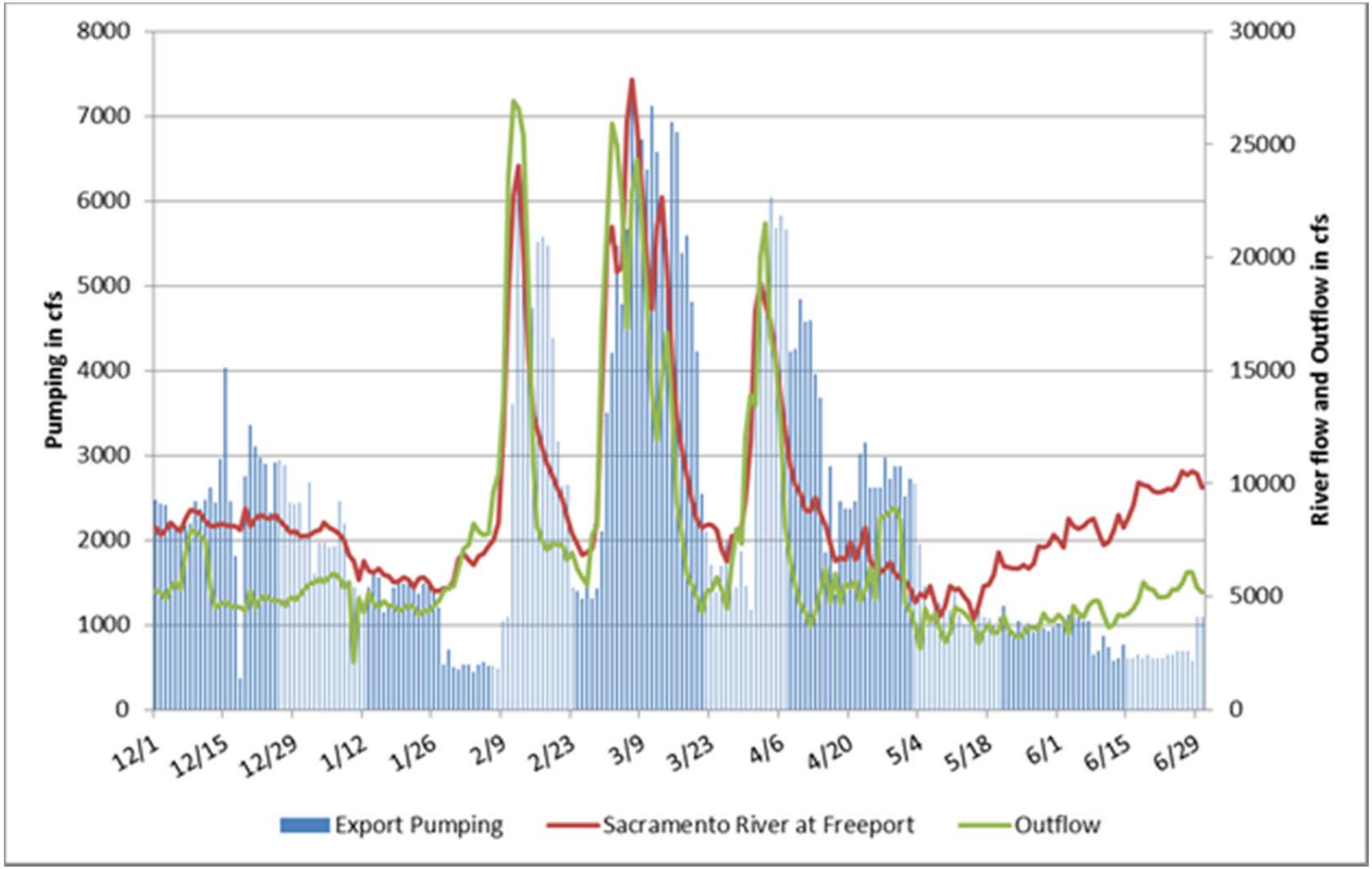


Figure 3. Export pumping, river flow, and outflow levels for WY 2014

The Delta Smelt Working Group and the Delta Smelt Risk Assessment Matrix

The delta smelt risk assessment matrix (DSRAM) consists of month by month criteria which, when exceeded will trigger a meeting of the Delta Smelt Working Group (Working Group). The Working Group consists of experts in delta smelt biology from the U.S. Fish and Wildlife Service (Service), U.S. Bureau of Reclamation (Reclamation), U.S. Environmental Protection Agency (EPA), and California Departments of Water Resources (DWR) and Fish and Game (DFG). The purpose of the DSRAM is to take actions to protect delta smelt in a proactive manner prior to salvage events at the Federal and State Delta export facilities. Reclamation and/or DWR are responsible for monitoring the DSRAM criteria and reporting back to the Service and the Working Group. The DSRAM has been modified from the delta smelt decision tree, which was peer-reviewed and presented in the Interagency Ecological Program (IEP) Newsletter. It is the intent of the Service that the DSRAM be sent out for independent peer review. The DSRAM is an adaptive management tool which may be further modified by the Working Group and the interagency Water Management Operations Team (WOMT) as new information becomes available, without undergoing formal reconsultation. An informative link to an existing website will be developed that compiles monitoring data from IEP and DFG to enable members of the Working Group to easily track the progress of the triggering criteria. Data will be updated at least weekly to determine the need for a meeting.

Should a triggering criterion be met or exceeded, Reclamation and/or DWR will inform the members of the Working Group and the Working Group will determine the need to meet. Any member of the Working Group may initiate a meeting of the Working Group at any time. A meeting of the Working Group may consist of an in-person meeting, a conference call, or a discussion by email. If needed, the Working Group will meet prior to the weekly meetings of the DAT and the WOMT and information will be shared with these groups. The Working Group will be available to present management briefings as needed.

If a meeting of the Working Group proves necessary, the group will review the available monitoring and survey data and decide whether to recommend a change in water project operations (referred to as "fish actions"). These potential fish actions are listed in the DSRAM by the months wherein each of these tools generally becomes available. Generally, if the Working Group recommends a fish action, it will be shared with the Data Assessment Team (DAT) during its weekly conference call and forwarded to the WOMT for discussion and potential implementation; however, the Working Group may make recommendations to WOMT at any time. Recommendations will include a discussion of the level of concern for delta smelt and will include a list of the participants in the Working Group discussions. All dissenting opinions and/or discussion points will also be forwarded to the WOMT. The Working Group will meet at least weekly throughout the period in which the triggering criteria are met or exceeded, to determine the need to provide further recommendations to the WOMT.

Notes and findings of Working Group meetings will be submitted to the Service and members of the WOMT for their records. Meeting notes will also be available to the public on the Sacramento Fish and Wildlife Office's web page. The WOMT will respond to the Working Group's recommendations and the actions taken by the WOMT will be summarized by Reclamation and/or DWR annually and submitted to all WOMT agencies.

If an action is taken, the Working Group will follow up on the action to attempt to ascertain its effectiveness. An assessment of effectiveness will be attached to the notes from the Working Group's discussion concerning the action.

Life Stage	Adults	Adults	Adults	Adults and larvae	Adults and larvae	Larvae and juveniles	Larvae and juveniles	Juveniles
Previous Year's Fall Midwater Trawl Recovery Index (1)	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74	Index below 74
Risk of Entrainment (2)				X2 upstream of Chipps Island and temps are ≥ 12°	X2 upstream of Chipps Island and temps are between 12° and 18°C	X2 upstream of Chipps Island and mean delta-wide temps <18°C and south delta temps below 25°C	X2 upstream of Chipps Island and temps are below 25°C	X2 upstream of Chipps Island and temps are below 25°C
Duration of Spawning period (number of days temperatures are between 12 and 18°C) (3)					39 days or less by April 15	50 days or less by May 1		
Spawning Stage as determined by spring Kodiak trawl and/or salvage (4)			Presence of Adults at spawning stage ≥ 4	Adult spawning stage ≥ 4	Adult spawning stage ≥ 4			
smelt distribution (5)	See footnote #5	See footnote #5	See footnote #5	See footnote #5 or negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance	Negative 20mm centroid or low juvenile abundance
Salvage Trigger (6)	Adult concern level calculation	Adult concern level calculation	Adult concern level calculation	Adult concern level calculation		If salvage is above zero	If salvage is above zero	

Tools for Change (7)	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**July**
Export reduction at one or both facilities	X	X	X	X	X	X	X	X
Change in barrier operations						X	X	X
Change in San Joaquin River flows				X	X	X	X	X
Change position of cross channel gates						X	X	

Delta Smelt Risk Assessment Matrix Footnotes (note: the references for the DSRAM are also included in the literature cited section of the biological opinion)

1 The Recovery index is calculated from a subset of the September and October Fall Midwater Trawl sampling (http://www.delta.dfg.ca.gov/). The number in the matrix, 74, is the median value for the 1980-2002 Recovery Index (Figure DS1)

The temperature range of 12 to 18 degrees Celsius is the range in which most successful delta smelt spawning occurs. This has been analyzed by using observed cohorts entering the 20-mm Survey length frequency graphs (1996-2002). Cohorts were defined by having a noticeable peak or signal and occurring over three or more surveys during the rearing season. Back calculations were made using the first survey of that cohort with fish less than 15 mm fork length. Temperature data from IEP's HEC-DSS Time Series Data web site was compiled using three stations representing the south Delta (Mossdale), confluence (Antioch), and north Delta (Rio Vista) and averaged together. Spawning dates for each cohort were back-calculated by applying an average daily growth rate (wild fish) of 0.45 mm/day (Bennett, DFG pers. comm.) and egg incubation period of 8-14 days (Baskerville-Bridges, Lindberg pers. comm.)(Mager et al. 2004) from the median value of the analyzed cohort. Each spawning event was then plotted against temperature over time (Figure DS2.1). While spawning does occur outside of the 12-18 degree range, larval survival is most likely reduced when temperatures are either below (DFG pers. comm.) or above this range (Baskerville-Bridges & DFG pers. comm.).

Critical thermal maxima for delta smelt was reached at 25.4 degrees Celsius in the laboratory (Swanson et al., 2000); and at temperatures above 25.6 degrees Celsius smelt are no longer found in the delta (DFG, pers. comm.).

Websites for the temperature data: http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=RSAN007
http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=RSAN087
http://iep.water.ca.gov/cgi-bin/dss/dss1.pl?station=RSAC101

Mager RC, Doroshov SI, Van Eenennaam JP, and Brown RL. 2004. Early Life Stages of Delta Smelt. American Fisheries Society Symposium 39:169-180.

Swanson C, Reid T, Young PS, and Cech JJ. 2000. Comparative environmental tolerances of threatened delta smelt (*Hypomesus transpacificus*) and introduced Wakasagi (*H. nipponensis*) in an altered California estuary. Oecologia 123:384-390.

3 Figure DS3: The working hypothesis for delta smelt is that spawning only occurs when temperatures are suitable during the winter and spring. In years with few days having suitable spawning temperatures, the spawning "window" is limited, so the species produces fewer cohorts of young smelt. When there are fewer

cohorts the risk that mortality sources such as entrainment may substantially reduce population size increases. The figures below were used to help define years when there were relatively few days with suitable temperatures. For April 15 and May 1, the figures show the cumulative spawning days for each year during 1984-2002. The cumulative spawning days for each year were calculated based on the number of days that the mean water temperature for three Delta stations (Antioch; Mossdale and Rio Vista) was in the 12 - 18 C range starting on February 1. The results are plotted in terms of the ranks to identify the lower quartile. In other words, years in the lower quartile represent examples of years with relatively few spawning days.

4 The adult spawning stage is determined by the Spring Kodiak Trawl and/or fish collected at the salvage facilities (http://www.delta.dfg.ca.gov/). A stage greater than or equal to 4 indicates female delta smelt are ripe and ready to spawn or have already spawned (Mager 1996).

Mager RC. 1996. Gametogenesis, Reproduction and Artificial Propogation of Delta Smelt, *Hypomesus transpacificus*. [Dissertation] Davis: University of California, Davis. 115 pages. Published.

5 The spring kodiak trawl will be used to generally evaluate the distribution of adult delta smelt. However, since the spring kodiak trawl is not intended to be a survey for abundance or distribution, no definitive trigger for concern can be determined at this time.
Juveniles (March-July) – distribution of juvenile delta smelt where the centroid is located upstream (negative) or downstream (positive) of the Sacramento-San Joaquin River confluence (Sacramento RKI 81; Figure DS5.1). The 20-mm Survey centroid is calculated by multiplying the observed delta smelt station CPUE (fish/10,000 m3) by a distance parameter in km from Sacramento RKI 81. The summed result (summed over a survey) is divided by the survey CPUE which gives the survey centroid position (Figure DS5.2).

Low juvenile abundance will also be a trigger. When juvenile abundance is low, concern is high. Low abundance is indicated when the total cumulative catch in the 20-mm Survey is less than or equal to the 1995-2003 median value of cumulative 20-mm Survey catch for the same surveys (Table DS5).

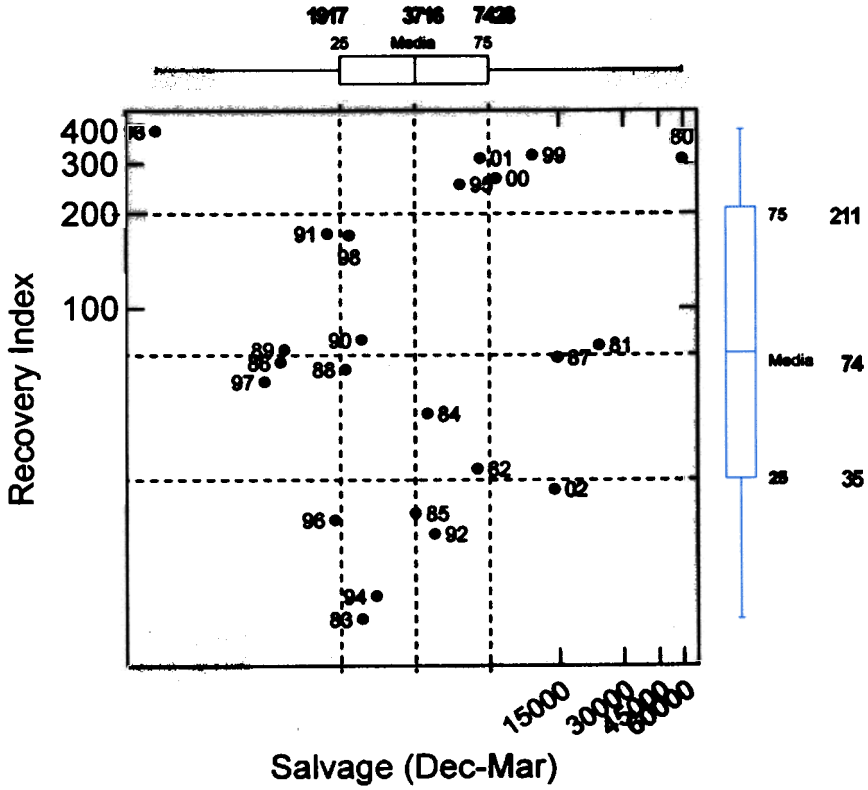
6 Adult salvage trigger: the adult delta smelt salvage trigger period is December through March and the trigger is calculated as the ratio of adult delta smelt salvage to the fall MWT index. This ratio will increase as fish are salvaged during the winter months. If the ratio exceeds the median ratio observed during December-March 1980-2002, then the trigger has been met (see Figure DS6 for more explanation of the calculation)

Juvenile salvage trigger: During May and June, if delta smelt salvage at the SWP/CVP facilities is greater than zero, then the working group will meet. This

is because May and June are the peak months of delta smelt salvage and salvage densities cannot be predicted. Therefore, during these two months, the delta smelt working group expects to meet regularly to look at relevant information such as salvage, delta temperatures, delta hydrology and delta smelt distribution and decide whether to recommend proactive measures to protect these fish.

7 The tools for change are actions that the working group can recommend to the WOMT to help protect delta smelt. Exports may be reduced at one or both of the south delta export facilities and a proposed duration of the reduction would be recommended by the working group. Export reductions and changes in San Joaquin River flows may be covered by B(2) or EWA assets. Details of past fish actions can be found at the Calfed Ops website: http://wwwoco.water.ca.gov/calfedops/index.html; >Operations [year]

Figure DS1



Points are labeled with the year representing the recovery index.
The winter salvage for this analysis starts on December 1 of the recovery index year and continues through March 31 of the following year.

Figure DS2.1. Successful delta smelt spawning periods (shaded blue area) and cohorts (black bars) plotted against water temperature (1996-2002). Spawning periods and cohorts were back calculated using 20-mm Survey catch data. Start of spawning season uses an egg incubation period of 14 d and a growth rate of 0.45 mm/day and end of spawning season 8 d with a growth rate of 0.45 mm/day. Black bars represent the range of 8-14 d egg incubation with a growth rate of 0.45 mm/day from laboratory results. Temperature data (°C) was compiled from IEP's HEC-DSS Time Series Data using mean daily temperatures from the confluence (Antioch), south Delta (Mossdale), north Delta (Rio Vista) and averaged together.

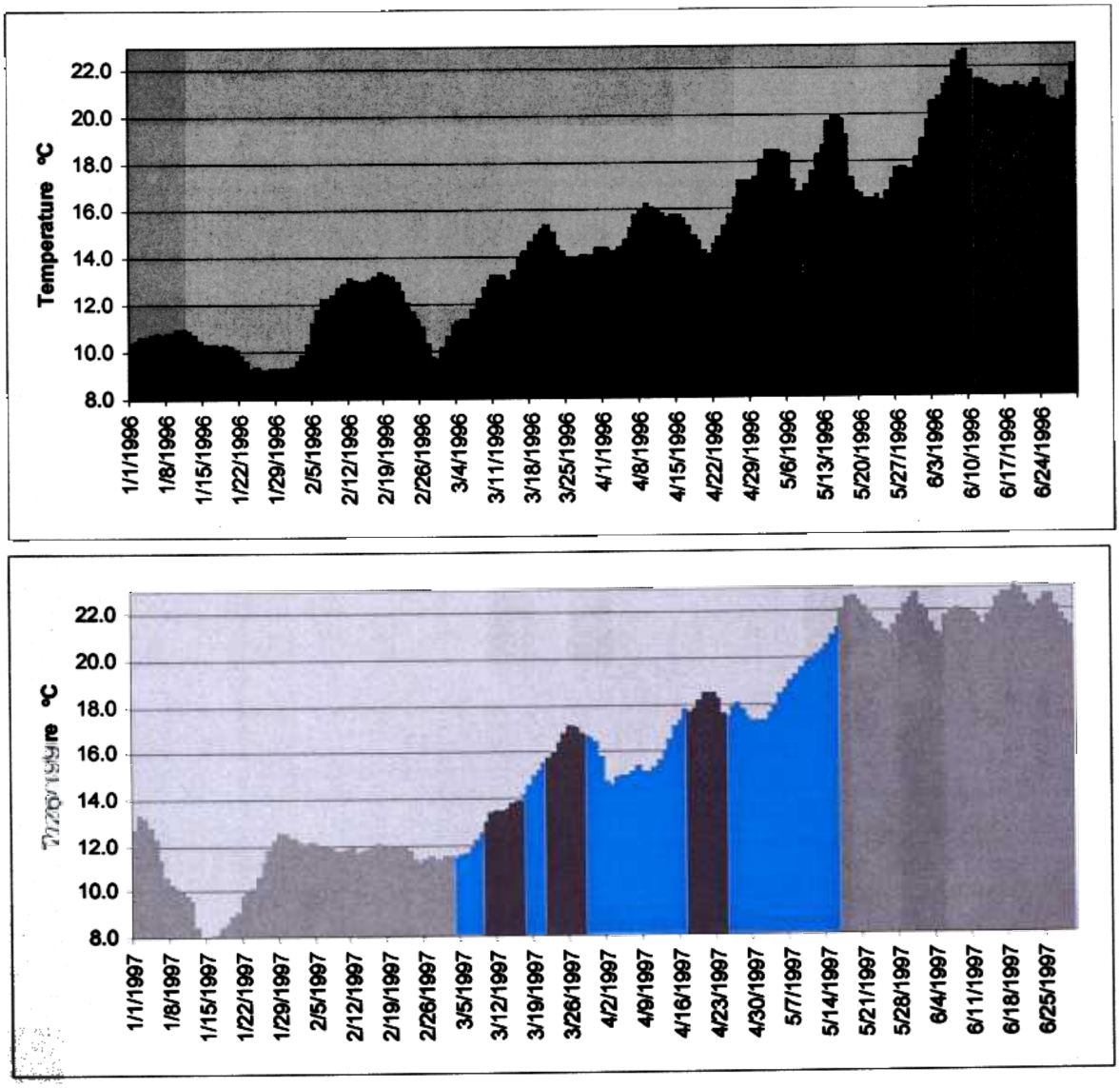


Figure DS2.1 cont.

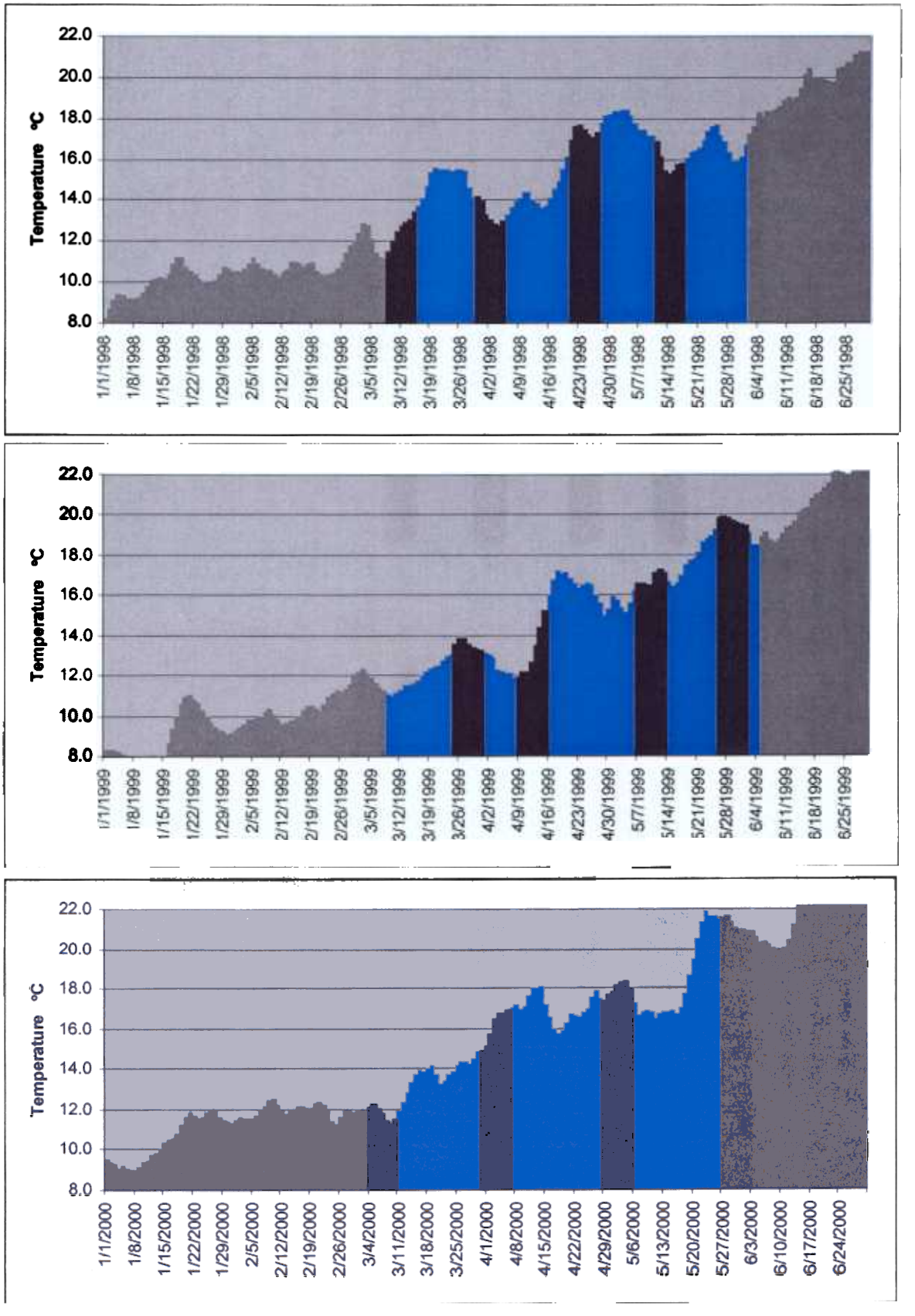


Figure DS2.1 cont.

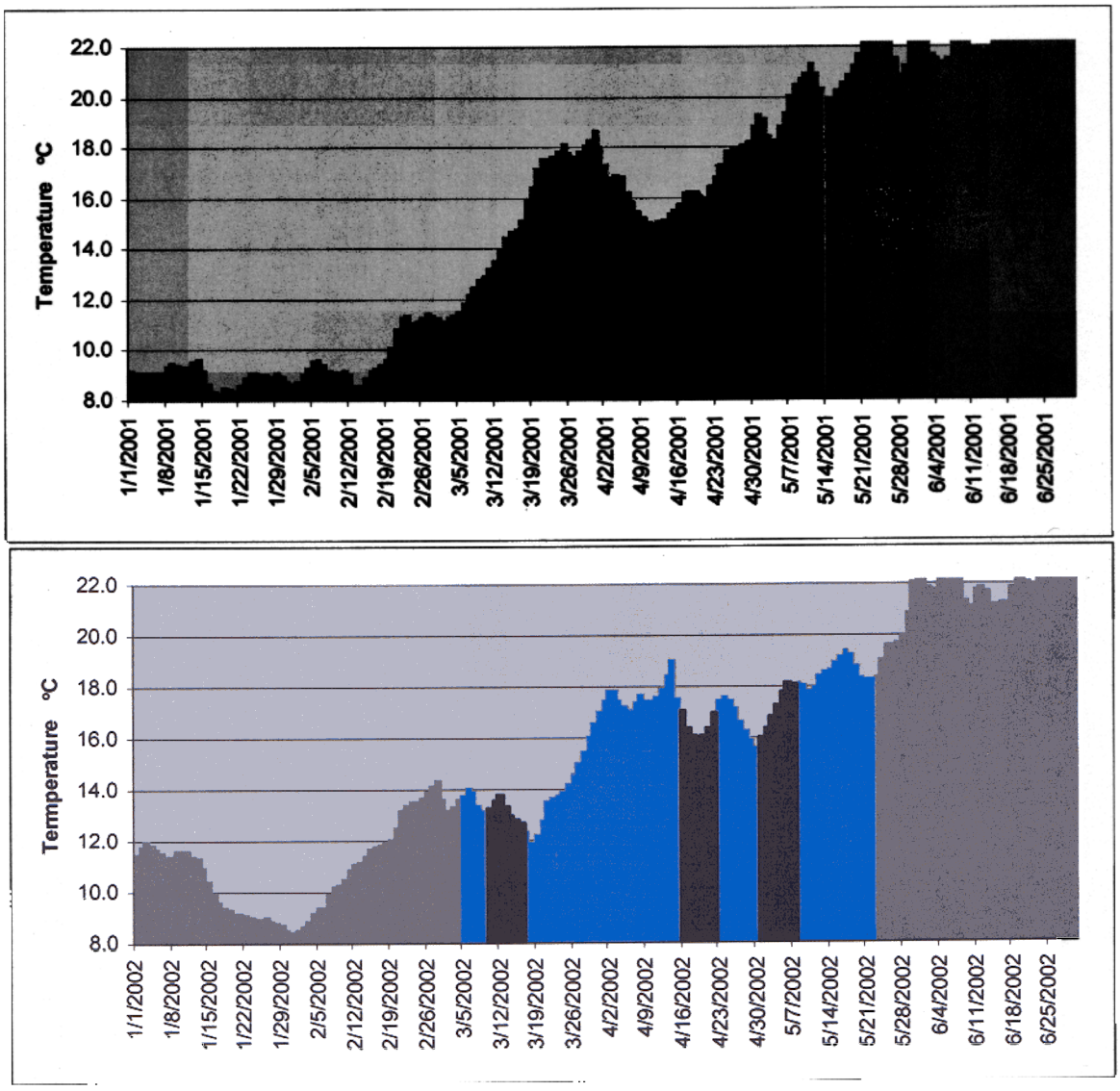
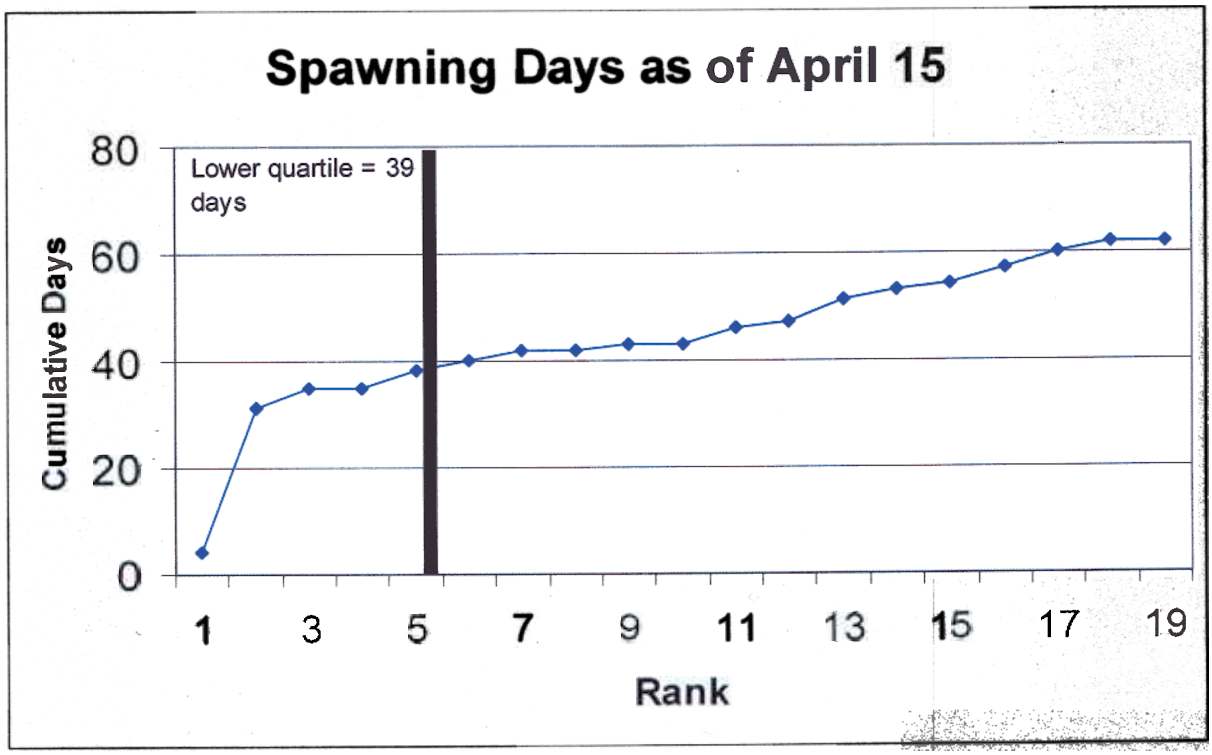


Figure DS3.


Spawning Days as of April 15
Lower quartile = 39 days
Cumulative Days
0
20
40
60
80
1
3
5
7
9
11
13
15
17
19
Rank

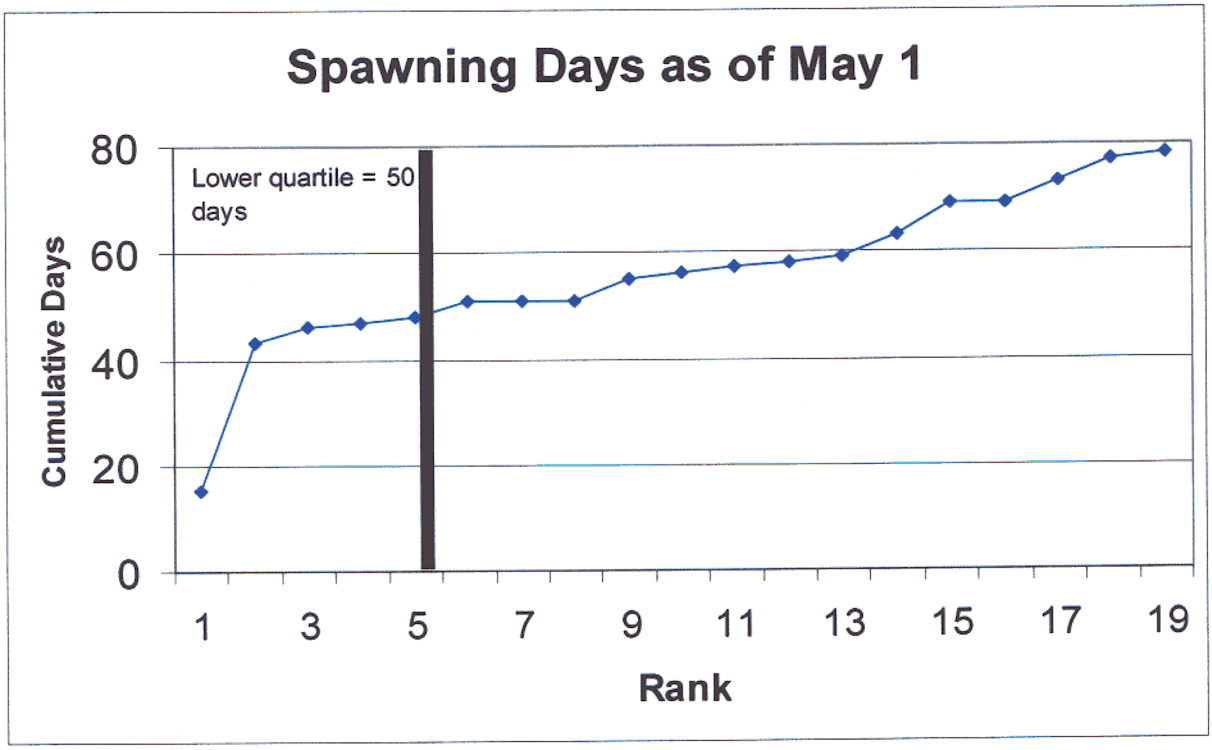

Spawning Days as of May 1
Lower quartile = 50 days
Cumulative Days
0
20
40
60
80
1
3
5
7
9
11
13
15
17
19
Rank

Figure DS5.1. A 20-mm Survey delta smelt bubble plot map with calculated centroid position from the confluence of Sacramento-San Joaquin Rivers with one standard deviation.

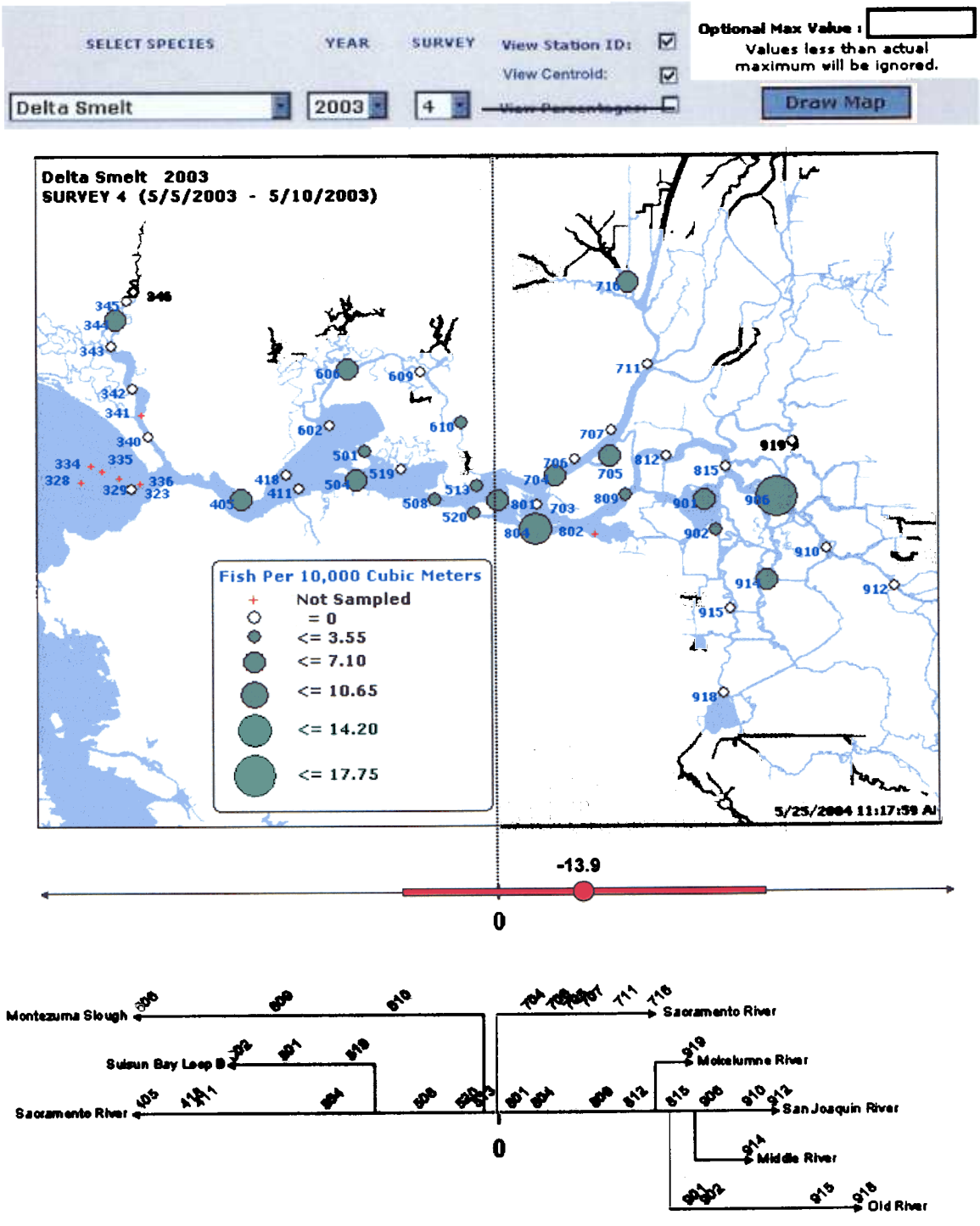


Figure DS5.2. Historic juvenile centroid position (20-mm Survey) with one standard deviation.

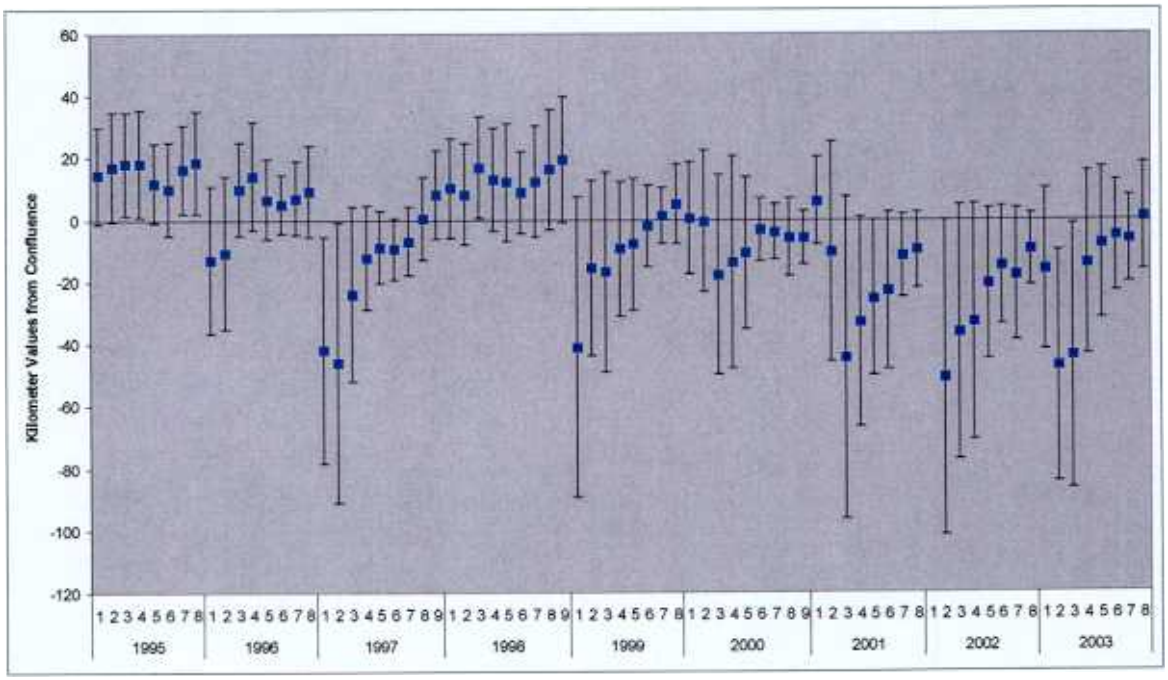


Table DS5. Median values of cumulative catch from the 20-mm Survey. When cumulative catch per survey during a season is at or below the calculated value, concern is high.

	survey 1	survey 2	survey 3	survey 4	survey 5	survey 6	survey 7	survey 8
Median Value	12	40	144	188	346	500	924	1019

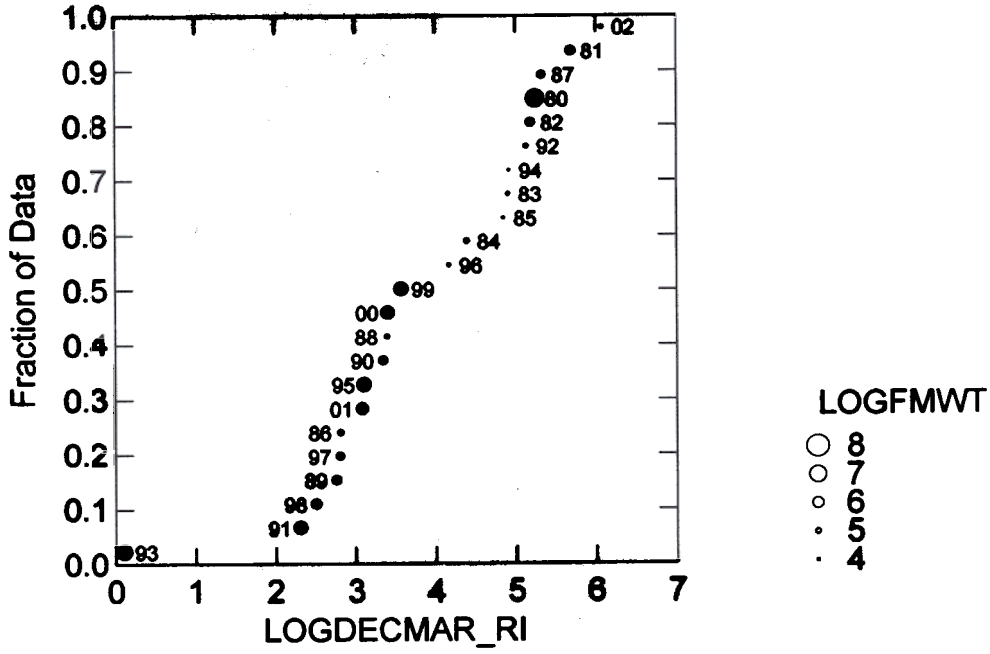
Figure DS6

The objective is to quantify a level of concern for adult delta smelt during the winter that is based upon the number of fish salvaged and the overall abundance of delta smelt. Our trigger reflects that when abundance is low and salvage is high concern is high, and conversely when abundance is high and salvage is low that concern is low.

Below is a Quantile plot of the ratio of winter salvage to the MWT recovery index (ln(winter salvage/recovery index)). Winter salvage is defined as the total salvage from December through March. In the figure below, the size of the bubbles is proportional to the log of the fall midwater trawl to demonstrate that concern may be high in years of

high or low fall abundance. The resulting quartiles of the ratio are as follows: 25% =: 2.950; 50%= 3.575; 75% 5.029.
Using this approach to calculate winter concern levels, all years above the 1999 point in the graph would have been years of concern. In other words, these are the years in which we may have recommended some protection. Comparing it to the protection afforded adult delta smelt in the winter by the 1995 Biological Opinion: "red light" was, or would have been, reached in fewer winters (1980, 1981, 1982, 1984 and 1999) .

The median was selected as the measure of concern and will be calculated by:
concern level = anti ln(3.575)* Recovery index



The goal for the DSRAM is to avoid the upper quartile of the above graph, which the Working Group thinks will avoid salvage events that are high relative to fall abundance. Actions may be taken prior to major salvage events.