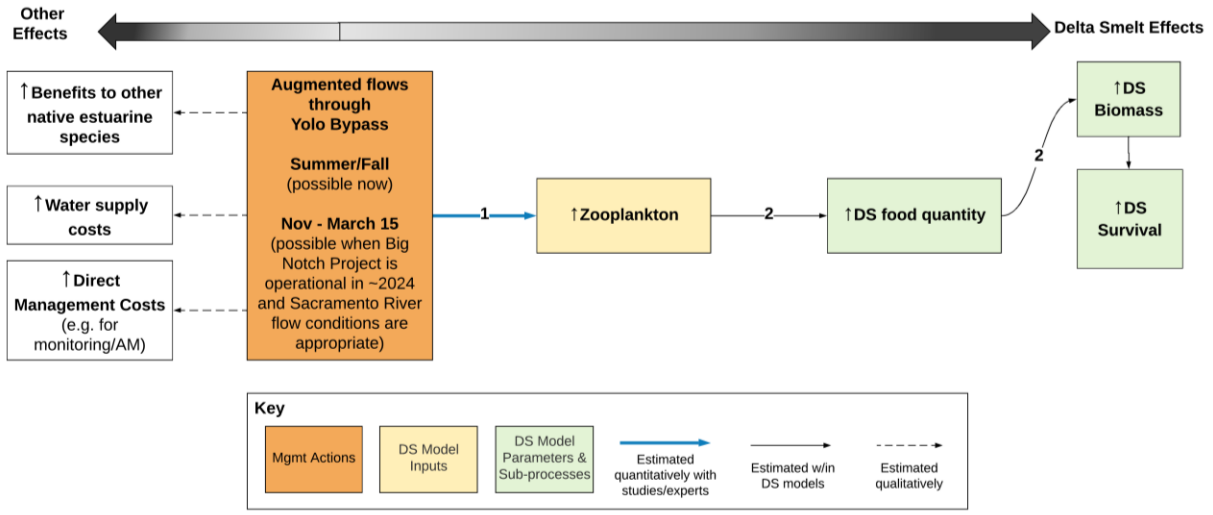
Action Specification Sheet:
North Delta Food Subsidies

1 Short Description and Hypothesized Bottleneck

The goal of this action is to increase flows and distribute food resources downstream using managed flow pulses through the Yolo Bypass, thereby restoring more natural flow patterns and enhancing the quantity and quality of food for Delta Smelt and other species in the North Delta. The North Delta region of the San Francisco Estuary is relatively rich in aquatic food resources compared to other regions, but low or negative flows from water diversions during summer and fall limit the distribution of these resources to downstream areas. The above information was informed by Twardochleb et al. (2021a).

2 Influence Diagram

The following influence diagram describes the hypothesized relationship between the NDFS action and key outcomes for Delta Smelt.



3 Action Evaluation

The following table summarizes the effects analysis of the NDFS action for the Round 1 SDM analysis. A more fulsome description of this action can be found in the Action Specification Sheet: *North Delta Food Subsidies – Colusa Basin Drain Study (NDFS)*.

#	Effect Hypothesis	Effect Characterization for Round 1 SDM
1	NDFS → increase zooplankton	NDFS (Action #1.1): Baseline zooplankton density is adjusted in the Summer/Fall period across 10 out of 20 model years as follows based on the Delta Coordination Group's modifications of estimates in the RMA (2021) study: • In dry years (2001, 2002, 2007, 2009, 2013), zooplankton increases by 114% and 81% in Yolo Bypass/Cache Slough subregion in September and October, respectively.

#	Effect Hypothesis	Effect Characterization for Round 1 SDM
		• In Above Normal and Below Normal years, (2003, 2004, 2005, 2010, 2012) zooplankton density increases by 157% and 92% in Yolo Bypass/Cache Slough subregion in August and September respectively. Smaller zooplankton changes are assumed in the above years and months in Upper and Lower Sacramento subregions.
Financial and water resources		
	Financial resource costs	We used estimates from expert input and previous analyses that includes annual operating costs and water. See Section 13 for details. **Final financial resource estimate:** **$4,228,092 per year**

4 Location(s)

North Delta regions Colusa Basin Drain/Ridge Cut Slough, Yolo Bypass, Cache Slough and Lower Sacramento.

5 Timing / Lifestage / Triggering Conditions

Twardochleb et al. (2021a) states:

- The action will occur annually in summer and/or fall depending on hydrology.
- In the absence of flow actions, low-to-moderate flow pulses may still occur in the Yolo Bypass due to local agricultural activities, but changes in net flow conditions are limited to the bypass and do not reach downstream regions.
- DWR may not pursue flow actions during the most extreme water years for both dry and wet conditions (wet or critically dry water year types).
- Monitoring by DWR has shown that water availability may be insufficient to generate a flow action in critically dry years (Figure 2-8), and non-managed flow pulses during critically dry water years may have negative effects on water quality and the Delta food web.
- Modeling by DWR has shown that a managed flow pulse with agricultural water is unlikely to negatively impact water quality (e.g., conductivity) in the Delta during dry water year types.
- Flow actions in wet years may not provide enough additional benefits beyond those of non-managed flow pulses during wet years to justify the resources for conducting an action. This has not been formally assessed. During wet years, net flow from the Yolo Bypass is usually positive during summer without flow modifications.
- Managed flow pulses with Sacramento River water will likely be limited to Below Normal and Above Normal years because it requires sufficient inflow to Shasta Reservoir.
- No flow action is planned for the summer or fall of 2021 due to an ongoing drought.

Laura Twardochleb provided the following update in June 2021: “MA-SR action may be possible during other time periods (e.g. Fall) or using an alternative reservoir source (e.g., Oroville), which could expand the water year types under which we consider an action. With the help of the DCG hydrology and

operations working group, we are assessing whether alternative action types, such as a MA-SR action followed by a MA-Ag action during fall, are feasible. Also exploring the feasibility of water sources as alternatives to Shasta reservoir."

The decision chart from Twardochleb et al. (2021a) is provided below:
Note that while this decision chart only outlines a give WY type, the previous WY is also important. A prior Dry year with low Shasta inflow may affect the ability to conduct a MA-SR action even in a present BN or AN year.

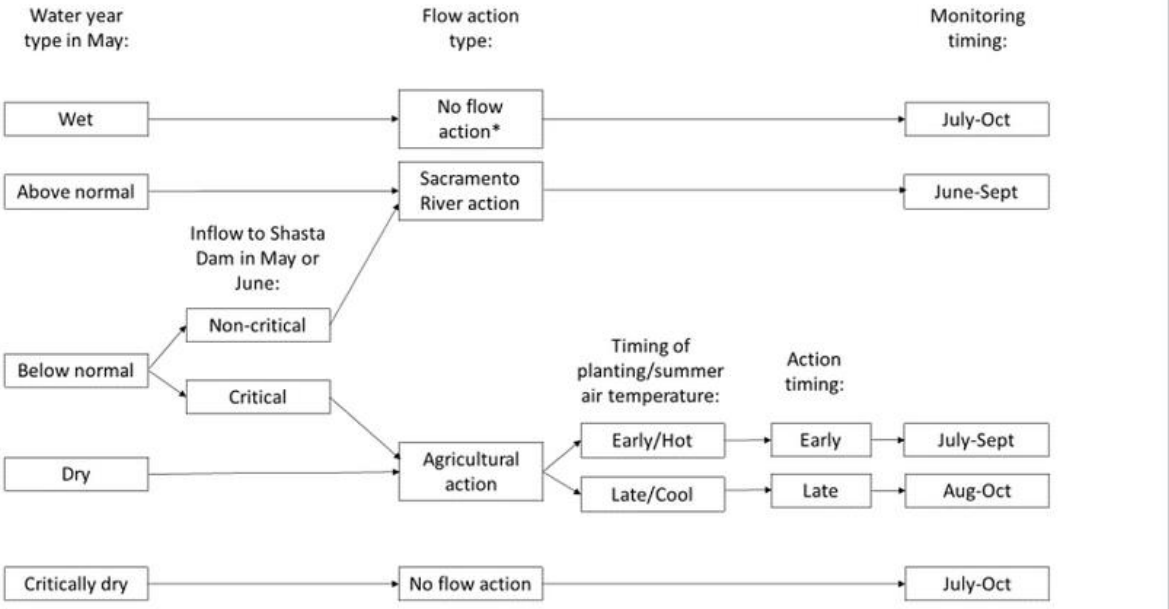


Figure 2-4. Decision chart for conducting a Sacramento River (MA-SR) vs. agricultural (MA-Ag) flow action. The type of flow action in any year will depend on (left to right): Projected water year type (wet to critically dry) with the final hydrologic forecast in May, and inflow to Shasta Dam in May or June (critical or non-critical). In addition, summer air temperature and the timing of agricultural planting in the north Delta region will both affect the timing of an agricultural action. Monitoring timing depends on the type and timing of the flow action. *Note that a flow action will not normally be conducted in a wet year, except under certain circumstances such as a wet winter and a dry spring.

6 Intensity Required

A larger than normal flow pulse requires about ~20-25 TAF, which is used to create a managed flow pulse for up to 2-4 weeks with greater than 300 cfs net flow in the Yolo Bypass.

7 Evidence

With interagency support, DWR has led three managed flow pulses in recent years (2016, 2018, and 2019). DWR has also analyzed data for non-managed flow pulses through the Yolo Bypass in years between 2011 and 2019. A draft synthesis of managed and non-managed flow pulses is under review currently and should be available in August 2021. Brittany Davis and Laura Twardochleb presented results from this synthesis to the Bay-Delta Science Conference on April 7, 2021. The table below is a summary of flow pulses through the Yolo Bypass from 2011-2019 from Twardochleb et al. (2021a):

Table 1-1. Annual positive, net flow pulse magnitude and duration measured at Lisbon Weir in the Yolo Bypass. WY indicates water year type including wet (W), below normal (BN), dry (D), and critically dry (C). Flow pulse types include managed flow pulses using diversions of Sacramento River water (MA-SR) or agricultural return flows (MA-Ag), non-managed flow pulses during construction (CA), or non-managed flow pulses (NF) from agricultural activities. Flow pulse magnitude is measure in cubic feet per second (cfs) and acre feet (AF). In the absence of flow pulses, net flow is negative (upstream) through the Yolo Bypass during this time. Since beginning in 2016, DWR has conducted the NDFS managed flow actions annually, except in 2017 and 2020, due to construction on infrastructure in the Yolo Bypass region.

Year	WY Type	Flow pulse type	Max Daily Ave Net Flow (cfs)	Total Average Net Volume (AF)	Total Days Net Positive Flow	Date Range (start/end of flow pulse)	Downstream Phytoplankton Response
2011	W	NF	412	22,356	63	Aug 23 - Oct 24	Yes
2012	BN	CA	723	27,224	38	Aug 26 - Oct 2	Yes
2013	D	NF	283	11,437	42	Aug 22 - Oct 2	No
2014	C	NF	239	2,503	15	Sep 9 - Sep 23	No
2015	C	NF	383	17,909	42	Aug 21 - Oct 1	No
2016	BN	MA-SR	546	12,752	19	Jul 14 - Aug 1	Yes
2017	W	CA	125	1,022	12	Aug 29 - Sep 18	No
2018	BN	MA-Ag	548	19,821	30	Aug 28 - Sep 26	No
2019	W	MA-Ag	750	31,600	26	Aug 26 - Sep 21	No
2020	D	NF	159	3,081	17	Sep 1 - Sep 16	No

At a Stakeholder meeting of the North Delta Flow Action Project in May 2020, DWR presented updates on the 2019 field season and plans for the 2020 season. Conclusions from the 2019 flow action included:

- Upstream and Yolo Bypass responses to flow pulse (in water quality, nutrients, and chlorophyll) were observed, but downstream was not significantly changed
- Increased densities and diversity of phytoplankton and zooplankton Upstream and Yolo
- Some evidence of contaminants in zooplankton
- Good survival of hatchery grown delta smelt

8 Delta Smelt Model Results

The table below shows predicted population outcomes across the 20-year model timeframe for the action that was tested with the IBMR and LF models.

Action run ID	Scenario name	Population Growth Rate		% Change in Population Growth Rate from Baseline	
		IBMR	LF	IBMR	LF
		Average lambda (1995-2014)	Average lambda (1995-2014)	% change in average lambda (1995-2014)	% change in average lambda (1995-2014)
1.1	NDFS	0.98	0.86	0%	0%

9 Discussion and Next Steps

This action is at an advanced stage of exploratory implementation. AM trials over the coming years will establish the relative benefits and adverse impacts of the action, and will permit adjustments to be made in response to monitoring results.

From the context of this SDM process, there seems to be limited value in further modelling analysis of this action in isolation. However, there is likely value in modeling this action as part of portfolios of actions. Results from ongoing monitoring will be useful in parameterizing models used for this purpose in Phase 3 of this work.

9.1 Uncertainties

There are a few key uncertainties related to the implementation of this action:

- Feasibility in dry years: Monitoring by DWR has shown that water availability may be insufficient to generate a flow action in critically dry years.
- Benefits in wet years: Flow actions in wet years may not provide sufficient additional benefits beyond those of non-managed flow pulses during wet years to justify the required resources for conducting an action. This has not been formally assessed.

10 Relationships with Other Actions

This action is one of several habitat and food actions in the Delta Smelt Summer Fall Habitat Action. Other actions include the Suisun Marsh Salinity Control Gates Re-operation, Sacramento Deep Water Shipping Channel Food subsidy project, the Roaring River Distribution System and Managed Wetlands; however, only Suisun Marsh Salinity control gates and the current action have been implemented, while the others are in feasibility and planning stages.

11 Key Contacts

DWR is the lead implementing entity for this action with federal, state, and local partner coordination. Twardochleb et al. (2021a) provides their current operations and monitoring plan for this action.

Project Manager: Laura Twardochleb, DWR

Water Operations Manager: Josh Martinez, DWR

Project Sponsor: Brittany Davis, DWR

12 References

RMA 2021. Numerical Modeling in Support of Reclamation Delta Smelt Summer/Fall Habitat Analysis. Technical Memorandum, May 14, 2021. Prepared for: United States Bureau of Reclamation. Prepared by: Resource Management Associates. RMA Shiny Demo (rmanet.app)

Twardochleb L., Martinez, J., Bedwell, M., Frantzich, J., Sommer, T., and B. Davis. 2021a. North Delta Food Subsidies 2021-2023 Operations and Monitoring Plan. Department of Water Resources, Division of Environmental Services.

Twardochleb L., Maguire A., Dixit L., Bedwell M., Orlando J., MacWilliams M., Bever A., and B. Davis. 2021b. North Delta Food Subsidies Study: Monitoring Food Web Responses to the North Delta Flow Action, 2019 Report. Department of Water Resources, Division of Environmental Services.

13 Appendix 1 – Financial Resource Cost Calculations

The table below provides cost estimates and assumptions used for the action. It shows an example calculation for the action, which was applied to Portfolio 1b in the Round 1 evaluation. The orange cell indicates the annualized cost used for this action in that portfolio.

North Delta Food Subsidies
Portfolio(s) 1b

Component		Notes	Quantity	Unit Cost		Frequency		Total	
Initial Costs									
	High	[a]							
	Low	[b]							
Annual Operating Costs									
	High	[c]		$300,000	/year for	70%	of years	210,000	/yr
	Low	[d]		$100,000	/year for	70%	of years	70,000	/yr
Water Costs			24,000	af/pulse flow and 2 pulse flows each year with September free water					
	High	[e]	24,000	af @ $398	/af	70%	of years	6,689,605	/yr
	Medium	[f]	24,000	af @ $265	/af	70%	of years	4,459,737	/yr
	Low	[g]	8,000	af @ $265	/af	70%	of years	1,486,579	/yr
Undiscounted average annual costs									
High								6,899,605	/yr
Average of high and low								4,228,092	/yr
Low								1,556,579	/yr

Notes

Frequency of Water Year Types & Assumed Water Prices
Assumed water prices from CAMT, Aug. 11, 2017 meeting discussion.
Source: Table DFL-5b

Year Type	Historic Frequency	Project Frequency		Water Price ($/af)
W	33%	17%		$100
AN	14%	14%		$125
BN	18%	18%		$250
D	21%	21%		$500
C	14%	0%		
Total	100%	70%	Avg:	$265

[a]
[b]
[c] For staff time & monitoring (estimate from T. Sommer)

For staff time. Assumes monitoring conducted through existing programs. (Compass/S.

[d] Hamilton assumption)

[e] 150% of medium cost (S. Hamilton assumption)

[f] See North Delta Food Subsidies for calculation of water cost

[g] Assumes only consumptively used water needs to be purchased.

Possible Improvements

Confirm if only consumed water needs to be purchased

Confirm if water is free in September