# Delta Smelt Summer-Fall Habitat Action

## 2023 Action Plan

**April 28, 2023**

Photo: Sunrise 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.

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## Summary

If the final Water Year (WY) 2023 Sacramento Valley water year designation (40-30-30 Index based on the May 1 50% exceedance forecast) is Dry, no Summer-Fall Habitat Action (SFHA) will occur. If the final WY designation is Below Normal, the Suisun Marsh Salinity Control Gates will be operated with a seven-days-on, seven-days-open schedule to a target of 4 ppt starting as soon as the salinity at Belden’s Landing reaches 4 ppt and continuing until 60 days is reached. If the final WY designation is Above Normal, the Gates will be operated for 60 days consecutively during July and August. If the final water year designation is Above Normal or Wet, the 30-day average X2 value will be <80 km for the months of September and October. No North Delta Food Subsidy Action (NDFS) will be conducted during the summer or fall of 2023, because of inadequate time for Reclamation and DWR to complete the detailed proposed action and associated effects analysis in order to request initiation of ESA consultation with the US Fish and Wildlife Service and National Marine Fisheries Service before the action was scheduled to be implemented. However, the following Action Plan describes a hypothetical recommendation for NDFS in a Below Normal or Above Normal year to capture DCG deliberations. This SFHA recommendation was reached by the Delta Coordination Group (DCG) through the structured decision-making process as described below. Monitoring and science to evaluate the effectiveness of Summer-Fall actions will accompany the actions.

If the WY is Above Normal or Wet, the California Department of Fish and Wildlife plans to use an additional 100 thousand acre feet (TAF) block of water during summer-fall. Potential operations include extending daily operations of the Suisun Marsh Salinity Control Gates through October and/or use the 100 TAF to push out X2 in September and October. Scenarios for implementation of this action were determined through coordination between the California Department of Fish and Wildlife and the Department of Water Resources, and are described in the Delta Outflow Plan (a condition in the CDFW Incidental Take Permit) and were not determined through the DCG. Potential scenarios for action implementation are further described in this Action Plan.

## 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 and State Water Project, and corresponding Biological Opinions (NMFS 2019, USFWS 2019).

Planning, recommendations for implementation, and reporting of the SHFA 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 temperature (< 24 °C), 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

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

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 1-4 are described in this plan, as others are not applicable in the 2023 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. Extra 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 undergoing 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 ESA consultation and feasibility studies)
6. Managed Wetlands Food subsidy study (still undergoing feasibility studies)

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.

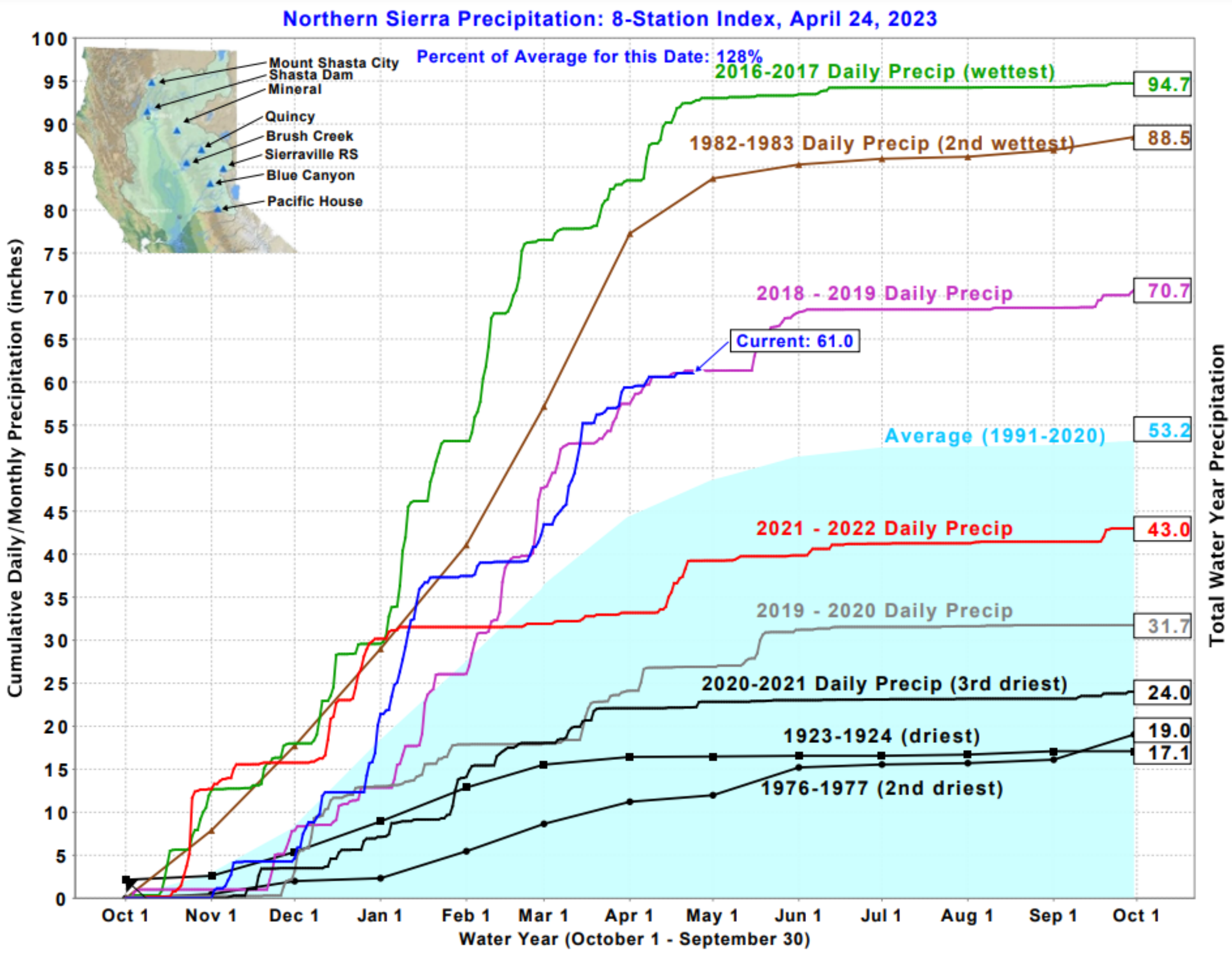
Given wetter conditions, SFHA successive dry year planning (a requirement in the ITP COA 9.1.3.2) was not considered this year; however, continued science and monitoring, and DCG discussions of potential options during dry conditions will continue to occur.

The purpose of this Action Plan is to describe DCG planning activities and recommendations for implementation for the 2023 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 has not occurred in the last three years due to drought conditions, including Dry (2020) and Critical (2021, 2022) water year designations. However, information has been gained from previous SFHA reporting of baseline conditions, special studies relative to actions, and previous iterations of SDM. With 2023 likely to be wetter than previous years, it may be the first opportunity to implement an action. This Action Plan describes specifically X2, SMSCG, NDFS, and extra 100 TAF actions in Wet, Above Normal, Below Normal, and Dry water year types, where applicable, as well as improvements to quantitative and conceptual models and development of ranking and swing weighting to inform SDM and evaluation of consequences.

## 2023 Hydrology and temperature forecast

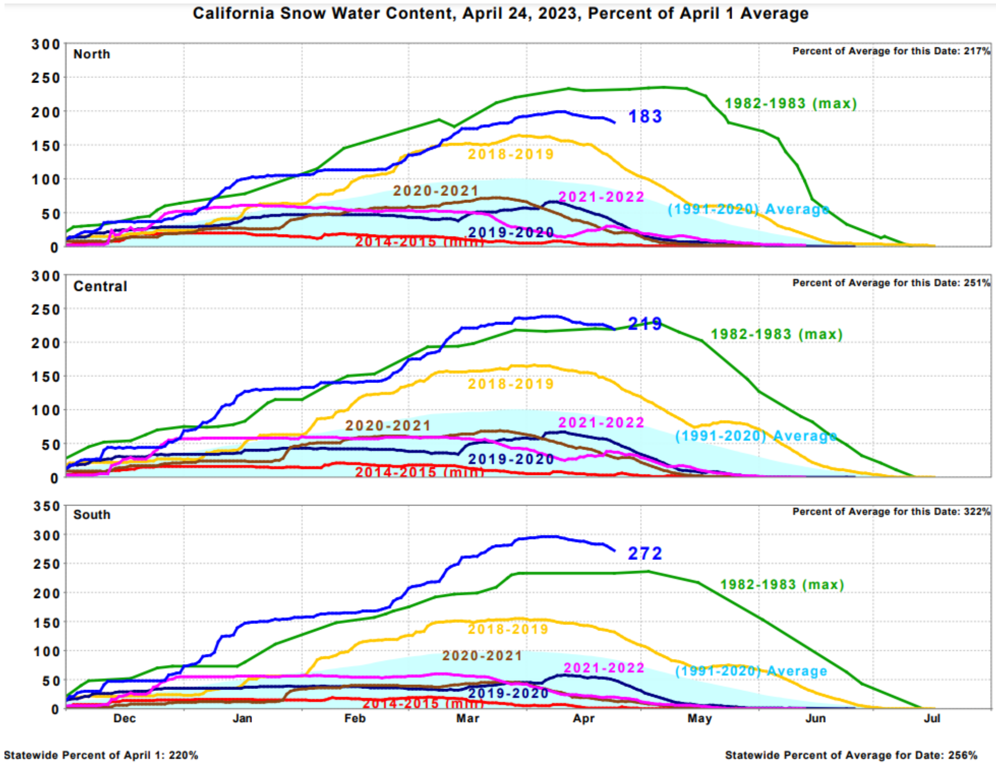
WY 2023 is much wetter than the previous few years, following one Dry and two Critical years. Modest rains in November and December were followed by a series of intense atmospheric rivers in January (Figure 1). After a pause in early February, rains returned in March, providing a March 1 and April 1 50% exceedance forecast of Above Normal and Wet, respectively. Despite the wet conditions during the rainy season which may result in higher-than-usual Delta outflow into summer, seasonal temperature forecasts indicate that the summer of 2023 is likely to be warmer than average (Figure 2), which could 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 for Delta Smelt (FLOAT MAST 2021).

**Figure 1** **Northern Sierra Precipitation, 8-station index as April 24th, 2023**



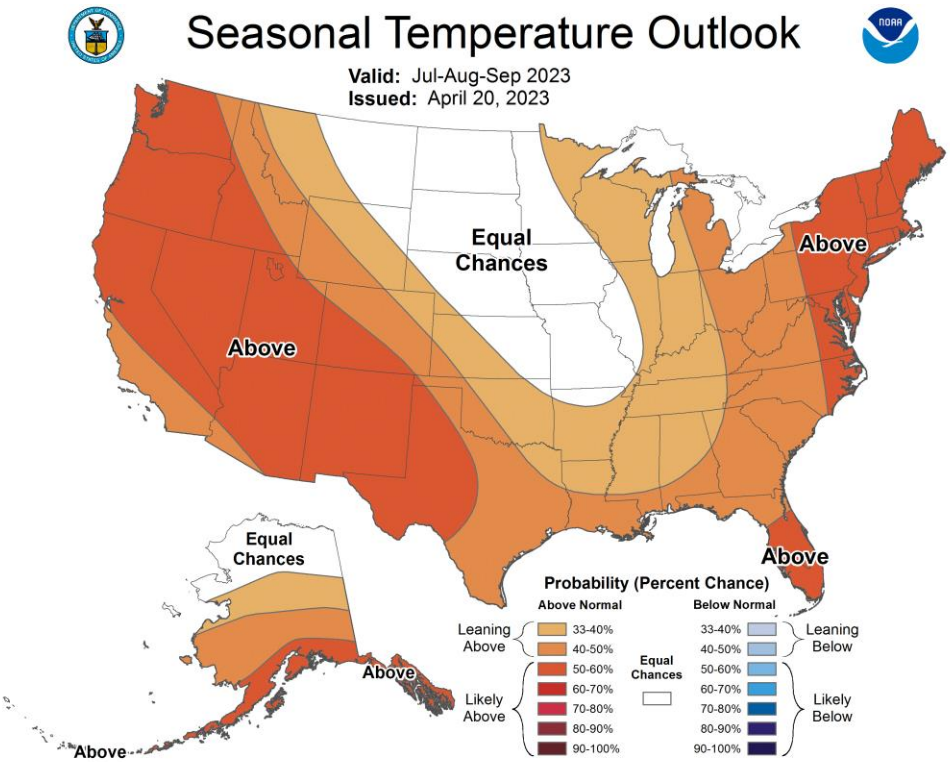

Graph from https://cdec.water.ca.gov/cgi-progs/products/PLOT_ESI.pdf.

## Figure 2 California Snow Water Content as of April 24, 2023; 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 Distribution

Given the decline in endangered Delta Smelt and few detections the last decade, implementation of experimental releases of cultured Delta smelt into the wild has been completed for 2 of 3 planned years to inform future supplementation efforts and support the existing population. In water year 2022, 55,733 cultured Delta Smelt were released across Delta and Suisun Marsh regions, with 113 recaptures. Six unmarked Delta Smelt were caught in the summer-fall period in the Lower Sacramento Region, Sacramento Deepwater Ship Channel and Suisun Marsh, likely as a result from increased spawning stock of fish due to the experimental release. In the current water year, an additional 43,705 Delta Smelt were released in the Lower Sacramento River and Sacramento Deep water ship channel from late November 2022 to January 2023, with current recaptures spread widely across the estuary, including the CVP and SWP fish facilities, Cache Slough Complex, lower Sacramento River, Suisun Marsh, and Suisun Bay. Early January storms have triggered several entrainment mitigation actions.

Planned actions for 2023 SFHA aim to improve summer-fall environmental and biological conditions for Delta Smelt.

## Actions, hypotheses, and uncertainties

Based on the February and March 2023 forecasts and continued wet conditions in March, the DCG discussed hydrology scenarios that might result in a Wet, Above Normal (AN), Below Normal (BN), and/or Dry (unlikely to occur) water year 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 during September and October. Use of the additional 100 TAF of outflow could be used to lower upper estuary salinity further, creating expanded Delta Smelt habitat during one or more preceding months. No SMSCG action is required by the ITP, but the 100 TAF action could include SMSCG operations if requested by CDFW. The Gates will be held closed for up to 10 days in September or October of 2023 to conduct planned maintenance. An NDFS action would not likely occur due to wet conditions extending through late spring; additionally, ESA coverage is not anticipated to have been finished in time to coordinate a Yolo food action.

#### 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 in the low salinity zone 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 of outflow

The ITP requires an additional 100 TAF of 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). Because the deployment of this block of water is outside the scope of the DCG, no alternatives were evaluated. However, in a Wet water year CDFW discussed the potential to operate the SMSCG daily starting when Belden's Landing hits 4 ppt or 2 ppt with the goal to expand freshwater habitat spatially and temporally for as long as possible during summer-fall months using 100 TAF outflow block. Doing this may provide some refuge from warm water temperatures in inland areas by increasing access to suitable habitat conditions in the marsh and Grizzly Bay (e.g., cooler water, higher turbidity and possibly, elevated prey density). The Gates will be held closed for up to 10 days in September or October of 2023 to conduct planned maintenance.

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:

- 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, which will result in higher Delta smelt growth and survival.
- Operating the SMSCGs during the summer and fall will increase biomass of calanoid copepods in Suisun Marsh through increased transport of freshwater species from upstream, which will result in higher Delta smelt growth and survival.
- Operating the Gates will increase the area of appropriate Delta smelt habitat in Grizzly Bay.

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?

### AN water year type

In an AN water year, Fall X2, SMSCG, extra 100 TAF outflow, and NDFS actions would occur; however, NDFS is unlikely to be implemented in 2023 based on ESA coverage as mentioned above.

#### 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 would also be the same.

#### SMSCG operations

In Above Normal years, the ITP requires 60 days of SMSCG operations between June and August 31. Modeling suggests the salinity in the Marsh will begin to increase sometime during July, so gate operations will begin on July 1 and continue through August 30, operating continuously. Operations will end on August 30 because the Fall X2 action is in effect in September and October, further benefiting smelt habitat. The Gates will be held closed for up to 10 days in September or October of 2023 to conduct planned maintenance. Gate operations will resume in September or October as dictated by the Suisun Marsh Preservation agreement or as determined by the Delta Outflow Plan (ITP COA 8.20).

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, which will result in higher Delta Smelt growth and survival.

- Operating the SMSCGs during the summer and fall will increase biomass of calanoid copepods in Suisun Marsh through increased transport of freshwater species from upstream, which will result in higher Delta Smelt growth and survival.
- Operating the SMSCGs will increase the area of appropriate Delta smelt habitat in Grizzly Bay.

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 of outflow

Alternatives considered by CDFW for an AN water year included 1) an extension of daily SMSCG operations through October and/or 2) the use of 100 TAF to push out X2 in September and potentially October with the goal to expand suitable habitat during summer-fall to Grizzly Bay.

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.

### NDFS

The DCG included the following NDFS implementation options in an AN year with the following order of preference: (1) a summer Sacramento River pulse of low magnitude and long duration; (2) a managed summer Sacramento River pulse of high magnitude and short duration; (3) a summer Sacramento River pulse followed by a managed fall agricultural pulse of low magnitude and long duration; and (4) a managed fall agricultural pulse of low magnitude and long duration. The DCG would no longer recommend implementing a managed fall agricultural pulse of high magnitude and short duration (Table 3).

The different magnitude-duration implementation options test the hypotheses that longer residence time will result in greater productivity. Agricultural versus Sacramento River pulse water tests the hypothesis that agricultural water is higher in contaminants, will negatively impact zooplankton survival and reproduction, or Delta Smelt's growth response.

Hypotheses:

- Augmented flow pulses of varied magnitudes and durations result in similar transport and redistribution water and lower trophic resources in the Yolo Bypass to the Cache Slough Complex.
- A longer duration, lower flow pulse redistributes phytoplankton from upstream, but results in longer water residence times that support a greater zooplankton response to the newly available primary production than short-duration pulses.
- Delta Smelt will have higher growth and survival with a food subsidy.
- A Sacramento River flow pulse will result in a greater increase in zooplankton biomass and Delta Smelt growth per unit of flow than an agricultural return water pulse because the latter is higher in contaminants.

Uncertainties:

- What if any habitat attributes limit Delta Smelt growth and survival during the summer and fall?
- How the nutrient and chlorophyl 'seed' upstream is altered by Sacramento River water versus agricultural drainage water, and how future upgrades to wastewater treatment facilities may influence the upstream nutrient levels seeding the Yolo Bypass.
- What is the effect of unintended negative consequences such as increased contaminants and low dissolved oxygen in the Yolo Bypass and Cache Slough Complex on zooplankton, Delta Smelt, and potentially other species?
    - What are the relative risks regarding total contaminant concentrations versus types of contaminants in flow pulses? Total contaminants are assumed to be lower in association with the Sacramento River action options compared to the managed agricultural options; however, the types of pesticides in the

Sacramento River (e.g., pyrethroids) compared to the agriculture drainage may have differential effects on zooplankton, smelt, or other species.

  - What is the level of dissolved oxygen in the bypass in late spring and summer before a flow pulse and can dissolved oxygen concentrations can be increased via operational changes in how water is moved through the bypass? DWR will be installing a new continuous water quality monitoring station in the upstream region to track real time oxygen conditions for DCG evaluation of implementing the action for consideration of salmonids.

Constraints and Contingencies:

- Acquiring the necessary ESA coverage for implementation.
- Securing agreements with upstream irrigation and reclamation districts for redirecting Sacramento River water into the bypass.
- Water availability and timing influence feasibility of NDFS alternatives and the ability to reach operation targets.
  - Sacramento River flows at Wilkins Slough being at or greater than 5,000 cfs to meet operation feasibility of Sacramento River action options.
  - Colusa Basin agricultural practices in response to seasonal conditions (e.g., temperature and water availability) may influence flow pulse timing and magnitude. While the timing for a Sacramento River action in July is more narrow (monitoring June-August), timing of the agricultural drainage action could occur in August (monitoring July-September) if rice fields are planted early and summer air temperatures are hot, or it could occur in September (monitoring August-October) if fields are planted late and summer air temperatures are cool (Figure 6).

### BN water year type

The DCG considered the same NDFS actions as an AN water year, as described in Table 3. Because SMSCG operations are dictated by regulation, multiple scenarios were not evaluated, and the decision was only on the

NDFS action. No Fall X2 and no additional 100 TAF block of water would occur.

### SMSCG operations

The ITP requires 60 days of SMSCG operations between June and October with a target salinity at Belden’s Landing of 4ppt. To achieve this the DCG adopted the 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 while optimizing water cost and days of operation. The Gates will be held closed for up to 10 days in September or October of 2023 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 the AN year operations.

### NDFS

NDFS alternatives, hypotheses, and uncertainties would be the same as described above in the AN water year.

### Dry water year type

Since 2022 was classified as critically dry, 2023 would be a dry year following a critically dry year, therefore no SMSCG action would be required, and no extra 100 TAF outflow would apply. The NDFS is the only action that can be considered for a Dry year.

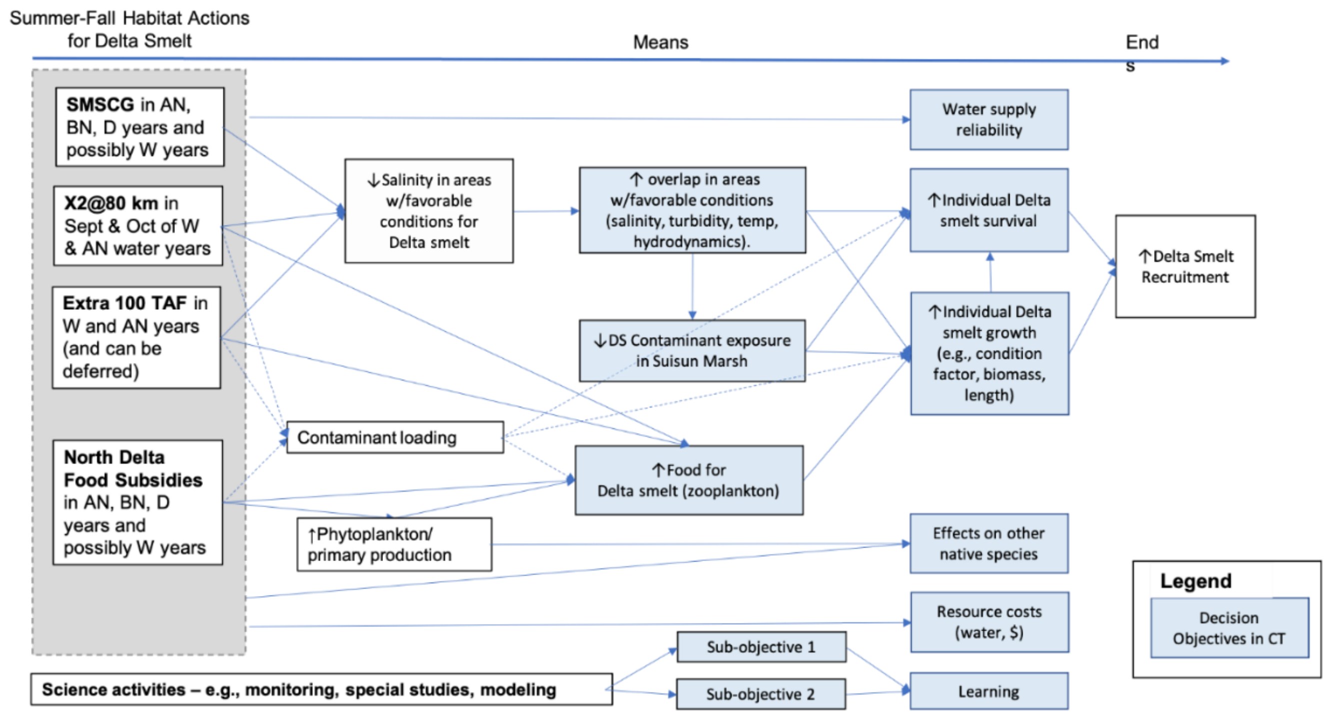
### NDFS

Evaluation of NDFS alternatives were only described in a BN year in the 2023 SDM process and the DCG would rely on the 2022 SDM evaluation of NDFS alternatives in a Dry year. However, the Sacramento River action alternatives were not evaluated for a Dry year in 2022 SDM, but new analysis of required flows at the Sacramento River at Wilkins Slough (>5000 cfs) indicate a Sacramento River managed flow pulse would be feasible in most dry years and not require supplemental reservoir releases as done in 2016.

Critical water year type

Based on heavy precipitation in January, the March water year forecast indicated the year would not be critically dry.

**Figure 4 Influence diagram of Summer-Fall Habitat Action (SFHA) developed by the DCG 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.

## 2023 Structured Decision-Making

### Process, Objectives, and Metrics

For the 2023 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 and February forecasts — Wet, Above Normal, Below Normal, and Dry (as described in above Actions section). The DCG concluded the 2023 SDM decision-frame would only evaluate NDFS action alternatives (e.g., Sacramento River, agricultural return, no action) and options for how to implement the action (i.e., varied duration and intensity). The Fall X2 action would be implemented as prescribed in September and October, and given results of the 2022 SDM process, the DCG agreed that there was no longer a decision to make regarding the SMSCG action. The 2022 SDM model demonstrated that operating to the 4 ppt target at Belden's Landing better met the environmental and biological objectives as compared to operating to a 6 ppt target at Belden's Landing. Therefore, SMSCG in 2023 would be implemented as prescribed in the regulatory framework (Table 9A in the ITP), operated to the 4 ppt target with some modifications, and likewise not considered further in the SDM. The extra 100 TAF action was not considered or discussed by the DCG for the 2023 SDM. See Appendix B for the current draft documenting the 2023 SDM process and supporting materials.

The fundamental objective of the SFHA is improved Delta Smelt recruitment (by improved growth and survival); means objectives address habitat (including contaminants) and prey quality and quantity, effects on other native species, and water supply and resource (i.e., direct management) costs (Table 1). The conceptual model and hypotheses were developed by Baxter et al. (2015) following the Management Analysis and Synthesis Team models. The means-ends diagram below illustrates the hypothesized relationships between the NDFS management action and objectives (Figure 5) developed in 2023 by the DCG.

The 2023 SDM decision was based on previous analyses, and the order of preference would be as in Figure 6, with a Sacramento River action preferred before any agricultural pulse alternative, and with a long duration-low intensity approach preferred to a short duration-high intensity approach. The decision for the DCG is whether, if conditions permit, an action should be taken.

SDM objectives, sub-objectives, and more detailed hypothesizes are described in Table 1. Performance measures used to calculate consequences for each objective or sub-objective are identified in Table 2. Information sheets were developed for each performance measure and updated in 2023 where applicable. The information sheets include the following: (1) a conceptual model and influence diagram (where possible) describing how the NDFS actions are hypothesized to influence the performance measure; (2) the calculations and/or expert elicitation used for scoring; (3) key assumptions and uncertainties that may affect scoring; (4) a table of the scores for each alternative; (5) additional information and context for interpreting the scores; and (6) references. The information sheets for each performance measure, consequence assessment, and anticipated outcomes are included in the 2023 DCG SDM Process document (Appendix B). The final consequence table was compiled as of March 7, 2023, and is provided in this action plan.

**Figure 5 Influence Diagram developed by the DCG in the 2023 SDM process for the North Delta Food Subsidies Action (NDFS).**

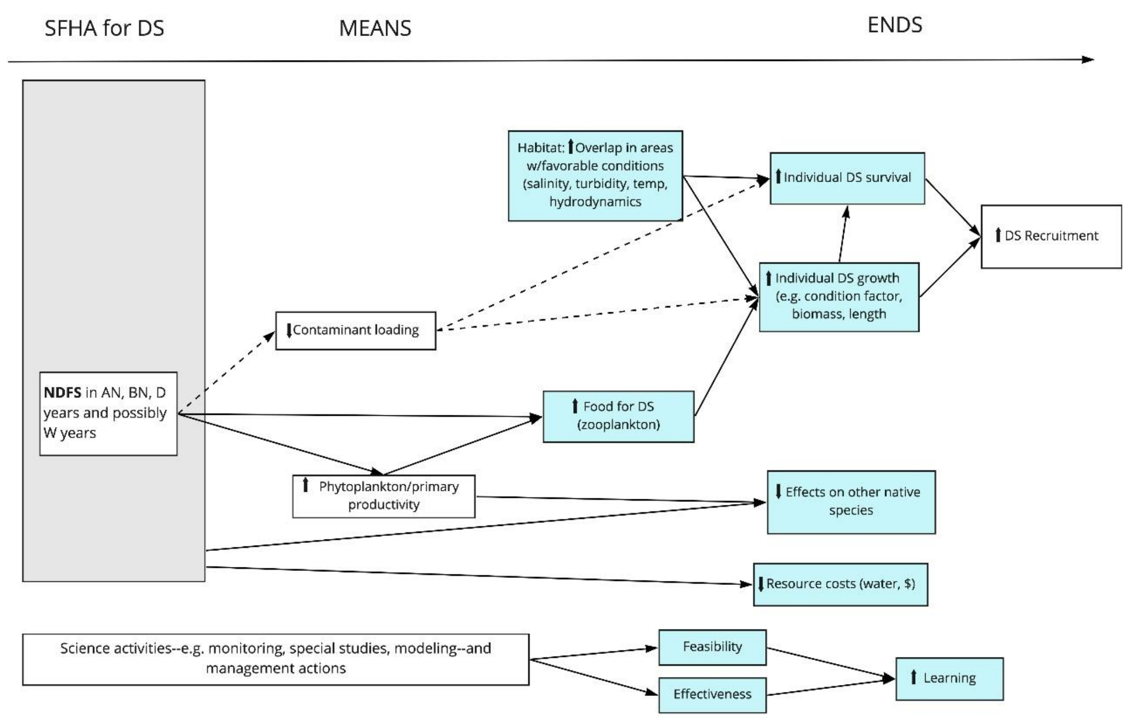


**Table 1 Decision objectives identified by the DCG for SDM**

| Decision Objective | Sub-Objective | Description |
|---|---|---|
| Delta Smelt growth and survival | Individual growth | Increasing Delta Smelt survival and recruitment is the ultimate aim of the SFHAs. Growth, survival, and recruitment are correlated at times, but growth is most readily estimable at present and is the sole PM in this category for the WY 2022 SDM process. Consequences were evaluated separately for four regions: Yolo, Lower Sac, Confluence, and Suisun Marsh. |
| Delta Smelt growth and survival | Individual survival | See above. |
| Delta Smelt food and habitat | Zooplankton | Targeted actions to increase feeding success of Delta Smelt in key locations are hypothesized to be able to replace more water-costly actions. |
| Delta Smelt food and habitat | Suitable Habitat | Overlap of salinity, turbidity, temperature, and hydrodynamics suitable for Delta Smelt, based on Bever et al. (2016) and temperature tolerance. Reducing salinity in Suisun Marsh will allow Delta Smelt to more freely access the marsh's complex, relatively food-rich habitat. |
| Contaminant Effects | Delta Smelt growth, survival, and recruitment; zooplankton abundance and quality. | Some SFHAs have the potential to increase or decrease Delta Smelt exposure to contaminants, either through changing contaminant concentrations in areas where smelt are expected to be and/or by affecting the overlap of suitable habitat for Delta Smelt and areas of lower contaminant concentrations. For example, Suisun Marsh has lower insecticide contaminant concentrations compared to other areas used by Delta Smelt. Contaminant exposure could directly affect individual smelt growth and survival and effect recruitment directly and through sublethal effects. As well as indirect effects on Delta Smelt if they were to consume prey that had higher body burdens of contaminants. Contaminant exposure could directly affect zooplankton abundance. |
| Resource costs | Direct management costs | Costs for staff, operations used to implement actions, and science and monitor including field and lab work, contracting costs, analysis and reporting. Resource costs will differ for implementation of different suites of actions and action options. The objective is to minimize these costs. |
| Effects on other native species | Winter-run: individual; population (annual cohort) | The NDFS action could increase adult salmonid straying into the Yolo Bypass, leading to reduced spawning success and leading to increased contaminant exposure and decreased adult survival. |

| Decision Objective | Sub-Objective | Description |
|---|---|---|
| Effects on other native species | Spring-run: individual; population (annual cohort) | The NDFS action could increase adult salmonid straying into the Yolo Bypass, leading to reduced spawning success and leading to increased contaminant exposure and decreased adult survival |
| Effects on other native species | Steelhead: individual; population (annual cohort) | The NDFS action could increase adult salmonid straying into the Yolo Bypass, leading to reduced spawning success and leading to increased contaminant exposure and decreased adult survival |
| Effects on other native species | Fall-run: individual; population (annual cohort) | The NDFS action could increase adult salmonid straying into the Yolo Bypass, leading to reduced spawning success and leading to increased contaminant exposure and decreased adult survival. |
| Effects on other native species | Green Sturgeon: individual; population (annual cohort) | Not included in influence diagram |
| Learning | Feasibility | For actions that have never been implemented, simply learning whether or not they are feasible has value. |
| Learning | Effectiveness | There is significant uncertainty about the performance of NDFS alternatives on all objectives. Reducing this uncertainty could improve DCG members' ability to evaluate risks and make tradeoffs in future years, as well as to decide when to pivot to other possible SFHA actions. |

**Table 2 Performance measures evaluated for each SDM decision objective**

| Decision Objective | Sub-Objective | Performance Measures (PM) | Units | Direction |
|---|---|---|---|---|
| Delta Smelt growth and survival | Individual growth | Difference in potential growth predicted by the bioenergetics model, between conditions representing no action and conditions representing the effects of a management action | mm fork length | Higher |
| Delta Smelt food and habitat | Suitable habitat | Habitat Suitability Index (HSI): Bever et al. (2016) with water temperature threshold added | n/a | Higher |

| Decision Objective | Sub-Objective | Performance Measures (PM) | Units | Direction |
|---|---|---|---|---|
| Delta Smelt food and habitat | Zooplankton and mysid biomass in (a) Suisun area and (b) Cache Slough area | The change in biomass per unit effort between an action scenario and a no action scenario. | µg/L | Higher |
| Contaminant Effects | Delta Smelt growth, survival, and recruitment; zooplankton abundance and quality. | Constructed scale:<br>-2 = 50% or greater reduction in PM relative to the No Action Alternative, equivalent to an EC50, where the effect is the relevant PM being evaluated<br>-1 = 10 - 49% reduction in performance metric relative to the No Action Alternative, equivalent to at least an EC10, but less than EC50<br>0 = insignificant (i.e., less than 10%) effect on PM relative to the No Action Alternative<br>1 = 10 - 49% increase in PM relative to the No Action Alternative<br>2 = 50% or greater increase in PM relative to the No Action Alternative | n/a | Higher |
| Resource costs | Direct management costs | $1000/yr | $1000/yr | Lower |

| Decision Objective | Sub-Objective | Performance Measures (PM) | Units | Direction |
|---|---|---|---|---|
| Effects on other native species | Winter-run: individual | Constructed scale:<br>1 = Overall, the action would benefit the salmonid in question<br>0 = Overall, the action would not affect the salmonid in question<br>-1 = Overall, the action would negatively affect the salmonid in question, with minor sublethal effects (occurring in up to 100% of exposed individuals) and/or low likelihood (occurring in <10% of exposed individuals) of serious sublethal or lethal effects.<br>-2 = Overall, the action would negatively affect the salmonid in question, with intermediate likelihood (occurring in 10%-50% of exposed individuals) of serious sublethal or lethal effects.<br>-3 = Overall, the action would negatively affect the salmonid in question, with high likelihood (occurring in >50% of exposed individuals) of serious sublethal or lethal effects. | n/a | Higher |

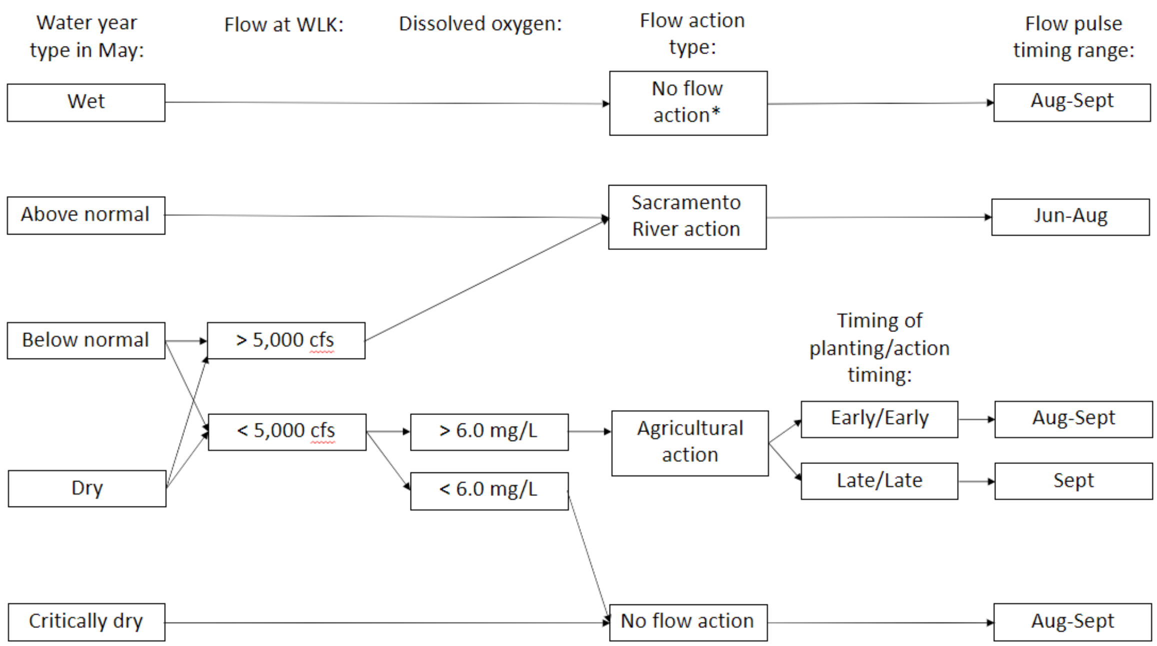
| Decision Objective | Sub-Objective | Performance Measures (PM) | Units | Direction |
|---|---|---|---|---|
| | Winter-run: population (annual cohort) | Constructed scale:<br>1 = Overall, the action would benefit the salmonid in question<br>0 = Overall, the action would not affect the salmonid in question<br>-1 = Overall, the action would negatively affect the salmonid in question, with minor sublethal effects (occurring in up to 10% of the population) and very low likelihood (occurring in <1% of the population) of serious sublethal or lethal effects.<br>-2 = Overall, the action would negatively affect the salmonid in question, with minor sublethal effects (up to 50% of the population) and/or low likelihood (occurring in < 10% of the population) of serious sublethal or lethal effects.<br>-3 = Overall, the action would negatively affect the salmonid in question, with minor sublethal effects (occurring in >50% of the population) and/or intermediate to high likelihood (occurring in >50% of the population) of serious sublethal or lethal effects. | | |
| | Spring-run: individual; population (annual cohort) | Constructed scale: see above | n/a | Higher |
| | Steelhead: individual; population (annual cohort) | Constructed scale: see above | n/a | Higher |
| | Fall-run: individual; population (annual cohort) | Constructed scale: see above | n/a | Higher |
| | Green Sturgeon: individual; population (annual cohort) | Constructed scale: see above | n/a | Higher |
| Learning Feasibility | Feasibility | Constructed scale, 1 to 3; with 1 being little to no learning and 3 being high learning. | n/a | Higher |

| Decision Objective | Sub-Objective | Performance Measures (PM) | Units | Direction |
|---|---|---|---|---|
| | Effectiveness: Learning Potential | Constructed scale, 1 to 5;<br>Based on the number of the times an action had been implemented or a similar flow pulse occurred through unmanaged flows since monitoring began in 2011. Lower scores indicate a greater amount of existing data (i.e., lower learning potential). | n/a | Higher |
| | Effectiveness: Learning Increment (with and without special studies) | Constructed scale, 1 to 3; with 1 being little to no additional learning gained by implementing the alternative and 3 being high learning increment. | n/a | Higher |

**Table 3 North Delta Food Subsidy (NDFS) Action alternatives included in the 2023 SDM**

| Alternative name | Alternative description |
|---|---|
| Sac long-low | Sacramento River water would be directed through Yolo Bypass for a longer duration (4 weeks) at a lower intensity (400 cfs) |
| Sac short-high | Sacramento River water would be directed through Yolo Bypass for a shorter duration (2 weeks) at a higher intensity (800cfs) |
| Ag long-low | Agricultural return water would be directed through Yolo Bypass for a longer duration (4 weeks) at a lower intensity (400 cfs) |
| Ag short-high | Agricultural return water would be directed through Yolo Bypass for a shorter duration (2 weeks) at a higher intensity (800cfs) |
| Sac-Ag | This alternative involves a Sac long-low summer action followed by an Ag long-low fall action to generate a longer duration pulse (60 rather than 30 days) and time period with net positive flow. While assumed to be operationally feasible, this approach has never been implemented. |
| No action | No managed flow pulse in summer or fall. Variable flow in fall due to local drainage activities. |

### Figure 6 Example of decision framework for the NDFS (from NDFS Operations, Science and Monitoring Plan)




Note: A wet year action would be discussed in the DCG and likely only warranted if spring conditions were dry.

## Results

The modeling results reported here are largely the same as those developed for the 2022 SDM process (see the 2022 SFHA Action Plan, Appendix B for model fact sheets and performance metric infosheets). Modeling in 2022 suggested that the relative performance of the NDFS alternatives were similar in relative magnitude between water year types. Therefore, although detailed modeling was not performed for Above Normal or Wet years, the relative benefits and decision from a Below Normal water year are anticipated to also apply to other water year types.

### Delta Smelt Growth

Bioenergetic modeling (BEM) showed all combinations of water year type, regions, and action scenarios, could produce a potential benefit to growth rate. Regional differences in potential growth rate indicated the most energetically favorable region was Suisun Marsh and least favorable Lower Sacramento region (Table 4). The Marsh region had greater predicted growth of 3.4 and 3.6 mm in Dry and Below Normal years, respectively, as compared to Lower Sacramento. The incremental differences between the action scenarios on energetics and growth were much smaller ranging from 0-0.6 mm across the summer (Table 5). The highest predicted incremental growth was from a NDFS SacAg action (0.63mm/summer).

**Table 4 Bioenergetics model predicted and reference Delta Smelt length at the end of October, assuming a July 1 length of 30mm FL**

| | Year type = Below Normal | |
|---|---|---|
| **Region** | **BEM-based (No action)** | **Reference** |
| Yolo | 62.36 | 59.21 |
| Lower Sac | 62.07 | 59.21 |
| Confluence | 62.76 | 59.21 |
| Marsh | 65.64 | 59.21 |
| | **Year type = Dry** | |
| **Region** | **BEM-based (No action)** | **Reference** |
| Yolo | 62.10 | 59.21 |
| Lower Sac | 61.81 | 59.21 |
| Confluence | 62.42 | 59.21 |
| Marsh | 65.24 | 59.21 |

**Table 5a Growth increment (performance measure) for each region-year type-scenario combination. Year type is Below Normal.**

| Region | NDFS-AgLong-Low | NDFS-AgShort-High | NDFS-SacAg | NDFS-SacLong-Low | NDFS-SacShort-High |
|---|---|---|---|---|---|
| Yolo | 0.30 | 0.22 | 0.63 | 0.33 | 0.21 |
| Lower Sac | 0.05 | 0.05 | 0.07 | 0.05 | 0.05 |
| Confluence | 0 | 0 | 0 | 0 | 0 |
| Marsh | 0 | 0 | 0 | 0 | 0 |

**Table 6b** **Growth increment (performance measure) for each region-year type-scenario combination. Year type is Dry.**

| Region | NDFS-AgLong-Low | NDFS-AgShort-High | NDFS-SacAg | NDFS-SacLong-Low | NDFS-SacShort-High |
|---|---|---|---|---|---|
| Yolo | 0.42 | 0.34 | — | — | — |
| Lower Sac | 0.07 | 0.07 | — | — | — |
| Confluence | 0 | 0 | — | — | — |
| Marsh | 0 | 0 | — | — | — |

Note: Growth increment was the difference between BEM-predicted growth with simulated action minus predicted growth with no action.

### Delta Smelt Habitat and Food

Modeling for NDFS showed flow in the Yolo Bypass at Lisbon Wier became positive under each scenario compared to the no-action alternative. The scenario that has not yet been experimented — a summer Sacramento action followed by a fall agricultural action — would result in the longest duration of positive net flow (Figure 7). Modeling will be improved in future assessments to better capture the Sacramento River alternatives that would occur during July and not overlap with fall Agriculture actions.

Overall habitat suitability for Delta Smelt did not change for different NDFS scenarios (Figure 8).

**Figure 7 Modeled flow (CFS) in Yolo Bypass as Lisbon Wier for different water year type and operation scenarios as modeled by DSM2**

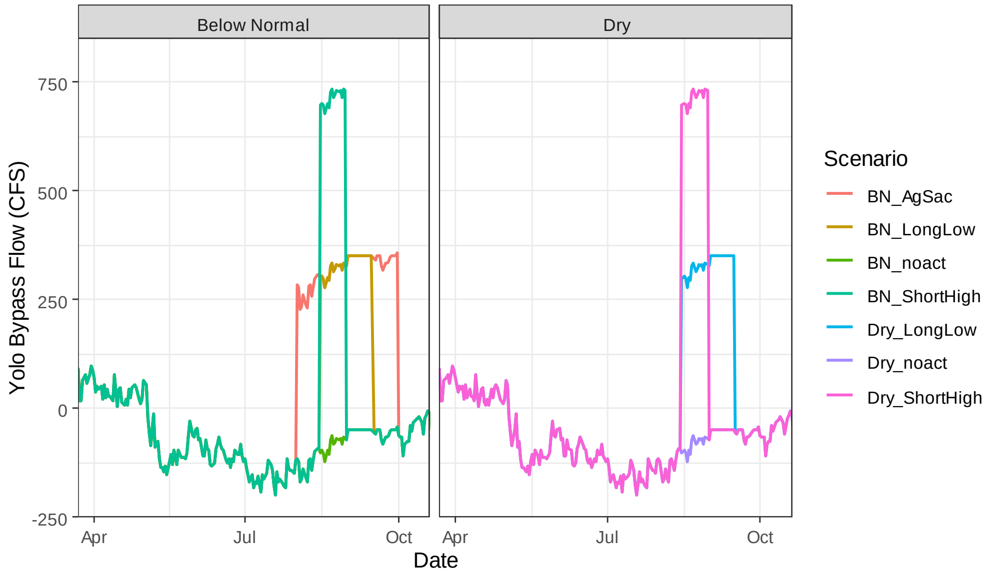
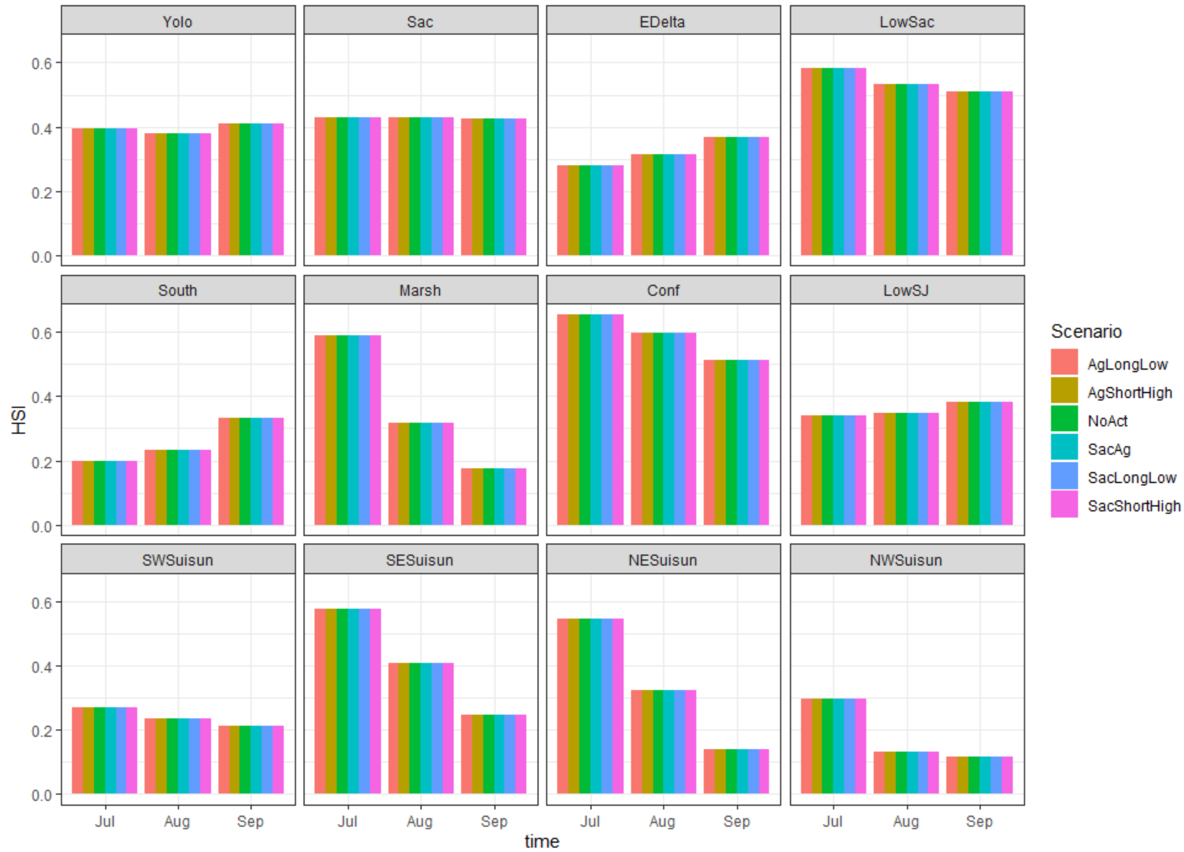


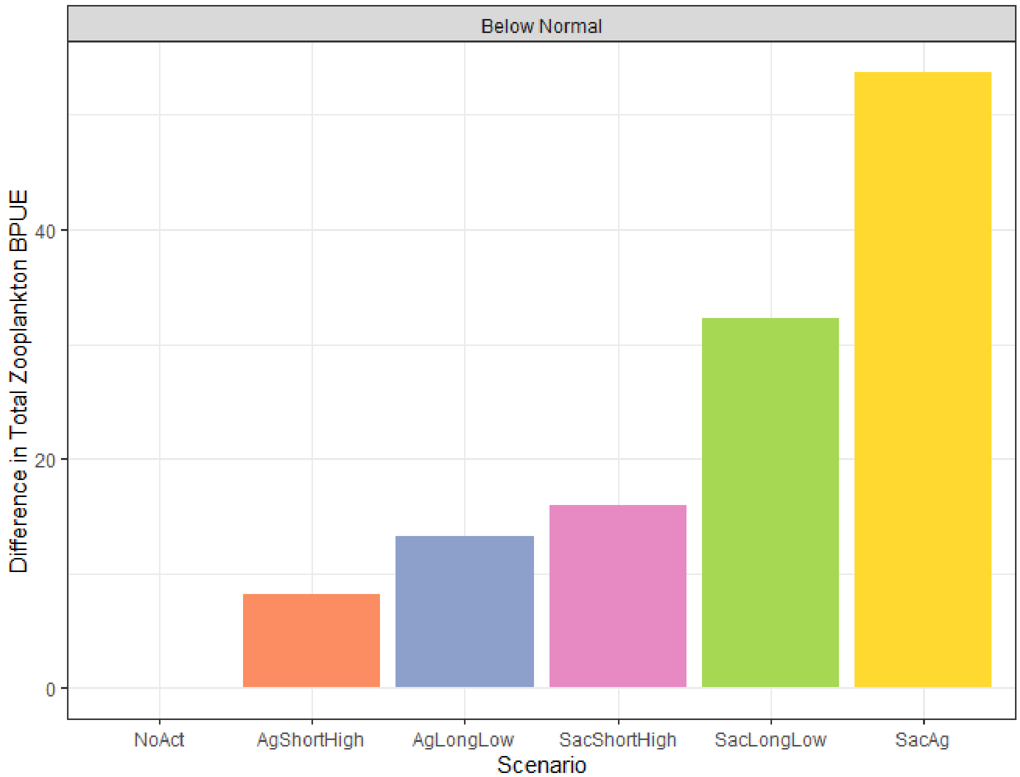
**Figure 8 Modeled Habitat Suitability Index (HSI) by region, scenario, and month for a Below Normal water year**




Zooplankton Biomass

For the NDFS action, modeled summer Sacramento River actions had a greater increase in zooplankton biomass than an agricultural action, and long duration, low intensity pulses had greater increases than a short duration, high intensity pulse (Figure 9). The combination of a summer Sacramento River action and fall Agricultural action had the highest increase in zooplankton. However, zooplankton biomass is highly variable, both spatially and temporally, which makes predicted responses inherently imprecise. The standard error on the mean biomass used for the baseline was quite large. The expert elicitation for the NDFS action was also subject to the differing opinions of the experts used and the inputs to the RMA copepod model used to base the relationships on. Thus, the expert elicitation added uncertainty in this instance.

**Figure 9 Difference in total, Delta-wide zooplankton BPUE between a no-action scenario and scenarios with each type of NDFS action**




Note: Modeling was conducted for a Below Normal year, but relative benefits of the different actions will apply to other water year types.

### Water Costs

The NDFS action re-routes flow with minimal difference in losses between the paths and therefore water costs were determined to be inconsequential.

### Contaminants

An expert elicitation was repeated in 2023 to improve the evaluation of the effect of action alternatives on potential contaminant impacts to food quantity and quality and Delta Smelt. The elicitation effort involved 1) a conceptual model solicitation group to develop the constructed scale of effects of alternatives on contaminant effects and, 2) a respondent group from the IEP Contaminant Project Work Team with subject matter expertise to provide their scores for each action alternative. A total of 8 experts participated in the respondent group and contributed opinions on the potential impacts of the actions on contaminant toxicity to zooplankton abundance, zooplankton quality, Delta Smelt growth, Delta Smelt survival, and Delta Smelt recruitment (Figure 10). The conceptual model group developed the constructed scale of -2 to 2, with 2 being increase and -2 being decrease from the no-action alternative. The elicitation included 2 workshops with the respondent group, to make sure they understood the actions, present data on contaminants related to NDFS, and finally, to provide an opportunity for participants to discuss any differences in scores (see Appendix B for additional elicitation details).

There were some contrasting scores, with some scores of -2 and 2 on a performance metric for the same alternative. Some experts did not feel qualified to state an opinion or did not leave comments for scores. Other experts recused themselves because they had a vested interest in the action or monitoring associated with the action. While others provided helpful feedback to consider in the future. For example, some experts suggested the zooplankton quality metric should be focused on contaminant loading and biomass, whereas others discussed potential effects of contaminants on species composition and nutrient concentration that were not in the scope of the elicitation. There was also concern over correlation between Delta Smelt survival and recruitment scores such that recruitment into the next year class would be an improvement in survival of the individual and should not be considered separately.

Overall, second year contaminant elicitation results were consistent with the first elicitation in 2022, previous conceptual models, and studies (Orlando et al. 2020; Davis et al. 2022). The elicitation concluded that the NDFS Sacramento River action was better supported in that respondents predicted smaller decreases in performance metrics for zooplankton and Delta Smelt than they did for the NDFS agricultural action. The long duration-low intensity alternative was considered better than the short duration-high intensity alternatives (for Sacramento River and Agriculture drainage actions), with experts describing potential benefits from low flows in reducing contaminant concentrations as they partition to organic matter or settle out in sediment where they are no longer bioavailable. Other experts noted that high intensity pulses may lead to increased acute toxicity effects while others indicated there is not enough difference in the alternatives to merit different scores, it depends on the contaminant mixtures, or that enough contaminants already exist in the system such that augmented flow pulses would not substantially expose zooplankton or fish to different conditions relative to no-action. In contrast to 2022, the 2023 expert group described a neutral and relatively positive effect of the Sacramento River action of long duration and low intensity on the zooplankton and Delta Smelt performance metrics demonstrated by scores that were positive on average (Figure 10), noting the potential for improved habitat and quality for zooplankton and smelt growth beyond a no-action alternative. Note however, the wide range in individual responses led to high uncertainty in this 'average' conclusion. Lastly, the experts concluded the agriculture flow pulse with a high intensity and short duration was the worst alternative for contaminant exposures, which mirrored similar discussions internal to the DCG.

**Figure 10 Contaminants elicitation results of NDFS action alternative effects on zooplankton and Delta Smelt performance metrics in a Below Normal water year**

Objective: Zooplankton quality

| Alternative | Min | Max | Diff | Average | E1 | E2 | E3 | E5 | E6 | E7 | E9 | E10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag Long-Low | -2 | 1 | 3 | -0.88 | -1 | -2 | -1 | -1 | -1 | -1 | 1 | -1 |
| Ag Short-High | -2 | 0 | 2 | -1.25 | -2 | -1 | -2 | -1 | -2 | -1 | 0 | -1 |
| Sac Long-Low | -1 | 2 | 3 | 0.38 | 2 | 2 | -1 | 0 | -1 | 0 | 1 | 0 |
| Sac Short-High | -2 | 1 | 3 | -0.25 | 1 | 0 | -1 | 0 | -2 | -1 | 1 | 0 |
| Sac-Ag | -2 | 1 | 3 | -0.38 | 0 | 1 | -2 | -1 | -1 | 0 | 0 | 0 |

Objective: Zooplankton survival

| Alternative | Min | Max | Diff | Average | E1 | E2 | E3 | E5 | E6 | E7 | E9 | E10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag Long-Low | -1 | 1 | 2 | -0.75 | -1 | -1 | -1 | -1 | -1 | -1 | 1 | -1 |
| Ag Short-High | -2 | 1 | 3 | -0.88 | -1 | 0 | -2 | -1 | -2 | -1 | 1 | -1 |
| Sac Long-Low | -1 | 1 | 2 | 0.25 | 1 | 1 | -1 | 0 | -1 | 1 | 1 | 0 |
| Sac Short-High | -2 | 1 | 3 | -0.25 | 1 | 0 | -1 | 0 | -2 | -1 | 1 | 0 |
| Sac-Ag | -2 | 1 | 3 | -0.13 | 0 | 1 | -2 | -1 | -1 | 1 | 1 | 0 |

Objective: Delta smelt growth

| Alternative | Min | Max | Diff | Average | E1 | E2 | E3 | E5 | E6 | E7 | E9 | E10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag Long-Low | -1 | 1 | 2 | -0.63 | -1 | -1 | -1 | -1 | -1 | -1 | 1 | 0 |
| Ag Short-High | -2 | 0 | 2 | -0.75 | 0 | 0 | -2 | -1 | -2 | -1 | 0 | 0 |
| Sac Long-Low | -1 | 1 | 2 | 0.13 | 1 | 1 | -1 | 0 | -1 | 0 | 1 | 0 |
| Sac Short-High | -2 | 1 | 3 | -0.25 | 1 | 0 | -1 | 0 | -2 | 0 | 0 | 0 |
| Sac-Ag | -2 | 1 | 3 | -0.25 | 0 | 1 | -2 | -1 | -1 | 1 | 0 | 0 |

Objective: Delta smelt survival

| Alternative | Min | Max | Diff | Average | E1 | E2 | E3 | E5 | E6 | E7 | E9 | E10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag Long-Low | -1 | 1 | 2 | -0.13 | 0 | -1 | 0 | 0 | -1 | 0 | 1 | 0 |
| Ag Short-High | -2 | 0 | 2 | -0.63 | 0 | -1 | -1 | 0 | -2 | -1 | 0 | 0 |
| Sac Long-Low | -1 | 1 | 2 | 0.00 | 0 | 0 | 0 | 0 | -1 | 0 | 1 | 0 |
| Sac Short-High | -2 | 1 | 3 | -0.25 | 0 | 0 | 0 | 0 | -2 | -1 | 1 | 0 |
| Sac-Ag | -1 | 0 | 1 | -0.29 | 0 | 0, 1 | -1 | 0 | -1 | 0 | 0 | 0 |

Objective: Delta smelt recruitment

| Alternative | Min | Max | Diff | Average | E1 | E2 | E3 | E5 | E6 | E7 | E9 | E10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ag Long-Low | -1 | 1 | 2 | -0.50 | 0 | -1 | -1 | -1 | -1 | -1 | 1 | 0 |
| Ag Short-High | -2 | 1 | 3 | -0.57 | 0 | 0, -1 | -1 | -1 | -2 | -1 | 1 | 0 |
| Sac Long-Low | -1 | 1 | 2 | 0.13 | 0 | 1 | 0 | 0 | -1 | 0 | 1 | 0 |
| Sac Short-High | -2 | 1 | 3 | -0.13 | 0 | 0 | 0 | 0 | -2 | 0 | 1 | 0 |
| Sac-Ag | -1 | 1 | 2 | -0.29 | 0 | 0, -1 | -1 | -1 | -1 | 1 | 0 | 0 |

Scores different for other WYT?

| | Min | Max | Diff | Average | E1 | E2 | E3 | E5 | E6 | E7 | E9 | E10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DryWYT | -1 | 1 | 2 | -0.71 | | -1 | -1 | -1 | -1 | 1 | -1 | -1 |
| AN WYT | -1 | 1 | 2 | 0.21 | | 0 | 0 | 0.5 | 1 | -1 | 1 | 0 |

Note: The average score was calculated from individual expert scores (E1–E10). Green indicates positive effects, yellow neutral effects, and red negative effects. Scores are also provided in the last table for different effects in an AN or BN water year.

### Effects to other species

Effects to salmonids and sturgeon were evaluated using a combination of the 2022 expert elicitation (see Appendix B in the 2022 SFHA Plan for elicitation materials and conceptual models) focused only on the NDFS evaluations in a Dry and BN year, and supplemental scores for DWR given their fish monitoring and recent synthesis analysis of salmonids in summer-fall in the bypass (Davis et al. 2022). Some of the key assumptions and uncertainties of the 2023 scoring process include 1) that 4-week action scores evaluated in 2022 are representative for the short-high and long-low alternatives in 2023; 2) that BN scores evaluated in 2022 are representative for Dry and Above Normal alternatives, and 3) respondents in the 2022 elicitation all had the same understanding of NDFS action alternatives and scoring.

The elicitation included a constructed scale of -3 to 1, with 1 being benefits to salmonids and -3 being negative effects (e.g., sublethal effects and mortality) from the no-action alternative. There were some contrasting scores, with some scores of -3 and 0 on an individual or population metric for the same alternative and species or run-type. A number of scores indicated some experts felt the NDFS action would have relatively neutral effects, but no experts demonstrated potential benefits of the NDFS action. Not all experts left comments for scores, and some did not score juvenile life stages given large uncertainties. Final metric scores were calculated as the average of all scores provided (whether for juveniles/subadults, adults, or stage-agnostic) for each species and/or Chinook run-type (Table 6). Average scores ranged from neutral (0) to minor sublethal effects and/or low-intermediate likelihood of serious sublethal or lethal effects (-1).

Scores and comments from experts demonstrate different effects of NDFS actions across run-types and life-stages. ESA-listed spring-run and winter-run Chinook salmon were noted as not present in the NDFS area in summer or fall, but yearling spring-run or early winter-run young of year could be affected by fall action. In contrast, fall-run Chinook concern was focused on potential negative effects of the NDFS action in fall on adults. Some experts noted attraction of Chinook salmon into Yolo Bypass may result in migration delay and exposure to poorer water quality. Presence of Steelhead was also noted in summer and fall, but fall was noted more as a concern due to exposure to poor water quality. Action effects on straying into the bypass remains uncertain given other studies' evidence indicating a suite of factors that may affect straying (Davis et al. 2022). Green sturgeon was not scored by all experts or agencies, but sub-adults in fall may be negatively affected by exposure to poor water quality.

While effects to individuals were part of the expert elicitation and are the most direct mechanistic linkage to the conceptual model, DCG focused on the population level scoring when developing the action plan for WY 2023. In particular, DCG considered potential negative effects on Fall-run Chinook Salmon and Steelhead, which were considered most likely to be present in the action area of the NDFS actions.

Future expert elicitations for effects to salmonids and sturgeon should consider 1) including more experts in the respondent group and more workshops with the experts to make sure they understand the actions and allow them to discuss any differences in scores or refine the influence diagram, 2) expand alternatives to match the suite of potential actions in all year types, and 3) standardize the treatment of life stage.

The DCG should reexamine this performance metric in the future to see if other native species should be considered, such as non-listed fishes.

**Table 7 Expert elicitation results of NDFS action effects on individuals (individ) and populations (pop) of Spring Run (SR), Fall Run (FR) and Winter Run (WR) Chinook salmon, Steelhead (SteelH) and Green Sturgeon (GS) in a Dry (D) water year type and a Below Normal (BN) water year type.**

| WY | NDFS Action | Scorer | SR Individ Score | SR Pop Score | FR Individ Score | FR Pop Score | SteelH Individ Score | SteelH Pop Score | WR Individ Score | WR Pop Score | GS Individ Score | GS Pop Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D | Sac River | CDFW | 0 | 0 | 0 | 0 | *no score given* | *no score given* | 0 | 0 | *not elicited* | *not elicited* |
| D | Sac River | CFS | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | *not elicited* | *not elicited* |
| D | Sac River | NMFS | 0 juv<br>0 adults | 0 juv<br>0 adults | *no score given* | *no score given* | 0 juv<br>0 adults | 0 juv<br>0 adults | 0 juv<br>0 adults | 0 juv<br>0 adults | 0 subadult<br>0 adults | 0 subadult<br>0 adults |
| D | Sac River | DWR | 0 to -1 juv<br>0 adults | 0 adults | 0 to -1 juv<br>0 adults | 0 adults | 0 to -1 adults | 0 | 0 | 0 | *not elicited* | *not elicited* |
| **D** | **Sac River** | **Average score (juveniles)** | **-0.25** | **0** | **-0.5** | **NA** | **0** | **0** | **0** | **0** | **0** | **0** |
| **D** | **Sac River** | **Average score (adults)** | **0** | **0** | **0** | **0** | **-0.25** | **0** | **0** | **0** | **0** | **0** |
| **D** | **Sac River** | **Average Total** | **-0.08** | **0** | **-0.38** | **0.00** | **-0.13** | **0** | **0** | **0** | **0** | **0** |
| D | Ag | CDFW | -1 | 0 | -3 | -2 | -3 | -2 | 0 | 0 | *not elicited* | *not elicited* |

| WY | NDFS Action | Scorer | SR Individ Score | SR Pop Score | FR Individ Score | FR Pop Score | SteelH Individ Score | SteelH Pop Score | WR Individ Score | WR Pop Score | GS Individ Score | GS Pop Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D | Ag | CFS | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | *not elicited* | *not elicited* |
| D | Ag | NMFS | 0 juv<br>0 adults | 0 juv<br>0 adults | *no score given* | *no score given* | 0 juv<br>-2 adults | 0 juv<br>-1 adults | 0 juv<br>0 adults | 0 juv<br>0 adults | -2 subadult<br>-1 adults | 0 subadult<br>0 adults |
| D | Ag | DWR | 0 to -1 juv<br>0 adults | 0 adults | 0 to -1 juv<br>-1.5 adults* | -1.5 adults* | -1 | 0 | 0 | 0 | *not elicited* | *not elicited* |
| **D** | **Ag** | **Average score (juvs)** | **0.25** | **0** | **-0.5** | **NA** | **0** | **0** | **0** | **0** | **-2** | **0** |
| **D** | **Ag** | **Average score (adults)** | **0** | **0** | **-1.5** | **-1.5** | **-2** | **-1** | **0** | **0** | **-1** | **0** |
| **D** | **Ag** | **Average Total** | **-0.25** | **0** | **-1.5** | **-1.17** | **-1.2** | **-0.6** | **0** | **0** | **-1.5** | **0** |

| WY | NDFS Action | Scorer | SR Individ Score | SR Pop Score | FR Individ Score | FR Pop Score | SteelH Individ Score | SteelH Pop Score | WR Individ Score | WR Pop Score | GS Individ Score | GS Pop Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BN | Sac River | CDFW | 0 | 0 | 0 | 0 | *no score given* | *no score given* | 0 | 0 | *not elicited* | *not elicited* |
| BN | Sac River | CFS | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | *not elicited* | *not elicited* |

| WY | NDFS Action | Scorer | SR Individ Score | SR Pop Score | FR Individ Score | FR Pop Score | SteelH Individ Score | SteelH Pop Score | WR Individ Score | WR Pop Score | GS Individ Score | GS Pop Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BN | Sac River | NMFS | 0 juv<br>0 adults | 0 juv<br>0 adults | *no score given* | *no score given* | 0 juv<br>0 adults | 0 juv<br>0 adults | 0 juv<br>0 adults | 0 juv<br>0 adults | 0 subadult<br>0 adults | 0 sub-adult<br>0 adults |
| BN | Sac River | DWR | 0 | 0 adults | 0 to -1 juv<br>-1 adults | -1 adults | -1 adults | 0 | 0 | 0 | *not elicited* | *not elicited* |
| BN | Sac River | **Average (juvenile)** | 0 | 0 | -0.5 | NA | 0 | 0 | 0 | 0 | 0 | 0 |
| BN | Sac River | **Average (adults)** | 0 | 0 | -1 | -1 | -0.5 | 0 | 0 | 0 | 0 | 0 |
| BN | Sac River | **Average Total** | 0 | 0 | -0.63 | -0.33 | -0.25 | 0 | 0 | 0 | 0 | 0 |
| BN | Ag | CDFW | -1 | 0 | -3 | -2 | -3 | -2 | 0 | 0 | *not elicited* | *not elicited* |
| BN | Ag | CFS | 0 | 0 | -1 | 0 | 0 | 0 | 0 | 0 | *not elicited* | *not elicited* |
| BN | Ag | NMFS | 0 juv<br>0 adults | 0 juv<br>0 adults | *no score given* | *no score given* | 0 juv<br>-2 adult | 0 juv<br>-1 adults | 0 juv<br>0 adults | 0 juv<br>0 adults | -2 subadult<br>-1 adults | 0 subadult<br>0 adults |
| BN | Ag | DWR | 0 to -1 juv<br>0 adults | 0 adults | 0 to -1 juv<br>-1.5 adults* | -1.5 adults* | -1 | 0 | 0 | 0 | *not elicited* | *not elicited* |
| **BN** | **Ag** | **Average score (juvenile)** | **-0.25** | **0** | **-0.5** | **NA** | **0** | **0** | **0** | **0** | **-2** | **0** |
| **BN** | **Ag** | **Average score (adults)** | **0** | **0** | **-1.5** | **-1.5** | **-2** | **-1** | **0** | **0** | **-1** | **0** |

| WY | NDFS Action | Scorer | SR Individ Score | SR Pop Score | FR Individ Score | FR Pop Score | SteelH Individ Score | SteelH Pop Score | WR Individ Score | WR Pop Score | GS Individ Score | GS Pop Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **BN** | **Ag** | **Average Total** | **-0.25** | **0** | **-1.5** | **-1.17** | **-1.2** | **-0.6** | **0** | **0** | **-1.5** | **0** |

Note: Average scores (in bold) were calculated from 4 experts (CDFW, Cramer Fishery Sciences, NMFS, and DWR (added in 2023)) for juveniles, adults, and stage agnostic (total). Final stage-agnostic scores (total) used in the SDM consequence table are highlighted. Blue indicates average scores for a Sacramento River (Sac River) action and orange represents an Agriculture (Ag) return water action.

### Resource Costs

Baseline science and monitoring for a no-action scenario costs approximately $1 million (including staff time). Additional costs for an agricultural NDFS action cost approximately $100K, which would be the same for short-high and long-low. Additional costs for a Sacramento River action would be approximately $250K, thought there is some uncertainty surrounding the different intensity and duration alternatives. Conducting a summer Sacramento River + fall Agriculture NDFS action would be the most expensive option because baseline monitoring would be extended from roughly 3 months to 5 or 6 months, giving a cost of $500K above baseline.

**Table 8 Consequence table with scoring of each NDFS alternative based on the sub-objectives and performance measures chosen by the DCG**

| Objective | Performance Measure | Unit | Direct-ion | No Act (D) | Sac LL (D) | Sac SH (D) | Sac-Ag (D) | Ag LL (D) | Ag SH (D) | No Act (BN) | Sac LL (BN) | Sac SH (BN) | Sac-Ag (BN) | Ag LL (BN) | Ag SH (BN) | No Act (AN) | Sac LL (AN) | Sac SH (AN) | Sac-Ag (AN) | Ag LL (AN) | Ag SH (AN) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Delta Smelt Growth | | | | | | | | | | | | | | | | | | | | | |
| Yolo | Growth increment | mm | higher | 0 | | | | 0.37 | 0.30 | 0 | 0.32 | 0.21 | 0.58 | 0.26 | 0.2 | 0 | 0.32 | 0.21 | 0.58 | 0.26 | 0.2 |
| Lower Sac | Growth increment | mm | higher | 0 | | | | 0.06 | 0.06 | 0 | 0.04 | 0.04 | 0.06 | 0.04 | 0.04 | 0 | 0.04 | 0.04 | 0.06 | 0.04 | 0.04 |
| Zooplankton | Unweighted BPUE | Biomass/ unit effort | higher | 611.2 | | | | 619.7 | 626.3 | 679.6 | 711.9 | 695.6 | 733.3 | 692.8 | 687.8 | | | | | | |
| | Difference in BPUE | Biomass/ unit effort | higher | 0 | | | | 15.12 | 8.54 | 0 | 32.32 | 16 | 53.7 | 13.25 | 8.19 | 0 | 32.32 | 16 | 53.7 | 13.25 | 8.19 |
| **Contaminant Effects** | **Constructed scale** | **-2 to 2** | **higher** | **0** | **-0.63** | **-1.06** | **-0.97** | **-1.29** | **-1.53** | **0** | **0.18** | **-0.23** | **-0.26** | **-0.58** | **-0.81** | **0** | **0.3** | **-0.13** | **-0.04** | **-0.6** | **-0.36** |
| Zoop quality effects | Constructed scale | -2 to 2 | higher | 0 | -0.57 | -1.14 | -1.14 | -1.57 | -1.86 | 0 | 0.38 | -0.25 | -0.38 | -0.88 | -1.25 | 0 | 0.36 | -0.21 | -0.21 | -0.64 | -0.93 |
| Zoop abundance (survival) effects | constructed scale | -2 to 2 | higher | 0 | -0.57 | -1.14 | -0.86 | -1.43 | -1.57 | 0 | 0.25 | -0.25 | -0.13 | -0.75 | -0.88 | 0 | 0.36 | -0.21 | 0.07 | -0.5 | -0.64 |
| DS growth effects | constructed scale | -2 to 2 | higher | 0 | -0.71 | -1.14 | -1 | -1.29 | -1.57 | 0 | 0.13 | -0.25 | -0.25 | -0.63 | -0.75 | 0 | 0.21 | -0.21 | -0.07 | -0.36 | -0.64 |
| DS survival effects | constructed scale | -2 to 2 | higher | 0 | -0.71 | -1 | -0.93 | -0.86 | -1.43 | 0 | 0 | -0.25 | -0.29 | -0.13 | -0.63 | 0 | 0.21 | -0.07 | 0 | 0.07 | -0.5 |
| DS recruitment effects | constructed scale | -2 to 2 | higher | 0 | -0.57 | -0.86 | -0.93 | -1.29 | -1.21 | 0 | 0.13 | -0.13 | -0.29 | -0.5 | -0.57 | 0 | 0.36 | 0.07 | 0 | -0.36 | -0.29 |
| Operating Cost | Relative to No Action | $1000/yr | lower | 0 | 250 | 250 | 500 | 100 | 100 | 0 | 250 | 250 | 500 | 100 | 100 | 0 | 250 | 250 | 500 | 100 | 100 |
| **Effects on other native species** | **Constructed scale** | **-3 to 0** | **higher** | **0** | **0** | **0** | | **-1.77** | **-1.77** | **0** | **-0.33** | **-0.33** | | **-1.77** | **-1.77** | **0** | **-0.33** | **-0.33** | | **-1.77** | **-1.77** |
| Fall Run | Constructed scale | -3 to 1 | higher | 0 | 0 | 0 | | -1.17 | -1.17 | 0 | -0.33 | -0.33 | | -1.17 | -1.17 | 0 | -0.33 | -0.33 | | -1.17 | -1.17 |

| Objective | Performance Measure | Unit | Direct-ion | No Act (D) | Sac LL (D) | Sac SH (D) | Sac-Ag (D) | Ag LL (D) | Ag SH (D) | No Act (BN) | Sac LL (BN) | Sac SH (BN) | Sac-Ag (BN) | Ag LL (BN) | Ag SH (BN) | No Act (AN) | Sac LL (AN) | Sac SH (AN) | Sac-Ag (AN) | Ag LL (AN) | Ag SH (AN) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Steelhead | Constructed scale | -3 to 1 | higher | 0 | 0 | 0 | | -0.6 | -0.6 | 0 | 0 | 0 | | -0.6 | -0.6 | 0 | 0 | 0 | | -0.6 | -0.6 |
| **Learning: With special studies** | **Constructed scale** | **3 to 11** | **higher** | **3** | **7** | **6** | **8** | **6** | **5** | **3** | **7** | **6** | **8** | **5** | **6** | **3** | **7** | **6** | **8** | **5** | **6** |
| Feasibility | Constructed scale | 1 to 3 | higher | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 |
| Learning potential | Constructed scale | 1 to 5 | higher | 1 | 3 | 3 | 4 | 2 | 2 | 1 | 3 | 3 | 4 | 2 | 2 | 1 | 3 | 3 | 4 | 2 | 2 |
| Learning increment | Constructed scale | 1 to 3 | higher | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |

Note: Habitat suitability was removed from the table given no difference among the alternatives in any water year, Spring run and winter run chinook salmon, and green sturgeon were removed given no effects on these species, and water costs were removed given inconsequential effects of NDFS. Scores in bold are averaged (e.g., contaminant effects) or summed (e.g., species effects and learning) across objectives in some cases.

### Consequence Evaluations

Performance metric scores for each objective and sub-objective were compiled into a single table above (Table 7) for all NDFS action alternatives (in Dry, BN and AN years), including new 2023 scores for the contaminants elicitation, effects to other species, and learning. As in the 2022 water year assessment, habitat suitability was uninformative for comparisons and water costs are inconsequential for NDFS, therefore, both were ignored in the trade-off evaluation. Delta Smelt growth (in Yolo and Lower Sacramento), zooplankton biomass, contaminants, resource costs, and effects to other species (e.g., ESA listed), and learning were evaluated.

The AltaViz SDM application tool (Compass Resource Management, Vancouver, Canada) was used for the DCG to visually compare and discuss consequences and tradeoffs between action alternatives in a BN year (Figure 11). Dry and AN water year scores were also included in the AltaViz tool but not discussed in detail. Across all alternatives, some agencies of the DCG prioritized minimizing the effects of contaminants on Delta Smelt growth and zooplankton, as well as minimizing effects to other species. However, other agencies identified more interest the value of learning from implementing certain alternatives for the adaptive management of NDFS despite potential negative consequences. This learning could include studies that determine how important baseline contaminant effects are as a constraint on Delta Smelt growth and how the NDFS could alter that baseline.

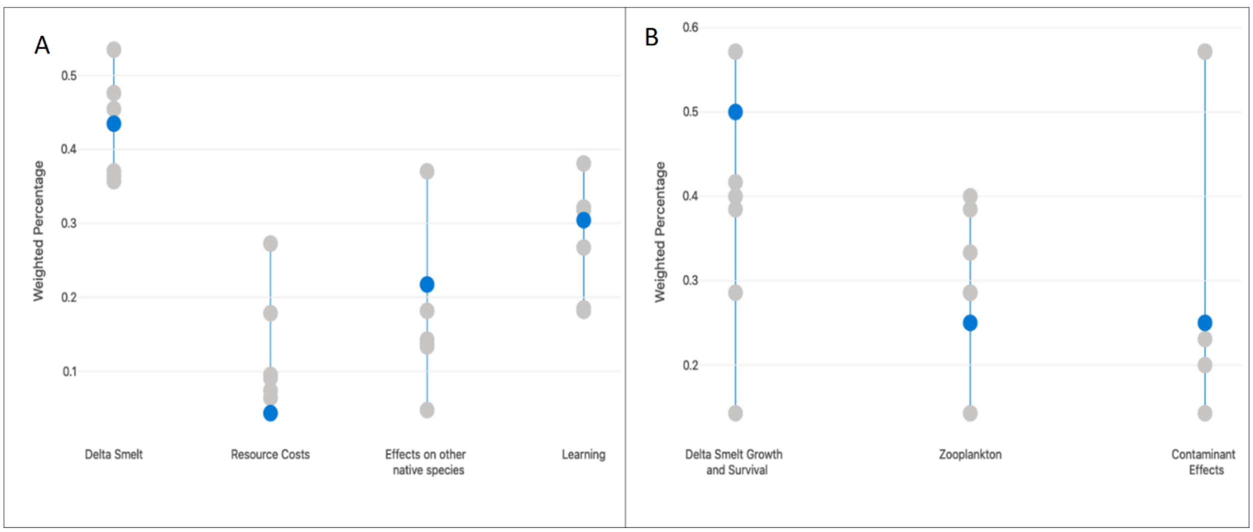
## Figure 11 AltaViz tool evaluation of NDFS alternatives in a Below Normal year including all objectives and subobjectives

| Objective<br>Expand All Collapse All | Performance Measure | Unit | BN No Action | BN NDFA Sac Long-Low | BN NDFA Sac Short-High | BN NDFA Ag Long-Low | BN NDFA Ag Short-High | BN NDFA Sac-Ag |
|---|---|---|---|---|---|---|---|---|
| Delta Smelt | | | | | | | | |
| Delta Smelt Growth and Survival | Growth Increment | mm | 0 | .36 | .25 | .30 | .24 | .64 |
| Zooplankton | Difference in BPUE | Biomass per unit effort | 0 | 32.32 | 16 | 13.25 | 8.19 | 53.7 |
| Contaminant Effects | Constructed scale | -2 to 2 | 0 | 0.18 | -.23 | -.58 | -.81 | -.26 |
| Zoop quality effects | Constructed scale | -2 to 2 | 0 | .38 | -.25 | -.88 | -1.25 | -.38 |
| Zoop abundance (survival) effects | constructed scale | -2 to 2 | 0 | .25 | -.25 | -.75 | -.88 | -.13 |
| DS growth effects | constructed scale | -2 to 2 | 0 | .13 | -.25 | -.63 | -.75 | -.25 |
| DS survival effects | constructed scale | -2 to 2 | 0 | 0 | -.25 | -.13 | -.63 | -.29 |
| DS recruitment effects | constructed scale | -2 to 2 | 0 | .13 | -.13 | -.5 | -.57 | -.29 |
| Resource Costs | Operating costs | $1000/year | 0 | 250 | 250 | 100 | 100 | 500 |
| Effects on other native species | Constructed scale | -3 to 1 | 0 | -0.07 | -0.07 | -0.35 | -0.35 | |
| Spring Run | Constructed scale | -3 to 1 | 0 | 0 | 0 | 0 | 0 | |
| Fall Run | Constructed scale | -3 to 1 | 0 | -0.33 | -0.33 | -1.17 | -1.17 | |
| Steelhead | Constructed scale | -3 to 1 | 0 | 0 | 0 | -0.6 | -0.6 | |
| Winter Run | Constructed scale | -3 to 1 | 0 | 0 | 0 | 0 | 0 | |
| Green Sturgeon | Constructed scale | -3 to 1 | 0 | 0 | 0 | 0 | 0 | |
| Learning | Constructed scale | 1 - 11 | 3 | 7 | 6 | 5 | 6 | 8 |
| Feasibility | Constructed scale | 1-3 | 1 | 2 | 1 | 1 | 2 | 2 |
| Effectiveness | | | 2 | 5 | 5 | 4 | 4 | 6 |
| Learning potential | Constructed scale | 1-5 | 1 | 3 | 3 | 2 | 2 | 4 |
| Learning increment | Constructed scale | 1-3 | 1 | 2 | 2 | 2 | 2 | 2 |

Note: Blue is the highlighted alternative for comparison, light blue indicates the other alternative scores better, orange does worse, and white the same.

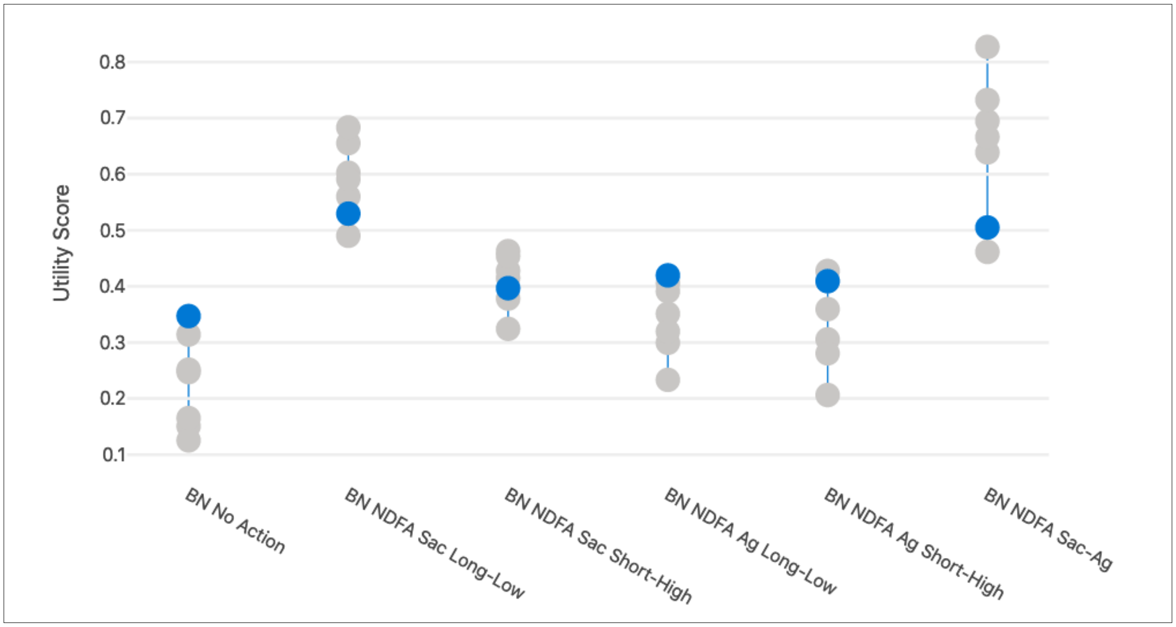
Given the challenge of incorporating the diversity of DCG member values, the DCG took a new quantitative approach to evaluating the consequence table and tradeoffs in 2023 using the Simple Multi-Attribute Ranking Technique using Swings (SMARTS). The SMARTS allowed each DCG member agency to express its take on the relative importance of different objectives in the context of the decision by assigning weights to each objective. Through the SMARTS process, the DCG SFHA decision was reduced to four top-level decision objectives: Delta Smelt, Resource Costs, Effects on Other Species, and Learning (Figure 12A). Each of these top-level objectives had sub-objectives representing different components of the top-level objective (as described in Table 2). Most sub-objective scores were rolled up assuming equal weights on all sub-objectives. However, for the three Delta Smelt sub-objectives (e.g., growth, zooplankton, contaminants), DCG agencies assigned weights for the contribution of the sub-objectives, which influenced each member's overall Delta Smelt utility score (Figure 12B). For each DCG agency, an overall utility score was calculated for each alternative by normalizing scores for each objective/subobjective, multiplying normalized scores by the weights, and summing the weighted normalized scores. These gross utility scores help to visualize the NDFS decision quantitatively (Figure 13). In addition to weighting, DCG agencies directly ranked each of the 6 NDFS action alternatives (see Table 3 for reference) from least to most preferred. This direct ranking helped assess the degree of confidence the DCG had in the weights and indicated where discussion was warranted regarding agency evaluation. Overall, the DCG indicated that the 2023 SMARTS approach better quantified agencies' values and concerns.

**Figure 12 Swing weight percentages for (A) the four top-level decision objectives, and (B) weights for the contribution of the sub-objectives to the overall Delta Smelt utility**




Note: Each point represents a single DCG member and blue represents a single agency weight as an example.

**Figure 13 Gross utility scores by NDFS action alternatives for normalized consequence scores in a BN year**




Note: Each point represents a DCG agency. Blue points highlight a single DCG member's score for example.

### Offramps

While the DCG evaluated all the NDFS scenarios listed above, the final Summer-Fall actions chosen for 2023 will depend on the final water year type and other constraints. Due to other conflicting resource needs, the ESA coverage for the NDFS action will not be complete by fall of 2023, so all scenarios for this action will not be included this year. However, the evaluation of the alternatives will be a useful starting point for future year's actions.

### Primary Conclusions of SDM from DCG

In a BN or AN year, the DCG would recommend implementation of the experimental NDFS summer Sacramento River managed flow pulse as part of the SFHA with a preferred ranking of alternatives based on feasibility. If feasible, the DCG would first recommend implementing a Sacramento River pulse with low intensity and long duration, second a high intensity and short duration pulse second, and lastly, a summer Sacramento River pulse followed by a fall Agriculture return pulse given the toxicity from use of agriculture drainage water reviewed above. If a summer Sacramento River managed flow action was not feasible, the DCG would recommend implementation of a managed Agriculture drainage flow pulse in the fall with low intensity and long duration. However, the DCG would not recommend implementation of the high intensity, short duration fall flow pulse alternative.

In the 2022 evaluation, DCG members expressed most concerns regarding operation costs and uncertainty in benefits (i.e. smelt growth and zooplankton). In contrast, DCG agencies in 2023's decision focused on NDFS actions were most concerned about potential consequences of contaminants in drainwater and effects to other species (including non-ESA listed species). Several agencies indicated opposition to implementation of any agriculture drain water actions, and some of these agencies indicated only moderate support for Sacramento River actions, but interestingly, all agencies were in support of the double summer-Sacramento River + fall Agriculture action. Further discussions regarding concerns, uncertainties, past results and potential for a learning opportunity from an agriculture action with a long duration and low intensity resulted in some agencies indicating that while they still were not in total agreement, they would support moving forward for the purpose of learning more about benefits and consequences, testing hypotheses (e.g., residency time and transport), and to inform adaptive management of the entire NDFS project (e.g., alternatives, thresholds, termination). DCG agencies also noted their recommendation this year may vary from other years based on new information and continued science and monitoring to reduce uncertainties and that special studies particularly surrounding contaminants and stable isotopes should be included.

## Modeling of benefits of the extra 100 TAF block of water

To analyze the potential benefit of the 100 TAF block of water deployed in different ways, DWR used SCHISM to model operational scenarios for an Above Normal year and Wet year. For both the Above Normal and Wet year models, hydrology from 2017 was used, which was Wet. However, additional modeling scenarios are being run using 2010 hydrology as a proxy for an Above Normal year, because, while the water year was officially 'below normal', if it had not been preceded by a dry year it might have been 'above normal'. Modeling results for 2010 will be available by mid-May. In all scenarios, the block of water would be provided from Oroville releases, export reductions, or a combination of the two. The operational scenarios were as follows:

- No SMSCG action – Fall X2 at 80 km for September and October (note this scenario is for a base-case such that in an AN year SMSCG would operate Jul-Aug)
- 60 days of SMSCG operation from July 1 through Aug 31 and fall X2 at 80 km for September and October
- 60 days of SMSCG operation from July 1 through Aug 31 and the 100 TAF used September and October as flow (no gates) and Fall X2 at 80 km for September and October
- 60 days of SMSCG operation from July 1 through Aug 31 and the 100 TAF used for a September and October gates action and Fall X2 at 80 km for September and October

For the Wet year, the operational scenarios were as follows:

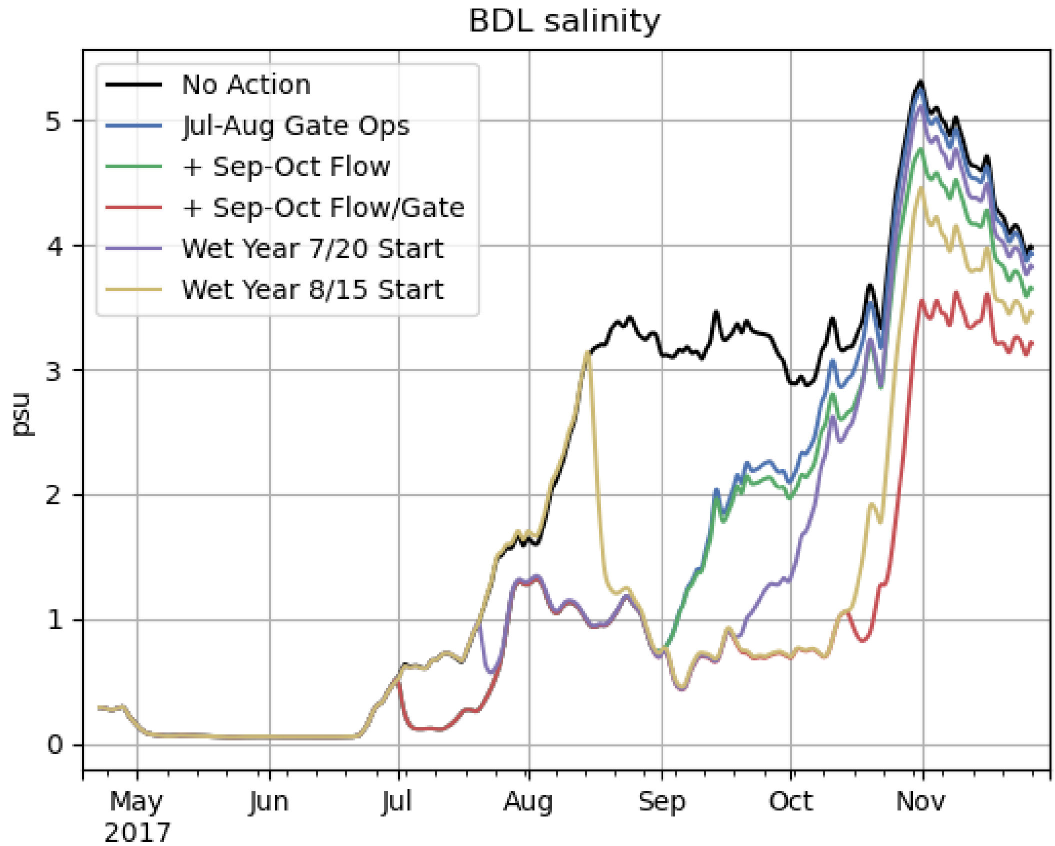
- No SMSCG action – Fall X2 at 80 km for September and October
- 100 TAF used to operate the SMSCGs from July 20 through September 17, and Fall X2 at 80 km for September and October
- 100 TAF used to operate the SMSCGs from August 15 to October 15

Results:

During an Above Normal year, operating the SMSCGs during September and October extended the period of high Delta Smelt habitat suitability index (HSI) area versus operating the gates in July and August only (Figure 14). Adding the 100 TAF as outflow provided similar results to using the 100 TAF to offset gate operations.

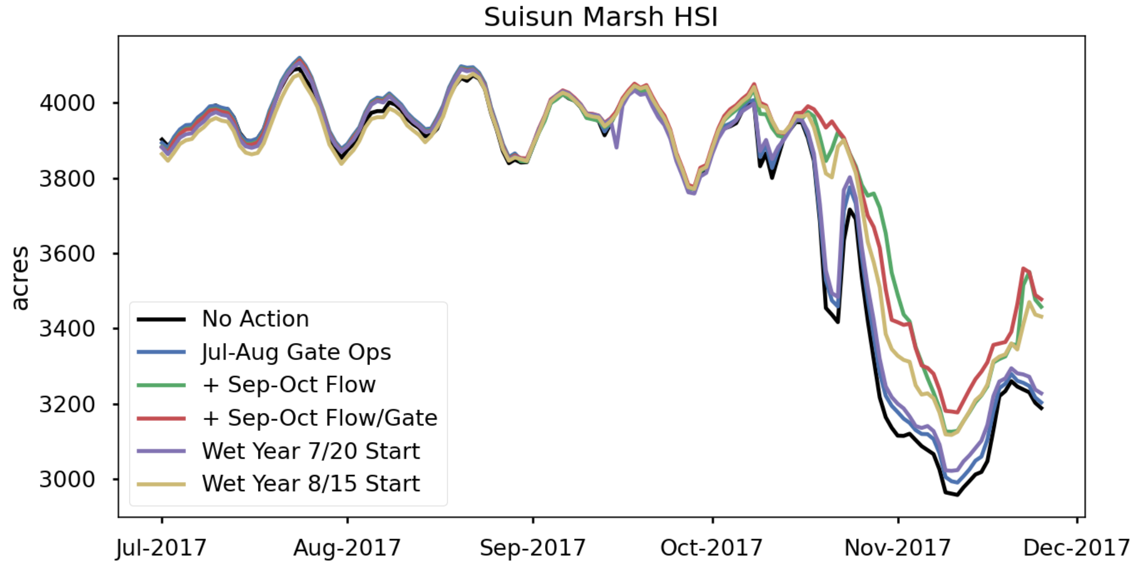
During a Wet year, operating the SMSCGs when Beldon’s hit 2 ppt (mid-July through mid-September) did not have a large impact on high HSI area. Operating the gates later in the year, from August 15 through October 15th had a slightly greater impact on high HSI area that lasted longer into the year (Figure 15, 16).

**Figure 14 Salinity at Beldon's Landing (BDL) with various SMSCG operational scenarios assuming Wet (2017) hydrologic conditions**



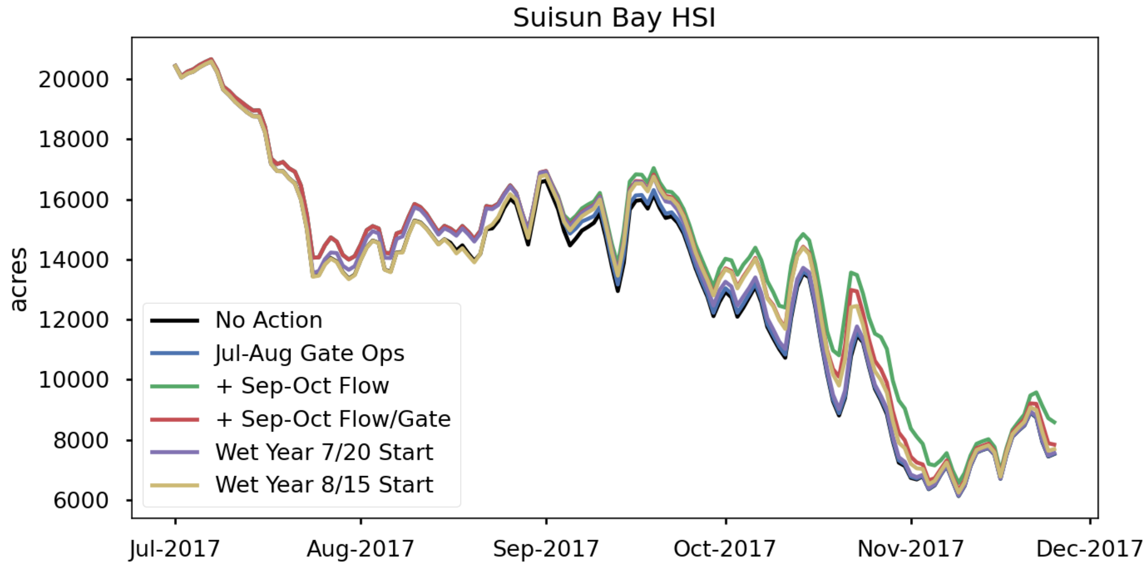

Note: Above Normal year scenarios are Jul-Aug SMSCGs (blue), 100 TAF Sept-Oct as outflow (green), 100 TAF Sept-Oct as SMSCG operations (red), and Wet year scenarios for 100 TAF using SMSCGs for 60 days starting July (purple) or Aug (yellow). All scenarios are adjusted for the Fall X2 action.

**Figure 15 Area of appropriate Delta Smelt Habitat Suitability Index (HSI) in Suisun Marsh with various operational scenarios assuming wet (2017) hydrologic conditions**




Note: Scenarios are described as in Figure 14.

**Figure 16 Area of high Delta Smelt HSI in Suisun Marsh with various operational scenarios assuming wet (2017) hydrologic conditions**




Note: Scenarios are described as in Figure 14.

## Monitoring and scientific investigations

Both the NDFS and the SMSCG actions include robust monitoring programs that occur in both action and non-action years. This includes collection of phytoplankton, zooplankton, and water quality data, as well as special studies of contaminants, energy sources and trophic transfer (via stable isotopes), benthic invertebrates, and fish. A full description of the monitoring can be found in the study plans for the actions (Appendices C and D). The extra 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) and 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 A) 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 provided as appendices. 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 monthly throughout 2023. 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 and updated Science and Monitoring Plan. The DCG anticipates using lessons learned from this year’s SDM process to identify 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 continue to meet approximately monthly, when needed, to provide technical support and to evaluate directed science proposals aimed at filling information gaps and reducing uncertainty. SDM for water year 2024 is anticipated to begin in October 2023, if applicable.

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.

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## Appendices

A. Delta Smelt Summer Fall Habitat Action (SFHA) Monitoring and Science Plan
B. 2023 Delta Coordination Group Structured Decision Making (SDM) Decision-Process Document and supporting appendices
C. SMSCG Science and Monitoring Plan
D. NDFS Operations and Monitoring Plan

Appendices are provided as separate attachments.