

Smelt Working Group
Report to the Independent Review Panel
Water Year 2010

In an effort to enable review of the coordinated operation decisions under the *Endangered Species Act Consultation on the Proposed Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP)* (“OCAP”) and real-time species information underlying those decisions, the Bay-Delta Fish and Wildlife Office (BDFWO) has prepared the following report. The report is intended to facilitate review by the Independent Technical Panel, and includes introductory text as well as a summary of the actions implemented under the Reasonable and Prudent Alternative (RPA).

The reader should be aware that the tables and figures in this document were constructed from the data available to and used by the Smelt Working Group in near-real-time. In some instances, these data may have been updated. However, the data provided herein reflect the data that were reviewed by the SWG *at the time*, irrespective of whether subsequent updates may be available.

Introduction

The federal Endangered Species Act (Act) is administered primarily by the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (Service). A *biological opinion* is a product of an interagency consultation under section 7 of the Act, 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...” The biological opinion includes the written opinion of the Service, a summary of the information used, and a detailed discussion of the effects of the proposed action on the listed species or its critical habitat, and reasonable and prudent measures necessary in order for the project to move forward.

There are three major factors related to operations of the CVP/SWP affecting delta smelt population resilience and long-term viability. These three factors are: 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 (USFWS B.O., p 325). Entrainment of all life stages of delta smelt is associated with Delta hydrology. Reverse flows on Old and Middle Rivers (OMR) resulting from Project export pumping is a proximal

cause of entrainment, while the position of the two-parts-per-thousand isohaline (termed “X₂” and measured as kilometers from the Golden Gate) is a distal cause of entrainment.

In formal consultation with the U.S. Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR), the Service determined that the coordinated operations of the CVP and SWP, as proposed, were likely to jeopardize the continued existence of the delta smelt and adversely modify its critical habitat. Thus, the Service developed a *reasonable and prudent alternative* (RPA). The Service’s biological opinion for delta smelt (“OCAP”) includes five RPA components to protect different delta smelt life stages and minimize impacts to critical habitat. The two primary components affecting CVP and SWP operations are components 1 and 2. Component 1 protects adult delta smelt by reducing Old and Middle River (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 the project diversions, occurring as early as December and continuing 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 until June 30, or when water temperatures reach 25° Celsius.

Table 1. Simple Illustration of the First Two Components of the OCAP RPA

Component 1			Component 2
Action 1(a)	Action 1(b)	Action 2	Action 3
Dec 1-20			
	Dec 20 – Action 2		
		Immed. Following Action 1	
			Onset of Spawning

These components are implemented through an adaptive process that is guided by hydrological and biological data, an interagency team of delta smelt biologists (SWG), and real-time project operational decisions.

Adaptive Decision Process

Real-time decision-making to assist fishery management is a process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. For CVP and SWP operations, high uncertainty exists for how to best manage water operations while protecting listed species. Sources of uncertainty relative to CVP and SWP operations include:

- Hydrologic conditions

- Ocean conditions
- Listed species biology

Under the proposed action the goals for real time decision-making to assist fishery management are:

- Meet contractual obligations for water delivery
- Minimize adverse effects for 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 such decisions, the Project Agencies and the Service, NMFS, and the California Department of Fish and Game (DFG) have developed and refined a set of processes for various fish species 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 are made up of management staff from Reclamation, DWR, the Service, NMFS, and the DFG. Information teams are teams whose role is to disseminate and coordinate information among agencies and stakeholders. Fisheries and Operations Technical Teams 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; it then provides a recommendation to the agency with statutory obligation to enforce protection of the species in question. The agency's staff and management then review the recommendation and use it as a basis for developing, in cooperation with Reclamation and DWR, a modification of water operations that will minimize adverse effects to listed species by the Projects. If the Project Agencies do not agree with the action, then the fishery agency with the statutory authority makes the final decision on an action that they deem necessary to protect the species. .

The outcomes of protective actions that are implemented are monitored and documented, and this information informs future recommended actions (USFWS B.O. pp 27-29).

Smelt Working Group

The SWG evaluates biological and technical issues regarding delta smelt and develops recommendations for consideration by the Service. Since the longfin smelt (*Spirinchus thaleichthys*) became a state candidate species in 2008, the SWG has also developed for DFG recommendations to minimize adverse effects to longfin smelt. The SWG consists of

representatives from the Service, NMFS, DFG, U.S. Environmental Protection Agency (EPA), DWR, and Reclamation. The Service chairs the group, and members are assigned by each agency.

The SWG compiles and interprets the latest near-real-time information regarding state- and federally-listed smelt, such as stages of development, distribution, and salvage. After evaluating available information and if they agree that a protection action is warranted, the SWG will submit their recommendations in writing to the Service and DFG.

The SWG may meet at any time at the request of the Service, but generally meets weekly during the months of December through June, when smelt salvage at Jones and Banks has occurred historically. However, 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. Further, with the State listing of longfin smelt, the group will also convene based on longfin salvage history at the request of DFG (USFWS B.O., pp 30-31).

Typically, around the beginning of December, the SWG begins meeting weekly to review information about delta hydrology and smelt distribution and abundance. Once data indicate that smelt may be at risk for entrainment, the SWG recommends OMR flows within the ranges in the RPA to the Service. The Service's staff and managers then review the recommendation and, if warranted and in cooperation with Bureau of Reclamation and the California Department of Water Resources (DWR), use it to develop a modification of water operations that will minimize adverse effects to listed species caused by operations. If Reclamation and DWR do not agree with the action, the agency with statutory authority will make a final decision on the action. This adaptive process continues throughout the winter and spring until smelt are no longer vulnerable to entrainment. For detailed notes on the SWG 2010 Water Year meetings please visit http://www.fws.gov/sacramento/es/OCAP_BO_actions.htm and /or <http://www.fws.gov/sfbaydelta/ocap> .

Water Year 2010 Decision Processes

Smelt Working Group. The SWG held regular conference calls that were well-attended. At least one representative from each agency was able to participate on all calls. In most instances, the SWG was able to provide the Service with a unanimous recommendation; when this was not possible, alternative viewpoints were provided. The SWG was able to provide their recommendation within the time specified in the biological opinion. The Service was able to use the recommendation to draft a Determination within the time specified in the biological opinion.

Water Operations Management Team. The WOMT met in person or via conference call throughout the December-through-June implementation period. The Service provided the WOMT with its draft Determination for discussion. The WOMT was able to discuss the

recommendation and the Service was able to finalize its Determination within the time specified in the biological opinion.

Information Reviewed

The Smelt Working Group typically met weekly via conference call, and reviewed a variety of near-real-time environmental, survey and modeling data. The RPA provides specific guidance to the SWP on the interpretation of the data.

Action 1. Adult delta smelt entrainment is characterized by a pulse of pre-spawning migrants entering the Central and South Delta following a “first flush” flow event in winter. This event is characterized by the first substantial flow increase of the winter and coincident with an increase in turbidity. Flow and turbidity are believed to serve as cues for adult delta smelt migration. Action 1, once triggered, 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 or 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 anticipated to decrease the risk of entrainment to pre-spawning adult delta smelt, therefore improving habitat conditions for the species. Additionally, Action 1 is intended to decrease the risk of entrainment to larvae and juvenile delta smelt by allowing environmental cues to encourage the species to spawn in the northern delta.

Therefore, the SWG monitored turbidity and flow as an indicator of the occurrence of first flush in their effort to assess the risk of entrainment. Additionally, the SWG monitored salvage and survey results in the event that turbidity did not adequately predict entrainment.

Action 2. Action 2 reflects the period when OMR prescriptions for pre-spawning adult delta smelt are still required to protect parental stock prior to reproduction, however, such controls may generally be relaxed because the main pulse of fish migration has occurred and adults are holding more tightly to their selected spawning areas. Action 2 may also be needed to extend protections consistent with Action 1 in years of longer spawning migration periods or changing environmental conditions. Conditions are highly variable in any given year. Rather than provide a prescription that is protective under all circumstances, an adaptive process based on the guidelines outlined herein is warranted. This process can most efficiently and effectively provide protections utilizing analysis of all available data and seasonal conditions. 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 (USFWS B.O. pp 354-356).

Action 3. Implementation of Action 3 begins when the SWG determines that spawning has begun and larval fish are present in the Delta. 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. Therefore, the SWG monitors water temperature, adult spawning condition (i.e., spent female delta smelt) and larval occurrence and distribution to assess the relative risk of entrainment. Action 3 concludes when Delta water temperatures reach a daily average of 25⁰C at Clifton Court Forebay for three consecutive days, or until June 30 (USFWS B.O. pp 357-359).

Data and Sources

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, with university and private partners. There are currently 16 fish monitoring programs that are implemented year-round across the entire estuary. Each captures delta smelt to some degree, however, only a few are commonly used to index the abundance and distribution of delta smelt.

The Fall Mid-Water Trawl (FMWT) and the Summer Tow-Net Survey (STNS) are the two longest-running IEP fish monitoring programs that are used to index delta smelt abundance. Neither was designed specifically to sample delta smelt. Two more recent programs, the 20-mm Survey and the Spring Kodiak Trawl (SKT) survey, were designed specifically to sample delta smelt. Each of these four sampling programs targets different life stages and encompasses the entire life cycle and distribution. Data from the FMWT (September – December) is used to calculate relative indices of abundance and is used in the B.O. to set calculate allowable incidental take. Data from the SKT (January – May) is used to monitor distribution and spawning readiness of adults. Data from the 20-mm Survey (March – June) is used to monitor the distribution and relative abundance of post-larval delta smelt. Data from the STNS (June – August) is used to monitor the distribution and relative abundance of juvenile delta smelt.

Both the state and federal water projects have 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 not thought to 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 information on a web site (USFWS B.O., pp 143-145).

Hydrologic information is available from the California Data Exchange Center (CDEC) and the U.S. Geological Survey. Particle Tracking Modeling is supplied by DWR when and as requested. Please see Attachment 2, SWG Notes for June 1, for an example of how this information was used by the SWG.

Water Year 2010 Summary

- **February 8** – FWS began implementing RPA Action 2. SWG recommended OMR be set no more negative than -2000 cfs. Delta smelt actively migrating. Total expanded salvage at 24
- **February 16** – SWG recommended that OMR flows be no more negative than -5000 cfs, the lower limit (most negative) imposed by the Service BO. Spawning may have begun, widespread spawning likely in the next couple of weeks.
- **February 22** – FWS began implementing RPA Component 2 (Action 3 in Attachment B of the BO) due to appropriate temperatures in the Delta and the presence of mature eggs in salvaged females. OMR no more negative than -5000 cfs continued
- **March 15** – SWG recommended OMR flows be no more negative than -3000 cfs to reduce entrainment of adult delta smelt
- **March 22** - No salvage occurrence since March 14. SWG recommended OMR flow be no more negative than -5000 cfs.
- **April 12 to May 24** – No recommendations made to the service from SWG regarding OMR flows. The decision was based on expected flows and corresponding pumping levels for the VAMP experiment.
- **May 24** – SWG recommended flows be no more negative than -5000 cfs
- **June 1** – SWG unable to reach consensus regarding OMR flows. Dual recommendations made: -2000 cfs and -5000 cfs. As of May 31 juvenile delta smelt salvage was 23, expanded.
- **June 7-28** SWG recommended that OMR flow be no more negative than -5000 cfs

SWG Discussions

The SWG meetings on November 30, 2009, January 11, 18, 25, and February 1, 2010 resulted in no recommendations to the Service for OMR flows. Salvage during this period was low (total combined, expanded salvage was 16 fish through February 7). Combined pumping ranged from 3934 cfs to 7788 cfs during this time. Temperatures ranged from 8.5 to 11.4 C (below 10 C approximately 67% of the time between November 30 and February 8). Three-day average turbidity exceeded 12NTU at Prisoner's Point on January 24 and Holland Tract on January 30. Turbidity never exceeded 12NTU at Victoria Canal during the WY2010 OCAP implementation period. Therefore, during WY2010 (as in WY 2009), Action 1 was not implemented.

By February 8, the SWG reviewed the available data, unanimously agreed that first flush had already occurred, and recommended that adult delta smelt be afforded the protections provided under Action 2, specifically, that OMR be set at no more negative than -2000cfs (although a minority of SWG members supported a recommendation of -4000 cfs OMR flow). Although PTM was discussed, the results did not contribute to the recommendation, as the modeling runs

only pertain to larval delta smelt, and the recommendation pertained to adult fish only. The following is excerpted from the SWG notes for February 8, 2010:

The Group would like to avoid cuing more delta smelt to enter the south Delta (reducing future entrainment events) and to minimize entrainment occurring now to the greatest extent practicable. Past field sampling and salvage evidence indicates that delta smelt are actively migrating, which makes them vulnerable to entrainment. The Working Group expects that the current salvage event will continue over the next week (because the fish observed over the next few days will have already been pulled into Old and/or Middle Rivers). The Group's recommendation to change OMR to no more negative than -2000 cfs is expected to minimize and potentially avoid future salvage events by avoiding conditions that cue delta smelt in the mainstem of the San Joaquin River to move further south toward the pumps. The Group views this as a preventative action to keep salvage under the incidental take limit and to reduce the likelihood that additional actions will be needed to protect spawners. Based on the PTM runs, the group expects that at -2000 cfs OMR the Projects' "footprint" will not strongly influence the mainstem San Joaquin River. The Group was reminded that in recent years the highest density of adult delta smelt salvage typically occurs over a short period of time (usually over a week or two) prior to March, and that CVP salvage typically precedes SWP salvage. Given these recent historical trends in adult salvage (and the salvage over the past several days), the Working Group felt that a strong protective action was appropriate this week, to minimize the risks described above.

The Working Group discussed the possibility that at -2000 cfs OMR, some net flow would be moving out of the Old and Middle Rivers further north and west, and that this could assist delta smelt that are just moving into the central Delta to remain in the mainstem San Joaquin River.

On February 16, the SWG recommended that OMR flows be no more negative than -5000 cfs, the lower limit (most negative) imposed by the Service BO. The following is excerpted from the SWG notes for February 16:

The Group believes it possible that the anticipated "peak" of salvage discussed last week was avoided. The Working Group felt that the strong protective action recommended last week could be relaxed, within the overall range provided in the RPA.

The Working Group discussed the status of spawning for the species. The Group agreed that some spawning may have already begun, but that most males are likely holding, waiting for the females to be ready to spawn. The group felt that widespread spawning was likely within the next couple of weeks.

On February 22, the SWG recommended that OMR flows be no more negative than -5000 cfs. Additionally, the SWG discussed the status of spawning for the species and indicated that RPA

Component 2 (Action 3 in Attachment B of the BO) had begun due to appropriate temperatures in the Delta and the presence of mature eggs in salvaged females. The following is excerpted from the SWG notes for February 22:

The Working Group determined that there was some risk of entrainment for newly emerged larvae hatching in the lower San Joaquin River (if this is occurring) at the current level of OMR flow, but that the risk to the overall population of delta smelt was very low. The Group felt that more protective actions might be warranted starting in the next couple of weeks

On March 1, the SWG recommended that OMR flows be no more negative than -5000 cfs. The following is excerpted from the SWG notes for March 1:

The Working Group discussed the status of spawning for the species. Water temperatures in the Delta remain appropriate for spawning. The Group agreed that spawning likely has begun, and that eggs are likely on the substrate, with at least some larvae already hatched out. Delta temperatures are 12.5°C. Given water temperature patterns over the past few weeks, it is possible that some delta smelt larvae have already entered the water column but have not yet been detected in sampling programs. However, large fractions of annual larval production are not expected until temperatures reach 15°C.

The Working Group determined that the risk of entrainment for newly emerged larvae hatching in the lower San Joaquin River (if this is occurring) at the current level of OMR flow was low, and that the risk to the overall population of delta smelt was very low.

The SWG believes the risk of adult entrainment is relatively low under present conditions. Four adult delta smelt (estimated 16 expanded) have been salvaged at the CVP since February 22 and none have been salvaged at the SWP. Current hydrological conditions, results from the SKT #2, and the planned operations of the projects (approximately 7700 cfs combined exports ~ 22% export to inflow ratio) support this assessment.

On March 4, the SWG recommended that if the concern level was reached or three adult delta smelt were taken in salvage in a single day that OMR flow should be reduced to no more negative than -2000 cfs. This recommendation was based upon the proximity to the concern level and the taking of pre-spawning females at the export facilities. The following was excerpted from the SWG notes for March 4:

The Working Group did not have an immediate concern regarding larval salvage. However, if adult salvage were to continue through the weekend at the present rate of one to two fish per day, salvage could exceed the concern level of 92, and potentially approach the incidental take limit of 123 fish. The Working Group also reiterated that

recently salvaged fish have exhibited sexual maturity, which suggests that spawning is either in progress or imminent.

The Working Group noted that even with the five-day OMR at about -4000 cfs, adult delta smelt are still being taken at the export facilities. Salvage has continued to occur even as OMR has varied from about -3500 cfs to about -5000 cfs. An OMR of -2000 cfs would be expected to avoid or minimize further salvage of adults.

On March 8, the SWG recommended that OMR flows be set at no more negative than -5000 cfs to adequately protect larval delta smelt for this week. The SWG cautioned the Service as to the current amount of adult salvage. The following was excerpted from the SWG notes for March 8:

In the past, strongly negative OMR that corresponded in time with the primary upstream migration of adult delta smelt led to clearly discernable salvage peaks. The SWG observed that this year's adult salvage pattern differs from the typical historical pattern in that "spikes" in salvage have not been observed. The Working Group thinks the lack of a salvage peak is the result of managing OMR to limit the export influence north and west of Franks Tract and also partially as a result of record low abundance. The Working Group has remained concerned about the potential for a spike in salvage over the last few weeks, but thus far, such a spike has not materialized. Rather, the trend this season has been small numbers of fish in daily salvage (an average of 2.4 expanded fish per day over last 30 days, 4.6 expanded fish per day over last 7 days) over an extended period. The spawning behavior of delta smelt has not been described in the wild, but based on laboratory observations and studies of other smelts in other systems, it is likely that delta smelt make overnight forays into spawning habitats. This year's pattern of small numbers of ripe delta smelt salvaged over an extended period might reflect spawning forays rather than a "bulk" entrainment of delta smelt moving upstream.

The Working Group anticipates that the adult salvage concern level (92 fish, expanded) will be reached this week. The Working Group observed that if the salvage rates of the past 30 days continue, the authorized take level would also be reached before the end of March. Using the salvage rate of the previous 7 days, the authorized take level would be reached even sooner – possibly by next week. In other words, at the 30-day rate of salvage, the authorized take level would be reached in 19 days and at the March rate, in 8 days.

On March 15, the SWG recommended OMR flows be no more negative than -3000 cfs. This recommendation was intended to reduce the risk of entrainment for adult delta smelt. See excerpt from March 8 notes above.

On March 22, the SWG recommended OMR flows be no more negative than -5000 cfs. The Working Group agreed that the level of risk to adult delta smelt was reduced this week as compared to the previous week, given that no salvage had occurred since March 14 and the latest

SKT survey suggests that the greatest densities of delta smelt were in the Sacramento River and outside the influence of the pumps. This recommendation was repeated on March 29, April 5, and 12.

From April 12 until May 24, the SWG did not make any recommendations to the Service regarding OMR flows. This was based upon the expected flows and corresponding pumping levels for the VAMP experiment and implementation of NMFS RPA Action IV.2.1.

On May 24, the SWG recommended OMR flows be no more negative than -5000 cfs. The following was excerpted from the SWG notes for May 24:

The Working Group noted that juvenile delta smelt salvage so far this year is low (23 expanded salvage), one detected occurrence of larval delta smelt at the facilities on May 12, and the results from the 20mm survey #5, and the Spring Kodiak Trawl #5 indicate that the risk of entrainment of larval and adult delta smelt is likely low. The Working Group noted the positive hydrological conditions in the interior Delta and positive 5-day and 14-day values of OMR also would suggest a low risk of entrainment to larval delta smelt. The Working Group agreed that -5000 cfs OMR flow would be adequately protective for larval delta smelt for the next week.

On June 1, the SWG was unable to reach a consensus opinion regarding OMR flows. A recommendation of -2000 cfs OMR was based upon providing a short-term proactive action during the current neap tidal cycle, affording juvenile delta smelt the opportunity to move downstream during this outflow period, which continued for the next few days (see notes from 5/28/2010). A recommendation of -5000 cfs OMR was based upon the absence of salvage since May 21 and the latest survey data, indicating that the overall risk of entrainment was currently low (see notes from 5/24/2010).

On June 7, the SWG recommended that OMR flow be set at no more negative than -5000 cfs, based upon the absence of salvage since May 21 and the latest survey data, indicating that the overall risk of entrainment was currently low. This recommendation was repeated on June 14, 21, and 28. Low levels of salvage occurred in early June, although the SWG did not feel the levels indicated an overall risk to the species.

Table 2 summarizes the SWG Recommendations for Old and Middle River (OMR) flows for Water Year (WY) 2010. All values are in cubic feet per second (cfs) recorded at U.S. Geological Survey gauges. Also included are the corresponding Service Determinations, ranges of allowable flows for the Service BO, and observed OMR values.

Table 2: Weekly OMR Recommendations/Determinations WY2010

Date	SWG Recommendation	Service Determination	BO allowable flow range	Observed OMR range next 7 days (14 day avg)
February 8	-2000	-4000 ¹	-1250 to -5000	-4757 to -5261 ²
February 16	-5000	-5000	-1250 to -5000	-4417 to -4552 ²
February 22	-5000	-5000	-1250 to -5000	-2970 to -5080
March 1	-5000	-5000	-1250 to -5000	-3580 to -6420
March 4	-2000	-5000 ³	-1250 to -5000	-4584 to -4741
March 8	-5000	-5000	-1250 to -5000	-4509 to -4741
March 15	-3000	-5000	-1250 to -5000	-4298 to -4453
March 22	-5000	-5000	-1250 to -5000	-4150 to -4680
March 29	-5000	-5000	-1250 to -5000	-2938 to -4786
April 5	-5000	-5000	-1250 to -5000	-498 to -2519
April 12	-5000	-5000	-1250 to -5000	557 to -61
May 24	-5000	-5000	-1250 to -5000	1284 to 1023
June 1	-2000/-5000 ⁴	-5000	-1250 to -5000	-1427 to -3831 ²
June 7	-5000	-5000	-1250 to -5000	-3831 to -5053
June 14	-5000	-5000	-1250 to -5000	-4555 to -4879
June 21	-5000	-5000	-1250 to -5000	
June 28	-5000	-5000	-1250 to -5000	

1—Determination included a provision to reduce pumping to 1000 cfs if expanded salvage exceeded four on any single day.

2—USGS 14-day OMR was unavailable during this period. Provisional OMR values were surrogated.

3—Determination included provision to reduce pumping to -2000 cfs if salvage reached Concern Level.

4—SWG unable to reach consensus. Dual recommendations for this week.

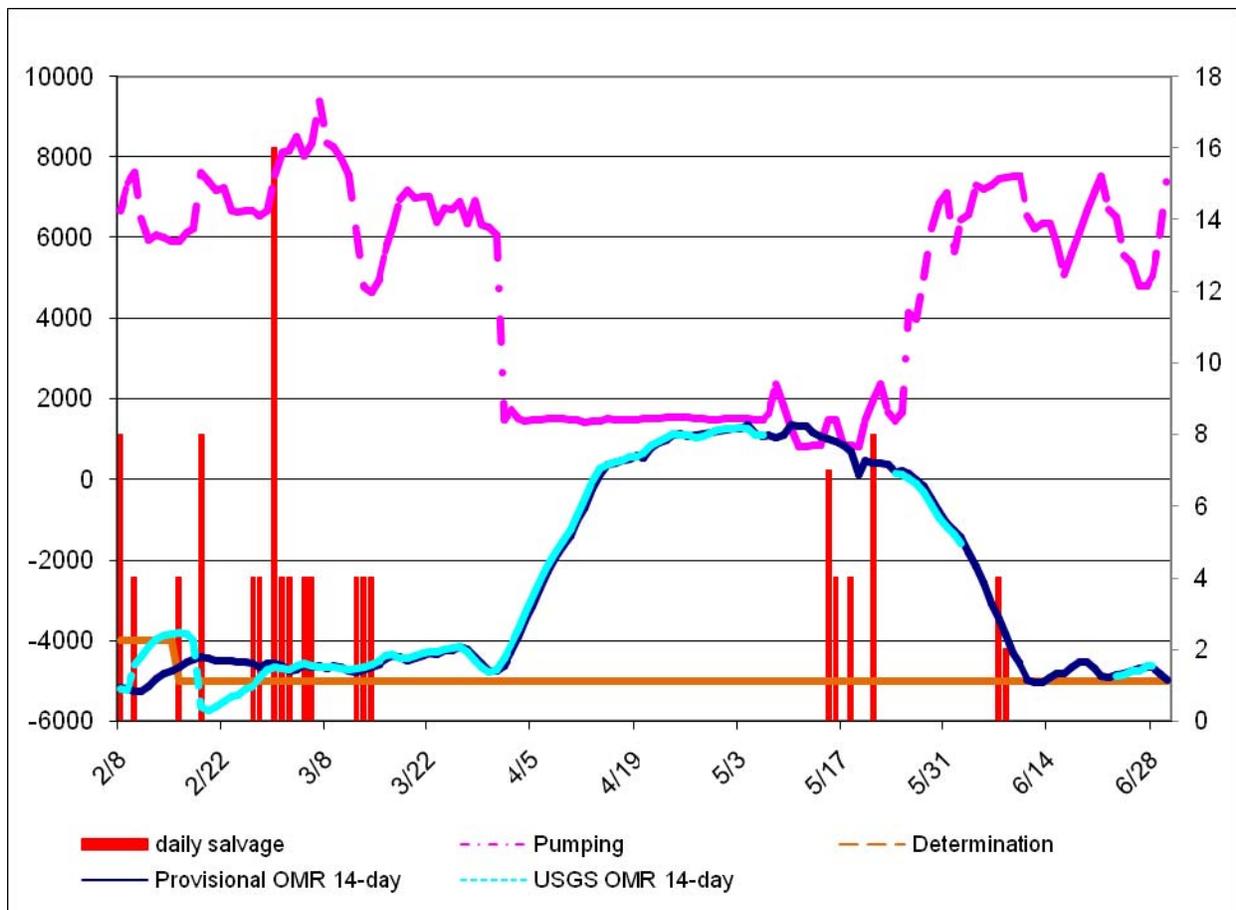


Figure 1. Combined Project exports, Service determinations, observed Old and Middle River (“OMR”) flows and observed daily salvage over the period that the SWG made recommendations to the Service regarding OMR flows. The left vertical axis is cubic feet per second and the right vertical axis is counts.

Outcomes

Incidental Take. Incidental take is defined as take that results from, but is not the primary purpose of, an otherwise lawful action. Within the framework of a finding of jeopardy, the Service developed a reasonable and prudent alternative to the proposed operations of the CVP and the SWP. The Service anticipated that incidental take of delta smelt would be minimized through the implementation of the RPA; in other words, limiting entrainment through limiting reverse flows when delta smelt were at risk.

There is currently no generally accepted method of determining total entrainment of delta smelt by the CVP and the SWP. However, it is generally accepted that incidental take is proportional to the number of fish “salvaged” at the fish facilities adjacent to the pumping plants. Recent research indicates that each fish salvaged may represent between ten and as many as 100 additional fish that are not actually observed and counted. This is likely due to pre-screen losses

(e.g., to predation) as well as to unavoidable inefficiencies within the fish salvage facilities themselves. Further, reported salvage is a subsample of all fish that enter the facility. Samples from the salvage stream are generally taken for thirty minutes out of every two hours; when salvaged fish are relatively numerous, these samples may in turn be subsampled. Due to the difficulty of distinguishing between very young delta smelt, longfin smelt and wakasagi, only fish greater than 20 mm total length are counted in salvage.

Adults. The amount of incidental take authorized is based upon the number salvaged, and also the Fall Mid-Water Trawl (FMWT) index for the current water year. A *Cumulative Salvage Index* is calculated as the total year’s adult salvage (December through March) divided by the FMWT index. The salvage index normalizes salvage to abundance; when delta smelt populations are high, salvage may also be relatively high and when populations are low, salvage (and therefore incidental take) must also be low (USFWS B.O., pp 383-388).

To indicate that salvage may be approaching the allowable level, the Service also calculated a *Concern Level* at 75% of the allowable level. Throughout the water year, as the SWG convenes and reviews data, reaching the Concern Level for adult salvage requires an immediate specific recommendation to the Service.

In WY 2010, based upon a FMWT index of 17, the concern level was 92 and the total allowable take of adult delta smelt was 123. Cumulative salvage of adults reached the concern level (92) in WY 2010.

Juveniles. Because identification of larval smelts is difficult, only juveniles greater than 20 mm total length are counted at the salvage facilities. Juvenile entrainment is very difficult to predict; therefore, the mean monthly values from the years 2005-2008 were used to estimate expected salvage. The *Concern Level* is the monthly mean multiplied by the current FMWT. The monthly allowable take is calculated as 1.5 times the concern level. Monthly salvage totals are additive; for example, the total allowable take for May includes fish counted in April.

In WY 2010, based upon a FMWT index of 17, the concern levels, total allowable, and observed take were:

Month	Concern	Total	Observed (Cumulative)
April	5	7	0
May	222	333	23
June	561	842	29
July	637	955	0

Monthly cumulative salvage of juveniles remained below the concern level in all months.

Table 3. Detail of Delta Smelt Salvage, WY 2010

Date	SWP Salvage	CVP Salvage
Dec 12		4
Feb 3		4
Feb 6		8
Feb 8		8
Feb 10		4
Feb 16		4
Feb 19		8
Feb 26		4
Feb 27		4
Mar 1	8	8
Mar 2		4
Mar 3	4	
Mar 5		4
Mar 6		4
Mar 12		4
Mar 13		4
Mar 14	4	
Adult Sub-Total	16	76
May 15		7
May 16		4
May 18		4
May 21		8
Jun 7	4	
Jun 8	2	
Juv. Sub-Total	6	23
Annual Total	22	99

Critical Habitat. Operations of the CVP and SWP alter hydrologic conditions throughout delta smelt critical habitat. Different regions of the Delta provide different habitat conditions for different life stages, but those habitat conditions must be present when needed, and have sufficient connectivity to provide migratory pathways and the flow of energy, materials and organisms among the habitat components. The four *primary constituent elements* (PCEs) of delta smelt critical habitat are physical habitat, water, river flow and salinity. RPA Components 1 and 2 specifically address river flow, but also affect the other three PCEs.

River Flow. This PCE includes Delta inflow, Delta outflow and OMR flow. River flow interacts with PCE 2, water, to influence the distribution of turbidity, food and contaminants.

River flow interacts with PCE 4, salinity, to influence the extent and position of the highly productive low-salinity zone, within which delta smelt rear. RPA Components 1 and 2 directly address the effects of reverse flows on delta smelt critical habitat.

Particle Tracking Modeling (PTM) can provide an indicator of the extent to which the implementation of the RPA reduced the effects of reverse flows in WY 2010. The DWR’s particle tracking model simulates the fate of particles moving through Suisun Marsh and the Sacramento/San Joaquin River Delta. The model uses velocity, depth and flow output from the one-dimensional hydrodynamic Delta Simulation Model-2 (DSM2) to determine the location of a particle at a given time-step, based upon specified hydrodynamic input variables. The model uses four types of particle movement (transverse velocity, vertical velocity, transverse mixing and vertical mixing) to represent the particles’ ability to move through the water. When a particle approaches a junction, a directional choice is made by allocating probabilities to each channel in proportion to flow. The model can track particle movement from any location within the network and at varied velocities, and can be used to simulate settling or swimming. Mortality can be modeled as losses to water diversions or can be assigned as a rate, which can be a function of age or location in the Delta.

In WY 2010, the SWG was provided with PTM output for the following scenarios:

Table 4. Summary of Particle Tracking Scenarios Modeled in WY 2010

Scenario Date	OMR in cfs A	OMR in cfs B	OMR in cfs C	OMR in cfs D
Feb 5	-5000	-4000	-3000	-2000
Feb 12	-5000	-4000	-3000	-2000
Mar 11	-5000	-4200	-3500	-2000
Mar 18	-5000	-4000	-3000	-2000
Mar 28	-5000	-4000	-3000	-2000

Because PTM is intended to model the passive movement of neutrally-buoyant particles, the results do not accurately predict the movement of adult delta smelt, particularly those that are actively migrating. However, in addition to simply tracking the movement of particles, reduced entrainment at any given location can be interpreted as an indicator of reduced magnitude of reverse flows and hence, of improved habitat. PTM output indicates that for every 1000 cubic feet per second decrease in reverse flow at Station 815, entrainment may be reduced by 40% or more.

Table 5. Average Modeled Changes in Modeled Entrainment with 1000 cfs Change in Old and Middle River Flow

Scenario ^a # Days	Average % Change, A to B	Average % Change, B to C	Average % Change, C to D
6	N/A ^b	N/A ^b	N/A ^b
11	62.5	82.8	96.7
16	44.5	74.5	90.7
21	40.2	64.5	83.1

^aexcluding Mar 11 scenarios; ^btoo many zeros in data

Station 815 is located in the central Delta on the lower San Joaquin River near Potato Slough, where Old River rejoins the mainstem San Joaquin (**Figure 2**). Station 815 roughly corresponds to the point at which the diversion pathways (Old River and Middle River) converge. When the risk of entrainment at Station 815 is minimized, river flows in the northern, western and about half of the central Delta better support delta smelt critical habitat values (**Figure 3**).

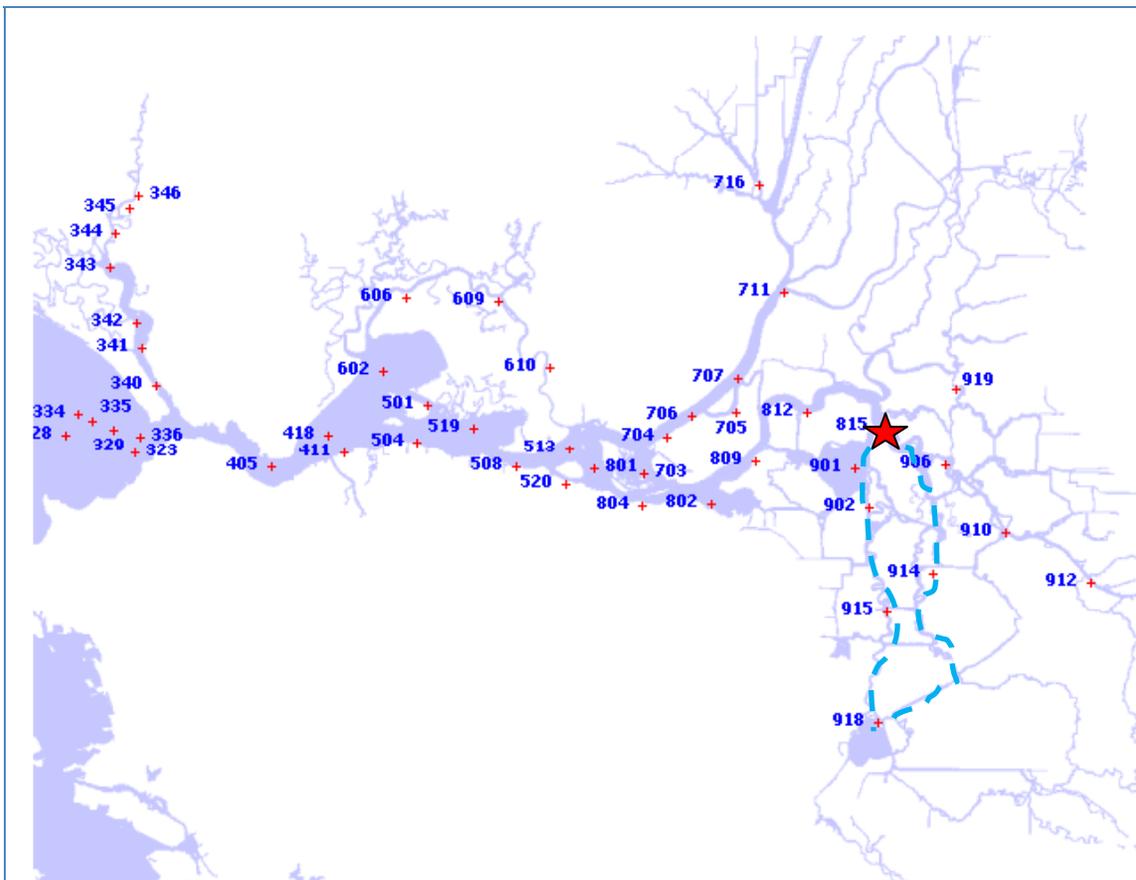


Figure 2. CDFG 20-mm Survey Stations Highlighting Station 815 and Old and Middle Rivers.

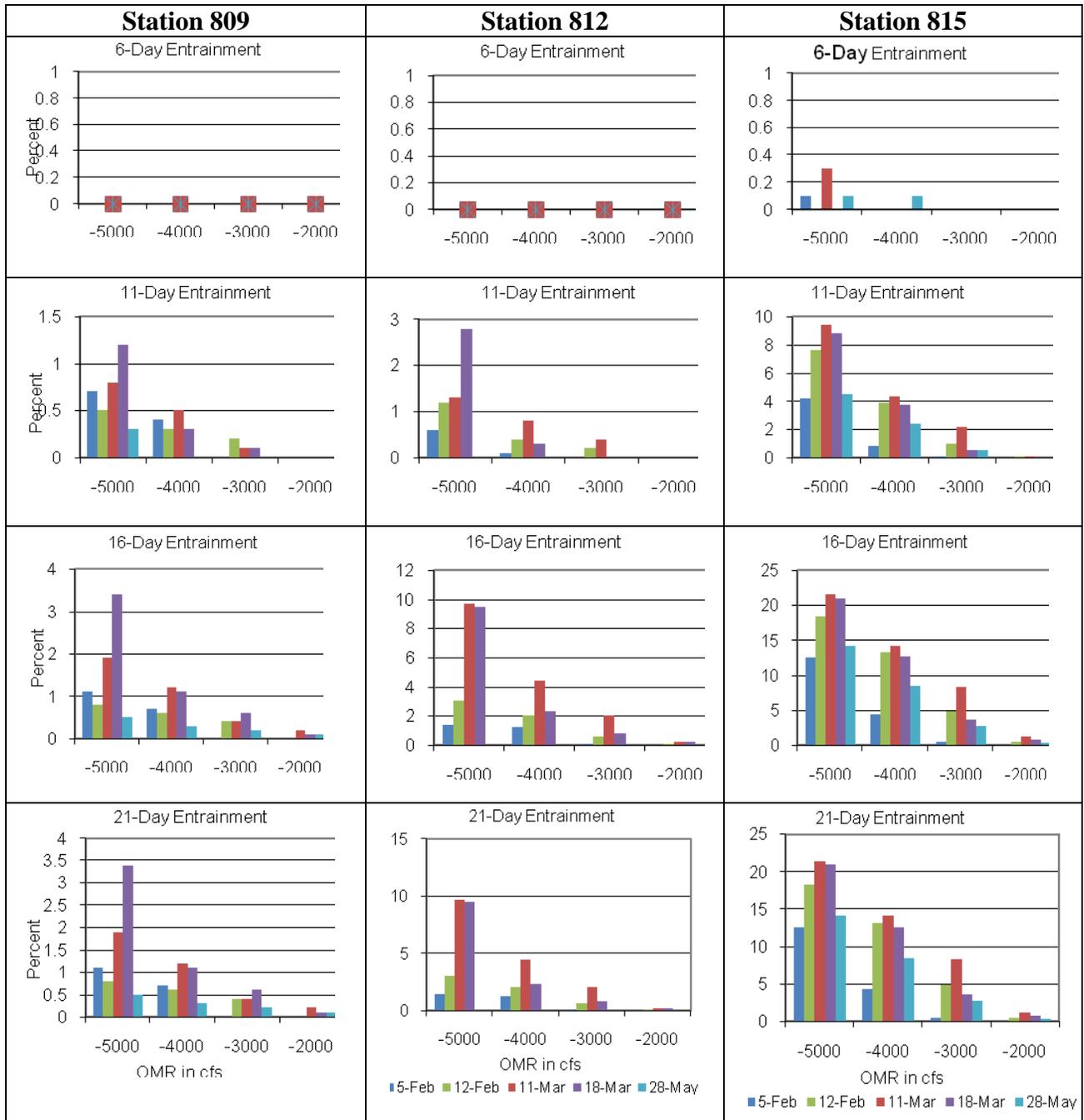


Figure 3. Summary of modeled entrainment at selected stations for four levels of reverse (OMR) flows. Note that the modeled risk of entrainment at Stations 809 and 812, both downstream on the San Joaquin River relative to Station 815, is reduced when entrainment risk at Station 815 is reduced. All scenarios were developed by DWR for WY 2010.

As reverse flows in Old and Middle Rivers decrease, the risk of entrainment decreases with increasing downstream distance from Station 815, indicating that critical habitat values are incrementally better supported at decreased reverse flow rates.

Implementation Challenges

The SWG has identified the following technical challenges and potential solutions for those challenges.

- Challenge: The three turbidity stations outlined in the BO do not appear to reliably detect the “first flush.” The current stations include Prisoner’s Point, Holland Tract, and Victoria Canal.
- Proposed Solution: Turbidity stations under consideration for WY2011 are Prisoner’s Point, False River, Dutch Slough at Jersey Point, Old River at San Joaquin River, and Holland Tract. These stations appear better poised to detect turbidity levels at the periphery of the interior delta along channels through which the species likely passes to reach the interior delta. These stations are anticipated to give the SWG a clearer picture of how turbidity is moving in the delta and if the species will become at risk for entrainment.
- Challenge: Turbidity values during the incoming tides may be critically important in determining when pre-spawning delta smelt may begin moving to the interior delta. The current working hypothesis is that migrating adults surf the incoming tides, potentially for the greater sediment loads they carry relative to the outgoing tides. During Water Year 2010, turbidity values examined by the SWG were daily averages only and often did not reflect the higher turbidity of the incoming tide that delta smelt may be using.
- Proposed Solution: Incorporate peak turbidity on the incoming tide into SWG evaluation process

