INITIAL DRAFT OPERATIONS PLAN

(Data, forecasts, and projections preliminary, provisional, and subject to change)
March 15, 2018

WATER OPERATIONS FORECAST

- One weather system moved through California and another is forecasted to impact portions of California beginning Thursday March 15th and continue into Friday March 16th. At this time forecasts indicate that additional precipitation may occur middle of the following week as well (March 20th – 22nd). These storm systems are expected to impact most of California including the Central Valley as well as higher elevations of the Sierra Nevada watersheds, with 2 to 4 inches of precipitation in these areas.
- Runoff from this storm is anticipated to result in moderately increased flow into the Sacramento–San Joaquin Delta. This increase is expected to augment the already elevated flow resulting from the previous event that occurred March 12th and 13th.

IDENTIFICATION OF ELIGIBLE STORM EVENT

- Forecasts for flows at Freeport and Vernalis based on best professional judgement as well as information from the NOAA Cal-Nevada River Forecast Center (CNRFC) are found in Table 1 below.
- Storm Event Eligibility
    - Old and Middle River (OMR) requirements of the Biological Opinions (BiOps) are expected to control the ability to export water from the Delta, and anticipated to continue to control exports through the duration of this event.
    - Delta Outflow projections indicate a higher level of flow will be available for diversion
    - Additional exports can be utilized to fill San Luis Reservoir and/or meet water supply needs
    - Conditions are not currently the "First Flush" of sediment to the Delta as defined in the BiOps.

CONDITIONS

- Central Valley Project (CVP) and State Water Project (SWP) operations are currently controlled by State Water Resources Control Board's Water Right Decision (D-1641) 35% E/I Ratio and delta outflow (NDOI) of 7,100 cfs.
- As flows increase into the delta, operations will be controlled by the National Marine Fisheries Service (NMFS) Reasonable and Prudent Alternative (RPA) Action IV.2.3 OMR Flow Management (14-day average OMR at negative 5,000 cubic feet per second [cfs])
- Total Project exports from the Delta are currently limited to approximately 6,200 cfs
- Water temperatures and turbidity are currently not factors in operations
- State Water Resources Control Board's Water Right Decision (D-1641) conditions are being met (Delta outflow, E/I ratio, other pertinent conditions)
- As of Thursday, March 15th, current projections for precipitation and flow/runoff are available only through Tuesday, March 20th. Projections past March 20th are highly uncertain.
- All flow projections past March 20th are based on assumptions using recent runoff conditions and assumed rates of recession from projected flow increases. Projections are

highly preliminary and are subject to change based on new and/or changing forecasts and information.

PROPOSED CONDITION COMPARED TO BASELINE

The CVP and SWP are proposing to operate to an OMR Index of no more than -5,700 cfs during the 5-day period from Tuesday March 20th to Saturday March 24th.

- Proposed action forecasted to increase combined project pumping by approximately 8,000 ac-ft
- 5-day average delta outflow forecasted to be reduced by approximately 800 cfs.
- Average OMR prior to the action is anticipated to be approximately -5,000 cfs
- Average OMR after the action is anticipated to return to -5,000 cfs, pending additional storms and ongoing review/analysis
- 14-day E/I ratio will remain at or below 35%
- 3-day NDOI will remain above 7,100 cfs

Table 1. Baseline and proposed action scenarios.

Date	Forecasted Flows		Baseline Conditions			Proposed Action (-5,700 OMR)		
	Freeport	Vernalis	Delta Outflow (NDOI)	Total Export	OMR Index	Delta Outflow (NDOI)	Total Export	OMR Index
	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)	(cfs)
3/20/18	22,000	2,200	19,200	6,200	-4,920	18,400	7,000	-5,650
3/21/18	19,000	2,000	18,100	6,200	-4,890	17,300	7,000	-5,620
3/22/18	17,000	1,900	14,300	6,200	-4,990	13,500	7,000	-5,720
3/23/18	15,000	1,900	12,200	6,200	-5,040	11,400	7,000	-5,770
3/24/18	13,000	1,900	10,200	6,200	-5,050	9,400	7,000	-5,780
Total (AF)				61,500			69,400	
Average (cfs)			14,800		-4,980	14,000		-5,710

ACTIONS TO AVOID RISK OF ADDITIONAL ADVERSE EFFECT

Precautionary actions to avoid exceedance of the CVP/SWP incidental take statement will be implemented as part of the Proposed Operational Changes. Precautionary actions during the Proposed Operation Change will be based on these threshholds and actions:

- If cumulative non-adipose-clipped winter-run-sized Chinook salmon loss over the 5-day duration of the flex period exceeds 37 fish (5 days x 7.4 fish/day), exports will be reduced to achieve daily OMR flows no more negative than -5,000 cfs.
- If daily winter-run Chinook salmon density exceeds 2.5fish/taf, exports will be reduced to achieve -5,000 OMR flows.
- If loss of spring-run Chinook salmon surrogate groups is greater than 0.25%, exports will be reduced to achieve -5,000 OMR flows.
- If salvage or loss of green sturgeon in greater than 50% of the incidental take limit, exports will be reduced to achieve -5,000 OMR flows.
- If steelhead salvage is greater than 1,500 fish, exports will be reduced to achieve -5,000 OMR flows
- If delta smelt take is great than 50% of the incidental take limit, exports will be reduced to achieve -5,000 OMR flows.

Biological Analysis

Prevailing RPA Actions

2009 NMFS Biological Opinion RPA Action IV.1.2 (DCC gate operations):

- Gates will remain closed per operations described in RPA Action IV.1.2.

2009 NMFS Biological Opinion RPA Action IV.2.3 (OMR Management)

- Implementation of this action in WY 2018 is from 1/1/18 through 6/15/18, and requires that Old and Middle River (OMR) flow be no more negative than -5,000 cfs.
- The older juvenile salmon fish loss density trigger was exceeded on 3/6/18 (3.48 fish/ thousand acre-feet [TAF]). The rapid DNA assay results confirmed that the older juveniles observed in salvage (winter-run by length-at-date) were in fact genetic winter-run Chinook salmon. The first day of export reductions to meet the required -3,500 cfs OMR flows was on 3/8/18. The final day of export reductions to meet the required -3,500 cfs OMR flows was on 3/12/18.
- Implementation of this action in WY 2018 is from 1/1/18 through 6/15/18, and requires that OMR flow be no more negative than -5,000 cfs. OMR flows are reported weekly with the OMR index and the tidally filtered USGS gauges at the 5-day and 14-day running averages.

2009 NMFS Biological Opinion RPA Action IV.3 (Reduce likelihood of entrainment or salvage at the export facilities, including alert that indicates that export operations may need to be altered):

- Implementation of this action in WY 2018 is from 11/1/17 through 4/30/18.
- The third alert [March 1 through April 30: Knights Landing Catch Index (KLCI) or Sacramento Catch Index (SCI) >15] was not triggered during the past week.
- Since 1/1/18, salvage based triggers per RPA IV.2.3 were exceeded on 3/6/18 based on a genetically confirmed winter-run Chinook salmon fish loss density of 3.48 fish/TAF, resulting in an OMR flow limit of no more negative than -3,500 cfs for 5 consecutive days (3/8/18 – 3/12/18).

2008 FWS Biological Opinion RPA Component 1, 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 range of net daily OMR flows will be no more negative than - 1,250 to -5,000 cfs. Depending on extant conditions (and the general guidelines below) specific OMR flows within this range are recommended by the Working Group from the onset of Action 2 through its termination

Biological Review of Winter-run Chinook Salmon

Winter-run Chinook Salmon	Life Stage Affected?	Change in Risk of SD/CD Entrainment	Change in Risk of Facility Loss	Certainty of Risk Determination
Egg	This life stage is not present in the Delta			
Natural-origin Juvenile	Wild winter-run Chinook are distributed broadly from the Sacramento River through the Delta			
6-14% upstream of the Delta in the Sacramento River	No	No Change	No Change	High
54-68% in the Delta	Yes	Increased	Increased	High
26-32% past Chipps Island	No	No Change	No Change	Moderate
Hatchery Juveniles	Hatchery winter-run Chinook were released on March 1, March 13, and March 14. DOSS has not provided distribution estimates for hatchery winter-run Chinook in WY18.			
Adults	No	No Change	No Change	High

Status of Winter-run Chinook Salmon

Monitoring data suggest that the majority of natural-origin juvenile winter-run Chinook Salmon are currently residing in the Delta and Lower Sacramento River, and more than 25% have exited the Delta past Chipps Island (Figure 1). The current methods of race assignment used in the monitoring of Chinook Salmon (length-at-date) has presented challenges for run assignment of fish captured at Red Bluff Diversion Dam this season. It was genetically proven that a portion of the length-assigned spring-run were actually late-hatching winter-run. While early life stage survival of eggs and juveniles in natal reaches appears high, winter-run Chinook Salmon escapement was low due to drought impacts on the returning adult cohort and winter-run Chinook Salmon juvenile abundance is at a low level. Multiple pulses of juvenile winter-run Chinook Salmon have been observed passing Knights Landing and Tisdale rotary screw trap fish monitoring sites, and are now being observed passing Chipps Island (Figure 1).

Over the last month, from February 13 through March 15, 19 winter-run sized juveniles were captured at Delta monitoring sites (2 in the Lower Sacramento, 3 in the San Joaquin, and 14 at Chipps Island; Figures 2 and 3). Last week 3 winter-run were captured at GCID, 1 was captured at Tisdale rotary screw trap, 1 was captured in the beach seines, and 6 were captured at Chipps Island mid-water trawl. These recent catches support the DOSS distribution estimates that a small

proportion of the winter-run population remains upstream of the Delta, the majority of the population is residing in the Delta, and some of the winter-run have started exiting the Delta. Historical patterns indicate that the majority of out-migration typically occurs in March and is not complete until early spring (del Rosario *et al*. 2013). 42 wild winter-run sized juveniles have been salvaged this water year (loss=145), 20 of which were salvaged this past week (loss=74).

Hatchery winter-run Chinook were released on March 1, March 13, and March 14, 2018. The natural-origin juvenile winter-run Chinook Salmon remaining upstream of the Delta are anticipated to migrate with the projected flow pulse into the Delta and lower Sacramento River tributaries over the next several weeks.

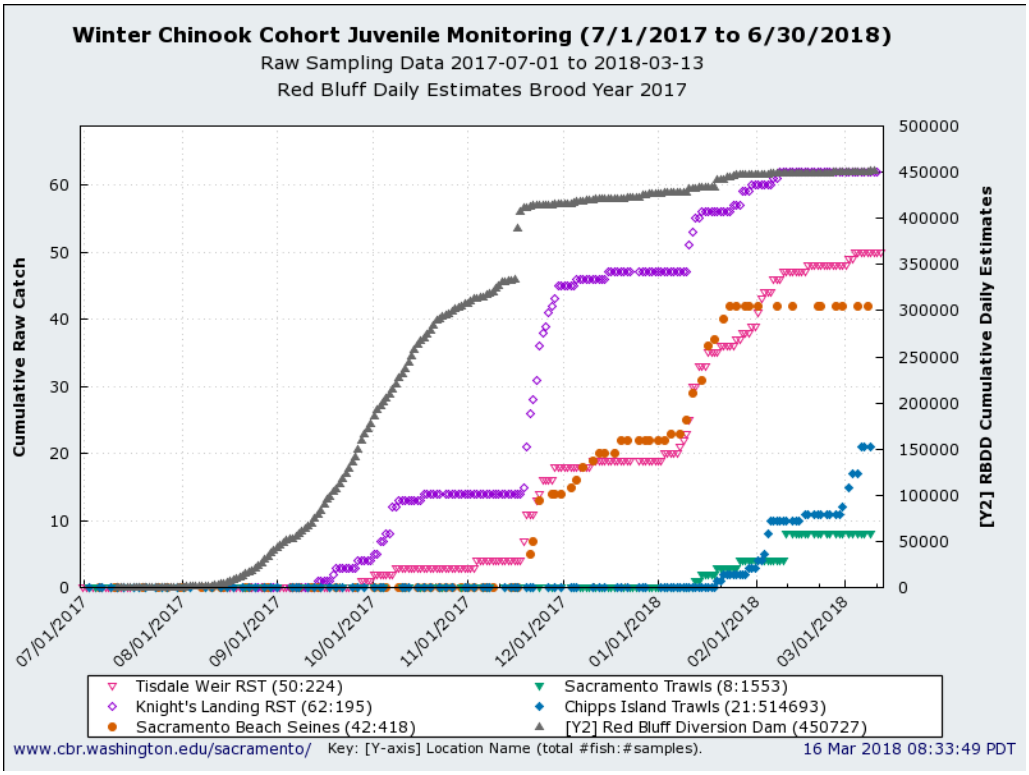


Figure 1. Brood Year 2017 Winter-run Chinook Salmon presence in Sacramento and Bay-Delta fish monitoring.

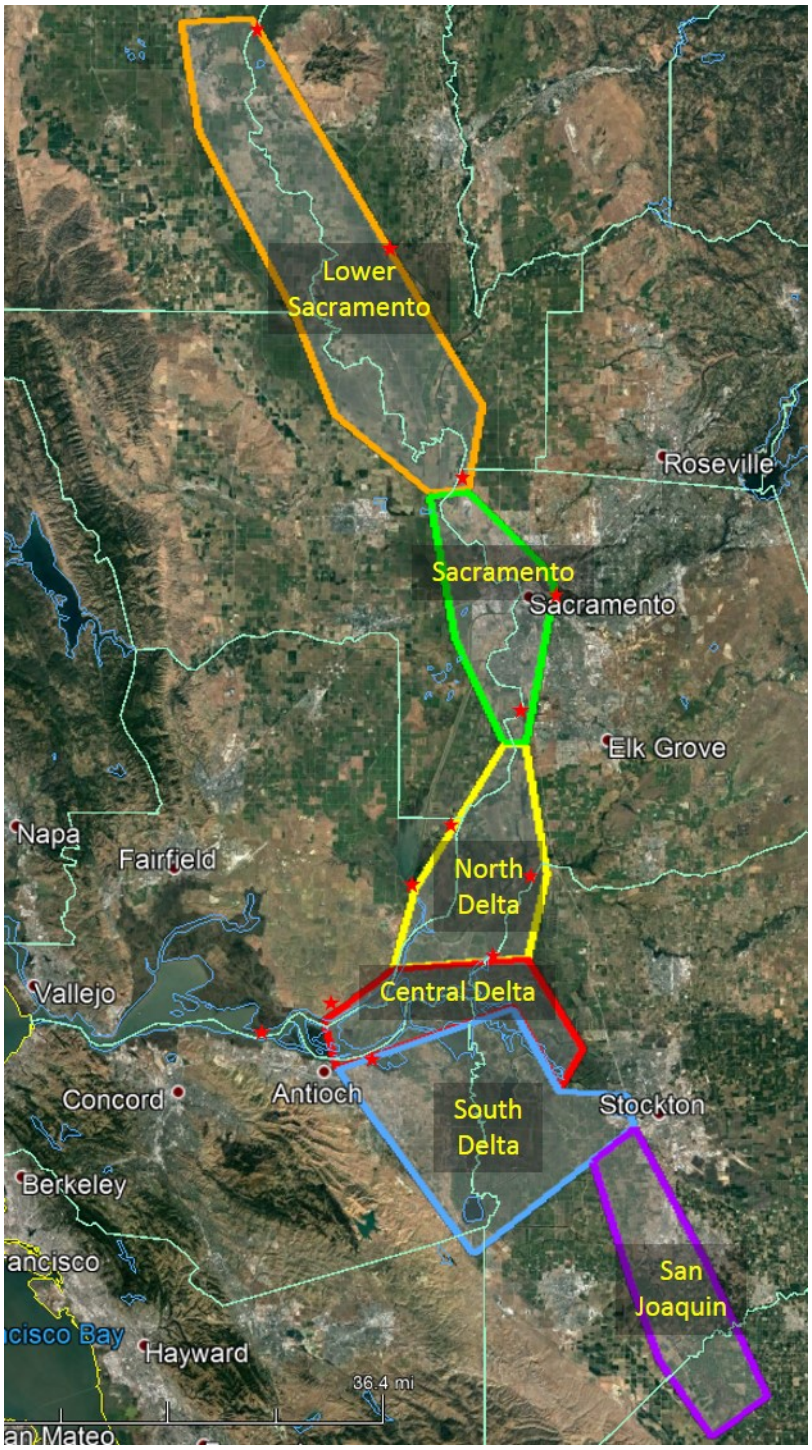


Figure 2. Delta monitoring regions (color coded polygons) with acoustic telemetry gates (red stars).

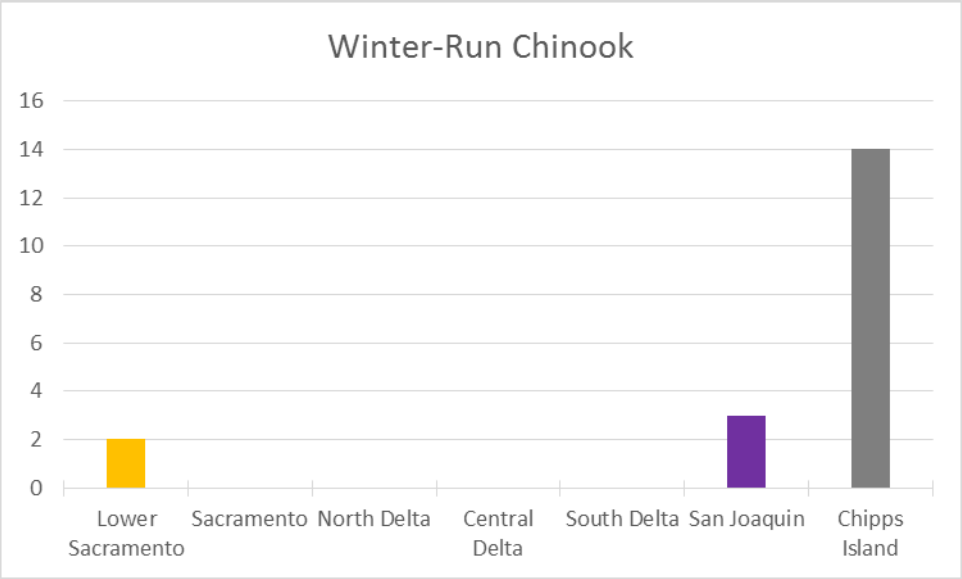


Figure 3. Capture of winter-run Chinook in Delta monitoring regions from February 13, 2018-March 15, 2018.

Effects of Proposed Actions on Winter-run Chinook Salmon

Reclamation and DWR are currently operating consistent with RPA actions in the NMFS BiOp (NMFS 2009). Action IV.2.3 is in place January 1 through June 15 to reduce the vulnerability of emigrating salmonids to entrainment into the central and south Delta and loss at the facilities. During March, this RPA primarily protects winter-run and spring-run Chinook Salmon and steelhead. Reclamation proposes to modify this action, consistent with the WIIN Act, to allow for an OMR Index more negative than the maximum prescribed in Action IV.2.3 (-5,000 OMR), to capture peak storm flow. Peak flow capture is forecasted to occur over a 5-day period, from March 20 to 24. If density triggers, as described in Action IV.2.3 are exceeded, negative OMR flows will be reduced consistent with the NMFS BiOp (NMFS 2009) and WIIN Section 4002.

Due to changes in Delta conditions (*i.e.*, flows and possibly turbidity) during the storm, changes in migratory behavior of juveniles may increase the risk of entrainment into the central and south Delta regardless of the Proposed Action. These flows and increased turbidity during the storm event may reduce the potential for predation associated with operations, and do not affect their rearing, feeding or sheltering behavior. Salmonids use changes in flow from storms as cues for emigration. An estimated total of 54-68% of brood year 2017 winter-run Chinook Salmon are currently rearing in the Delta. This is a decrease in winter-run residing in the Delta, compared to last week's estimate of 64-73%, as fish begin to emigrate out of the Delta past Chipps Island, and additional downstream movement is expected, concurrent with the storm runoff pulse. The storm event's increased Sacramento inflows have the potential to reduce entrainment of fish entering the Delta into the Central and South Delta by increasing entrainment into Sutter and Steamboat sloughs and reducing entrainment into Georgiana Slough. The DCC gates were closed on November 24, 2017 and remained closed starting December 1, 2017 per Action IV.1.2 of the NMFS BiOp. The DCC gate closure will help mitigate the risk of the remaining emigrating salmonids upstream of the Delta from straying out of the Sacramento River and into the central and south Delta.

DSM2 modeling of the Proposed Operations Change shows hydrodynamic changes (ie. more negative average daily flows) that enhance the risk of entrainment of juveniles into the central and South Delta during and after the 5 days of increased exports for fish that may be in these regions. The DSM2 modeling shows more negative average velocities, which can affect migration behavior during the Proposed Operational Change, and this is how the Proposed Operational Change may enhance the risk of loss at the facilities for fish that are present in the south Delta. Winter-run sized Chinook Salmon and coded wire tagged (CWT) fishes from the Sacramento River have been observed in Delta beach seine and trawl monitoring and at the CVP/SWP fish collection facilities, supporting winter-run Chinook salmon are currently occupying these regions. There is moderate certainty in our understanding of how hydrodynamic affects juvenile winter-run Chinook behavior and distribution. Due to the low abundance of juvenile winter-run Chinook salmon this year, monitoring of winter-run sized fish to minimize operational impacts may be more difficult this year, and genetic testing will be used to confirm species of fish salvaged at the CVP and SWP fish collection facilities.

Summary of Effects on Winter-run Chinook

Winter-run Chinook Salmon will be present in the Delta during the Proposed Operational Change, and the percent of the population in the Delta may increase due to migration cues from the storm event, since the storm's environmental conditions and the species' periodicity are optimal for smolt migration and continued rearing of juvenile winter-run Chinook Salmon. The Proposed Operational Change will not affect winter-run Chinook salmon rearing, foraging, or sheltering behavior, and the storm event's flows and turbidity likely reduce the potential for predation during the Change. The risk of entrainment into the interior Delta is likely reduced due to the storm event's increase Sacramento River flows, but hydrodynamic modeling of the Proposed Operational suggest hydraulic alteration that may increase the risk of entrainment into the central Delta. Maintaining a short period of OMR flows more negative than -5,000 cfs may increase the risk of loss at the CVP/SWP fish collection facilities for any winter-run Chinook Salmon in the south Delta during and after the five days of increases export. The risk of greater monthly loss at the fish collection facilities is highest when OMR flows are -10,000 cfs and monthly loss decreases exponentially as OMR flows approach -5,000 cfs (Figure 4 and 5). Due to the low production of natural origin winter-run, the population entering the Delta is very low. As such, implementation of the NMFS Biological Opinion (NMFS 2009) uses the default minimum older juvenile Chinook Salmon density trigger (2.5 fish/TAF), which is identified as a threshold value to avoid the potential for additional adverse effect on the species.

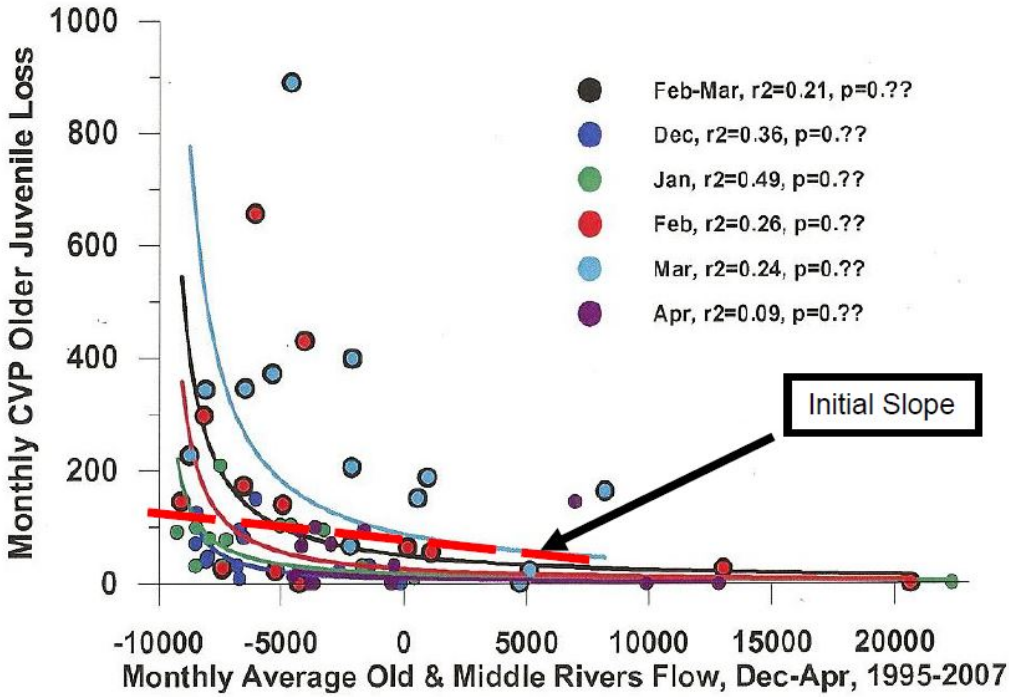


Figure 4. Relationship between OMR flows and older juvenile Loss at the CVP (NMFS 2009).

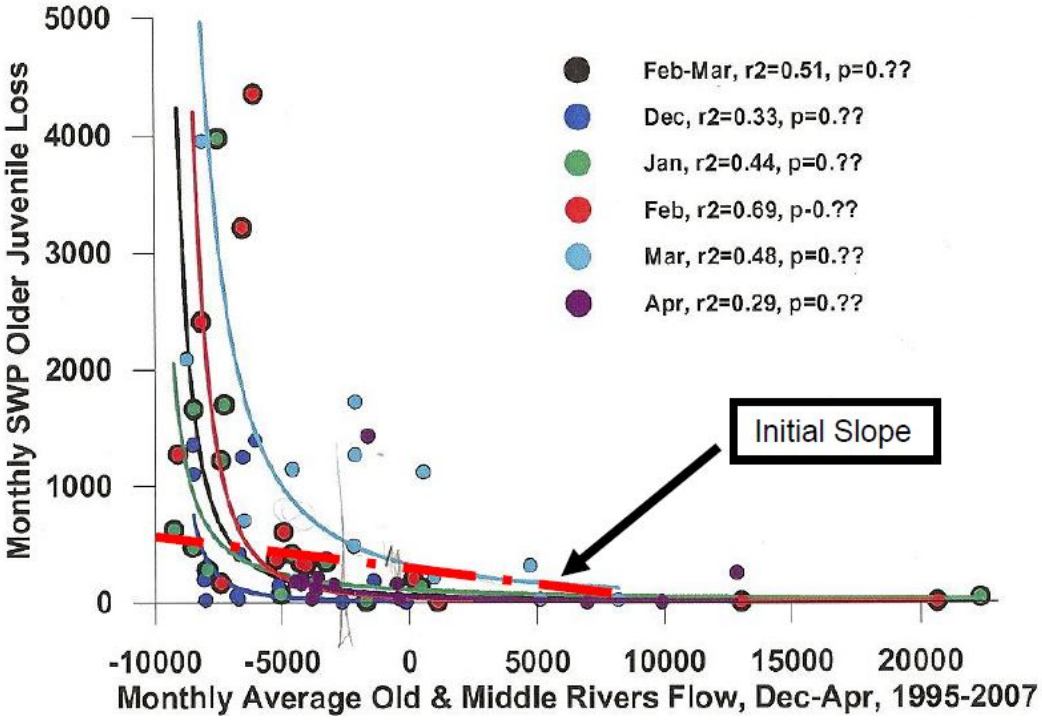


Figure 5. Relationship between OMR flows and older juvenile Loss at the SWP (NMFS 2009).

Biological Review of Spring-run Chinook Salmon

Spring-run Chinook Salmon	Life Stage Affected?	Change in Risk of SD/CD Entrainment	Change in Risk of Facility Loss	Certainty of Risk Determination
Eggs	This life stage is not present in the Delta			
Wild YOY Juveniles	Wild spring-run Chinook salmon are distributed broadly from the Sacramento River through the Delta			
18-36% upstream of the Delta in the Sacramento River[1]	No	No Change	No Change	Moderate
64-82% in the Delta	Yes	Increased	Increased	Moderate
0% past Chipps Island	No	No Change	No Change	Moderate
Wild Yearlings	Wild yearling spring-run Chinook salmon are distributed broadly from the Sacramento River through the Delta			
An uncertain proportion upstream of the Delta in the Sacramento River	No	No Change	No Change	Low
An uncertain proportion in the Delta	Yes	Increased	Increased	Moderate
0% past Chipps	No	No Change	No Change	Moderate
Hatchery spring-run Surrogates	The first release of hatchery spring-run Chinook salmon surrogates were released 1/8/2018. The second release occurred on 1/18/2018. The third release occurred on 1/25/2018			
>30% upstream of the Delta (all release groups 1, 2, 3)	No	No Change	No Change	Moderate
<70% in the Delta	Yes	Increased	Increased	Moderate
0% past Chipps	No	No Change	No Change	Moderate
Adults	No	No Change	No Change	High

Status of Spring-run Chinook Salmon

[1] This upstream fish distribution estimate is from 3/13/18 draft DOSS meeting notes and reflects distribution based on the previous week.

Approximately 144,000 juvenile spring-run sized Chinook Salmon have been observed passing Red Bluff Diversion dam as of March 12, 2018 which based on long-term averages represents about 75% of the expected passage of spring-run sized Chinook Salmon at Red Bluff Diversion Dam. The current methods of race assignment used in the monitoring of Chinook Salmon (length-at-date) has presented challenges for run assignment of fish captured at Red Bluff Diversion Dam this season. It is hypothesized that a portion of the length-assigned spring-run may actually be late hatching winter-run. Monitoring data suggest that 64 to 82% of natural-origin YOY juveniles are currently residing in the Delta, downstream of Knights Landing. Through March 9, 2018, 17 juvenile spring-run have been captured at seine sites. No unmarked spring-run sized juveniles have been observed in the Chipps Island trawl monitoring, indicating that few, if any, have left the Delta.

Historical data indicates that the median catch of spring-run sized juvenile Chinook Salmon in Sacramento Trawl is typically early to mid-April (Figure 6). Yearling spring-run observations are expected to be rare because of their relatively large size and strong swimming ability (associated with gear avoidance), and low abundance relative to young-of-the-year (YOY) spring-run. The Delta Operations for Salmonids and Sturgeon Group does not estimate yearling Spring-run Chinook distribution. An estimated 64-82% of YOY spring-run are currently rearing in the Delta, and additional downstream movement will be expected, concurrent with the flow pulse, for all juvenile stages still residing upstream of the Delta in the main stem Sacramento River.

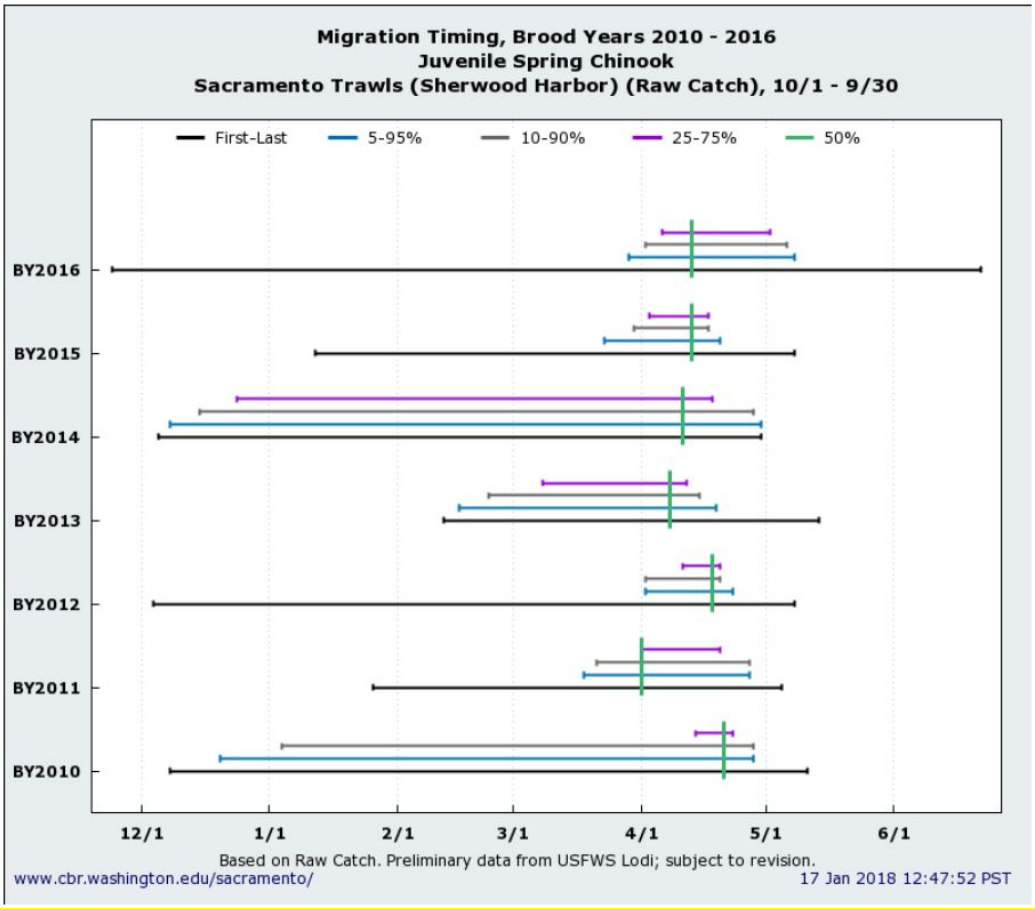


Figure 6. Historical timing for spring-run Chinook captured at Sacramento Trawls.

Three hatchery-origin spring-run yearling surrogates were released on January 8, 18, and 25, 2018, (approximately 235,400 late fall-run Chinook from Coleman NFH). An estimated loss of 8.66 and 16.87 have been lost to the facilities from the first and third release groups, respectively. The natural-origin juvenile spring-run Chinook Salmon remaining upstream of the Delta are anticipated to migrate with the projected flow pulse into the Delta and lower Sacramento River tributaries to rear over the next several weeks.

Effects of Proposed Operational Changes on Spring-run Chinook Salmon

Reclamation and DWR are currently operating consistent with RPA actions in the NMFS BiOp (NMFS 2009). Action IV.2.3 is in place January 1 through June 15 to reduce the vulnerability of emigrating salmonids to entrainment into the central and south Delta and loss at the facilities. During JanuaryMarch, this RPA primarily protects winter-run and spring-run Chinook salmon and steelhead. Reclamation proposes to modify this action, consistent with the WIIN Act, to allow for an OMR Index more negative than the maximum prescribed in Action IV.2.3 (-5,000 OMR), to capture peak storm flow. Peak flow capture is forecasted to occur over a 5-day period, from March 20 to 24.

Salmonids use changes in flow from storms as cues for emigration, thus the storm event will result in another pulse of fish emigrating into the Delta. The storm event's increased Sacramento inflows have the potential to reduce entrainment of fish entering the Delta into the Central and South Delta by increasing entrainment into Sutter and Steamboat sloughs and reducing entrainment into Georgiana Slough. The DCC gates were closed on November 24, 2017 and remained closed starting December 1, 2017 per Action IV.1.2 of the NMFS BiOp. The DCC gate closure reduced the risk of emigrating salmonids straying out of the Sacramento River and into the central Delta. Due to changes in Delta conditions (i.e., flows and possibly turbidity) during the storm, changes in migratory behavior of juveniles have the potential to increase entrainment of fish in the Delta into the central and south Delta regardless of the Proposed Operational Changes. The storm event's flows and increased turbidity likely reduce the potential for predation associated with operations, and do not affect their rearing, feeding or sheltering behavior.

DSM2 modeling of the Proposed Operations Change shows small hydrodynamic changes (ie. more negative average daily flows) that enhance the risk of entrainment of juveniles into the central and South Delta during and after the 5 days of increased exports for fish that may be in the south Delta. The DSM2 modeling shows more negative average velocities, which can affect migration behavior, and this is how the Proposed Operational Change may enhance the risk of loss at the facilities for fish that are present in the south Delta during the five day increased export period. Older juvenile-sized Chinook Salmon and coded wire tagged (CWT) fishes from the Sacramento River have been observed in Delta beach seine and trawl monitoring and at the CVP/SWP fish collection facilities, suggesting spring-run Chinook salmon are currently occupying these regions (See Figure 7, 8, and 9). As described above, the distribution of spring-run Chinook Salmon is likely to change during and after the forecasted storm event and may affect the risks of entrainment and loss at the facilities for fish that are present in the south Delta.

The Delta Operations for Salmonids and Sturgeon Group estimated that the risk of salmonid entrainment into the facilities is medium-high for exports of -5000 cfs and high for exports of -

6,250 cfs. DOSS advised "that OMR flows more negative than -5,000 cfs will have high overall entrainment risks at the CVP and SWP fish salvage facilities given current salmon distributions. OMR flows more negative than -5,000 cfs will create conditions that are not protective of listed salmonids in the southern Delta." There is moderate certainty in our understanding of how hydrodynamic affects juvenile spring-run Chinook behavior and distribution. Due to the low abundance of juvenile spring-run Chinook Salmon this year, monitoring of older juvenile and spring-run sized fish to minimize operational impacts may be more difficult this year, and genetic testing will be used to confirm species of fish salvaged at the CVP and SWP fish collection facilities.

Summary of Effects on Spring-run Chinook Salmon

A majority of the Spring-run Chinook Salmon population will be present in the Delta during the Proposed Operational Changes, and the percent of the population in the Delta may increase due to emigration cues from the storm event, since the storm's environmental conditions and the species' periodicity are optimal for migration and continued rearing of juvenile spring-run Chinook Salmon. The Spring-run Chinook surrogates have been released, but loss of release groups is not approaching 0.5%. The Proposed Operational Change is unlikely to modify behavior patterns of spring-run Chinook salmon associated with rearing, feeding, or sheltering. Maintaining a short period of OMR flows more negative than -5,000 cfs may affect migration, but is not likely to increase the duration spring-run Chinook salmon spend in the Delta. The Proposed Operational Change potentially increases the risk of entrainment and loss at the CVP/SWP fish collection facilities for any spring-run Chinook Salmon in the south Delta, but includes triggers to protect against additional adverse effects to the species.

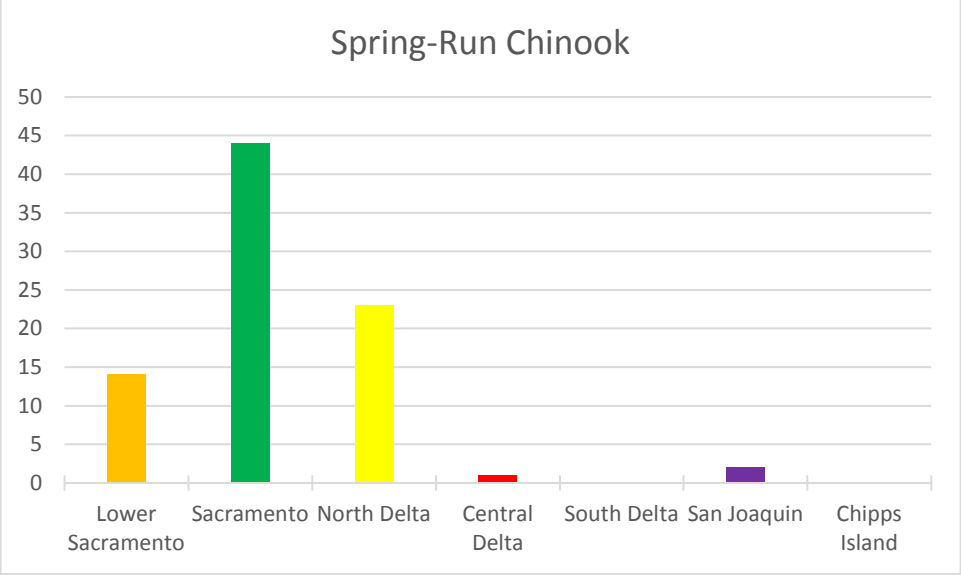


Figure 7. Total number of Spring-run Chinook Salmon captured at Delta monitoring sites (beach seines, midwater trawl, and Kodiak trawl) from 2-13-2018 to 3-15-2018. Monitoring sites correspond with map (see Figure 2)

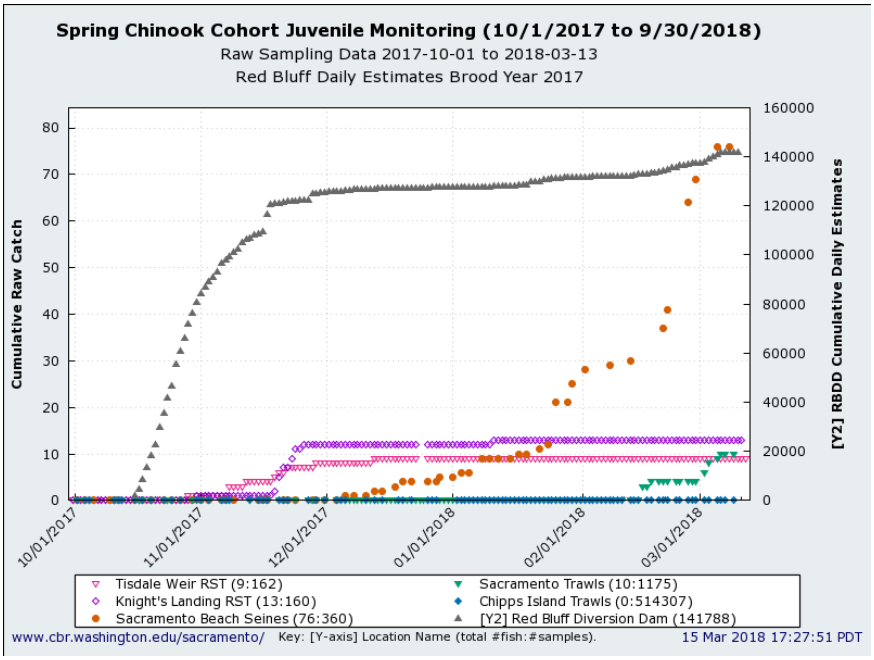


Figure 8. Juvenile Spring-run Chinook cohort monitoring (Tisdale Weir and Knight's Landing rotary screw trap, Sacramento Beach Seines and Trawls, Chipps Island Trawls, and Red Bluff Diversion Dam).

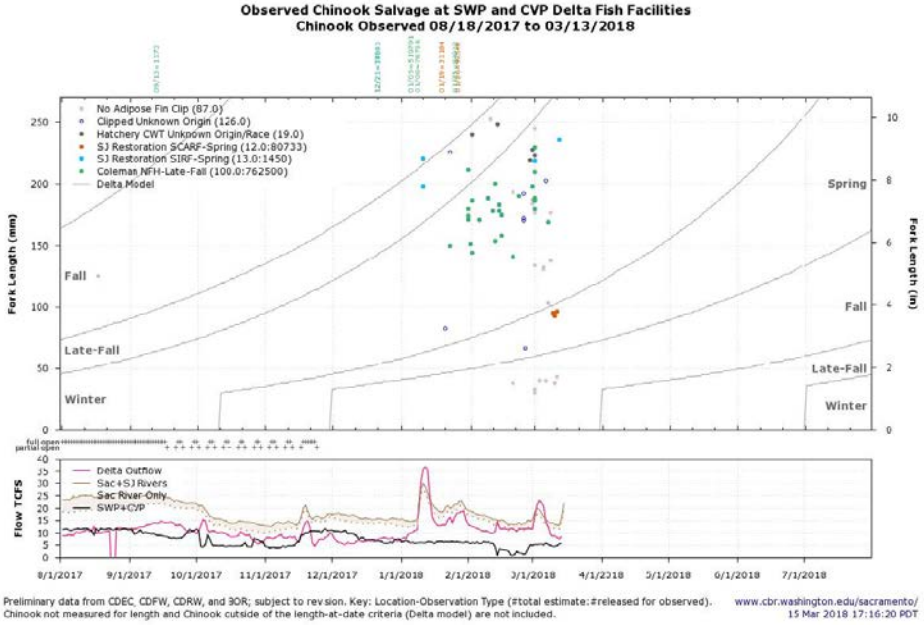


Figure 9.8 Salvage of observed Chinook salmon at the SWP and CVP Delta Fish Facilities from 08/18/2017 to 03/13/2018.

Biological Review of Green Sturgeon

Green Sturgeon	Life Stage Affected?	Change in Risk of SD/CD Entrainment	Change in Risk of Facility Loss	Certainty of Risk Determination

Egg	This life stage is not present in the Delta.			
Juvenile (<3 year old)	Juvenile green sturgeon are distributed throughout the Delta.			
Delta	Yes	No Change	No Change	Low
Subadults	This life stage is not present in the Delta.			
Adults	Adult green sturgeon may be entering the Delta and previous year's spawners may still be exiting the Delta			
Delta	Yes	No Change	No Change	High

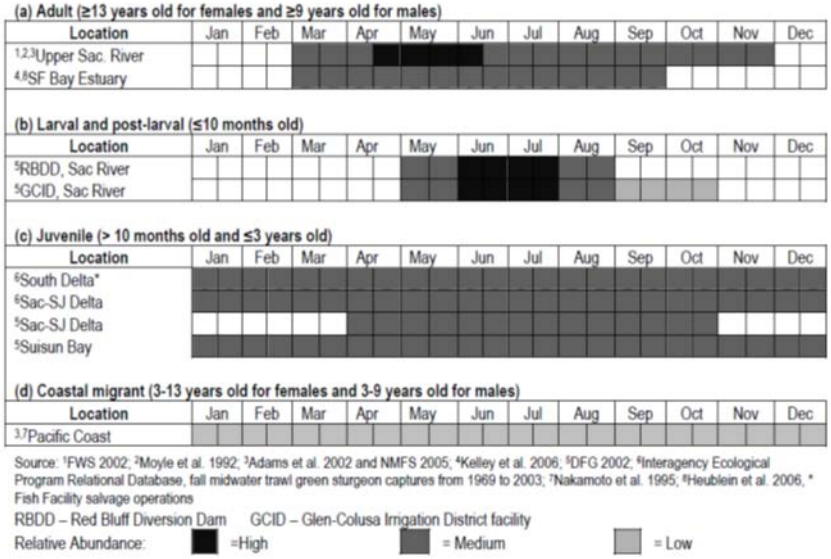
Status of Green Sturgeon

Large numbers of larvae (n=4,881; greater than the long-average) and juveniles (n=26) were observed at the Red Bluff fish monitoring rotary screw traps between May 28 and November 17, 2017. No empirical estimates of the juvenile population (0-3 years) in the Delta are available nor is there information about their rearing and distribution patterns within the Delta. Juvenile and adult green sturgeon will be present in the San Joaquin and Sacramento rivers and Delta during the Proposed Operational Changes. These life stages will continue to be dispersed through the fresh and brackish portions of the region. These distributions normally expose green sturgeon to a broad spectrum of tidally-dominated flow conditions, and they freely move throughout the Delta, including the central and south Delta regions, to find suitable conditions for their needs (Table 1). In October 2017, an adult green sturgeon was observed in the Stanislaus River, near Knights Ferry. Additionally, one dead adult green sturgeon was observed on the Trach Fish Collection Facility trash rack in December 2017. There has been no additional observations of green sturgeon in river, Delta, Bay, or salvage monitoring during this water year.

Effect of Proposed Operational Changes on Green Sturgeon

Hydrodynamic modeling of the Proposed Operational Changes did not predict differences in water velocities in channels measured across the North and Western Delta. The Proposed Operational Changes is expected to cause hydrodynamic changes in the south Delta, but no relationship between monthly OMR flows or velocities and risk of entrainment of facility loss exists for green sturgeon. Green sturgeon observations are extremely rare in the Delta and none have been observed in lower Sacramento and Delta fish monitoring surveys or at the state and federal fish collection facilities in the South Delta in recent years. In 2011, over 3,000 juvenile green sturgeons were captured in the RSTs at RBDD, but no green sturgeon were observed in any of the river, Delta, or Bay fish monitoring surveys. It is unclear if there would be additional adverse effects on green sturgeon due to the Proposed Operational Changes. There is low certainty in our understanding of how hydrodynamic affects Green Sturgeon behavior and distribution.

Table 1. The temporal occurrence of (a) adult, (b) larval and post-larval, (c) juvenile, and (d) coastal migrants of the southern DPS of North American green sturgeon. Locations are specific to the Central Valley of California. Darker shades indicate months of greatest relative abundance. From NMFS BiOp 2009.



Summary of Effects on Green Sturgeon

Green sturgeon will be present in the Delta during the Proposed Operational Changes. The Proposed Operational Changes will not significantly impair green sturgeon behavior including rearing, migrating, feeding, or sheltering. The Proposed Operational Change is unlikely to affect the duration that juvenile or adult green sturgeon are in the Delta, their predation risk, or entrainment risk. The Proposed Operational Change will not increase the risk of exceeding the 10-year average salvage (n=74) or loss (n=106) of green sturgeon at the facilities.

Biological Review of Central Valley Steelhead

Steelhead	Life Stage Affected?	Change in Risk of SD/CD Entrainment	Change in Risk of Facility Loss	Certainty of Risk Determination
Egg	This life stage is not present in the Delta			
Wild Sacramento smolts				
<40% upstream of the Delta in the Sacramento River and tributaries	No	No Change	No Change	High
>40% in the Delta	Yes	Increased	Increased	Moderate
<10% past Chipps Island	No	No Change	No Change	Moderate
Wild San Joaquin smolts				
<40% upstream in the San Joaquin River and tributaries	No	No Change	No Change	Moderate
>40% Delta	Yes	Increased	Increased	Moderate
<10% past Chipps Island	No	No Change	No Change	Moderate
Hatchery Sacramento smolts	Coleman Hatchery Fish released on 12/20/2017 and 1/2/2018			
<20% upstream of the Delta in the Sacramento River	No	No Change	No Change	Low
>30% in the Delta	Yes	Increased	Increased	Low
Adults	Yes	Not Affected	Minimal	Moderate

<u>Updated Status of Central Valley Steelhead</u>

Juvenile and adult Central Valley steelhead trout will be present in the San Joaquin and Sacramento rivers and within the Delta during the Proposed Operational Changes. The distributions of these life stages are broad. A historical average indicates that mid-March is typically when steelhead are sampled in the Sacramento beach seines and trawls (Figures 10). A substantial proportion of Sacramento origin and San Joaquin River origin wild juveniles are predicted to be in the Delta during the 5-day Proposed Operational Changes, due to downstream emigration into the Delta with the recent and upcoming storm events. One wild steelhead was captured this water year at the Knights Landing rotary screw trap. Three wild steelhead were captured at the Tisdale Weir and no wild steelhead were caught in Sacramento beach seine. Nine wild steelhead were caught in the Sacramento trawl fish monitoring sites (Figure 11). The last wild steelhead was captured in the Chipps Island Trawl on March 3, 2018 (total of 6; Figure 12).

As of March 13, 2018, steelhead have been observed in the south or central Delta seining regions and the CVP/SWP fish collection facilities. Fifty-two wild and 344 hatchery steelhead have been salvaged at the state or federal export facilities (Figure 13 and 14).

Effect of Proposed Operational Changes on Central Valley Steelhead

Reclamation and DWR are currently operating consistent with RPA actions in the NMFS BiOp (NMFS 2009). Action IV.2.3 is in place January 1 through June 15 to reduce the vulnerability of emigrating salmonids to entrainment into the central and south Delta and loss at the facilities. During March, this RPA primarily protects winter-run and spring-run Chinook Salmon and steelhead. Reclamation proposes to modify this action, consistent with the WIIN Act, to allow for an OMR Index more negative than the maximum prescribed in Action IV.2.3 (-5,000 OMR), to capture peak storm flow. Peak flow capture is forecasted to occur over a 5-day period from March 20-24.

Salmonids use changes in flow from storms as cues for emigration, thus the storm event is likely to result in a pulse of outmigrating steelhead emigrating into the Delta. The storm event's increased Sacramento inflows have the potential to reduce entrainment of fish entering the Delta into the Central and South Delta by increasing entrainment into Sutter and Steamboat sloughs and reducing entrainment into Georgiana Slough. The DCC gates were closed on November 24, 2017 and remained closed starting December 1, 2017 per Action IV.1.2 of the NMFS BiOp. The DCC gate closure reduced the risk of emigrating salmonids straying out of the Sacramento River and into the central Delta. Due to changes in Delta conditions (i.e., flows and possibly turbidity) during the storm, changes in migratory behavior of juveniles have the potential to increase entrainment of fish in the Delta into the central and south Delta regardless of the Proposed Operational Changes. These flows and increased turbidity during the storm event likely reduce the potential for predation associated with operations and do not affect their rearing, feeding or sheltering behavior. Adult steelhead may still be migrating through the Delta to spawn and kelts are likely to be outmigrating through the Delta, but are not likely to be affected by the hydraulic alteration due to the Propose Action. There is low certainty in our understanding of how hydrodynamic affects juvenile or adult steelhead behavior and distribution.

DSM2 modeling of the Proposed Operations Change shows small hydrodynamic changes (ie. more negative average daily flows) that enhance the risk of entrainment of juvenile steelhead into the central and South Delta during and after the 5 days of increased exports for fish that may be in the south Delta. The DSM2 modeling shows more negative average velocities, which can affect migration behavior, and this is how the Proposed Operational Change may enhance the risk of loss at the facilities for fish that are present in the south Delta during the five day increased export period. Wild and hatchery juvenile steelhead have been observed at the CVP/SWP fish collection facilities, suggesting juvenile steelhead are currently occupying these regions. As described above, the distribution of juvenile steelhead is likely to change during and after the forecasted storm event and may affect the risks of entrainment and loss at the facilities for fish that are present in the south Delta. As part of the Proposed Operation Change, precautionary actions and threshholds are identified to avoid exceedance of the annual incidental take limit associated with operations of the CVP and SWP.

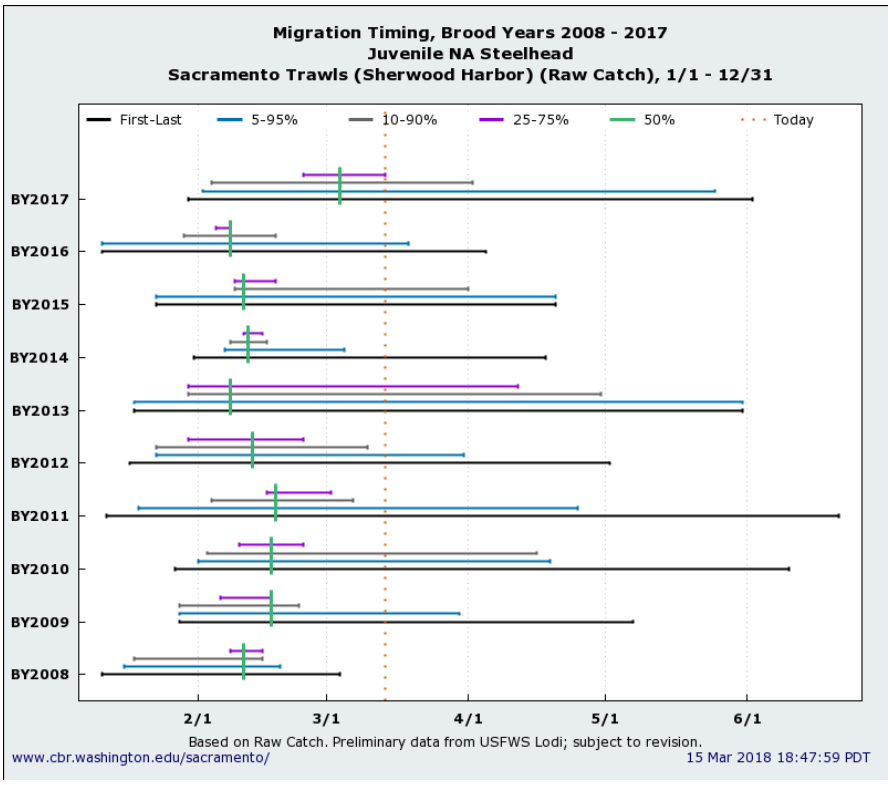


Figure 10. Historical timing for steelhead captured at Sacramento Trawls.

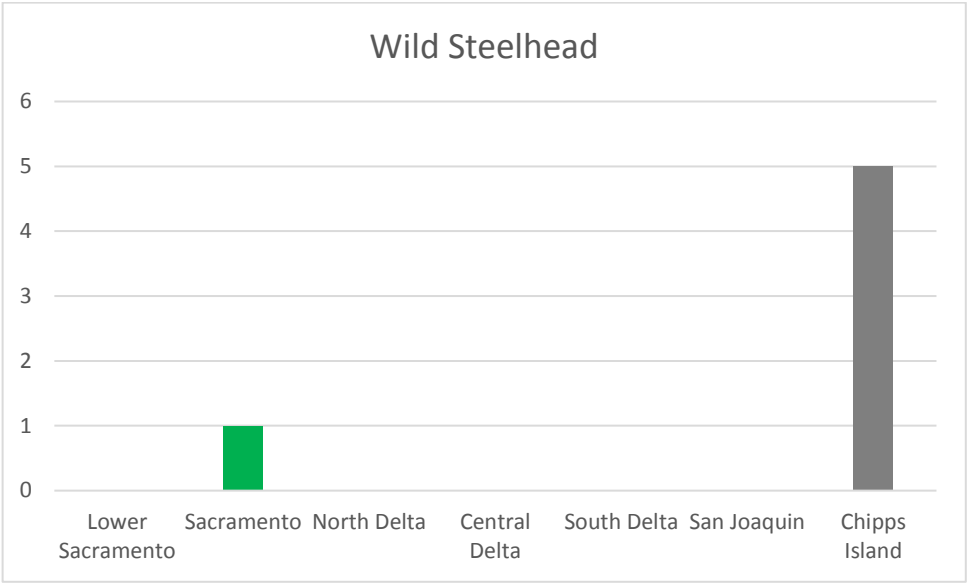


Figure 11. Total number of wild steelhead clipped sampled at Delta monitoring sites (beach seines, midwater trawl, and Kodiak trawl) from 2-13-2018 to 3-15-2018. Monitoring sites correspond with map (see Figure 2).

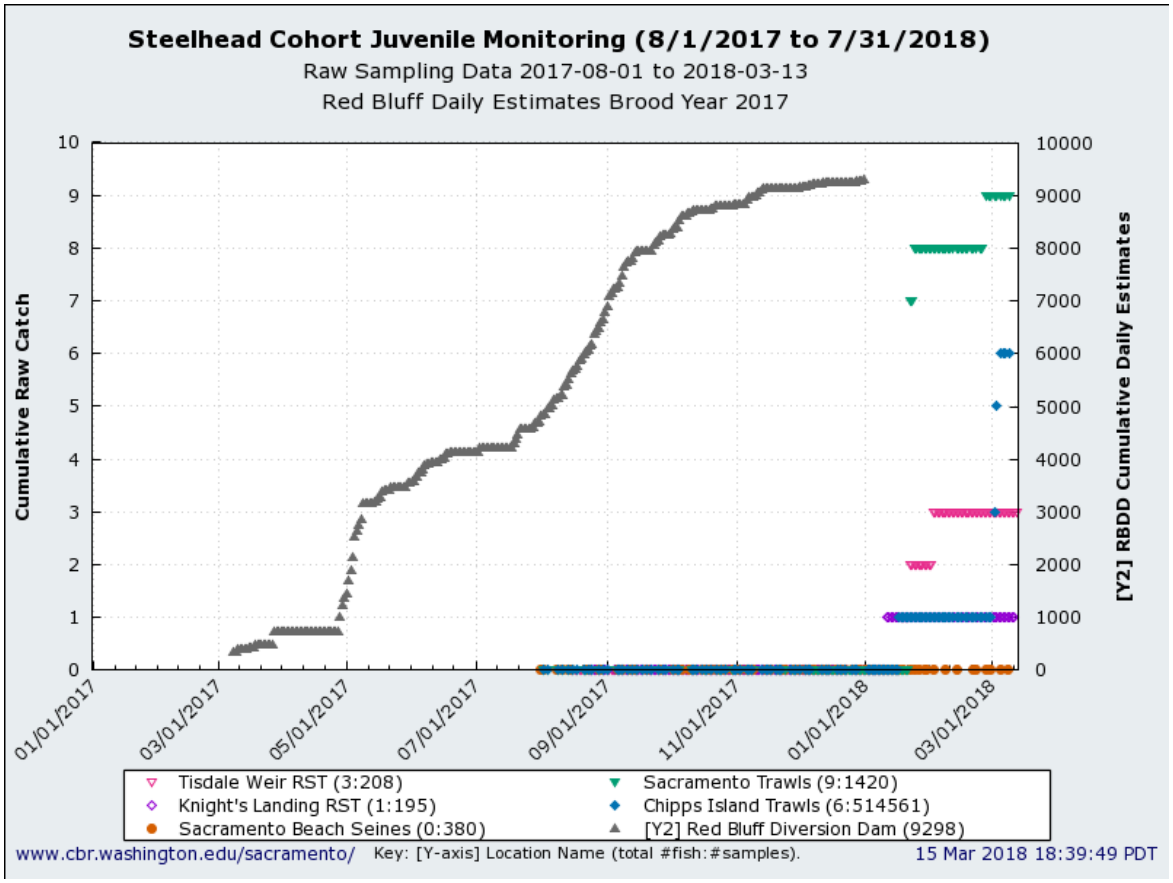


Figure 12. Steelhead cohort juvenile monitoring from 8-1-2017 to 3-13-2018 (Tisdale Weir and Knight's Landing rotary screw trap, Sacramento Beach Seines and Trawls, Chipps Island Trawls, and Red Bluff Diversion Dam).

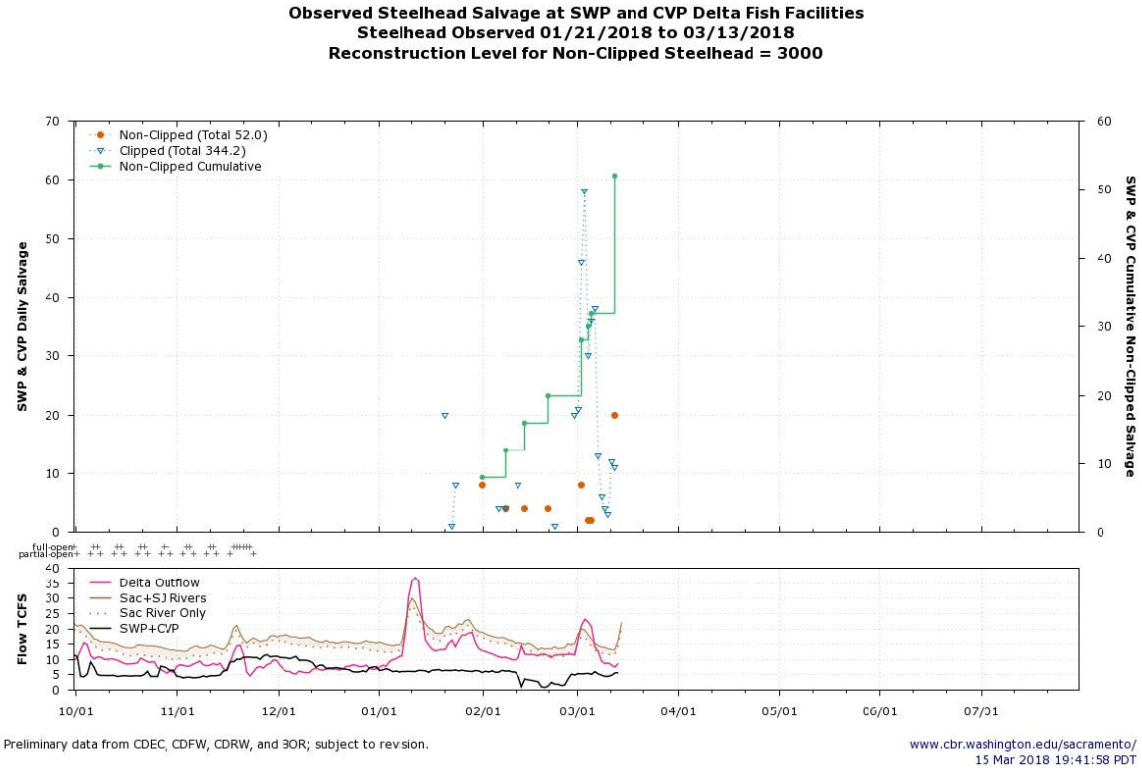


Figure 13. Wild and hatchery-raised steelhead salvaged at the CVP and SWP fish facilities from 01/21/2018 to 03/13/2018.

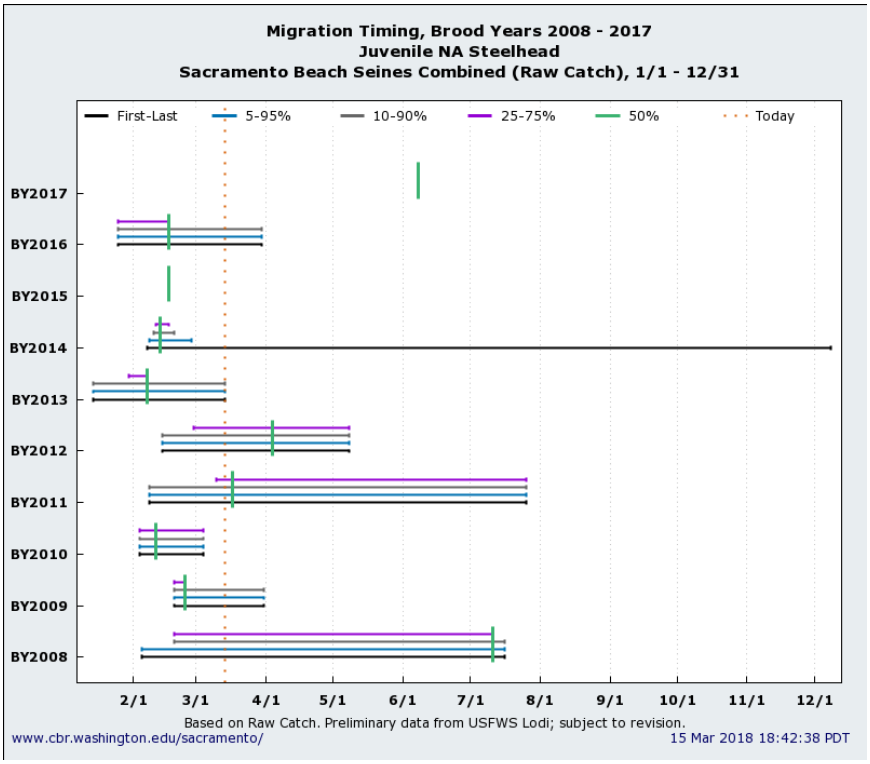


Figure 13. Historical timing for steelhead captured at Sacramento beach seine monitoring sites.

Summary of Effects on Central Valley Steelhead

Steelhead will be present in the Delta during the Proposed Operational Changes. There is limited information about the adult steelhead population, but it is estimated to be small, consequently limiting the productivity of the population. A significant proportion of juvenile steelhead are currently in the Delta and current storm conditions will increase the proportion of these fish migrating through the Delta. Maintaining a short period of OMR flows more negative than -5,000 cfs will not affect steelhead rearing, feeding, or sheltering behavior, but potential increases risks of entrainment and loss at the facilities for juvenile steelhead in the south Delta, since current environmental conditions and timing is optimal for migration. The Proposed Operational Change is not expected to affect the duration that juvenile or adult steelhead migrate through the Delta or increase the potential for indirect predation. The Proposed Operational Change included precautionary threshholds and actions to avoid exceedance of the steelhead incidental take limit associated with the export operations of the CVP and SWP.

Biological Review of Delta Smelt

Delta Smelt (Pre-Storm Distribution)	Life stage Affected	Change in Risk of SD/CD Entrainment	Change in Risk of Facility Loss	Certainty of Risk Determination
Eggs	Attached to substrate with very low risk of entrainment			
Larvae	Based on recent adult maturation stage spawning may have just begun or will begin soon; few if any eggs are likely to have hatched. Assumption is eggs are distributed roughly where adults have been detected.			
Cache Slough / Liberty Island (% unknown; no catch in recent surveys)	No	No Change	No Change	High
40% Sac Deep Water Ship Channel	No	No Change	No Change	High
20% South Delta	Yes	Increased	Increased	High
40% Lower Sacramento	Possible	Increased	No Change	Low
Lower San Joaquin (% unknown; no catch in recent surveys)	Yes	Increased	Increased	High
downstream of Confluence (% unknown; no catch in recent surveys)	No	No Change	No Change	High
Juvenile	It is too early in the year for juvenile Age-0 Delta Smelt			
Adults	Distribution based on February 12-March 8, 2018 monitoring			
Cache Slough / Liberty Island (% unknown; no catch in recent surveys)	No	No Change	No Change	High

40% Sac Deep Water Ship Channel	No	No Change	No Change	High
20% South Delta	Yes	Increased	Increased	High
40% Lower Sacramento	Possibly	Increased	Increased	Low
Lower San Joaquin (% unknown; no catch in recent surveys)	Yes	Increased	Increased	High
downstream of Confluence (% unknown; no catch in recent surveys)	No	No	No	High

Status of Delta Smelt

Delta Smelt are at record low abundance throughout the Delta. Like many other species in the Delta, the Delta Smelt population is expected to have low recruitment again this year. No Delta Smelt were captured in November or December 2017 Fall Midwater Trawls (FMWT), indicating that Delta Smelt abundance remains at record low levels (final index for 2017 was 2). One Delta Smelt was observed in a salvage count on 3/9/18 at the federal facility, no other Delta Smelt have been observed in salvage counts at either the state or federal export facilities this water year.

From 2/12/18 to 3/8/18 the Enhanced Delta Smelt Monitoring Program (EDSM) has captured three Delta Smelt (one in the Sacramento Deep Water Ship Channel and two in the Lower Sacramento). Current EDSM strata are not labeled by risk, but neither of these strata have previously been considered high entrainment risk strata. From 3/5/18 to 3/8/18 the Spring Kodiak Trawl Survey #3 captured 1 Delta Smelt from the Sacramento Deep Water Ship Channel. No Delta Smelt have been captured at the Spring Kodiak Trawl Survey stations 809, 812, 815, 902, 906, 910, 912, 914, and 915. As of 3/5/18 no Delta Smelt has been identified in the Smelt Larval Survey. Distribution of Delta Smelt can change rapidly and indicators of distribution should be evaluated as frequently as data allow during and following storms.

Effect of Proposed Action on Delta Smelt

The following discussion is based on limited catches of Delta Smelt in monitoring programs. Reclamation and DWR are currently operating consistent with RPA actions in the 2008 FWS BiOp and the 2009 NMFS BiOp to reduce the vulnerability of Delta Smelt and emigrating salmonids to entrainment into the central and south Delta and loss at the facilities. During January, this RPA primarily protects winter-run and spring-run Chinook Salmon and steelhead, but also reduces entrainment of Delta Smelt. Component 1, Action 2 of the 2008 FWS BiOp uses “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.” In addition, the RPA stipulates that “the range of net daily OMR flows will be no more negative than - 1,250 to -5,000 cfs. Depending on extant conditions specific OMR flows within this range are recommended by the Working Group from the onset of Action 2 or 3 through its termination…” Reclamation proposes to modify this action, consistent with the WIIN Act, to allow for an OMR Index more negative than the maximum prescribed in Action 2 or 3 (-5,000 OMR), to capture peak storm flow. Peak flow capture is forecasted to occur over a 5-day period, from March 20th to Saturday March 24th

Due to changes in Delta conditions (*i.e.*, flows, temperatures, and turbidity) during the storm event, changes in the migratory behavior of Delta Smelt suggest a potential increased risk of entrainment into the south and central Delta and an increased risk of loss at the CVP/SWP fish collection facilities. The Proposed Operational Change is unlikely to impacts the behavior of Delta smelt spawning, incubation, rearing, feeding, or shelter. The Proposed Operational Change does not change the duration Delta smelt are present in Delta, and storm event increased turbidity may reduce the potential for indirect predation. Precautionary actions to avoid adverse additional effects on Delta smelt will avoid loss of Delta smelt greater than the Incidental Take Limit.

DSM2 modeling of the Proposed Operations Change shows hydrodynamic changes (i.e. more negative average daily flows) that enhance the risk of entrainment of Delta Smelt into the central and South Delta during and after the 5 days of increased exports for fish that may be in the south Delta. Delta Smelt have been observed at the CVP/SWP fish collection facilities, supporting presence in the South Delta. Based on current Delta conditions, water export levels, and the recently salvaged Delta Smelt, the SWG concluded that Delta Smelt entrainment risk would be high for OMR levels above -4600, medium-high for OMR levels from -3,500 to -4,600 cfs, and low at OMR levels more positive than -3,500 cfs (Figure 15). Delta Smelt migratory behavior is influenced by changes in environmental conditions, such as temperature, photoperiod, changes in flow and turbidity. Thus, the distribution of Delta Smelt is likely to change during and after the forecasted storm event and may affect the risks of entrainment and loss at the facilities for fish that are present in the south Delta. As part of the Proposed Operation Change, precautionary actions and thresholds are identified to avoid exceedance of the annual incidental take limit associated with operations of the CVP and SWP.

Summary of Effects on Delta Smelt

Modeling of the Proposed Operational Change suggests hydrodynamic changes that enhance the risks of entrainment of Delta Smelt and loss at the export facilities. The spawning status and spatial distribution of Delta Smelt should continue to be evaluated as frequently as data allow to assess changes in the risk of entrainment. Evidence of spawning has yet to be observed but is expected to occur soon or is occurring undetected at this time. The EDSM program can provide critical warning of the presence of Delta Smelt in the zone of entrainment, if OMR flows are managed at a level that do not result in high salvage before Delta Smelt are detected. As part of the Proposed Operation Change, precautionary actions and thresholds are identified to avoid exceedance of the annual incidental take limit associated with operations of the CVP and SWP.

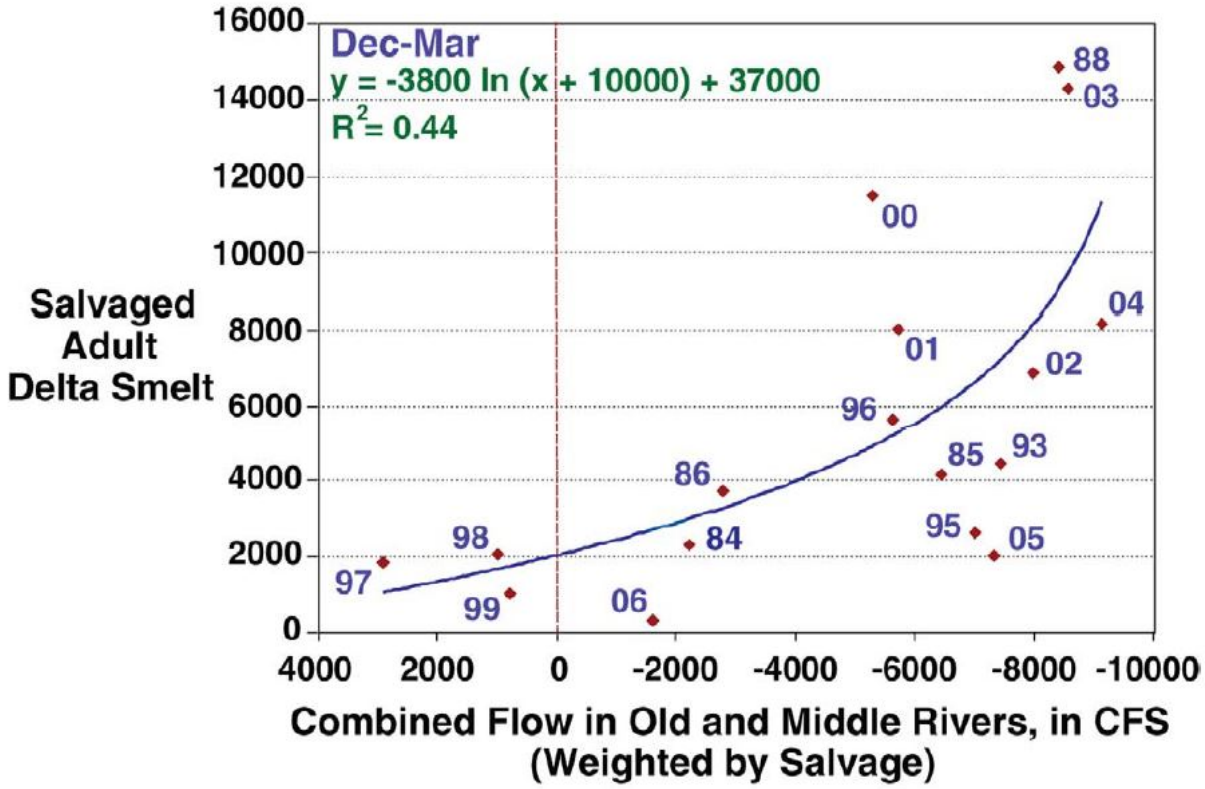


Figure 15. Relationship between OMR flows and Delta Smelt salvage at the export facilities.

Status of Longfin Smelt

No adult/sub-adult Longfin Smelt were captured by EDSM during Week 15 (3/12/18 to 3/15/18) and two were captured during Week 14 (3/5/18 to 3/8/18) in the Suisun Bay area. No adult/sub-adult Longfin Smelt have yet to be identified from Spring Kodiak Trawl (SKT) Survey #3 (3/5/18 to 3/8/18). Bay Study sampled the upper estuary the week of February 20 and detected only two adult/sub-adult Longfin Smelt within the Delta, both in the Sacramento River adjacent to Sherman Lake. The Smelt Larval Survey (SLS) #5 (2/26/18 to 3/5/18) identified the majority of Longfin Smelt larvae were present from the confluence and downstream (Figure 16). The 20-mm Survey #1 (3/12/18 to 3/15/18) identified the same pattern. No Longfin Smelt have been salvaged at either the state or federal export facilities this water year.

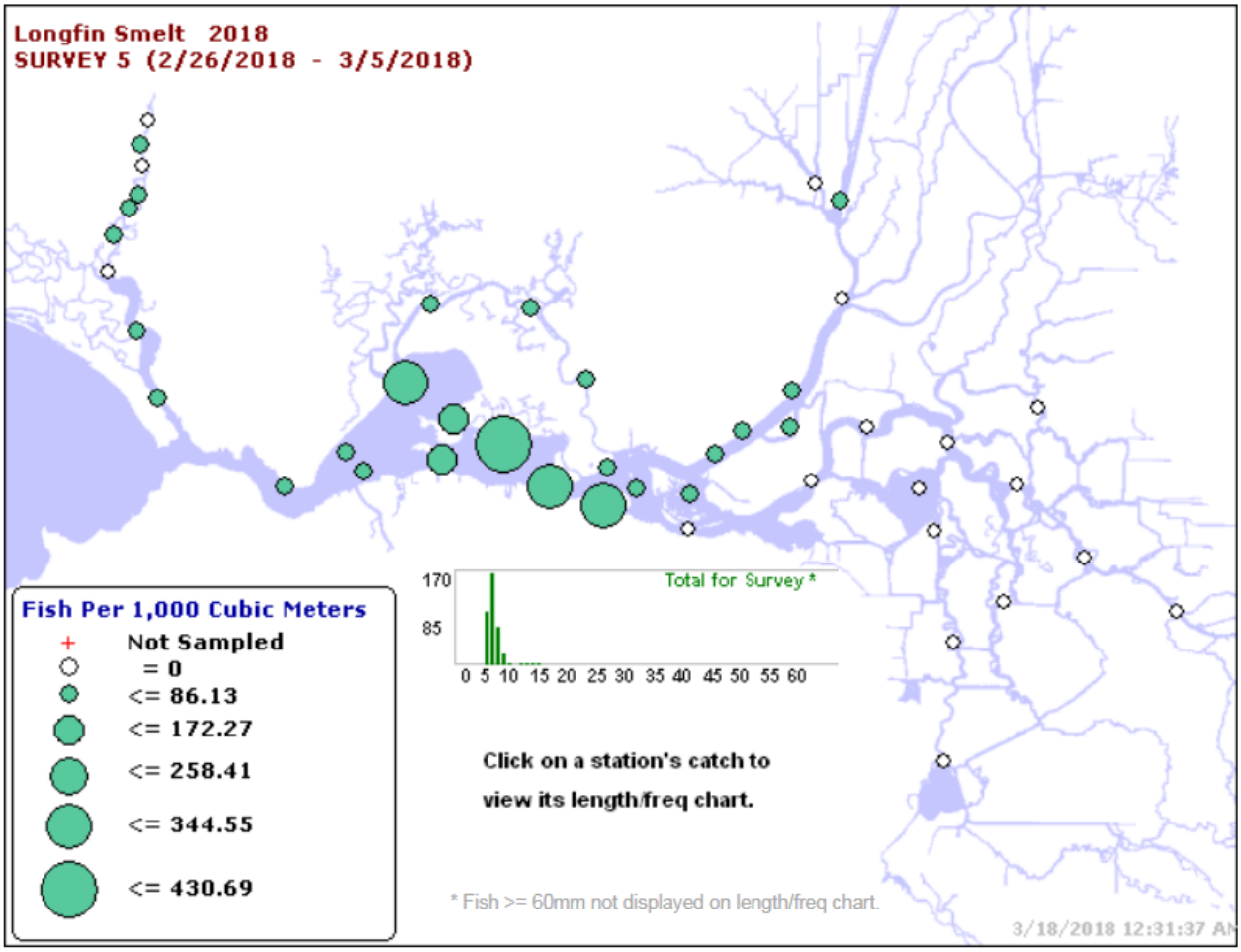


Figure 16. Smelt Larval Survey #5 results for Longfin Smelt (from: https://www.wildlife.ca.gov/Conservation/Delta/Smelt-Larva-Survey).

Effect of Proposed Operational Changes on Longfin Smelt

The following discussion is based on catches of Longfin Smelt in monitoring programs. Reclamation and DWR are currently operating consistent with RPA actions in the 2008 FWS BiOp and the 2009 NMFS BiOp to reduce the vulnerability of Delta Smelt and emigrating salmonids to entrainment into the central and south Delta and loss at the facilities. During January,

this RPA primarily protects winter-run and spring-run Chinook Salmon and steelhead, but also reduces entrainment of Delta Smelt. Component 1, Action 2 of the 2008 FWS BiOp uses "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." In addition, the RPA stipulates that "the range of net daily OMR flows will be no more negative than - 1,250 to -5,000 cfs. Depending on extant conditions specific OMR flows within this range are recommended by the Working Group from the onset of Action 2 or 3 through its termination…" Reclamation proposes to modify this action, consistent with the WIIN Act, to allow for an OMR Index more negative than the maximum prescribed in Action 2 or 3 (-5,000 OMR), to capture peak storm flow. Peak flow capture is forecasted to occur over a 5-day period, from March 20th to Saturday March 24th

DSM2 modeling of the Proposed Operations Change shows hydrodynamic changes (i.e., more negative average daily flows) that enhance the risk of entrainment of Longfin Smelt into the central and South Delta during and after the 5 days of increased exports for fish that may be in the south Delta. Longfin Smelt have not been observed at the CVP/SWP fish collection facilities this water year.

Based on current Delta conditions, water export levels, and a recently salvaged Delta Smelt, the SWG concluded that Delta Smelt entrainment risk would be high for OMR levels above -4600, medium-high for OMR levels from -3,500 to -4,600 cfs, and low at OMR levels more positive than -3,500 cfs (Figure 15). Delta Smelt migratory behavior is influenced by changes in environmental conditions, such as temperature, photoperiod, changes in flow and turbidity. Thus, the distribution of Delta Smelt is likely to change during and after the forecasted storm event and may affect the risks of entrainment and loss at the facilities for fish that are present in the south Delta. As part of the Proposed Operation Change, precautionary actions and threshholds are identified to avoid exceedance of the annual incidental take limit associated with operations of the CVP and SWP.

Summary of Effects on Longfin Smelt

Like other species, Longfin Smelt is likely to have reduced recruitment this year due to effects of the extended drought and low abundance. The Proposed Operational Changes are unlikely to substantially negatively affect Longfin Smelt spawning and recruitment across the population in any measureable manner, as recent surveys indicate the majority of both adult and larval Longfin Smelt are distributed outside the zone of influence of the export facilities. Any adult Longfin Smelt in the San Joaquin River are unlikely to be affected by the Proposed Operational Changes. Any larval Longfin Smelt in the San Joaquin River are at an elevated risk of entrainment into the south Delta under the Proposed Operational Changes scenario. Any Longfin Smelt in the South Delta are already present, thus they are at a high risk of entrainment under both baseline and Proposed Operational Changes scenarios.

Please help me out biologists!

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Appendix

Table 1. DSM2 output comparing baseline and Proposed Operational Changes conditions for mean flow (cfs) and mean daily velocity (ft/s) of key channel nodes (model run averaging March 20-24).

		Mean daily Flow (cfs)			Mean Daily Velocity (ft/s)		
Channel Number	Delta Juvenile Fish Monitoring Program	OMR -5000	OMR -5700	Difference between OMR -5700 and Baseline	Baseline	OMR	Difference between OMR and EI
6	San Joaquin	1856.7	1857	0	0.99	0.99	0.00
9	San Joaquin	488.9	502	-13	0.37	0.37	-0.01
12	South Delta	414.6	427	-13	0.23	0.23	-0.01
21	South Delta	506.2	519	-13	0.04	0.04	0.00
49	Central Delta	381.3	658	-277	0.03	0.03	0.00
50	Central Delta	98.0	391	-292	0.04	0.04	0.00
54	San Joaquin	1320.1	1307	13	1.03	1.02	0.01
81	South Delta	-3052.3	-2693	-359	-0.87	-0.76	-0.11
94	South Delta	-2581.0	-2396	-185	-0.27	-0.25	-0.02
107	South Delta	-881.4	-832	-50	-0.24	-0.22	-0.01
108	South Delta	-1487.7	-1363	-125	-0.12	-0.11	-0.01
124	South Delta	-248.6	-147	-101	-0.01	0.00	-0.01
147	South Delta	-3314.2	-3224	-91	-0.12	-0.12	0.00
148	South Delta	-1484.3	-1395	-89	-0.23	-0.21	-0.01
160	South Delta	-1310.2	-1227	-83	-0.13	-0.12	-0.01
173	South Delta	-531.1	-491	-40	-0.04	-0.03	0.00
310	Central Delta	-519.8	-494	-26	-0.06	-0.06	0.00
421	North Delta	1782.7	1664	118	0.28	0.26	0.02
422	North Delta	-1224.6	-1161	-63	-0.05	-0.05	-0.01
423	North Delta	7745.5	7744	2	0.90	0.90	0.00
429	North Delta	7740.5	7739	2	0.88	0.88	0.00
434	North Delta	4855.5	4859	-3	0.78	0.78	0.00

Table 2. DSM2 output comparing daily mean flows (cfs) from baseline and Proposed Operational Changes conditions for 8 key channel nodes between March 20-30.

Date	Channel 12			Channel 49			Channel 50			Channel 94		
	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.
20Mar2018	479.8	495.8	-16	-2126	-1707	-419	-2506	-2072	-434	-3559.3	-3208.8	-350
21Mar2018	387.5	413.8	-26	-3775	-3176	-599	-4594	-3961	-633	-3569.1	-3172.7	-396
22Mar2018	369.7	396.2	-27	-5139	-4526	-613	-6241	-5594	-647	-3500.5	-3102.1	-398
23Mar2018	457.9	486.1	-28	-4667	-4069	-598	-5872	-5238	-634	-3149.0	-2749.5	-400
24Mar2018	481.2	510.6	-29	-962	-377	-585	-2104	-1489	-615	-2877.6	-2481.5	-396
25Mar2018	490.7	499.9	-9	3205	3381	-176	2828	3019	-191	-1818.2	-1759.6	-59
26Mar2018	447.7	448.8	-1	4393	4412	-19	4537	4556	-20	-1798.1	-1785.1	-13
27Mar2018	426.2	427.1	-1	4457	4472	-15	4905	4920	-16	-1834.4	-1824.5	-10
28Mar2018	376.2	376.9	-1	3962	3972	-11	4451	4462	-11	-1913.0	-1905.9	-7
29Mar2018	327.0	327.5	-1	3014	3022	-8	3413	3422	-9	-2139.0	-2133.5	-6
30Mar2018	317.0	317.4	0	1832	1838	-6	2263	2269	-6	-2233.2	-2229.2	-4

Date	Channel 124			Channel 148			Channel 422			Channel 423		
	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.
20Mar2018	-4195.9	-4043.0	-153	-1787.5	-1629.1	-158	11281	11277	4	7599.0	7601.9	-3
21Mar2018	-4176.1	-3985.4	-191	-1837.4	-1658.3	-179	10056	10052	4	6616.1	6622.4	-6
22Mar2018	-3959.0	-3768.3	-191	-1846.9	-1670.2	-177	8958	8954	4	5744.1	5750.9	-7
23Mar2018	-3406.2	-3214.0	-192	-1616.8	-1441.8	-175	7910	7906	4	4939.2	4946.1	-7
24Mar2018	-3172.2	-2972.5	-200	-1412.2	-1224.9	-187	6932	6927	5	4272.9	4279.4	-7
25Mar2018	-2722.8	-2673.3	-49	-854.6	-829.0	-26	6752	6754	-1	4243.7	4247.5	-4
26Mar2018	-2619.1	-2611.8	-7	-873.9	-868.8	-5	6750	6750	0	4218.5	4218.7	0
27Mar2018	-2742.4	-2737.0	-5	-919.6	-915.5	-4	6705	6705	0	4116.7	4116.8	0
28Mar2018	-2981.0	-2977.3	-4	-977.5	-974.5	-3	6640	6639	0	3979.4	3979.6	0
29Mar2018	-3173.9	-3171.1	-3	-1101.3	-1098.9	-2	6589	6589	0	3867.6	3867.7	0
30Mar2018	-3307.8	-3305.8	-2	-1184.8	-1183.1	-2	6572	6572	0	3813.8	3813.9	0

Table 3. DSM2 output comparing daily mean velocities (ft/s) from baseline and Proposed Operational Changes conditions for 8 key channel nodes between March 20-30.

Date	Channel 12			Channel 49			Channel 50			Channel 94		
	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.
20Mar2018	0.255	0.261	0.01	-0.005	0.000	0.01	0.008	0.012	0.00	-0.387	-0.347	0.04
21Mar2018	0.217	0.228	0.01	-0.027	-0.019	0.01	-0.015	-0.009	0.01	-0.386	-0.340	0.05
22Mar2018	0.211	0.222	0.01	-0.045	-0.037	0.01	-0.034	-0.027	0.01	-0.376	-0.330	0.05
23Mar2018	0.248	0.259	0.01	-0.039	-0.031	0.01	-0.030	-0.023	0.01	-0.337	-0.291	0.05
24Mar2018	0.255	0.267	0.01	0.009	0.016	0.01	0.010	0.016	0.01	-0.307	-0.261	0.05
25Mar2018	0.258	0.262	0.00	0.062	0.065	0.00	0.062	0.064	0.00	-0.181	-0.174	0.01
26Mar2018	0.242	0.243	0.00	0.079	0.080	0.00	0.082	0.082	0.00	-0.175	-0.173	0.00
27Mar2018	0.236	0.237	0.00	0.083	0.083	0.00	0.090	0.090	0.00	-0.175	-0.174	0.00
28Mar2018	0.217	0.217	0.00	0.080	0.080	0.00	0.090	0.090	0.00	-0.182	-0.181	0.00
29Mar2018	0.196	0.196	0.00	0.070	0.070	0.00	0.083	0.083	0.00	-0.208	-0.207	0.00
30Mar2018	0.192	0.192	0.00	0.056	0.056	0.00	0.072	0.073	0.00	-0.220	-0.219	0.00

Date	Channel 124			Channel 148			Channel 422			Channel 423		
	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.	-5700 OMR	-5000 OMR	Projected Diff.
20Mar2018	-0.160	-0.153	0.01	-0.194	-0.176	0.02	1.251	1.251	0.00	1.196	1.196	0.00
21Mar2018	-0.158	-0.150	0.01	-0.199	-0.178	0.02	1.124	1.123	0.00	1.052	1.052	0.00
22Mar2018	-0.149	-0.141	0.01	-0.199	-0.179	0.02	1.009	1.008	0.00	0.922	0.923	0.00
23Mar2018	-0.126	-0.118	0.01	-0.173	-0.152	0.02	0.897	0.896	0.00	0.800	0.801	0.00
24Mar2018	-0.117	-0.109	0.01	-0.150	-0.128	0.02	0.791	0.791	0.00	0.698	0.699	0.00
25Mar2018	-0.099	-0.097	0.00	-0.083	-0.080	0.00	0.771	0.771	0.00	0.693	0.693	0.00
26Mar2018	-0.093	-0.093	0.00	-0.082	-0.082	0.00	0.770	0.770	0.00	0.688	0.688	0.00
27Mar2018	-0.096	-0.096	0.00	-0.085	-0.085	0.00	0.764	0.764	0.00	0.673	0.673	0.00
28Mar2018	-0.105	-0.105	0.00	-0.090	-0.089	0.00	0.756	0.756	0.00	0.651	0.651	0.00
29Mar2018	-0.112	-0.112	0.00	-0.103	-0.103	0.00	0.750	0.750	0.00	0.633	0.633	0.00
30Mar2018	-0.118	-0.118	0.00	-0.114	-0.114	0.00	0.748	0.748	0.00	0.625	0.625	0.00

Figure 15. PTM flux and injection map.

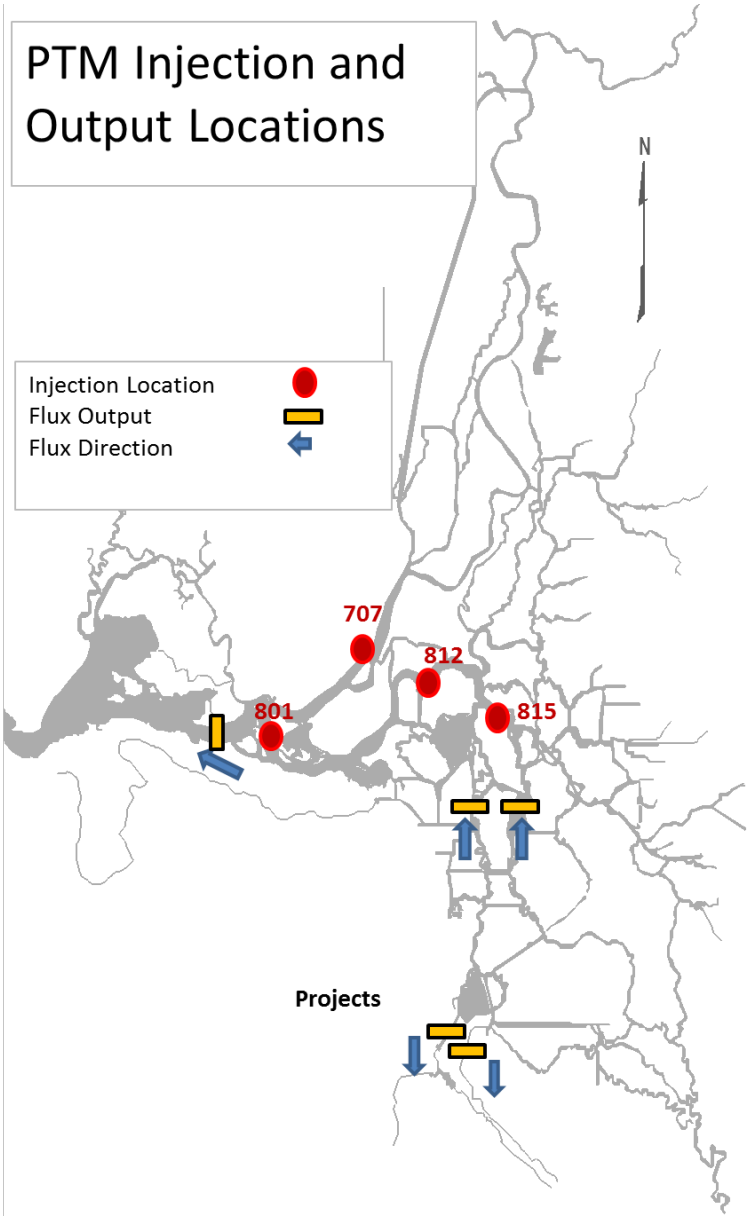
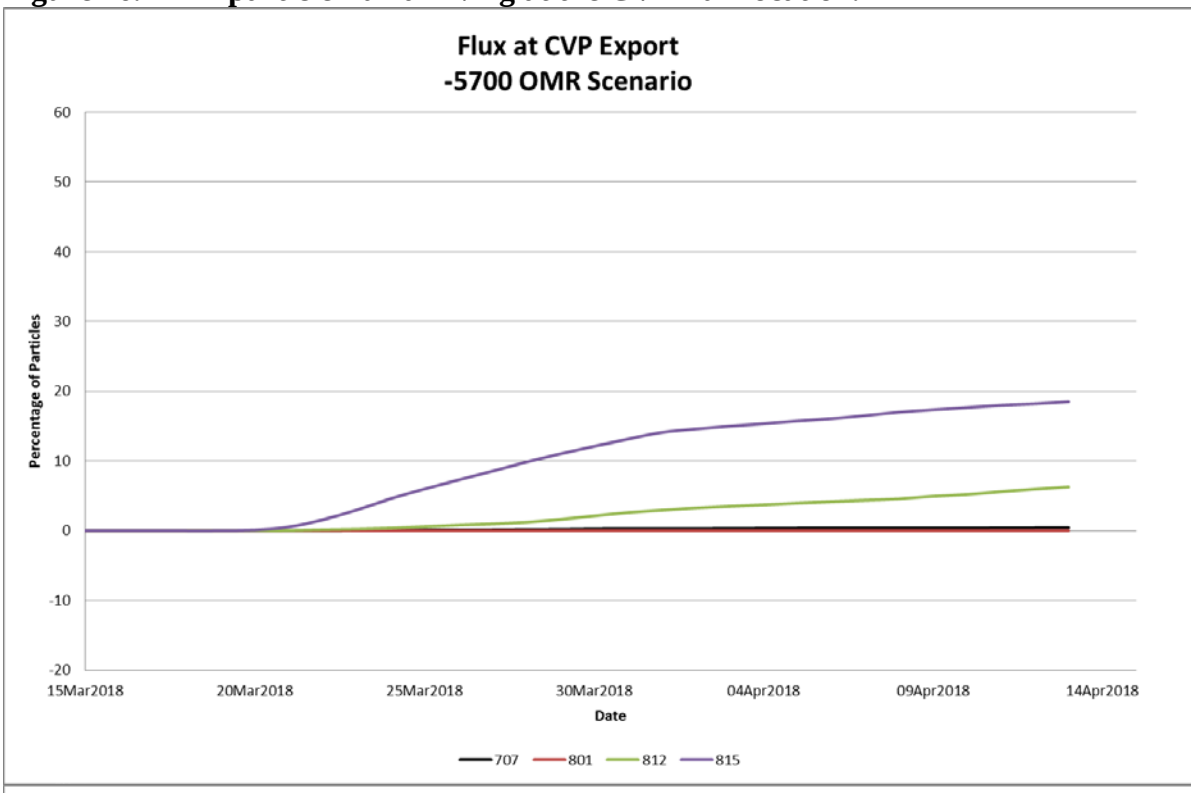


Figure 16. PTM particle flux arriving at the CVP flux location.



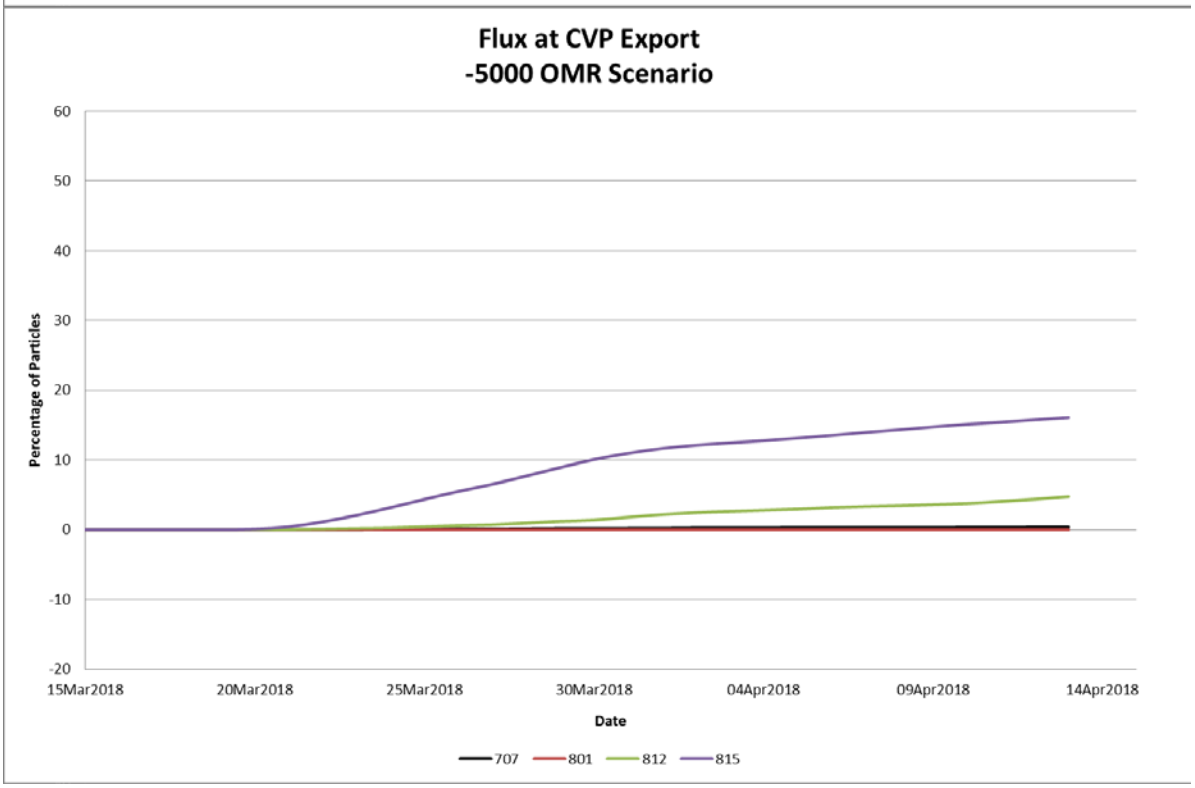


Figure 17. PTM particle flux arriving at the SWP flux location.

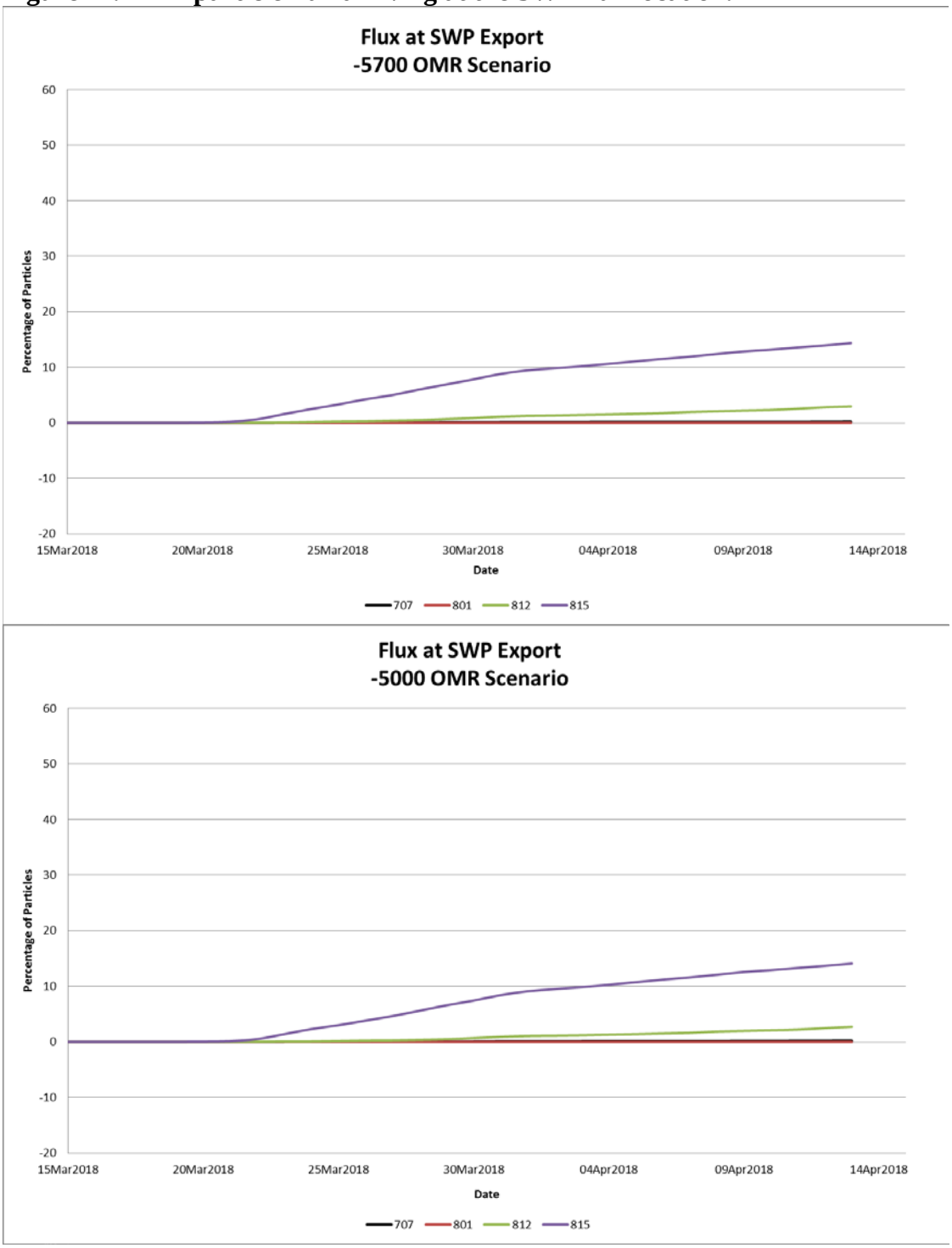
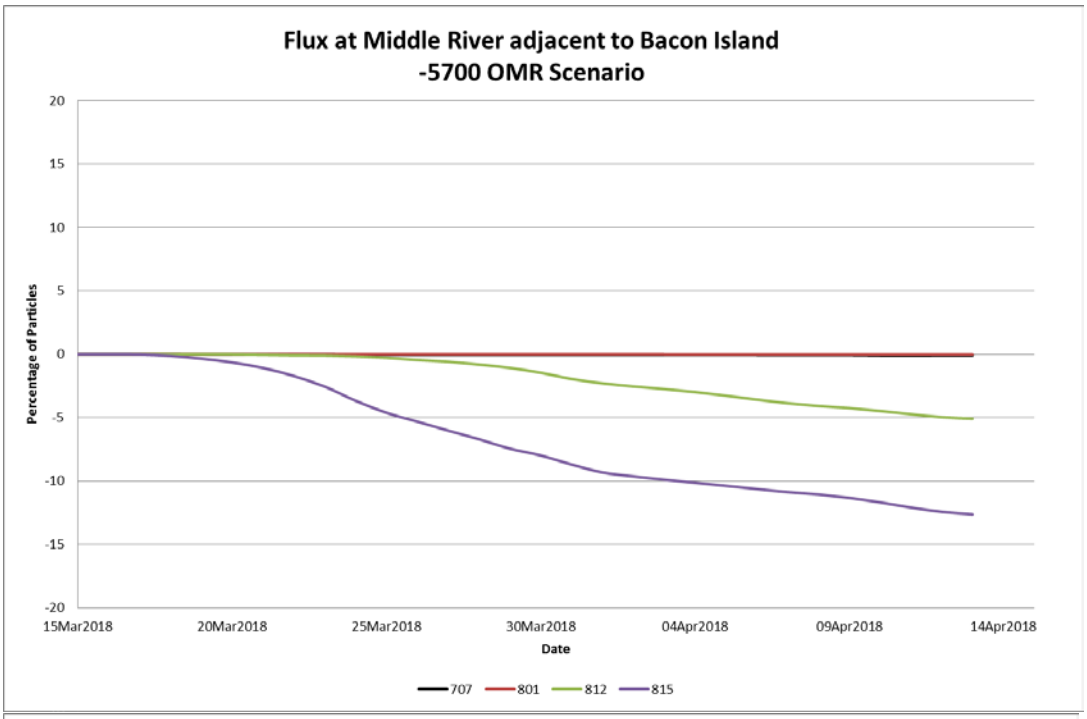


Figure 18. PTM particle flux arriving at the Middle River flux location.



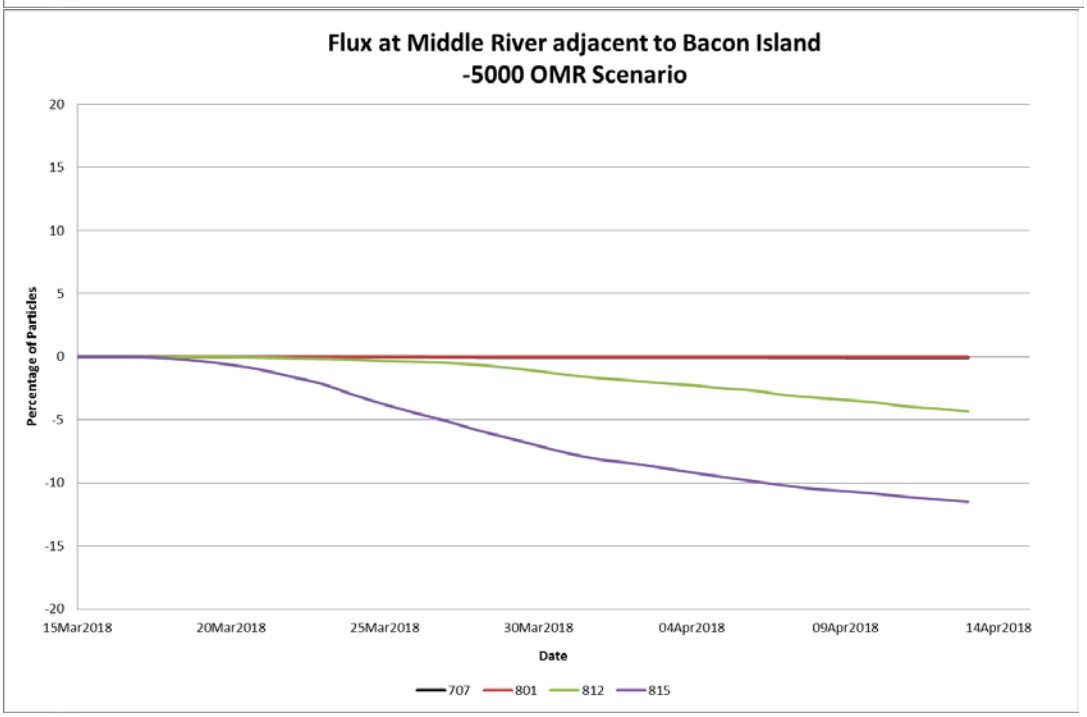
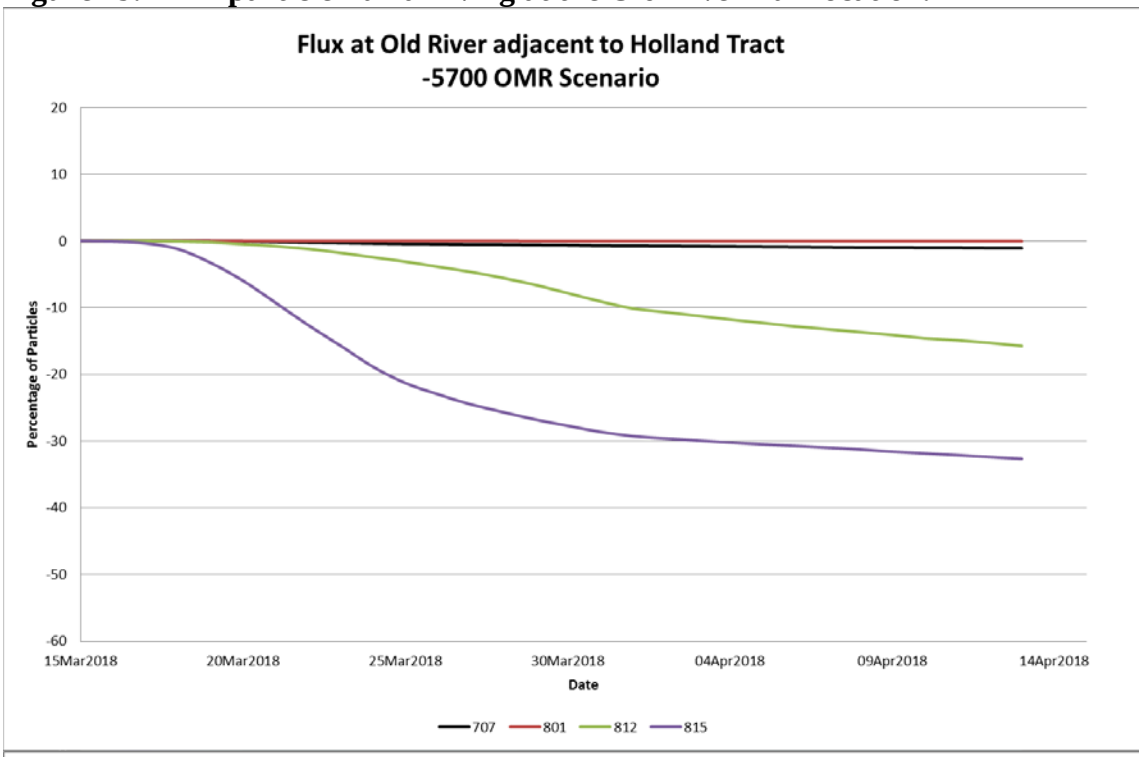


Figure 19. PTM particle flux arriving at the Old River flux location.



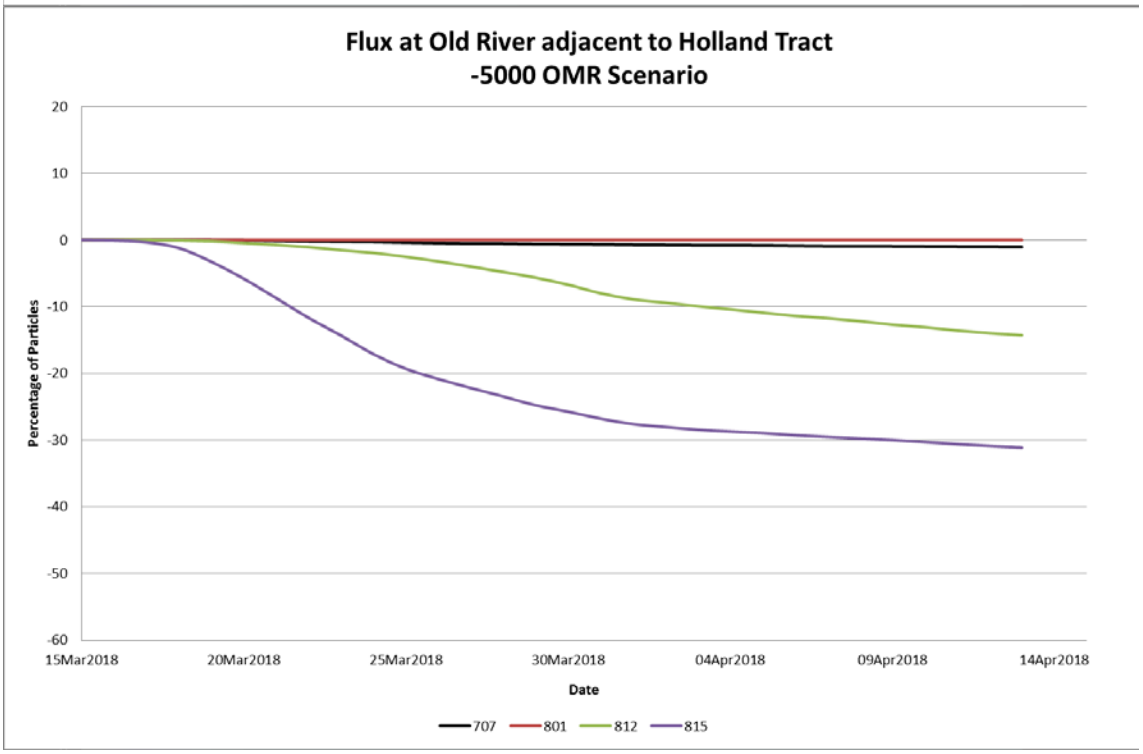


Figure 20. PTM particle flux arriving at the Chipps Island flux location.