Action Specification Sheet

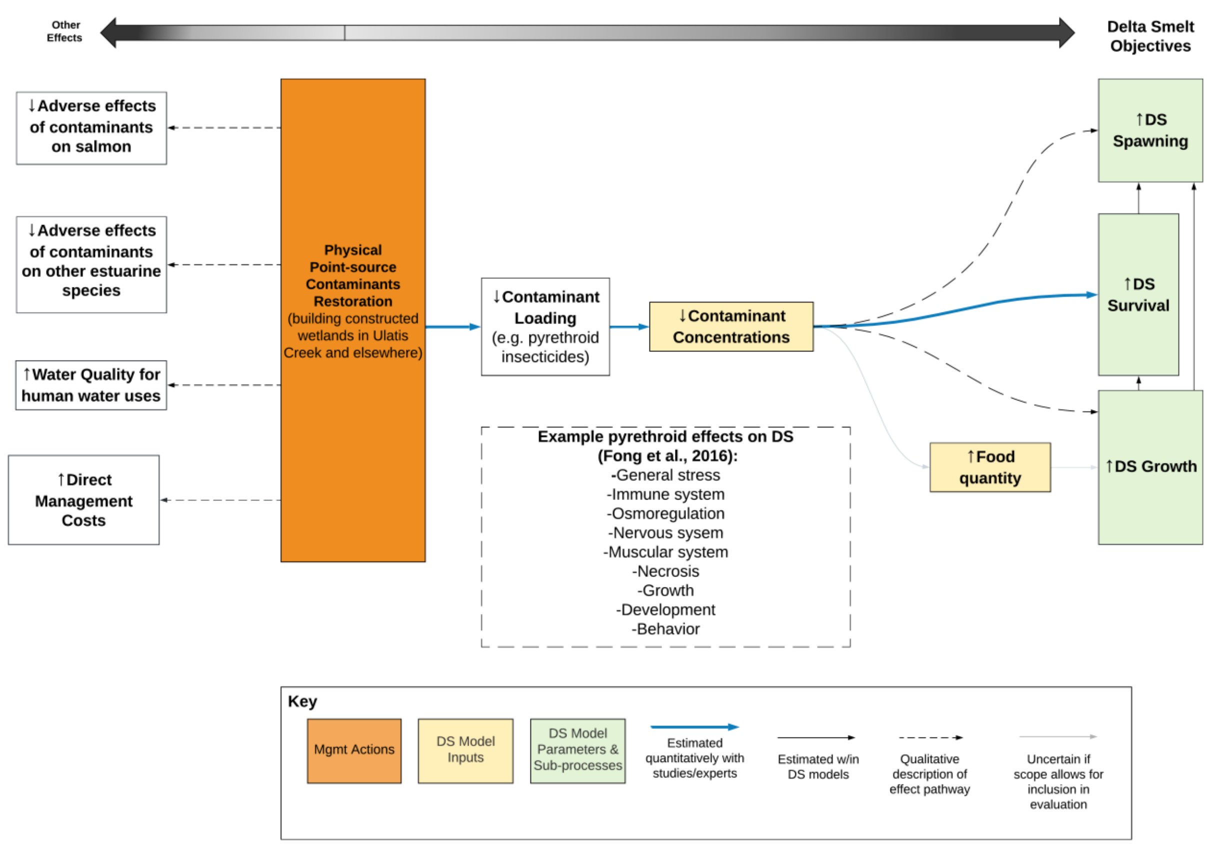
Physical Point Source Contaminants Restoration

1 Short Description and Hypothesized Bottleneck

The basic concept of this action is to apply constructed wetlands to reduce contaminant loading and contaminant concentrations in specific locations where these contaminants are known to concentrate. The action would include a range of physical treatment - settling, transformation; permanent structures, etc., as required following an engineering evaluation of the options available.

Chemical and toxicological testing in the Cache Slough complex of the North Delta indicated the aquatic biota are exposed to a variety of wastewater-derived food additives, pharmaceuticals, and personal care products in highest concentration during dry periods, and many insecticides, herbicides, and fungicides with peak concentrations after winter rains (Weston and Lydy 2010; Weston et al. 2019). The insecticide groups currently known to be of greatest toxicological concern are the pyrethroids and the fiproles (i.e., fipronil and its degradation products). After stormwater runoff enters the system via Ulatis Creek, both pesticide groups attained concentrations that posed a threat to aquatic life (Weston and Lydy 2010; Weston et al. 2019). When the commonly used testing species, *Hyalella azteca*, was placed in Cache Slough, toxicity — and, at times, near total mortality — was seen over at least an 8-km reach of Cache Slough that extended from the uppermost end almost to the junction with the Deep Water Ship Channel (Weston et al. 2019).

2 Influence Diagram

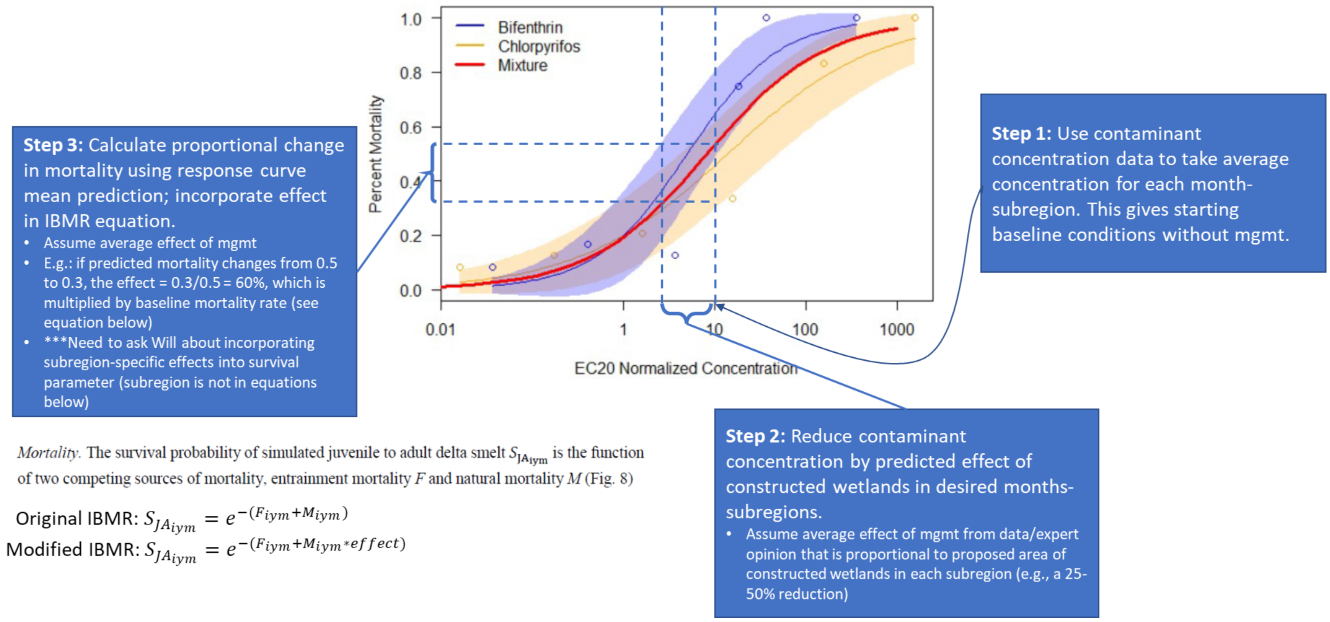


3 Action Evaluation

#	Effect Hypothesis	Estimation Method For Round 1 SDM Evaluation
Delta Smelt		
1	**↓ Contaminant concentration**	Methods for quantifying contaminant concentrations, given management effects were adapted from Landis et al. (2023): • Selected four contaminants to use in analysis: Bifenthrin, Chlorpyrifos, Triadimefon, Myclobutanil. • Used data from Wayne Landis to estimate median concentration of those contaminants by month and subregion between 1995 and 2014. • Specified a "best-case" effect of contaminant reduction from this action. For Round 1 of the SDM evaluation, we assumed a 50% reduction in local contaminants in all months; we assumed that 10% of a subregion's flow go through the managed area. Therefore, the subregion-wide reduction in contaminant concentration is assumed to be 5%. • Specified two build out scenarios: (1) contaminant reduction at Ulatis Creek influencing contaminants in Yolo/Cache subregion, and (2) a full build out scenario with contaminant reduction in all subregions.
2	**↓ Delta Smelt mortality** (or ↑ Delta Smelt survival rates as defined in IBMR) "…the population decline of Delta Smelt is significantly associated with multiple stressors, including insecticide use" (Fong et al. 2016)	**IBMR:** Slight modifications to the IBMR were required to incorporate a direct effect from contaminant reduction on life stage-specific mortality rates. Methods for quantifying changes in Delta Smelt mortality, given changes in contaminant concentrations (see Figure 1): • Starting with baseline contaminant concentration conditions, used contaminant response curves (relating % mortality to concentration) from Wayne Landis to calculate the estimated mean "baseline mortality" • Used the expected reduced contaminant concentration level, given the action, to calculate mean "reduced mortality" with the response curves • Calculated the proportional change in mortality by dividing "reduced mortality" by "baseline mortality". E.g., if mortality changes

#	Effect Hypothesis	Estimation Method For Round 1 SDM Evaluation
		from 0.5 to 0.3, the proportional change = 0.3/0.5 = 60% • Multiplied the natural mortality rate (M) in the IBMR by the proportional change in mortality for months-subregions affected by the action • Response curves were calculated in a lab experiment using Mississippi silversides (*Menidia beryllina*). No study has estimated contaminant effects on Delta Smelt. We assumed response curves and predicted changes in mortality for silversides are similar to those for Delta Smelt and can be used directly in the Round 1 SDM evaluation. • As a starting point, we assumed no additional effects (either direct or indirect through changes in contaminant concentration) of this action on local zooplankton, salinity, etc. See CRM (2023) for more details.
Financial and water resources		
	Upfront Costs: Construction Operating Costs: Maintenance	Estimate with available data & expert judgment from Shawn Acuna (MWD) based on estimates used in the SDM Demo Project. Final annualized cost estimates per subregion (site) included initial costs and annual operating costs and used an average of the upper and lower estimates. See Section 11 for details. **Final financial resource estimate: $6,976,927 per year per site**

Figure 1. Methods for using Wayne Landis's contaminant concentration response curves to estimate reduction in Delta Smelt mortality due to the physical point source contaminant reduction action.



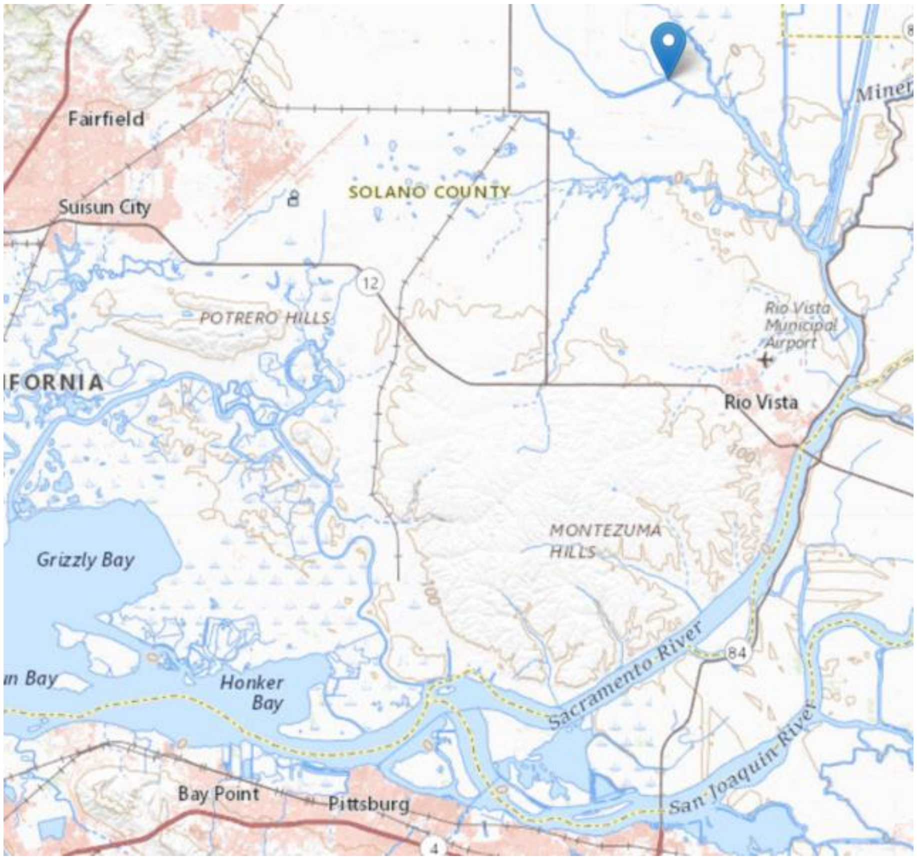
4 Intensity & location(s)

Two potential locations and scales have been proposed for this action.

1) Analysis could focus on reducing contaminants at one specific location – the Ulatis Creek area in the Cache Slough Complex subregion, which acts as a pinch point for contaminants entering Cache Slough.
2) Analysis could simulate a larger-scale scenario of reducing contaminants at Ulatis Creek as well as other similar hotspots (e.g., Pacheco Creek [also known as No Name Slough], Dow wetlands, etc.).

The TWG's Contaminant Sub-Group recommended simulating the larger-scale version of this action for the SDM evaluation (TWG Sub-Group meeting on 25 Feb 2021). Both scales were discussed by the TWG in subsequent meetings, and further resolution is needed around which scale(s) should be used to simulate effects in the SDM evaluation. The constructed wetland for Ulatis Creek will affect the proportion of the total loading into the subregion of Cache Slough Complex. To upscale the action to the whole area occupied by Delta smelt we would assume that similar actions could be done with similar results. This would allow for a system level effect that could be separated regionally if need be.

Figure 2. Location of Ulatis Creek (marker) in the Cache Slough Complex subregion of the Delta (USGS).



5 Timing / Life stage / Triggering Conditions

This action uses permanent infrastructure that would affect contaminant concentrations – and subsequent effects on Delta Smelt – across all months/life stages after implementation. However, contaminant loads often peak with high winter precipitation and stormwater runoff, so reductions in contaminant loads may be greatest in December and January. Therefore, benefits to Delta Smelt survival may be greatest for pre-spawning adults.

6 Evidence / Examples

Evidence for pyrethroid contamination effects are demonstrated in Fong et al. (2016), Weston et al. (2014) among others.

7 Delta Smelt Model Results

The table below shows predicted population outcomes across the 20-year model timeframe for several versions of the action that were tested with the IBMR. The action resulted in a 0 – 3% reduction in natural mortality to Delta Smelt for a given month and subregion in the IBMR.

	Population Growth Rate	% Change in Population Growth Rate from Baseline
	IBMR	IBMR

Action run ID	Scenario name	Average lambda (1995-2014)	% change in average lambda (1995-2014)
12.1	Contam Yolo	1.00	1%
12.2	Contam Delta	1.14	16%

- Multiple runs were used to explore population outcomes while varying the spatial scale of the action (locally in 1 subregion [Yolo/Cache Slough at Ulatis Creek], and Delta-wide in 12 subregions).
- **Round 1 portfolios varied in spatial scales to which contaminant reduction was simulated. The assumed/quantified local effects were the same across all runs.**

8 Action Specification

- This action was first identified by the TWG's Predation Sub-Group (Bill Bennett, Scott Hamilton, Andrew Schultz) at their April 20, 2021 meeting. Compass drafted the action description based on the discussion at this meeting and provided it to the Predation Sub-group for review and input.
- The action was further discussed and specified at the TWG's Contaminant Sub-Group meeting on 25 February 2021. The Sub-Group recommended testing the "larger scale" version of this action simulating reduction of contaminants at all known hotspots.
- Compass met with Shawn Acuña and Wayne Landis in July 2021, August 2021, and February 2022 to discuss available data and modeling approaches for quantifying the effects of contaminant load on Delta Smelt mortality.
- Wayne Landis modeled relationships between contaminant loads and Mississippi silverside mortality and will provide these models to Compass.
- At the 18 February 2022 TWG meeting, the TWG discussed the intensity/scales at which this action could be modeled. Will Smith suggested it was possible to capture direct effects of this action on Delta Smelt mortality in the IBMR with slight modifications.

9 Key Contacts

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10 References

Compass Resource Management (CRM), 2022. Methods for predicting changes in Delta Smelt mortality due to contaminant reduction actions (Technical Note). Prepared for CSAMP Delta Smelt SDM Technical Working Group (TWG). 11 Jul 2022.

Fong, S., Louie, S., Werner, I., Davis, J., Connon, R.E., 2016. Contaminant effects on California Bay–Delta species and human health. San Francisco Estuary and Watershed Science 14.

Landis, W., Lawrence, E., et al., 2023. The Relative Contributions of Contaminants to Ecological Risk in the Upper San Francisco Estuary (Project Report). Delta Science Program. 30 Jun 2023.

Weston, D.P., Lydy, M.J., 2010. Urban and agricultural sources of pyrethroid insecticides to the Sacramento-San Joaquin Delta of California. Environmental Science and Technology 44, 1833–1840.

Weston, D.P., Asbell, A.M., Lesmeister, S.A., The, S.J., Lydy, M.J. 2014. Urban and agricultural pesticide inputs to a critical habitat for the threatened Delta Smelt (*Hypomesus transpacificus*). Environmental Toxicology and Chemistry. https://doi.org/10.1002/etc.2512

Weston, D.P., Moschet, C., Young, T.M., Johanif, N., Poynton, H.C., Major, K.M., Connon, R.E., Hasenbein, S., 2019. Chemical and toxicological effects on Cache Slough after storm-driven contaminant inputs. San Francisco Estuary and Watershed Science 17(3), https://doi.org/10.15447/sfews.2019v17iss3art3.

11 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 at 12 sites (12 subregions), which was applied to Portfolios 3a and 3d in the Round 1 evaluation. The orange cell indicates the annualized cost used for this action in those portfolios.

Contaminants Reduction through Stormwater Management
Restoration Projects
Portfolio(s) **3a, 3d**
Source: See table notes

Component		Notes	Quantity		Total	
Initial Costs						
	High	[a]			267,752,306	/IBMR subregion
	Low	[b]			1,270,598	/IBMR subregion
Annual Operating Costs						
	High	[c]			375,650	/yr
	Low	[d]			127,060	/yr
Number of subregions/sites			12			
Undiscounted annual costs			20	years		
High					165,159,182	/yr
Average of high and low					83,723,129	/yr
Low					2,287,076	/yr

Notes

[a], [b] Based on S. Acuna's estimate of contaminant restoration for the SDM Demo Project. High estimate include land purchase and low efficiency of stormwater mgmt. Low estimate includes no land purchase and high efficiency of stormwater mgmt.

[c],[d] O&M - Shawn found: 4% - 14.1%. Compass assumes 10% of high construction cost and 10% of low construction cost to get range of operating costs

Possible Improvements

The assumed land cost is making the high estimate very high. Could get more information on what type of land would be needed to do this action and the market value of that land (e.g. land in the flood zone might be less costly than what is assumed here)