DEPARTMENT OF WATER RESOURCES
Division of Operations and Maintenance
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

— BUREAU OF —
RECLAMATION

BUREAU OF RECLAMATION
Central Valley Operations Office
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

Ms. Eileen Sobeck
Executive Director
California State Water Resources Control Board
1001 I Street
Sacramento, California 95814

The California Department of Water Resources (DWR) and the United States Bureau of Reclamation (Reclamation) are submitting the attached Temporary Urgency Change Petition (TUCP) to seek an urgent, temporary change in the State Water Project and Central Valley Project's (SWP and CVP) water rights compliance location for X2 during the months of February and March.

DWR and Reclamation are working to actively manage the SWP and CVP to ensure the availability of an adequate water supply while also ensuring protection of critical species and the environment. Following the driest three-year period on record, California experienced an extremely wet January that provided much-needed rain and snowfall but did not end drought conditions for much of the state. Regions that rely on the water from the Sacramento–San Joaquin Delta (Delta) and Central Valley as well as the Colorado River system face increasingly severe water shortage conditions. Additionally, groundwater basins that serve communities in the Central Valley have not recovered from back-to-back years of drought and chronic overdraft.

The rapid shift from extreme dry conditions to extreme wet conditions, and potentially back to extreme dry conditions, is a new reality that challenges our ability to balance water project operations while storing as much water as possible, given the uncertain outlook for the remaining two months of the traditional rainy season.

Extremely wet conditions in January triggered a water quality standard in the Delta that, coupled with the extended dry period since then, pursuant to Water Right Decision 1641 (D-1641), would require a sharp decrease in Delta water supply exports and a sharp increase in releases from upstream storage reservoirs such as Lake Oroville and Folsom Lake. Historically, wet conditions in January would be expected to be followed by extended runoff through February and March, thus muting the water supply impacts from a decrease in exports and an increase in releases from upstream reservoirs. However, as 2022 climate extremes showed, a wet winter can be followed by an extremely dry period. A return to dry conditions the rest of winter and spring of 2023, coupled with the current D-1641 requirements, would mean that the water storage available for release later in the spring and summer would be hundreds of thousands of acre-feet less than needed.

Deteriorating hydrology requires the SWP and CVP to modify operations to comply with the X2 water quality requirements prescribed by D-1641. DWR and Reclamation have prepared this TUCP to file with the State Water Resources Control Board (State Water Board) to seek the State Water Board's approval of an urgent, temporary change in the projects' water rights compliance location for X2 during the months of February and March. Our modeling shows that January's wet hydrology, along with operational actions from the SWP and CVP, created conditions that will be protective of species throughout February and March. Temporarily moving our permit compliance point to the east will allow the projects to operate in a way that does not result in significant impacts to delta smelt and longfin smelt, given favorable conditions provided through the January storms and reduced project exports, while enabling additional water storage to stabilize water supply in the spring and summer. The proposed change will provide clear storage benefits south of the Delta and will also have the potential to provide storage benefits north of the Delta. Maintaining water storage is critical should dry conditions return. The expectation is that as snowmelt occurs later this winter and spring, inflows into the Delta will return in significant volumes that naturally extend wetter conditions.

We must consider this new weather reality of extremes and continue our efforts to provide adequate water to simultaneously protect California's species and the environment and meet the water supply needs of the people of California.

Sincerely,

Karla Nemeth

Karla Nemeth, Director
California Department of Water Resources

Ernest Conant

Ernest A. Conant, Regional Director
United States Bureau of Reclamation

Please indicate County where your project is located here:

Various

MAIL FORM AND ATTACHMENTS TO:
State Water Resources Control Board
DIVISION OF WATER RIGHTS
P.O. Box 2000, Sacramento, CA 95812-2000
Tel: (916) 341-5300 Fax: (916) 341-5400
http://www.waterboards.ca.gov/waterrights

PETITION FOR CHANGE

Separate petitions are required for each water right. Mark all areas that apply to your proposed change(s). Incomplete forms may not be accepted. Location and area information must be provided on maps in accordance with established requirements. (Cal. Code Regs., tit. 23, § 715 et seq.) Provide attachments if necessary.

☐ **Point of Diversion** Wat. Code, § 1701
☐ **Point of Rediversion** Cal. Code Regs., tit. 23, § 791(e)
☐ **Place of Use** Wat. Code, § 1701
☐ **Purpose of Use** Wat. Code, § 1701
☐ **Distribution of Storage** Cal. Code Regs., tit. 23, § 791(e)
☒ **Temporary Urgency** Wat. Code, § 1435
☐ **Instream Flow Dedication** Wat. Code, § 1707
☐ **Waste Water** Wat. Code, § 1211
☐ **Split** Cal. Code Regs., tit. 23, § 836
☐ **Terms or Conditions** Cal. Code Regs., tit. 23, § 791(e)
☐ **Other**

Application Various   Permit Various   License Various   Statement

I (we) hereby petition for change(s) noted above and described as follows:

Point of Diversion or Rediversion – Provide source name and identify points using both Public Land Survey System descriptions to ¼- ¼level and California Coordinate System (NAD 83).
Present: Not requested

Proposed: No change

Place of Use – Identify area using Public Land Survey System descriptions to ¼- ¼level; for irrigation, list number of acres irrigated.
Present: Not requested

Proposed: No change

Purpose of Use
Present: Not requested

Proposed: No change

Split
Provide the names, addresses, and phone numbers for all proposed water right holders.

Not requested

In addition, provide a separate sheet with a table describing how the water right will be split between the water right holders: for each party list amount by direct diversion and/or storage, season of diversion, maximum annual amount, maximum diversion to offstream storage, point(s) of diversion, place(s) of use, and purpose(s) of use. Maps showing the point(s) of diversion and place of use for each party should be provided.

Distribution of Storage
Present: Not requested

Proposed: No change

Temporary Urgency
This temporary urgency change will be effective from 02/13/2023 to 03/31/2023.

Include an attachment that describes the urgent need that is the basis of the temporary urgency change and whether the change will result in injury to any lawful user of water or have unreasonable effects on fish, wildlife or instream uses.

Instream Flow Dedication – Provide source name and identify points using both Public Land Survey System descriptions to ¼- ¼ level and California Coordinate System (NAD 83).
Upstream Location: Not requested

Downstream Location: Not requested

List the quantities dedicated to instream flow in either: ☐ cubic feet per second or ☐ gallons per day:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

Will the dedicated flow be diverted for consumptive use at a downstream location? ☐ Yes ☐ No
If yes, provide the source name, location coordinates, and the quantities of flow that will be diverted from the stream.

Waste Water
If applicable, provide the reduction in amount of treated waste water discharged in cubic feet per second.

Will this change involve water provided by a water service contract which prohibits your exclusive right to this treated waste water? ☐ Yes ☒ No

Will any legal user of the treated waste water discharged be affected? ☐ Yes ☒ No

General Information – For all Petitions, provide the following information, if applicable to your proposed change(s).

Will any current Point of Diversion, Point of Storage, or Place of Use be abandoned? ☐ Yes ☒ No

I (we) have access to the proposed point of diversion or control the proposed place of use by virtue of:
☒ ownership ☐ lease ☐ verbal agreement ☐ written agreement

If by lease or agreement, state name and address of person(s) from whom access has been obtained.

Give name and address of any person(s) taking water from the stream between the present point of diversion or rediversion and the proposed point of diversion or rediversion, as well as any other person(s) known to you who may be affected by the proposed change.

All Right Holders Must Sign This Form: I (we) declare under penalty of perjury that this change does not involve an increase in the amount of the appropriation or the season of diversion, and that the above is true and correct to the best of my (our) knowledge and belief. Dated 2/13/2023 at Sacramento, CA.

Karla Nemeth
Right Holder or Authorized Agent Signature

Ernest Conant
Right Holder or Authorized Agent Signature

NOTE: All petitions must be accompanied by:
(1) the form Environmental Information for Petitions, including required attachments, available at:
http://www.waterboards.ca.gov/waterrights/publications_forms/forms/docs/pet_info.pdf
(2) Division of Water Rights fee, per the Water Rights Fee Schedule, available at:
http://www.waterboards.ca.gov/waterrights/water_issues/programs/fees/
(3) Department of Fish and Wildlife fee of $850 (Pub. Resources Code, § 10005)

State of California
State Water Resources Control Board
DIVISION OF WATER RIGHTS
P.O. Box 2000, Sacramento, CA 95812-2000
Tel: (916) 341-5300   Fax: (916) 341-5400
http://www.waterboards.ca.gov/waterrights

ENVIRONMENTAL INFORMATION FOR PETITIONS

This form is required for all petitions.

Before the State Water Resources Control Board (State Water Board) can approve a petition, the State Water Board must consider the information contained in an environmental document prepared in compliance with the California Environmental Quality Act (CEQA). This form is not a CEQA document. If a CEQA document has not yet been prepared, a determination must be made of who is responsible for its preparation. As the petitioner, you are responsible for all costs associated with the environmental evaluation and preparation of the required CEQA documents. Please answer the following questions to the best of your ability and submit any studies that have been conducted regarding the environmental evaluation of your project. If you need more space to completely answer the questions, please number and attach additional sheets.

DESCRIPTION OF PROPOSED CHANGES OR WORK REMAINING TO BE COMPLETED

For a petition for change, provide a description of the proposed changes to your project including, but not limited to, type of construction activity, structures existing or to be built, area to be graded or excavated, increase in water diversion and use (up to the amount authorized by the permit), changes in land use, and project operational changes, including changes in how the water will be used. For a petition for extension of time, provide a description of what work has been completed and what remains to be done. Include in your description any of the above elements that will occur during the requested extension period.

The California Department of Water Resources (DWR) and United States Bureau of Reclamation (Reclamation) are submitting this Temporary Urgency Change Petition (TUCP) to request that the State Water Resources Control Board (State Water Board) modify certain terms of the water rights permits for the State Water Project (SWP) and Central Valley Project (CVP) (collectively, “Projects”) from what is currently provided in Water Right Decision 1641 (D-1641) for February through March 2023. Specifically, DWR and Reclamation are requesting to Modify footnote [d] of Table 4 in D-1641 as follows: “[d] This standard applies only in months when the average EC at Port Chicago during the 14 days immediately prior to the first day of the month is less than or equal to 2.64 mmhos/cm. This standard does not apply to February and March, 2023.” All other X2 conditions in Table 4 would continue to apply.

Temporary modification of Table 4, footnote [d] in D-1641 is urgently needed to allow the Projects to operate in a way that does not result in unreasonable effects on fish, wildlife, or other instream beneficial uses. This includes avoiding unreasonable impacts on delta smelt and longfin smelt, given the favorable conditions provided by January 2023 storms and reduced Project exports. The temporary change would enable additional water storage to extend available supplies, including storage benefits south of the Sacramento–San Joaquin Delta (Delta) and potential storage benefits north of the Delta for beneficial uses later in 2023. Given the ongoing drought emergency, maintaining water storage is critical should recent dry conditions continue. As stated in the TUCP, the proposed changes in operations will not injure other lawful users of water, will not unreasonably affect public trust resources such as fish and wildlife or other instream beneficial uses, and are in the public interest.

The TUCP is only for modification to certain terms of the CVP and SWP water right permits from what is currently provided in D-1641 and does not include construction activities, changes in land use, nor changes to how the water will be used.
See Attachment 1 "Supplement to Temporary Urgency Change to Certain DWR and Reclamation Permit Terms as Provided in D-1641" and Attachment 2 "Biological Review for the 2023 February through March Temporary Urgency Change Petition.”

Insert the attachment number here, if applicable: 1 and 2

Coordination with Regional Water Quality Control Board

For change petitions only, you must request consultation with the Regional Water Quality Control Board regarding the potential effects of your proposed change on water quality and other instream beneficial uses. (Cal. Code Regs., tit. 23, § 794.) In order to determine the appropriate office for consultation, see: http://www.waterboards.ca.gov/waterboards_map.shtml. Provide the date you submitted your request for consultation here, then provide the following information.

Date of Request

02/13/2023

Will your project, during construction or operation, (1) generate waste or wastewater containing such things as sewage, industrial chemicals, metals, or agricultural chemicals, or (2) cause erosion, turbidity or sedimentation? ☐ Yes ☒ No

Will a waste discharge permit be required for the project? ☐ Yes ☒ No

If necessary, provide additional information below:

Insert the attachment number here, if applicable:

Local Permits

For temporary transfers only, you must contact the board of supervisors for the county(ies) both for where you currently store or use water and where you propose to transfer the water. (Wat. Code § 1726.) Provide the date you submitted your request for consultation here.

Date of Contact

For change petitions only, you should contact your local planning or public works department and provide the information below.

Person Contacted: Not Applicable

Date of Contact:

Department:

Phone Number:

County Zoning Designation:

Are any county permits required for your project? If yes, indicate type below. ☐ Yes ☒ No

Grading Permit Use Permit Watercourse Obstruction Permit

Change of Zoning General Plan Change Other (explain below)

If applicable, have you obtained any of the permits listed above? If yes, provide copies. ☐ Yes ☐ No

If necessary, provide additional information below:

Not Applicable

Insert the attachment number here, if applicable:

Federal and State Permits

Check any additional agencies that may require permits or other approvals for your project:

☐ Regional Water Quality Control Board ☐ Department of Fish and Game

☐ Dept of Water Resources, Division of Safety of Dams ☐ California Coastal Commission

☐ State Reclamation Board ☐ U.S. Army Corps of Engineers ☐ U.S. Forest Service

☐ Bureau of Land Management ☐ Federal Energy Regulatory Commission

☐ Natural Resources Conservation Service

Have you obtained any of the permits listed above? If yes, provide copies. ☐ Yes ☐ No

For each agency from which a permit is required, provide the following information:

Agency	Permit Type	Person(s) Contacted	Contact Date	Phone Number
Not Applicable				

If necessary, provide additional information below:

Insert the attachment number here, if applicable:

Construction or Grading Activity

Does the project involve any construction or grading-related activity that has significantly altered or would significantly alter the bed, bank or riparian habitat of any stream or lake? ☐ Yes ☒ No

If necessary, provide additional information below:

Not applicable

Insert the attachment number here, if applicable:

Archeology

Has an archeological report been prepared for this project? If yes, provide a copy. ☐ Yes ☒ No

Will another public agency be preparing an archeological report? ☐ Yes ☒ No

Do you know of any archeological or historic sites in the area? If yes, explain below. ☐ Yes ☒ No

If necessary, provide additional information below:

Not Applicable

Insert the attachment number here, if applicable:

Photographs

For all petitions other than time extensions, attach complete sets of color photographs, clearly dated and labeled, showing the vegetation that exists at the following three locations:

- ☐ Along the stream channel immediately downstream from each point of diversion
- ☐ Along the stream channel immediately upstream from each point of diversion
- ☐ At the place where water subject to this water right will be used

Maps

For all petitions other than time extensions, attach maps labeled in accordance with the regulations showing all applicable features, both present and proposed, including but not limited to: point of diversion, point of rediversion, distribution of storage reservoirs, point of discharge of treated wastewater, place of use, and location of instream flow dedication reach. (Cal. Code Regs., tit. 23, §§ 715 et seq., 794.)

Pursuant to California Code of Regulations, title 23, section 794, petitions for change submitted without maps may not be accepted.

All Water Right Holders Must Sign This Form:
I (we) hereby certify that the statements I (we) have furnished above and in the attachments are complete to the best of my (our) ability and that the facts, statements, and information presented are true and correct to the best of my (our) knowledge. Dated 2/13/2023 at Sacramento, CA

Karla Nemeth — Water Right Holder or Authorized Agent Signature

Ernest Conant — Water Right Holder or Authorized Agent Signature

NOTE:

- **Petitions for Change may not be accepted unless you include proof that a copy of the petition was served on the Department of Fish and Game. (Cal. Code Regs., tit. 23, § 794.)**
- **Petitions for Temporary Transfer may not be accepted unless you include proof that a copy of the petition was served on the Department of Fish and Game and the board of supervisors for the county(ies) where you currently store or use water and the county(ies) where you propose to transfer the water. (Wat. Code § 1726.)**

ATTACHMENT 1:
SUPPLEMENT TO TEMPORARY URGENCY CHANGE FROM TO CERTAIN DWR AND RECLAMATION PERMIT TERMS AS PROVIDED IN D-1641

California Department of Water Resources

Application Numbers 5630, 14443, 14445A, 17512, and 17514A; Permits 16478, 16479, 16481, 16482, and 16483

United States Bureau of Reclamation Permits for the Central Valley Project

Application Numbers 23, 234, 1465, 5626, 5628, 5638, 9363, 9364, 9366, 9367, 9368, 13370, 13371, 14858A, 14858B, 15374, 15375, 15376,15764, 16767, 16768, 17374, 17376, 19304, and 22316

License Number 1986; Permit Numbers 11885, 11886, 12721, 11967, 11887, 12722,12723, 12725, 12726, 12727, 11315, 11316, 16597, 20245,11968,11969, 11970, 12860, 11971, 11972, 11973, 12364, 16600, and 15735

I. Requested Change

The California Department of Water Resources (DWR) and United States Bureau of Reclamation (Reclamation) are submitting this Temporary Urgency Change Petition (TUCP) to request that the State Water Resources Control Board (State Water Board) modify certain terms of the water rights permits for the State Water Project (SWP) and Central Valley Project (CVP) (collectively, “Projects”) from what is currently provided in Water Right Decision 1641 (D-1641) for February through March 2023.

Temporary modification of Table 4, footnote [d] in D-1641 (as described below) is urgently needed to allow the Projects to operate in a way that does not result in unreasonable effects on fish, wildlife, or other instream beneficial uses. This includes avoiding unreasonable impacts on delta smelt and longfin smelt, given the favorable conditions provided by January 2023 storms and reduced Project exports. The temporary change would enable additional water storage to extend available supplies, including storage benefits south of the Sacramento–San Joaquin Delta (Delta) and potential storage benefits north of the Delta for beneficial uses later in 2023. Given the ongoing drought emergency, maintaining water storage is critical should recent dry conditions continue.

Spring X2 is the approximate location of the upstream boundary of the interface between salt water and fresh water. Positive changes in X2 indicate westward movement of this interface, which is generally considered desirable for aquatic species. Westward transport of aquatic species typically corresponds to higher survival outcomes, more opportunities for productive rearing habitat, and movement away from areas of lower survival and entrainment zones. There are three spring X2 compliance locations (from east to west): Collinsville, Chipps Island, and Port Chicago. The X2 requirement at Collinsville always applies, while the requirement at Chipps Island is a function of the previous month's Eight River Index (8RI). The requirement at Port Chicago is also based on the previous month's 8RI, but it applies only when the average electrical conductivity (EC) at Port Chicago during the 14 days immediately before the first day of the month is less than or equal to 2.64 millimhos per centimeter (mmhos/cm). The X2 requirements are provided in D-1641, Table 4, with conditions footnoted. Footnote [d] describes the conditions in which Port Chicago requirements apply.

Extreme wet conditions and freshwater quality conditions in January triggered the Port Chicago requirement for February. DWR and Reclamation are requesting that footnote [d], which is conditioned on the water quality just before February, not apply for February and March 2023. All other X2 requirements would continue to apply.

Absent a TUCP in February and March, DWR and Reclamation would attempt to meet all D-1641 water quality requirements, including the Port Chicago standard, through a combination of upstream releases from Lake Oroville and Folsom Lake, as well as export reductions. Releases from Shasta Lake would likely not be needed. These actions would reduce the amount of storage in both Projects and would therefore hamper efforts to recover from the ongoing drought.

See **Table Action1** for a summary of the 2023 TUCP Operations Framework.

Table Action1: Summary of 2023 Temporary Urgency Change Petition Operations Framework

Time Frame	Proposed Water Right Decision 1641 Action(s)
February through March 2023	Modify footnote [d] of Table 4 in D-1641 as follows: "[d] This standard applies only in months when the average EC at Port Chicago during the 14 days immediately prior to the first day of the month is less than or equal to 2.64 mmhos/cm. <u>This standard does not apply to</u> <u>February and March, 2023.</u>" All other X2 conditions in Table 4 would continue to apply.

DWR and Reclamation provide the information below to support the findings necessary under California Water Code Section 1435. The modifications requested, along with additional actions, are intended to reduce the risk that DWR and Reclamation will be unable to provide future protection of beneficial uses that rely on storage from the Projects. Therefore, the modifications requested are urgent and critical and can be implemented in a manner satisfying requirements of Water Code section 1435, as described below.

Information on how the proposed change will not adversely affect public trust resources[1] is also provided.

I. A. Summary of Calendar Year 2020 through November 2022 Drought Conditions

California has experienced the driest three-year period (2020–2022) on record. In 2021, California experienced its warmest statewide monthly average temperatures ever recorded.[2] On May 10, 2021, Governor Newsom issued an emergency proclamation (Emergency Proclamation) based on drought conditions in the Bay-Delta and other watersheds, stating that the continuation of extremely dry conditions in the Delta watershed had resulted in scarce water supply. It was determined that meeting all water right permit obligations for Delta outflow and water quality requirements under D-1641 would exacerbate the already low upstream Project storages.

On May 17, 2021, DWR and Reclamation submitted a TUCP to the State Water Board requesting modifications of certain requirements of D-1641. The TUCP was conditionally approved by the State Water Board on June 1, 2021, allowing DWR and Reclamation to conserve upstream storage by modifying Delta outflow and water quality standards set forth in D-1641 for the period of June 1, 2021, through August 15, 2021.

Faced with the potential for continuing dry conditions and extremely low storage conditions, DWR and Reclamation prepared and submitted a TUCP on December 1, 2021, requesting modification to D-1641 standards for the February through April 2022 period. However, the TUCP was withdrawn because storage conditions improved as a result of well-above-average conditions in October and December 2021. Hydrologic conditions took a turn for the worse in early 2022. A high-pressure system that set up off the California coast in early January 2022 directed storm systems well to the north. January through March 2022 were the driest January-through-March period on record, thereby negating much of the storage and soil moisture gains made in the fall and early winter.

Operational forecasts using a dry hydrology forecast in February 2022 indicated concerns with respect to the risk of reservoir storage level depletion. As dry conditions persisted through February 2022, it became evident that the March 2022 forecast would also decrease.

Thus, on March 18, 2022, DWR and Reclamation submitted a TUCP to the State Water Board requesting modifications of certain outflow and water quality requirements of D-1641. The TUCP was conditionally approved by the State Water Board on April 4, 2022, allowing DWR and Reclamation to conserve upstream storage by modifying Delta outflow and water quality standards set forth in D-1641 for the period of April 4, 2022, through June 30, 2022.

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[1] Per *2020 Settlement Agreement and Release of Claims for California Sportfishing Protection Alliance, Aqualliance, and California Water Impact Network vs. California State Water Resources Control Board*.

[2] National Oceanic and Atmospheric Administration's National Centers for Environmental Information, October 2021.

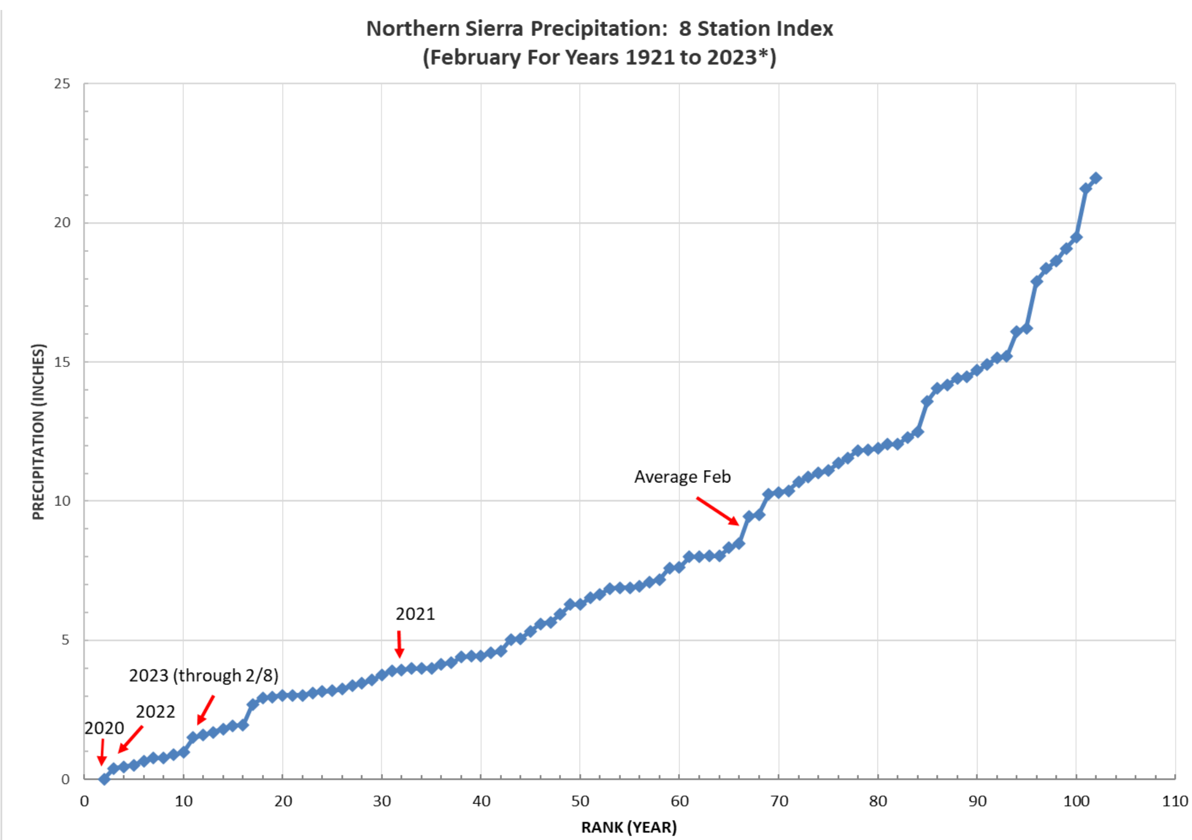
Drought conditions continued into the start of Water Year (WY) 2023.

I. B. Summary of Water Year 2023 Precipitation and Drought Conditions

WY 2023 has so far provided another example of extreme hydrologic variability. After the driest three-year period on record, California experienced an extremely wet December and January as a result of a series of atmospheric rivers that began in late December. In January 2023, the state experienced one of the wettest three-week periods on record, yielding a snowpack that was at 205 percent of average on February 1, 2023; yet to date, February has been dry, and the snowpack has not reduced stresses on the state's water resources, including low storage levels, depleted aquifers, and diminished local water supplies. This underscores the need for the State to continue water-conservation measures and drought-resilience actions to extend available supplies, protect water reserves, and maintain critical flows for fish and wildlife. On February 13, 2023 Governor Newsom issued Executive Order N-3-23 to build water resilience amid climate-driven extreme weather.

Figure 1-1 shows the precipitation totals in February for the last 103 years. Based on data as of February 8, February 2023 would be the 10th lowest precipitation month on record if no further precipitation occurs in February. Near-term weather forecasts indicate no appreciable precipitation through at least the third week of February.

Figure 1-1 Ranking of historical February Northern Sierra 8-Station Index precipitation.



Seasonal outlooks published by the National Oceanic and Atmospheric Administration (NOAA) identify the likelihood that total precipitation amounts will be above, near, or below average, and indicate how drought conditions are anticipated to change in the months ahead. **Figure 1-2** depicts the latest Seasonal Precipitation Outlook (issued in January 2023), which shows equal chances of above- or below-average precipitation.

Figure 1-2 NOAA seasonal precipitation outlook (issued in January 2023).

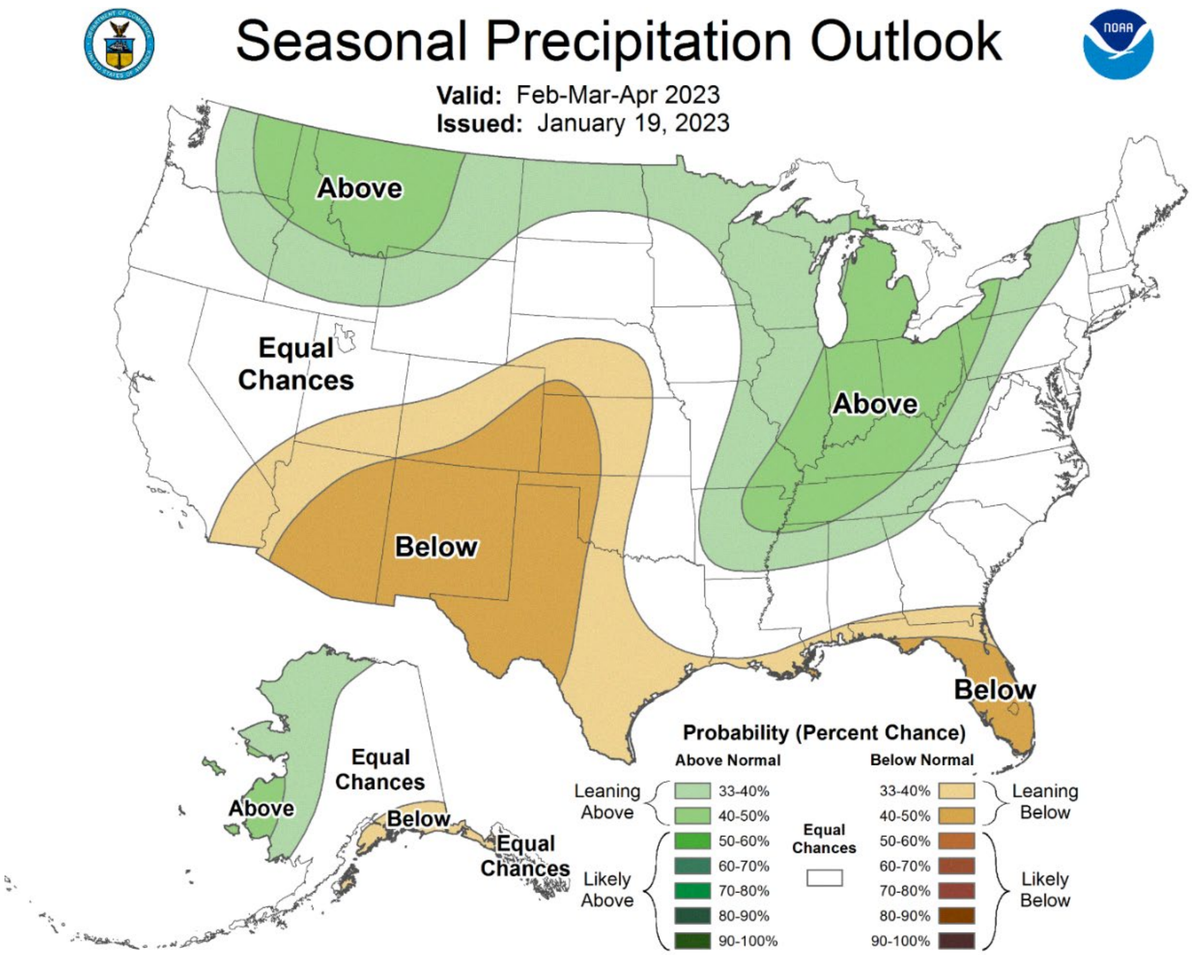
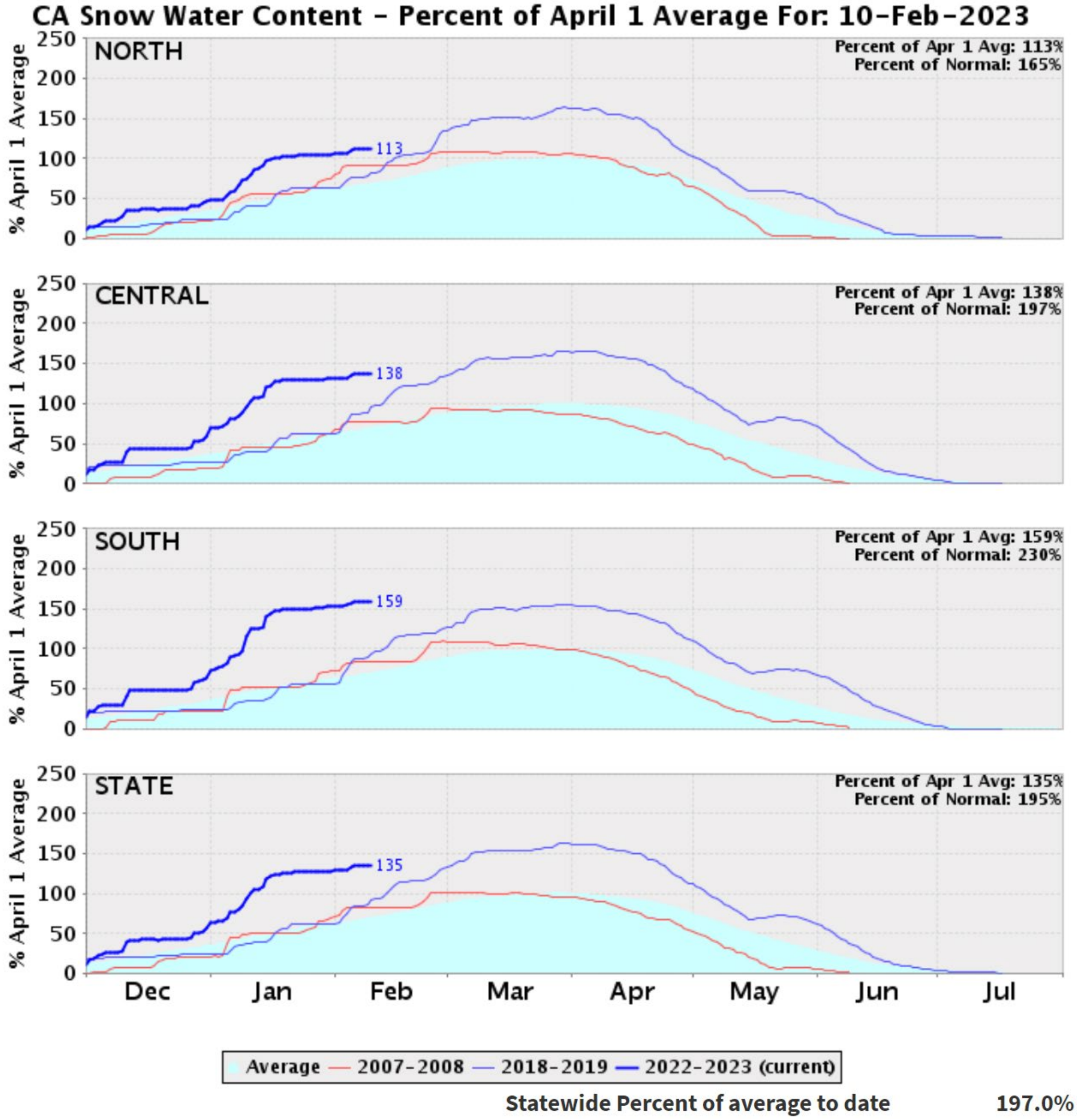


Figure 1-3 shows the progression of snow water content for WY 2023 as compared to WY 2008 (a critically dry year), WY 2019 (a wet year), and the long-term average. There were significant gains early in the season; however, additional gains in snow water content since mid-January have been minimal. The plots show snow water content in the Northern Sierra and Trinity, where the major Project reservoirs are located (Trinity, Shasta, and Oroville). The northern snow water content, though 165 percent of normal to date, is just above average (113 percent) for April 1. As indicated in the North plot, the snow water content levels for WYs 2008 and 2019 were in a similar state around this time period. As these data suggest, this year's Northern Sierra water supply outcome is far from settled.

Figure 1-3 Progression of snow water content for Water Year 2023 as compared to Water Year 2008, Water Year 2019, and long-term average.

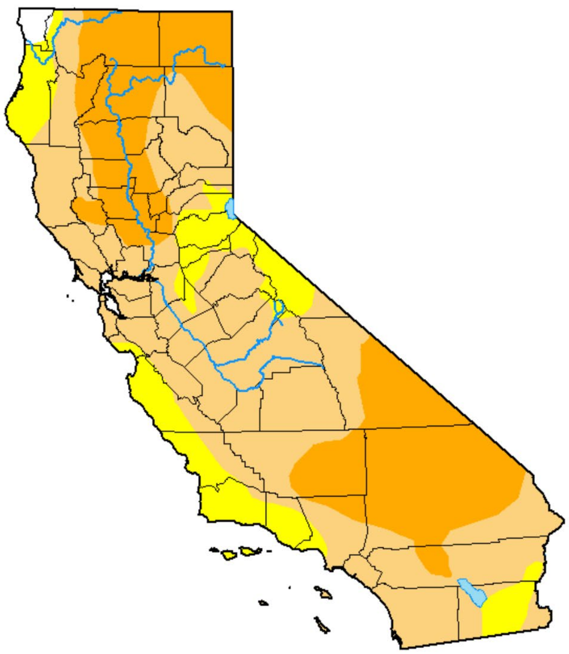


In addition, as shown in **Figure 1-4**, the Drought Monitor indicates that the majority of California is still experiencing some level of drought conditions.

Figure 1-4 U.S. Drought Monitor as of February 7, 2023.

U.S. Drought Monitor

California



February 7, 2023
(Released Thursday, Feb. 9, 2023)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0	D1	D2	D3	D4
Current	0.64	14.76	51.98	32.62	0.00	0.00
Last Week 01-31-2023	0.64	9.80	56.99	32.57	0.00	0.00
3 Months Ago 11-08-2022	0.00	0.49	11.43	46.69	24.83	16.57
Start of Calendar Year 01-03-2023	0.00	2.07	26.79	44.04	27.10	0.00
Start of Water Year 09-27-2022	0.00	0.24	5.75	53.11	24.34	16.57
One Year Ago 02-08-2022	0.00	0.75	32.83	65.03	1.39	0.00

Intensity:
None
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
Brian Fuchs
National Drought Mitigation Center

droughtmonitor.unl.edu

I. C. The Need for a Change Petition in 2023 and Requested Change

California has experienced the driest three-year period on record, prompting Governor Newsom to declare a state of emergency on April 21, 2021 (which remains in effect), and Executive Order N-3-23 on February 13, 2023 to build water resilience amid climate-driven extreme weather. Even though conditions were extremely wet from December 2022 through mid-January 2023, when up to 30 inches of rain and 15 feet of snow fell in a three-week period, California's water resources—including the SWP and CVP systems—still have not recovered. The precipitation forecast for the remainder of WY 2023 is uncertain and could change dramatically beyond what current forecasts and hydrologic models can predict. The speed of the change between extreme dry conditions and extreme wet conditions represents a new reality not considered by many of California's existing regulations (as exhibited by an extremely dry January–March period in 2022), which challenges historically routine water management practices.

D-1641 requires water project operators to release enough water to maintain salinity in the western Delta. During the recent extreme wet-weather events and high-flow river conditions in early January 2023, the SWP and CVP were operated in accordance with the National Marine Fisheries Service (NMFS) 2019 Long-Term Operations (LTO) Biological Opinion and U.S. Fish and Wildlife Service (USFWS) 2019 LTO Biological Opinion (2019 BiOps) and the California Department of Fish and Wildlife (CDFW) 2020 SWP Incidental Take Permit (2020 CDFW ITP) to protect State-listed and federally listed endangered species. Operating the Projects in accordance with the 2019 BiOps and 2020 CDFW ITP limited SWP and CVP pumping to levels substantially less than what would have been allowed by D-1641 alone.

The extremely wet conditions in January 2023 resulted in high outflows that pushed Delta salinity to the west. This triggered a Delta water quality standard identified in D-1641, the Port Chicago X2 requirement, on January 31, 2023. Coupled with the current and foreseeable dry period, adherence to this water quality standard would require the SWP and CVP to sharply decrease Delta water supply exports and sharply increase releases from upstream storage from reservoirs such as Lake Oroville and Folsom Reservoir, resulting in a reduced water supply for communities, farms and the economy, and other beneficial uses.

The Port Chicago X2 requirement was developed at a time when a wet January would be expected to be followed by a wet February and March, which would mute the water supply impacts of a decrease in exports and an increase in releases from upstream reservoirs. However, as WY 2022 climate extremes showed, a wet early winter can be followed by an extremely dry late winter and spring. Should recent dry conditions continue into spring 2023, coupled with the current D-1641 requirements, this would mean the loss of hundreds of thousands of acre-feet of water supply resiliency. The modeling for the effects analysis indicated that without the Port Chicago requirement, the Projects could conserve up to an additional 700,000 acre-feet of water to be used for beneficial uses. This estimate is based on an assumption of dry conditions through March. Therefore, proactive management of SWP and CVP water resources is needed for February and March 2023.

Per the California Water Code, a temporary change is necessary to further the constitutional policy that the water resources of the state be put to beneficial use to the fullest extent of which they are capable, and that waste of water be prevented. Therefore, starting this week, DWR and Reclamation will operate the SWP and CVP during February and March to meet the X2 water quality requirements as prescribed by D-1641 at all designated locations, *except* at Port Chicago. January's wet hydrology has provided species protections for February and March. This temporary action will allow additional storage of water in Project reservoirs for use later in the spring and summer, while still providing adequate conditions for delta smelt and longfin smelt and maintaining Old River and Middle River protective measures for listed salmonids under the 2020 LTO Record of Decision (ROD) based on the 2019 BiOps and under the 2020 CDFW ITP. In addition, the temporary change will not affect DWR and Reclamation's compliance with actions required by the 2019 BiOps or 2020 CDFW ITP.

The storage of water is vital for promoting water supply resiliency now and if the recent dry conditions continue, as was the case for 2022. DWR and Reclamation are filing the TUCP petition with the State Water Board to seek its concurrence with and approval of this D-1641 modification. Granting this TUCP would support DWR and Reclamation in balancing the competing demands on the state's water supply, as it would be able to provide opportunities to maintain or to expand water supplies north and south of the

Delta, including those for health and safety, while maintaining fish and wildlife and salinity control protections.

The exact hydrologic conditions for the remainder of February through March 2023 cannot be known in advance, but available near-term forecasts and experience from recent years suggest an elevated risk that dry conditions may continue. DWR and Reclamation are therefore requesting that the State Water Board temporarily modify specific standards defined by D-1641 as described in **Table Action1**.

I. D. Agency Coordination

On February 8 and 10, 2023, DWR and Reclamation met with NMFS, USFWS, CDFW, and the State Water Board to discuss the TUCP and associated Biological Review outline and identify methods to be used in the Biological Review. Information from those meetings was incorporated into the development of the TUCP Biological Review (see Attachment 2).

II. Basis to Authorize Modification of Water Rights

California Water Code Section 1435 authorizes the State Water Board to grant a temporary change order for any permittee or licensee that has an urgent need to change a permit or license, where the State Water Board finds that: (1) the permittee has an urgent need for the proposed change; (2) the proposed change may be made without injury to any other lawful user of water; (3) the proposed change can be made without unreasonably affecting fish, wildlife, or other instream beneficial uses; and (4) the proposed change is in the public interest. The law also requires consultation with representatives of CDFW.

1) DWR and Reclamation Have an Urgent Need for the Proposed Change

As described above in I. C., *The Need for a Change Petition in 2023 and Requested Change,* the rapid shift from extreme dry conditions to extreme wet conditions, and potentially back to extreme dry conditions, is a new reality that challenges DWR and Reclamation's ability to balance Project operations while storing as much water as possible, given the uncertain outlook for the remaining two months of the traditional rainy season. The proposed change would provide clear storage benefits south of the Delta and would also have the potential to provide storage benefits north of the Delta. Maintaining water storage is critical should the recent dry conditions continue. The Governor's Executive Order N-3-23 addresses this issue directly by modifying two previous Emergency Proclamations:

> Paragraph 4 of my State of Emergency Proclamation dated May 10, 2021 and Paragraph 4 of my State of Emergency Proclamation dated July 8, 2021 are withdrawn, and each is replaced with the following text:
>
> To ensure adequate water supplies for purposes of health, safety, the environment, or drought resilient water supplies, the Water Board shall consider modifying requirements for reservoir releases or diversion limitations in Central Valley Project or State Water Project facilities to: (i) conserve water upstream later in the year in

order to protect cold water pools for salmon and steelhead, (ii) enhance instream conditions for fish and wildlife, (iii) improve water quality, (iv) protect carry-over storage, (v) ensure minimum health and safety water supplies, or (vi) provide opportunities to maintain or to expand water supplies north and south of the Delta. The Water Board shall require monitoring and evaluation of any such changes to inform future actions. For any actions taken pursuant to this paragraph and any approvals granted in furtherance of this paragraph, Water Code Section 13247 and Public Resources Code, Division 13 (commencing with Section 21000) and regulations adopted pursuant to that Division are suspended. Nothing in this Paragraph affects or limits the validity of actions already taken or ongoing under Paragraph 4 of my May 10, 2021 Proclamation or Paragraph 4 of my July 8, 2021 Proclamation.

a. <u>Coordination with Water Operations and Watershed Monitoring Technical Teams</u>

Consistent with the 2020 LTO ROD, DWR and Reclamation propose utilizing the team of managers already part of the Water Operations Management Team (WOMT) to discuss TUCP actions and other actions as appropriate. These managers are already authorized to meet weekly and coordinate the management of water supplies and protection of natural resources during the course of the declared drought emergency. The WOMT managers include representatives from the State Water Board, DWR, Reclamation, CDFW, NMFS, and USFWS.

DWR and Reclamation will provide weekly updates to the State Water Board and the State and federal fisheries agencies during the period covered by this TUCP. DWR and Reclamation will use the WOMT and the Long-Term Operations Agency Coordination Team, consisting of staff members from the State Water Board, DWR, Reclamation, CDFW, NMFS, and USFWS, for this coordination effort. The WOMT meets weekly to provide hydrology and operations updates.

In addition, as part of this petition, DWR and Reclamation will continue to coordinate with each of the Upper Sacramento, Clear Creek, American, Delta, and Stanislaus watersheds (Watershed Monitoring Workgroups) to continue the robust monitoring programs for long-term Project operations.

DWR and Reclamation propose continued discussions, as described below in subsection (b), “Proposed Reporting,” to evaluate the continued use of this TUCP to best balance the protection of all beneficial uses.

b. <u>Proposed Reporting</u>

As stated in Executive Order N-3-23, it is critical for the State to take certain immediate actions to prepare for and mitigate the effects of the drought conditions. To facilitate the directives in the executive order, DWR and Reclamation propose that the operations and regulatory changes requested in this petition include monitoring using existing stations and programs to ensure that the objectives of this proposal and the requirements of Water Code Section 1435 are met under any changed conditions.

2) The Proposed Change Will Not Result in Injury to Any Other Lawful Users of Water

Modification of certain terms of the Projects' water rights permits for February and March 2023 will allow DWR and Reclamation to operate the Projects to conserve storage for critical water supplies, including those for minimum health and safety, while maintaining significantly better than required water quality as prescribed by water quality standards for agricultural and municipal and industrial uses in the Delta. Executive Order N-3-23explicitly calls for modifying requirements for reservoir releases or diversion limitations to protect water supplies, as well as other beneficial uses. The requested changes would broadly benefit water users and not result in injury to other legal users of water.

3) The Proposed Change Will Not Result in Unreasonable Impacts to Fish, Wildlife, and Other Instream Uses

Analyses provided in Attachment 2, *Biological Review for the 2023 February and March Temporary Urgency Change Petition*, indicate that there would not be an unreasonable impact on fish, wildlife, or other instream resources in the Delta as a result of the 2023 February and March TUCP. The Biological Review analysis indicates that effects attributable to the TUCP are limited due to species' life history characteristics (e.g., timing of movement through the Delta). The analysis also indicates that the TUCP is unlikely to appreciably increase entrainment of species of management concern during February through March 2023 at the South Delta export facilities because of the existing protections being implemented or that would be implemented under the 2019 BiOps and the CDFW 2020 ITP to limit entrainment risk. Specifically, real-time monitoring and weekly risk assessment would continue to inform South Delta operational adjustments, operating to daily loss limit trigger thresholds based on a record-low yearly incidental take limit; and OMR flow requirements would be maintained under the TUCP, limiting entrainment to low levels.

Through-Delta survival of juvenile Chinook salmon and steelhead migrating from the Sacramento River basin during February and March 2023 under the TUCP could be lower than without the operational changes proposed under this TUCP because the lesser Delta inflow could affect North Delta hydrodynamics, including greater entry into the interior Delta through Georgiana Slough. Through-Delta survival for juveniles emigrating from the San Joaquin River basin would not be expected to be changed with the TUCP.

Migration conditions for adult Chinook salmon and steelhead in the Sacramento River basin generally would be similar under the base case (representing operations that would occur without the TUCP) and the TUCP. However, higher exports under the TUCP could result in greater straying potential for returning adult Chinook salmon and steelhead returning to the San Joaquin River basin, should similar mechanisms exist as observed for fall-run Chinook salmon in the fall in the San Joaquin River.

The TUCP's modifications relative to the base case may have limited effects on riverine or through-Delta survival of juvenile green sturgeon, although there is some uncertainty in the conclusion, given the general lack of information on the species. It is expected that little to no salvage of green sturgeon at the South Delta export facilities would continue, consistent with recent years.

The TUCP has the potential to result in negative changes to delta smelt and their habitat relative to the base case. This includes uncertain reductions in zooplankton prey in the low-salinity zone and higher salinity, leading to a lower probability of occurrence in areas where delta smelt may otherwise have occurred with higher outflows, such as Montezuma Slough. Preliminary analyses discussed in the 2015 biological review and more recent peer-reviewed analyses suggest the potential for negative effects on delta smelt recruitment from less Delta outflow under the TUCP.

Lower Delta outflow could have limited, uncertain negative effects on longfin smelt prey. The reduction in outflow due to the TUCP may have some negative impact on longfin smelt abundance based on observed correlations between abundance indices and Delta outflow: The statistical analysis based on March–May and December–May Delta outflow suggests that the probability of a lower abundance index under the TUCP, relative to the base case, is not greatly different than 0.5 (i.e., 50 percent chance). Salinity in larval/juvenile longfin smelt habitat in the Delta and Suisun Bay/Marsh would not exceed the range occupied by these life stages. Entrainment risk is low based on the current species distribution; and even if the species distribution moves farther upstream because of lower Delta outflow under the TUCP, the TUCP is unlikely to appreciably increase entrainment of longfin smelt at the South Delta export facilities due to continued entrainment risk management under the 2020 CDFW ITP.

In addition, the reduction in outflow due to the TUCP may have negative and/or positive impacts on other native and nonnative species, including the migratory, pelagic, and littoral species. The TUCP period would likely overlap with some juvenile fall-run Chinook salmon rearing and migration through the Delta. Lower Delta inflow under the TUCP could result in increased juvenile Chinook salmon entry into the low-survival interior Delta through Georgiana Slough and reduced through-Delta survival, although the main period of migration is after the TUCP period. Species with positive correlations with Delta outflow such as striped bass and American shad may be negatively affected, whereas species with negative correlations may be positively affected.

TUCP impacts are considered in light of the WY 2023 salvage trends, and the operational requirements that would be implemented under the 2019 BiOps and 2020 CDFW ITP will continue to be in effect to protect listed species. This temporary action will allow additional storage of water in Project reservoirs for use later in the spring and summer, while still providing adequate conditions for delta smelt and longfin smelt and maintaining OMR protective measures for listed salmonids under the 2020 ROD, based on the 2019 BiOps and 2020 CDFW ITP. In addition, the temporary change will not affect DWR’s and Reclamation’s required actions per the 2019 BiOps or 2020 CDFW ITP. The storage of water is vital for improving critical water supply. Based on these factors, there would not be an unreasonable impact of the TUCP on public trust resources such as fish and wildlife or other instream resources.

4) The Proposed Change Is in the Public Interest

Temporarily modifying Table 4, footnote [d] in D-1641 is in the public interest by allowing the Projects to operate in a way that does not result in unreasonable impacts on delta smelt and longfin smelt, given favorable conditions provided through the January storms and reduced Project exports, while enabling additional water storage to extend available supplies, including storage benefits south of the Delta and potential storage benefits north of the Delta for beneficial uses later in 2023. Maintaining water storage is critical should recent dry conditions continue.

5) The Proposed Change Will Not Adversely Affect Public Trust Resources

The proposed changes would not adversely affect, and would be protective of, public trust resources (including fishery resources), as described below.

Biological Resources: As described in Attachment 2, operational requirements that would be implemented under the 2019 BiOps and 2020 CDFW ITP will remain in effect. These operational requirements protect listed aquatic and terrestrial species. As described in Section 3, *The Proposed Change Will Not Result in Unreasonable Impacts to Fish, Wildlife, and Other Instream Uses,* there would not be an unreasonable impact of the proposed change on public trust resources such as fish and wildlife or other instream resources.

Water Quality: As described in Attachment 2, DWR and Reclamation prepared the Biological Review of the proposed D-1641 changes for compliance with the Porter-Cologne Water Quality Control Act (Division 7 of the California Water Code), which establishes California’s statutory authority for the protection of water quality. Attachment 2 explains that water quality impacts would not occur from the proposed change; therefore, the proposed change is consistent with applicable basin plans.

Recreation: The proposed change would be operated under the 2020 LTO ROD, which found that impacts on recreational resources (e.g., in-water recreational resources and in-river transportation) would not occur.

Based on these findings, the proposed changes are feasible, would not adversely affect public trust resources, and are in the public interest.

III. Due Diligence Has Been Exercised

DWR and Reclamation rely upon sound science and methods to forecast and project hydrology and water supply needs. This scientific approach to water management is the most prudent course of action in such a complex and variable system. Based on this approach, DWR and Reclamation revisit the forecasts and projections frequently and adjust the Projects’ operations accordingly. These may include updated hydrodynamic and water quality modeling simulations.

During the TUCP period, if unregulated flows are sufficient to meet unmodified D-1641 standards or if DWR and Reclamation operate according to unmodified D-1641 standards, the TUCP’s criteria would not apply.

Before this petition, DWR and Reclamation provided weekly hydrology and condition updates through the WOMT. These updates will continue during the period proposed in this TUCP. DWR and Reclamation have met with State Water Board staff and representatives of CDFW, NMFS, and USFWS to discuss the elements of this TUCP, and will continue to provide updates and to seek their technical assistance on how best to manage multiple needs for water supply. In addition, as stated above, DWR and Reclamation will continue to coordinate with Long-Term Operation Agency Coordination Team working groups to continue the robust monitoring program used in the 2021 and 2022 Drought Contingency Plans and Drought Ecosystem Monitoring and Synthesis Plan.

IV. References

California Department of Fish and Wildlife (CDFW). 2020. California Endangered Species Act Incidental Take Permit No. 2081-2019-066-00. Long-Term Operation of the State Water Project in the Sacramento–San Joaquin Delta. CDFW Ecosystem Conservation Division. Sacramento, CA.

National Marine Fisheries Service. 2019. *Biological Opinion on the Long-term Operation of the Central Valley Project and State Water Project*. National Marine Fisheries Service, West Coast Region. October 21, 2019.

United States Bureau of Reclamation. 2020. Record of Decision for the Reinitiation of Consultation on the Coordinated Long-Term Modified Operations of the Central Valley Project and State Water Project. Mid-Pacific Region.

U.S. Fish and Wildlife Service. 2019. Biological Opinion for the Reinitiation of Consultation on the Long Term Operation of the Central Valley Project and State Water Project. USFWS Pacific Southwest Region. Sacramento, CA.

ATTACHMENT 2:
BIOLOGICAL REVIEW FOR THE 2023 FEBRUARY THROUGH MARCH TEMPORARY URGENCY CHANGE PETITION

I. Purpose and Background

The California Department of Water Resources (DWR) for the State Water Project (SWP) and the United States Bureau of Reclamation (Reclamation) for the Central Valley Project (CVP) (collectively, "Projects") are requesting through a 2023 Temporary Urgency Change Petition (2023 TUCP) that the State Water Resources Control Board (State Water Board) change the terms of the SWP and CVP water rights permits from what is currently provided in Water Right Decision 1641 (D-1641) for February and March 2023, as summarized in **Table Action1** and outlined below.

Table Action1: Summary of 2023 Temporary Urgency Change Petition Operations Framework

Time Frame	Proposed D-1641 Action(s)
February through March 2023	Modify footnote [d] of Table 4 in D-1641 as follows: "[d] This standard applies only in months when the average EC at Port Chicago during the 14 days immediately prior to the first day of the month is less than or equal to 2.64 mmhos/cm. <u>This standard does not apply in February and March 2023.</u>" All other X2 conditions in Table 4 would continue to apply.

Spring X2 is the approximate location of the upstream boundary of the interface between salt water and fresh water. Positive changes in X2 indicate westward movement of this interface, which is generally considered desirable for aquatic species. Westward transport of aquatic species typically corresponds to higher survival outcomes, more opportunities for productive rearing habitat, and movement away from area of lower survival and entrainment zones. There are three spring X2 compliance locations (from east to west): Collinsville, Chipps Island, and Port Chicago. The X2 requirement at Collinsville always applies, while the requirement at Chipps Island is a function of the previous month's Eight River Index (8RI). The requirement at Port Chicago is also based on the previous month's 8RI, but it applies only when the average electrical conductivity (EC) at Port Chicago during the 14 days immediately before the first day of the month is less than or equal to 2.64 millimhos per centimeter (mmhos/cm). The X2 requirements are provided in D-1641, Table 4, with conditions footnoted. Footnote [d] describes the conditions in which Port Chicago requirements apply.

Extreme wet conditions and freshwater quality conditions in January triggered the Port Chicago requirement for February. DWR and Reclamation are requesting that footnote

[d], which is conditioned on the water quality just prior to February, not apply for February and March of 2023. All other X2 requirements will continue to apply.

Absent a TUCP in February and March, DWR and Reclamation would attempt to meet all D-1641 water quality requirements including the Port Chicago standard through a combination of upstream releases from Lake Oroville and Folsom Lake, as well as export reductions. Releases from Lake Shasta would likely not be needed. These actions would reduce the amount of storage in both Projects and therefore hamper efforts to recover from the ongoing drought.

Agency Coordination

On February 8 and 10, 2023, DWR and Reclamation met with the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and the State Water Board to discuss the TUCP and associated Biological Review outline and identify methods to be used in the biological review. Information from those meetings was incorporated into the development of the TUCP Biological Review.

DWR and Reclamation will provide weekly updates to the State Water Board and State and federal fisheries agencies during the period covered by this TUCP. DWR and Reclamation will use the existing Water Operations Management Team (WOMT) and the Long-term Operations Agency Coordination Team, composed of staff from Reclamation, DWR, NMFS, USFWS, CDFW, and the State Water Board, for this coordination effort. The WOMT meets weekly to provide hydrology and operations updates.

During the TUCP period, if unregulated flows are sufficient to meet unmodified D-1641 standards or if DWR and Reclamation operate according to unmodified D-1641 standards, the TUCP's criteria would not apply.

In addition, as part of this petition, DWR and Reclamation will continue to coordinate with each of the Upper Sacramento, Clear Creek, American, Delta, and Stanislaus watersheds (Watershed Monitoring Workgroups) to continue the robust monitoring programs for long-term Project operations.

The analysis for the 2023 TUCP incorporated operations described in the 2020 Record of Decision (ROD) implementing Alternative 1 (2020 ROD), which was consulted upon for the 2019 NMFS and USFWS Biological Opinions (BiOps) for the Re-initiation of Consultation (ROC) on the Long-Term Operation (LTO) of the CVP and SWP (2019 BiOps), and the 2020 Incidental Take Permit (ITP) from CDFW (2020 CDFW ITP) for LTO of the SWP in the Sacramento–San Joaquin Delta (Delta), as analyzed in the Final Environmental Impact Report certified by DWR on March 27, 2020.

II. Purpose of Biological Review

As described in the 2023 TUCP, legal users of water will not be injured by the requested changes. In support of the 2023 TUCP, DWR and Reclamation have prepared this

Biological Review of these proposed changes for compliance with the Porter-Cologne Water Quality Control Act (Division 7 of the California Water Code), which establishes California's statutory authority for the protection of water quality. Under the Porter-Cologne Water Quality Control Act, the State must adopt water quality policies, plans, and objectives that protect the State's waters. The Porter-Cologne Water Quality Control Act sets forth the obligations of the State Water Board and Regional Water Quality Control Boards pertaining to the adoption of Basin Plans and establishment of: (1) beneficial uses to be protected; (2) water quality objectives for the reasonable protection of beneficial uses; and (3) a program of implementation for achieving the water quality objectives. The beneficial uses protected in Basin Plans include fish and wildlife, rare, threatened, or endangered species, and their habitats. Additional information is also provided in the Biological Review to inform the State Water Board with respect to potential effects to other public trust resources, such as fish and wildlife. The Biological Review included technical assistance from CDFW, NMFS, USFWS, and the State Water Board staff.

Scope of Analysis

The area of analysis for the Biological Review is limited to the Delta region because the proposed modification to D-1641 standards associated with the 2023 TUCP addresses Delta conditions. The 2020 ROD implementing the Proposed Action consulted upon in the 2019 BiOps addresses federal Endangered Species Act (ESA)–listed species on the Sacramento River, Clear Creek, Stanislaus River, and American River, and the Delta, and their flow and temperature management requirements, 2020 CDFW ITP, and the NMFS 2016 BiOp addresses Feather River flow management requirements.

As indicated above, operational requirements that would be implemented under the 2019 BiOps, and 2020 CDFW ITP will continue to be in effect to protect listed species. Based on these factors, there would not be an unreasonable impact of the TUCP on public trust resources such as fish and wildlife or other instream resources.

Port Chicago requirements for February are based on water quality conditions of the last day of January. The effects of operating with or without Port Chicago X2 days for both February and March were considered in the operational scenarios used in the effects analysis for the 2019 BiOps and the 2020 CDFW ITP. One of the operational scenarios assumed no water quality trigger for Port Chicago, while the other X2 requirements continued to be required as defined in D-1641.

The Biological Review assesses the potential for biological impacts that could result from the 2023 TUCP, specifically, those actions identified in Table Action1 above. A description of the DWR DSM2 hydrodynamic study is provided below.

III. Methods and Modeling

The potential impacts of the proposed 2023 TUCP operational actions as part of the TUCP are considered in the context of conceptual models, current regulatory documents, and peer-reviewed literature. For example, the delta smelt (*Hypomesus transpacificus*) conceptual model (Interagency Ecological Program Management, Analysis, and Synthesis

Team 2015); the 2019 BiOps (National Marine Fisheries Service 2019; U.S. Fish and Wildlife Service 2019); the 2020 CDFW ITP (CDFW 2020); conceptual models for winter-run Chinook salmon (*Oncorhynchus tshawytscha*) (Windell et al. 2017), and green sturgeon (*Acipenser medirostris*) (Heublein et al. 2017a, 2017b); and other information as cited below are materials considered in developing this Biological Review.

Considerations

The Port Chicago X2 requirement in February is determined based on conditions in January, where the 8RI determines the number of days required and the water quality conditions at the Port Chicago station are less than or equal to 2.64 mmhos/cm EC. January 2023 was a very wet month where the resulting runoff and water quality conditions indicated that there would be 27 days of Port Chicago required in February. However, February precipitation to date has been well below average and antecedent runoff conditions from January are dropping. Absent modification to the Port Chicago requirement, upstream releases and SWP/CVP exports would need to be adjusted to provide additional outflow to meet the Port Chicago standard. In addition, if the Port Chicago requirement remains in effect, the requirement would likely need to be met for the most part with outflow at a 3-day average of 29,200 cubic feet per second (cfs). With a requirement of 27 days of compliance, there is a high potential for the water quality at Port Chicago at the end of February, due to the high outflow required, to trigger a continued Port Chicago requirement in March.

The biological analysis modeling does not cover the starting conditions for aquatic species in the estuary. High San Joaquin and Sacramento River flows and reduced Project exports implemented in accordance with 2019 BiOps; the 2020 CDFW ITP requirement during January created favorable conditions for aquatic species. During January, SWP and CVP project operations were primarily controlled by the cap on Old and Middle River (OMR) flow at -5,000 cfs, Integrated Early Winter Pulse Protection “first flush” action (OMR @ -2,000 cfs), and a turbidity bridge (OMR @ -2000 cfs for 5 days, additional 5 days at -3,500 cfs). As a result of these actions, both delta smelt and longfin smelt were distributed to favorable rearing habitats away from the interior Delta and direct entrainment risk. Specifically, adult longfin smelt distribution shifted seaward, mostly downstream of the Delta altogether. Subsequently, larval longfin smelt spawning observed to date has been centered between western Suisun Bay and San Pablo Bay, indicating that entrainment risk for cohorts spawned early will be very low during the spring. Although delta smelt population abundance is low, detections of delta smelt in January and February have been highest in the northern arc of the upper estuary (Suisun Bay to Cache Slough). This suggests that 2019 USFWS BiOp and the 2020 CDFW ITP “first flush action” and “turbidity bridge avoidance” actions yielded the expected results by severely limiting the entrainment of delta smelt into the interior Delta and Project salvage facilities. The first flush action appears to have resulted in entrainment protection for winter-run salmon as well. To date, zero genetically confirmed winter-run have been salvaged. High Sacramento River flows also resulted in overtopping of Fremont Weir, potentially allowing a portion of the migrating cohort of juvenile winter-run Chinook salmon to enter the Yolo Bypass, a migratory pathway that does not expose fish to the entry routes into the interior Delta. Throughout the spring, the SWP and CVP will continue to operate to ESA and California Endangered Species Act (CESA) entrainment measures until those measures are off ramped in June per identified criteria.

Hydrology

The modeling for the proposed modification analyzes the conditions with and without the Port Chicago requirement in February and March while maintaining all other requirements. The precipitation forecast for the remainder of Water Year (WY) 2023 is uncertain and could change dramatically beyond what current forecasts and hydrologic models can predict. Near-term weather forecasts indicate no appreciable precipitation through at least the third week of February, and the experience from recent years suggest an elevated risk that dry conditions may continue. Therefore, a 90 percent exceedance hydrology was blended with recent observed and near-term projections for use in this analysis. At the time of initiating this analysis, the forecast from early January, with hydrologic conditions through December 31, was the latest available. The January Water Supply Index (WSI) forecast provided estimated flows to the reservoirs and was used to develop forecasted flows entering the Delta from the San Joaquin River. The January WSI forecasted hydrology also included estimated runoff between the Project reservoirs and the Delta; this is also referred to as the Sacramento River accretion/depletion. The forecasted hydrology from January was blended with actual conditions observed the first 5 days in February and flow trends for the remainder of the month. March and onward relied on forecasted data primarily from the January WSI forecast, with the exception to the accretion/depletion forecast which relied on a historic exceedance forecast. The 90 percent historic exceedance forecast better matched the observed conditions; therefore, it was used instead of the accretion/depletion from the January WSI.

The operational analysis parameters were used to capture a large range of reasonable Delta operations, where most of the change occurs at the exports. February export projections were made assuming actual conditions through the first 5 days of February and minimizing exports to meet Port Chicago under base conditions and maximizing exports up to other regulatory constraints, like OMR of -5,000 cfs, under conditions without Port Chicago. Releases from Lake Oroville and Folsom Lake were increased to provide additional outflow when export changes alone were not able to meet the assumed Port Chicago requirement.

Recent Updated Hydrology

After the modeling analysis was initiated for this petition, new hydrologic forecasts were made available with the release of the February WSI at the end of the day on February 8. Time constraints limited the ability to update the analysis with the most recent forecasts; however, a comparison of the new forecast and the one used for this effects analysis indicates that the analysis used in the modeling remains valid and provides for more extreme differences than would be analyzed with updated hydrology.

The February WSI hydrology forecast incorporated hydrologic conditions through the end of January and is generally forecasting wetter conditions than those forecasted in the January WSI. Port Chicago days were estimated to be 9 days in March using the 90 percent exceedance 8RI from the January WSI, whereas the updated forecast based on the February WSI estimates 12 days of Port Chicago in March. This would increase the estimated prorated monthly average Net Delta Outflow Index (NDOI) required from about 16,600 cfs to about 18,300 cfs, which is an increase of 1,700 cfs in additional required flow. In addition to the increase in 8RI, accretion/depletion estimates increased. The analysis used an accretion/depletion for March based on a 90 percent historical exceedance, which was about 9,000 cfs of additional flows on the Sacramento above the Delta. The updated February WSI 90 percent forecast estimates about 11,000 cfs for the coming March, which is a 2,000 cfs increase in available flows that would offset any operational change needed to meet 3 additional days of Port Chicago, or additional NDOI of 1,700 cfs, in March.

DSM2 Modeling

DSM2 simulations were performed and evaluated for two operational management scenarios: a base case representing operations that would occur without the TUCP and a case representing a TUCP for the Port Chicago requirement. These simulations were designed to evaluate potential impacts of the TUCP on Delta flows, salinity, and other factors described below, in order to infer potential impacts to fish and aquatic resources as part of this biological review.

To model the Delta flows, water levels and salinity, Delta models such as DSM2 need boundary inflows, exports and diversions, stages, and salinity data. Data to run the model for this analysis were developed from multiple sources:

- Up to February 1, observed historical data was used.
- From February 1 onward, forecasted data from DWR's Delta Coordinated Operations (DCO) model, which estimates SWP water supply, were used. Information that is included in the DCO includes hydrology data, SWP contractor delivery requests, and legal restrictions on exports. The DCO forecasts that were used for this analysis utilized 90 percent exceedance hydrology for reservoir inflows. This represents a forecast for a very dry year. Based on historical data, a 90 percent exceedance hydrology assumes that only one in 10 years would be drier than this forecast.

A detailed breakdown of operational assumptions in each case is provided below:

- **Base (No TUCP) case**
  - Uses 90 percent exceedance January WSI for inflows and accretions in the system.
  - The Projects meet the Port Chicago requirements; it was assumed that 27 days in February would be required as well as 9 days in March.
  - Assumes BiOp and ITP result in OMR requirements of –5,000 cfs.

- **TUCP case**
  - Uses 90 percent exceedance January WSI for inflows and accretions in the system.
  - The Port Chicago requirements are relaxed, and the Projects meet the X2 requirement at Chipps (and therefore Collinsville).
  - Assumes BiOp and ITP result in OMR requirements of –5,000 cfs.

Table Model1 provides a summary of the primary modeling assumptions. Additional summaries of Delta flows and other variables are provided in the *Analysis of the Impacts of TUCP* below.

Non-hydrologic modeling assumptions are listed below; these assumptions are common to the baseline and TUCP scenarios unless otherwise noted:

- Suisun Marsh Salinity Control gates are open.
- The Delta Cross Channel Gates are closed from the start of the forecast until June 21, 2023.
- The Middle River barrier will be installed by June 3, 2023. The Old River Tracy Barrier will be installed by June 19, 2023. The Grant Line Canal Barrier will be installed by June 26, 2023.

Table Model1. Summary of Assumed Number of Days Meeting D-1641 Port Chicago and Chipps X2 Requirements and Modeled (February–July) or Actual (December–January) Delta Flows and Operations by Case for December through July 2023 (Note that Only February and March are the Subject of the TUCP).

Month	Base (No TUCP)	Base (No TUCP)	Base (No TUCP)	Base (No TUCP)	Base (No TUCP)	Base (No TUCP)	TUCP	TUCP	TUCP	TUCP	TUCP	TUCP
	Port Chicago (days)	Chipps (days)	NDOI (cfs)	SJR at Vernalis (cfs)	Sac R at Freeport (cfs)	Combined Exports (cfs)	Port Chicago (days)	Chipps (days)	NDOI (cfs)	SJR at Vernalis (cfs)	Sac R at Freeport (cfs)	Combined Exports (cfs)
December			10,600	1,100	10,700	3,300			10,600	1,100	10,700	3,300
January			98,900	14,050	50,850	9,800			98,900	14,050	50,850	9,800
February	27	28	28,550	6,000	23,350	2,800	14*	28	20,050	6,000	20,450	8,400
March	9	31	16,600	4,050	16,250	3,400	0	31	12,750	4,050	16,250	7,250
April	0	26	10,800	3,650	9,100	1,350	0	26	10,800	3,650	9,550	1,800
May	0	1	7,250	3,950	6,600	1,600	0	1	7,250	3,950	6,600	1,600
June	0	0	7,100	1,450	11,250	2,250	0	0	7,100	1,450	11,350	2,350
July			4,150	1,250	15,650	8,650			4,150	1,250	16,300	9,300

* Resulting Port Chicago days calculated based on assumed NDOI and monthly weighted average with Chipps Island days.

IV. Analysis of the Impacts of TUCP

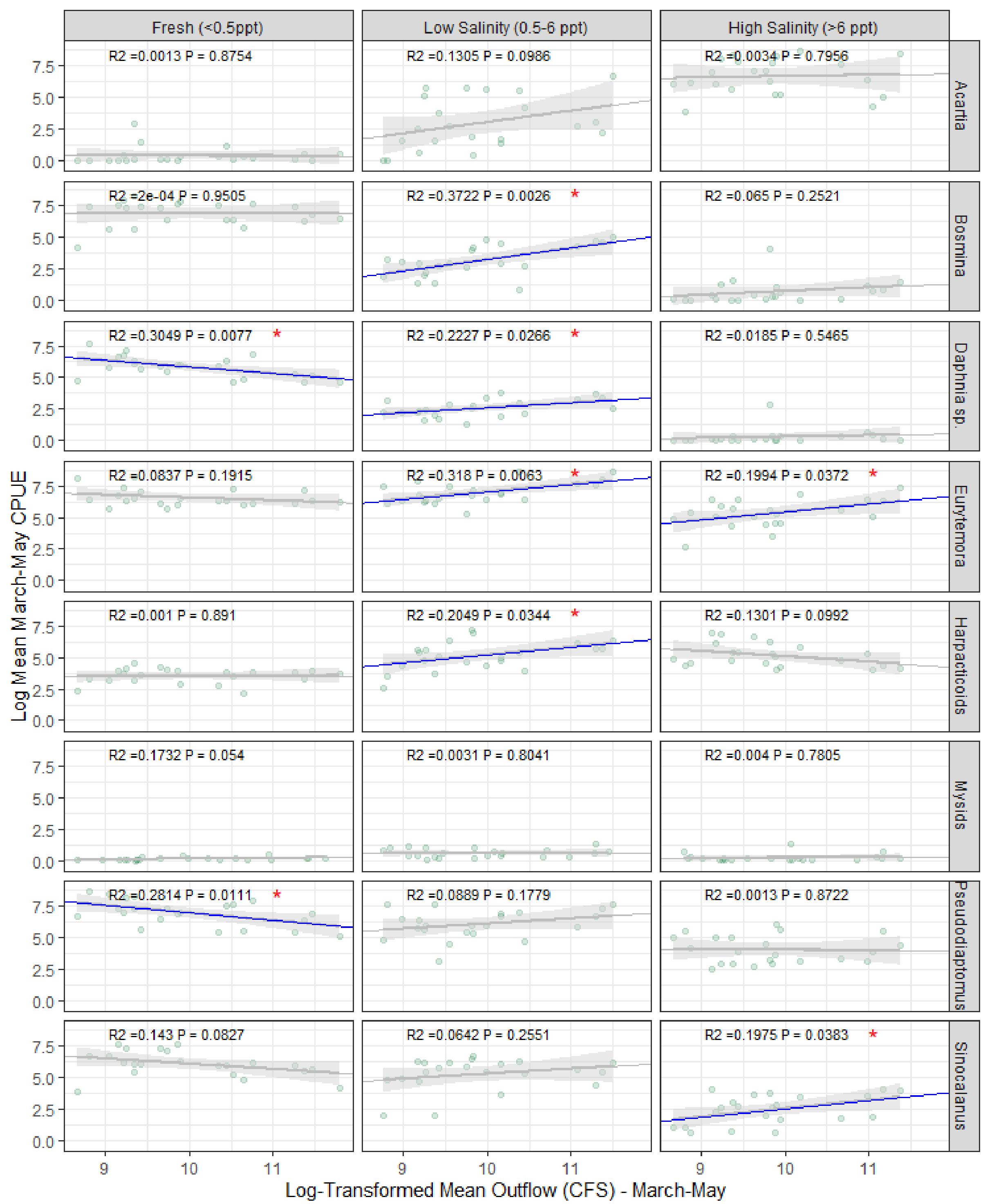
Ecosystem Impacts

Impacts of the 2023 TUCP on focal species and their habitat are discussed in the species-specific sections below. Impacts to species and their habitat reflect ecosystem-level impacts of hydrological conditions, key among them being factors such as potential impacts on food webs. Phytoplankton and zooplankton abundance is correlated with flow, with phytoplankton blooms frequently occurring during lower flows in the past (Glibert et al. 2014). At the overall scale sampled by existing monitoring programs in the Delta and Suisun Bay/Marsh, there are a number of statistically significant positive relationships between common zooplankton taxa catch per unit effort in spring Delta outflow (**Figure ZOOP1**). However, this varies by salinity, with some taxa showing significant relationships in the low-salinity zone, but no relationship in freshwater, and some taxa showing negative relationships with outflow in freshwater and no relationship in the low or high salinity zone. Zooplankton abundance in the freshwater zone is most important for spawning delta smelt in the freshwater Delta, whereas low and higher salinity areas are more important for spawning and early life stages of longfin smelt, and primarily low salinity areas for early life stages of delta smelt.

Overall, abundance of some zooplankton species increases with outflow in the low-salinity zone (Figure ZOOP1). In contrast, zooplankton abundance of some key species decreases with outflow in the freshwater areas of the upper estuary. This suggests that the TUCP may impact key species of concern, including delta smelt and longfin smelt, in different areas of the estuary depending on life stage. However, application of the statistically significant regression relationships to the TUCP and base modeling cases gives differences between the cases of 5–10 percent, depending on species, which are within the confidence intervals of the regressions. This indicates uncertainty in possible differences.

The density of the mysid shrimp *Neomysis mercedis*, prey for species such as longfin smelt (Feyrer et al. 2003; Jungbluth et al. 2021; Baxter et al. 2010) in the low-salinity zone has also been correlated with Delta outflow during March through May, although with a relatively modest proportion of variation in density explained by outflow ($r^2 = 0.32$; Hennessy and Burris 2017). *Neomysis mercedis* abundance indices declined considerably in the late 1990s and by far the most abundant mysids now are *Hyperacanthomysis longirostris* and *Neomysis kadiakensis* (Grimaldo et al. 2020 supplemental material; Barros 2021). Neither *H. longirostris* nor *N. kadiakensis* have statistically significant correlations with Delta outflow, which is reflected in the lack of significant correlations with Delta outflow for all three mysid taxa combined (Figure ZOOP1). This indicates that the TUCP would be unlikely to have effects on the most abundant mysids in the low-salinity zone (see also the analysis of impacts to longfin smelt).

Figure ZOOP1. Regression Relationships of the 8 Most Abundant Zooplankton Taxa Environmental Monitoring Program and 20-mm Survey Stations and Mean March through May Delta Outflow, 2000 through 2021. Catch is divided into freshwater (<0.5 part per thousand), low-salinity zone (0.5-6 part per thousand), and high salinity (>6 part per thousand).



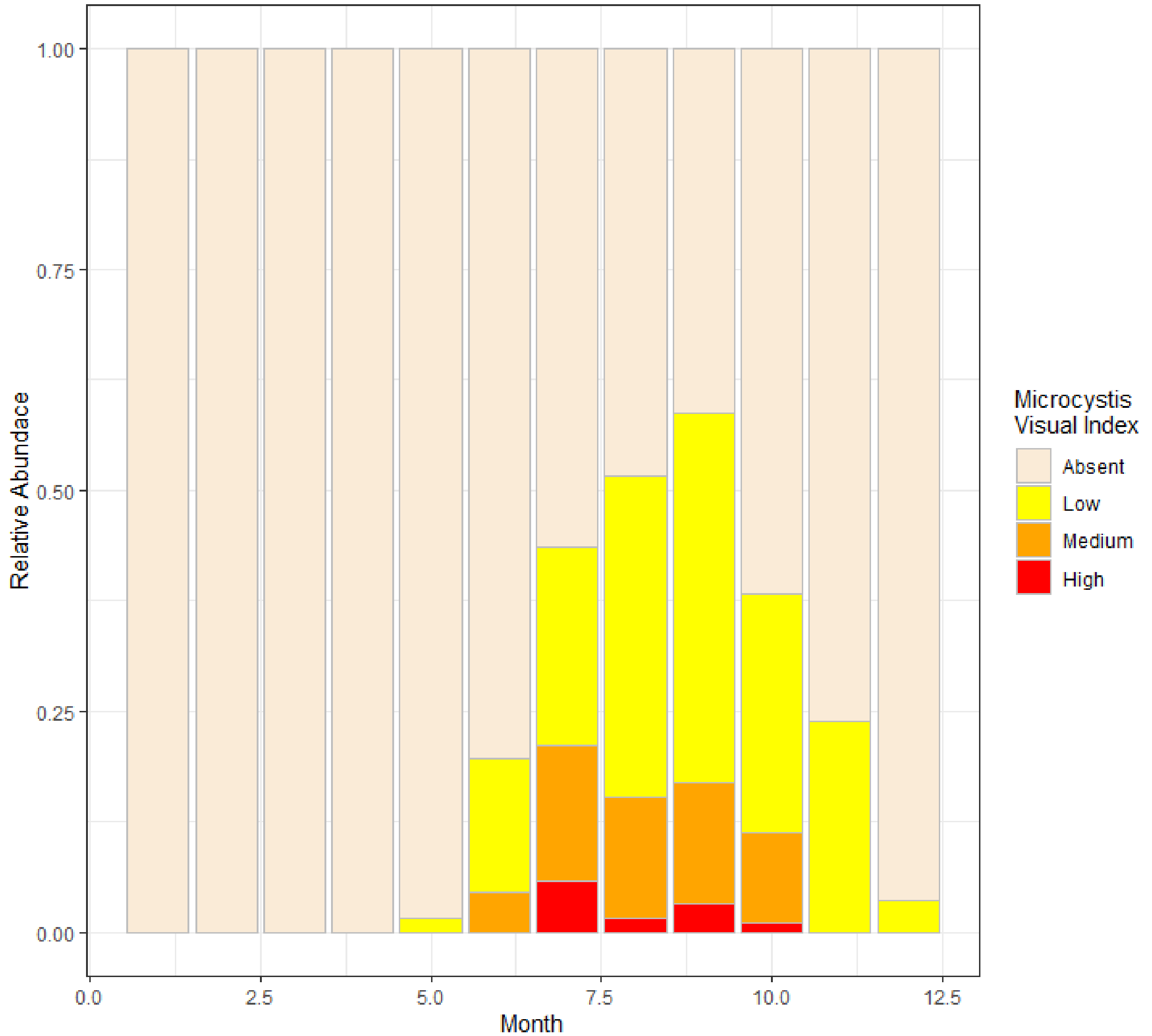
Note: Blue lines indicate regressions statistically significant at p<0.05.

Abundance indices of Mississippi silversides (*Menidia audens*), predators of larval delta smelt (Schreier et al. 2016), are negatively related to spring (March through May) South Delta exports (Mahardja et al. 2016). Overall spring South Delta exports would be higher under the TUCP compared to the base case, indicating potential for negative effects to silversides under the TUCP relative to the base case, albeit with uncertainty given that the study examined correlative patterns. Summer Delta inflow was also found to be negatively related to silverside abundance indices by Mahardja et al. (2016), but this factor would not differ between the TUCP and the base case.

The spring period of the TUCP occurs prior to the warmer seasons and potential flow-related effects from harmful algal blooms such as *Microcystis* (Lehman et al. 2018; Lehman et al. 2022). Observations of *Microcystis* in the open waters of the Delta very rarely occurs between January and May (**Figure ZOOP2**), though it can occur throughout the year in backwater channels and marinas. Furthermore, *Microcystis* is believed to over-winter in the sediment, and the series of high flow events in January of 2023 most likely flushed out much of the benthic *Microcystis*. This may delay the formation of any harmful algal blooms, such as was seen in 2017 (Lehman et al. 2022). Analysis of previous TUCPs found that even during summer TUCPs, changes to water management caused by TUCPs did not significantly change occurrence or severity of Microcystis blooms in the Delta (Hartman et al. 2022; U.S. Bureau of Reclamation 2022).

Discussion of other relevant ecosystem impacts is provided in the species-specific analyses below.

Figure ZOOP2. Frequency of Occurrence of *Microcystis* Visual Index Observations by Month Collected by DWR's Environmental Monitoring Program for 2015-2021.



Winter-Run Chinook Salmon

<u>Presence and Life Stages of Winter-Run Chinook Salmon</u>

The Juvenile Production Estimate for natural-origin winter-run Chinook salmon entering the Delta in water year 2023 is 49,924 fish (National Marine Fisheries Service 2023).[1] The Salmon Monitoring Team (SaMT), which meets weekly, estimated on February 7, 2023, that 25-35 percent of winter-run juveniles were yet to enter the Delta, the majority (55-75 percent) were in the Delta, and up to 10 percent had exited the Delta (**Figure WR1**). Juvenile winter-run Chinook salmon migrating to the Delta have been

[1] See: https://media.fisheries.noaa.gov/2023-01/jpe-letter-2022.pdf.

observed to potentially rear for the entire winter in the Delta and historically exit during March and April, with juveniles tending to leave around the same time each year (del Rosario et al. 2013). This winter-long rearing period is consistent with historical timing suggested in summaries by NMFS (National Marine Fisheries Service 2019: **Tables WR1 and WR2**) and the SacPAS database of Central Valley monitoring efforts (**Figures WR2, WR3, and WR4**). The first of two planned releases of hatchery juvenile winter-run Chinook salmon occurred on January 26 and January 27, 2023. The initial release comprised approximately 58 percent of the total production release (432,458 of 740,967). Estimates from the February 7, 2023, SaMT meeting were 98-100 percent were still upstream of the Delta, 0-2 percent were in the Delta, and 0 percent have exited. While hatchery fish do not exhibit the same in-Delta rearing as natural origin juvenile winter-run Chinook salmon, they will likely be present in the Delta in February and March. Adult winter-run also migrate through the Delta in highest abundance in February and March and in lower abundance until June (Table WR2).

Figure WR1. Salmon Monitoring Team Estimates of the Percentage of Juvenile Winter-Run Chinook Salmon Yet to Enter the Delta, In Delta, and Exited Delta.

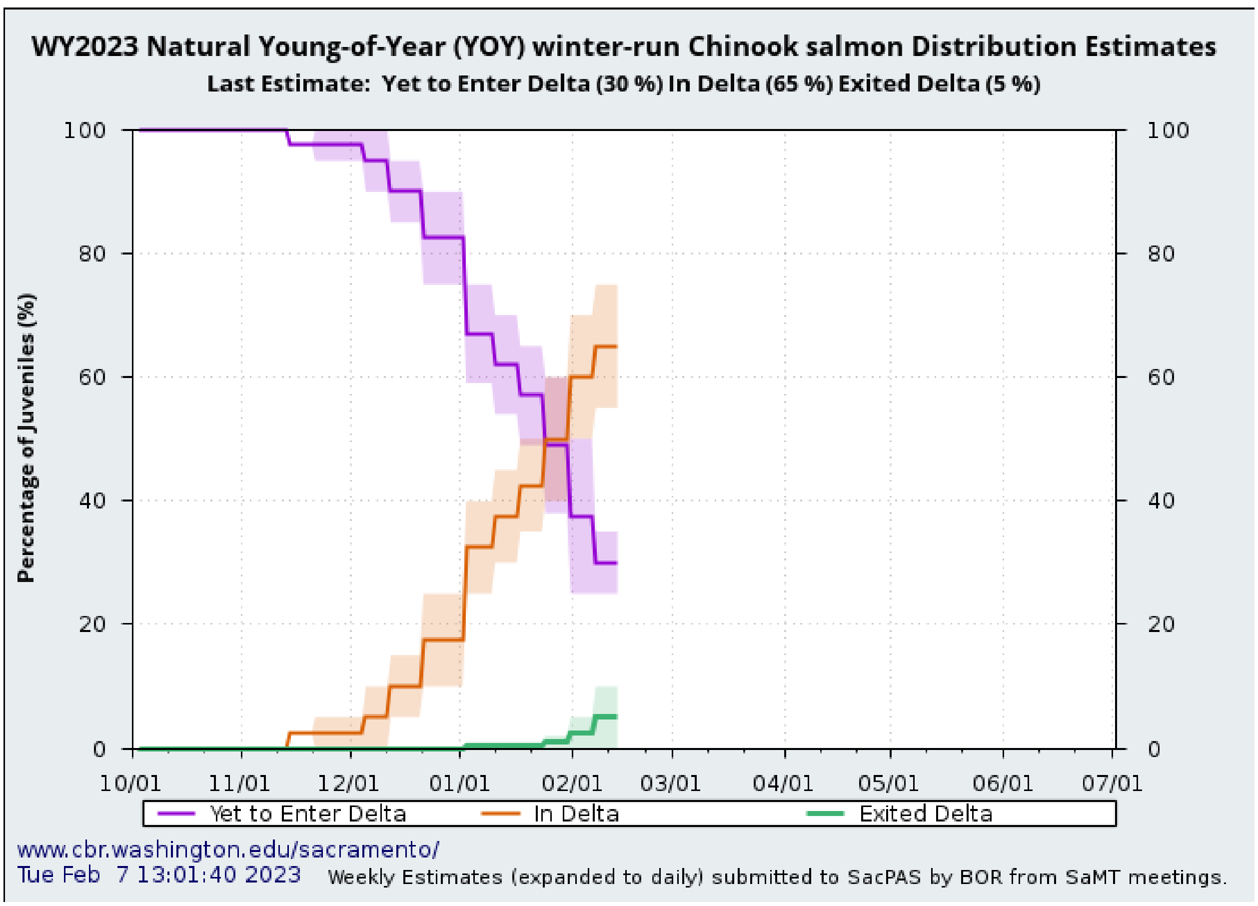


Table WR1. Temporal Occurrence of Sacramento River Winter-Run Chinook Salmon by Life Stage in the Sacramento River

Relative Abundance	High (▼)			Medium (⊠)			Low (#)			None (-)		
Adults Freshwater	Month											
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin [a,b]	⊠	⊠	⊠	⊠	⊠	⊠	⊠	-	-	-	⊠	⊠
Upper Sacramento River spawning [c]	-	-	-	-	#	▼	▼	⊠	-	-	-	-
Juvenile Emigration	Month											
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River at Red Bluff [d]	#	#	#	-	-	-	#	⊠	⊠	⊠	⊠	⊠
Sacramento River at Knights Landing [e]	▼	⊠	#	-	-	-	-	-	-	#	⊠	▼
Sacramento trawl at Sherwood Harbor [f]	⊠	▼	▼	#	-	-	-	-	-	-	⊠	▼
Midwater trawl at Chipps Island [f]	⊠	⊠	▼	▼	#	-	-	-	-	-	-	#

Sources: [a] Yoshiyama et al. (1998), Moyle (2002) ; [b] Myers et al. (1998); [c] Williams (2006); [d] Martin et al. (2001); [e] Knights Landing Rotary Screw Trap Data, CDFW (1999-2019); [f] Delta Juvenile Fish Monitoring Program, USFWS (1995-2019), del Rosario et al. (2013).

Source: National Marine Fisheries Service 2019:67.

Table WR2. Temporal Occurrence of Sacramento River Winter-Run Chinook Salmon by Life Stage in the Delta

Relative Abundance	High (▼)			Medium (⊠)			Low (#)		None (-)		
Life-Stage	Month										
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult [1]	⊠	▼	▼	▼	⊠	⊠	-	-	-	-	⊠	⊠
Juvenile [2]	#	⊠	▼	⊠	-	-	-	-	-	#	#	⊠
Salvaged [3]	⊠	▼	▼	#	#	#	-	-	-	-	-	#

[1] Adults enter the Bay November to June (Hallock and Fisher 1985) and are in spawning ground at a peak time of June to July (Vogel and Marine 1991).
[2] Juvenile presence in the Delta was determined using Delta Juvenile Fish Monitoring Program data.
[3] Months in which salvage of wild juvenile winter-run at State and Federal pumping plants occurred (National Marine Fisheries Service 2016c).

Source: National Marine Fisheries Service 2019:68.

Figure WR2. Catch Index Timing and Number of Unclipped Juvenile Winter-Run Chinook Salmon in Sacramento Beach Seines, Brood Years 1998 through 2021.

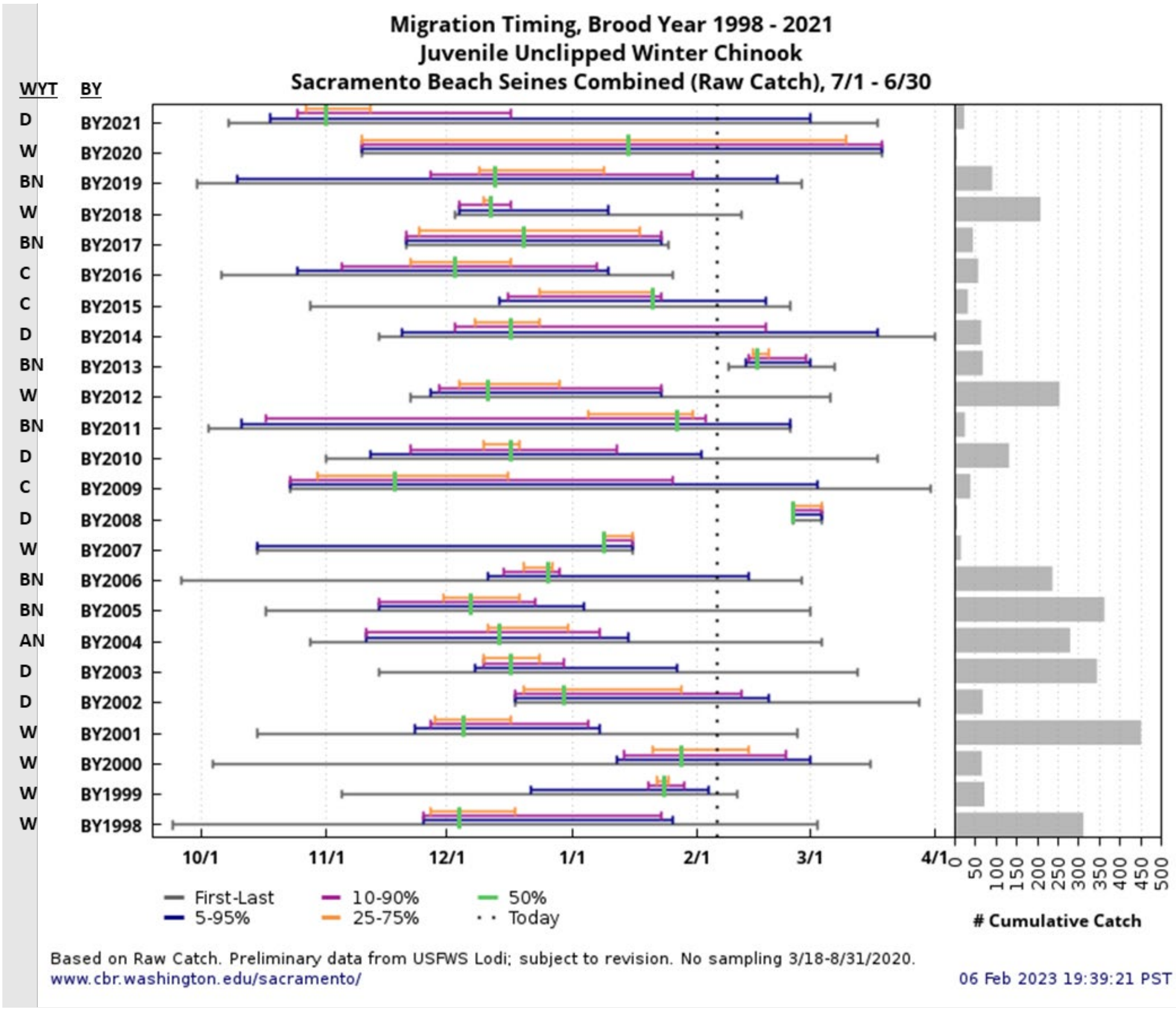


Figure WR3. Catch Index Timing and Number of Unclipped Juvenile Winter-Run Chinook Salmon in Sacramento Trawls at Sherwood Harbor, Brood Years 1998 through 2021.

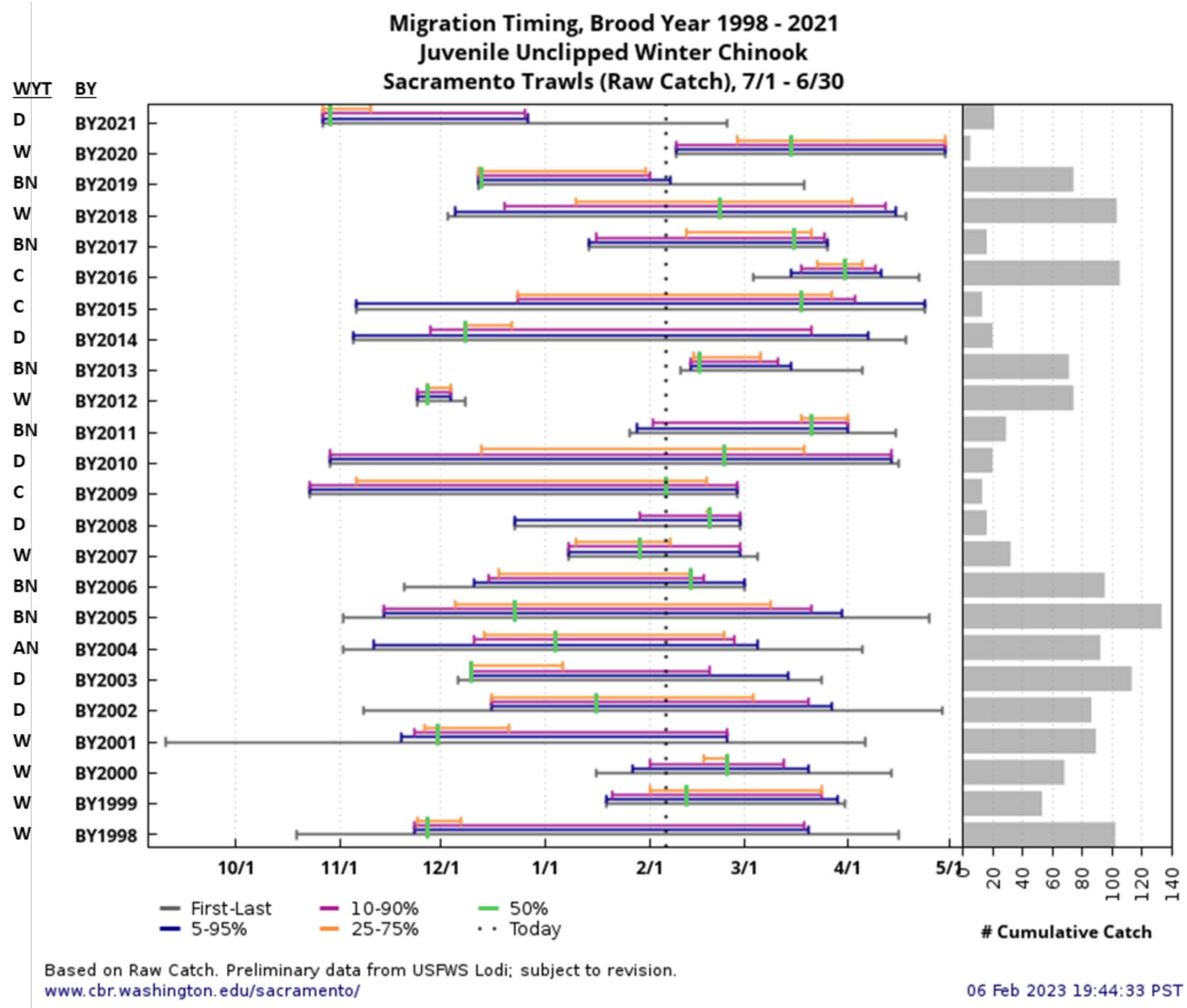
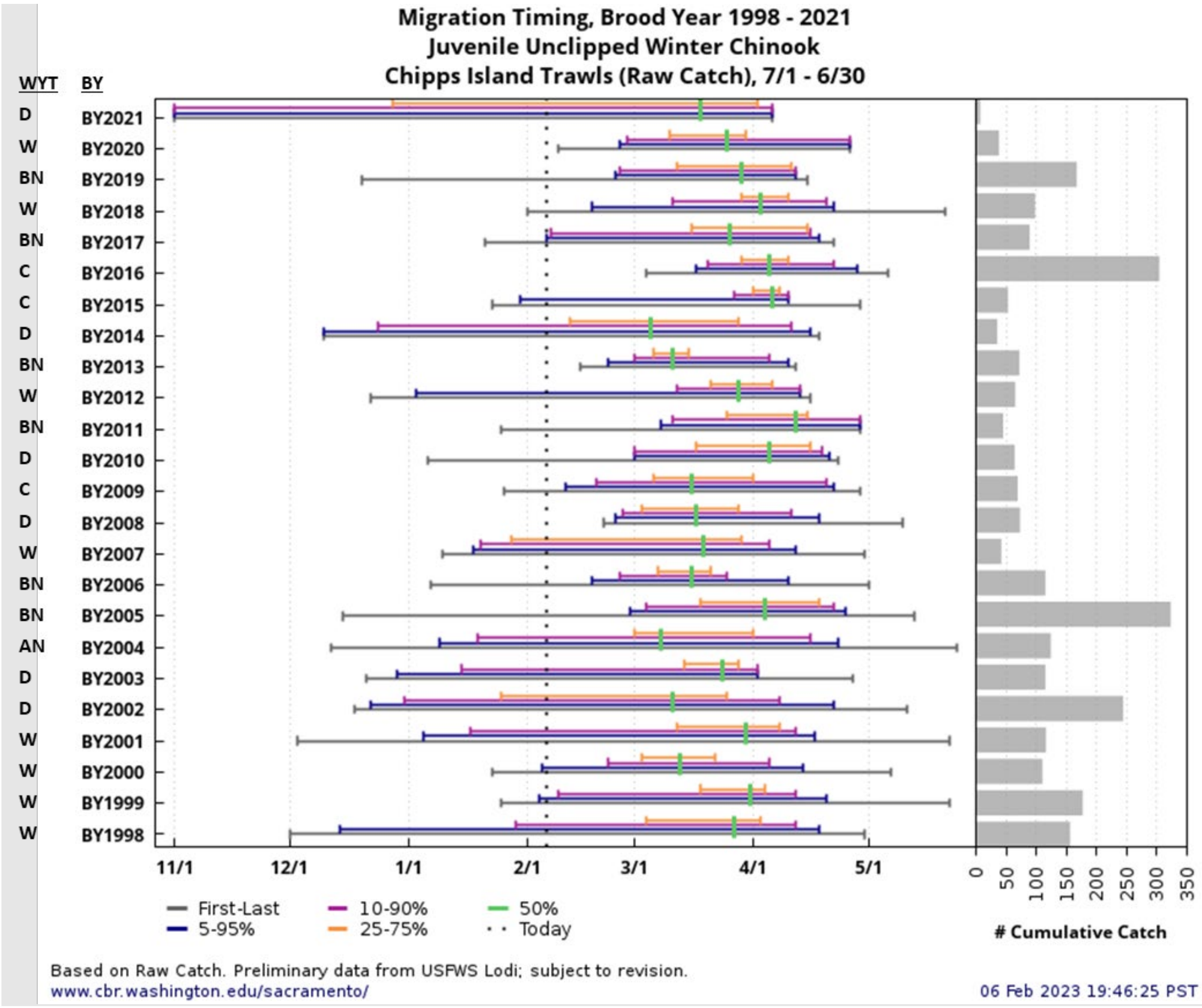


Figure WR4. Catch Index Timing and Number of Unclipped Juvenile Winter-Run Chinook Salmon in Chipps Island Trawls, Brood Years 1998 through 2021.



<u>Impacts of TUCP on Winter-Run Chinook Salmon</u>

Per the presence summary above, in water year 2023 individuals migrating during February could experience reduced through-Delta survival based on factors such as increasing reverse flows and slower mean flow velocity, both of which have been shown to result in longer travel times (Romine et al. 2013; Perry et al. 2018) as a result of the TUCP, and thereby increasing predation risk relative to base conditions. Hydrological modeling results for the Sacramento River at Freeport and Delta Cross Channel gate opening status were used to estimate through-Delta survival based on the model of

Perry et al. (2018).[2] Estimates of through-Delta survival from this model integrate flow impacts on North Delta hydrodynamics, including channel flow and proportion of flow entering distributaries such as Georgiana Slough. Note that this model does not include South Delta exports.

Results from applying the Perry et al. (2018) model indicated that the differences in Freeport flow may result in lower through-Delta survival probability of juvenile Chinook salmon for the TUCP than the base case (0.02 [i.e., 2 percent absolute difference], or 4 percent relative difference) in February, with little or no difference in other months (**Table WR3**). These results reflect flow-survival relationships and the probability of entry into low-survival pathways. With respect to the latter, the Perry et al. (2018) model estimated juvenile Chinook salmon entry into the low-survival interior Delta through Georgiana Slough and the Delta Cross Channel from the Sacramento River would be greater in February (0.01, or 4 percent relative difference) under the TUCP relative to the base case (**Table WR4**); these patterns are part of the through-Delta survival estimates.

Table WR3. Mean Monthly Probability of Through-Delta Survival of Juvenile Chinook Salmon Based on Freeport Flow and Delta Cross Channel Position from the Model of Perry et al. (2018).

Month	Base	TUCP
February	0.51	0.49 (-4%)
March	0.45	0.45 (0%)
April	0.38	0.38 (1%)

Note: Percentage difference in parentheses represents TUCP minus base.

Table WR4. Mean Monthly Probability of Juvenile Chinook Salmon Entering the Interior Delta Through Georgiana Slough and the Delta Cross Channel Based on Freeport Flow and Delta Cross Channel Position from the Model of Perry et al. (2018).

Month	Base	TUCP
February	0.22	0.23 (4%)
March	0.24	0.24 (0%)
April	0.28	0.27 (-1%)

Note: Percentage difference in parentheses represents TUCP minus base.

[2] The North Delta Routing Management Tool is a spreadsheet-based tool that was provided by Perry (pers. comm.) and reproduces the mean response of the STARS (Survival, Travel time, And Routing Simulation) model (Perry et al. 2019). Note that the statistical relationships in the model were based on large hatchery-origin late fall Chinook salmon smolts that migrated through the Delta during December–March, so survival of other runs could have a different response to operations (Perry et al. 2019: 14).

As noted in the 2015 TUCP biological reviews, at low outflow (i.e., decreased as a result of decreased riverine inflow), channel margin habitat becomes exposed and is unavailable for juvenile salmonids that are present. This lack of cover in habitat may reduce juvenile survival. The 2015 TUCP biological reviews hypothesized that lower outflows may intensify the density of littoral predators into a smaller, shallower area and/or decrease the quantity of cover available to outmigrating salmonids to avoid predators but noted that there is a high level of uncertainty in this conclusion. Note that such effects may be represented to some unknown extent by the flow-dependent survival relationships in the through-Delta survival model results described above.

The TUCP would have more negative OMR flows (**Table WR5**) than the base case (Table WR5) and therefore greater potential for entrainment. However, in order to minimize entrainment loss of juvenile winter-run Chinook salmon, real-time monitoring and weekly risk assessment is required by the 2020 ROD and 2020 CDFW ITP in order to determine South Delta operational adjustments; this would continue under the TUCP, limiting entrainment to low levels. Operational triggers and daily loss set on the lowest recorded incidental take limit for natural origin juvenile winter-run Chinook salmon on record, along with triggers for juvenile hatchery winter-run Chinook salmon releases and potentially spring-run protection releases, genetic analysis, and applicable OMR limits are set to minimize entrainment and to quickly respond if detections occur. Therefore, although Table WR5 indicates Old and Middle River flows of -5,000 cfs in February and March for the TUCP, less negative flows would occur consistent with applicable permits if required to reduce winter-run Chinook salmon entrainment risk. As residence time is driven largely by the time of entry and juvenile winter-run Chinook salmon generally exit within a narrow window (del Rosario et al. 2013), the changes in outflow for the period of the February and March 2023 TUCP are not expected to result in changes to the general period observed for their outmigration.

Table WR5. February through April 2022 Old and Middle River Flows (cfs).

Month	**Base**	**TUCP**
February	100	-5,000
March	-1,500	-5,000
April	50	-350

Based on timing information in Table WR2 above, the TUCP period would coincide with the highest relative abundance of adult winter-run Chinook salmon migrating through the Delta. Delta Cross Channel operations would not differ between the base case and the TUCP, thus there would not be any difference between these cases in delay of adult winter-run Chinook salmon that may move upstream via the Mokelumne River when the Delta Cross Channel is open. There is little information from which to infer the potential for adult winter-run Chinook salmon migratory delay because of reductions in Delta inflow (e.g., reduced upstream migration cues), although the available information for hatchery-origin fall-run Chinook salmon released north of the Delta indicates straying rates of fish returning to the Sacramento River (compared to straying into the San

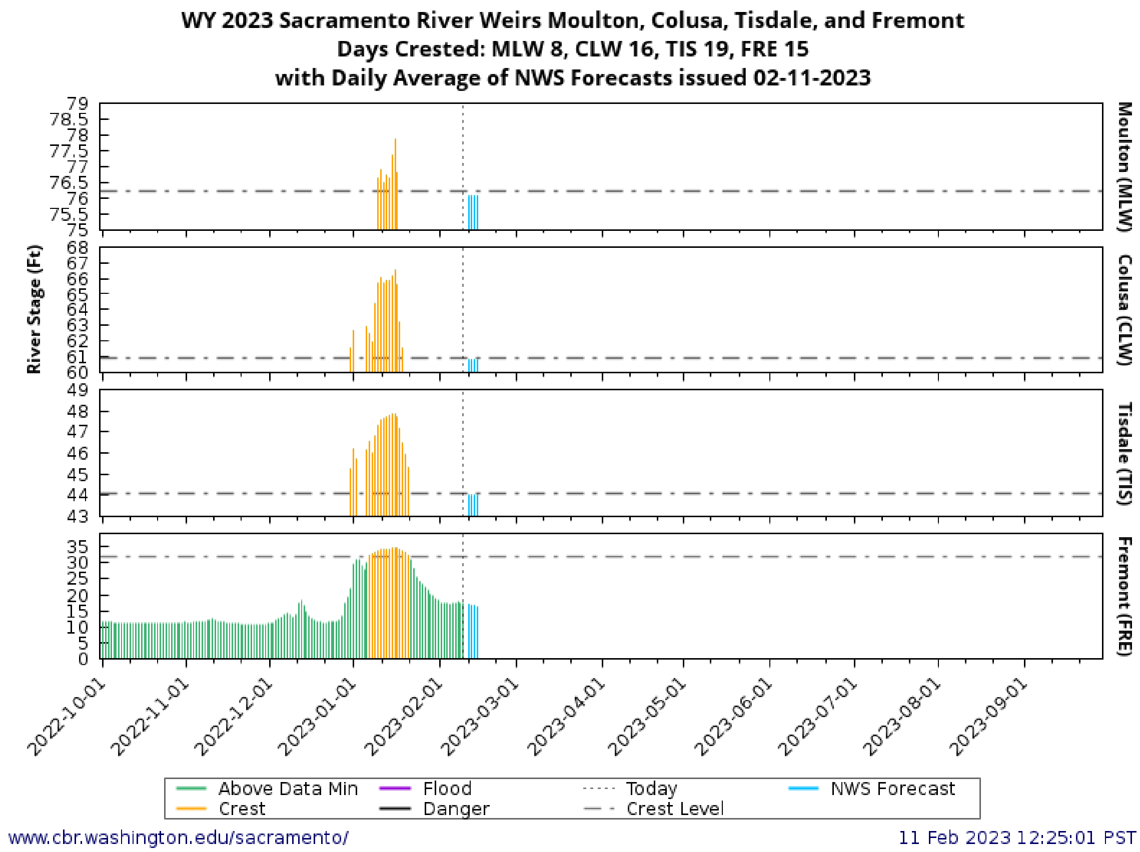
Joaquin River) are relatively low (Marston et al. 2012). Further, within the Sacramento River basin, Williamson and May (2005) found that off-site release of hatchery-reared juveniles was the primary factor associated with adult straying rates of fall-run populations. This suggests relatively little influence of flows and therefore no likely difference between the TUCP and the base case for winter-run Chinook salmon adults returning during the TUCP period.

Conclusions for Winter-Run Chinook Salmon

In the Delta, a large portion of WY 2022 juvenile winter-run Chinook salmon may be in or migrating through the Delta during the 2023 TUCP period, although entry into the Delta had already begun in appreciable numbers.[3] Hatchery juvenile winter-run Chinook salmon will also be entering and traversing through the Delta during the 2023 TUCP period. While entrainment risk is greater under the TUCP case, these juvenile winter-run Chinook salmon in the Delta would not experience risk of high levels of entrainment at the South Delta export facilities during the TUCP period because of continued implementation of entrainment risk assessment and operations adjustments. Efforts to quickly identify listed salmon runs through genetic analysis of salvaged juvenile Chinook salmon is occurring to more effectively manage species protection and operations; and as of February 8, 2023, no genetically confirmed juvenile winter-run Chinook salmon have been salvaged in water year 2023. Sacramento River flows were sufficient to allow overtopping of Fremont Weir into the Yolo Bypass for a period of the downstream migration period (**Figure WR5**) which may have provided benefits to juvenile winter-run Chinook salmon while also providing an alternate pathway isolated from Georgiana Slough, thereby potentially reducing overall entrainment into the interior Delta for some of the cohort. Through-Delta survival of juveniles migrating during February could be less than the base case though because of less Delta inflow resulting in negative changes to North Delta hydrodynamics, including greater entry into the interior Delta through Georgiana Slough. Migration conditions for adult winter-run Chinook salmon adults generally would be similar under the base case and TUCP.

[3] As previously noted, as of January 31, 2023, it was estimated that 60 percent of juvenile winter-run Chinook salmon had entered the Delta.

Figure WR5. Sacramento Weir Overtopping periods, October 2022 through February 11, 2023.



Spring-Run Chinook Salmon

<u>Presence and Life Stages of Spring-Run Chinook Salmon</u>

The Salmon Monitoring Team, which meets weekly, estimated on February 07, 2023, 58-75 percent of young-of-the-year (YOY) spring-run Chinook salmon were yet to enter the Delta, 25-40 percent were in the Delta, and 0-2 percent had exited the Delta (**Figure SR1**). Historical migration timing data suggest that the greatest period of abundance for young-of-the-year in the Delta is April and May (**Tables SR1 and SR2**; **Figures SR2, SR3, and SR4**). The footnote for Table SR1 indicates that yearling downstream emigration generally occurs in fall and winter, resulting in considerably less potential overlap with the 2023 TUCP period than for young-of-the-year juveniles. Adult presence in the Delta is relatively high in February and March, extending into June (Table SR2).

Figure SR1. Salmon Monitoring Team Estimates of the Percentage of Juvenile Spring-Run Chinook Salmon Yet to Enter the Delta, In Delta, and Exited Delta.

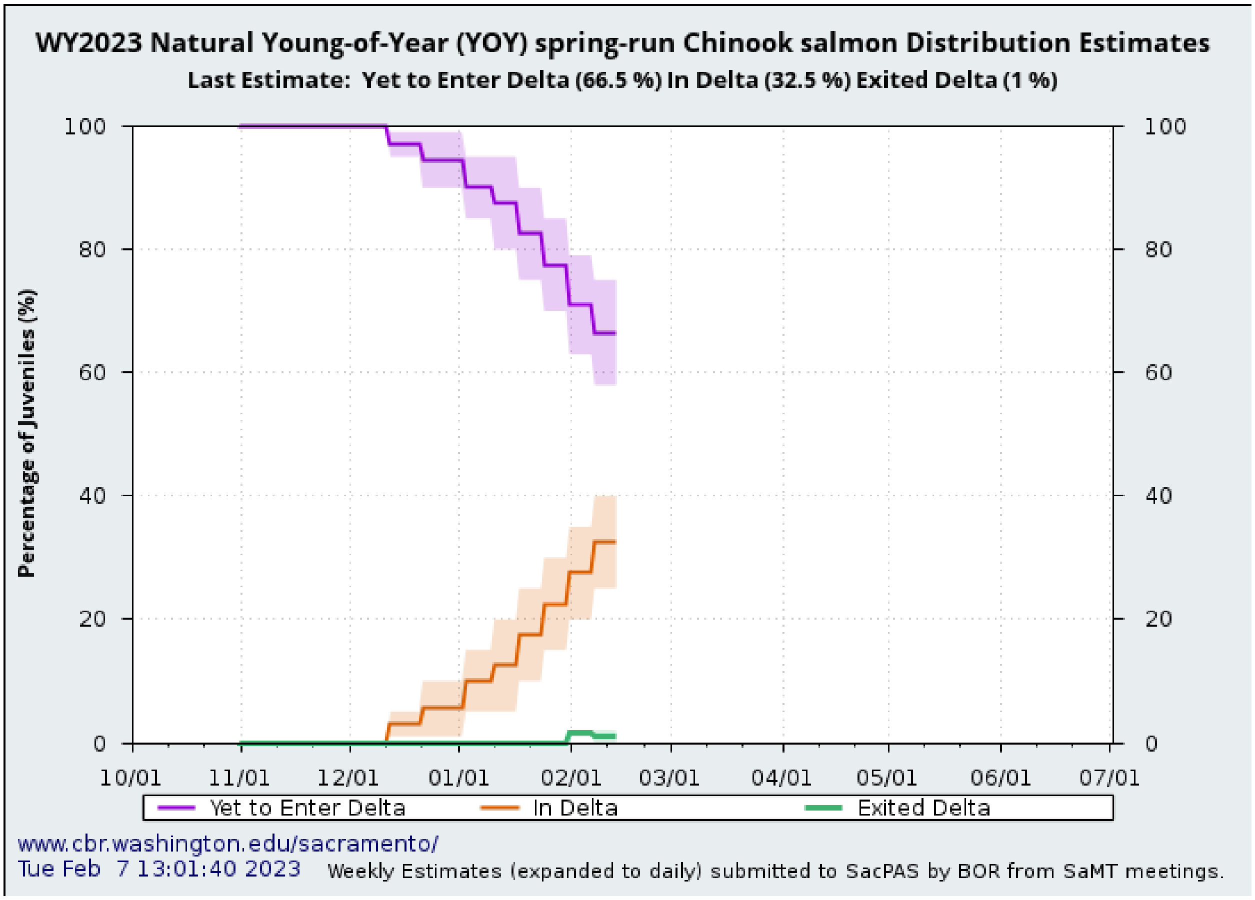


Table SR1. Temporal Occurrence of Central Valley Spring-Run Chinook Salmon by Life Stage in the Sacramento River

Relative Abundance	High (▼)								Medium (☒)								Low (#)						None (-)		
(a) Adult Migration	Month																							
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River Basin [a,b]	-	-	-	-	☒	☒	☒	☒	▼	▼	▼	▼	☒	☒	☒	☒	☒	☒	#	-	-	-	-	-
Sac. River Mainstem [b,c]	-	#	#	#	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	#	#	-	-	-	-	-	-	-	-
Adult Holding [a,b]	-	-	#	#	☒	☒	▼	▼	▼	▼	▼	▼	▼	▼	▼	☒	☒	#	#	-	-	-	-	-
Adult Spawning [a,b,c]	-	-	-	-	-	-	-	-	-	-	-	-	-	-	#	☒	▼	▼	☒	#	-	-	-	-
(b) Juvenile Migration	Month																							
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River at Red Bluff Diversion Dam [c]	▼	▼	#	#	#	#	#	#	#	-	-	-	-	-	-	-	-	-	-	-	▼	▼	▼	▼
Sac. River at Knights Landing[h]	☒	☒	☒	☒	▼	▼	▼	▼	☒	☒	-	-	-	-	-	-	-	-	-	-	☒	☒	▼	▼

Sources: [a] Yoshiyama et al. (1998); [b] Moyle (2002); [c] Myers et al. (1998); [d] Lindley et al. (2004); [e] California Department of Fish and Game (1998); [f] McReynolds et al. (2007); [g] Ward et al. (2003); [h] Snider and Titus (2000b)

Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young-of-the-year spring-run Chinook salmon emigrate during the first spring after they hatch.

Source: National Marine Fisheries Service 2019:83.

Table SR2. Temporal Occurrence of Central Valley Spring-Run Chinook Salmon by Life Stage in the Delta

Relative Abundance	High (▼)			Medium (☒)		Low (#)		None (-)			
Life Stage	Month										
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult [1]	☒	▼	▼	▼	☒	☒	-	-	-	-	-	-
Juvenile [2]	#	#	#	▼	☒	-	-	-	-	-	-	#
Salvaged [3]	#	#	☒	▼	☒	-	-	-	-	-	-	-

[1]*Adults enter the Bay late January to early February* (California Department of Fish and Game 1998) *and enter the Sacramento River in March* (Yoshiyama et al. 1998). *Adults travel to tributaries as late as July* (Lindley et al. 2004). *Spawning occurs September to October* (Moyle 2002).
[2]*Juvenile presence in the Delta based on Delta Juvenile Fish Monitoring Program data.*
[3]*Juvenile presence in the Delta based on salvage data* (National Marine Fisheries Service 2016a).

Source: National Marine Fisheries Service 2019:84.

Figure SR2. Catch Index Timing and Number of Unclipped Juvenile Spring-Run Chinook Salmon in Sacramento Beach Seines, Brood Years 1998 through 2021.

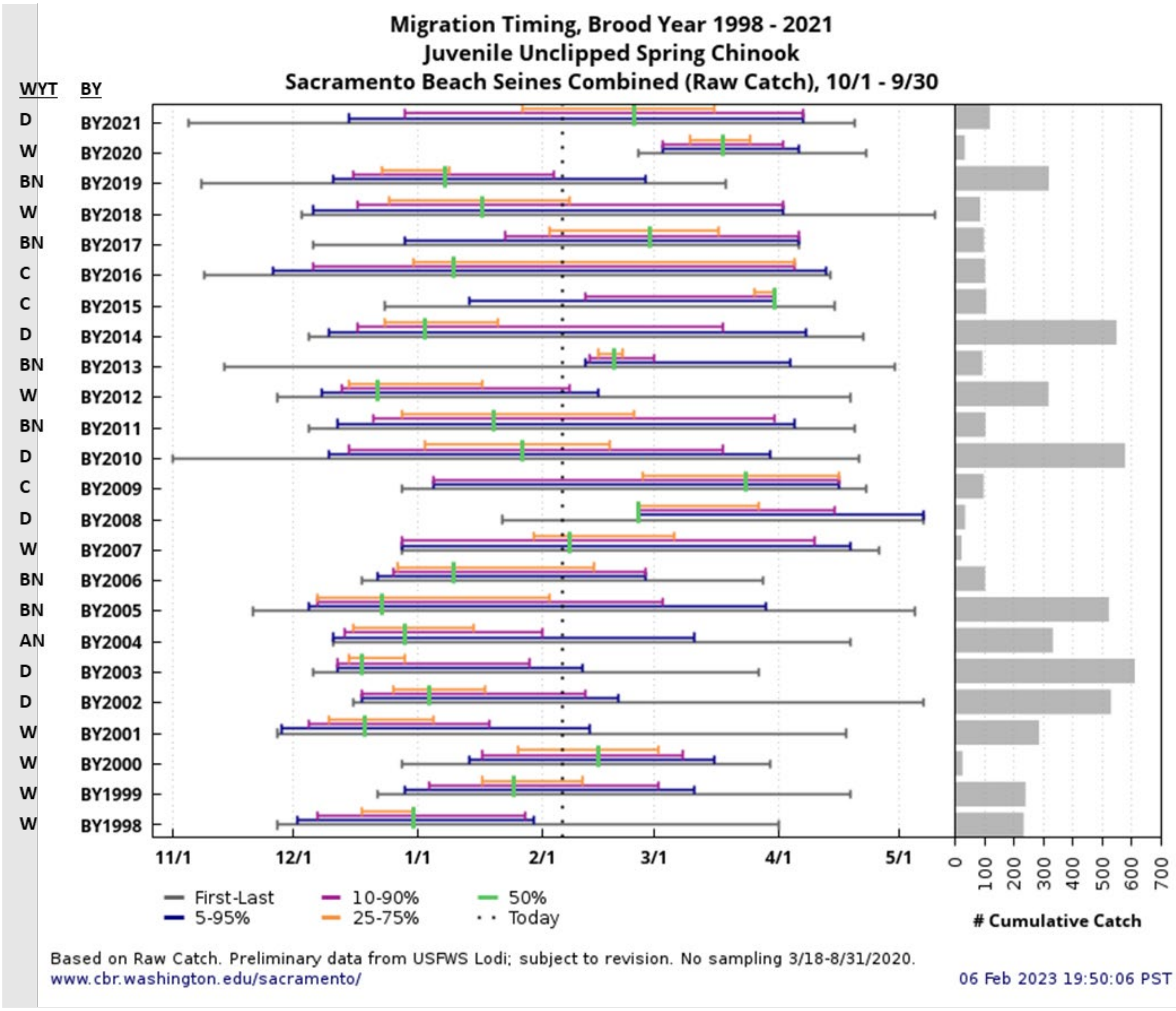


Figure SR3. Catch Index Timing and Number of Unclipped Juvenile Spring-Run Chinook Salmon in Sacramento Trawls at Sherwood Harbor, Brood Years 1998 through 2021.

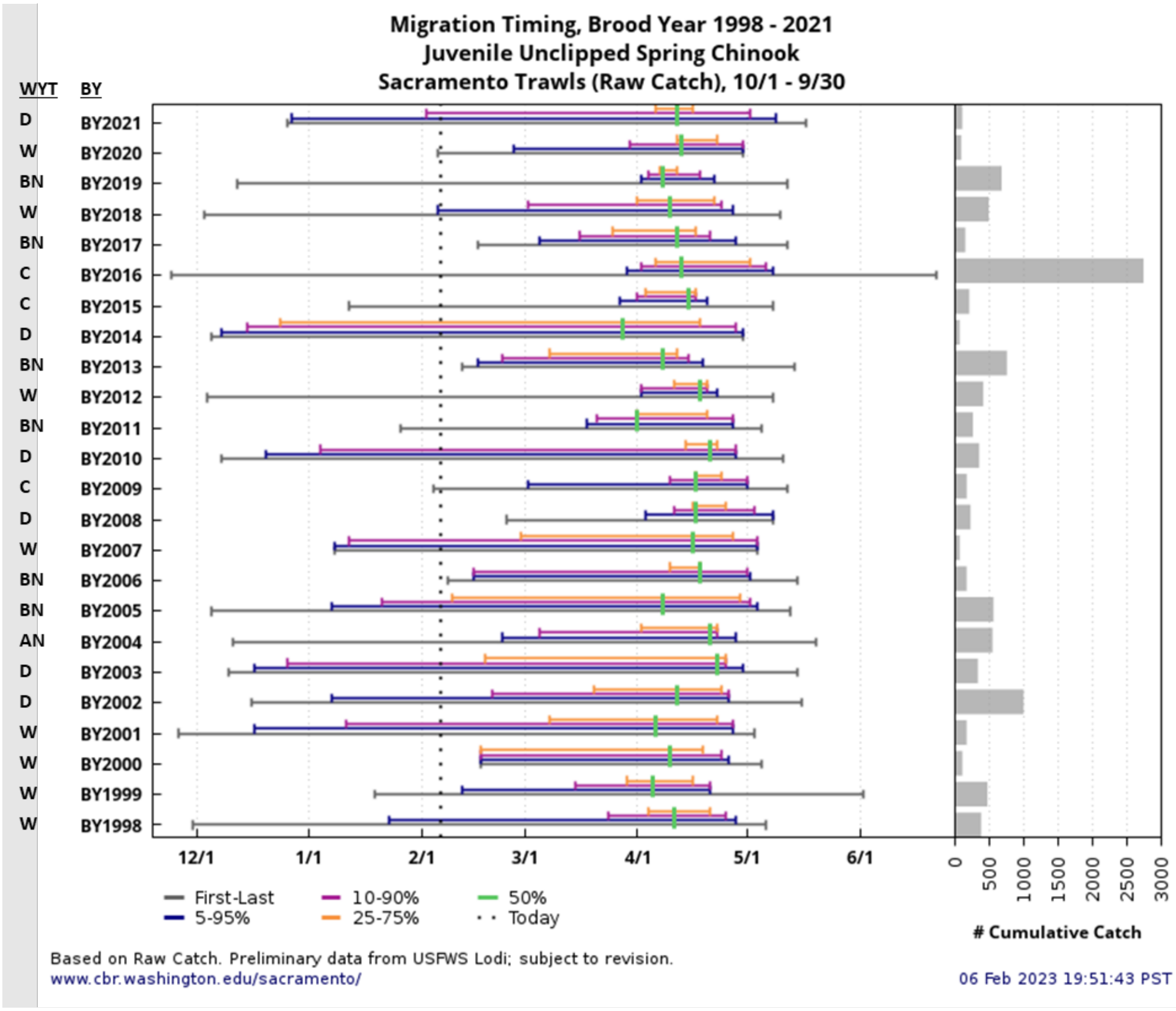
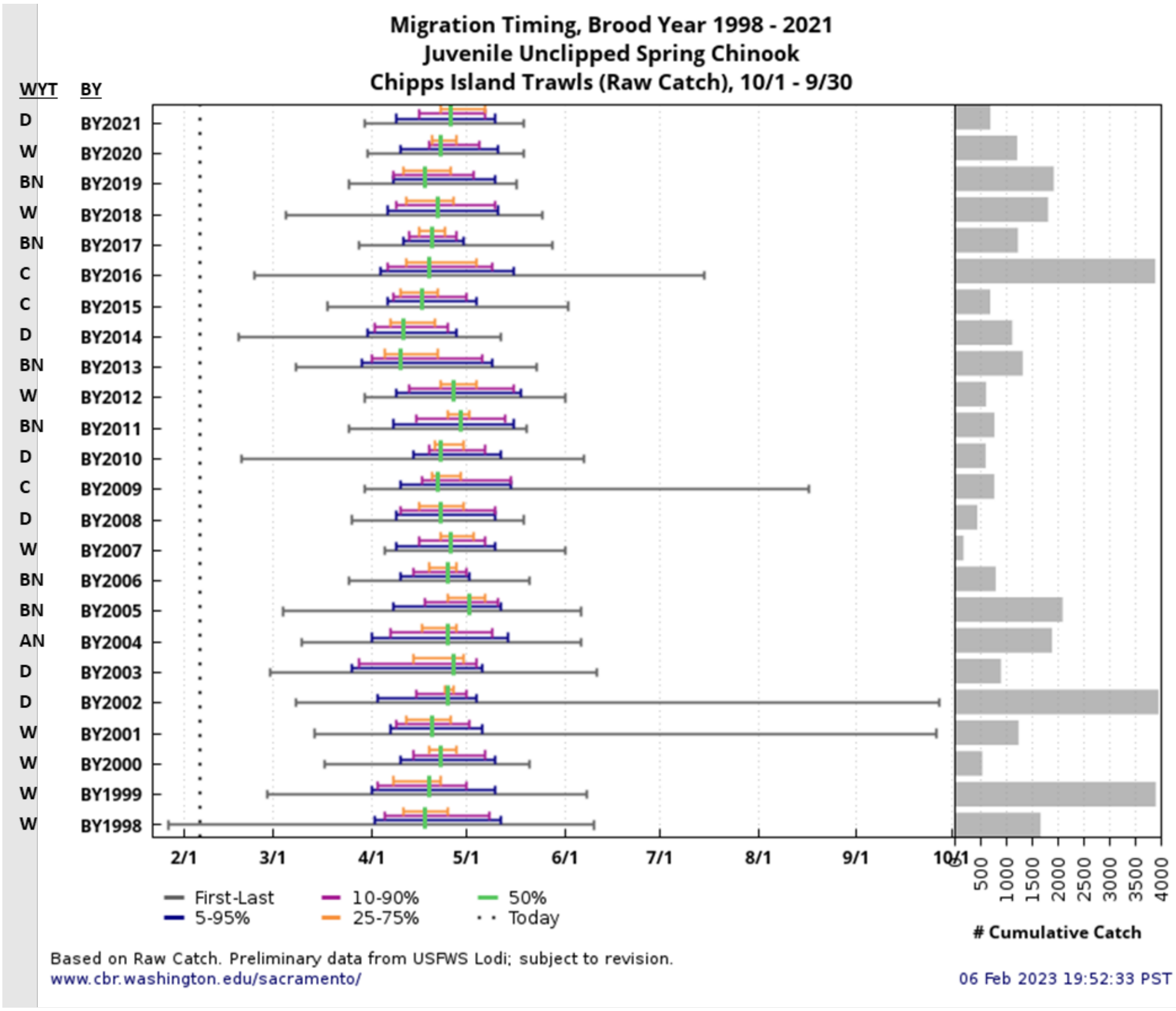


Figure SR4. Catch Index Timing and Number of Unclipped Juvenile Spring-Run Chinook Salmon in Chipps Island Trawls, Brood Years 1998 through 2021.



Impacts of TUCP on Spring-run Chinook Salmon

Within the Delta, there is potential for similar types of impacts to young-of-the-year juvenile spring-run Chinook salmon and habitat as discussed previously for winter-run. The footnote for Table SR2 indicates that yearling spring-run Chinook salmon downstream emigration generally occurs in fall and winter, although monitoring outside of tributaries does not sample yearlings consistently. In the February 07, 2023, Weekly Assessment, the Salmon Monitoring Team[4] noted that yearling spring-run Chinook salmon are thought to be migrating through the Delta. The Salmon Monitoring Team also noted that spring-run Chinook salmon fry have completed egg emergence and fry are rearing in tributary streams, young-of-the-year juveniles on the Sacramento River are beginning their downstream migration and have been observed in the real-time monitoring stations indicating Delta entry is occurring. Hatchery-origin surrogate

[4] See https://wildlife.ca.gov/Conservation/Watersheds/Water-Operations.

yearling spring-run were released from the Coleman National Fish Hatchery into Battle Creek on December 5, 2022, December 23, 2022, and January 13, 2023, with a cumulative total of 198,504 fish. The last detection of these releases at salvage occurred on January 14, 2023. Hatchery origin Chinook salmon survival data (https://oceanview.pfeg.noaa.gov/CalFishTrack) from acoustically tagged seasonal survival study fish, week 1, released on December 13, 2022, were last detected at Benicia on January 8, 2023. In water years 19-22, acoustically tagged seasonal survival study, week 1 fish, and late-fall Chinook salmon released as yearling spring-run surrogates in December and January were last detected at Benicia in mid-February (February 18). Elevated tributary and Delta outflow in January, detection data from acoustic studies, as well as salvage data from water year 2023 suggest that the majority of yearling spring-run Chinook salmon migration may have occurred, although some overlap may occur with the onset of the TUCP period.

The peak of young-of-year spring-run Chinook salmon abundance in the Delta occurs in April (Table SR2). Entrainment of any migrating spring-run Chinook salmon at the South Delta export facilities during the TUCP would be low because of the continued entrainment risk management (see discussion for winter-run Chinook salmon). As with winter-run Chinook salmon, through-Delta survival modeling suggests young-of-the-year Sacramento River basin juvenile spring-run Chinook salmon through-Delta survival could be reduced as a result of the TUCP (Table WR3), reflecting factors such as increased entry into lower survival pathways in the interior Delta (Table WR4). As noted for winter-run Chinook salmon, the available through-Delta survival modeling tools do not account for South Delta entrainment, although as noted above, South Delta entrainment would be low because of entrainment risk management.

Small numbers of juvenile spring-run Chinook salmon may also be emigrating from the San Joaquin River basin. Potential impacts of the TUCP were assessed with the Structured Decision Model Routing Application (see California Department of Water Resources 2020, Appendix E, Section E.4.6 *Structured Decision Model (Chinook Salmon Routing Application)* for method description). The results from this model suggested that through-Delta migration survival of juvenile spring-run Chinook salmon from the San Joaquin River basin would be minimal under the base case and the TUCP (**Table SR3**), consistent with recent results from acoustic telemetry studies (Buchanan et al. 2018). There were small absolute differences in estimates of through-Delta survival between the base case and the TUCP, with greater survival than the base case under the TUCP in February and March reflecting the positive relationship between South Delta exports and survival represented in the model. Overall, however, any differences between scenarios would be minimal relative to the very low survival that is estimated.

Based on timing information in Table SR2 above, the highest relative abundance of adult spring-run Chinook salmon would be migrating through the Delta during the TUCP period. As discussed for winter-run Chinook salmon, Delta Cross Channel operations would not differ between the base case and the TUCP, thus there would not be any difference between these cases in delay of adult spring-run Chinook salmon that may move upstream via the Mokelumne River when the Delta Cross Channel is open. There is little information from which to infer the potential for adult spring-run Chinook salmon migratory delay because of reductions in Delta inflow (e.g., reduced upstream migration cues), although the available information for hatchery-origin fall-run Chinook salmon released north of the Delta indicates stray rates of fish returning to the Sacramento River (compared to straying into the San Joaquin River) are relatively low (Marston et al. 2012). Further, within the Sacramento River basin, Williamson and May (2005) found that off-site release of hatchery-reared juveniles was the primary factor associated with adult straying rates of fall-run populations. This suggests relatively little influence of flows and therefore no likely difference between TUCP options and the base case for spring-run Chinook salmon adults returning during the TUCP period. Straying of adult spring-run Chinook salmon returning to the San Joaquin River basin has not been studied in relation to flows in the same way it has been for fall-run adults (Marston et al. 2012). However, if similar mechanisms apply as for fall-run Chinook salmon (Marston et al. 2012), there may be greater potential for straying under the TUCP because of greater South Delta exports.

Table SR3. Mean Monthly Probability of Through-Delta Survival of Juvenile Chinook Salmon from the San Joaquin River Basin Based on the Structured Decision Model Routing Application.

Month	Base	TUCP
February	0.0202	0.0342 (70%)
March	0.0068	0.0319 (368%)
April	0.0055	0.0055 (1%)

Note: Percentage difference in parentheses represents TUCP minus base.

Conclusions for Spring-run Chinook Salmon

In the Delta, a large portion of WY 2022 juvenile spring-run Chinook salmon may be in or migrating through the Delta during the TUCP period. Yearling Spring-run surrogates have been observed in salvage starting on December 9, 2022, with the last observation on January 14, 2023. This, with consideration of data from acoustically tagged seasonal survival study (week 1) and late-fall surrogate releases in water years 2019 through 2022, may be an indication that the surrogate groups have largely outmigrated. Spring-run Chinook salmon in the Delta would not experience risk of high levels of South Delta entrainment in February and March 2023, because of continued implementation of entrainment risk assessment and operations adjustments from the 2019 NMFS BiOp and the 2020 CDFW ITP. Through-Delta survival of juveniles migrating from the Sacramento River basin during February under the TUCP could be less than the base case because of less Delta inflow affecting North Delta hydrodynamics, including greater entry into the interior Delta through Georgiana Slough. Through-Delta survival for juveniles emigrating from the San Joaquin River basin would be very low with or without the TUCP. Migration conditions for adult spring-run Chinook salmon adults generally would be similar under the base case and TUCP. Greater South Delta exports under the TUCP could result in greater straying potential for adult spring-run Chinook returning to the San Joaquin River basin, should similar mechanisms exist as observed for fall-run Chinook salmon in the fall.

Southern Distinct Population Segment Green Sturgeon

Presence and Life Stages of Green Sturgeon

There are relatively limited monitoring data available for Southern Distinct Population Segment (sDPS) green sturgeon. In the Delta, juveniles and adults may occur year-round (**Tables GS1 and GS2**). The main adult upstream migration to spawning grounds primarily in the upper Sacramento River is late winter to early summer (Heublein et al. 2017a) and peaks in March (Colborne et al. 2022). Therefore, juveniles and adults overlap the period of the TUCP.

Table GS1. Temporal Occurrence of Southern Distinct Population Segment Green Sturgeon by Life Stage

Relative Abundance	High (▼)						Medium (⊠)							Low (#)						None (-)				
Life-Stage: (a) Adult-sexually mature[1]	Month																							
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac River (river mile 332.5-451)	#	#	#	#	⊠	⊠	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	⊠	⊠	⊠
Sac River (<river mile 332.5)	#	#	#	⊠	⊠	⊠	⊠	⊠	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#
Sac-SJ-SF Estuary	#	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	#	#
(b) Larva	Month																							
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac River (<river mile 332.5)	-	-	-	-	-	#	⊠	⊠	▼	▼	▼	▼	▼	▼	⊠	⊠	⊠	⊠	#	#	-	-	-	-
(c) Juvenile (≤5 months old)	Month																							
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac River (<river mile 332.5)	-	-	-	-	-	-	-	#	⊠	⊠	⊠	⊠	▼	▼	▼	▼	▼	▼	▼	⊠	⊠	⊠	⊠	⊠
(d) Juvenile (≤5 months old)	Month																							
Sac River (<river mile 391)	⊠	⊠	⊠	⊠	#	#	#	#	#	#	#	⊠	⊠	⊠	⊠	▼	▼	▼	▼	▼	▼	▼	▼	#
(e) Sub-Adults and Non-spawning adults	Month																							
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac-SJ-SF Estuary	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	▼	⊠	⊠
Pacific Coast	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠
Coastal Bays & Estuaries	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	▼	▼	▼	▼	▼	▼	▼			▼	▼ ▼	▼ ▼	⊠	⊠

[1] *Sexually mature adults (≥4.8 feet TL females, ≥ 3.9 feet TL males including pre- and post- spawning individuals)*

Sources: (a) (Heublein et al. 2009); (DuBois and Danos 2018; Klimley et al. 2015a; Mora et al. 2018; Poytress et al. 2015); (b) (Heublein et al. 2017; Poytress et al. 2015); (c) (Heublein et al. 2017; Poytress et al. 2015); (d) (California Department of Fish and Game 2002; Heublein et al. 2017; Poytress et al. 2015; Radtke 1966); (e) (DuBois and Danos 2018; Erickson and Webb 2007; Huff et al. 2011; Lindley et al. 2011; Lindley et al. 2008; Moser and Lindley 2007). Outside of Sac-SJ-SF estuary (e.g. Columbia R., Grays Harbor, Willapa Bay).

Source: National Marine Fisheries Service 2019:113–114.

Table GS2. Temporal Occurrence of Southern Distinct Population Segment Green Sturgeon by Life Stage in the Delta

Relative Abundance	High (▼)	Medium (☒)	Low (#)	None (-)

Life Stage	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult [1]	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Juvenile [2]	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒	☒
Salvaged [3]	#	#	#	#	#	-	☒	▼	#	#	#	#

[1]*Adult presence was determined to be year round according to information in (California Department of Fish and Game 2008; California Department of Fish and Game 2009; California Department of Fish and Game 2010a; California Department of Fish and Game 2011; California Department of Fish and Game 2012; California Department of Fish and Wildlife 2013a; California Department of Fish and Wildlife 2014a; Lindley et al. 2008; Moyle 2002).*
[2]*Juvenile presence in the Delta was determined to be year round by using information in (USFWS Delta Juvenile Fish Monitoring Program data), (Moyle et al. 1995; Radtke 1966).*

Source: National Marine Fisheries Service 2019:115.

Impacts of TUCP on sDPS Green Sturgeon

Juvenile and sub-adult green sturgeon rearing in and utilizing the Delta as part of their critical habitat are expected to have limited effects from the TUCP changes to Delta flows relative to the base case, although there is uncertainty. In most of the Delta where juvenile green sturgeon are expected to be rearing, flows are tidally dominated and therefore, changes in riverine inflow would have minimal to no effect. However, there is low certainty in understanding of the juvenile and sub-adult green sturgeon biological processes affected by flow in the Delta. Evaluation of green sturgeon salvage data from recent years (January 2010 through February 8, 2023) showed a total of 3 green sturgeon were sampled and extrapolated to a salvage of 12 green sturgeon at the CVP Tracy Fish Collection Facility,[5] with one sampled fish extrapolated to a salvage of 4 at the SWP Skinner Delta Fish Protective Facility. No salvage of green sturgeon has occurred at either facility since July 2020. Salvage of these green sturgeon occurred during January at the SWP, and June or July at the CVP, which if representative of the period of greatest entrainment, indicates no overlap with the TUCP period. Overall, the available information suggests there would be very low or zero salvage expected under the TUCP or base case.

The NMFS's DPS green sturgeon recovery plan suggested that green sturgeon larval abundance and distribution may be influenced by spring and summer outflow, and recruitment may be highest in wet years, making water flow an important habitat parameter (National Marine Fisheries Service 2018: 12). As noted by NMFS (National Marine Fisheries Service 2018: 12), there are correlations between white sturgeon year-class strength and Delta outflow, which have previously been used to infer potential impacts on green sturgeon (ICF International 2016: 5-197 to 5-205). The largest

[5] See https://apps.wildlife.ca.gov/Salvage/Chart/AcrefeetSalvage?Adipose=All&SampMethod=2&orgCode=28&orgDes=Green%20Sturgeon&endDate=02%2F08%2F2023%2000%3A00%3A00&StartDate=01%2F01%2F2010%2000%3A00%3A00&ShowValue=False.

sturgeon recruitment occurs in wetter years (Fish 2010; Gingras et al. 2013); if relatively low spring outflow occurs in 2023 than it would be uncertain the extent to which the difference in outflow between the TUCP and the base case would result in differing impacts to green sturgeon compared to the potential impacts that may occur between much broader ranging hydrological conditions (i.e., different water year types). As discussed in more detail for white sturgeon below in the analysis of other native species, application of statistical relationships between white sturgeon year-class strength and Delta outflow gives negative estimates of year-class strength under the base case and the TUCP, suggesting that very little recruitment may occur under either of the cases.

Adult green sturgeon will be potentially present in the Delta throughout the TUCP as they migrate into and out of the Sacramento River and possibly forage in the Delta during the summer. The reductions in outflow through multiple distributaries in the North Delta from the TUCP could increase straying and travel time of green sturgeon in this region during the TUCP period, although this is uncertain.

Conclusions for sDPS Green Sturgeon

Cumulatively, the TUCP's modifications relative to the base case may have limited effects on riverine or through-Delta survival of juvenile sDPS green sturgeon, although there is some uncertainty in the conclusion given the general lack of information on the species. There would be expected to be little to no salvage of sDPS green sturgeon at the South Delta export facilities, consistent with recent years. The reductions in outflow through multiple distributaries in the North Delta from the TUCP could increase straying and travel time of green sturgeon in this region during the TUCP period, although this is uncertain.

Central Valley Steelhead

Presence and Life Stages of Central Valley Steelhead

The Salmon Monitoring Team, which meets weekly, estimated on February 7, 2023, 65-75 percent of young-of-the-year (YOY) Central Valley steelhead (*O. mykiss*) were yet to enter the Delta, 20-25 percent were in the Delta, and 5-10 percent had exited the Delta (**Figure SH1**). Historical abundance in surveys shows juvenile peaks in the Delta during late winter/spring, including the February and March period (**Figures SH2 and SH3**). Salvage may continue into June in low numbers and some juveniles are present in low numbers in the Delta in summer. Adults occur in the Delta in July through March with peak occurrence from September and October (**Table SH2**).

Figure SH1. Salmon Monitoring Team Estimates of the Percentage of Juvenile Steelhead Yet to the Enter the Delta, In Delta, and Exited Delta.

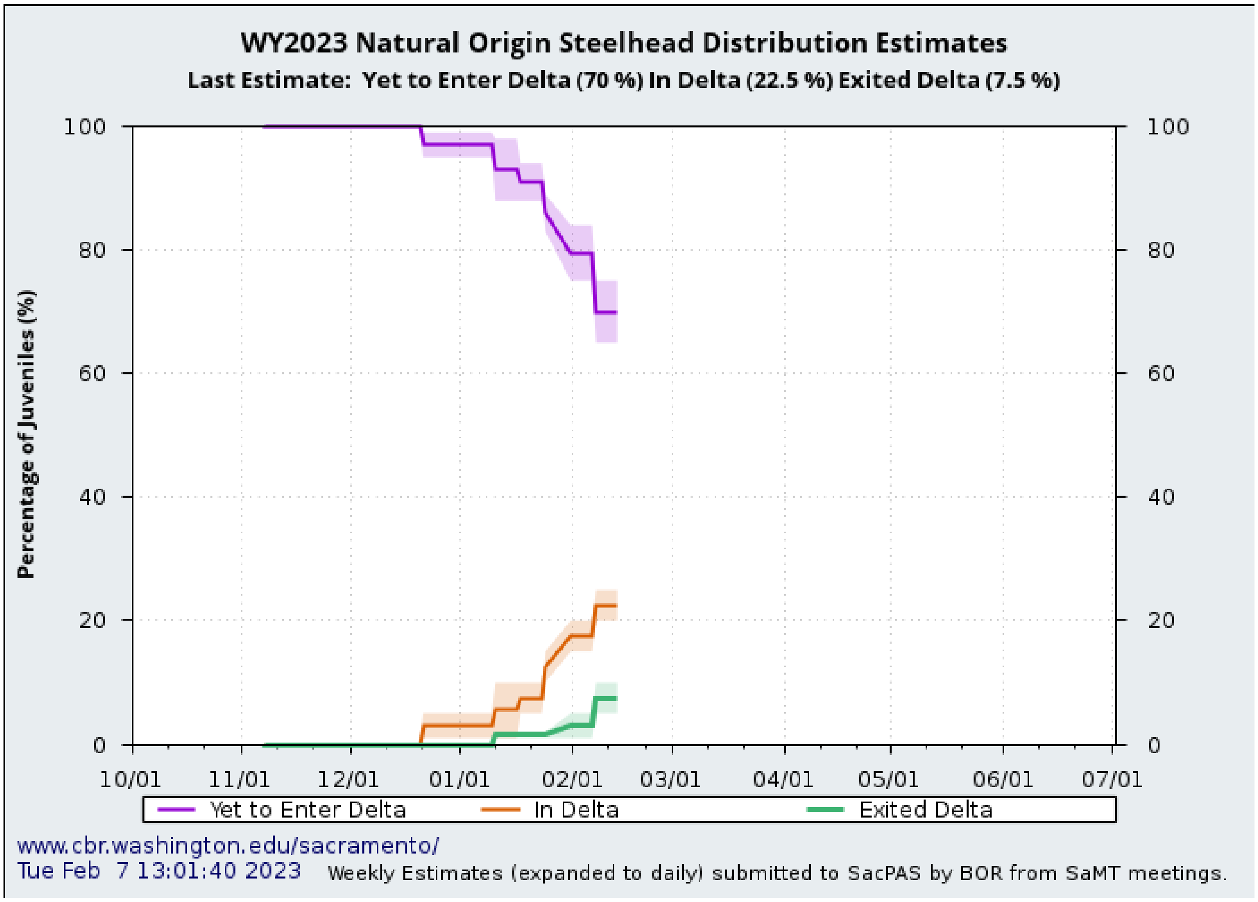


Figure SH2. Catch Index Timing and Number of Unclipped Juvenile Steelhead in Sacramento Beach Seines, Brood Years 1998 through 2022.

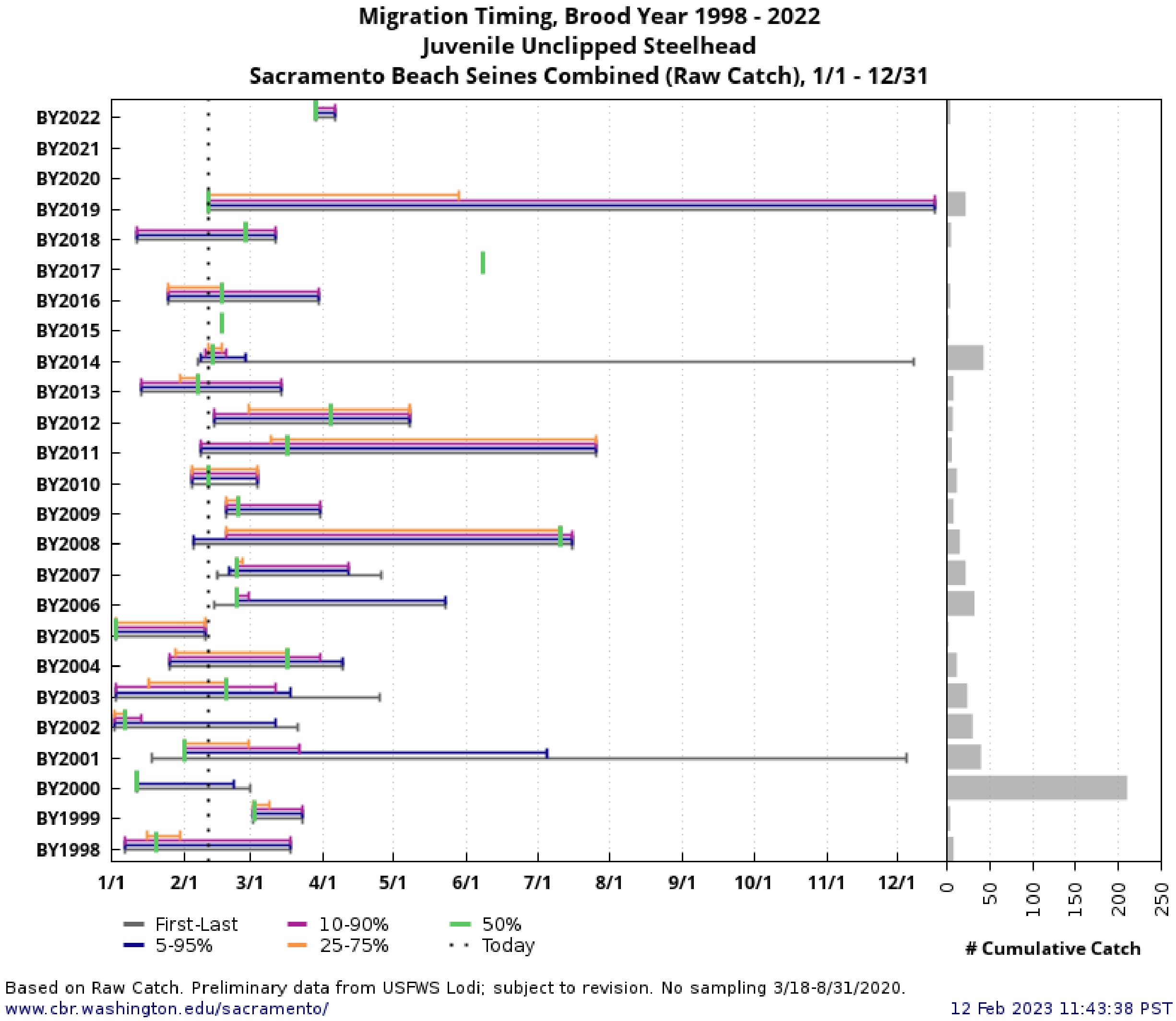


Figure SH3. Catch Index Timing and Number of Unclipped Juvenile Steelhead in Sacramento Trawls at Sherwood Harbor, Brood Years 1998 through 2022.

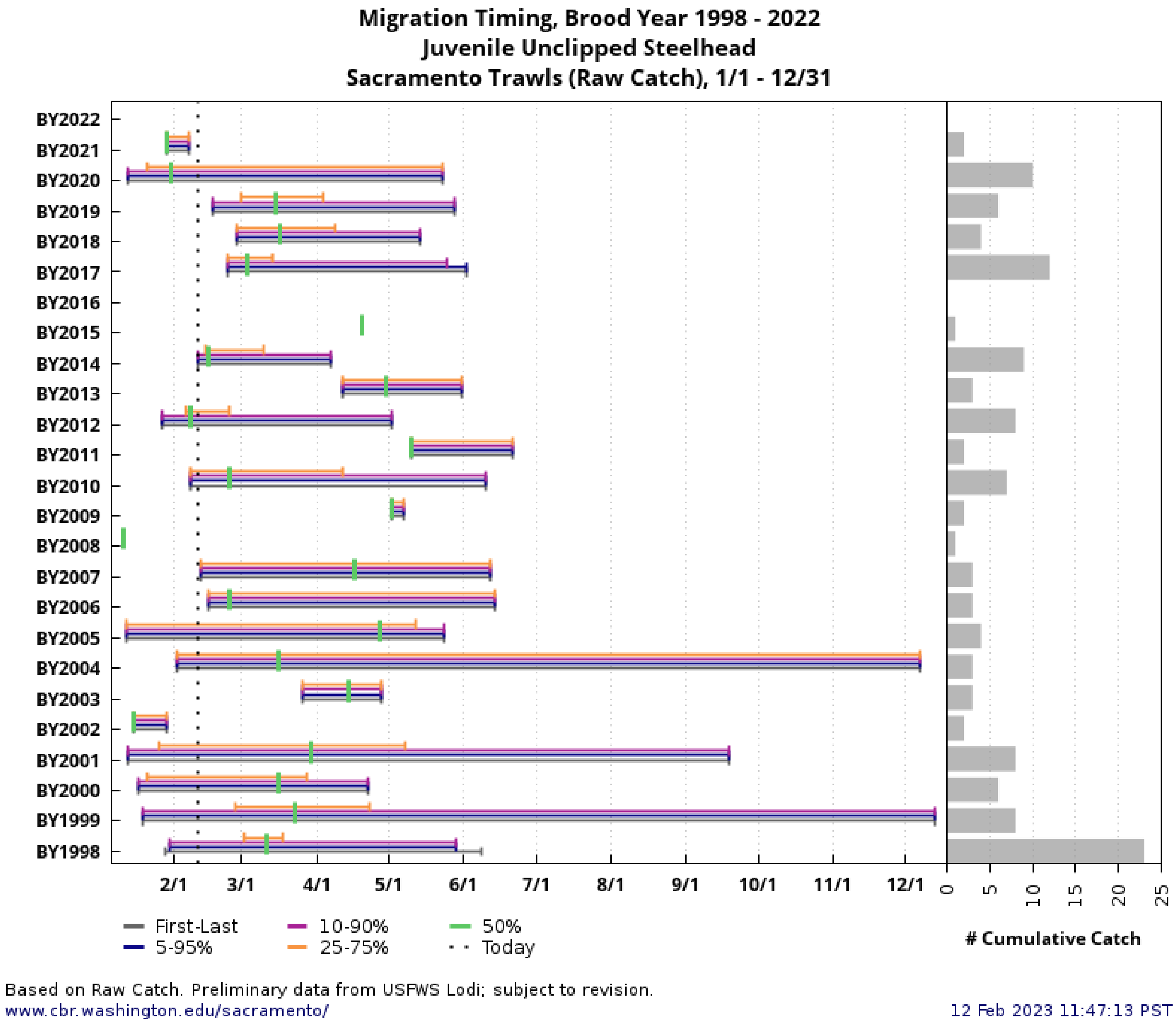


Table SH1. Temporal Occurrence of Central Valley Steelhead by Life Stage

Relative Abundance	High (▼)						Medium (⊠)						Low (#)					None (-)						
Migration Life Stage: (a) Adult	Month																							
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
[1]Sacramento R. at Fremont Weir	#	#	#	#	#	-	-	-	-	-	-	#	#	#	#	⊠	▼	▼	▼	⊠	#	#	#	#
[2]Sacramento R. at Red Bluff Diversion Dam	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	#	⊠	⊠	▼	⊠	#	#	#	#
[3]San Joaquin River	▼	▼	⊠	⊠	#	#	-	-	-	-	-	-	#	#	#	#	⊠	⊠	⊠	⊠	⊠	⊠	▼	▼
Migration Life Stage: (b) Juvenile	Month																							
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
[1,2]Sacramento R. near Fremont Weir	#	#	#	#	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	#	#	#	#	#	#	⊠	⊠	⊠	⊠	#	#
[4]Sacramento R. at Knights Landing	▼	▼	▼	▼	⊠	⊠	⊠	⊠	#	#	#	#	-	-	-	-	-	-	-	-	#	#	#	#
[5]Chipps Island (clipped)	⊠	⊠	▼	▼	⊠	⊠	#	#	#	#	-	-	-	-	-	-	-	-	-	-	-	-	#	#
[5]Chipps Island (unclipped)	⊠	⊠	⊠	⊠	▼	▼	▼	▼	▼	▼	⊠	⊠	#	#	-	-	-	-	-	-	-	#	#	#
[6]San Joaquin R. at Mossdale	-	-	#	#	⊠	⊠	▼	▼	▼	▼	#	#							#	#	-	-	-	-

Sources: [1] Hallock et al. (1957); [2]McEwan (2001); [3]California Department of Fish and Game (2007); [4]NMFS analysis of 1998-2018 CDFW data; [5]NMFS analysis of 1998-2018 USFWS data; [6]NMFS analysis of 2003-2018 USFWS data.

Source: National Marine Fisheries Service 2019:100.

Table SH2. Temporal Occurrence of Central Valley Steelhead by Life Stage in the Delta

Relative Abundance	High (▼)			Medium (⊠)		Low (#)			None (-)		
Life Stage	Month										
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Adult [1]	⊠	⊠	⊠	⊠	▼	-	#	⊠	▼	⊠	⊠	⊠
Juvenile [2]	#	⊠	⊠	▼	▼	#	#	-	#	-	-	#
Salvaged [3]	⊠	▼	▼	⊠	#	#	-	-	-	-	#	#

1Adult presence was determined using information in Moyle (2002), Hallock et al. (1961), and California Department of Fish and Wildlife (2015b).
2Juvenile presence in the Delta was determined using Delta Juvenile Fish Monitoring Program data.
3Months in which salvage of wild juvenile steelhead at State and Federal pumping plants occurred; values in cells are salvage data reported by the facilities (He and Stuart 2016).

Source: National Marine Fisheries Service 2019:101.

Impacts of TUCP on Central Valley Steelhead

Given the species' timing in the Delta (Table SH2), juvenile steelhead migrating through the Delta from the Sacramento River basin in spring 2023 could experience similar types of impacts of the TUCP as previously described for juvenile winter-run and spring-run Chinook salmon, with the highest relative abundance occurring in April and May. There is uncertainty in the extent of the negative effect given that factors such as through-Delta survival as a function of flow have not been examined in a similar manner as done for Chinook salmon, although as with juvenile Chinook salmon, low survival through the interior Delta relative to the Sacramento River has been observed (Singer et al. 2013). As with juvenile Chinook salmon, low South Delta exports and entrainment risk management under the 2019 NMFS BiOp would limit entrainment risk for juvenile steelhead. Buchanan et al. (2021) developed statistical models based on detections of steelhead fitted with acoustic tags and found San Joaquin River flow at Vernalis to be a significant predictor of survival from the Head of Old River to Chipps Island; South Delta exports were not a significant predictor of survival. For juvenile steelhead emigrating from the San Joaquin River basin, San Joaquin River inflow under the TUCP would be the same as under the base case, therefore there would not be expected to be a difference in through-Delta survival between the TUCP and the base case per the Buchanan et al. (2021) statistical model.

As shown in Table SH2, adult steelhead may occur in the Delta during February and March in medium numbers. As discussed further for adult winter-run and spring-run Chinook salmon, migration delay or straying of adult steelhead generally would not be expected to greatly differ for adult steelhead returning to the Sacramento River. Straying of adult steelhead returning to the San Joaquin River basin has not been studied, so it is uncertain what effect increases in South Delta exports under the TUCP relative to the base case may have on straying. As noted for spring-run Chinook salmon, if similar mechanisms apply as for fall-run Chinook salmon (Marston et al. 2012), there may be greater potential for straying under the TUCP.

Conclusions for Steelhead

The 2023 TUCP period coincides with portions of the main period of juvenile and adult steelhead in the Delta. Juvenile steelhead in the Delta would not experience greater risk of South Delta entrainment in spring 2023, as a result of continued implementation of entrainment risk assessment and operations adjustments from the 2019 NMFS BiOp. Assuming similar mechanisms apply as to through-Delta survival of juvenile Chinook salmon migrating from the Sacramento River basin, survival under the TUCP could be somewhat less than the base case in February as a result of less Delta inflow affecting North Delta hydrodynamics, including greater entry into the interior Delta through Georgiana Slough. Through-Delta survival for juveniles emigrating from the San Joaquin River basin would not be lower under the TUCP relative to the base case. Migration conditions for adult steelhead generally would be similar under the base case and TUCP. Greater South Delta exports under the TUCP could result in greater straying potential for adult steelhead returning to the San Joaquin River basin, should similar mechanisms exist as observed for fall-run Chinook salmon in the fall.

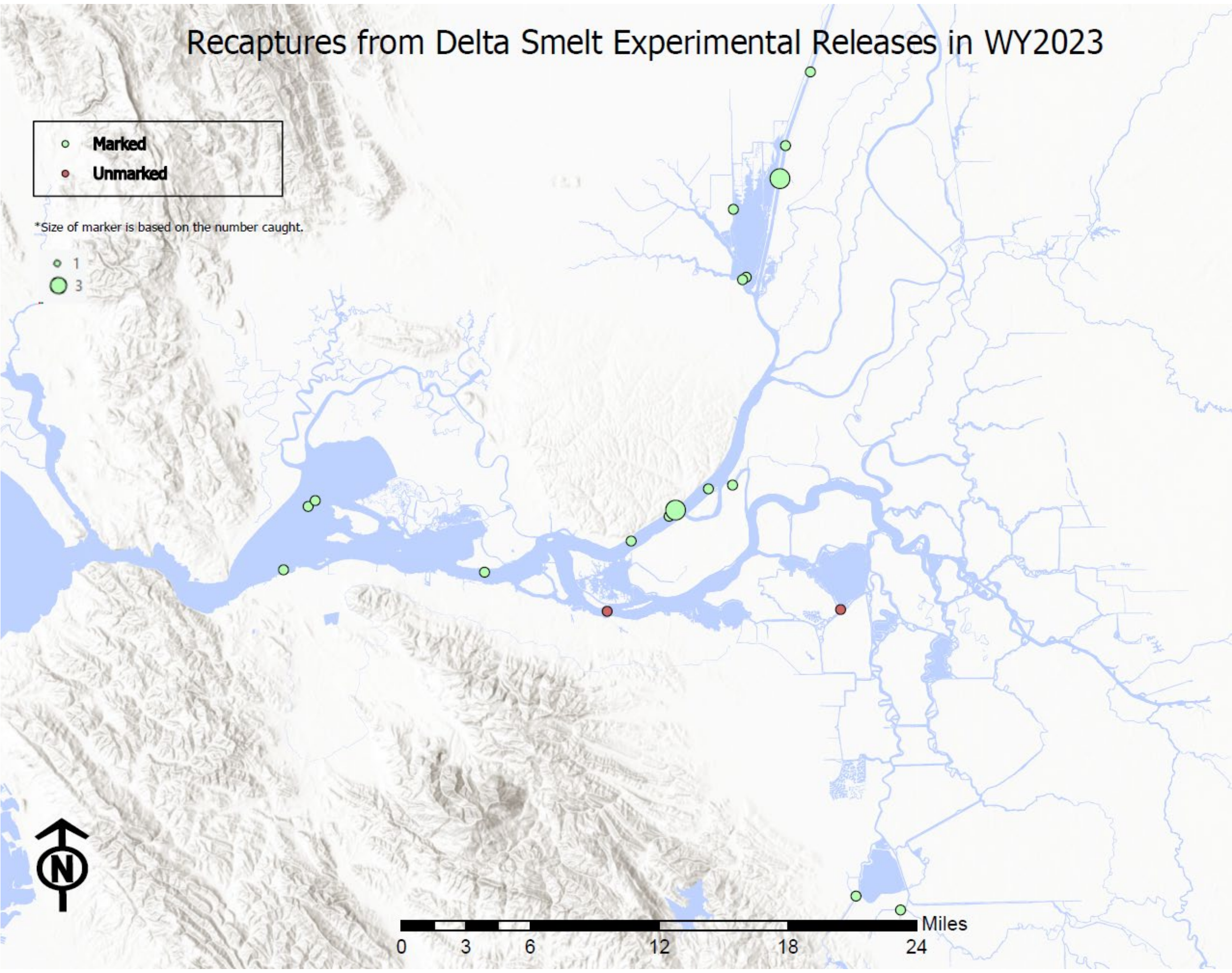
Delta Smelt

Presence and Life Stages of Delta Smelt

The 2022 CDFW Fall Midwater Trawl abundance index of delta smelt was zero for the fifth year in a row. A total of 25 sub-adult and adult delta smelt have been detected since December 1, 2022 (**Figure DS1**), including 18 in Enhanced Delta Smelt Monitoring (EDSM), 2 in salvage at the CVP/SWP, 1 in the Chipps Island Trawl, 2 in the

Spring Kodiak Trawl, and two in the University of California, Davis, Fish Conservation and Culture Laboratory broodstock collection sampling. Of the 25 detections, three were of unmarked fish and 22 were of marked fish associated with the WY 2023 delta smelt experimental releases.[1] No larval or juvenile delta smelt have been detected so far in WY 2023.

Figure DS1. Catch of delta smelt in all monitoring since December 1, Water Year 2023.



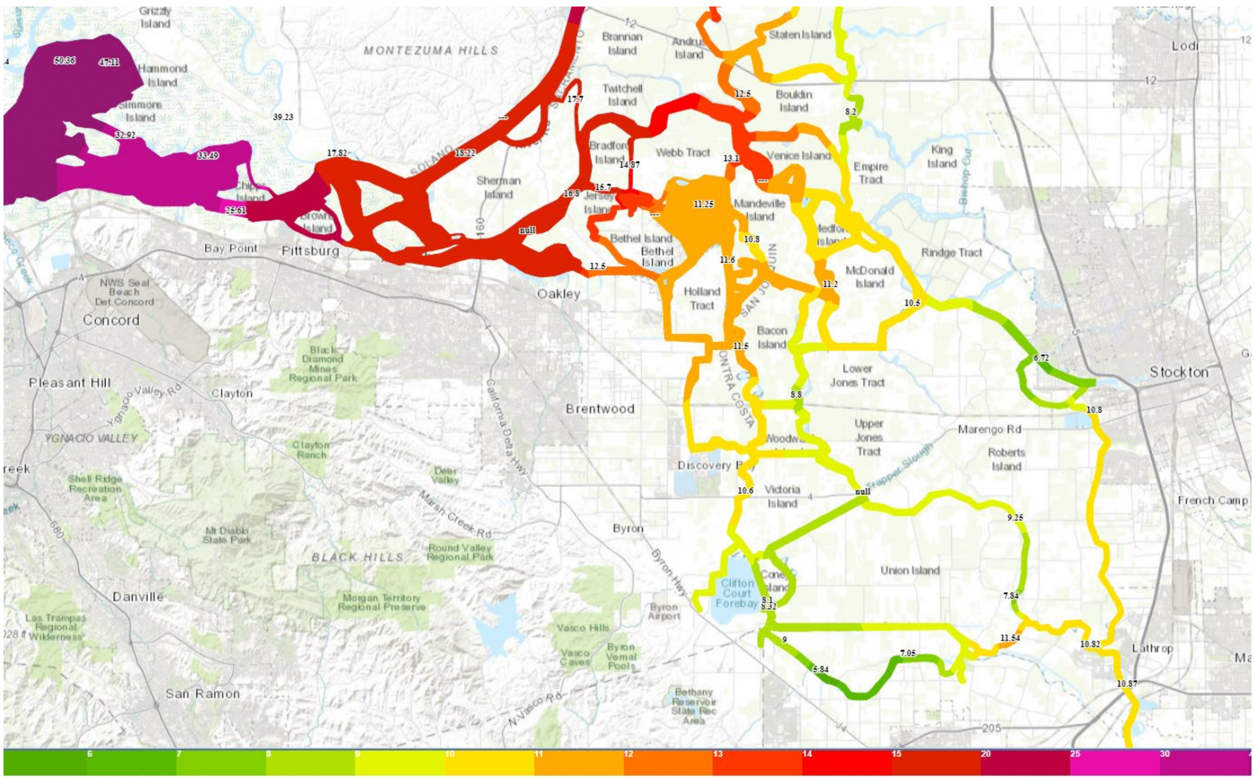
Experimental releases of captive-reared delta smelt occurred in November 2022 to January 2023[2]: in the Sacramento River at Rio Vista (approximately 13,000 fish on 11/29/2022-11/30/2022; approximately 17,500 fish on 01/18/2023-01/19/2023), and in the Sacramento River Deep Water Ship Channel (13,000 fish on 01/25/2023-01/26/2023). All released fish were marked by either adipose fin clip or visible implant elastomer tag. The observed distribution of delta smelt captured by the EDSM program generally corresponds with the release locations (Figure DS1), with two released fish

[1] See https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=210460&inline.
[2] See http://www.cbr.washington.edu/sacramento/workgroups/delta_smelt.html.

being salvaged at the South Delta export facilities and several detected in Suisun Bay during the period of high Delta outflow in January.

The TUCP period would overlap the spring portion of the adult spawning, and egg and larval/early juvenile periods. The most recent risk assessments[3] for delta smelt entrainment, undertaken as part of 2020 CDFW ITP implementation, concluded that the risk of entrainment into the South Delta was low for delta smelt in the Sacramento River/ confluence; however, it was determined to be high for Central Delta areas because of a turbidity bridge, though the turbidity bridge is currently dissipating (**Figure DS2**).

Figure DS2. Turbidity heat map of the Central and South Delta, data from 02/09/2023.



Source: https://www.baydeltalive.com/current_conditions/turbidity-15-minute-data

Impacts of TUCP on Delta Smelt

The SWP and CVP operated to a first flush action from January 3 to January 16 (14 days at -2,000 cfs Old and Middle River flows) and then another 5 days of turbidity bridge avoidance (-2,000 cfs Old and Middle River flows) per criteria from 2019 USFWS BiOp and 2020 CDFW ITP implementation. After the initial turbidity bridge action, exports increased to achieve Old and Middle River flows of -3,500 cfs for 5 days. Overall, there were over three weeks of actions designed to minimize delta smelt entrainment, as well as the required -5,000 cfs limit on Old and Middle River flows

[3] See https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=210460&inline.

during the first and last few days of January. San Joaquin River flows at Vernalis were also very high in January, which combined with the Old and Middle River flow actions to limit the risk of adult entrainment. The observed distribution of adult delta smelt from EDSM monitoring generally indicates that most fish are in areas with low risk of entrainment (Figure DS1), although as previously discussed, two released fish were salvaged at the South Delta export facilities so there is some risk of entrainment. Risk of delta smelt entrainment during the TUCP period would be limited by continued entrainment risk assessment and, as necessary, operational adjustments as part of 2019 USFWS BiOp and 2020 CDFW ITP implementation. Additionally, reduced South Delta turbidities, and the cessation of a turbidity bridge in the OMR corridor, would be expected under drier conditions and would further limit entrainment risk. Although Table WR5 indicates OMR flows of -5,000 cfs in February and March for the TUCP, less negative flows would occur consistent with applicable permits if required to reduce delta smelt entrainment risk.

Table DS1. Mean Monthly QWEST (cfs) During February through April.

Month	Base	TUCP
February	9,250	3,300
March	3,600	-200
April	4,050	3,650

The discussion presented above related to *Ecosystem Impacts* described how the TUCP has the potential for negative effects to delta smelt zooplankton prey in the low-salinity zone. Miller et al. (2012) found that the minimum *Pseudodiaptomus* + *E. affinis* biomass density in April–June was one of the best predictors of delta smelt survival from fall to the subsequent summer and from fall to fall. Polansky et al. (2021) did not find that prey represented by March–May total copepod nauplii + juvenile biomass per unit volume was strongly supported as a predictor of delta smelt recruitment. In contrast, Smith et al. (2021) found mean carbon-weighted density of adult calanoid copepods, cyclopoid copepods, cladocerans, and mysid shrimp observed during February and March zooplankton surveys to be well supported as a predictor of delta smelt recruitment. Although the TUCP has the potential for negative effects on delta smelt zooplankton prey, the differences between the cases are within the confidence intervals of the regressions and are uncertain.

Lower Delta outflow under the TUCP generally would result in higher conductivity, which may reduce the probability of occurrence of delta smelt in areas they would otherwise occur in, particularly downstream of the confluence of the Sacramento and San Joaquin rivers. Polansky et al. (2018) found that adult delta smelt had several regional hotspots of highest density from Spring Kodiak Trawl sampling in January through May, including (among other areas) the waterways surrounding Grizzly Island such as Montezuma Slough. This area is relevant to consideration of potential TUCP effects because salinity could be affected and modeling information is available, whereas other hotspots are farther upstream and therefore unlikely to have negative salinity effects. DSM2 modeling suggests that conductivity in Montezuma Slough near Belden's Landing would be relatively low (several hundred micromhos per centimeter [μmhos/cm]) at the start of the TUCP period in February 2023 (Figure DS2). Conductivity under the TUCP would be up to around 1,000 μmhos/cm greater than under the base case during mid-late March, with absolute values of around 3,000–4,000 μmhos/cm (Figure DS1). Given the negative relationship between adult delta smelt density and conductivity observed by Polansky et al. (2018), the TUCP may reduce the density of adult delta smelt in Montezuma Slough. However, Hamilton and Murphy's (2020) analysis examining habitat affinity as the difference between habitat availability and use found that for pre-spawning adult delta smelt in February, a conductivity range of 350–6,100 μmhos/cm is suitable and a range of 350–10,000 μmhos/cm is adequate.[4] Based on this classification, the TUCP would not cause less than adequate habitat for pre-spawning delta smelt in Montezuma Slough at Belden's Landing. Hamilton and Murphy (2020) also found that for spawning adult delta smelt in March and April, conductivity greater than 1,630 μmhos/cm is unsuitable and conductivity greater than 5,900 μmhos/cm is uninhabitable. Thus, habitat in Montezuma Slough for spawning adult delta smelt could be unsuitable under TUCP for approximately the first three weeks of March, whereas under the base case, spawning habitat may remain adequate (up to 1,630 μmhos/cm per Hamilton and Murphy 2020). Larval/early juvenile delta smelt probability of occurrence in the 20-mm Survey is greatest at approximately 1,000–2,000 μmhos/cm and decreases as conductivity increases (Sommer and Mejia 2013). Thus, the TUCP may reduce the probability of occurrence of larval/early juvenile delta smelt in Montezuma Slough based on higher conductivity (**Figure DS3**).

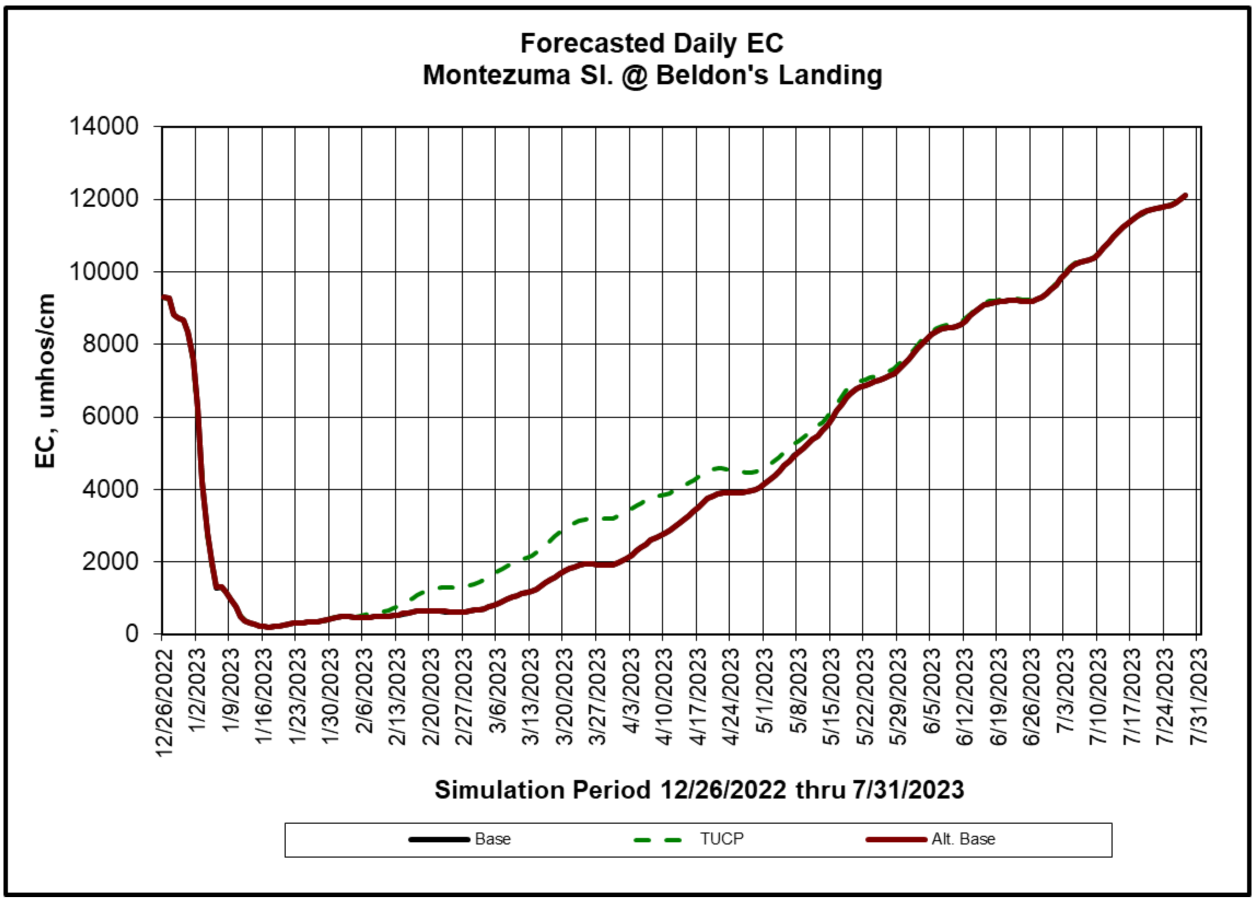
As described in the *Ecosystem Impacts* section of this biological review, there is correlative evidence of Mississippi silverside abundance being negatively related to summer Delta inflow and spring South Delta exports (Mahardja et al. 2016), and therefore the potential for lower silverside abundance under the TUCP than base case, although with considerable uncertainty given the correlative nature of the relationship. Miller et al. (2012) found some support for predation risk from predators including Mississippi silversides as a negative predictor of fall to fall survival of delta smelt, whereas the recent analysis by Polansky et al. (2021) did not find strong support for March–May inland silverside catch per seine as a predictor of delta smelt recruitment.

The biological review for the 2015 February through March TUCP noted the existence of an outflow-recruitment relationship between spring (February through May) X2 and the ratio of the delta smelt 20-mm Survey index and the prior Fall Midwater Trawl index, which was based on a preliminary regression formulated by Interagency Ecological Program, Management, Analysis, and Synthesis Team (2015). Based on that regression, the 2015 biological review described that lower outflow under the 2015 TUCP would predict a negative effect on delta smelt larval production. The 2015

[4] Hamilton and Murphy's (2020) affinity analysis classified ranges of environmental variables as suitable (habitat use minus availability is statistically significant positive), adequate (habitat use minus availability is positive, although not statistically significant), inadequate (habitat use minus availability is negative, although not statistically significant), unsuitable (habitat use minus availability is statistically significant negative), and uninhabitable (habitat use is always equal zero, i.e., delta smelt were never observed).

biological review noted that the Interagency Ecological Program, Management, Analysis, and Synthesis Team (2015) called for more sophisticated life cycle modeling and publication in a peer review journal to draw firm conclusions. Subsequent analysis in a peer review journal using a nonlinear state space model by Polansky et al. (2021) found statistical support for both a negative effect of March through May X2 and Export:Inflow (E:I) ratio on recruitment of delta smelt, although these covariates were not included in the subsequent life cycle modeling by Smith et al. (2021). Information from Polansky et al. (2021) suggests the TUCP could result in negative effects to delta smelt, based on higher March through May X2 under the TUCP (approximately 75.9 kilometers [km]) relative to the base case (approximately 74.1 km).

Figure DS3. Daily Electrical Conductivity in Montezuma Slough at Beldon's Landing from DSM2 Modeling.



Note: Base and Alt. Base have essentially the same values.

<u>Conclusions for Delta Smelt</u>

Implementation of the TUCP would result in low entrainment risk to delta smelt in spring 2023 for delta smelt because the existing entrainment risk management under the 2019 USFWS BiOp and the 2020 CDFW ITP would continue.

The TUCP has the potential to result in negative changes to delta smelt habitat relative to the base case, including an uncertain reduction in zooplankton prey in the low-salinity zone and higher salinity leading to lower probability of occurrence in Montezuma Slough. Preliminary analyses discussed in the 2015 biological review and more recent peer-reviewed analyses suggest the potential for negative effects to delta smelt recruitment from less spring outflow under the TUCP relative to the base case.

Longfin Smelt

<u>Presence and Life Stages of Longfin Smelt</u>

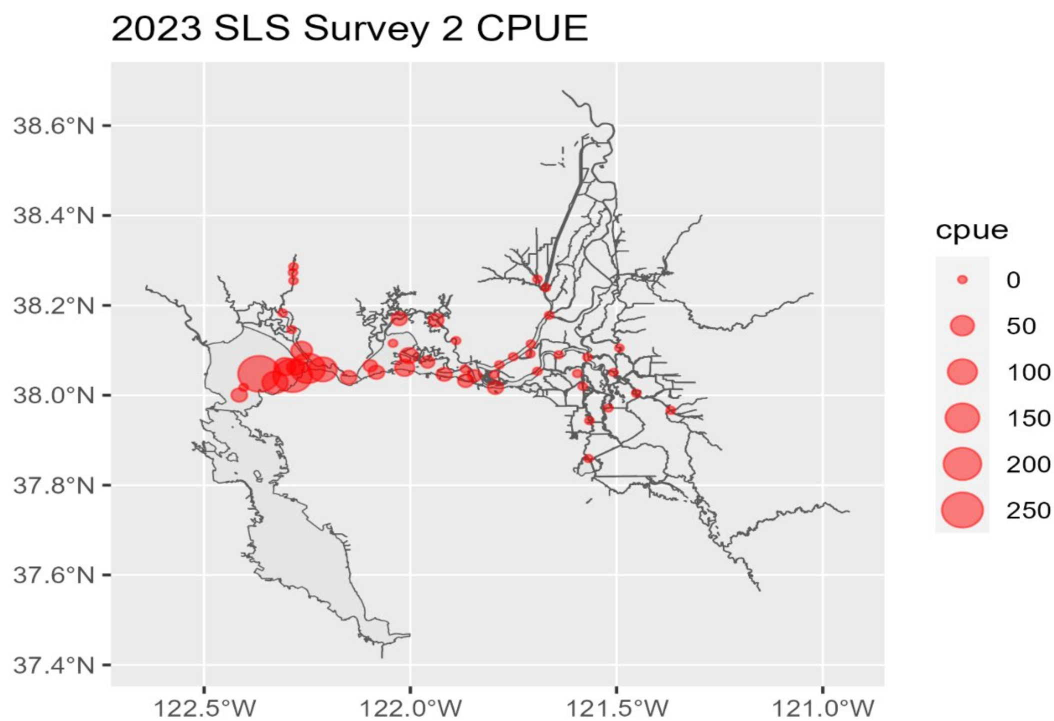
The 2022 CDFW Fall Midwater Trawl abundance index for longfin smelt was 403, considerably less than the full survey period (1967–2020) mean of 6,453, but approximately the same as the 2000–2022 mean (402) and the highest index since 2011.

The most recent risk assessments[5] for longfin smelt entrainment, undertaken as part of 2020 CDFW ITP implementation, concluded that the risk of entrainment into the South Delta was low for longfin smelt in the Sacramento River/confluence and low to moderate for Central Delta areas because of a turbidity bridge. One adult longfin smelt was detected at the state fish salvage facility on 01/17/23; the cumulative salvage is 20. One sub-adult longfin smelt was detected in the Lower San Joaquin River by EDSM on 01/19/23. Although one larval longfin smelt was detected in the Lower San Joaquin River (station 812) by Smelt Larvae Survey 13 on 12/19/22, and 2 larval longfin smelt were detected in the Lower Sacramento River by Smelt Larva Survey 1 on 01/06/23, no larvae were detected in the Central and South Delta in Smelt Larva Survey 1. The most recently available full Smelt Larva Survey (SLS 2) information shows larval longfin smelt at the Sacramento/San Joaquin confluence or downstream (**Figure LFS1**), though SLS 3 preliminary data indicates four longfin smelt larvae were detected in the lower San Joaquin River (two each at stations 809 and 812) on 01/30/2023.

Many fish were detected by Smelt Larva Survey and EDSM in and westward of Suisun Bay, suggesting that longfin smelt are dispersing widely, and distribution has shifted more downstream with the increased January outflow. Adult and sub-adult longfin smelt were detected by EDSM in San Pablo, Suisun Bay, Suisun Marsh, Lower Sacramento River, and Lower San Joaquin River (**Figure LFS2**), and at the Confluence by Chipps Island Trawl.

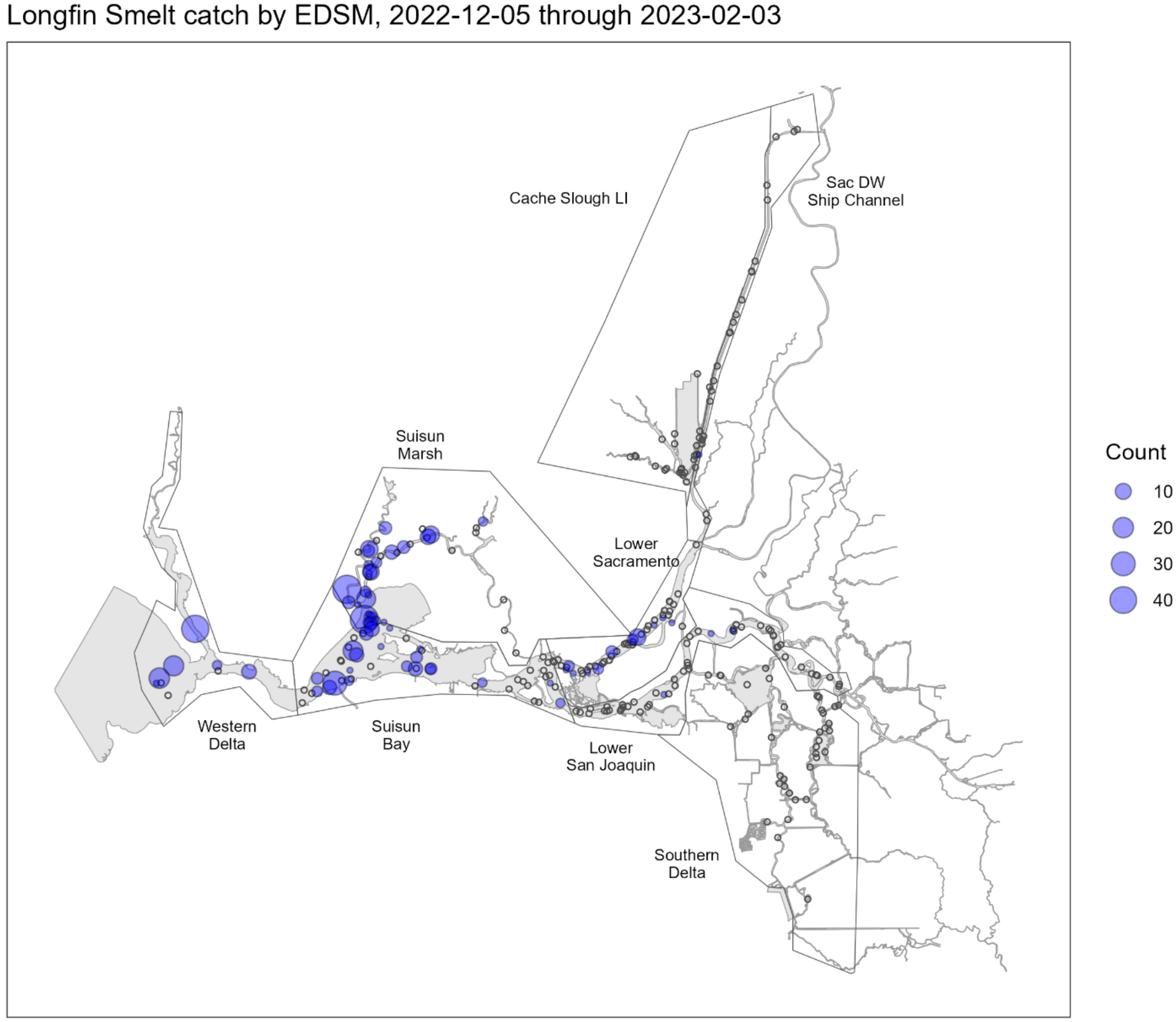
[5] See https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=210460&inline

Figure LFS1. Distribution of Longfin Smelt Larvae from Smelt Larva Survey 2, January 17–January 19, 2023.



Source: James Hobbs (CDFW).

Figure LFS2. Distribution of Longfin Smelt from Phase 1 Enhanced Delta Smelt Monitoring



Source: Lara Mitchell (USFWS)

Impacts of TUCP on Longfin Smelt

As noted above in *Presence and Life Stages of Longfin Smelt*, longfin smelt were salvaged at the South Delta export facilities in water year 2023. The overall distribution of the species during this time period indicates that most of the population is not at risk of entrainment (see Figures LFS1 and LFS2). Although greater South Delta exports would occur under the TUCP relative to the base case, hydrodynamic indicators of potential risk (QWEST) based on modeling suggest entrainment risk would be limited under the TUCP and the base case (see discussion above for delta smelt). There will also be continued risk assessments and, as necessary, operational adjustments as part of CDFW 2020 ITP implementation to limit entrainment risk for longfin smelt. Therefore, although Table WR5 indicates Old and Middle River flows of -5,000 cfs in February and March for the TUCP, less negative flows would occur consistent with the CDFW 2020 ITP if required to reduce longfin smelt entrainment risk.

The TUCP will reduce Delta outflow relative to the base case. There are statistically significant relationships between longfin smelt abundance indices and winter-spring Delta outflow or X2 (e.g., Kimmerer et al. 2009; Thomson et al. 2010; Nobriga and Rosenfield 2016). The potential for negative effects on longfin smelt was assessed with a method estimating fall midwater trawl index as a function of parental stock size (represented by fall midwater trawl index two years earlier, i.e., in 2021), a coefficient to account for the Pelagic Organism Decline, and total March through May and December through May Delta outflow (see method description by California Department of Water Resources 2022: Appendix 12B, p.12B-199). Predicted abundance between the base case and the TUCP (6 percent lower mean) falls well within the posterior distribution of the model. (**Figure LFS3**). Based on the statistical model, the probability of longfin smelt Fall Midwater Trawl index under the TUCP being less than the base case is just under 0.53, i.e., 3 percent greater than a 50 percent:50 percent (equal) chance of the abundance index being greater or less than the base case. This relatively even probability is because of the variability in the model that is not related to Delta outflow. Differences between the TUCP and the base case in mean modeled longfin smelt abundance are very small relative to typical interannual variability in abundance indices.

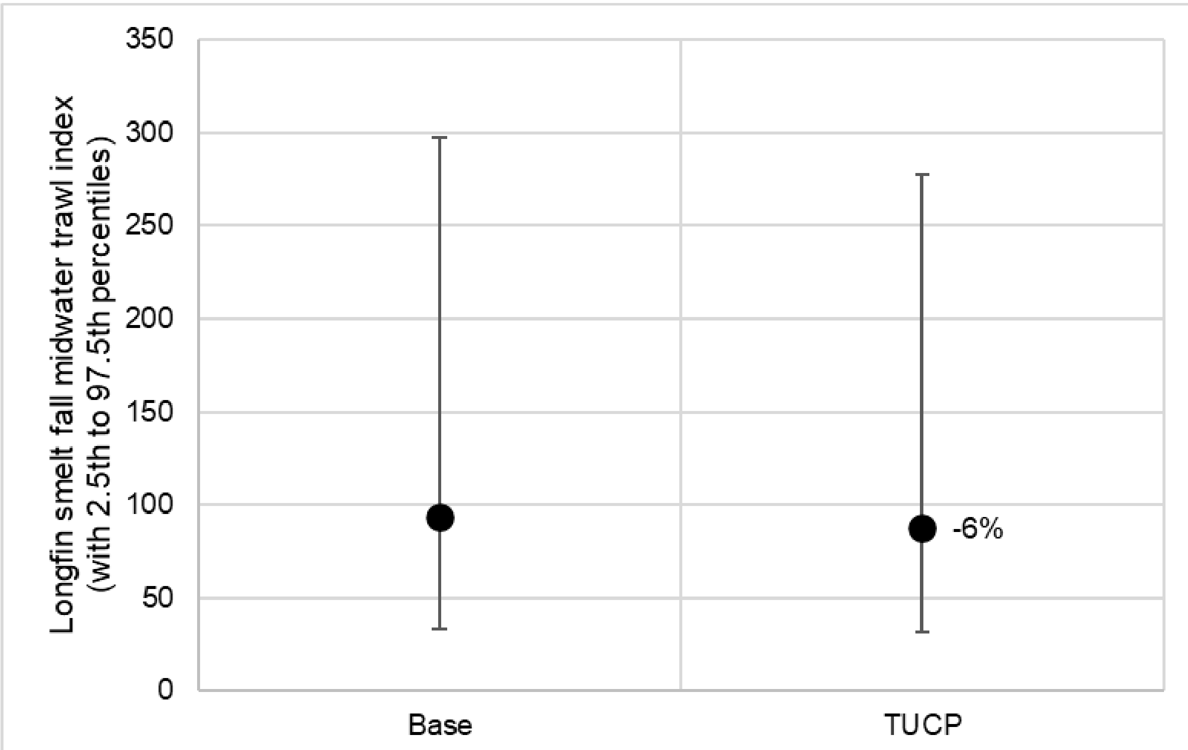
Under the TUCP, modeled DSM2 in February–April[6] was approximately 55–74 km under the base case and approximately 62–75 km under the TUCP. Based on application of the predictive equation from Unger (1994), this indicates that the upper end of the main salinity range occupied by rearing larvae (12 parts per thousand [ppt]; Grimaldo et al. 2017) and juveniles (18 ppt; Unger 1994) would not be moved west into Suisun Bay, thereby limiting potential differences in rearing habitat extent in Suisun Bay and upstream.

As described previously for delta smelt and, in the discussion related to *Ecosystem Impacts*, the TUCP has the potential to result in lower smelt zooplankton prey for longfin smelt than the base case, although differences are uncertain. The mysid shrimp *N. mercedis* has a statistically significant positive relationship with Delta outflow but is a minor component of the overall mysid assemblage and there is not a

[6] April is considered to account for the lagging effects of the TUCP on the salinity distribution.

statistically significant relationship with Delta outflow all three mysid taxa as a whole, so the TUCP would have very limited, if any, effects on mysids as a whole in terms of diet for longfin smelt.

Figure LFS3. Longfin Smelt Fall Midwater Trawl Index as a Function of Total December through May and March through May Delta Outflow.



Note: Circles represent mean of posterior predictive distribution, with percentage labels indicating relative difference of mean estimates of TUCP compared to the base case. Error bars represent the 2.5th–97.5th percentiles from the posterior predictive distribution. See California Department of Water Resources (2022), Appendix 12B, p.12B-199, for additional description of the statistical model.

Conclusions for Longfin Smelt

Lower Delta outflow could have limited, uncertain negative effects on larval longfin smelt prey. The reduction in Delta outflow due to the TUCP is modeled to have a small negative impact on longfin smelt abundance, but the overall probability of a lower abundance index under the TUCP, relative to the base case is not greatly different than 0.5 (i.e., 50 percent chance). Salinity in larval/juvenile longfin smelt habitat in the Delta and Suisun Bay/Marsh would not exceed the range occupied by these life stages (Mac Williams et al. 2016; Grimaldo et al. 2017; Grimaldo et al. 2020). Recent modeling investigations have found that proportional entrainment losses of larval longfin smelt SWP and CVP to be small in comparison to the 100-fold dynamic range of the population index (Gross et al. 2022; Kimmerer and Gross 2022). Therefore, the larval entrainment is no longer considered important as a mechanism to explain the outflow-fall abundance relationship (Gross et al. 2022; Kimmerer and Gross 2022). Kimmerer and Gross (2022) concluded that the mechanisms underlying the strong variability in the annual abundance index of longfin smelt with freshwater flow are constrained to occur after March, which would therefore limit the potential effects of the February–March TUCP. Larval and juvenile entrainment risk is low given the current distribution of larval longfin smelt. Even if the larval and juvenile distribution shifts landward because of lower Delta outflow under the TUCP, the TUCP is unlikely to appreciably increase entrainment of longfin smelt at the South Delta export facilities due to continued entrainment risk management under the CDFW 2020 ITP.

Other Native and Nonnative Species

The Delta is a large network of tidally influenced channels located at the confluence of the Sacramento and San Joaquin rivers that is the most important and complex geographic area in California for anadromous fish production, estuarine fish species, introduced fish species, and distribution of water resources for numerous beneficial uses.

In addition to the rare, threatened, and endangered species described and analyzed above, the Delta provides shallow open-water and emergent marsh habitat for a variety of common, native and nonnative, resident and migratory fish and macroinvertebrates, including several recreationally important fish species. The purposeful and unintentional introductions of nonnative fish, macroinvertebrates, and aquatic plants have contributed to a substantial change in the species composition, trophic dynamics, and competitive interactions affecting the population dynamics of native Delta species.

Water quality variables such as temperature, salinity, turbidity, dissolved oxygen, pesticides, pH, nutrients (nitrogen and phosphorus), dissolved organic carbon, chlorophyll, and mercury may influence habitat and food-web relationships in the Delta. Water quality conditions in the Delta are influenced by natural environmental processes (including floods and droughts), water management operations, and waste discharge practices. Delta water quality conditions can vary dramatically because of year-to-year differences in runoff and upstream water storage releases, and seasonal fluctuations in Delta flows.

The concentration of materials in inflowing rivers are often related to streamflow volume and season. Transport and mixing of materials in Delta channels are strongly dependent on river inflows, tidal flows, agricultural diversions, drainage flows, wastewater effluents, and exports. Water quality objectives and concerns are associated with each beneficial use of Delta water.

Extended droughts have broad-scale impacts on aquatic ecosystems and aquatic communities, including changes to the physical environment and biological communities (Bogan et al. 2015). For example, drought conditions can provide opportunities for invasive species to become established in a new system, with cascading impacts on communities even after drought conditions recede (Beche et al. 2009).

Mahardja et al. (2021) examined over five decades of fish monitoring data from the Delta, including 2014 and 2015 TUCP years, to evaluate the resistance and resilience of fish communities to disturbance from prolonged drought events. High resistance was defined by the lack of decline in species occurrence from a wet to a subsequent drought period, while high resilience was defined by the increase in species occurrence from a drought to a subsequent wet period.

Mahardja et al. (2021) found some unifying themes connecting the multiple drought events over the 50-year period. Pelagic fishes consistently declined during droughts (low resistance) but exhibit a considerable amount of resiliency and often rebound in the subsequent wet years. However, full recovery did not occur in all wet years following droughts, leading to permanently lower baseline numbers for some pelagic fishes over time. In contrast, littoral fishes seem to be more resistant to drought and may even increase in occurrence during dry years.

Impacts of TUCP on Other Native Species

The TUCP period would likely overlap with some juvenile fall-run Chinook salmon rearing and migration through the Delta. Based on the results from the spreadsheet implementation of the Perry et al. (2018) modeling, less Delta inflow under the TUCP could result in increased juvenile Chinook salmon entry into the low-survival interior Delta through Georgiana Slough and reduced through-Delta survival, although the main period of migration is after the TUCP period. Entrainment at the South Delta export facilities would be expected to be low under the TUCP because of restrictions on South Delta exports. Adult fall-run Chinook salmon would not be expected to migrate through the Delta during the TUCP period; the peak of the overall potential June through December migration period is September/October (Moyle et al. 2017: 47).

As previously discussed for green sturgeon, NMFS (2018: 12) noted that there are positive correlations between white sturgeon (*Acipenser transmontanus*) and Delta outflow, which have previously been used to infer potential impacts on green sturgeon (ICF International 2016: 5-197 to 5-205). Any impacts on white sturgeon as a result of changes in flow under the TUCP may be limited primarily because the largest sturgeon recruitment occurs in wetter years (Fish 2010). Application of the statistical relationships between white sturgeon year-class strength and April through May and March through July Delta outflow (ICF International 2016: 5-197 to 5-205) gives negative estimates of year-class strength under the base case and the TUCP, suggesting very little recruitment may occur under any of the cases.

Abundance indices of starry flounder (*Platichthys stellatus*) and California bay shrimp (*Crangon* spp.), two estuarine and coastal taxa occurring in the San Francisco Estuary, have statistically significant negative correlations with X2 (Kimmerer 2002; Kimmerer et al. 2009), indicating a positive relationship with Delta outflow. The correlation for California bay shrimp is with March through May X2 and for starry flounder is March through June X2, which overlaps the TUCP period. Application of the regression coefficients from Kimmerer et al. (2009) gives differences in bay shrimp mean abundance index of 2 percent less than the base case. A similar analysis for starry flounder gives a difference in mean abundance index of 9 percent less than the base case for TUCP. Note that prediction intervals were not calculated because the analysis only used the mean coefficients provided by Kimmerer et al. (2009), but such intervals are generally quite broad. In addition, starry flounder distribution is not restricted solely to the San Francisco Estuary and it is not known how abundance in the Estuary—

possibly reflecting increased upstream movement and retention with greater Delta outflow (Kimmerer et al. 2009)—relates to the overall species abundance across the species' range from Alaska to southern California.

Resilience to low flow and drought conditions for those species described above and other native fishes, appears to be contingent on the suite of environmental factors critical to each species and how they relate to the increased flow during post-drought periods. Mahardja et al. (2021) found that the Delta-endemic Sacramento splittail (*Pogonichthys macrolepidotus*) demonstrated low resistance to drought, but consistently recovered during subsequent wet years. This is consistent with the current understanding that the relatively long-lived Sacramento splittail (Daniels and Moyle 1983) depend on strong year classes that are recruited during wet years when floodplain habitat is available for spawning (Sommer et al. 1997, Moyle et al. 2004). Low flows under both cases would likely result in minimal, if any, inundation of floodplain habitat important to splittail and other native fish during the spring; should storm events occur resulting in floodplain inundation (e.g., overtopping of Fremont Weir and resulting flooding of Yolo Bypass), these events would be present under both cases.

Impacts of TUCP on Nonnative Species

According to Mahardja et al. (2021), nonnative pelagic fishes of the Delta (e.g., threadfin shad (*Dorosoma petenense*), American shad (*Alosa sapidissima*), and striped bass (*Morone saxatilis*) generally exhibited low drought resistance and high resilience during the study period. However, these nonnative pelagic fish species did not demonstrate synchronous decline and rebound throughout every drought cycle. There is a lack of information on the flow-related mechanisms that would affect the abundance and distribution of these species; however, previous studies indicated that availability of suitable freshwater habitat may increase their occurrence during wet years (Feyrer et al. 2007, Kimmerer et al. 2009). Application of statistical relationships from Kimmerer et al. (2009) that estimate American shad abundance indices as a function of mean February through May X2 gave mean estimates for the bay midwater trawl survey that were 12 percent less than the base case for the TUCP, and mean estimates for the fall midwater trawl survey that were 9 percent less than the base case for the TUCP. Application of statistical relationships from Kimmerer et al. (2009) that estimate juvenile striped bass abundance or survival indices from several different surveys as a function of mean April through June X2 gave mean estimates that were 1–3 percent less than the base case for the TUCP.

The nonnative littoral fish species included in the Mahardja et al. (2021) analysis (e.g., largemouth bass (*Micropterus salmoides)*, bluegill (*Lepomis macrochirus*), redear sunfish (*Lepomis microlophus*), and Mississippi silverside) are generally considered warm-water and drought-tolerant species and, as such, they rarely show decline during droughts. Numbers of largemouth bass, bluegill, and redear sunfish seem to have progressively increased between 1995 and 2011 (Mahardja et al. 2021), possibly due to the expansion of invasive submerged aquatic vegetation in the Delta over the past decade or two that have been associated with drought (Conrad et al. 2016, Santos et al. 2016, Kimmerer et al. 2019). On the other hand, Mississippi silverside appears to have a negative association with freshwater flow that led to a mostly positive drought resistance (Mahardja et al. 2016; see also discussion above in *Ecosystem Impacts*).

Conclusions for Other Native and Nonnative Species

The reduction in outflow due to the TUCP may have negative and/or positive impacts on other native and nonnative species, including the migratory, pelagic, and littoral species described above. Species with positive correlations with Delta outflow such as striped bass and American shad may be negatively affected, whereas species with negative correlations may be positively affected.

V. Coordination with Water Operations and Watershed Monitoring Technical Teams

DWR and Reclamation convene the WOMT and Watershed Monitoring Workgroups for each of the Upper Sacramento, Clear Creek, American, Delta, and Stanislaus watersheds (Watershed Monitoring Workgroups). DWR convenes a Feather River Operations Group. Each of the Watershed Monitoring Workgroups are responsible for real-time synthesis of fisheries monitoring information (e.g., Rotary Screw Traps, Enhanced Delta Smelt Monitoring Program, Trawls, other status and trends monitoring) and providing recommendations on scheduling specific volumes of water and implementing protective measures as specified in the 2020 Record of Decision, ITP, and FERC licenses. The Delta Monitoring Workgroup is responsible for integrating species information across watersheds, including delta and longfin smelt and winter-run Chinook salmon and other salmonids and sturgeon. In addition to Delta Watershed Monitoring Workgroup, the program includes Smelt Monitoring Team and Salmonid Monitoring Team. The Watershed Monitoring Workgroups include technical representatives from federal and state agencies and stakeholders and will provide information to DWR and Reclamation on species abundance, species distribution, life stage transitions, and relevant physical parameters.

The WOMT, comprised of agency managers, coordinates the implementation of water operations under the 2020 ROD, as well as for the 2020 CDFW ITP. WOMT oversees the Watershed Monitoring Workgroups, seeks to resolve disagreements within the technical teams, and elevates policy decisions to the Directors of the agencies where necessary. This management-level team was established to facilitate timely decision-support and decision-making. The goal of WOMT is to resolve disagreements between technical staff from each agency; however, the participating agencies retain their authorized roles and responsibilities as set forth in the 2020 ROD and 2020 CDFW ITP.

As part of implementation of the TUCP, DWR and Reclamation will coordinate with the State Water Board, CDFW, NMFS, and USFWS at WOMT meetings. This process allows the regulatory agencies to stay up to date on information and provide feedback on potential project operations and related impacts on an ongoing basis as the impacts of the recent three-year drought is addressed. As a result of this coordination, DWR and Reclamation may submit to the State Water Board additional information on developing standards appropriate for operation of the CVP/SWP. For example, DWR and Reclamation will continue to coordinate with Long-term Operation Agency Coordination working groups to continue the robust monitoring program used in the recent 2021 and 2022 Drought Contingency Plans and Drought Ecosystem Monitoring and Synthesis Plan.

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