Delta Smelt Summer-Fall Habitat Action

2024 Action Plan

May 14, 2024

Photo: Rainbow over the Suisun Marsh Salinity Control gates. From California Department of Water Resources.

Prepared by

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In coordination with the California Department of Fish and Wildlife, the United States Fish and Wildlife Service, the National Oceanic and Atmospheric Administration National Marine Fisheries Service, and representatives from the California State Water Contractors and Federal Water Contractors.

Contents

Tables

Figures

Summary

The Delta Smelt Summer and Fall Habitat Action (SFHA) Plan describes the Delta Coordination Group (DCG) planning activities and recommendations for implementation for Water Year (WY) 2024. The SFHA is intended to improve growth, survival, and recruitment of critically endangered Delta Smelt (*Hypomesus transpacificus*) by enhancing habitat and food availability through coordinated management actions. Due to the time lag for the final determination of the WY type, the report includes scenarios for possible WY type designations. If the final Water Year (WY) 2024 Sacramento Valley water year designation (40-30-30 Index based on the May 1 50% exceedance forecast) is Wet, Above Normal, or Below Normal a Summer-Fall Habitat Action (SFHA) will occur.

- If the final WY is Wet or Above Normal, the 30-day average X2 value will be <80 km for the months of September and October.

- If Above Normal, the Suisun Marsh Salinity Control Gates (SMSCG) will be operated for 60 consecutive days to a target of 4 PSU at Belden's Landing starting July 1 and continuing until 60 days is reached.

- If Above Normal, the California Department of Fish and Wildlife (CDFW) has the option to deploy an additional 100 thousand acre feet (TAF) during the summer-fall in conjunction with the initial 60-day SMSCG operation. CDFW has decided this would follow the initial 60 consecutive days of operation, potentially extending gate operation through October. If the 100TAF action is implemented, the California Department of Water Resources will operate the gates and use a previously developed method for accounting for the additional fresh water needed to meet all relevant salinity standards and targets simultaneously. The action will end by October 31 or when the 100 TAF has been expended, whichever comes first. Scenarios for implementation of this action were discussed with the DCG and are described in the Delta Outflow Plan (a condition in the CDFW Incidental Take Permit). Potential scenarios for action implementation are further described in this Action Plan.

- If the final WY designation is Below Normal the Gates will be operated for 60 consecutive days to a target of 4 PSU at Belden's Landing

starting as soon as the salinity at Belden's Landing reaches 4 PSU and continuing until 60 days is reached.

These SFHA recommendations were discussed by the DCG through a decision-making process described below. The DCG acknowledges variation in individual group member opinions regarding preferred operations; however, no agency or contractor expressed hesitation in proceeding with the aforementioned recommendations. Monitoring and science to evaluate the effectiveness of Summer-Fall actions will accompany the actions.

No North Delta Food Subsidy Action (NDFS) will be conducted during the summer or fall of 2024. Request of initiation of ESA consultation with the US Fish and Wildlife Service and National Marine Fisheries Service before the action can be implemented has been postponed until completion of focused studies to further evaluate action efficacy and remaining suitable habitat in the northern Delta in summer.

Background

The Delta Smelt Summer Fall Habitat Action (SFHA) is intended to improve growth, survival, and recruitment of critically endangered Delta Smelt (*Hypomesus transpacificus*) by enhancing habitat and food availability through coordinated management actions. The SFHA and investigation of summer-fall habitat conditions are included as condition of approval 9.1.3 of the California Department of Fish and Wildlife's (CDFW) Incidental Take Permit (ITP) issued to DWR for State Water Project operations (CDFW 2020) and are also components of U.S. Bureau of Reclamation and California Department of Water Resource's Proposed Action for coordinated long-term operation of the Central Valley Project (CVP) and State Water Project (SWP), and corresponding Biological Opinions (NMFS 2019, USFWS 2019).

Planning, recommendations for implementation, and reporting of the SFHA are coordinated through the Delta Coordination Group (DCG), consisting of state and federal agencies and CVP and SWP water contractors. Annually, during February, March, and April, the DCG assesses current water year hydrology forecasts, status of smelt populations, and operations. The DCG conducts qualitative and/or quantitative activities to inform structured decision making (SDM) and develop a SFHA action plan (this document), which considers what specific actions to take in Dry, Below Normal, Above

Normal, and Wet years (as established by the Sacramento Valley Hydrologic Classification Index)[1]. Implementation and monitoring of actions (or no-action baseline conditions) are conducted June through October after which the SFHA seasonal report is compiled with a draft completed by December of each year.

Current actions of the SFHA are aimed to provide suitable environmental and biological conditions for Delta Smelt based on current conceptual models. For example, the best available science is that Delta Smelt habitat should include low salinity (0–6 ppt), low water temperature (< 22 °C based on temperature constructs determined by the DCG in 2023), turbidity of at least 12 NTU, and high food availability in open water habitats (FLaSH Synthesis; Brown et al. 2011). The SFHA is being undertaken recognizing that the highest quality habitat in the Bay-Delta includes areas with complex bathymetry, in deep channels close to shoals and shallows, and in proximity to extensive tidal or freshwater marshlands and other wetlands (Bever et al. 2016; Hammock et al. 2019). The intent of the SFHA is to provide these habitat components in the same geographic area through a range of actions to improve water quality and food supplies locally and to increase their spatial overlap in some locations. Current SFHA actions include the following; however, only 1-3 are described in this plan, as others are not applicable in the 2024 water year:

1. Management of X2 during September and October (applicable in Above Normal and Wet years)
2. Suisun Marsh Salinity Control Gates (SMSCG) operations for June-October (applicable in Above Normal, Below Normal, and Dry years)
3. 100 TAF block of water for Delta Outflow (applicable in Above Normal and Wet years, or deferred to the following year)
4. North Delta Food Subsidy (NDFS) – Colusa Basin Drain action (still requires ESA consultation, but applicable in Dry, Below Normal, Above Normal, and potentially Wet years depending on conditions)
5. Sacramento Deep Water Shipping Channel Food study (still undergoing feasibility studies)
6. Managed Wetlands Food subsidy study (still undergoing feasibility studies)

[1] See: https://cdec.water.ca.gov/reportapp/javareports?name=WSIHIST

Additional information on each action can be found in supporting documents including the DCG Guidance Document, SFHA Monitoring and Science Plan (Appendix A), and past SFHA Seasonal Reports.

Due to the wetter hydrologic conditions in WY 2024, SFHA successive dry year planning (a requirement in the ITP COA 9.1.3.2) was not considered this year; however, science and monitoring and DCG discussions of potential options during dry conditions will continue.

The purpose of this Action Plan is to describe DCG planning activities and recommendations for implementation for the 2024 SFHA (including a no-action option). This document also serves as a deliverable for ITP Condition of Approval (COA) 9.1.3.1 due to CDFW and to USFWS for the corresponding Biological Opinion evaluating Reclamation and DWR's Proposed Action. Implementation of the SFHA occurred for the first time in 2023; it did not occur during WY 2020 to 2022 due to drought conditions, resulting in Dry (2020) and Critical (2021, 2022) water year designations. Information has been gained from previous SFHA reporting of action years and non-action years (with baseline conditions), special studies relative to actions, and previous iterations of SDM. With 2024 likely to be another wetter year, it may be the first opportunity to replicate the suite of actions implemented in 2023. This Action Plan describes specifically X2, SMSCG, and 100 TAF actions in Wet, Above Normal, Below Normal, and Dry water year types, where applicable, as well as improvements to quantitative and qualitative evaluations to inform SDM and other ongoing evaluations of anticipated consequences.

2024 Hydrology and Temperature Forecast

WY 2024 follows the wet year of WY 2023, which broke the 2020-2022 drought. Below average precipitation in November and December were followed above average precipitation in January and February with a few intense atmospheric rivers (Figure 1). Rains continued in early March, providing a March 1 50% exceedance forecast of Above Normal. Despite the wet conditions during the rainy season and snowpack (Figure 2) which may result in higher-than-average Delta outflow into summer, seasonal temperature forecasts indicate that the summer of 2024 is likely to be warmer than average (Figure 3), which could once again limit benefits historically expected in a wet water year for Delta Smelt habitat. A similar

hot, wet summer was thought to limit benefits of the high flows in 2017 and 2019 for Delta Smelt (FLOAT MAST 2021; Smith and Nobriga 2023).

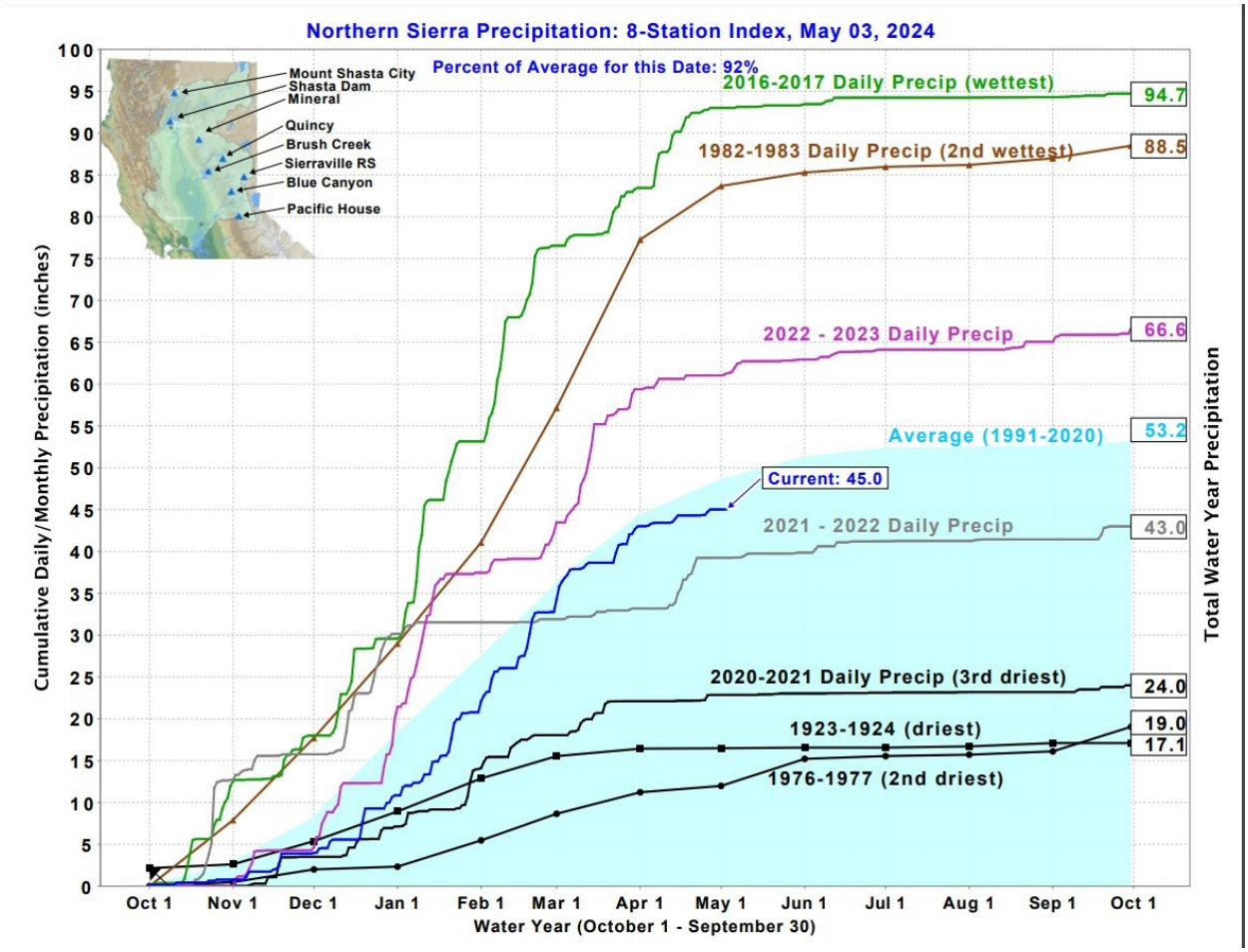

Figure 1 Northern Sierra Precipitation, 8-station index as of May 3rd, 2024. Graph from https://cdec.water.ca.gov/cgi-progs/products/PLOT_ESI.pdf.

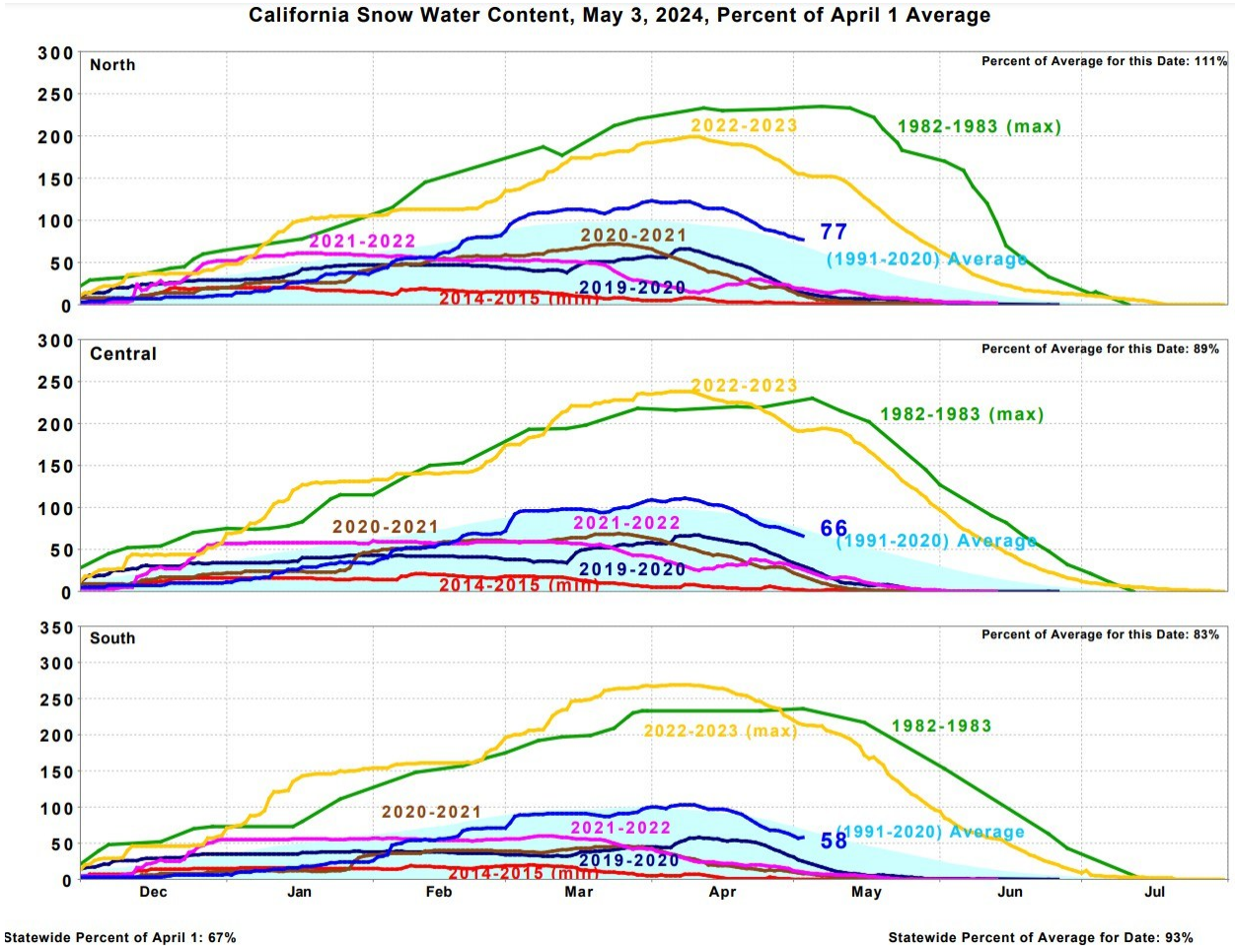

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Figure 2 California Snow Water Content as of May 3, 2024; percent of April 1 average. Graph from https://cdec.water.ca.gov/reportapp/javareports?name=PLOT_SWC

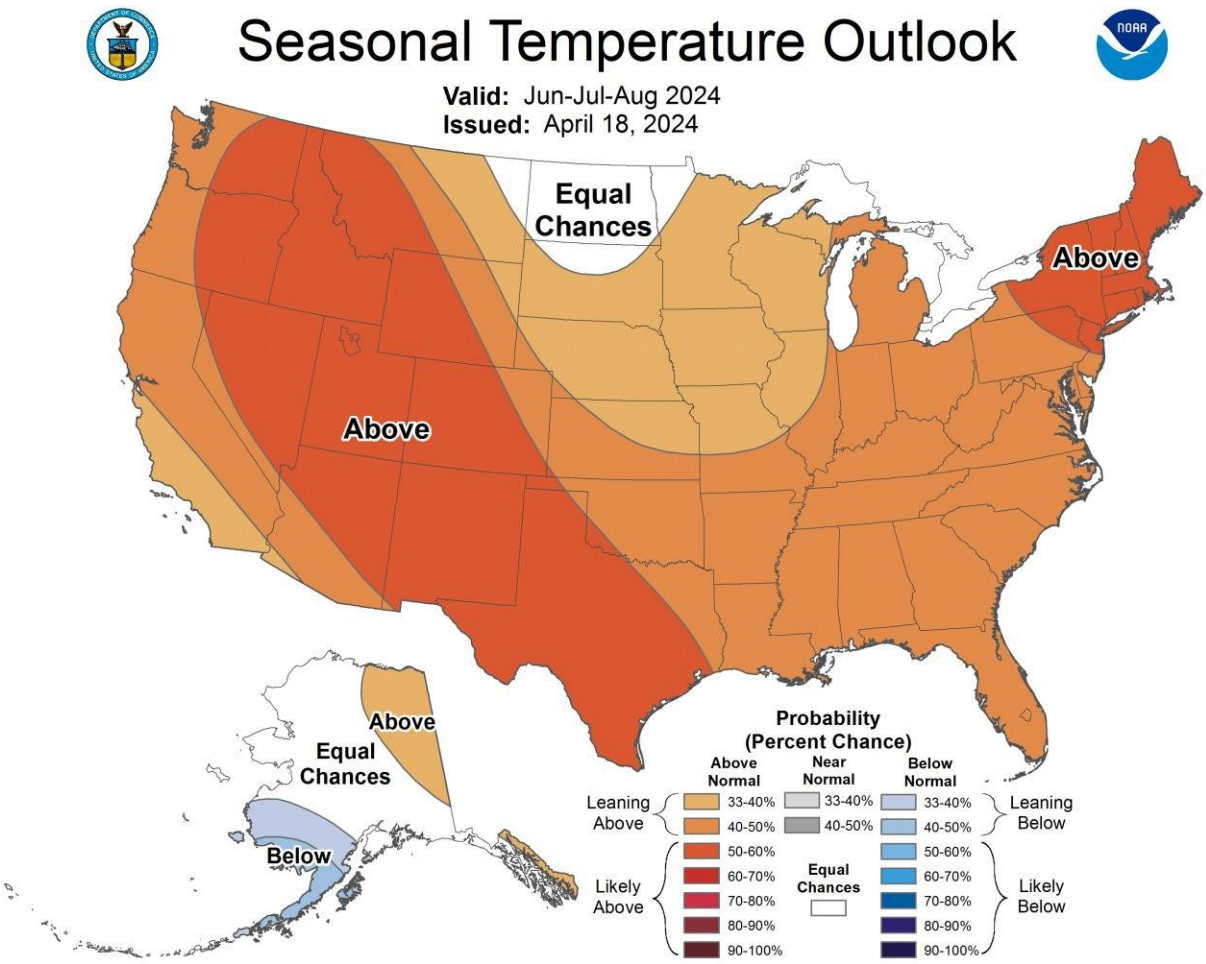

Figure 3 Seasonal temperature outlook for the United States. From NOAA's Seasonal Forecast Center
https://www.cpc.ncep.noaa.gov/products/predictions/long_range/seasonal.php?lead=3.

Delta Smelt Status and Distribution

In response to the continued decline in Delta Smelt coupled with few detections from ~ 2018-2021, implementation of experimental releases of cultured Delta Smelt into the wild began in the winter of water year 2022 and have occurred every year since. In WY 2022, 55,733 cultured Delta Smelt were released across Delta and Suisun Marsh regions, and in WY 2023 another 43,725 were released with recaptures following releases in both years (e.g., 113 recaptures in WY 2022, 92 recaptures in WY 2023). In 2022, six unmarked Delta Smelt were caught in the summer-fall period in

the Lower Sacramento Region, Sacramento Deepwater Ship Channel and Suisun Marsh. While genetic methods are not available to differentiate between offspring of experimental release fish versus wild fish, these fish were most likely a result from increased spawning stock of fish due to the experimental release. In 2023, ten Delta Smelt were caught in the summer-fall period in the Lower Sacramento River, Confluence, Chipps and Sherman Islands, and a few fish in Montezuma Slough and Grizzly Bay during the 2023 summer-fall action. These fish were also most probably offspring of experimental release fish, though it is possible that improved habitat conditions could have increased recruitment success of wild fish as well.

In the current water year, an additional 91,468 Delta Smelt were released in the Lower Sacramento River from mid November 2023 to January 2024, with a total of 47 current (as of 3/29/2024) recaptures spread widely across the estuary, including the CVP and SWP fish facilities, Cache Slough Complex, lower Sacramento River, Suisun Marsh, Suisun Bay, and Sacramento Deepwater Ship Channel (see preliminary distribution data in [2]). January-February storms triggered winter pulse protection actions to reduce entrainment for adults, and in February actions were triggered for larvae and juveniles. Planned actions for 2024 SFHA aim to improve summer-fall abiotic and biological conditions for Delta Smelt.

Actions, Hypotheses, and Uncertainties

Based on the February and March 2024 forecasts, the DCG discussed hydrology scenarios that might result in a Wet, Above Normal (AN), or Below Normal (BN) WY type. The DCG described SFHA scenarios and implementation options for different combinations of actions in each water year that aligned with Table 9-A of the ITP. The following sections describe the SFHA scenarios, hypotheses (see also Figure 4) and uncertainties:

Wet Water Year Type

During a wet water year, a Fall X2 action would lower upper estuary salinity and expand Delta Smelt distribution downstream, at least during September and October. The extra 100 TAF of outflow could be used to lower upper estuary salinity further, creating expanded Delta Smelt habitat during one or more preceding months, especially in Suisun Marsh. No SMSCG action is required by the ITP in a wet year, but the 100 TAF action could be used to

[2] https://rosiesstuff.shinyapps.io/smeltmap/

modify SMSCG operations if requested by CDFW. The Gates will be held closed for 10 days in November of 2024 to conduct planned maintenance.

Fall X2

The ITP and Biological Opinion require the 30-day average of X2 to be less than or equal to 80 km for the months of September and October. Because this action is mandated by regulation, no alternatives were evaluated.

Hypotheses:

- Decreasing X2 will maximize the area of Delta Smelt habitat with appropriate temperatures, turbidity, and salinity, which will result in higher Delta Smelt growth and survival.
- Decreasing X2 will increase biomass of calanoid copepods, specifically *Pseudodiaptomus forbesi* abundance in Suisun Bay through increased transport of freshwater species from upstream, which will result in higher Delta Smelt growth and survival.

Uncertainties:

- What, if any, habitat attributes limit Delta Smelt growth during the fall and subsequent survival?

100 TAF Block of Water

The ITP requires DWR to provide 100 TAF block of water for Delta outflow from June through October (ITP COA 8.19), either released from Lake Oroville or potentially through export reductions, per the Delta Outflow Plan (ITP COA 8.20). The deployment of this block of water was determined outside the scope of the DCG by CDFW in 2023 and no alternatives were evaluated. In WY 2023, CDFW used the 100 TAF outflow block in conjunction with the SMSCGs daily starting when Belden's Landing hit 4 PSU. The goal was to expand low salinity habitat spatially and temporally for as long as possible during summer-fall months and potentially provide some refuge from warm water temperatures in inland areas by increasing access to more suitable habitat conditions in the marsh and Grizzly Bay (e.g., cooler water, higher turbidity and possibly, elevated prey density). CDFW is considering a similar action in WY 2024 if it is classified as AN or Wet.

If implemented, evaluation of 100 TAF implementation will be done in the months following the action using existing science and monitoring in place for the SMSCG, including Interagency Ecological Program (from DWR, CDFW, and USFWS) survey data and DWR enclosure studies.

Hypotheses:

- Operating the SMSCGs during the summer and fall will maximize the duration and area of Delta Smelt habitat with appropriate temperatures, turbidity, and salinity that can be accomplished with 100 TAF of water, including in Grizzly Bay. Greater, suitable habitat will result in higher Delta Smelt growth and survival.
- Operating the SMSCGs during the summer and fall will increase biomass of calanoid copepods, specifically *Pseudodiaptomus forbesi,* in Suisun Marsh through increased transport of freshwater species from upstream, which will result in higher Delta Smelt growth and survival.

Uncertainties:

- What, if any, habitat attributes limit Delta Smelt growth during the fall and subsequent survival?
- Will gate operations provide benefits during a wet year when the Marsh is generally fresh enough to support Delta Smelt occupancy?
- Is there an alternative use for this water that could provide greater benefits to Delta Smelt in June-October?

Above Normal Water Year Type

In an AN water year, Fall X2, SMSCG, and the 100 TAF outflow would occur.

Fall X2

Maintaining X2 standards would be the same as in a Wet year, which requires the 30-day average of X2 to be less than or equal to 80 km for the months of September and October. Hypothesized benefits and uncertainties are the same as a Wet year.

SMSCG operations

In AN years, the ITP requires 60 days of SMSCG operations between June and August 31. Modeling suggests the salinity in Suisun Marsh will begin to

approach 4 PSU sometime during July, so gate operations are anticipated to begin on July 1 and continue through August 30, operating continuously. Operations will end on August 30 because the Fall X2 action is implemented in September and October, providing some of the same smelt habitat benefits. Gate operations will continue as dictated by the Suisun Marsh Preservation agreement or as determined by the Delta Outflow Plan (ITP COA 8.20). The DCG considered an alternative scenario to operate the SMSCG discontinuously for 7 days on and 7 days off (7/7) until 60 days was met (i.e., about 9 weeks) given previously modeling results showing slightly less habitat benefits compared to a continuous operation, but extending those habitat benefits for a longer period of time. However, this scenario was not preferred as described in the SDM 'consequence evaluation' section.

Hypotheses:

- Operating the SMSCGs during the summer will maximize the duration and area of Delta smelt habitat with appropriate temperatures, turbidity, and salinity, including in Grizzly Bay. Greater, suitable habitat will result in higher Delta Smelt growth and survival.
- Operating the SMSCGs during the summer and fall will increase biomass of calanoid copepods, specifically *Pseudodiaptomus forbesi,* in Suisun Marsh through increased transport of freshwater species from upstream, which will result in higher Delta Smelt growth and survival.

Uncertainties:

- What if any habitat attributes limit Delta Smelt growth and survival during the summer and fall?
- Will Delta Smelt utilize habitat created in Suisun Marsh? The SMSCG action assumes that Delta Smelt will more frequently access relatively food-rich habitat in Suisun Marsh in response to the lower salinity levels. The degree to which Delta Smelt outside of Suisun Marsh will detect and respond to the action and move into the marsh is uncertain.

100 TAF Block of Water

Alternatives considered by CDFW for implementation in an AN water year include an extension of daily SMSCG operations through October with the

goal to expand suitable habitat during summer-fall into some of Grizzly Bay. The use of 100 TAF to push out X2 in September and potentially October was determined to not be as effective as gate operations in WY 2023 modeling and was not considered in WY 2024.

Evaluation of 100 TAF implementation will be done using existing science and monitoring in place for the SMSCG and Interagency Ecological Program (from DWR, CDFW, and USFWS) survey data. Hypotheses and uncertainties are the same as a wet year with the following additional hypothesis:

- The sequence of deploying the 100 TAF with SMSCG operation after implementation of the SMSCG operations action will maximize the area of Delta Smelt habitat with appropriate conditions throughout the entire action implementation time period (July – October), resulting in even higher Delta Smelt growth and survival than would be accomplished by either action alone.

Below Normal Water Year Type

The DCG considered the same SMSCG actions as an AN water year, as described in Table 3. If WY 2024 is BN, the Fall X2 and 100 TAF actions will not be implemented.

SMSCG operations

The ITP requires 60 days of SMSCG operations between June and October with a target salinity at Belden's Landing of 4ppt. Based on model forecasts, DWR expects to begin implementing SMSCG operations on July 1 and continue through August 30. Operating the SMSCG discontinuously for 7 days on and 7 days off (7/7) until 60 days was met was considered given previous modeling used for the Proposed Action being developed for the 2021 Reinitiation of Consultation on the State Water Project/Central Valley Project. This modeling showed that operating the gates for seven days of tidal operation before holding the Gates open for seven days, maintained salinities below 4ppt at Beldon's Landing for longer at the same water cost and total days of operation. However, hydrodynamics modeling conducted as part of DCG deliberations indicated that continuous operations for 60 days lowered salinity in the northern part of Grizzly Bay during the summer so it was the preferred alternative. The Gates will be held closed for up to 10

days in November of 2024 to conduct planned maintenance. The water cost for this action was assumed to come from export cuts. Hypotheses and uncertainties are the same as for an AN year.

Dry Water Year Type

Based on the March water year forecast, WY 2024 will not be Dry. However, if the year were Dry, following Wet WY 2023, a SMSCG action would be required, but the 100 TAF would not be available. In dry years following wet years, the ITP requires 60 days of SMSCG operations between June and October with a target salinity at Belden's Landing of 4 PSU. Operations would presumably be the same as in a below normal year.

Critical Water Year Type

Based on conditions to date, WY 2024 will not be critically dry.

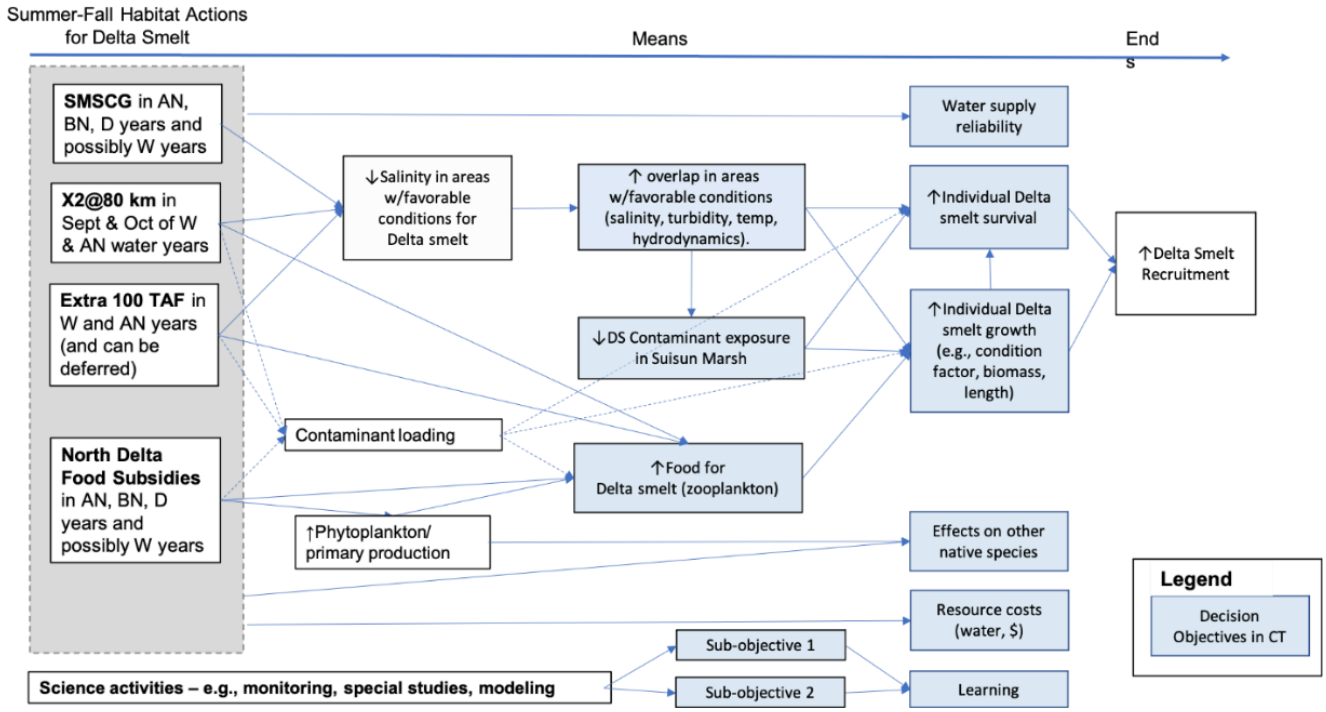

Figure 4 Influence diagram of Summer-Fall Habitat Action (SFHA) developed by the DCG in 2021 illustrating the hypothesized relationships between the SFHA management action and objectives. Note: Management actions are described in the grey shaded box, with the end-objective of increased smelt recruitment in the white box, influenced by the means-objectives in blue.

2024 Structured Decision-Making

Process, Objectives, and Metrics

For the 2024 SFHA SDM process, the DCG initially identified the suite of actions to occur June to October, given the likely water year types from the January through March forecasts — Wet, Above Normal, Below Normal, and Dry (as described in the Actions section above). In contrast to WY 2023, CDFW proposed inclusion of the 100 TAF action in the SDM process to harness the DCG's creative backgrounds identifying alternative implementation options and supporting their decision on how to use the 100 TAF block of water (if available). The DCG concluded that the 2024 SDM decision-frame would evaluate the operations scheduling of a SMSCG action (60 days continuously or 60 days discontinuously, with a 7 days tidal operation/ 7 days open pattern) in addition to alternative uses of the Additional 100 TAF in the given WY or potential uses if deferred to WY 2025 (described in Appendix B) though the final decision of the 100 TAF action is at CDFW's discretion). The Fall X2 action would be implemented as prescribed in September and October if the final water year forecast is Wet or Above Normal.

The fundamental objective of the SFHA is improved Delta Smelt recruitment (by improved growth and survival). The means objectives of the SFHA are increasing quality and extent of abiotic habitat, increasing quality and biomass of smelt prey, limiting impacts to other native species, and limiting resource costs (Figure 4). The idea behind these objectives came from the work of Baxter et al. (2015) following the Management Analysis and Synthesis Team models and updated with additional research on smelt ecology and physiology (e.g. Hammock et al. 2017, Smith and Nobriga 2023). The DCG developed an initial means-end diagram of the full suite of Summer-Fall actions in 2021 (Figure 4). Given the complexity and unpredictable hydrology, annual iterations of SDM have focused on either a subset of habitat or food actions and/or included adjustments to means objectives and performance metrics.

The 2024 recommendation was based on previous SDM iterations developed by the DCG, new analyses of low salinity zone habitat, temperature, and food (i.e., *Pseudodiaptomus forbesi*) for scenarios, and a series of collaborative discussions within the DCG of predicted benefits to Delta Smelt. The decision for the DCG is, if a SMSCG action is taken, what is the best

operation schedule to maximize habitat benefits to Delta Smelt? The DCG also discussed the relative benefits of using the 100 TAF block of water, if available, in WY 2024 or deferring to WY 2025, but the final decision to use or defer the block of water was CDFW's decision, not the DCG's.

SDM objectives, sub-objectives, and more detailed hypotheses for WY 2024 decision framework are described in Table 1. Performance measures used to evaluate consequences for each objective or sub-objective are identified in Table 2. The information for each performance measure, consequence assessment, and anticipated outcomes are described in the following sections. The final consequence table was compiled as of March 28, 2024, and is provided in this action plan.

For the WY 2024, the DCG utilized the existing information compiled in the last year's SDM process to guide this year's recommendation for summer-fall habitat actions. Given previous years' findings and the current suite of prescribed actions, the decision framework for WY 2024 was simplified by removing objectives and performance metrics that were either not applicable or did not have updated modeling results. For example, Delta Smelt growth, habitat suitability index, contaminants, and effects to salmonids were not evaluated in this year's SDM. Delta Smelt growth rate potential was predicted by the bioenergetics model in the WY 2022 and 2023 SDM process for SMSCG actions (4 PSU v. 6 PSU) for Dry and Below Normal WYs for regions including Yolo, Lower Sac, Confluence, and Suisun Marsh. For WY 2024 decision-making, the growth metric would need to be predicted for AN and Wet water years, additional action alternatives, and adjustments to temperature thresholds, which was not feasible to complete given agency capacity. The DCG acknowledged some summer-fall actions have the potential for unintended effects (e.g., contaminants, effects to other species), however, given outcomes of previous expert elicitations and uncertainties, only metrics for Low Salinity Zone and calanoid copepods were used. Because CDFW was interested in the DCG's insights related to benefits to Delta Smelt and possibly Longfin Smelt of different uses of the 100 TAF and not in discussion of potential costs and risks related to the deploy/defer decision, the DCG evaluated only objectives related to benefits to Delta Smelt and Longfin Smelt.

Table 1 Modified decision objectives for the 2024 SDM.

Decision Objective	Sub-Objective	Description
Delta Smelt food and habitat	Suitable Habitat	Targeted actions to increase overlap suitable habitat attributes including low salinity, high turbidity, cooler temperature, and favorable hydrodynamics for Delta Smelt. Expanding the low salinity zone area in Suisun Marsh and Grizzly Bay will allow Delta Smelt to more freely access complex, relatively food-rich habitat, and potentially cooler thermal habitat.
Delta Smelt food and habitat	Zooplankton	Targeted actions to increase calanoid copepod biomass for Delta Smelt in key locations are hypothesized to offset Delta Smelt summer-fall food limitation and improve overall suitable habitat
Effects on other native species	Longfin smelt benefit	Not included in assessment for WY 24.

Table 2 Performance measures evaluated for each SDM decision objective.

Decision Objective	Sub-Objective	Performance Measures (PM)	Units	Direction
Delta Smelt food and habitat	Suitable habitat	Mean area of Low Salinity Zone (LSZ) in Suisun Marsh between July and October (out of 5026 acres total)	Acres	Higher
Delta Smelt food and habitat	Suitable habitat	Mean Area of Low Salinity Zone (LSZ) in Grizzly Bay between July and October (out of 12,433 total acres)	Acres	Higher
Delta Smelt food and habitat	Suitable habitat	Mean Area of Low Salinity Zone (LSZ) in Suisun Bay for July and October (out of 13,324 total acres)	Acres	Higher
Delta Smelt food and habitat	Suitable habitat	Mean Percent increase of LSZ area in Suisun Marsh of an action scenario and the base scenario	%	Higher
Delta Smelt food and habitat	Suitable habitat	Mean Percent increase of LSZ area in Grizzly Bay of an action scenario and the base scenario	%	Higher

Decision Objective	Sub-Objective	Performance Measures (PM)	Units	Direction
Delta Smelt food and habitat	Suitable habitat	Mean Percent increase of LSZ area in Suisun Bay of an action scenario and the base scenario	%	Higher
Delta Smelt food and habitat	Calanoid Copepod biomass in Suisun area	Predicted change in *P. forbesi* abundance between an action scenario and the base scenario.	qualitative	Higher

Analysis of Benefits of Summer-Fall Actions

DWR used SCHISM to analyze the potential benefit of SMSCG operations alone and with the use of the 100 TAF block of water to support a longer period of Gate operations, modeling operational scenarios for a Wet, Above Normal, Below Normal, and Dry year. Hydrology from 2020 was used for the Dry year simulations, hydrology from 2016 was used for the Below Normal year simulations, hydrology from 2010 (which was classified as 'Below Normal') was used with operational conditions required by an Above Normal year for the Above Normal scenarios, and hydrology from 2017 was used for the Wet year scenarios. In all cases, the 100 TAF was used to offset salinity intrusion via Suisun Bay that can occur when operating the SMSCG (Table 3). Each of the 60-day ITP operational scenarios was modeled as a continuous operation or 7-7 to compare the predicted habitat consequences of each one. Delta Smelt habitat was defined as the mean area of LSZ, i.e., areas of less than 6 PSU, between July 1 and October 31 located in either Suisun Marsh, Grizzly Bay, or Suisun Bay (Suisun Bay includes Honker Bay and Suisun Bay). In all scenarios including the 100 TAF, the block of water would be provided from Oroville releases, export reductions, or a combination of the two. The baseline scenario does not include Gate operations in order to quantify the expected improvement of either implementation scenario. The operational scenarios are described in Table 3 and Table 4.

Low Salinity Zone area (in acres) and the percent increase in LSZ over baseline were calculated for all operation scenarios and averaged across time (July to October) for each water year type in Grizzly Bay, Suisun Bay, and Suisun Marsh. LSZ area and percent increase were also calculated for

each month across regions to support the DCG's evaluation of spatial and temporal tradeoffs of the different summer-fall scenarios.

Pseudodiaptomus forbesi, is a freshwater calanoid copepod that is one of the primary prey items of Delta Smelt during summer-fall. Potential changes to *P. forbesi* abundance were evaluated qualitatively using long-term zooplankton monitoring data and literature review. Numerous studies have shown increases in *P. forbesi* abundance in Suisun Bay and Suisun Marsh during periods of higher outflow and fresher conditions (Kimmerer et al. 2018; Barros et al. in press). During the 2022 SDM process, changes to abundance with decreases in salinity in Suisun Marsh were evaluated quantitatively using a generalized additive model, but we chose to evaluate changes qualitatively in 2024 due to staff availability and high uncertainty in the model.

To visualize previous changes in *P. forbesi* abundance and provide a basis for a qualitative analysis, we graphed *P. forbesi* abundance in Grizzly Bay, Suisun Marsh and Suisun Bay for the SFHA time period from 2000-2023. Data from zooplankton surveys conducted by CDFW's Summer Townet Survey and Fall Midwater Trawl Survey as well as DWR/CDFW's Environmental Monitoring Program and the Reclamation-funded Directed Outflow Project were supplemented by additional samples in Suisun Bay and Suisun Marsh starting in 2018 to evaluate the effectiveness of a summer SMSCG action (see monitoring plan for details). Catch per unit effort of adult and subadult *P. forbesi* was summarized for July through October and log-transformed to show differences between years. CPUE was plotted for Grizzly Bay, Suisun Marsh, and Suisun Bay regions compared to a Sacramento River region directly to the east.

Water temperature trends were evaluated spatially and temporally using data from 2023. First, spatial maps of water temperature were created for two-week periods, August 16-31 (start of action), September 1-15 (middle of action) and October 1-15 (end of action). Second, continuous water temperature data was assessed from July to October to determine the differences between Grizzly Bay water temperatures and temperatures in Suisun Marsh. Continuous water quality stations included Belden's Landing at Montezuma Slough (BDL), and three sites in Grizzly Bay; Grizzly Bay Buoy (GZB), Grizzly Bay (GZL), and Grizzly Bay at Montezuma Slough (GZM) (see SMSCG monitoring plan for additional information on stations).

Table 3 Summer-Fall alternatives included in the WY 2024 SDM

	Alternative name	Alternative description
W, AN	Base	Fall X2 at 80km Sept and Oct. No SMSCG action.
W	100 TAF Aug 15	SMSCG operated for 60 consecutive days starting Aug 15th ; and Fall X2 at 80 km Sept and Oct
AN	60 days continuous	SMSCG operated for 60 consecutive days starting on July 1, and Fall X2 at 80 km Sept and Oct (100 TAF block of water deferred)
AN	60 days 7/7	SMSCG operations for 7 days on/7 days off starting July 1 until 60 days of operations met, and Fall X2 at 80 km Sept and Oct (100 TAF block of water deferred)
AN	60 days continuous + 100 TAF	SMSCG operated for 60 consecutive days starting July 1, following by additional SMSCG operations Sept through Oct expending the 100 TAF, and Fall X2 at 80 km Sept and Oct
BN	Base	No summer-fall habitat actions
BN	60 d continuous	SMSCG operated for 60 consecutive days when Belden's Landing hit 4 PSU (modeled as Jun 13)
BN	60 days 7/7	SMSCG operations for 7 days on/ 7 days off starting when Belden's Landing hit 4 PSU (modeled as Jun 13) until 60 days of operations had accumulated

Results

The modeled effects of action scenarios on LSZ area in Suisun Marsh and Suisun Bay compared to the base scenario, water temperature trends, and *P. forbesi* biomass across water years that were used in discussions with the DCG are summarized below.

Low Salinity Zone

During a Wet year, operating the SMSCG (using the 100 TAF) from August 15 through October 15 had an increased LSZ area in October, (Figure 5, Figure 6, Figure 9) resulting in an average ~3% increase in LSZ area in Suisun Marsh (147 acres), a 1% increase in Suisun Bay (122 acres), and a 7% increase in Grizzly Bay (425 acres). Modeling data were not available for discontinuous operational scenarios (7/7), but they were discussed qualitatively as having similar results to the discontinuous operation in other water year types, with a longer duration of low salinity habitat in Suisun Marsh but a lower area of habitat in Grizzly Bay when compared to continuous operation.

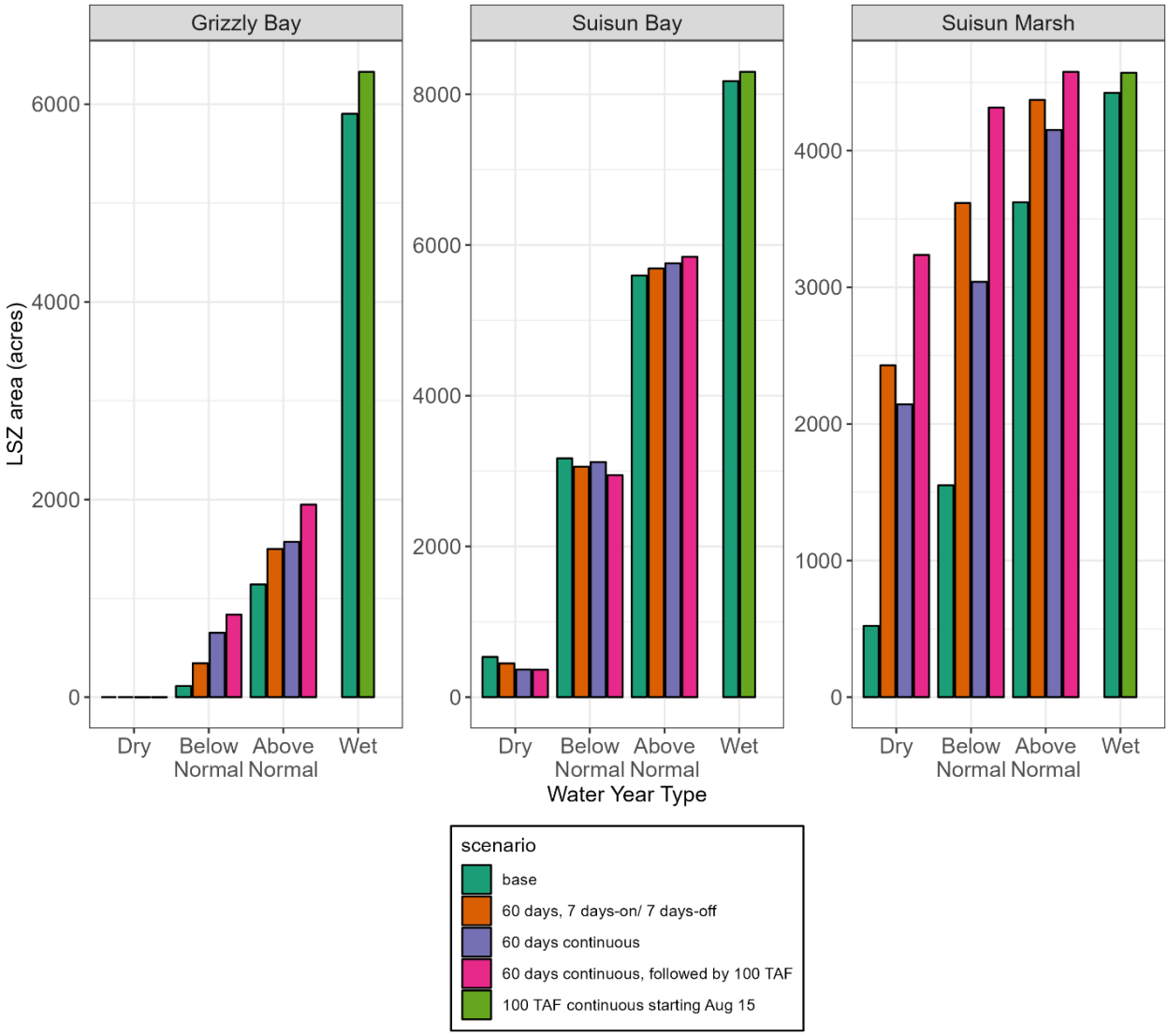

Figure 5 Mean area of each region below 6 PSU for July 1-October 31 for each water year type and scenario.

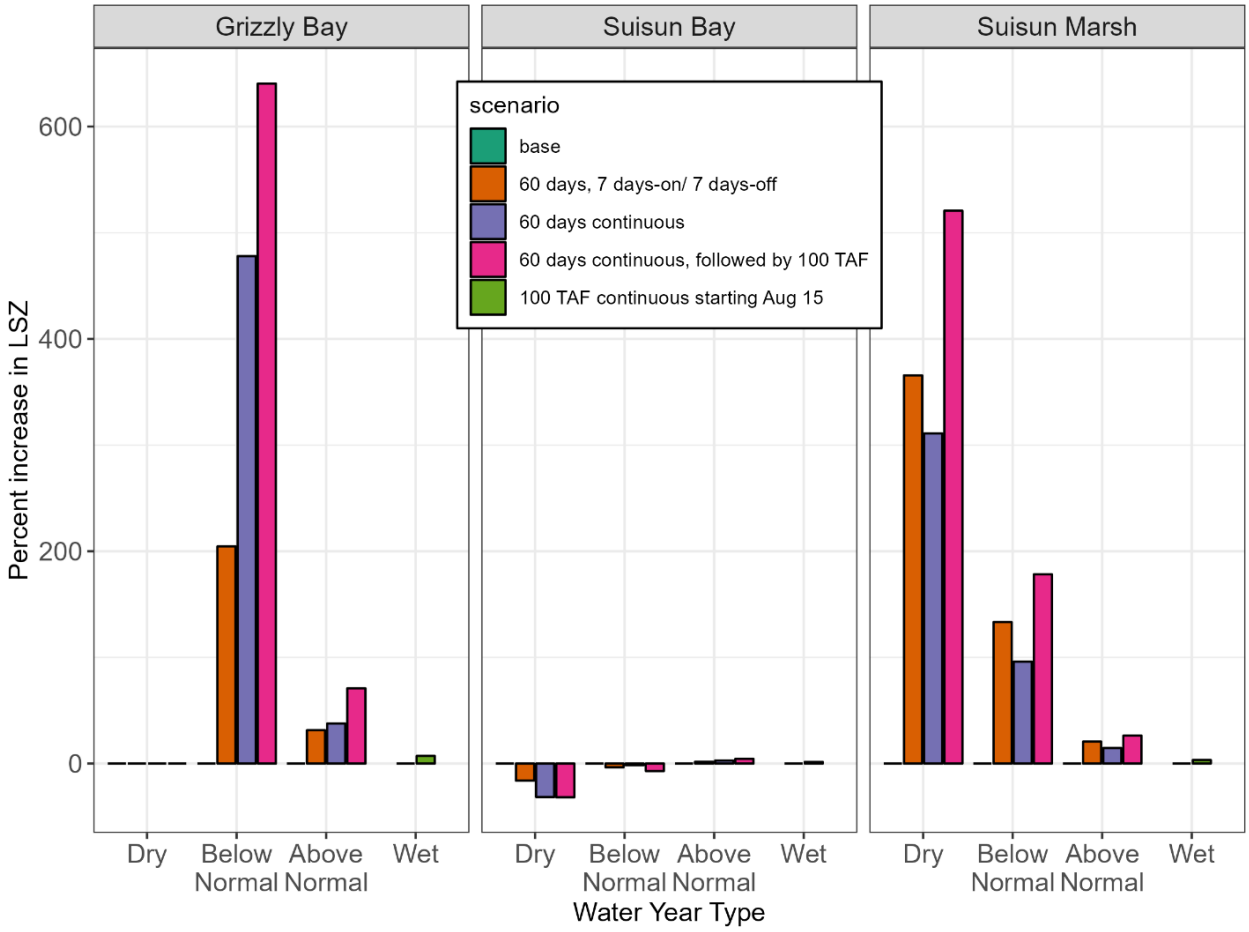

Figure 6 Percent increase in LSZ habitat for July1-October 31 in each region and each scenario in each water year type modeled.

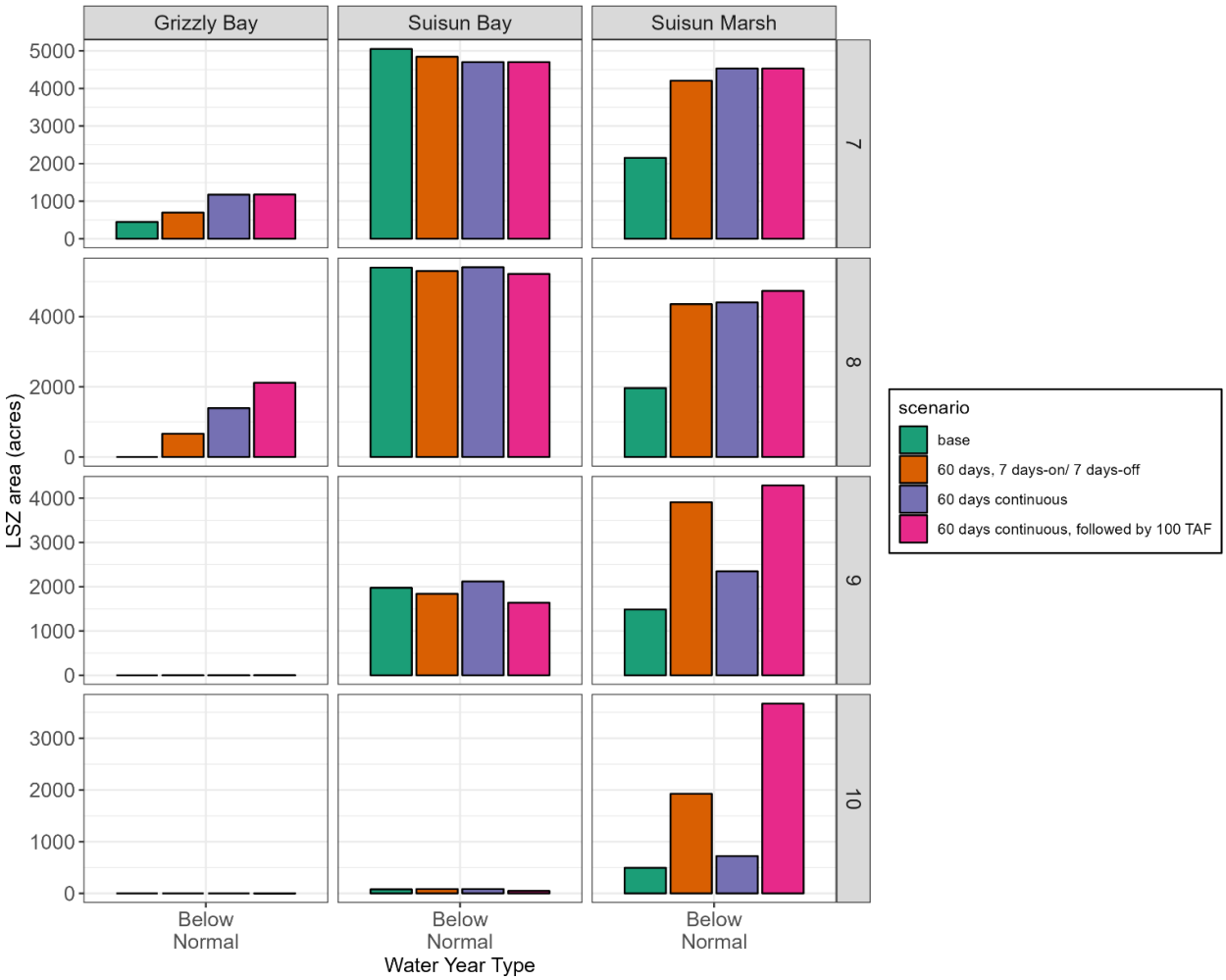

Figure 7 Mean LSZ area of each region per month below 6 PSU for July (7), August (8), September (9), and October (10) for each scenario in a Below Normal year.

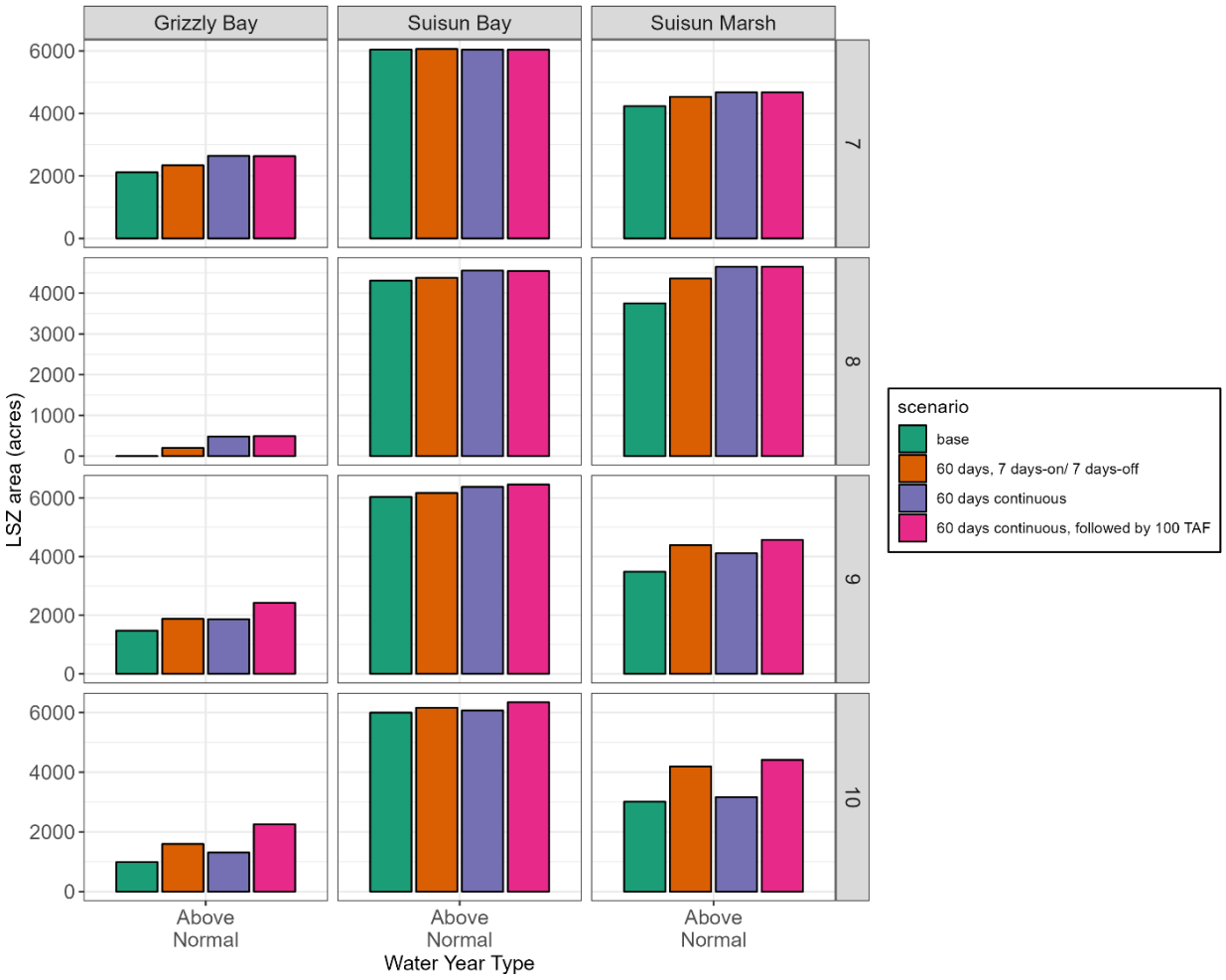

Figure 8 Mean LSZ area of each region per month below 6 PSU for July (7), August (8), September (9), and October (10) for each scenario in an Above Normal year.

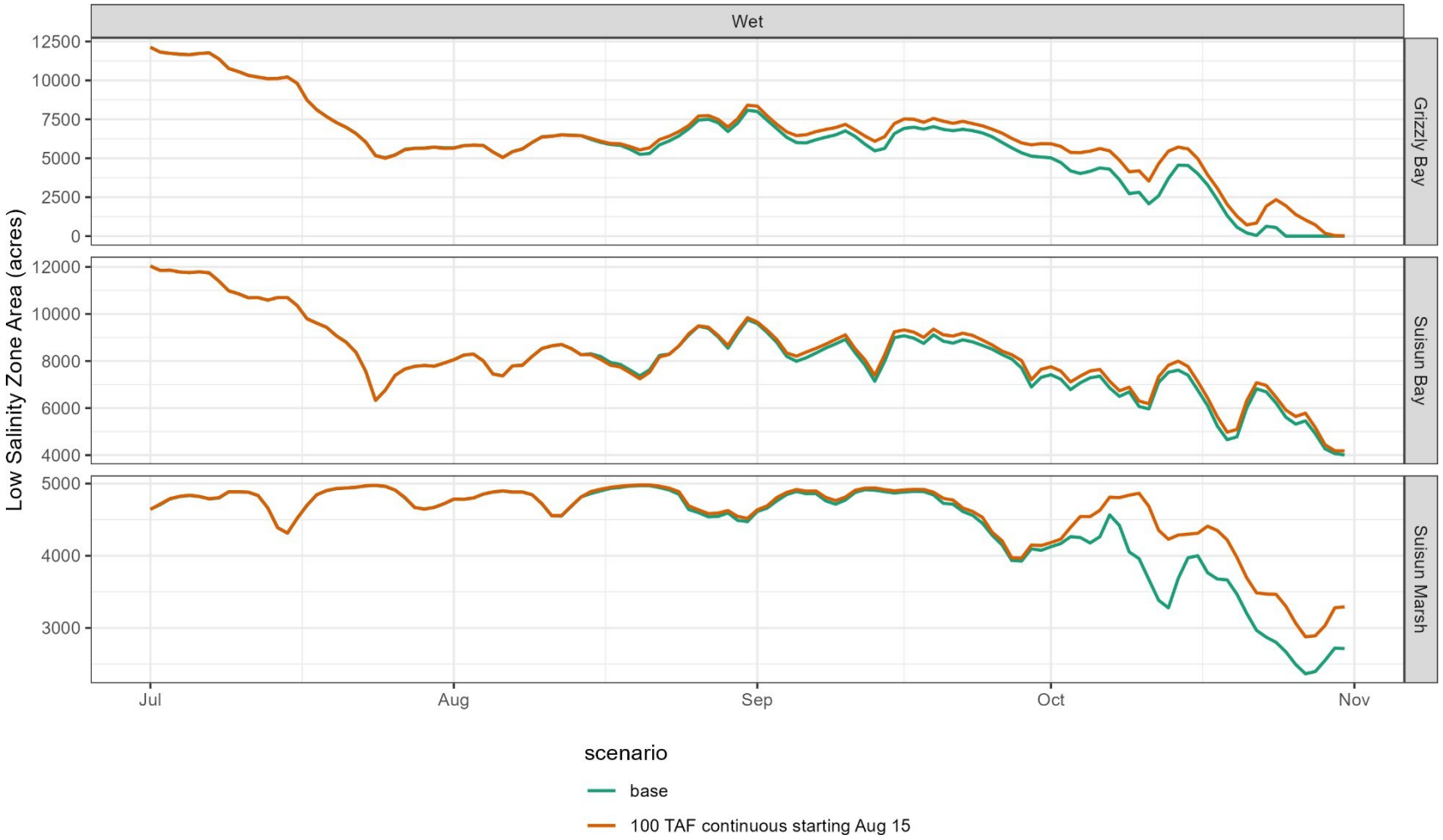

Figure 9 Modeled Low Salinity Zone Area (acres) in Suisun Bay and Suisun Marsh in a Wet year for different 100 TAF action scenarios (using Gate operations) compared to the base scenario. Note different y-axes between panels.

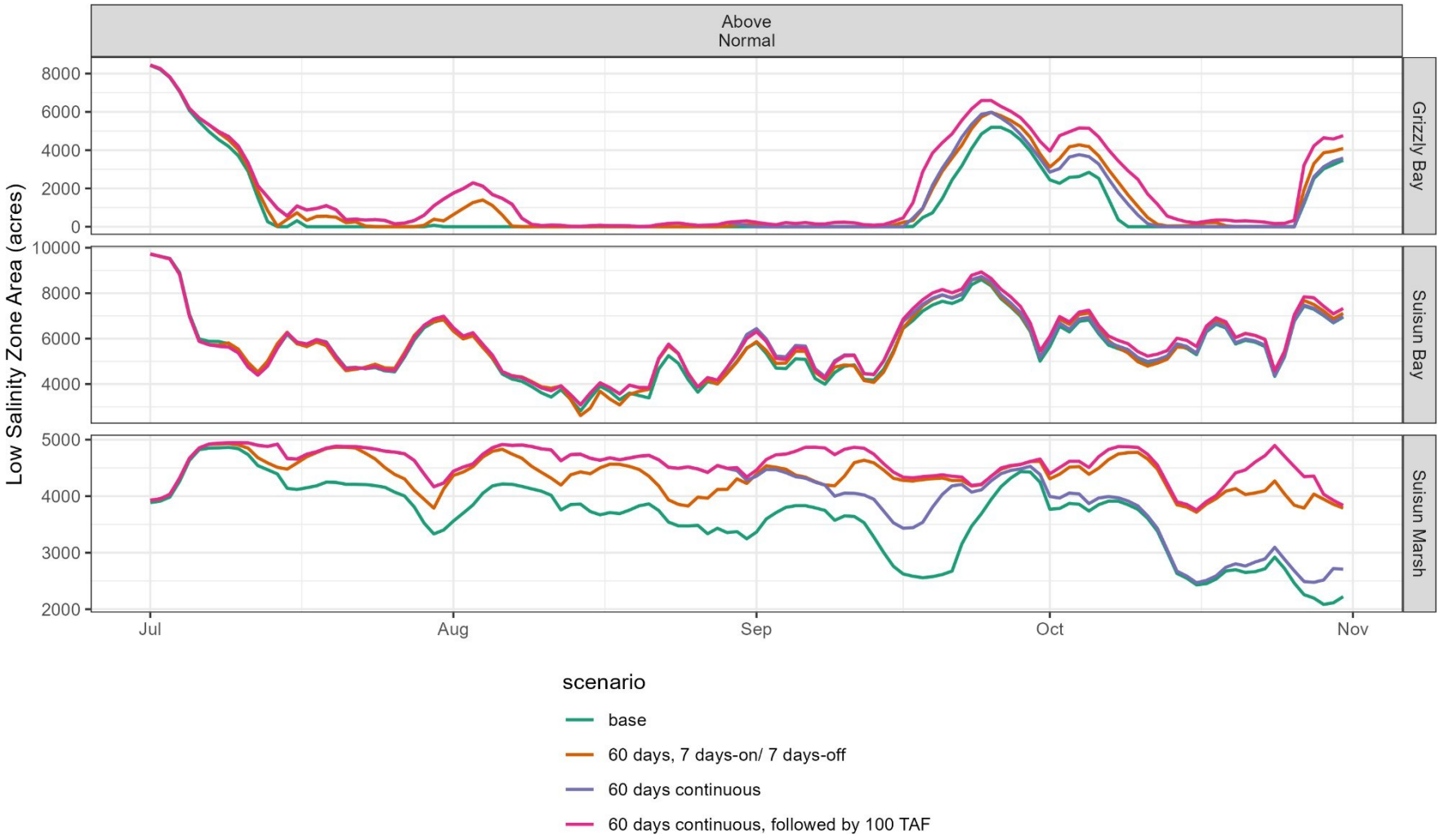

Figure 10 Modeled Low Salinity Zone Area (acres) in Suisun Bay and Suisun Marsh in an Above Normal year for different Suisun Marsh Salinity Control Gate operation scenarios. Note different y-axes between panels.

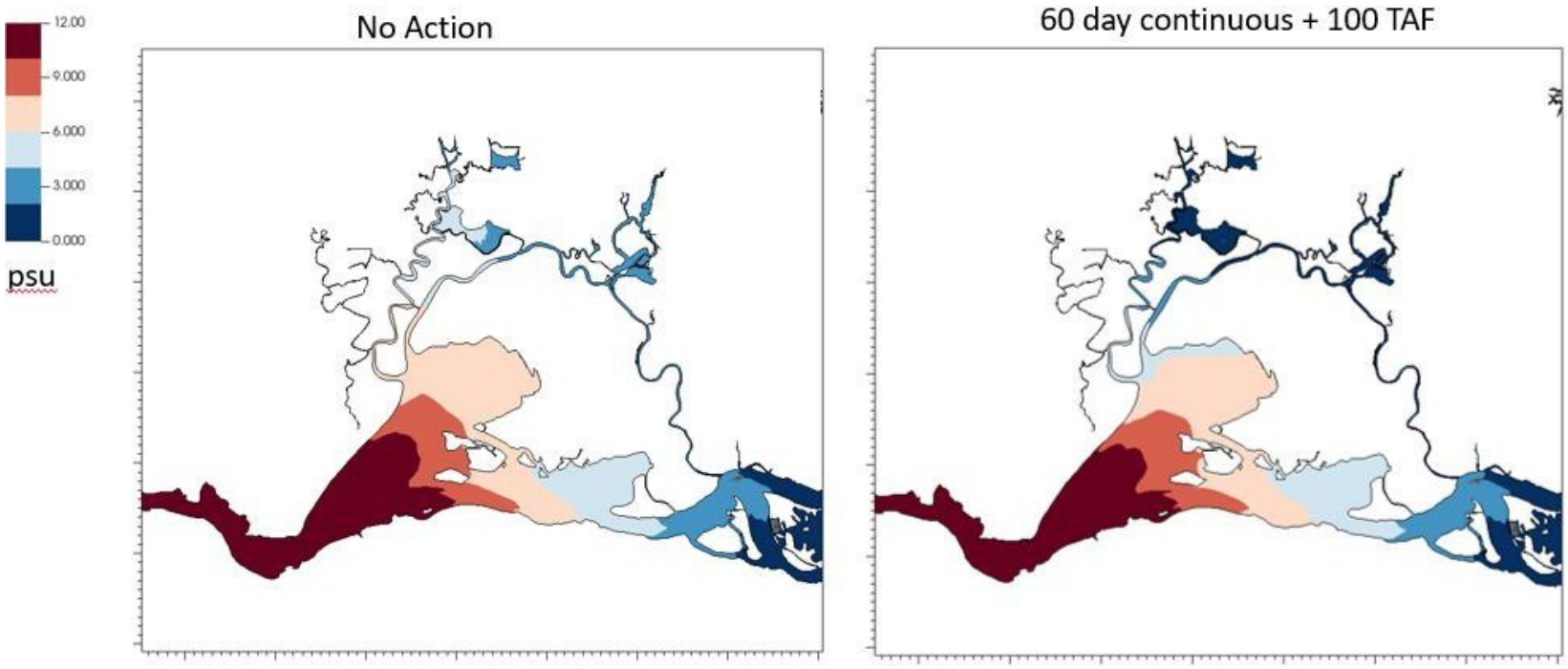

Figure 11 Average salinity (in PSU) during August 1-14 during no summer-fall action compared to 60 days of Gates operations and 100 TAF additional block of water. Note: PSU is practical salinity units, ranging from 0-12.

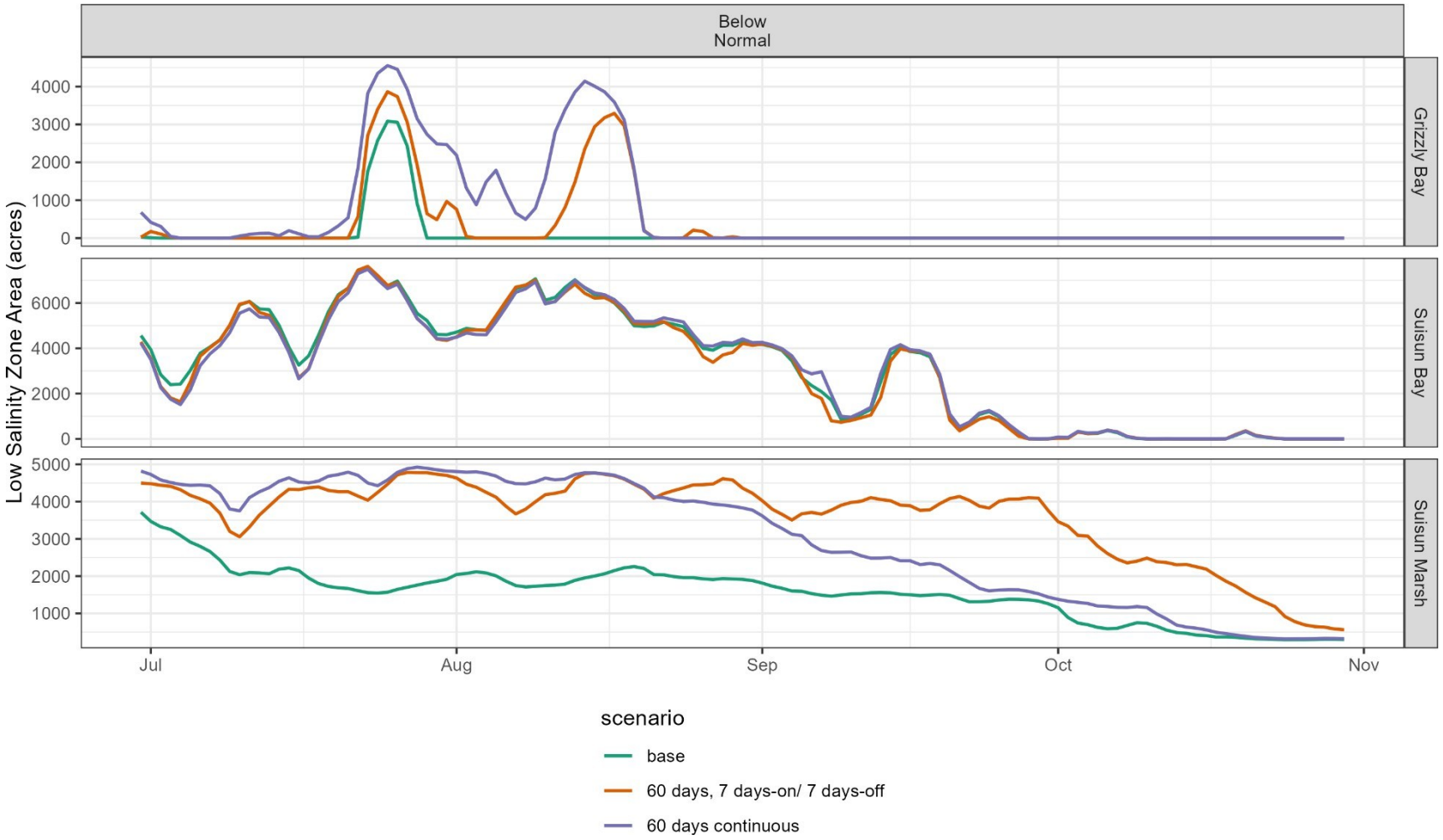

Figure 12 Modeled Low Salinity Zone Area (acres) in Suisun Bay and Suisun Marsh in a Below Normal year for different Suisun Marsh Salinity Control Gate operation scenarios. Note different y-axes between panels.

During an AN year in Suisun Bay, operating the SMSCG for 60 days continuously resulted in a 3% increase in LSZ area (163 acres), operating for 7 days on 7 days off resulted in a 2% increase (104 acres), and operating continuously followed by operations with the 100 TAF resulted in a 4% increase (249 acres) (Figure 5, Figure 6, Figure 10). In Grizzly Bay, operating continuously resulted in a 38% increase in LSZ area (430 acres), operating 7 days on, 7 days off resulted in a 31% increase in LSZ area (359 acres), and operating continuously followed by operations with the 100 TAF resulted in a 71% increase (approximately 809 acres; Figure 5 Figure 6), with most of this habitat improvement occurring in late September and October (Figure 10). In Suisun Marsh, 60 days of consecutive SMSCG operations increases LSZ area by an average of 14% (530 acres, Figure 5, Figure 6), mostly through September after which conditions become more similar to the base (Figure 10). Continuing gate operations through September and October (with the 100 TAF) extended the period of greater LSZ area versus operating the gates in July and August only (for an average of 955 acres, 26% increase, Figure 10). Spatial modeling also showed the SMSCG action followed by 100 TAF block of water lowered salinity (<6 PSU) through Montezuma Slough and edge habitat of northern Grizzly Bay (Figure 11). The 7/7 operation of SMSCGs provides a 21% increase in LSZ area from July through November (749 acres in average, similar to the SMSCG action and 100 TAF action) though the peaks are lower than with a continuous operation (Figure 5, Figure 6, Figure 10).

In a BN year, model results show both SMSCG operation scenarios increase the LSZ area in Grizzly Bay and Suisun Marsh from July to September compared to the base case (with no gate operations), but decreased LSZ area in Suisun Bay by 2-3% (48-109 acres; Figure 5, Figure 6). Operating the SMSCG for 60 consecutive days increased the LSZ area in Grizzly Bay and Suisun Marsh throughout July and August (Figure 12), with an average increase of 478% in Grizzly Bay (535 acres) and 96% in Suisun Marsh (Figure 6). Operating the SMSCG with a 7/7 schedule resulted in an increase in average LSZ area of 133% (2062 acres) in Suisun Marsh and an increase of 205% in Grizzly Bay when compared to the base case (Figure 6). The maximum LSZ areas were larger for the 60 days continuous operation scenario, however the 7/7 scenario extended the duration of LSZ acreages through October in Suisun Marsh, Figure 12).

Water Temperature

Water temperature is not affected as a direct result of the summer-fall actions. Increasing the amount of freshwater input to Suisun Bay and Marsh does not meaningfully lower the water temperature of these regions (less than 0.2 degree Celsius (°C) difference between the operation and no-operation scenario, Figure 13) but it can move low-salinity water west such that parts of the LSZ can become cooler if the overlying air temperature is cooler. Specifically, the summer-fall actions may provide a low-salinity corridor by which Delta Smelt can access the northern part of Grizzly Bay where overlying air temperature is often cooler than it is in Suisun Marsh or the Delta. Modeled water temperature during summer operations in 2023 showed water temperatures in August between Delta Smelt sublethal (22°C) and tolerance thresholds (25°C) in the (baseline) River and (action) Suisun regions (

Figure 13). Temperatures decreased in fall months below the Delta Smelt's 22°C sublethal temperature threshold, but there was no longer a modeled difference in the operation and no operation scenarios by that time of year.

The DCG discussed the hypothesis that Grizzly Bay may provide cooler habitat but there was some concern that northern Grizzly Bay water temperatures would be about the same as Montezuma Slough due to water exchange at the slough mouth. With new monitoring sites across Grizzly Bay, 2023 summer-fall data show that Montezuma Slough and Belden's Landing had warmer water temperatures than any of the Grizzly Bay sites. GZM, the Grizzly Bay station nearest Montezuma Slough also had relatively high water temperatures due to its proximity to the warmer marsh stations (Figure 13

Figure 13 and Figure 14). However, Grizzly Bay sites furthest away from the slough mouth (GZB and GZL) were often 0.5-1°C cooler; and as much as 2°C cooler in the mid-July 2023 heat-wave, Figure 14). With temperatures near Delta Smelt tolerance of 25°C in the marsh, a 2°C cooler habitat in Grizzly Bay may provide smelt critical habitat needed to survive.

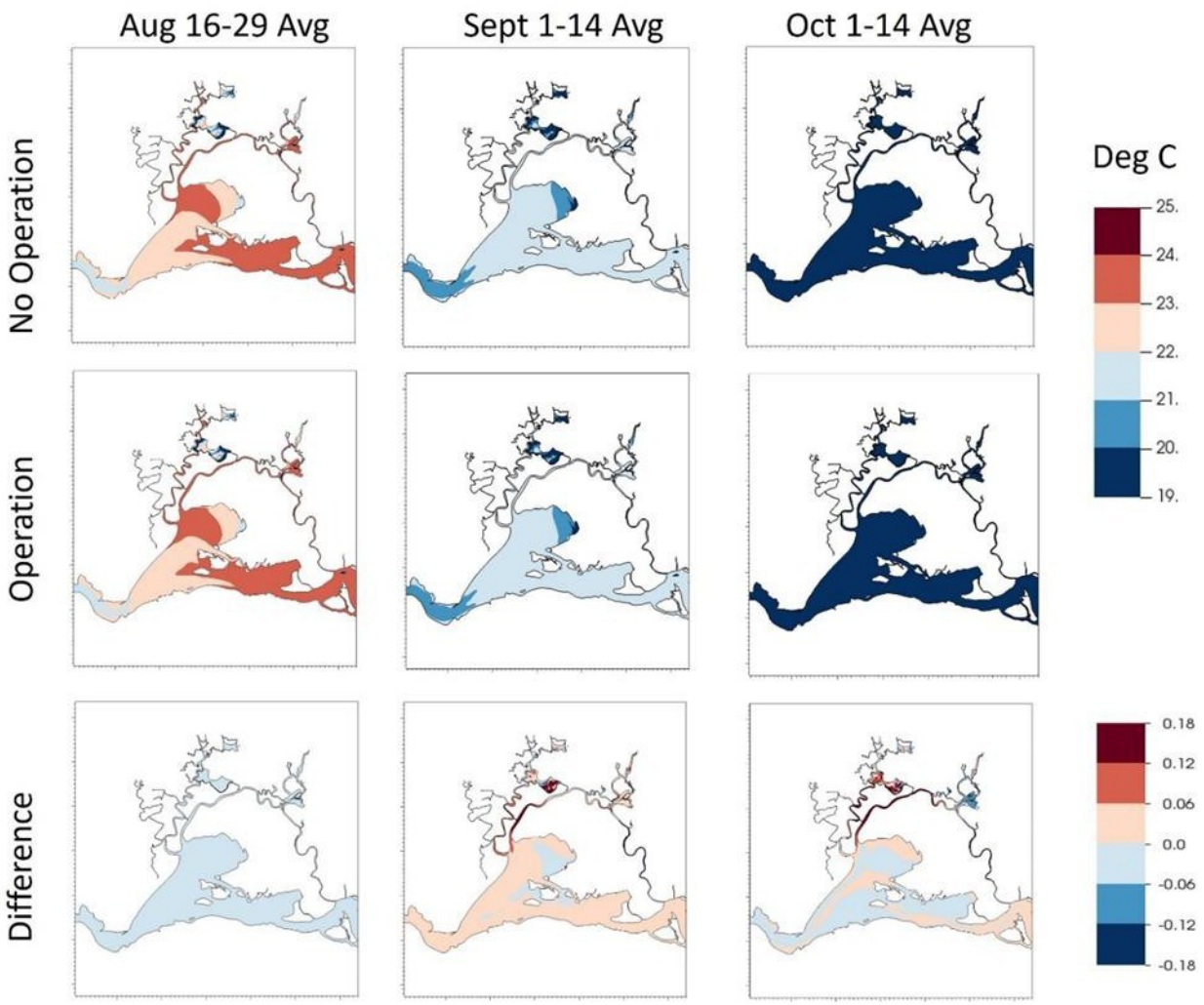

Figure 13 Modeled water temperature during the summer-fall action, 2023.

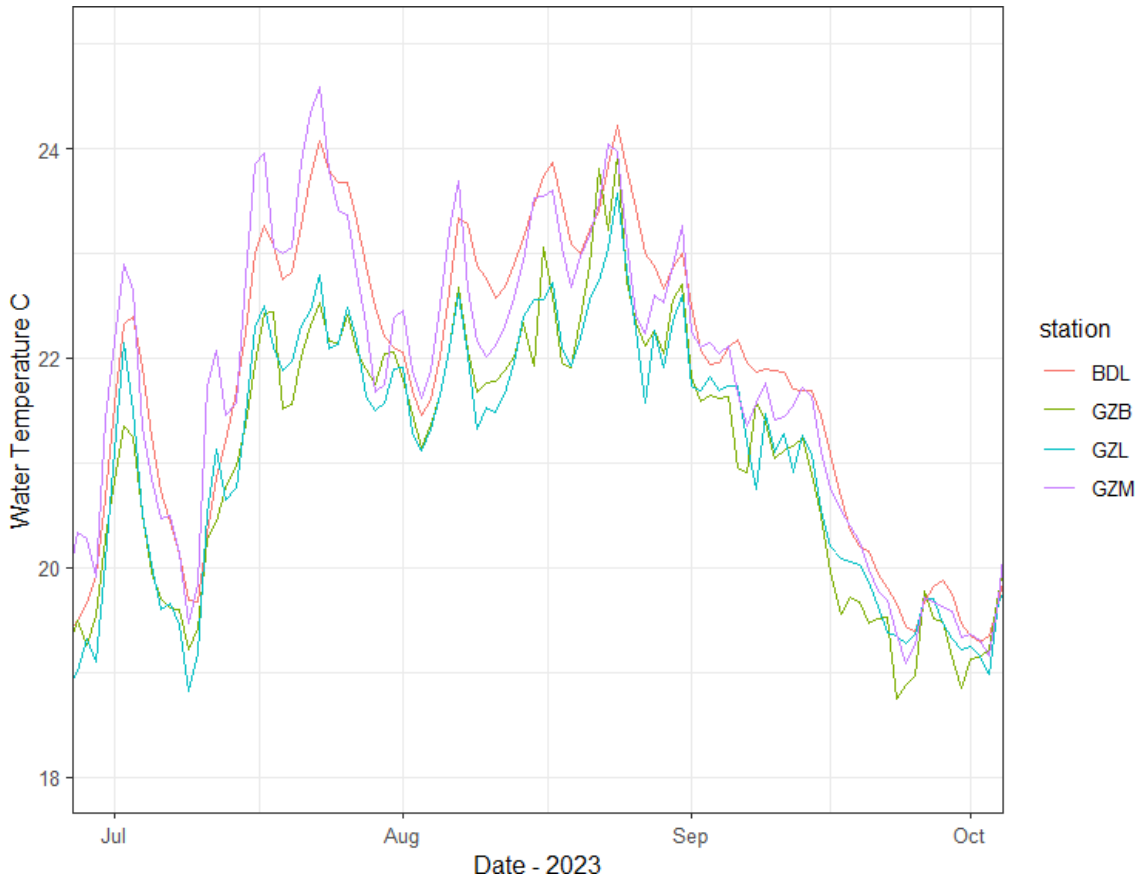

Figure 14 Mean daily water temperature July-October 2023 in Suisun Marsh and Grizzly Bay. Note: Water temperature is in degrees Celsius.

Pseudodiaptomus forbesi

The analysis of *P. forbesi* abundance by region showed higher densities in the River compared to brackish habitats of Grizzly Bay, Suisun Marsh and Suisun Bay (Figure 15). In wet years with naturally high summer outflow or summer-fall actions (e.g. 2011, 2017, 2019, 2023) *P. forbesi* abundance in June to October was higher than in dry years with lower outflow and no actions (e.g. 2007-2010, 2012-2016, 2020-2022). However, elevated *P. forbesi* abundance was also observed in wetter conditions such as 2006 that pre-date active management of fall X2 or SMSCG in the summer. Previous research has shown that *P. forbesi* relies on a subsidy from the Delta to maintain its density in the low-salinity zone because of overbite clam and predatory copepod grazing pressure on its larval life stage (Kayfetz and Kimmerer 2017; Kimmerer et al. 2019). The subsidy is enhanced somewhat

by elevated Delta outflow (Hassrick et al. 2023). The natural phenology of the *P. forbesi* life cycle in the estuary involves increasing abundance in late spring to a peak during summer and senescence in the fall because the species is considered sub-tropical in its native range (i.e., its reproductive rates are highest when the water is warmest; Sullivan and Kimmerer 2013).

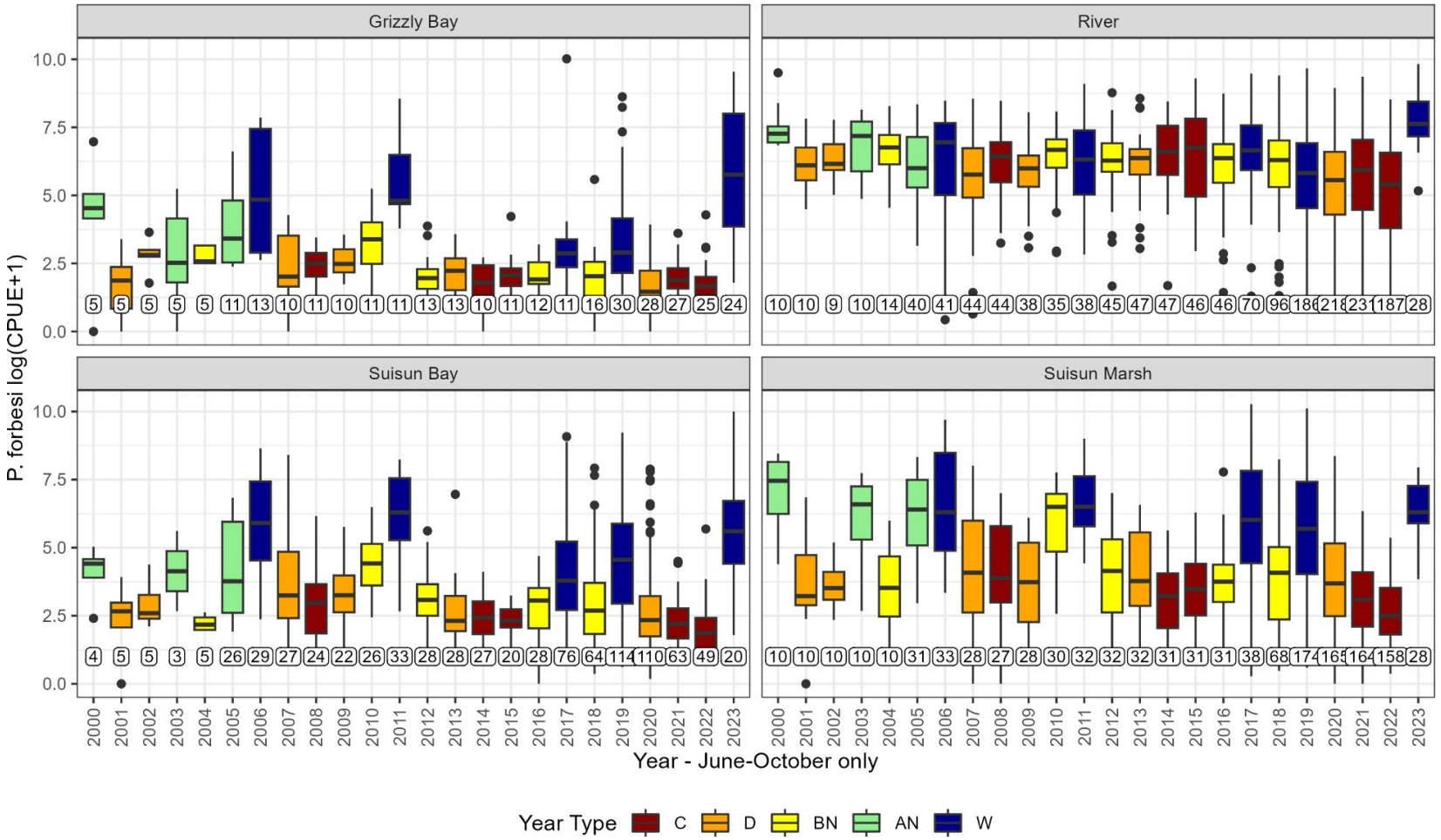

Figure 15 ***Psuedodiaptomus forbsei*** **catch per unit effort for July-October from 2000-2023 across regions. Note: Water year types (Yrtype) are described as Critical (C), Dry (D), Below Normal (BN), Above Normal (AN), and Wet (W). Sample size is indicated in the label below each box.**

Table 4 Consequence table (WY 2024) with scoring of each alternative based on the sub-objectives and performance measures.

		2024 Below Normal	2024 Below Normal	2024 Above Normal	2024 Above Normal	2024 Above Normal	2024 Wet	2024 Wet
Performance Measure	**Description/ Unit**	**60 days continuous**	**7/7 operation**	**60 days continuous, Fall X2**	**7/7 operation, Fall X2,**	**60 days continuous +100 TAF, Fall X2**	**Fall X2**	**Fall X2, 100 TAF starting August or 4 PSU**
LSZ area in Marsh	modeled acres (of 5026)	3039	3617	4152	4370	4576	4422	4569
LSZ area in Grizzly Bay	modeled acres (of 12422)	653	344	1572	1500	1950	5903	6328
LSZ area in Suisun Bay	modeled acres (of 13324)	3120	3059	5757	5689	5843	8176	8298
LSZ area % increase in Marsh	% increase from base scenario	96%	133%	14	21	26	NA	3.30
LSZ area % increase in Grizzly Bay	% increase from base scenario	478	205	38	31	71	NA	7
LSZ area % increase in Suisun Bay	% increase from base scenario	-2	-3	3	2	4	NA	1
LSZ area tradeoffs	qualitative	Maximized at start, but declines in Sep. and Oct. when days run out.	133% increase over no action. Highest ave. LSZ area over entire time period	14% increase over no action. Max at start, but declines in Sep. and Oct. when days run out.	21% increase over no action. Higher ave. LSZ area over entire time period	26% increase over no action. Highest ave. LSZ area over entire time period	Lots of habitat created in both Suisun bay and marsh	Highest ave. LSZ area over entire time period. Less than 4% increase in LSZ area versus no SMSCG action
Zooplankton	qualitative	More P. *forbesi* during action, declines after 60 days	More P. forbesi over the entire time period	More P. *forbesi* during action, declines after 60 days	More P. forbesi over the entire time period	Highest increase in P. *forbesi*	More *P. forbesi*	Most *P. forbesi*

Consequence Evaluations

Performance metric scores for each objective and sub-objective were compiled into a single table for WY 2024 (in Wet, AN, BN years, Table 4). The 2024 decision-approach deviated from previous SDM iterations such that habitat suitability index, Delta Smelt growth, total zooplankton biomass, contaminants, water costs, and effects to salmonids were not included in the current iteration and were ignored in the trade-off evaluation. 'Learning' was not explicitly included or scored although it was discussed for WY 2024 in the context of contrasting versus replicating what was implemented in WY 2023. As described previously, habitat suitability index, Delta Smelt growth, total zooplankton biomass, and effects to salmonids were uninformative for scenario comparisons or did not influence the decision, water costs were acceptable, and contaminant impacts were considered negligible given predicted impacts from previous SDM efforts. Thus, the DCG focused on evaluating Low Salinity Zone area and percent area increase (in Suisun Marsh, Grizzly Bay, and Suisun Bay), and *P. forbesi* abundance across summer-fall operation scenarios.

The DCG used a combination of matrix tables and multiple presentations of results to visually compare and discuss consequences and tradeoffs between action scenarios in various water years (Table 4, Figure 5 - Figure 12). There was general agreement on the suite of alternatives in the decision-frame and the DCG agreed the performance metrics (with the additional focus on Grizzly Bay) were sufficient to inform an action recommendation for WY 2024. Within WY 2024, the DCG evaluation focused on the benefits to Delta Smelt in BN and AN water years because these are the most likely. Wet year scores were included in the tables but were not discussed in detail given there would be no decision for the DCG to evaluate. The participants first considered the risks of operation scenarios (particularly in AN years) such as water costs, losing the 100 TAF to spill (if deferred), and the transition to new Biological Opinions and Incidental Take Permits (anticipated in WY 25). DCG members identified that these risks may have meaningful information that would influence their preference for an action; however, these risks were not included in the consequence evaluation. For example, in a BN year the difference in water costs between the continuous and discontinuous SMSCG operations would likely be small enough to not impact DCG member preferences. In contrast, discontinuous SMSCG operations in an AN year may incur increased costs since the operation schedule overlaps with Fall X2,

which may require higher outflow to meet the criteria of 30-day average X2 ≤ 80 km in September and October than what would be associated with SMSCG operations in a BN year. Risks of operations (i.e., water costs, spill) if CDFW were to deploy or defer the 100 TAF were not further considered beyond an initial discussion as it was determined outside of the DCG's decision scope (see ITP COA 9.1.3.1).

The DCG accepted the refined scope of metrics (excluding the above risks) and acknowledged that CDFW would make the value judgement regarding risks associated with the extra 100 TAF. WY 2025 (should 100 TAF be used from WY 24) operation alternatives were described but little discussion occurred (see Appendix B). If CDFW were to defer the 100 TAF for summer-fall habitat next year, deployment options would be evaluated in the following WY 25 Action Plan.

Within both the BN and AN evaluation of continuous or discontinuous SMSCG operation scenarios, a general tradeoff between the freshness of the action (extending into Grizzly Bay) and the length of the action (extending through October) was discussed. New figures of Low Salinity Zone area across each month and region (Figure 7 (BN) and Figure 8 (AN)) were presented in addition to the season-long averages (Figure 5) to ensure everyone received the same information. In general, the continuous gate operation scenarios maximized LSZ area in early months of July and August after which they became similar to the base case, whereas the discontinuous operation of the gates generated less area in July and August, but significantly more habitat in September and October. This demonstrated several potentially important tradeoffs and points of discussion:

- Is it better to have a greater area of habitat or have the habitat last for a longer period of time?
- Should we be maximizing area of LSZ in Grizzly Bay or area in Suisun Marsh?
- Should we be attracting smelt to Suisun Marsh in the fall with the elevated potential for them to be entrained by wetlands managed for waterfowl?
- Is it better to increase food resources earlier in the season (when *P. forbesi* abundance is highest) or extend increased food resources into the fall when the population is naturally senescing?
- Is it appropriate to use a 6 PSU salinity cut-off for the entire season when Bennett (2005) showed nearly zero juveniles and less than 10%

of adults Delta were historically detected in areas with salinity >6 PSU?

Additional information regarding summer-fall conditions from the Delta Smelt life cycle model and Individual Based Model in R (IBMR) was highlighted to support the temporal tradeoff assessment of the SMSCG operations favoring maximized summer habitat (60 days continuous) versus good habitat through summer and fall (60 days discontinuous with 7/7 operation). For example, population modeling done by Smith et al. (2021) supported the benefit of higher outflow in the summer but not fall, and the importance of food and turbidity in the fall. It was confirmed Delta Smelt have a relatively wider salinity tolerance in laboratory studies (0-12 PSU or greater) without major affects to physiology, though this is inconsistent with distributions based on long-term monitoring. The DCG further discussed other abiotic and biotic factors such as food, turbidity, cooler water temperatures, and Delta Smelt's realized niche space within a community of fishes that likely drive behavior and distribution.

Collectively, DCG discussions of life cycle models, interest in maximizing habitat in summer, desire to replicate actions and monitoring, maximizing two wetter years (e.g., WY 2023 and WY 2024) to help Delta Smelt recruitment, and minimizing potential exposure to fall wetland waterfowl management operations led to a range of agency preferences for SMSCG operations in BN and AN years (Table 5). There was additional discussion of improvement of the decision-evaluation of the scenarios in future SDM iterations using modified performance metrics such as bioenergetics and historical catches, but these are potentially time consuming and would need to be further explored in future iterations. Furthermore, some agencies expressed interest in how restoration projects could influence summer-fall habitat outcomes. The group created a list of the key reasons for each operational schedule, key uncertainties, and other considerations during the meeting (Appendix A).

Table 5 Percentage of Delta Coordination Group support for each operation schedule of Suisun Marsh Salinity Control Gates (60 days continuous or 7/7 discontinuous) in BN and AN years.

Level of support	BN 60 cont	BN 7/7	AN 60 cont	AN 7/7
Full support to move forward	14	0	43	0
Reasonable idea and can move forward	43	71	57	57
Not in total agreement but can move forward	43	29	0	43
Need to discuss and not comfortable moving forward	0	0	0	0
Cannot move forward with the current proposal	0	0	0	0

Offramps

While the DCG evaluated all the scenarios listed above and provided recommendations, the final summer-fall actions implemented in 2024 will depend on the final water year type, CDFW's decision regarding use of the 100 TAF, and other operational constraints.

Primary Conclusions from DCG

In a BN year, the DCG concluded with no clear recommendation of a SMSCG operation schedule for WY 2024. There remained mixed support for 60 days continuous and discontinuous operations. One agency had a strong preference for 60 days continuous, recognizing the value of a longer action through fall but emphasizing a greater importance to improve summer conditions by maximizing freshwater habitat and higher abundance of *P. forbesi*. Three agencies agreed that 60 days continuous was a reasonable action to implement. Alternatively, three agencies indicated they were not in total agreement but would still support action implementation with one agency still preferring the 7/7 discontinuous operations to maintain suitable low salinity habitat for as long as possible (summer and fall) since no other actions (e.g., Fall X2 or 100 TAF) were available in a BN year. No agency directly expressed discomfort with moving forward with either planned operation scenario.

In an AN year, the DCG concluded with a stronger recommendation for implementation of 60 days of continuous SMSCG operations. Three agencies were in full support of continuous operations noting their preference to

maximize the LSZ area in July and August in Suisun Marsh and Grizzly Bay to provide a potential temperature refugium, overlap with potentially higher abundance of *P. forbesi*, and noted Fall X2 would begin in September to help maintain habitat suitability in much of the same regions. All other agencies and contractors indicated continuous operations were reasonable suggesting that the DCG is willing to proceed with planned operations of 60 days continuous. CDFW identified their desire to make habitat conditions the best possible in wetter years that may help recruitment and support population resilience of Delta Smelt. CDFW also recognized their decision of using the 100 TAF block of water in WY 2024 would not be finalized until the May water year designation was available and they had coordinated with DWR operators; however, they indicated their preference would be to use the 100 TAF for an additional SMSCG operations immediately following the required gate operations.

Monitoring and scientific investigations

Summer-Fall actions include robust science and monitoring plans (Appendix C) that occur in both action and non-action years. This includes monitoring of water quality, hydrodynamics, and collection of phytoplankton, zooplankton, benthic invertebrates, and fish. Special studies (e.g., enclosure studies, stable isotopes) are also conducted to improve mechanistic understanding when feasible. A description of the monitoring can be found in the SFHA Monitoring and Science Plan and project-specific workplans. The 100 TAF outflow action and the fall X2 action will leverage long-term monitoring and data collections from other summer-fall actions (e.g., SMSCG), which can be subsequently used to update existing modeling tools. CDFW and DWR will evaluate if new or enhanced monitoring elements are warranted.

The project-specific monitoring occurs in the context of the larger Interagency Ecological Program monitoring enterprise. Data on fish response to the actions, in particular, relies heavily on data collected by existing monitoring surveys, such as the Fall Midwater Trawl, Environmental Monitoring Program, Summer Townet Survey, Yolo Bypass Fish Monitoring Program, Enhanced Delta Smelt Monitoring, and the Directed Outflow Project. All these data sources are integrated to assess the effectiveness of the actions.

Future science priorities are evaluated through the DCG Science and Monitoring work group and vetted by the DCG. In 2022, the Science and Monitoring Work Group identified their highest priority science actions to include a better understanding of the response of zooplankton to outflow, collecting baseline data on zooplankton in managed wetlands, and additional contaminant sampling. Experimental deployment of smelt enclosures is also a high priority in action years, though this approach will generally not be used in non-action years.

The SFHA Monitoring and Science Plan (Appendix C) is updated annually to provide general descriptions of ongoing monitoring activities and identify topics for potential work plan modifications or directed studies. Full action study plans are also available. Where possible, each of the hypotheses and scientific uncertainties listed under each action will be statistically evaluated using data collected by the monitoring activities described in the Monitoring and Science Plan. These analyses will be reported annually to the DCG to inform future decisions. The effectiveness of the action as a whole will be synthesized and reviewed by an independent panel at regular intervals.

Coordination and communication

The DCG will continue to meet at least monthly throughout 2024. From June through October, meetings will include monthly science and monitoring updates. The DCG will contribute to the development and review of annual deliverables including the annual SFHA report, updated Science and Monitoring Plans, and Independent Review panel letters. The DCG anticipates using lessons learned to update and prioritize knowledge gaps and science needs for future decision-making and to consider additional models, data, and tools that could be used to inform future decision-making. The Science and Monitoring Work Group and Hydrology and Operations Work Group will meet as needed to provide technical support and to evaluate directed science proposals aimed at filling information gaps and reducing uncertainty.

The DCG may provide occasional updates to different groups upon request, such as the Long-Term Operations coordination group, Collaborative Science and Adaptive Management Program's Delta Smelt SDM effort or other CAMT teams, and the Interagency Ecological Program's Science Management Team and Project Work Teams.

References

Bashevkin, S. M., R. Hartman, M. Thomas, A. Barros, C. E. Burdi, A. Hennessy, T. Tempel, K. Kayfetz, K. Alstad, and C. Pien. 2023. Interagency Ecological Program: Zooplankton abundance in the Upper San Francisco Estuary from 1972-2021, an integration of 7 long-term monitoring programs. ver 4. Environmental Data Initiative. https://doi.org/10.6073/pasta/8b646dfbeb625e308212a39f1e46f69b

Baxter, R., L. R. Brown, G. Castillo, L. Conrad, S. Culberson, M. Dekar, F. Feyrer, L. Grimaldo, T. Hunt, J. Kirsch, A. Mueller-Solger, S. Slater, T. Sommer, and K. Souza. 2015. An updated conceptual model for Delta Smelt: our evolving understanding of an estuarine fish. Interagency Ecological Program, Sacramento, CA.

Bennett, W.A. 2005. Critical assessment of the delta smelt population in the San Francisco Estuary, California. San Francisco Estuary and Watershed Science, 3(2). https://doi.org/10.15447/sfews.2005v3iss2art1

Bever, A. J., M. L. MacWilliams, B. Herbold, L. R. Brown, and F. V. Feyrer. 2016. Linking hydrodynamic complexity to Delta Smelt (*Hypomesus transpacificus*) distribution in the San Francisco Estuary, USA. *San Francisco Estuary and Watershed Science* 14(1). doi:10.15447/sfews.2016v14iss1art3

Brown, L. R., R. Baxter, G. Castillo, L. Conrad, S. Culberson, G. Erickson, F. Feyrer, S. Fong, K. Gehrts, L. Grimaldo, B. Herbold, J. Kirsch, A. Mueller-Solger, S. Slater, T. Sommer, K. Souza, and E. Van Nieuwenhuyse. 2014. Synthesis of studies in the fall low salinity zone of the San Francisco Estuary, September-December 2011. U.S. Department of the Interior, U.S. Geological Survey, Sacramento, CA. 136. doi:http://dx.doi.org/10.3133/sir20145041

CDFW. 2020. Incidental Take Permit for Long-Term Operation of the State Water Project in the Sacramento-San Joaquin Delta (2081-2019-066-00). California Department of Fish and Wildlife to the California Department of Water Resources, Sacramento, CA.

Davis et al. 2022. North Delta Food Subsidy Synthesis: Evaluating Flow Pulses from 2011-2019. Department of Water Resources, Division of Integrated Science and Engineering. Draft. 249 pp.

Hammock, B. G., R. Hartman, S. B. Slater, A. Hennessy, and S. J. Teh. 2019. Tidal Wetlands Associated with Foraging Success of Delta Smelt. *Estuaries and Coasts*. doi: https://doi.org/10.1007/s12237-019-00521-5

Hammock, B. G., Hobbs, J. A., Slater, S. B., Acuña, S., & Teh, S. J. 2015. Contaminant and food limitation stress in an endangered estuarine fish. *Science of the Total Environment*, *532*, 316-326.

Hassrick, J. L., J. Korman, W. J. Kimmerer, E. S. Gross, L. F. Grimaldo, C. Lee, and A. A. Schultz. 2023. Freshwater Flow Affects Subsidies of a Copepod (*Pseudodiaptomus forbesi*) to Low-Salinity Food Webs in the Upper San Francisco Estuary. *Estuaries and Coasts*, 46:450-462. https://doi.org/10.1007/s12237-022-01142-1

Kayfetz, K., and W. Kimmerer. 2017. Abiotic and biotic controls on the copepod *Pseudodiaptomus forbesi* in the upper San Francisco Estuary. *Marine Ecology Progress Series*, 581:85-101. https://doi.org/10.3354/meps12294

Kimmerer, W. J., T. R. Ignoffo, K. R. Kayfetz, and A. M. Slaughter. 2018. Effects of freshwater flow and phytoplankton biomass on growth, reproduction, and spatial subsidies of the estuarine copepod *Pseudodiaptomus forbesi*. *Hydrobiologia*, 807 (1):113-130. https://doi.org/10.1007/s10750-017-3385-y

Orlando, J.L., De Parsia, M., Sanders, C., Hladik, M. and Frantzich, J., 2020. *Pesticide concentrations associated with augmented flow pulses in the Yolo Bypass and Cache Slough Complex, California* (No. 2020-1076). US Geological Survey.

Smith, W. E., Polansky, L., and Nobriga, M. L. 2021. Disentangling risks to an endangered fish: Using a state-space life cycle model to separate natural mortality from anthropogenic losses. *Canadian Journal of*

Fisheries and Aquatic Sciences, 78(8), 1008–1029. https://doi.org/10.1139/cjfas-2020-0251

Teh, S.J., Schultz, A.A., Duarte, W.R., Acuña, S., Barnard, D.M., Baxter, R.D., Garcia, P.A.T. and Hammock, B.G., 2020. Histopathological assessment of seven year-classes of Delta Smelt. *Science of The Total Environment*, *726*, p.138333.

USFWS. 2019. Biological Opinion for the Reinitiation of Consultation of the Coordinated Operations of the Central Valley Project and State Water Project. U.S. Fish and Wildlife Service, Sacramento, California.

Sullivan, L. J., and W. J. Kimmerer. 2013. Egg development times of *Eurytemora affinis* and *Pseudodiaptomus forbesi* (Copepoda, Calanoida) from the upper San Francisco Estuary with notes on methods. *Journal of Plankton Research*, 35 (6):1331-1338. 10.1093/plankt/fbt076

Weston, D. P., Asbell, A. M., Lesmeister, S. A., Teh, S. J., & Lydy, M. J. 2014. Urban and agricultural pesticide inputs to a critical habitat for the threatened Delta Smelt (*Hypomesus transpacificus*). *Environmental Toxicology and Chemistry*, *33*(4), 920-929.

Weston, D. P., Chen, D., & Lydy, M. J. 2015. Stormwater-related transport of the insecticides bifenthrin, fipronil, imidacloprid, and chlorpyrifos into a tidal wetland, San Francisco Bay, California. *Science of The Total Environment*, *527*, 18-25.

Appendices

A. DCG thoughts and concerns about SMSCG operational schedule

B. Operation scenarios considered for WY 2025 if 100 TAF deferred

C. 2024 Summer-Fall Habitat Action Monitoring Plan (*provided as separate attachment*)

Appendix A: DCG thoughts and considerations about SMSCG operation schedule in WY 2024

Created March 28th, 2024 in DCG meeting

Goal of this document
To capture the "why" behind DCG member agency preferences and survey agencies preference for operation scenarios using the 'fist of five' approach.

Why do 60 days continuous?
- Replication of previous years (but note that there's lots of year-to-year variability, so won't be an exact replicate)
- Maximize possible overlap of LSZ and cooler areas of Grizzly Bay during summer months when temperatures are high (but note that there may be heat waves in the fall as well)
- Higher total area of LSZ in summer
- Maximize freshwater input in summer. We know this matters, not 100% certain why.
- Maximize freshwater input when Delta Smelt are younger and therefore potentially more sensitive to salinity
- Doesn't incentivize Delta Smelt to be in the Marsh in during duck season, when there could be take
- *P. forbesi* response to salinity is stronger in summer – higher abundance with fresher water.

Why do 7/7 discontinuous?
- Maintain LSZ availability into the fall
- More LSZ in Suisun Marsh
- More LSZ overall for 4-month period
- Get a contrasting data point (data on new approach)
- Decent *P. forbesi* across longer period

How do consequences matter differently in a Below Normal Year?
- Antecedent conditions may be drier, meaning summer habitat is extra-important relative to fall.

How do consequences matter differently in an Above Normal Year?
- Because of Fall X2, it's less important to have the extended operation of SMSCGs into the fall

Other considerations
- Water costs

Outstanding Questions?

- Are we getting Grizzly Bay habitat when we need it? How important is Grizzly Bay habitat in different seasons and water year types?
- How do we capture the temporal benefit vs. the benefit of creating more habitat?
    - What's the relative importance of the extra LSZ area we get with 60 continuous vs. 7/7?
    - What's the relative importance the extended time period of the LSZ area we get with 7/7 vs. 60 continuous?
- Is "area of 6 PSU or less" even the right metric to be looking at?

Fist-of-Five Survey

Following discussions of reasons why to do each operation scenario, addressing other considerations and outstanding questions the DCG used the 'fist-of-five' approach to survey agencies of the DCG preferred scenarios to formulate the final decision.

- Five = I'm in full support to move forward
- Four = I think it's a reasonable idea and we can move forward
- Three = I'm not in total agreement but we can move forward
- Two = I need to discuss and am not comfortable moving forward
- One = I cannot move forward with the current proposal

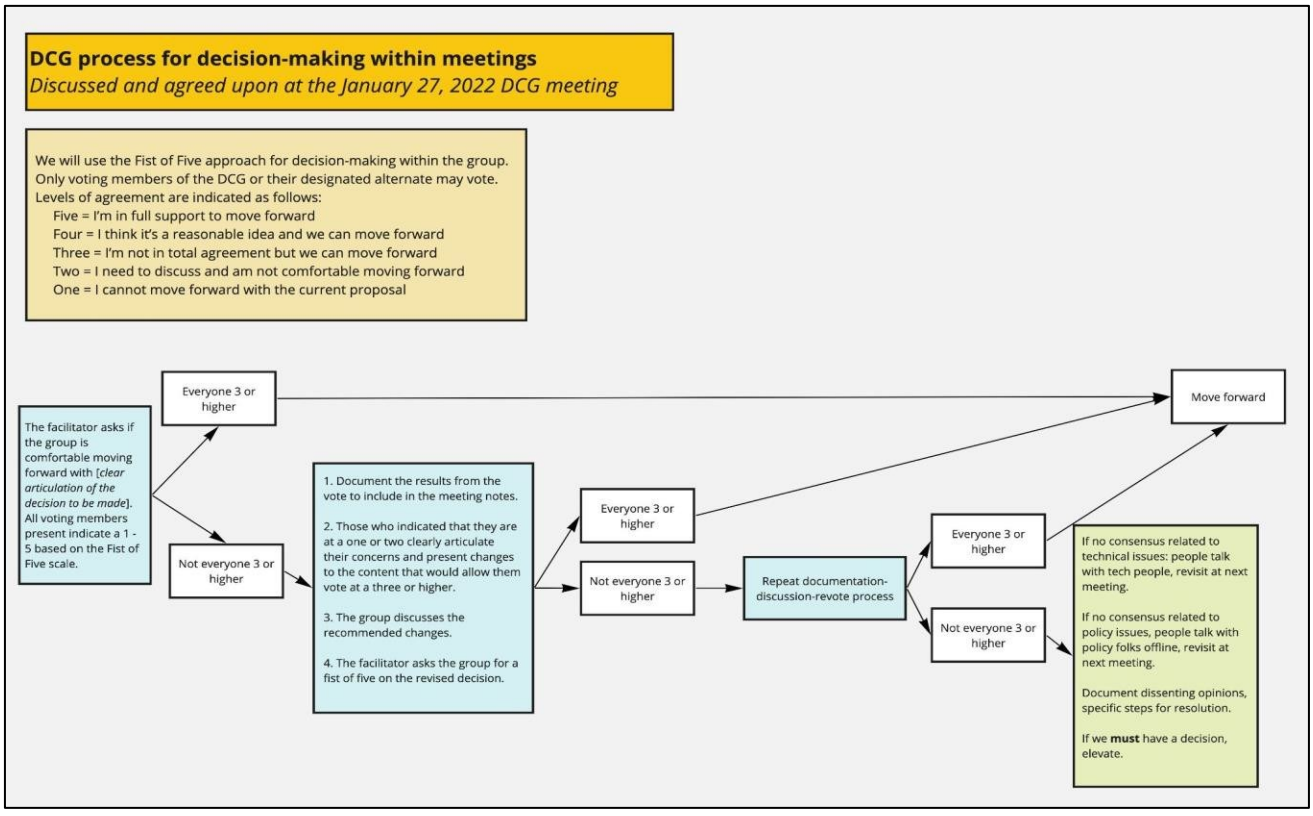

Figure 16 Conceptual 'fist of five' process for surveying the DCG.

Appendix B: Operation scenarios considered for WY 2025 if 100 TAF deferred

Operations scenarios for deferring the 100 TAF block (provided in WY 2024) to use in WY 2025 were briefly evaluated through alternative SMSCG scenarios in Below Normal and Dry year types (Table 6). As described in the WY 2024 Summer-Fall Action Plan, DWR used SCHISM to analyze the potential benefit of SMSCG operations with the use of the 100 TAF block of water. Hydrology from 2020 was used for the Dry year simulations, and hydrology from 2016 was used for the Below Normal year simulations. The Delta Coordination Group was presented with potential operations scenarios for using the 100 TAF in summer-fall for Delta Smelt, or as spring outflow for Longfin Smelt; however, it was recognized that this evaluation could wait until WY 2025 if focused on Delta Smelt, and some agencies expressed concern that evaluation of spring flow for Longfin were outside the scope of the DCG. Below describes scenarios briefly evaluated, visualizations of benefits to the LSZ habitat, and a preliminary consequence table (Table 7).

Table 6 Summer-Fall alternatives if 100 TAF block of water was deferred to WY 2025.

	Alternative name	Alternative description
D	60 days continuous	SMSCG operated for 60 consecutive days when Belden's Landing hit 4 PSU (use of WY24 deferred 100 TAF)
D	60 days 7/7	SMSCG operations for 7 days on/7 days off until 60 days of operations met (use of WY 24 deferred 100 TAF)
D	60 days continuous + 100 TAF	SMSCG operated for 60 consecutive days when Belden's Landing hit 4 PSU, following by additional SMSCG operations Sept through Oct (using WY24 deferred 100 TAF)
D	100 TAF Spring Flow	100 TAF of outflow in March – May
BN	60 days continuous	SMSCG operated for 60 consecutive days when Belden's Landing hit 4 PSU (use of WY24 deferred 100 TAF)
BN	60 days 7/7	SMSCG operations for 7 days on/7 days off until 60 days of operations met (use of WY24 deferred 100 TAF)
BN	60 d Gates + 100 TAF	SMSCG operated for 60 consecutive days when Belden's Landing hit 4 PSU, following by additional SMSCG operations Sept through Oct
BN	100 TAF Spring Flow	100 TAF of outflow in March – May

Note: Gray shaded regions exist as operation scenarios discussed by DCG but were not modeled.

If 2025 was Above Normal or Wet, it was assumed that the 2024 100 TAF block would be lost to spill. In Below Normal and Dry years, LSZ area is relatively low resulting in greater proportional change in LSZ habitat for all scenarios compared to the base case (Figure 17 and Figure 18). In a Below Normal year, using the 100 TAF for additional gate operations after the initial 60 consecutive days of operations increased the LSZ area in Suisun Marsh through November (Figure 17). Without the 100 TAF for additional gate operations, LSZ area is maintained through September with 60 consecutive days, and through October with the 7/7 operation schedule (Figure 17). Little LSZ area is gained in Suisun Bay with the 100 TAF compared to other scenarios. In a Dry year, differential effects of the operations scenarios are similar to the Below Normal year model outcomes, though effects do not quite maximize the LSZ habitat and do not last as long through September or November (Figure 18).

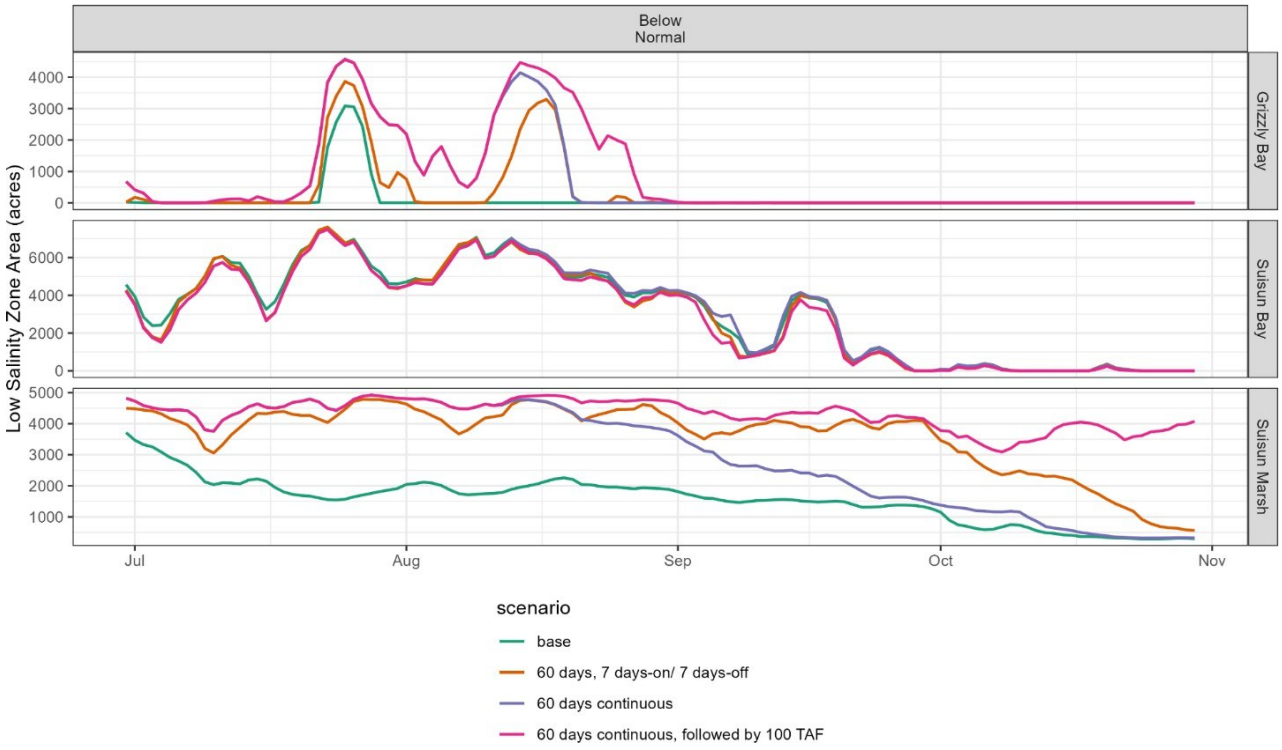

Figure 17 Modeled Low Salinity Zone Area (acres) in Suisun Bay and Suisun Marsh if a Below Normal year in WY 2025 and 100 TAF were deferred for different Suisun Marsh Salinity Control Gate operations. Note different y-axes between panels.

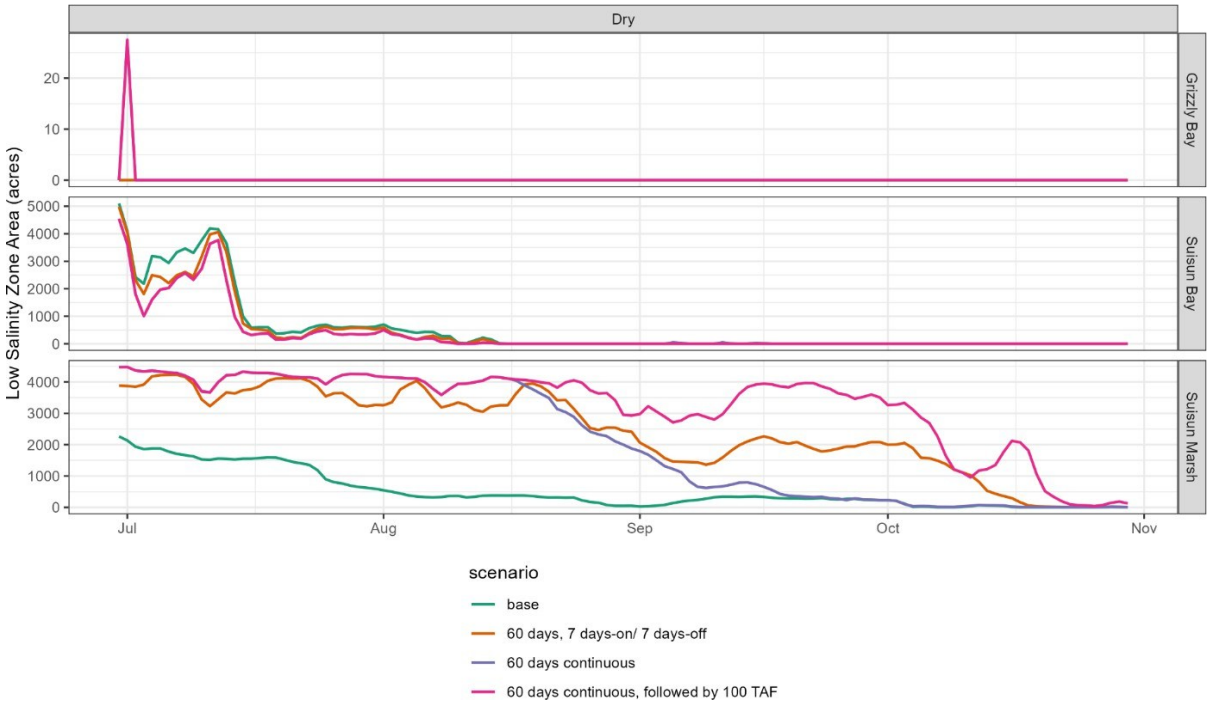

Figure 18 Modeled Low Salinity Zone Area (acres) in Suisun Bay and Suisun Marsh if a Dry year in WY 2025 and 100 TAF were deferred for different Suisun Marsh Salinity Control Gate operations. Note different y-axes between panels.

Table 7 Consequence table (WY 2025) with scoring of each 100 TAF alternative based on the sub-objectives and performance measures.

		2025 Dry	2025 Dry	2025 Dry	2025 Below Normal	2025 Below Normal
Performance Measure	**Description/Unit**	**100TAF for regular 60 day gate op**	**100TAF for additional gate operation on top of 60 day op**	**100TAF for spring flows**	**100TAF for additional gate operation on top of 60 day op**	**100TAF for spring flows**
LSZ area in Marsh	modeled acres (of 5026)	2143	3237	na	4315	na
LSZ area in Grizzly Bay	modeled acres (of 12422)	0.22	0.22	na	836	
LSZ area in Suisun Bay	modeled acres (of 13324)	367	365	na	3782	na
LSZ area % increase in Marsh	calculated % increase from base scenario	311%	521%	na	178%	na
LSZ area % increase in Grizzly Bay	calculated % increase from base scenario	inf. (base case is zero)	inf. (base case is zero)	na	640	na
LSZ area % increase in Suisun Bay	calculated % increase from base scenario	-31.0%	-31.0%	na	-7.1	na
LSZ area notes	na	Area decreases in the Bay early in the season, but it's zero for most of the season	Area decreases in the Bay early in the season, but it's zero for most of the season	na	na	na
Zooplankton	qualitative	Some increase in *P. forbesi*	Some increase in *P. forbesi*	na	Some increase in *P. forbesi*	na
Benefits to longfin smelt	na	No	No	Yes	No	Yes