Action Specification Sheet:

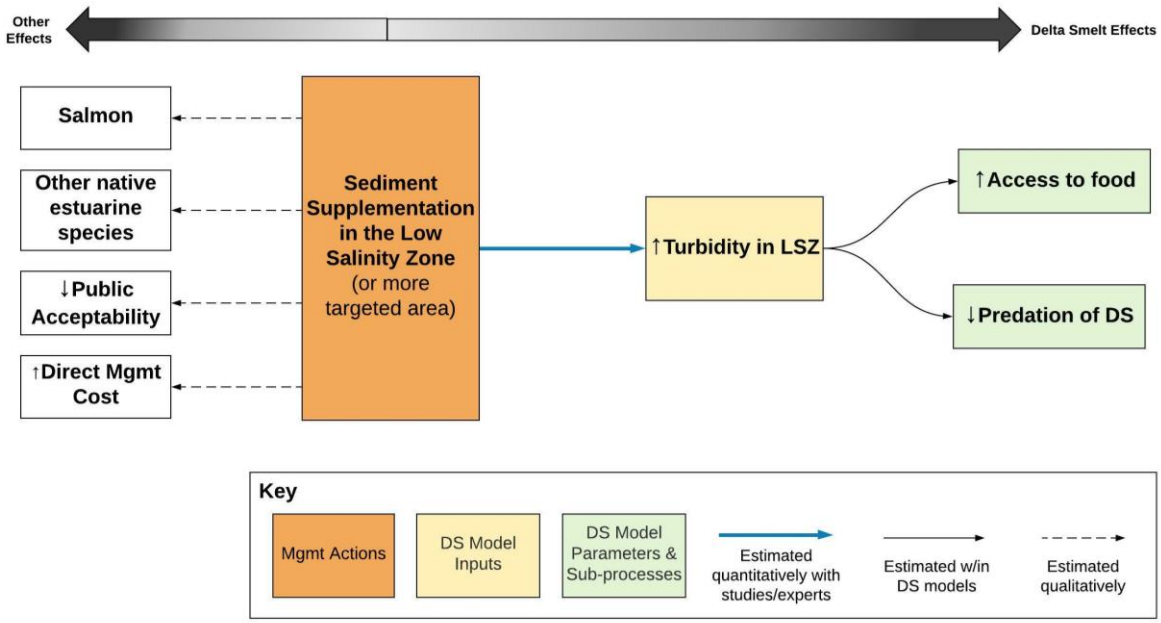
Sediment Supplementation in the Low Salinity Zone

1 Short Description and Hypothesized Bottleneck

This action involves adding sediment at Decker Island (just upstream from the confluence) to increase downstream turbidity and improve conditions for Delta Smelt growth and survival. The 2019 BiOP notes that:

> "Reclamation proposes to develop and implement a sediment supplementation feasibility study. The goal of this study will be to determine methods to reintroduce sediment in the Delta to increase turbidity which would provide better habitat conditions for all life stages of delta smelt, including increased cover for juveniles and feeding facilitation for larval smelt. This study will include, at minimum, consideration of sediment placement upstream of the Delta during low flow periods in the spring, summer and/or fall, followed by sediment remobilization following inundation during seasonal high flows. Reclamation will coordinate with the Service and other agencies to address necessary permitting for this study. Reclamation will coordinate with the Service on the design and findings of this study, including monitoring measures to assess its effectiveness and feasibility as a long-term management program, a method to phase implementation if required for permitting and other compliance needs."

2 Influence Diagram



3 Action Evaluation

3.1 Effects Analysis

#	Effect Hypothesis	Estimation Method For Round 1 SDM Evaluation
Delta Smelt		
1	**Sediment Supplementation in LSZ → Increased turbidity in LSZ.**	Used modeling results from MacWilliams and Bever (2017) to estimate change in turbidity with sediment supplementation at Decker Island from May 1 to Nov. 30 in all model years (1995-2014) except 2001 and 2002. All of these years have an average turbidity <15 NTU (or >40 cm secchi depth) during the period May 1 to Nov. 30. 15 NTU is a threshold that is used in the TWG's Dynamic Habitat Analysis Tool to separate suitable / not suitable habitat.
2	**Increased turbidity → Decreased predation** Ferrari et al. (2014) finds that turbidity probably assists delta smelt in avoiding predators.	Pathway included in IBMR (2022)
3	**Increased turbidity → Increased food visibility for DS larvae** Studies have shown that Delta Smelt larvae need turbidity to see their prey (Baskerville-Bridges et al., 2004; Hasenbein et al., 2016; Moyle et al., 2016). However, no studies show this relationship for adult and juvenile DS.	Pathway included in IBMR (2022)
Financial and water resources		
	Direct Management Costs	CAMT (2017) estimates the annual cost of the action at $8 Million for the time period May to Sept. 30, given an estimated total sediment supplementation volume of 400,000 cubic yards (or 250 acre feet) (MacWilliams and Bever 2017) and an assumption of $20/cubic yard cost for sediment. MacWilliams and Bever (2017) suggested that amount of sediment could be reduced by 20% to achieve target increase in turbidity (10 NTU). Therefore, a lower estimate is $6.4 Million per year. Final annualized cost estimates per year averaged the upper and lower estimates. See Section 12 for details. **Final financial resource estimate:** **$7,200,000 per year**

3.2 Implementation Notes

Implementation Need	Notes
Permitting	This action would need environmental review (CEQA/NEPA) and permits from Corps and Central Valley Regional Water Control Board (CVRWCB). CVRWCB has indicated openness to this action idea. (Carl Wilcox, pers. comm., Jan. 24, 2022)
Source of sediment	Decker Island is a possible source of sediment for this action because it is a fill site and is a logical sediment source in a good location. There are some other dredge disposal sites that could potentially be sources as well on the western side of the Sacramento River from Decker, at the Southern end of Grand Island, along the Deep Water Ship Channel. Another alternative could be to broadcast disposal of dredge material during channel maintenance operations. (Carl Wilcox, pers. comm., Jan. 24, 2022)
Feasibility Consideration and Uncertainty	Ching-Fu Chang (hydrologist with CCWD) and TWG member provided the following analysis: The estimated 1.08 million kg/day sediment need is based on the assumed silt/floc composition. To run this action May-November, depending on the porosity of the sediment, the volumetric sediment need can range from 80 acre-ft to more than 700 acre-ft (see SediSupp_IBMRInputs_16Mar2022.xlsx (sharepoint.com) for calculation). As a reference, the area of Decker Island is about 650 acres. The uncertainty regarding silt/floc composition and porosity could lead to difficulty in predicting the cost of implementing this action. Additional uncertainty arises from the fact that the study investigated one year in particular, while this action is being considered in a wide range of years with different hydrologic and hydrodynamic conditions.
Public acceptability	In the Delta Smelt Demo Project, the TWG at that time advised that any action where substances are added to the water typically raise significant public concerns – for example, around the cleanliness of the sediment and the perception of "dumping" sediment into the Delta.

4 Location(s) / Timing / Life Stage / Triggering Conditions

The action entails sediment supplementation at Decker Island in the Lower Sacramento subregion, and the increase in turbidity is assumed to occur there and westward in the Confluence and Suisun Marsh and Bay. These areas within the North Delta Arc historically have relatively high DS abundance (post-POD/clam), and acceptable food resources and temperatures (the latter may preclude certain areas during warmer years).

Timing of the action would occur from May 1 to Nov. 30 in all model years (1995-2014) except 2001 and 2002. All of these years have an average turbidity <15 NTU (or >40 cm secchi depth) during the period May 1 to Nov. 30. 15 NTU is a threshold that is used in the TWG's Dynamic Habitat Analysis Tool to separate suitable / not suitable habitat.

5 Intensity Required

Optimal intensity may change throughout ontogeny. That required to produce a beneficial effect of feeding enhancement by larval DS, cover from predators.

In the SDM Demo Project, intensity was defined using the Bever and MacWilliams (2017) study as:

- In years when the LSZ has low overlap with areas that have naturally high turbidity (e.g., water year 2010), add sediment to the LSZ to increase turbidity by approximately 10 nephelometric turbidity units (NTU) between Emmaton and Mallard Island for the period between May 1 and Sept. 30.
- Assume sediment is supplemented in the manner described in MacWilliams and Bever (2017) for a total sediment input of 1.08 million kg per day or 165.24 million kg total for the period between May 1 and Sept. 30 (153 days) to meet the 10 NTU target. This would be approximately 3,552 cubic yards[1] of sediment per day or a total of 543,000 cubic yards for that period (MacWilliams and Bever, 2017).

6 Evidence / Examples

Increasing turbidity decreases visual detection of prey fishes by predators (Gregory and Levings 1998; De Robertis et al. 2003; Ward et al. 2016; Ward et al. 2019). Regarding DS feeding: (Lindberg et al. 2004) (Hasenbein et al. 2013).

6.1 Bever and MacWiliams (2017)

A study undertaken by Bever and MacWilliams (2017) from Anchor QEA provides an order of magnitude estimate of sediment supplementation rate required to achieve 10 NTU increase from Emmaton to Mallard Island between May 1 and September 30. To do so required them to make significant assumptions regarding sediment composition (silt/floc), effectiveness of slurry at achieving suspension, and other dredged material properties. They found that:

- The amount of sediment needed to increase turbidity by at least 10 NTU from Emmaton to Mallard Island was estimated to be 3550 cubic yards on average per day or 543,000 cubic yards for the whole May 1 to Sept. 30 period.
- At lower outflow the effectiveness of the sediment supplementation is increased.

Bever and MacWilliams (2017) used water year 2010 as a baseline model year for their analysis. 2010 was a below normal water year preceded by a dry water year. They chose 2010 based on a comparison of conditions for Delta Smelt during the fall of 2010 and 2011, which indicated substantial differences in the overlap between the LSZ and areas of high turbidity following a below normal (2010) water year and a wet (2011) water year (Bever et al. 2016). Specifically, during the fall of 2010, the LSZ did not overlap with areas of high turbidity and low velocity as it did during 2011.

[1] The average dump truck holds anywhere from 10 to 14 cubic yards of sediment. At 14 cy per dump truck, supplying 3,552 cy/day of sediment would require 254 dump truck trips per day.

7 Delta Smelt Model Results

The table below shows predicted population outcomes across the 20-year model timeframe for the action that was tested with three Delta Smelt population models.

		Population Growth Rate			% Change in Population Growth Rate from Baseline		
		IBMR	LF	LCME	IBMR	LF	LCME
Action run ID	Scenario name	Average lambda (1995-2014)	Average lambda (1995-2014)	Median lambda (1995-2014)	% change in average lambda (1995-2014)	% change in average lambda (1995-2014)	% change in median lambda (1995-2014)
7.1	SediSupp	1.70	1.11	1.01	73%	29%	11%

8 Discussion and Next Steps

Time permitting in this project or a future project, additional actions, next steps and considerations to advance this action include:

- Clarifying the status of Reclamation's activities noted in the BiOP
- Consider biologically what levels of turbidity would be beneficial and where. Undertake a feasibility investigation of effort(s) needed to produce minimum desired effect
- Model how much sediment would be needed / How much will it be diluted in other locations. Consider hydrodynamics for dispersion.
- What are the interactions between the timing of sediment supplementation, effects to turbidity in the Lower San Joaquin subregion, Delta Smelt movement, and risk of entrainment? If increasing turbidity in the Lower San Joaquin with the current way the sediment supplementation action is specified (via release of sediment at Decker Island) increases risk of entrainment, are there alternative locations for sediment release that reduce these risks while still increasing turbidity to some subregions?

9 Action Specification

- Compass review of Bever and MacWilliams (2017, 2018) documentation and correspondence with Carl Wilcox (CDFW) in January 2022 to develop first draft.

10 Key Contacts

- DFW – Carl Wilcox
    - DFW is interested in doing a pilot to test feasibility of this action (Carl Wilcox, pers. comm., Jan. 24, 2022)
- DWR – Erik Loboschefsky
- Jim Levein – Manager for Montezuma Wetlands Project (this project, located at Collinsville at the eastern end of Montezuma Slouth, uses dredge material) – may have ideas for implementing this action (Carl Wilcox, pers. comm., Jan. 24, 2022)

11 References

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

Bever. A., and MacWilliams, M. (2017). Anchor QEA Memorandum Re: Evaluation of Sediment Supplementation in the Low Salinity Zone. January 23, 2017. Draft Memorandum.

Bever. A., and MacWilliams, M. (2018). Anchor QEA Presentation: Evaluation of Sediment Supplementation in the Low Salinity Zone. Delivered at the CWEMF 2018 Annual Meeting.

Smith, W.E., 2022. A delta smelt Individual-Based Life Cycle Model in the R statistical environment (Technical Note). Prepared for CSAMP Delta Smelt SDM Technical Working Group (TWG).

12 Appendix 1 – Financial Resource Cost Calculations

The table below provides cost estimates and assumptions used for the action. It shows an example calculation for performing the action for 14 years (out of 20 years = 70%), which was applied to Portfolio 3e in the Round 1 evaluation. The orange cell indicates the annualized cost used for this action in that portfolio.

Sediment Supplementation
Portfolio(s) **3e**
Source: See table notes

Component		Notes	Quantity		Unit Cost		Frequency		Total	
Annual Operating Costs										
	High	[a]	500,000	cu yds	$8,000,000	/year for	70%	of years	5,600,000	/yr
	Low	[b]	400,000	cu yds	$6,400,000	/year for	70%	of years	4,480,000	/yr
Undiscounted average annual costs										
High									5,600,000	/yr
Average of high and low									5,040,000	/yr
Low									4,480,000	/yr

Notes

[a] MacWilliams and Bever (2017) - Sediment Supplementation Initial Evaluation on increasing turbidity by 10 NTU in LSZ

[b] MacWilliams and Bever (2017) - Sediment Supplementation Initial Evaluation - using opinion that the amount of sediment could be reduced by 20% to achieve objective of increasing turbidity by 10 NTU on average

Possible Improvements

Consider scaled down action by just putting enough sediment in to reach 10-12 NTU in LSZ (current definition is to increase turbidity by NTU)