DRERIP Evaluation for Prospect Island Restoration Design Alternatives

Summary of a two-day workshop held at UC Davis
October 24-25, 2012

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Link to DRERIP Conceptual Models: http://www.dfg.ca.gov/erp/cm_list.asp

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i. Abstract

Restoration of Prospect Island is being planned under the Fish Restoration Program Agreement between DWR and DFG. The agreement provides for habitat restoration coordination under NOAA salmonid and USFWS delta smelt Biological Opinions. The opinions require restoration of 8,000 acres of intertidal and associated subtidal habitat over 10 years.

The goal of this workshop was to consider 15 alternative restoration designs for Prospect Island and recommend five for further consideration and environmental documentation. The restoration objectives are to 1) restore processes that promote primary and secondary productivity and tidal transport to enhance the pelagic food web; 2) increase the amount and quality of salmonid rearing habitat; 3) increase the survival of juvenile salmonids by enhancing migratory pathways; 4) provide other ecosystem services associated with tidal freshwater marsh habitat in the Delta.

An invited expert panel, hereafter referred to as Evaluation Team, considered restoration design options including levee breaches, overflow weirs, channel dredging, and DWR and Port of Sacramento property connections, as well as many factors that constrain restoration actions.

Summaries of the presentations and Evaluation Team discussions as well as their recommendations from the workshop are presented in this document. A complementary journal article that highlights the technical discussion is in preparation.

Table of Contents

I. Project Context (Dennis McEwan, DWR, FRPA program)

Dennis McEwan provided participants with the project context. Prospect Island restoration is being planned under the Fish Restoration Program Agreement (FRPA 2010) between DWR and DFG. The agreement provides for habitat restoration coordination under NOAA salmonid and USFWS delta smelt Biological Opinions, as well as the DFG longfin smelt incidental take permit. The opinions require restoration of 8,000 acres of intertidal and associated subtidal habitat over 10 years. Specifically, restorations should restore processes, structures, and functions that promote primary and secondary productivity that could be transported to support regional pelagic habitat—primarily to support delta smelt. Further, it should enhance migratory pathways for salmonids by increasing the amount and quality of rearing habitat. The agreement also requires monitoring and adaptive management to ensure desired outcomes over time. Finally, it must be consistent with other Delta plans and programs including the Bay Delta Conservation Plan (BDCP), the Delta Stewardship Council's Delta Plan, and the Ecosystem Restoration Program's (ERP) Conservation Strategy.

Dennis also emphasized several principles the Department of Water Resources (DWR) and the Department of Fish (DFG) would apply to FRPA/ERP progress toward the 8,000 acre requirement. First, as much as possible, the preferred plan is to "work with nature, and let nature do the work." That is, recognize the landscape potential of prospective restoration areas and allow natural processes (e.g., hydrodynamic, transport, sedimentation, vegetation, etc…) to do the work of landscape change toward desired outcomes. Second, there is recognition that going back to natural conditions is not possible, but historical landscape structure and process regimes should guide actions and performance measurement. Third, restoration actions should provide a diversity of habitat types to benefit multiple covered fish species and discourage colonization of non-natives. Fourth, projects will be designed as adaptive management experiments that are hypothesis driven and that continually update conceptual models about landscape processes, structures, and outcomes. FRPA near-term actions are focused on the Cache Slough complex but will support other program restorations in Suisun Marsh and Yolo Bypass.

Prospect Island overview

Prospect Island is about 1,600 acres—DWR owns about 1,300 acres (acquired from the federal government in 2010), the Port of Sacramento owns the southern 300 acres. Negotiations are ongoing, but the Port of Sacramento has signaled willingness to participate in an integrated restoration of the Island. Other important constraints being investigated include: assessing seepage potential to adjacent Ryer Island under Miner Slough if Prospect Island is tidally inundated; a legal obligation to maintain access to the Stringer property, a small parcel located along the Miner Slough levee; maintaining the Ryer Island levee, a US Army Corp of Engineers flood control project levee; allowing for some tidal connection on the northern end of the property on Miner Slough; and permits - permits for modification of the Deep Water Ship Channel (DWSC) levee tend to be more complicated to acquire than for levee modification on Miner Slough.

The goal for Prospect Island is to partially fulfill the Biological Opinion requirement to restore 8,000 acres to tidal action. Objectives include:

1) Enhance primary and secondary productivity and food availability for native Delta fishes within Prospect Island and surrounding Delta waterways
2) Increase the quantity and quality of salmonid rearing habitat within and in the areas surrounding Prospect Island
3) Increase the amount and quality of habitats to support other listed species, to the extent they can be supported by site conditions and natural processes
4) Provide other ecosystem services associated with increased Delta freshwater tidal marsh habitat, including water quality enhancement, recreation, and carbon sequestration
5) To the greatest extent practical, promote habitat resiliency to changes in future Delta conditions, such as land use conversions, climate change, sea level rise, and invasive species
6) Avoid promoting conditions adverse to other project objectives

US Bureau of Reclamation (USBR) purchased Prospect Island and the Trust for Public Land initially purchased a portion of Holland Tract with the intent that these parcels would be added to the national refuge system. Congress chose not to act on refuge funding in 1999 and Prospect Island has been "feral" since 1999 - when it also breached. USBR had been nearly ready to implement a restoration project design that included culverts (near the Stringer property). Reviving the USBR design was considered for inclusion in the initial screening alternatives, but the culvert is now thought to be too attractive to non-native fish (and fish by fish predation is a concern) so the design was shelved. Currently, the DWR portion is connected by a broken culvert with an invert below low tide level and a small breach on Port property. As such, the DWR property has muted tidal influence now. The Port property has a partially-repaired breach along an old meander bend of Miner Slough that allows muted tidal fluctuation. In 2007, the DWR property breach was repaired, stranding primarily non-native carp and striped bass that entered the property through the breach. With the exception of the small breached area adjacent to Miner Slough, levees are currently intact, but they are overgrown with vegetation and are generally in poor condition. Levees are not well maintained. If levees breach on their own accord, it could be considered as the "no project alternative." The project timeline has construction scheduled to begin in June 2016.

Other related activities

DWR is initiating development of a restoration strategy for the region around Prospect Island, called the Cache Slough Conservation Assessment. Like the Suisun Conservation Strategy prepared by The Nature Conservancy and Stuart Siegel and staff of Wetlands and Water Resources with collaboration by Chris Enright of the Delta Science Program, the strategy will include inventories of fundamental restoration considerations including levees, elevations, infrastructure, and land use. In addition, the strategy will cover restoration monitoring, stakeholder outreach, interim property management, and invasive plant management. It will leverage previously completed BDCP surveys on fish, birds, and plants. Finally, it will address numerous other related planning efforts.

Prospect Island restoration challenges

DWR is addressing several other restoration related challenges.

1) The Port of Sacramento property is beneficial to the overall restoration and negotiations continue with Port officials. Thus far, restoration planning assumes the Port property will participate.
2) Design breaches in the DWSC levee are of interest but levee removal is challenging because the Port would have to abandon all levee(s) south of a breach.
3) The DWSC is a USACE navigation levee so permitting will be difficult.
4) Miner Slough access to the Stringer property must be maintained. This will be especially challenging if a north Miner Slough breach option is implemented.
5) Interim land and wildlife management is an ongoing concern as Prospect Island has become a magnet for poaching.
6) The food web carbon export objectives of the project are problematic for the nearby Barker Slough pumping facility where minimizing organic carbon export is an objective.
7) Prospect Island's nearly 9,000 acre feet of accommodation space will be conveyed each tide from the surrounding channels which increases current speeds and levee scour potential.
8) The Miner Slough breach approaches would experience higher current velocities that could present erosions risk to adjacent Ryer Island levees.

Next steps for the Prospect Island Restoration Project following this workshop

- Select alternatives to carry forward into the next stage of restoration planning
- Refine the design of the alternatives moved forward
- Conduct additional hydrologic modeling and alternatives refinement
- Develop the Draft Restoration Plan for the project
- Prepare the CEQA document for the project
- Obtain permits
- Finalize the Restoration Plan to incorporate all changes from CEQA and permit processes
- Construct, monitor, manage, adapt

II. Alternatives (Stuart Siegel, Wetlands and Water Resources)

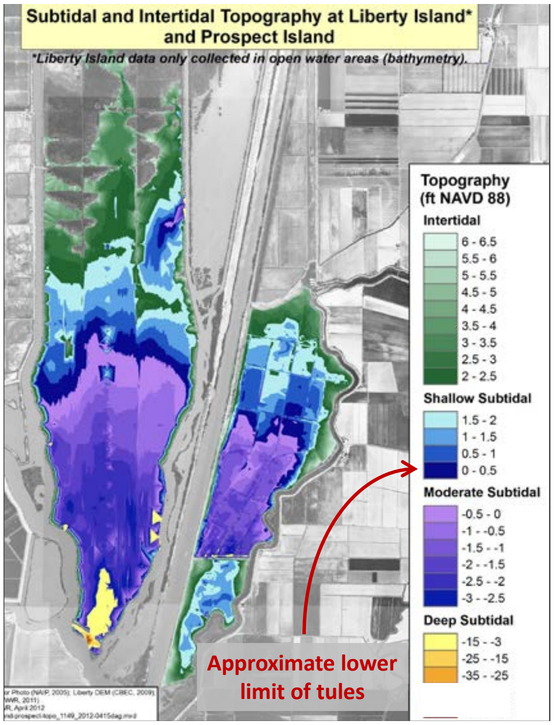
Stuart Siegel restated the project objectives as hypotheses:

- H1: Prospect Island restoration helps delta smelt through production and transport of food to the near-region pelagic food web.
- H2: Prospect Island is potential salmon rearing habitat due to its location on the Sutter/Steamboat Slough to Miner Slough migration corridor.
- H3: Prospect Island is potential delta smelt rearing habitat due to its location near the DWSC and Liberty Island.

Despite their proximity, Stuart suggested that Prospect Island is functionally not similar to Liberty Island because of differences in hydrologic inputs and very different substrate at restoration outset. Liberty was an active farm field while Prospect has “gone feral” after 12 years since farming was discontinued. There is now extensive wetland, some riparian edges, and lots of dead tree snags. Stuart further suggested three implications of these differences:

- Implication 1: sediment exchange between substrate and water column. Liberty has active sediment transport due to the lack of vegetation cover when it breached. The Yolo Bypass is a large sediment source for Liberty Island while Prospect Island may have less sediment input. Prospect will likely will be fairly ‘inactive’ due to vegetation-armored bed, especially when compared to Liberty.
- Implication 2: channel formation. Where elevations support it, Liberty may scour tidal channels into the bed while Prospect is less likely to scour due to vegetation armoring.
- Implication 3: vegetation. The existing conditions may need to be adjusted before breach including invasive plants management. Emergent vegetation colonization may need to be encouraged.

Similar to lower Liberty Island, the existing topography of Prospect Island is largely subtidal with similar north sloping elevation gradient (Figure 1). The large scour hole in the southern Liberty Island breach is an example of what can be expected at Prospect Island levee breaches. Liberty Island has extensive connectivity to surrounding tidal channels through degraded levees. It also has extensive unvegetated areas within suitable emergent vegetaton elevations.



Existing Topography

- Extensive deeper acreage at Liberty vs. Prospect
- Liberty deep scour hole at main breach, second scour hole at secondary breach; anticipate at Prospect
- Liberty has extensive perimeter connectivity through eroded levee; maintain or abandon Prospect levees?
- Liberty has extensive unvegetated areas within suitable emergent vegetation elevation: Substrate? Wind fetch? BREACH III. Promote emergent veg at Prospect

Figure 1. Regional topography of Prospect Island and Liberty Island.

The historical channel network morphology reflects Prospect Island's position in the estuary near the tidal-fluvial interface zone at the bottom of the Yolo floodplain. Today, the DWSC severs Prospect Island from its historic flood plain which removes it from most seasonal floodplain sediment dynamics. Sediment inputs to Prospect today depend on tidal dispersion of Cache Slough sediment and seasonal riverine transport from upstream via Miner Slough. Stuart summarized historical channel network morphology from the recent San Francisco Estuary Institute (SFEI) historical ecology work. SFEI's work suggests that sloughs in Prospect Island would all have subtidal invert elevations that potentially could be very deep (10-20 feet).

Alternatives selected for modeling

Thirty alternatives were initially formulated with input from the Cache Slough Complex Technical Team to represent a broad range of outcomes. Fifteen alternatives were subsequently chosen for screening level modeling and assessment based on attributes anticipated to result in a broad range of outcomes. A desired outcome from the workshop is to maximize the differences across selected alternatives to assess the greatest possible contrasts in the environmental review. There are other opportunities that may arise in the future including the possibility the Yolo Ranch project might offer dredge material that could be incorporated in the design. It was determined that the Evaluation Team should not consider those options in this workshop. Key design features for the 15 alternatives assessed in this workshop include levee breaches, overflow weirs, channel dredging--both primary and secondary; connector channels to breaches, DWR and Port property connections, and adjacent property access (Figure 2).

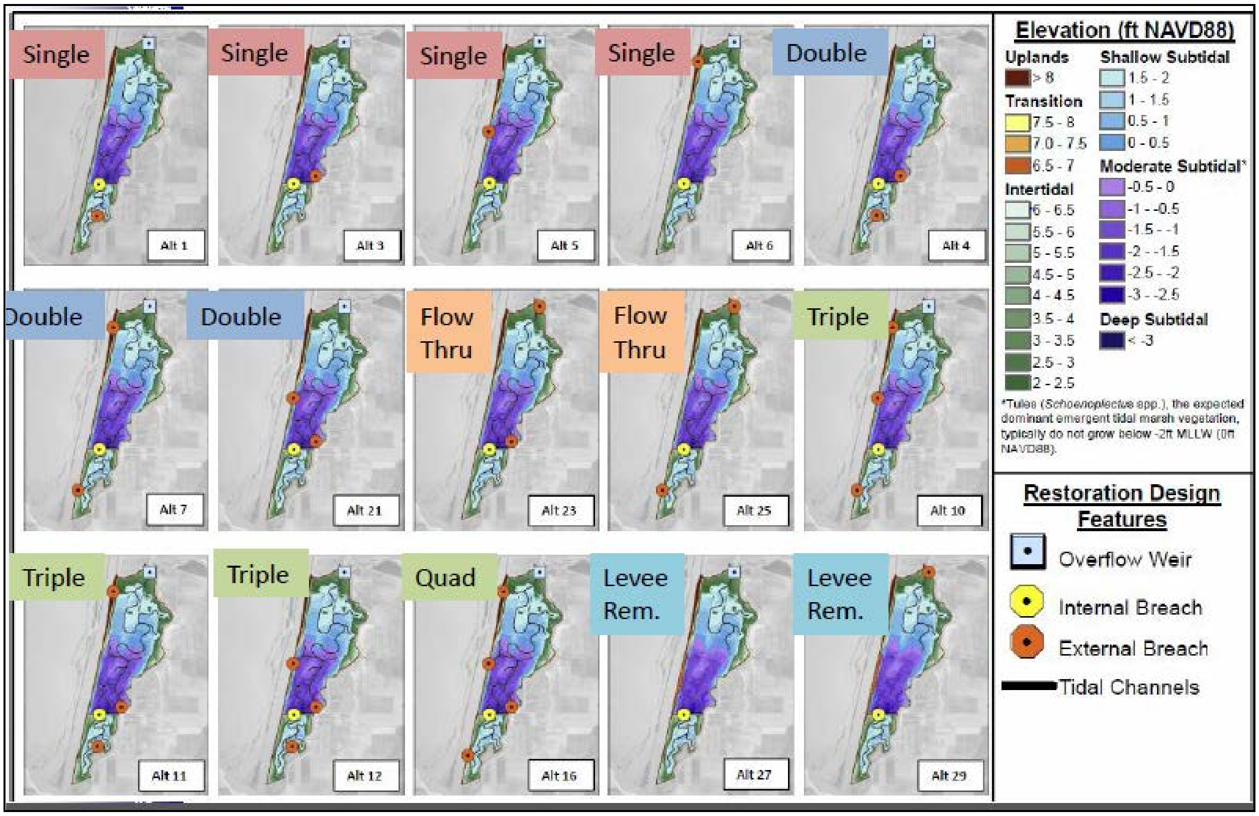


Figure 2. Fifteen restoration alternatives prepared for the DRERIP evaluation workshop.

The 15 restoration alternatives were grouped roughly by degree of connectivity. In general, greater connectively is expected to lead to shorter residence times (i.e., more tidal flows and exchange) and higher tidal exchange with surrounding tidal pelagic habitats. Open connections at the northeast corner onto Miner Slough are expected to yield high tidal exchange rates when combined with breaches at the southern end of the site. These groupings are:

1. Four single-breach alternatives including an overflow weir in each. These alternatives are assumed to induce maximum residence time and *in situ* productivity including extended residence times that can support production of toxic blue-green algae and encourage establishment of invasive plants.
2. Three two-breach alternative with overflow weir in each. These alternatives are assumed to induce relatively long residence time and *in situ* productivity but export more to the near pelagic system.
3. Two "flow-through" alternatives that have a full levee breach at the northeast Prospect Island levee on Miner Slough. These were referred to these as "pseudo reverse levee setback" options that may facilitate Sacramento River/Miner Slough salmon migration.
4. Three three-breach alternatives.
5. One four-breach alternative would generate short residence time and high pelagic channel exchange
6. Two large DWSC levee removal options may generate strong on-island gradients of residence time and pelagic exchange.

7. A “no-project’ alternative is also understood to result in progressive levee deterioration and uncertain future connectivity regime.

A note about the high-stage overflow weir at the northeast corner of Prospect Island

The evaluation included considerable discussion about operations and outcomes of the proposed high-stage overflow weir at the northeast corner of Prospect Island. The design intent of this weir is to create connectivity during winter high-flow conditions in Miner Slough to allow juvenile salmon direct access into Prospect Island as they migrate down Miner Slough. During the remainder of the year, the interior of Prospect Island at the weir location would be a terminal tidal slough setting. The hydrodynamic modeling conducted to date focused solely upon June/July conditions when the weir would be ‘disconnected.’ No modeling has yet been done for flow conditions when the weir would be connected. It appears from the nature of the discussion presented in many places in this Evaluation Report that the Evaluation Team was not clear on this matter, as there are numerous statements of ‘conclusion’ referencing modeling results that do not exist. Therefore, the Prospect Project Team suggests that the conclusions and recommendations of the Evaluation Team on this topic be granted further discussion as the project design advances and that the weir not necessarily be eliminated as an option based on this Evaluation.

Discussion

- Lars Anderson noted that the comparison between Prospect and Liberty Islands is currently true; however, once extensive *Ludwigia* and some Eurasian watermilfoil and curlyleaf pondweed populations are reduced, the Prospect Island bed may be more susceptible to scouring.
- Bruce Herbold suggested there should be a “sheet flow” alternative that would shave down levees on Miner Slough to allow salmon migration access during higher flows.
- Si Simenstad noted dredged interior channels might attract predatory fish—particularly for centrarchids – if they are too deep.
- Chris Foe indicated that floods are the primary morphological drivers. Compared to Liberty Island, Prospect Island is a bit more protected; however, whatever we get on Prospect Island will likely stay put for a while.
- Dennis McEwan said Prospect Island used to be part of the lower Yolo Bypass. Dennis remarked that we could restore connection to the bypass through the ship channel.
- Stuart Siegel showed Sherman Island as example and how there had not been a lot of change over 80 years. He also said that Sherman Island could be a food web subsidy analog although there are some important driver differences.

III. Hydrodynamic modeling results (Steve Andrews, RMA)

Steve Andrews presented modeling analysis designed to evaluate the productivity export potential for Prospect Island restoration alternatives using particle tracking methods. The modeling questions to be addressed were:

Maximize

- food web productivity within the restoration site
- tidal mixing of exported productivity

While minimizing

- dissolved organic carbon (DOC) impacts at Barker Slough Pump Plant
- flood conveyance impacts on the Yolo Bypass
- flood conveyance impacts on Miner Slough
- reduction of tidal range
- velocity cross currents in the DWSC
- scour potential to Ryer Island Miner Slough levee

The metric for assessing alternative performance is "*exposure time*" (ET) within a specific optimal time range. ET is the total time that the simulated particles "released" in Prospect Island reside there—a shallow and not nutrient or light limited autotrophic habitat. ET is thus a surrogate for the many factors that control phytoplankton production, and one that does not capture all those other controlling factors. Particles that leave Prospect Island and re-enter accumulate additional exposure time. 1-3 day ET is assumed to support diatom production while not being enough time for cyanobacteria production. The DRERIP floodplain conceptual model that links directly to temperature and dissolved oxygen and indirectly to water clarity was briefly reviewed. These three attributes in turn are drivers for phytoplankton and zooplankton production. For macro-invertebrate production, temperature, nutrients, and water quality are drivers regardless of ET.

Modeling approach

RMA II modeling simulations were conducted using June-July 2010 hydrology. Approximately 160,000 surrogate, "model" particles were released every two hours during a simulated 2-week spring-neap tidal cycle. The fate of each particle was tracked for seven days. The RMA II model grid has boundaries at Carquinez Strait, Sacramento River at Feather River confluence, and San Joaquin River at Vernalis. The grid mesh uses recent DWR survey bathymetry of Prospect Island and adds the designed dredged channels, levee breaches, and levee removal scenarios as called for by each alternative (Figure 3).

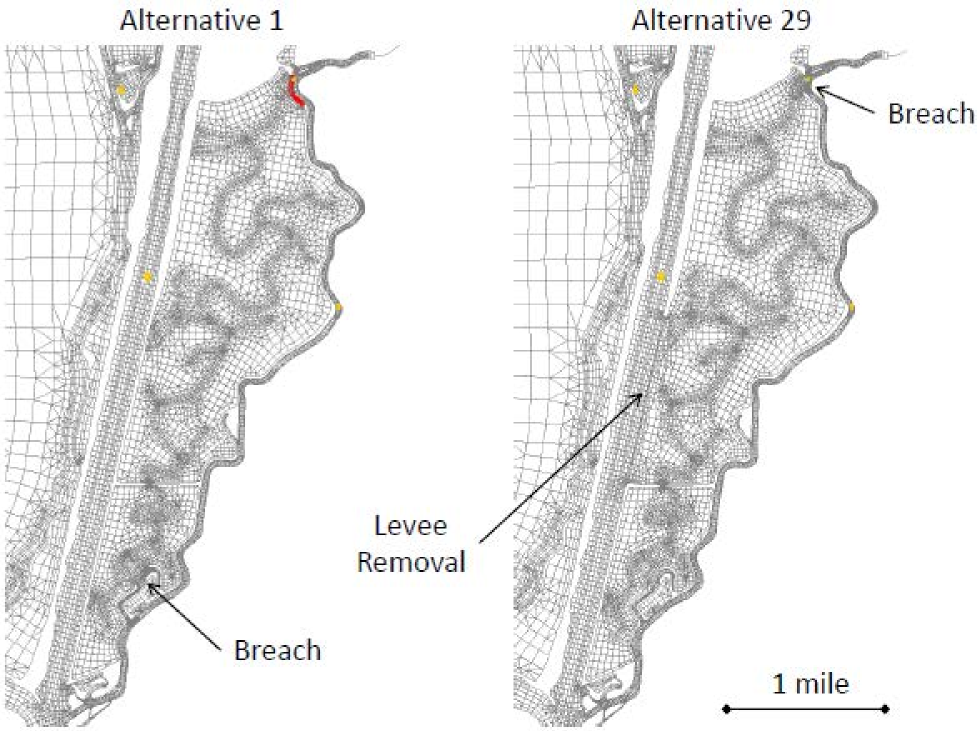


Figure 3. Example numerical grids in the RMA II model.

Simulated particle fate tracking was displayed several ways in tabular and graphical outputs. Exposure time for each of the 15 alternatives was displayed as histograms, tables of "time class", and contour maps. Each graphical approach depicts three exposure time bins: less than one day, 1-3 days, and greater than 3 days (Figure 4). All of these results referred to the median exposure time of particles released from several hundred release points within Prospect Island. In reality, particles released from the same position on Prospect Island every two hours over two weeks would have a distribution of exposure times and the median exposure time for any location is not unique. An additional graphical output illustrates contours of the percent of particles released from a given location that actually have 1-3 day exposure time (Figure 5). Finally, the Delta regional fate of particles after seven days was represented in a table and as bar charts of the three exposure time bins (Table 1).

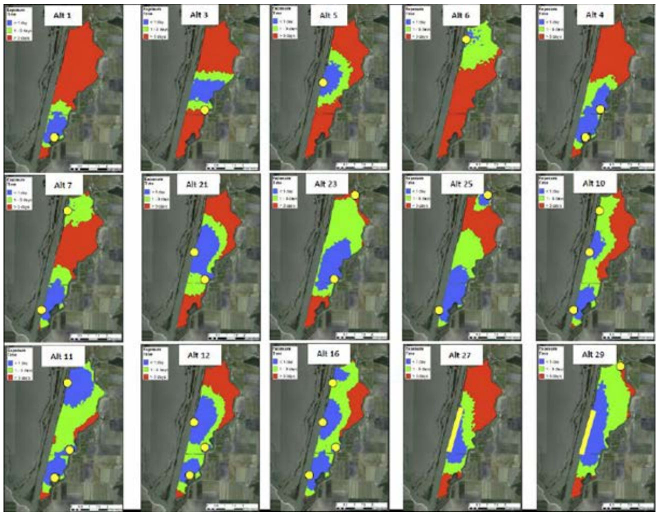


Figure 4. Simulated particle exposure time. Blue is <1 day, green is 1-3 days, red is > 3 days.

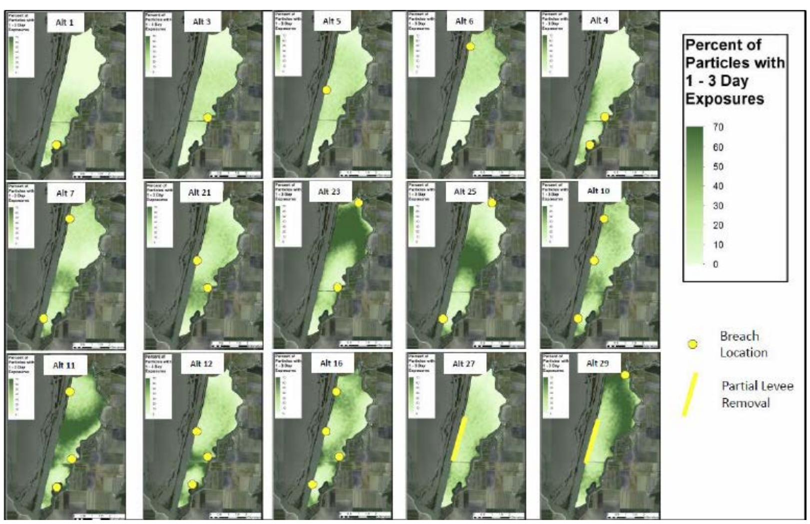


Figure 5. Percent of simulated particles with 1-3 day exposure time.

		Percentage of Total Particles with 1-3 Day Prospect Island Residence Times in Region after 1 Week						
	Alt No.	Sacramento	Prospect Island	Cache	DWSC	San Joaquin	Suisun	Miner
Single Breach	1	4.54	0.45	2.45	0.99	0.81	0.15	0.13
	3	6.68	0.72	3.79	1.35	1.17	0.24	0.40
	5	7.46	3.35	4.02	4.33	0.96	0.16	0.04
	6	4.61	4.02	3.09	8.69	0.31	0.04	0.01
Two Breaches	4	8.13	0.54	4.15	1.44	1.57	0.34	0.36
	7	9.18	4.19	4.77	6.30	1.51	0.31	0.03
	21	10.86	0.98	5.29	4.54	1.50	0.30	0.33
Flow-through Two Breaches	23	23.65	0.53	11.88	4.19	4.34	0.95	0.86
	25	16.17	0.39	7.54	4.30	2.89	0.67	0.26
Three and Four Breaches	10	13.94	3.49	6.62	4.55	2.52	0.58	0.06
	11	16.50	1.61	8.82	13.40	1.95	0.37	0.65
	12	12.05	0.96	5.55	4.19	1.99	0.42	0.38
	16	14.69	1.54	6.48	6.00	2.36	0.53	0.34
Levee Removal	27	10.07	2.28	4.44	1.99	1.95	0.44	0.05
	29	23.46	0.98	9.39	2.94	5.29	1.26	0.25
5-10%								
10-20%								
>20%								

Table 1. Fate of simulated particles that spent 1-3 days in Prospect Island after 7 days. Numbers are percentages of the total number of particles released.

Some processes not considered in RMA modeling include:

- Emergent and submersed vegetation roughness and distribution and its effect on light limitations on aquatic phytoplankton productivity and its generation of alternatives forms of aquatic food web productivity
- Adding dirt including channel excavation materials
- Wind energy
- Autotrophic vs heterotrophic food web connectivity

__Discussion__

A number of uncertainties remain about the hydrodynamics of the region, which prompted an extensive discussion of particle tracking connectivity with Liberty Island. At what rate does Liberty Island connect to Prospect Island? This question bears on the relationship between heterotrophic and autotrophic habitat exchange and subsidy. Particle tracking outputs (both written and demonstrated during the meeting) give the impression that there is strong tidal connectivity. However, the regional fate of particles after seven days (presented in table form) shows that of the total 1-3 day exposure time particles, only 2-12% end up in the Cache Slough area after 7 days. Several Evaluation Team members suggested that this result should be analyzed in more detail.

- It was noted that single breach cases all have more than 50% of particles experiencing greater than 3-day exposure time which could encourage blue-green algae blooms and limit potential diatom export.
- It was noted that the “reverse levee setback” flow through scenarios (alternatives 23 and 25) tend to have large 1-3 day exposure time extent and may be helpful for migrating salmon.
- Stuart Siegel noted that the modeling did not assess conditions when the weir at north end was connected to Miner Slough. The modeling did show that residence time is greater than three days at the north end of the property for many alternatives during the summer conditions when in effect there is no breach at the northeast corner of Prospect Island.

- Anke Mueller-Solger pointed out that the modeling period is June-July—a period when the weir would not overflow. Residence time would likely reduce during high flow periods.
- John Durand questioned the emphasis on 1-3 day diatom doubling saying that production should be thought of as a more complex overlap between zooplankton—doubling about every 2-weeks—with phytoplankton (diatoms) that double in 1-3 days. The goal should be to promote trophic linkages that may have different time scales.
- Lars Anderson also noted that longer residence times (i.e. >3 to 5 days) would facilitate establishment of aquatic plants in general, including invasive plants that may be transported to Prospect Island from upstream or adjacent populations.
- It was noted that there are several uncertainties not captured by the otherwise excellent modeling. Future vegetation composition and distribution will affect residence time; wind drift will bias floating material to the eastern end of the property; grazing by clams may be large—or not.

IV. DRERIP mercury conceptual model

The DRERIP mercury (Hg) conceptual model box-and-arrow diagram was presented (Alpers et al. 2008). It was noted that there is also a Supplement by Windham-Myers and Ackerman 2012 (which does not apply to tidal marshes). Also, there are papers in preparation by 1) Wes Heim and Mark Stephenson and 2) Stuart Siegel and his staff on mercury data collected at the Blacklock property in Suisun Marsh and another by Siegel et al. for data collected on duck clubs in Suisun Marsh.

The group discussed that Prospect Island would have some low-to-medium intertidal elevation and would otherwise have mostly aquatic perennial open water with submerged aquatic vegetation. Therefore, there is low potential in sediment and water for most of the property to methylate mercury. The intertidal areas will likely have low to medium potential to produce methylmercury (MeHg) based on the DRERIP model (Table 2 below) and other recent information. MeHg data in Prospect Island soil is not available so the actual potential is not known - although there is a strong suspicion that Hg is in the soil based on regional surveys by Darell Slotton at UCD. Tidal inundation doesn't allow the redox conditions needed for methylation so production of MeHg is not likely a big concern. It could be that construction-related disturbance would produce short term effects. To summarize, recent research has identified factors that produce hotspots like seasonal drying and flooding and presence of broad leaf vegetation. Permanent flooding situations such as what Prospect will have are more complex. The proposed restoration actions on Prospect Island should not result in a large increase in biotic MeHg compared to other restoration actions like seasonal wetlands. Nonetheless, the Central Valley Regional Water Quality Control Board has adopted a Phase I MeHg control plan for the Delta. This includes Prospect Island. It calls for studies to determine best management practices to mitigate to the maximum extent possible for MeHg production. A 401 permit will likely be required for the future restoration action and current 401 permits call for control studies. Both DFG and DWR are participating in the Phase 1 studies.

Discussion

- Chris Foe said that current understanding suggests we would not expect to see a significant increase in fish tissue concentrations in response to actions at Prospect Island. Prospect Island will likely to generate some MeHg but how much of that is transported off-site cannot be well quantified at this point.
- Stuart Siegel said that the work of Wes Heim and Mark Stephenson on the Blacklock restoration project shows that the restoration actions at that site have not caused an increase in MeHg concentrations as compared to surrounding areas.

Based on the relevant portion of Table 2 (below) from Alpers et al. 2008, Prospect Island MeHg concentrations in sediment and overlying water is anticipated to be low to moderate.

Table 2. Relations between habitats and methylmercury concentrations in sediment and overlying water in the San Francisco Bay-Delta region

[L, low; M, moderate; H, high; NA, not applicable]

Habitat	MeHg Overlying water	MeHg Sediment	Flooding Characteristics: Flooding mode	Months typically flooded (wet year)	Conditions during episodic flooding Cool / Warm / Hot (wet year)	References
Aquatic vegetation: Submerged	L – H	M	Perennial	All	All	1
Aquatic vegetation: Emergent	L – H	M	Perennial	All	All	1, 9
Aquatic vegetation: Floating	M ?	M ?	Perennial	All	All	
Aquatic perennial (open water)	L	L	Perennial	All	All	1,2
Tidal marsh: High Elevation	M?	H	Episodic (2x/month)	All	All	2,3,4,5
Tidal marsh: Low-Medium Elevation	L – M	L – M	Episodic (2x/day)	All	All	4,5
Riparian (woody)	L – M?	L – M?	Episodic (seasonal)	Jan-Mar (Dec-May)	Cool (to Warm)	

Table 2. Portion of Table 2 (p.16) from Alpers et al. 2008.

V. DRERIP aquatic vegetation conceptual model and aquatic vegetation surveys (Lars Anderson)

Lars Anderson reported on a ground and aerial plant survey of Prospect Island and the nearby surrounding areas that he recently conducted. He presented several aerial photographs with GIS polygons to characterize the extent of major plant communities. Lars created an index grid on aerial images and then did kayak surveys taking "hundreds" of samples. He also conducted boat surveys in the channels around the island. A summary of the survey is in Appendix 2. In his presentation to the Evaluation Team, Lars urged caution when distinguishing among floating, emergent, and submersed plants because they interact with physical and chemical factors differently. Floating plants tend to reduce dissolved oxygen in the water column below. Emergent plants oxygenate soil. Transport and colonization to and from Prospect Island will be fastest with floating plants. Submersed plants can often withstand high current velocity.

SAV conceptual model: Lars showed the DRERIP box-and-arrow conceptual model diagrams on the screen. For the SAV conceptual model, Lars focused on the sub-model depicting establishment, growth and dispersal. Temperature and light are the main SAV production drivers. Due to seasonal inflows and generally fertile sediments, there is no nutrient limitation at all. Depth, turbidity, and linkages to wind fetch affect light. All plants seen in Prospect Island are found elsewhere in the Delta. The model also shows the role of substrate (soft soils facilitate rooting, hard substrate does not) and velocity (low velocities do not impinge establishment, at some point high velocities can but the values not readily known and are species dependent).

FAV conceptual model: FAV is adept at sloughing material and adding to the organic sedimentation load and affecting substrate organic composition. FAV is also good at extracting heavy metals. The most abundant FAV is water hyacinth, which is salinity intolerant. Light and temperature affect production.

Aquatic emergent conceptual model: Nutrients are a critical factor for emergent aquatic plants. Sloughing during senescence can be a substantial contributor to organic sedimentation and substrate organic composition. Emergents in Prospect Island are mostly native though there are patches of A*rundo donax* and exensive populations of the non-native *Ludwigia* spp. (“Water Primrose” or “Primrose Willows” species complexes. Emergents aerate soil and increase redox potential though it varies seasonally. MeHg production is related to oxygen-poor soil conditions so emergent senescence in fall-winter is related to MeHg production though many other factors contribute. *Arundo donax* and *Ludwigia* are aggressive and should be controlled at Prospect Island.

Lars made several other points:

- We can expect interactions. If we take out floating SAV, it’s possible that *Egeria* would take its place. The interactions between nutrients, light, wind, and turbidity will change with any restoration design or control measures.
- The dominant non-native emergent plant is *Ludwigia* spp. (water primrose/ primrose willows species) covering more than 100 acres. Due to its phenotypic plasticity, it can occupy deep water (via buoyant rhizomes) as well as damp, partially (periodically) inundated shorelines. As is the rest of the Delta, it is spreading fast. Eurasian water milfoil (*Myriophyllum spicatum*) is also abundant in patches and covering 50-60 acres total. It produces seeds and is also dispersed and spread via fragments. Eurasian watermilfoil is also present in the channels outside of the island, primarily in backwater areas.
- *Ceratophyllum demersum* (“coontail”) is a native that has a patchy peripheral distribution of 15-20 acres both inside and outside of Prospect Island. This plant reproduces by seeds and fragments. Because it lacks true roots, it depends on nutrients in the water column.

- *Egeria densa* ("Brazilian waterweed", "Brazilian elodea") was not observed inside Prospect Island, but there are some small patches adjacent to Prospect Island (e.g. Miner Slough and DWSC). *Egeria* is transported as fragments. Seeds are not produced because only the male plant is present in N. America. *Egeria* outcompetes all other submersed plants, so the potential for introduction and establishment in "breached" Prospect Island is very high.
- There are fragments from sparse populations of native *Elodea canadensis* (1-2 acres), two species of native *Potamogeton* in sparse patches (*P*. *foliosa* and *P*. *nodosus*) and one non-native *Potamogeton* (*P. crispis, "curlyleaf pondweed"*)
- Two other species that should be considered for control because they can become dominant are A*rundo donax* (about 1 patchy acre so far) and S*esbania punicia* (now in the DWSC rip rap).
- Lars showed aerial photographs that document a big expansion of *Ludwigia* between August 9 vs September 27 on Stringer property.

<u>Discussion</u>

- Lars Anderson emphasized that we must manage *Ludwigia.* He believes it will likely expand when Prospect Island is breached, if left uncontrolled. He believes it should be managed before breaching so we have fewer ESA problems with use of aquatic herbicides as it will be easier to get permits before breaching.
- Lars Anderson suggested the best strategy might be to pre-treat invasives, see what the recruitment of natives is, and then adaptively manage the influx of new invasives. His belief is that most of the plants of concern would reestablish from the seed bank.
- Dave Zezulak said that Miner Slough has greater abundance of SAV and FAV propagules. Breaching on that side of Prospect Island would more likely allow introduction of plants into the site.
- Lars Anderson also shared that he thinks Miner Slough breaches will bring in non-natives more readily than breaches on the DWSC side.
- Si Simenstad said that Liberty Island has a history of agriculture which consolidated the surface and may inhibit colonization by rooted wetland plants.
- Several Evaluation Team members speculated about why *Egeria* is not in Prospect Island yet. One idea is that there is no boating in and out—which would change if there are levee breaches.
- Bruce Herbold, referring to the floating vegetation conceptual model, suggested that floating vegetation can only by affected by the current velocity "knob." Lars responded that if the design creates few quiescent areas then we might not require spray treatments later—which would also be easier from a regulatory standpoint. More dynamic flows tend to select for natives.
- John Durand hypothesized that even non-natives make useful structure for some aquatic invertebrates. At high SAV densities, however, such habitat may be productive but not accessible to native fishes.
- Bruce Herbold speculated that the velocities we will create will not exclude *Egeria*. (*note: internal velocities have not yet been modeled so this statement is speculative)*

- Dennis McEwan said that whatever levee we don't take out will erode unless it is maintained. Some breaches will make maintenance of adjacent levee reaches far more difficult and costly—an adaptive management challenge.

Stuart Siegel asked Lars what he concluded from the exposure time modeling maps. He asked if there are steps that can be taken to minimize occurrence/prevalence of invasive aquatic vegetation in the deeper, open water portions of Prospect Island. Lars Anderson's response:

- Miner Slough is a larger propagule source. He said that for non-native plant species control we want wind, current velocity, and turbidity. He suggested removing the DWSC levee down to mean sea level.
- One-breach alternatives have long residence time and great potential for encouraging growth of all plants.
- The velocities anticipated within Prospect Island won't be of sufficient magnitude to control SAV (*note: no internal velocities have been modeled yet so this statement is speculative*).
- Removal of DWSC levee will increase wind fetch in sections of Prospect Island. Wind could push FAV to the east side, potentially presenting some more effective control options. Increased wind fetch may also limit the ability of SAV/FAV to expand/proliferate.
- Turbidity is not likely to have much of an effect.
- Active SAV/FAV management will be required.
- The doubling time of water hyacinth in summer is 3-5 days so the exposure time classes (<1 day, 1-3 days, >3 days) used for the modeling exercise is also a reasonable first cut for thinking about risk of SAV and FAV establishment. SAV can reside in deep water 8-10 feet.

<u>Consideration of Alternatives following aquatic plants conceptual model evaluation</u>

At this point the group considered all of the alternatives and commented on which ones are best for competitive advantage of native plants compared to non-native plants. Potential for diatom productivity was also considered. Alternatives 11, 23, and 29 were generally endorsed. Most agree that control of water hyacinth and *Ludwigia* will be required. The design should avoid creating areas of dead water.

VI. DRERIP delta food web conceptual model (John Durand, UC Davis)

John Durand prepared the DRERIP Pelagic Food Web conceptual model (Durand 2008). Food production and regional pelagic ecosystem subsidy are the key ideas that John addressed. The restoration design's effect on turbidity, residence times, flow velocity, and depth are the key design "knobs" to turn when considering food web. Referring to the conceptual model diagram, Delta Food Web Overview-Critical Drivers and Linkages, John pointed out several controls on phytoplankton production. He noted that primary production is controlled by nutrient species, turbidity, stratification, residence time, and clam abundance. Ammonium may have a limiting effect on phytoplankton; nitrate tends to promote phytoplankton but the Prospect Island design will have no control over the nitrogen source (NH^4 vs.

NO^3). Second, turbidity and stratification control the exposure of phytoplankton to light from the surface, within turn controls growth rate. Third, residence time effects the local production versus exported production. Finally, grazing invasive clams (*Corbicula*) directly control phytoplankton biomass through predation. Phytoplankton blooms have occurred only rarely in the Estuary since 2000. For a bloom to occur, stratification and high residence times are essential, allowing ammonium to be drawn down to below 4 ug/L, phytoplankton to be retained in the photic zone, and production to be localized but maintained in surface layers free from predation by the benthic dwelling clams.

Fishes of interest may have relied historically upon a phytoplankton-based food web, of which diatoms were a major part. This simple energetically efficient trophic link has been altered since the 1980's by changing physical conditions and species invasions. Blooms presumably provided sufficient temporal and spatial overlap to provide each trophic level, including fish, access to food. The proposed 1-3 day exposure time metric is good for phytoplankton production, but neglects other trophic levels which would probably require higher residence times. Moreover, Prospect Island export of phytoplankton to the regional pelagic food web would be insignificant after dilution into the larger estuary.

Discussion

- Si Simenstad added that smelt food also comes from detritivores (amphipods, insects, crustaceans). The detritus-based food web is continuous—it doesn't rely on episodic, seasonal phytoplankton blooms. Most of the organic carbon from rivers is refractory and not an efficient food source, but wetland organic matter is a detritus source that works because it's not so refractory (more labile). Benthic diatoms may be important as a primary production source as well. Si suggested that we shouldn't argue about the pathway. Instead, create wetlands that magnify all of them.
- Bruce Herbold said that while wetland organic carbon is not good food, there is lots of it and micro-zooplankton can use it.
- John Durand said that when fish are recruiting, they need food (zooplankton) now—that is, they can't wait for blooms to fuel zooplankton production.
- Si Simenstad said that delta smelt show up in February-March when phytoplankton and zooplankton are not in high abundance. So the pelagic pathway is likely not supporting them so much during this time.
- Ted Sommer said that we have underestimated the organic carbon food web. Side channels produce the organic carbon –rotifer, bacteria, and flagellate pathway.
- Chris Foe said that the phytoplankton seed population is more available from the DWSC (3-8ug/L) versus 1-3 ug/L from Miner Slough. Algae double exponentially, so slightly higher initial seed concentration will result in much higher final values. This is important if the goal of the project is to make pelagic algae.
- Bruce Herbold said the bang-for-buck is the *in situ* production.
- Si Simenstad said that we need to balance criteria—balance flushing or exposure time with the time required to process detritus. This can be achieved by creating spatial gradients of residence time. If possible, create blind channels.

- John Durand said that aside from other considerations, a long blind channel might be best.
- Stuart Siegel said Prospect Island offers the option of creating two systems—a shallow, long residence time part, and a deep short residence time part.

VII. DRERIP tidal marsh conceptual model (Si Simenstad, University of Washington)

Si Simenstad presented an overview of the tidal marsh conceptual model he authored with Ron Kneib and Matt Nobriga (2008). It's a landscape model of existing, "mature" freshwater tidal marsh—the key interface is the aquatic-emergent wetland ecotone. The marsh surface is productive primarily because of *in situ* production and decomposition. Production and consumption within Prospect Island account for processes controlling trophic energy transfer across the emergent wetland-aquatic interface. Nekton concentrate their feeding behavior at the marsh edge such as along channel banks and the marsh edges with open water. Therefore, an important metric is channel complexity that produces large amount of edge habitats (sinuosity, channel density, etc…). Channel complexity drives the effectiveness of trophic transfer to nekton. It is therefore desirable to maximize both the pelagic food web and the organic matter food web. Fish depend on the pelagic food web now since there is limited emergent wetland pathway today. Si suggests updating the conceptual model to include more on marsh evolution.

Discussion

- Ted Sommer suggested that we be careful not to base everything on food web production metrics. For example, Liberty Island is "the other turbidity maximum" as well as providing a temperature refuge.
- Stuart Siegel said that maximizing channel density, connection between marsh plain and channels, and edge were major attributes of the Prospect design alternatives.

VIII. Salmon conceptual model (Ted Sommer, DWR)

Ted Sommer presented several design considerations that would benefit adult and juvenile salmonids based on the salmon conceptual model by John Williams (2008).

On juvenile salmon physical habitat:

- Connectivity from both Miner Slough and the DWSC would aid contingents using both migration pathways.
- Assure there is a low tide migration corridor.
- Design for current pathways through the property for both migration and trophic transfers.
- Create conditions that encourage turbidity to reduce predation.
- Design for off-corridor areas of reduced velocity for resting.

- Create conditions that moderate water temperature for bioenergetics and reduced predation.
- High dissolved oxygen.
- Design for depth diversity for feeding, resting, and predation refuge and encourage phenotypic life history diversity.

On vegetation:

- We want low SAV and FAV to discourage predator habitat.
- Emergent marsh edge should be encouraged as a source of food and refuge.
- Riparian edges are needed for food and temperature refuge.

On adult salmon

Adult salmon need channels with current through the site to allow movement across site and upstream connectivity so as not to get trapped (as happens in Yolo Bypass at Fremont Weir). This speaks against using a high stage overflow weir for connectivity to Miner Slough at the north end of Prospect Island (*note: the weir creates connectivity only during high flows; outside such periods, the site would not have attraction flows to the weir but instead to other breaches along Miner Slough and thus trapping would not be expected to be a concern as the marsh would 'look' like any other tidal marsh with terminal channels)*. Replacing the weir with a breach would allow for improved connectivity. Project represents an opportunity to enhance migration corridor for adults. Ted listed four keys for adult salmon:

- Physical habitat should include channel migration corridors
- Currents should cue movement through the migration corridor
- Lower temperatures aid egg survival
- High dissolved oxygen

Discussion

- Si Simenstad cited recent research in Washington that shows salmon behavior response to temperature. Salmon vacate marshes at about 20 degrees. Also, woody wetlands make cool water. Further, wind over shallow water can reduce temperature 2 degrees C. Also, access to diverse physical features is good. Chinook fry at 50mm will access lower order tidal channel as soon as they are more than one-half meter deep. The mouths of dendritic channels are where dipteran insect wash-off can be delivered.
- Chris Enright said there is little space for tidal channel structure and the potential for elevation building is uncertain.
- Si Simenstad said that if the project has an opportunity to receive material (perhaps dredge material from the Yolo Ranch restoration), then it should be concentrated in high-relief patches so some structure can establish.
- Si Simenstad cautioned against relying too much on current data for characterization of future responses because it is based on a physical system largely devoid of natural physical structure. New marshes in the Columbia River estuary offered new opportunities and salmon used it.

Bruce Herbold asked Ted Sommer and the group to look at the RMA modeling results for channel velocity at the flow split where fish can enter Prospect Island on Miner Slough; concern is that high velocities in the wrong part of the channel may make it difficult for juvenile salmon to access the site. Several alternatives propose a weir at the north end of Prospect Island from Miner Slough. The idea for the weir was to allow juvenile salmon access in winter during higher outflow events and otherwise have no connectivity at that point, thus making this part of Prospect Island a terminal tidal slough with higher *in situ* residence times. However, modeling shows perhaps too much residence time by the 1-3 day diatom exposure time metric for some alternatives. In other alternatives, the model shows that an open breach is better for residence time. There is concern, based on modeling, that current velocity produced by tidal filling and draining the site from Miner Slough will cause levee scour on the adjacent Ryer Island. Some group members suggested that a notch in the weir may help to control velocities in the channel. Stuart Siegel suggested that we may want to keep a no-notch weir and a complete north-end levee breach option to assure contrast among the five final alternatives.

Commenting directly on which of the 15 alternatives might benefit salmon, Ted Sommer said that connectivity is key. Alternatives 23 and 29 maximize flow and access. Alternative 16 is also good, but we should add a new alternative that adds a breach in the south end of the property from Miner Slough in alternative 29.

Discussion

- Si Simenstad suggested adding breaches to reduce water level differences and through-breach velocities between the project and Miner Slough. Also, the weir is an adaptive management opportunity to see how salmon respond.
- Chris Enright said that the modeled high flows in Miner are probably accurate, but the channel bed would probably scour and toward a deeper equilibrium state rather quickly. Levee scour could be mitigated with rock. Miner Slough levees on Prospect Island are not USACE standard and could get undermined; Miner Slough levees on Ryer Island are USACE flood protection standard levees.
- Chris Enright suggested that Prospect Island is subsided overall but the Port property is less so. The cross levee could be used to separate treatments that investigate the effect of depth on productivity and other issues.

IX. Delta smelt conceptual model (Bruce Herbold, USEPA)

Bruce Herbold recognized the DRERIP delta smelt conceptual model by Nobriga and Herbold (2009), but noted that this model may not be particularly relevant to Prospect Island, as it is focused primarily on issues associated with the low salinity zone and not freshwater environments. Bruce suggested the conversation should have less of a DRERIP conceptual model focus and instead be more of an informational discussion focused on recent findings from Cache Slough Complex as well as a recent white paper by Ted Sommer. Discussion recognized that delta smelt survive in freshwater and feeding is more complex than previously thought (namely, delta smelt use the physical and biotic environment in more diverse ways) and that Prospect Island could be good fresh water habitat for a portion of the population.

Lessons learned from Liberty Island that may have applicability to Prospect Island were highlighted and include:

- Delta smelt occur year around in Liberty Island.
- Delta smelt are caught more often in open water of Liberty Island.
- The tidal current and wind forcing on Liberty Island mobilize food sources and provide turbidity cover.
- Delta smelt in Liberty Island are planktonic feeders not generally associated with vegetation but feeding may be more versatile than previously thought.
- Connection to the DWSC and its accidentally beneficial morphology is a positive synergy for delta smelt.
- Increased wind-fetch stirs-up benthic organisms and other potential food items.

Synthesis of Delta smelt evaluation

- Delta smelt is a plankton feeder that is not generally found in vegetation. Recent studies show that feeding is more versatile than once thought.
- Design features that increase wind fetch and currents that that stir-up benthic organisms and other potential food items would benefit delta smelt. Due to its orientation on the west side, grading down or removing part of the DWSC levee would increase wind fetch and turbulent mixing of sediment and food. (*Note: Prospect substrate is fundamentally different than Liberty Island [mostly vegetated] and thus may not exhibit the same sediment resuspension processes seen at Liberty and thus this concept may not be applicable at Prospect)*.
- Like Liberty Island, increased connection to the DWSC and its accidentally beneficial morphology would be beneficial to delta smelt.

X. Predation

Predation is identified as a driver in several conceptual models, but a model focused specifically on predation has not yet been developed using the DRERIP conceptual model process.

There are two primary concerns:

- Mobile predators like striped bass utilize feeding locations set up by hydrodynamic/physical features. These are often referred to as predator “hot spots.” High velocity gradients (large changes between high and low velocity flows) associated with abrupt changes in structural features such as at breaches make fish less able to avoid predators. Striped bass and other predators learn to use shear currents for predation. (*Note: Prospect design utilizing large breaches to avoid these high velocity gradients.)*

- Lay-and-wait predators such as centrarchids make use of dense vegetation structure often associated with non-native SAV and FAV.

Discussion

- Dave Zezulak said that striped bass will patrol a large area while centrarchids will reside in Prospect Island and lie in wait for small fish. He also said that birds could be a large source of predation.
- Ted Sommer thought that birds won't drive down fish populations.
- Si Simenstad said he had never seen concentrated bird feeding. On the other hand, striped bass are at the breaches in Liberty Island "with their mouths open."
- Bruce Herbold asked what design knobs make predation harder. He suggested that breach openings and habitat structure are the two design knobs available. Velocity gradients could be too excessive with many of the alternative which could create predation hot spots. (*Note: Prospect design utilizing large breaches to avoid these high velocity gradients and their functionality is being validated through modeling.)* The levee removal alternatives remove this concern. Also, conditions that keep SAV and FAV out would help to keep turbidity high. The dead tree snags are possibly a refuge for centrarchid predation.
- Ted Sommer commented that large woody debris is good native species habitat structure in the Pacific Northwest but not in the Delta.
- Stuart Siegel said the woody debris on Prospect Island is all even-aged because it resulted from land use history and, if believed to be a predator support feature, should be cleaned up. This is another mark against the no-project alternative similar to invasive plants. Both of these issues will make the CEQA no-action evaluation more clear.
- There were many concurring comments that Alternative 29 is most useful for predation control because it reduces the velocities at levee breaches. High velocity gradients are predator habitat. (*Note: Prospect design utilizing large breaches to avoid these high velocity gradients and their functionality is being validated through modeling.)*

Synthesis of predation evaluation

- As the size of the breaches increase, the hydrodynamic structure available for use by predators decreases. Stuart Siegel reported that this concept has been incorporated into the design of the breaches and thus this concern is intended, through engineering design, to be avoided.
- Managing SAV/FAV, high turbidity, and removing woody debris identified as means by which to reduce predation potential in the subtidal portion of the site.
- Restoration design needs to minimize man-made structures. These are predation hot spots.
- Alternative 29 decreases hydrodynamic structure that may discourage predators.
- Two primary concerns: (1) highly mobile predators (e.g., striped bass) utilizing feeding locations set up by hydrodynamic/physical features (i.e., predator hot spots), and (2) lie and wait predators (e.g., Centrarchids) making use of vegetative structure (SAV/FAV).

- High velocity gradients at intakes make fish less able to avoid predators, striped bass, and other predators seek these out - another reason not to have a weir (*note: no modeling has been done yet to assess velocity gradients on the interior side of a high-stage overflow weir to determine whether this concern is validated or not)*.
- Need to clear out vegetation or increase the amount of vegetation to allow refuges
- Predation by birds also was discussed. In general, studies have not shown a high density of birds feeding of the fish. Birds have been seen at fish release locations.

XI. "Other native species" objective

Several points were made:

- Designs that enhance upstream migration and food production for salmon are also likely to benefit green sturgeon, white sturgeon, steelhead, tule perch, and hitch.
- Designs that create shallow open water for delta smelt may benefit waterfowl, primarily diving ducks.
- Designs that encourage *in situ* turbidity may contribute to the turbidity pool for the region and benefit delta smelt. (*Note: vegetation cover more likely to limit sediment resuspension and the emergent vegetation intended to be a sediment sink, so Prospect less likely to be a regional turbidity source area.)*
- Tidal marsh emergent vegetation could benefit black rail if there is sufficient upper edge marsh, including willow fern community.
- Restoration actions may create spawning and rearing habitat for splittail.
- Riparian marsh with large woody debris and open water areas may support western pond turtle.
- Riparian communities may support neotropical migrants, Swainson's hawk, song sparrow, etc…
- For Swainson's hawk, maximize riparian trees. Riparian songbirds would also benefit from riparian vegetation along levees.
- Increasing sturgeon will reduce *Corbicula*.
- Native plants will benefit from active management like *Mason's lilaeopsis* (*Lilaeopsis mansonii*) which is in the nearby DWSC.

XII. Key uncertainties

Bruce Herbold asked what uncertainties can be investigated with adaptive management experiments. The group constructed the following table relating to management changes or "knobs" and hypothesized outcomes and conflicts with other objectives (Table 3).

Risk Factor	Uncertainty	Driver or "knob" (Management Tool)	Outcome	Conflict with Other Goal(s)
SAV/FAV	Can we do selective management to encourage native plants and communities?	Wind Fetch	Turbidity	Reduces primary production
		Channels/ breach configuration	Velocity and sheared current structure	Dendritic channels good for juvenile salmon, but may support SAV and predator habitat
		Active management/ plantings	Species composition	Use of registered herbicides may be viewed by the Services (NOAA; FWS) as a threat to TEA's, even though management of invasive plants is desirable and necessary for restoration
		Depth	Variable light environments (photic zone)	May encourage clams
Clams	Can we do selective management to minimize clams to achieve food export and food onsite?	Residence time	Standing crop biomass	May reduce food subsidy and feed in situ clams
		Substrate management	Sediment (more fines)	More fine sediment may encourage SAV
		Channel structure – flow through	Sediment and flow rate	

Table 3. Summary of exercise evaluating key uncertainties/risks and potential management tools.

<u>Discussion about uncertainties</u>

- Anke Mueller-Solger suggested that the Port of Sacramento parcel might be used for experimental purposes while the DWR parcel would be the main restoration site that would be performance monitored.
- Stuart Siegel pointed out that Prospect Island was isolated from Yolo Bypass following construction of the DWSC. Therefore, the restoration design alternatives incorporate a channel design more similar to what occurred historically in the Central Delta (more estuarine-dominated structure than the fluvial influence of the historic Yolo floodplain).
- Stuart Siegel said the overflow weir at northeast end of Prospect Island was originally proposed as a static weir to capture high frequency flood flows coming down Miner Slough, primarily above high tide influence. The original thinking behind the overflow weir was to (1) support juvenile salmon by providing access to Prospect Island during out migration and (2) increase

residence time and food production during other times of the year when connectivity would not exist. A notched weir and a weir with operable gates were discussed as potentially better alternatives.

- Dennis McEwan pointed out that high maintenance costs likely will come with operable gates. We ultimately want to get away from intensive management of site and have it be resilient to disturbance.
- Anke Mueller-Solger said the temporal component is important. For example, operable gates may be valuable from an experimental standpoint, but over the long-term the site should not be reliant on operable gates. Perhaps we can learn in short-term and apply improved understanding to the long-term design.
- Chris Foe suggested that since Prospect Island is isolated from the Yolo Bypass, it is not subjected to the levels of energy from large storms and flood events that Liberty Island is. These high energy events are primarily responsible for large scour events, etc. Therefore, what we construct at Prospect is likely to remain for a long time.
- Chris Enright reminded the group of Steve Andrew's comment that Prospect Island could be a seasonal depositional area because it will be the first place where water from Miner Slough slows down.
- Chris Enright wondered why geomorphic change was not considered a key design objective. Native species resilience may have much to do with restoring native morphologies because native species have phenotypic capacity to use those structures to overall competitive advantage. This requires a longer-term perspective that allows for interim habitats that may not be immediately ideal for target species. Geomorphic change processes would be the primary performance measures for perhaps decades.
- John Durand said we need to further evaluate how residence time influences *Microcystis*, desirable phytoplankton, SAV, etc... Current approach of evaluating exposure time is useful for relative comparisons, but longer exposure times than say three days may not mean *Microcystis* will bloom and longer residence times may be beneficial for linkages between phytoplankton and zooplankton.
- Lars Anderson suggested adjusting actions to affect transport and establishment of different substrates and then examine the response of natives and invasive plants. The substrate drives outcomes.
- Erin Gleason said we need to have a diversity of habits with treatments that investigate intentionally different channel structures.

Other questions/uncertainties raised by the participants included:

- What are the sources of DOC to and within the site?
- What channel depths would promote salmon rearing?
- Do dendritic channels encourage SAV/FAV?
- What is the Influence of the native and non-native plant seedbank?
- What factors shift the balance from non-native to native aquatic vegetation?

XIII. Adaptive management using experimental treatment options

Several possible experimental treatments were suggested around using a notched or operable weir at the north breach and the cross levee as an opportunity for restoration action contrast. The Port of Sacramento parcel has been used for placement of dredge material, creating elevations higher than those present on the DWR parcel.

***On opportunities for experiments using an operable weir*:**
The original thinking in preparation for the evaluation was that the overflow weir at northeast end of Prospect Island would be a static design consisting of approximately 1,000 foot section of levee graded to slightly above local mean higher high water. It would allow connectivity between Miner Slough and Prospect Island during moderate and higher flood flows coming down Miner Slough, above high tide influence, at the time of year when Miner Slough would be expected to contain downstream migrating juvenile salmon. Connectivity would be removed at other times of year, increasing residence time for increased food production. The modeling assessed only summer conditions when the weir location was 'disconnected'; no modeling was done for the winter connectivity conditions and thus the weir's performance when connected could not be assessed. A notched weir or a weir with operable gates were discussed as potentially better alternatives, based on speculations only of how the fixed weir might function.

- Dennis McEwan pointed out that there would be high maintenance costs associated with operable gates. He said we ultimately want to get away from intensive management of site.
- Anke Mueller-Solger said there is a temporal component to the value of experimental learning. For example, operable gates may be valuable from an experimental standpoint, but based on what is learned over the long-term we would modify the design to be passive--not be reliant on operable gates.

Opportunities for experiments using the cross-levee for north-south parcel restoration treatments:

- Anke Mueller-Solger suggested using the Port of Sacramento parcel for experimental purposes while using the DWR parcel as the main restoration site.
- Someone suggested using different size channels in north vs south parcels to compare designs that would encourage native plants and keep out clams. If outcomes could be experimentally linked to channel size, then the low performing channel could be modified accordingly.
- Someone suggested trying a large breach treatment in one parcel and small breach treatment in the other. A related suggestion was to connect one parcel on the east (Miner Slough) and one on the west in the DWSC.
- Someone suggested trying a serial experiment where residence time is allowed to be long at first by limiting breach connectivity. Later, breaches could be enlarged to reduce residence time. While adaptive breach size reduction later would be impractical, this experiment design offers good opportunity for adaptive learning on several crucial questions including those related to in situ production and regional pelagic ecosystem subsidy. (*Note: this concept seems likely to promote large velocity gradients at breaches, exasperating fish predation problems.)*

- Chris Enright suggested setting connectivity conditions in the north and south parcels so as to have essentially the same exposure/residence time characteristics. Outcome differences could then be related to the differing elevation regimes of the sites.

XIV. The practice of adaptive management on the project

For the most part, participants were hard-pressed to link treatment outcomes to practical opportunities for design adaptation in the future—the definition of experiment-based adaptive management at the property scale. Most participants agreed that any experiment could be modified based on outcomes and learning, but that most modification opportunities would be very expensive and difficult to plan and permit. Moreover, the length of time required to discern the treatment-outcome linkage (signal) from all other environmental influences (noise) is often years to decades. The group generally agreed that, as a practical matter, the Prospect Island restoration design once implemented would continue on its own trajectory long into the future. No matter how the project performs in the future, the opportunity for adaptive learning is high as long as there is commitment to mechanistic science investigations at the site. This long-term knowledge gain allows Prospect to provide 'experiment-based adaptive management' at the regional scale to support future restoration projects.

- Ted Sommer said that we should do site-based adaptive management if it makes sense and outweighs the risks. Ted is not sure that adaptive management fits here otherwise.
- Si Simenstad said that we won't likely tweak the design after monitoring because it requires lots of resources and permits. However, "adaptive learning is almost as good." He suggested that we emphasize modeling and gather data to investigate hypotheses about how salmon and delta smelt use the site, and then look to see if it worked. We should apply lessons learned to other restoration sites and measure performance of conceptual models (and supporting statistical and mechanistic models) not treatments.
- Chris Enright said that Prospect Island is a place within a larger region that will be intentionally and unintentionally changed in the future. Whatever happens in the Cache Slough region and the larger estuary will affect actions taken at Prospect Island and vice versa. For example, regional restorations will affect tidal range and tidal prism dynamics. This makes adaptive management experiments challenging because physical drivers will not be static long enough to reliably discern the treatment effect (i.e., interference of signal-to-noise ratio problems).
- Chris Enright was concerned that the project objectives didn't include investments in geomorphic change. The characteristic historical geomorphic elements and associated functional outcomes that native species adapted to are missing at the site primarily because it is subsided. Diverse geomorphic structures are the foundation of native species phenotypic diversity and resilience. Objectives that would encourage geomorphic structure restoration require a long-term perspective. Interim habitats that arise through such an effort may not be ideal for target species, but achieve desirable conditions in the long-term. (*Note: the 6th project objective – restoring functionality for broad range of species – provides for a 'general' incorporation of this topic. Perhaps it can be edited to capture "long-term" explicitly.)*

XV. Group evaluation to choose five alternatives

After two days of discussion, the evaluation team quickly settled on five alternatives for advancement to refined analysis and environmental documentation. Alternatives 11, 16 (plus northeast Miner Slough breach), 25, 27 (plus operable gate), and 29 were chosen (Table 4 and Figure 6).

Alternative 11 included three breaches connecting to both Miner Slough and the DWSC. Connection on the north end to Miner Slough is through a seasonal overflow weir. Alternative 11 is expected to minimize invasive plants and maximize diatom productivity based on modeling of exposure time.

Alternative 16 (modified) includes five breaches. The alternative was modified to make the seasonal overflow weir a full levee breach. Modified Alternative 16 is expected to aid salmon migration and rearing. This alternative would have the most connectivity of any alternative. Si Simenstad felt this alternative has the best migratory connection for juveniles and adults and the greatest diversity of habitat for passage, rest, and food availability. With several points of access, entrance shear zones and thus predator ambush habitats may be minimized.

	Salmonids	Invasive Control/ Primary Productivity (diatoms)	Delta Smelt	Predation	Sediment Capture and macrophytes
Alt. #					
16 plus breach	x				
27 plus gates	x		x		
11		x			
25		x			x
29	x	x	x	x	x

Table 4. Final summary of Evaluation Team discussion on five alternatives.

Alternative 25 was called a “reverse levee setback” because it includes a full breach from Miner Slough on the north end and a breach to the DWSC from the Port property in the south. It therefore mimics a widening of the river corridor. It is expected to minimize non-native plant colonization, maximize exported productivity, and capture sediment in the northern parcel (DWR property) which may advantage macrophyte production.

Alternative 27 includes a long levee removal along the DWSC and a seasonal overflow weir on the north end at Miner Slough. The weir also could be configured as an operable gate that could be operated as an adaptive management experiment for salmon and delta smelt habitat and diatom production and export. This alternative maximizes shallow open water. The addition of an operable barrier enhances opportunities for learning but would need intensive management to assure salmon, steelhead, and sturgeon passage when they are there. Weir gate would likely generate larger velocity gradients and a predator hotspot. During low flows, onsite zooplankton productivity would be high.

Alternative 29 is the same as Alternative 27 except the seasonal overflow weir is changed to a full levee breach. Alternative 29 is expected to improve conditions for all objectives in Table 4.

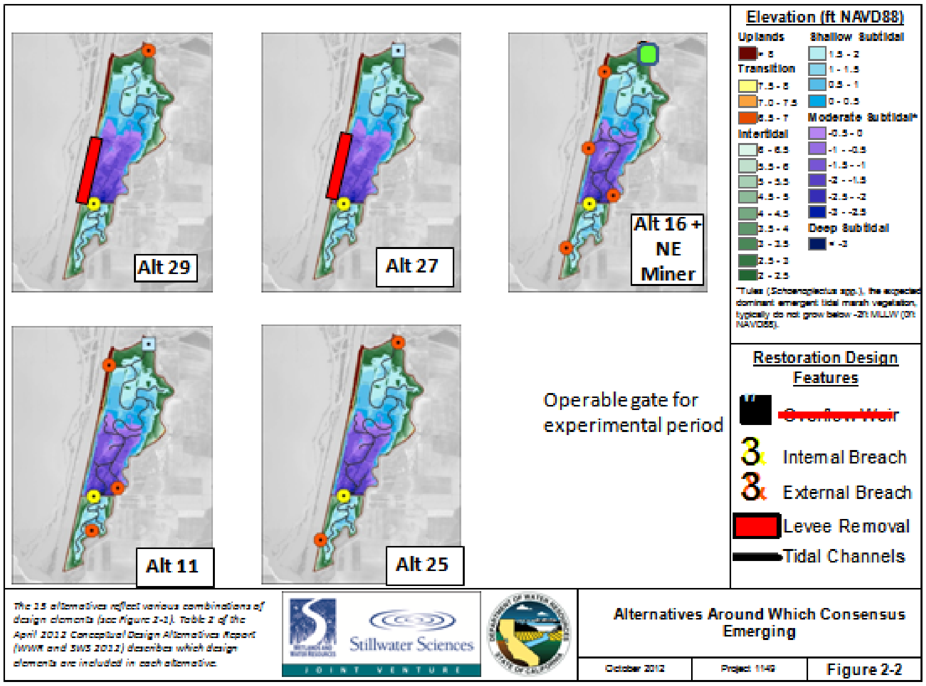


Figure 6. Alternatives Recommended to the Project Team.

XVI. "Geomorphic Option"

The Evaluation Team had additional discussion about a design that would capture sediment in the northern parcel (DWR property) during high flow events. The idea arose from a comment by Steve Andrews of RMA. Based on his understanding of the Cosumnes River Preserve breach, which accumulated a large sand splay, he suggested that suspended sediment from the Sacramento River coming through Miner Slough would encounter slower water for the first time after entering through the northeast Miner Slough breach. It is possible that the northern parcel could therefore accumulate mineral sediments quickly and encourage emergent vegetation growth. Stuart Siegel commented on design considerations that could be incorporated to facilitate capturing this sediment supply, such as channel and marsh plain geomorphology that provides overbank flooding to allow low water velocities that promote sedimentation. It should be noted that this approach will favor establishment of invasive emergent plants from upstream sources, so post-project monitoring and vegetation management will be critically important.

XVII. Fill Placement Option

Dennis McEwan noted that the State and Federal Contractors Water Agency (SFCWA) has suggested that sediment excavated from the nearby Lower Yolo Tidal Marsh Restoration Project that SFCWA is planning be transported to Prospect Island and used as fill source for subsidence reversal. The Lower Yolo project could generate as much as 2.5 million cubic yards. Stuart Siegel also noted that excavating soils within Prospect Island for constructing the channel network will generate a substantial quantity of sediment; very rough estimates suggest around 500,000 cubic yards of sediment. The Prospect Project Team posed the question to the Evaluation Team of its ideas for how these sediments could be used most beneficially to support project objectives.

The Evaluation Team expressed interest in focusing sediment placement in the northern portion of the DWR property, where current elevations are at or above the approximate colonization limit for tules and thus sediment placement would aid in emergent marsh formation. The Team suggested not placing sediment where current subtidal elevations are too deep for tules so that these areas would remain as perennial open water areas.

Responding to this idea, Stuart proposed an approach that would facilitate fill placement in the targeted area while still including a complete tidal slough network. Material properties (e.g., slurry or solid sediment) would dictate construction approach. Sediments requiring containment to retain as placed, such as slurry-delivered sediment, would include a low retention berm at the south end of the placement area (Figure 7). Channels would be constructed either through additional retention berms 'outlining' the path of channels – the 'do not fill the channel area' approach – or excavation of placed sediment – the 'dig it out after fill placed' approach. Sediments that can be placed without retention would be positioned on the intended marsh plain areas and not in the channel locations. Placement elevations would be no higher than about 0.5-1 foot below local mean high water, to allow natural processes to form suitable physical conditions of surface sediments that facilitate emergent vegetation colonization and benthic and epibenthic invertebrate community establishment.

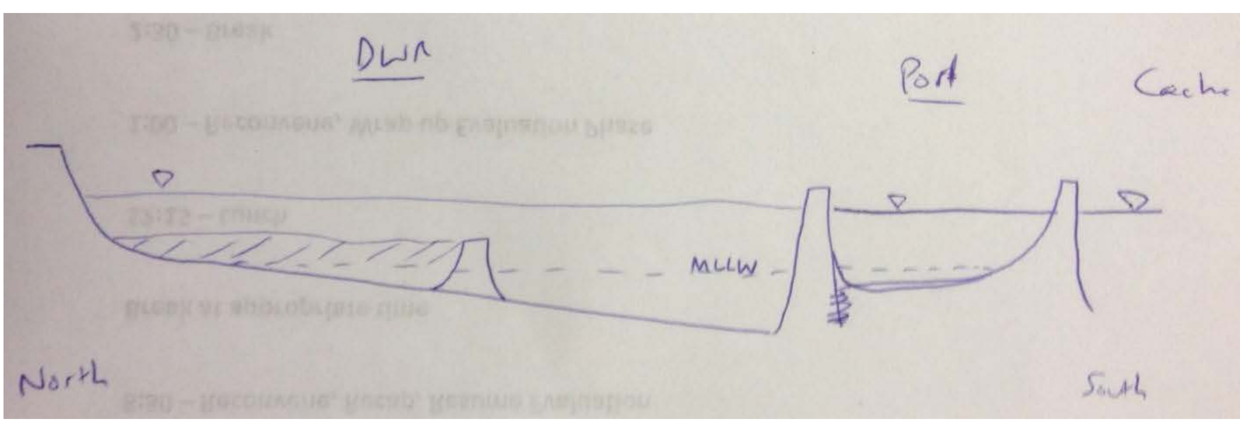


Figure 7. North-to-south cross-section through Prospect Island showing a low internal berm to facilitate sediment capture. View does not show additional features to allow for construction of the tidal slough network in the fill placement area.

XVIII. DRERIP Scientific Evaluation Process

The DRERIP scientific evaluation process was "trimmed" for Prospect Island specific alternatives screening. A "scientific evaluation worksheet" was presented to the participants. After two-days of discussion, the group was quite ready to make rapid evaluations of the five alternatives using the screening evaluation tools provided. The process has ten steps:

Step 1. *Evaluate Actions using the reference document: DRERIP Actions Prospect Island.*
Is the action written in such a way that it can be evaluated?

The Evaluation Team was presented with several resources entering the workshop including nine peer-reviewed modeling reports on various aspects of the 30 alternatives (15 of which were modeled) as well as a summary of the overall modeling results developed by the FRPA project team. In addition, several technical memos documented the development of screening alternatives. Presentations from the FRPA project proponents and ERP staff also gave the evaluation team a common contextual understanding of how the project fits into Biological Opinions' requirements as well as connections to BDCP and Delta Plan processes. The evaluation team was given clear direction about their charge to winnow 15 design alternatives to five that would be advanced for further design and evaluation and environmental documentation. The action was therefore written in such a way that it could be evaluated.

Step 2: *Assess support for action-outcome relationship using outcomes and stressor tables.*
Is the cause-effect relationship inferred in the action supported by the conceptual models or other source information?

The two-day workshop included presentations of individual DRERIP conceptual models in the context of Prospect Island restoration design (documented in sections IV-XI above). Several of the presentations were made by the model authors. Action-outcome relationships were an explicit focus of the group discussions. The workshop process therefore embodies Step 2.

Step 3: *Identify the scale of the action*

The scale of Prospect Island is 1,600 acres within a much larger regional landscape at the intersection of the fluvial process dominated Yolo floodplain and tidal estuary driven channel and tidal marsh landscapes. Based on particle tracking and tidal energy modeling analysis, there is evidence that the project has broad effects extending beyond the designed site dynamics. Prospect Island embraced these expected effects by seeking to maximize mixing of exported primary and secondary production that could food-subsidize the regional ecosystem. For example, particle tracking analysis suggests that Prospect Island production would distribute most to the Cache Slough Complex, DWSC, and lower Sacramento River and to a very degree to the San Joaquin River and Suisun Marsh. The final exported distribution would depend on the Prospect Island connection design. The scale of the action is therefore considered "large" in that it has "broad spatial extent, significant duration and/or frequency, and/or major reversal compared to existing conditions" (from the DRERIP Scientific Evaluation Worksheet—page 7).

Step 4: *Describe relation to existing conditions*

The project is likely to change the distribution of flows in the north Delta, though this question was not fully addressed. It will be addressed fully in Phase II evaluation of the five alternatives. The modeling results show that in general, tidal flows are increased downstream of the project on Miner Slough due to the increased accommodation space provided by the project. By the same process, additional tidal energy dissipation reduces tidal ranges several inches in the project area and lesser amounts over a wide area of the north Delta. Tidal flows upstream are generally reduced while there Sacramento River influence increases. While Phase II modeling will directly assess effects, it is expected that average flows through Sutter and Steamboat Sloughs will increase, while net flows in reach below Sutter and Steamboat Slough and the Delta Cross Channel/Georgiana Slough will decrease somewhat. These regional effects on tidal and net flows can be expected to increase with future restoration actions in the Cache Slough area.

Step 5: Identify *Positive and Negative Outcome(s) to be Evaluated*
Step 6*: Score Magnitude, Certainty and Worth of Potential Positive Ecological Outcome(s)*
Step 7*: Score Magnitude, Certainty and Risk of Potential Negative Ecological Outcome(s)*
Step 9: *Estimate Overall Degree of Worth and Risk*
Step 10: *Assess Reversibility and Opportunity for Learning*

The Evaluation Team summarized steps 5-10 (minus 8) with a summary scoring table (Table 4). Figure 4 is reprised here with yellow boarders around the five chosen alternatives. Step 5 is represented by the first column labeled "Outcome." The evaluated positive and negative outcomes were derived prior to the evaluation workshop in a technical memorandum called "Prospect Island Tidal Habitat Restoration Project Phase One Screening Criteria." Steps 6 and 7 were quickly filled in based on two days of discussion, learning, and synthesis by the group. Magnitude and certainty scores are derived from specific definitions contained in the DRERIP Scientific Evaluation Worksheet. Alternative 29 generally achieved the best combination of scores. Step 8 will be covered below. Step 9 presents "worth" for positive outcomes and "risk" for negative outcomes, following application of magnitude and certainty scores into separate "worth" and "risk" matrices included in the DRERIP worksheet instructions.

	Alt 16+NE Brch			Alt 27			Alt 11			Alt 25			Alt 29			No Action		
Outcome	M	C	W/R	M	C	W/R	M	C	W/R	M	C	W/R	M	C	W/R	M	C	W/R
P1 - Enhance productivity (primary and secondary) and food availability (tidal mixing) for native Delta fishes	3	3	H	3	3	H	3	3	H	3	3	H	4	3	H	1	3	M
P2 - Increase the amount and quality of salmonid rearing habitat in an area of known beneficial migratory pathway	4	3	H	2	3	M	1	3	M	3	3	H	4	3	H	NA	NA	
P3 - Increase the amount and quality of habitats to support other listed species, to the extent they can be supported by site conditions and natural processes	3	3	H	3	3	H	3	3	H	3	3	H	3	3	H	2	2	M
P4 - Increase the amount and quality of habitats to support delta smelt within PI	2	3	M	4	4	H	2	3	M	2	3	M	4	4	H	NA	NA	
P5 - Increase the amount and quality of sediment capture within PI	4	2	H	2	3	M	2	2	M	4	3	H	4	3	H	1	4	M
N1 - steep velocity gradients at breaches that support predation on native fishes	2	4	L	2	4	L	2	4	L	2	4	L	2	4	L	4	4	M
N2 - colonization and establishment of invasive aquatic vegetation	3	3	M	4	4	M	2	2	M	3	3	M	3	3	M	4	4	M
N3 - colonization and establishment of invasive aquatic invertebrates	3	2	H	3	2	H	3	2	H	3	2	H	3	2	H	2	2	M
N4 - steep velocity gradients at passage barriers that support predation on native fishes	1	1	M	2	2	M	3	3	M	1	1	M	1	1	M	1	1	M
N5 - steep velocity gradients at operable gate that support predation on native fishes	NA	NA		2	4	L	NA	NA		NA	NA		NA	NA		NA	NA	
Reversibility	Only with lots of money and a regulatory nightmare															Low		
Opportunity for learning	High across the board but slow except for Alt 27															High		

Table 4. DRERIP evaluation table for 5 Prospect Island alternatives. Evaluation rankings are 1-4 for magnitude of the effect (M), certainty of the effect (C), worth (positive outcomes), and risk (negative outcomes).

Step 10 assessed the reversibility of each action and opportunities for learning. Reversibility is considered “hard” because levee manipulation after initial breaches is difficult and expensive. Breaches and limited levee maintenance will remove land access for equipment and material and require barged equipment and fill. Secondly, several participants thought that environmental documentation and permitting would be onerous. Opportunities for learning are considered high for all five alternatives if a hypothesis-driven science and monitoring program is included in the project with enough observation capability and time commitment to discern outcome responses to the design and/or treatments. All participants agreed that most hypotheses will require several years of observations for learning that expands the knowledge base. If Alternative 27 includes an operable gate within the weir structure, several hypotheses may be investigated more quickly.

Step 8. *Identify any important gaps in information and/or understanding*

Almost every hypothesized action-outcome relationship is uncertain enough that opportunities for learning are very high. There are relatively few on-the-ground actions or “knobs” to turn for meeting the objectives. Levees can be breached to some width and depth, or they can be lowered. An operable weir or gate offers some connection flexibility. Fill sediment can be placed to reverse subsidence. Tidal sloughs can be constructed.

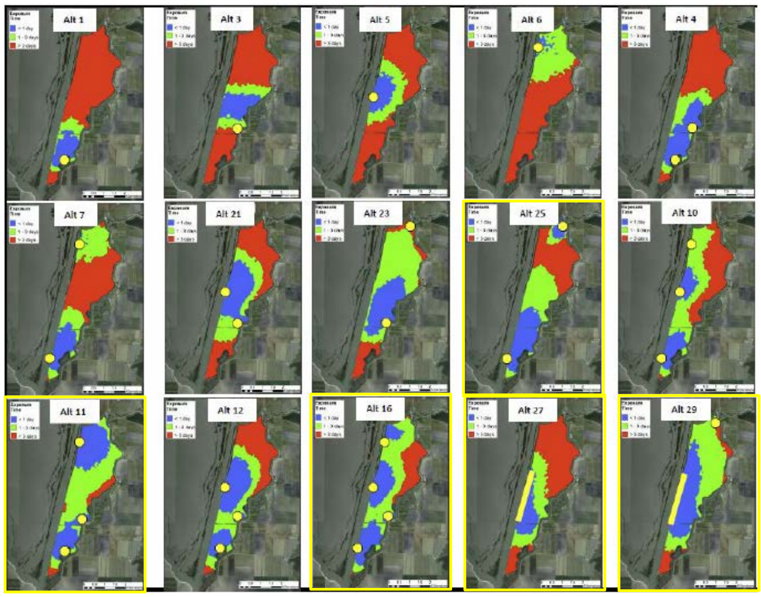


Figure 4 (reprise). The five alternatives chosen the evaluation team have yellow boarders.

XIX. Recommendations for more refined modeling

1. Particle tracking modeling gives the impression that there is strong connectivity, though the regional fate table from RMA shows that of the total 1-3 day exposure time particles, only 2-12% end up in the Cache Slough area after 7 days. Several Evaluation Team members suggested that this result should be analyzed in more detail.

- How does each of the alternatives "connect" to Liberty Island?

2. Encouraging sedimentation and emergent vegetation colonization are important objectives of the project. Modeling so far doesn't consider water retention and friction that would be generated by large patches of emergent vegetation in areas where elevations are conducive to colonization.

- Emergent vegetation roughness and distribution – Test the sensitivity of exposure time to the presence of high-friction edges where emergent vegetation may colonize.

3. The project has opportunities for accepting fill material from other projects and for using material from channel dredging.

- What are the potential volumes and how could they be used to bolster inboard levee slopes, create internal sediment trap berms, or otherwise increase elevation? How would these changes influence tidal currents and mixing?

4. The exchange between autotrophic (producer dominated) and heterotrophic (consumer dominated) habitats is a key linkage between Prospect Island and regional ecosystem carrying capacity.

- Can we improve on the exposure time metric in a way that characterizes the rate of autotrophic-heterotrophic habitat connectivity? Some mechanistic representation of primary production that included light, depth, and nutrients would be needed. Such a metric would allow tuning levee breach connection design to optimize (loosely speaking) regional carrying capacity

5. There is much room for testing the sensitivity of breach size for intermediate outcomes like current structure (especially at the breach site), and exposure time.

- What is the sensitivity of currents and exposure time to breach size (especially in the cross levee)?

6. Simulated Miner Slough velocities are unreasonably high because the channel is in equilibrium with no Prospect Island connection.

- What is the sensitivity of Miner Slough velocity to depth? Based on the analysis, adjust the five alternative model runs for an assumed new equilibrium depth. What is the impact on breach velocities, exposure time, and regional productivity mixing?

7. Does wind forcing change particle tracking results appreciably?

XX. References

For references, see Appendix 5.

Appendix 1. Prospect Island Evaluation Team and Expertise Summary

Member	Affiliation	Hydrodynamics	Tidal marsh restoration	Delta smelt	Salmon	Aquatic ecology	Food web dynamics	Methylmercury	Inv. species -- aquatic veg	Inv. species -- aq. invertebrates	Inv. species -- fish	Dissolved organic carbon	Water quality	Climate change
Hydrodynamics														
Chris Enright ***Lead, Evaluation Report***	DSC	1°	1°										1°	2°
Tidal Marsh Restoration														
Larry Brown	USGS		1°	1°	1°	1°	2°		2°	2°	2°	2°		
Si Simenstad	UW		1°		1°	1°	2°					2°		
Delta Smelt, Salmon, Aquatic Ecology, Food Web Dynamics														
Bruce Herbold ***Panel Chair***	USEPA			1°	1°	2°				2°	2°			
Ted Sommer	DWR			1°	1°	1°	1°		2°	2°	2°	2°		
Anke Mueller-Solger	DSC					1°	1°			2°	2°	1°	2°	2°
Erin Gleason	USFWS			1°		2°								
Lars Anderson	Private								1°	2°			2°	
John Durand	UC Davis	3°	3°			1°				2°	2°			2°
Methylmercury														
Chris Foe	CVRWQCB					1°	1°	1°					1°	

Appendix 2. Plant Survey by Lars Anderson

	Prospect Island (Interior)	Waters Adjacent to Prospect Island	Delta- general	Approximate Areal cover: Prospect Island (acres)
Species:				
Arundo donax	X	X	X	0.5-1 (P)
Sesbania punicia	X (riprap facing Deep Water Channel)	X	X	0.01 (a few shrubs)
Typha latifolia	X	X	X	200+ (D)
Schoenoplectus	X	X	X	200+(D)
Ceratophyllum dermersum	X	X	X	15-20 (P)
Egeria densa	None observed	X	X	0
Elodea canadensis	X	X	X	1-2 (F)
Lemna minor	X	X	X	2-5 (P)
Ludwigia spp (peploides-ss Montevendensis)*	X	X	X	>100 (D)
Myriophyllum spicatum	X	X	X	50-60 (P)
Polygonum amphibium	X	X	X	2-4 (D,P)
Polygonum spp	X	X	X	15 (D)
Potamogeton crispus	X	X	X	7-May
Potamogeton foliosa	X	X	X	<1 (F)
Potamogeton nodosus	Non observed	X	X	0
Spirodela polyrhiza	Non observed	X	?	0
Zannichellia palustris	X	X	X	1-2 (D, P)
Spirogyra sp. (filamentous algae)	X	X	X	25-30
Chara sp. (macro-algae)	X	X	X	10-20?

Aquatic macrophytes observed in surveys of Prospect Island and adjacent waters (June-August 2012).
Non-native, invasive species are in **bold typeface**.
P= patchy distribution; D= dense, large populations; F= few plants found.
* *Ludwigia* spp.: Estimates for southern ("Port") and immediately north of cross-levee. Species confirmation within *Ludwigia* pending; all considered invasive.

Appendix 3. Attendance Sheets for October 24 and 25, 2012

October 24, 2012 Attendance

Name	**Affiliation**
Panel	
Chris Enright	Delta Science Program
Bruce Herbold	USEPA
Anke Mueller-Solger	Delta Science Program
Larry Brown	USGS
Lars Anderson	Private Consultant
Ted Sommer	DWR
John Durand	UC Davis
Erin Gleason	USFWS
Charles "Si" Simenstad	University of Washington
Chris Foe	Central Valley Regional Water Quality Control Board
Project Team	
Stuart Siegel	Wetlands and Water Resources
Dennis McEwan	DWR
Noah Hume	Stillwater Sciences
Bruce Orr	Stillwater Sciences
Richard Rachiele	RMA
Steve Andrews	RMA
Meeting Staff	
Carol Atkins	DFG, ERP
Allen Barnes	UC Davis, ERP Peer Review Office
Julie Garcia	DFG, ERP
Hildie Spautz	DFG, ERP
Adam Ballard	DFG, ERP
Observers	
Dave Zezulak	DFG, ERP
John Downs	DFG, FRPA
Kelly Fritsch	DFG, ERP
Gina Ford	DFG, FloodSafe
Josh Grover	DFG, ERP
Bob Hosea	DFG, ERP
Mike Eakin	DFG, BDCP
Jason Roberts	DFG, BDCP
Steve Rodriguez	DFG, R3, ERP
Mike Hoover	USFWS
Pamela Lindholm	DWR, FRPA
Gina Benigno	DWR, FRPA
Ling-Ru Chu	DWR, FRPA
Ray McDowell	DWR, FESSRO
Ron Melcer	DWR, FESSRO
Lori Clamurro-Chew	DWR, FESSRO
Lauren Hastings	Delta Science Program
Marina Brand	Delta Science Program
Kristal Davis-Fadke	Delta Conservancy

October 25, 2012 Attendance

Name	**Affiliation**
Panel	
Chris Enright	Delta Science Program
Bruce Herbold	USEPA
Anke Mueller-Solger	Delta Science Program
Larry Brown	USGS
Lars Anderson	Private Consultant
Ted Sommer	DWR
John Durand	UC Davis
Erin Gleason	USFWS
Charles “Si” Simenstad	University of Washington
Chris Foe	Central Valley Regional Water Quality Control Board
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Observers	
Dave Zezulak	DFG, ERP
John Downs	DFG, FRPA
Kelly Fritsch	DFG, ERP
Gina Ford	DFG, FloodSafe
Josh Grover	DFG, ERP
Bob Hosea	DFG, ERP
Mike Eakin	DFG, BDCP
Jason Roberts	DFG, BDCP
Steve Rodriguez	DFG, R3, ERP
Mike Hoover	USFWS
Pamela Lindholm	DWR, FRPA
Gina Benigno	DWR, FRPA
Ling-Ru Chu	DWR, FRPA
Ray McDowell	DWR, FESSRO
Ron Melcer	DWR, FESSRO
Terri Gains	DWR, FESSRO
Marina Brand	Delta Science Program
Kristal Davis-Fadke	Delta Conservancy
Daniel Burmester	DFG, ERP
Jason Roeh	DFG, ERP
Junko Hoshi	DFG
Gena Lasko	DFG, ERP
Cathy Marcinkevage	NOAA

Appendix 4. List of Documents Reviewed by Evaluation Team

Number	Title
DRERIP Documents	
D1	DRERIP Evaluation Worksheet - Prospect-ready (10-2-12)
D2a	About the Outcomes Table
D2b	Outcome Table (v20)
D3a	DRERIP_Tidal_Marsh_CM_Text_2008
D3b	DRERIP_Delta Smelt_CM_2009
D3c	DRERIP_Salmon_final_2010
D3d1	DRERIP_Mercury_Alpers et al 24Jan08
D3d2	MeHg NPS_Synthesis Final Aug 2012
D3e	DRERIP_Fish_Habitat_Linkage Model 23Jan08
D3f	DRERIP _Food_web_Conceptual Model_final_12-02-08
D4	Boundary Conditions Draft
Prospect Island Documents	
P1	DRERIP Screening Analysis Prospectus (draft Prospect)
P2	DRERIP Actions Prospect Island
P3	Conceptual Alternative Report Prospect
P4	Overflow Weir Design Technical Memo Final
P5	Screening Criteria Technical Memo Final
P6	App A Alternative Criteria (final)
P6	App B Approach _ RMA (final)
P6	App C Approach _ cbec (final)
P6	App D Calibration-Verification RMA Delta Model (final)
P6	App E Calibration-Verification cbec_MIKE21FM (final)
P6	App F Model Results - Productivity (final)
P6	App G Model Results - NBAQ_DOC (final)
P6	App H Model Results - Flooding (final)
P6	App I Model Results - Tidal Range (final)
P6	App J Model Results - DWSC Cross Currents (final)
P6	App K Model Results - Ryer Scour Pot (final)
P6	Phase 1 Modeling Results Synthesis Final Report
Other Documents	
O1	Final POD 2010 Workplan
O2a	Suisun Tidal Marsh CM - Chapter 1 - Physical Processes
O2b	Suisun Tidal Marsh CM - Chapter 2 - Aquatic Environment
O2c	Suisun Tidal Marsh CM - Chapter 3 - Tidal Marsh
O2d	Suisun Tidal Marsh CM - Chapter 4 - Species
O3	SWRCB Flow Criteria
O4	DFG Biological Objectives and Flow Criteria
O5	CVRWQCB TMDL Staff report for MeHg in the Delta
O6	Ted Sommer, Delta Smelt Habitat paper (5/2012 draft manuscript)

Appendix 5. Full citations to list of documents provided to Evaluation Team (Appendix 4)

DRERIP Conceptual Models and Related Documents:

Alpers, C., Eagles-Smith, C., Foe, C., Klasing, S., Marvin-DiPasquale, M., Slotton ,D., and Winham-Myers, L. 2008. Mercury Conceptual Model. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

Anderson, Lars. 2008. Aquatic Vegetation Growth. (DRAFT). Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

DRERIP. 2012. Evaluation Worksheet: Prospect Island Alternatives Screening Evaluation. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

DRERIP. 2008. About the Outcomes Table. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

DRERIP. 2008. Outcomes Table. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

Durand, J. 2008. Delta Foodweb Conceptual Model. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

DWR. DRERIP Boundary Conditions (DRAFT). Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

Kneib, R., Simenstad, C., Nobriga, M., Talley, D. 2008. Tidal Marsh Conceptual Model. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

Nobriga, M. 2008. Aquatic Habitat Conceptual Model. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

Nobriga, M. and Herbold, B. 2009. The Little Fish in California's Water Supply: a Literature Review and Life-History Conceptual Model for delta smelt (*Hypomesus transpacificus*) for the Delta Regional Ecosystem Restoration and Implementation Plan. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

Williams, G. J. 2010. Life History Conceptual Model for Chinook Salmon and Steelhead. DRERIP Delta Conceptual Model. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan.

Windam-Myers, L. and Ackerman, J. 2012. A Synthesis of Mercury Science to Support Methylmercury Control Studies for Delta Wetlands and Irrigated Agriculture. Final Report. August.

Prospect Island Alternatives Documents

cbec, Inc. and Wetlands and Water Resources, Inc. 2012. Prospect Island Tidal Habitat Restoration Project Overflow Weir Design. Technical Memorandum. July.

Siegel, S. 2012. DRERIP Actions Prospect Island. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan. September.

Siegel, S. 2012. Prospectus for Conducting DRERIP Evaluation of the Prospect Island Tidal Restoration Project. DRAFT. Sacramento (CA): Delta Regional Ecosystem Restoration Implementation Plan. June.

Stillwater Sciences and Wetlands and Water Resources, Inc. 2012. Prospect Island Tidal Restoration: Synthesis of Phase 1 Screening-Level Modeling Evaluation of Conceptual Restoration Alternatives. Final Report. September.

Appendices:

Wetlands and Water Resources Inc. 2012. Prospect Island Tidal Restoration: Synthesis of Phase 1 Screening-Level Modeling Evaluation of Conceptual Restoration Alternatives. Appendix A: Alternatives Screening Criteria Report. April.

RMA. 2012. Prospect Island Tidal Restoration: Synthesis of Phase 1 Screening-Level Modeling Evaluation of Conceptual Restoration Alternatives: Appendix B: Modeling Approach for Phase 1 Screening Analysis. June.

cbec. 2012. Prospect Island Tidal Restoration: Synthesis of Phase 1 Screening-Level Modeling Evaluation of Conceptual Restoration Alternatives: Appendix C: Modeling Approach for Phase 1 Screening. July.

RMA. 2012. Prospect Island Tidal Restoration: Synthesis of Phase 1 Screening-Level Modeling Evaluation of Conceptual Restoration Alternatives. Appendix D: Prospect Island Tidal Restoration Project Calibration and Verification of Hydrodynamic Model Used for Phase 1 Preliminary Alternatives Screening. Technical Memorandum. June.

cbec. 2012. Prospect Island Tidal Restoration: Synthesis of Phase 1 Screening-Level Modeling Evaluation of Conceptual Restoration Alternatives. Appendix E: Prospect Island Tidal Restoration Project Calibration and Verification of Hydrodynamic Model to Assess Dissolved Organic Carbon Impacts to the North Bay Aqueduct. Technical Memorandum. September.

RMA. 2012. Prospect Island Tidal Restoration: Synthesis of Phase 1 Screening-Level Modeling Evaluation of Conceptual Restoration Alternatives. Appendix F: Phase 1 Modeling Results for Primary Productivity Enhancement and Export. September.

cbec. 2012. Prospect Island Tidal Restoration: Synthesis of Phase 1 Screening-Level Modeling Evaluation of Conceptual Restoration Alternatives. Appendix G: Phase 1 Modeling Results for DOC at Barker Slough Pumping Plant. September.

cbec. 2012. Prospect Island Tidal Restoration: Synthesis of Phase 1 Screening-Level Modeling Evaluation of Conceptual Restoration Alternatives. Appendix H: Phase 1 Modeling Results for Flood Conveyance. September.

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Appendix 6. Workshop Agenda

PROSPECT ISLAND
CONCEPTUAL RESTORATION ALTERNATIVES DRERIP EVALUATION

UC Davis, Alumni Center, Founder's Room
AGENDA

Day 1 (October 24)

8:00 – Meet and Greet

8:30 – Welcome

(Carol Atkins/Dave Zezulak, DFG Ecosystem Restoration Program)

Introductions of those in the room

8:40 – Project Introduction

(Stuart Siegel, Wetlands and Water Resources and Dennis McEwan, DWR)

- Overview of FRPA – Purpose, Suite of Projects
- Prospect – Project Goals, Objectives, Planning Status and Path Ahead
- Review Evaluation Purpose – helping to select five alternatives to carry forward
- Review Existing Site Conditions
- Conceptual Alternatives Modeled
- Present Anticipated Ecological Functions, Outcomes, and Variation across the Alternatives

10:15 – Break

10:30 – Presentation of Selected Modeling Results

- Understand nature of what the modeling is representing
- Discuss relative performance of alternatives on productivity, transport, perhaps other outcomes

12:15 – Lunch

1:00 – Evaluation Process Introduction (15 min) and begin work

Roles: Bruce Herbold (USEPA): Wrangler
Stuart Siegel (Wetlands and Watershed Science): Coach
Chris Enright (Delta Science Program): Champion

5:00 – Recap the accomplishments of the day; Confirm start time for next day

Day 2 (October 25)

8:00 – Meet and Greet

8:30 – Reconvene, Recap, Resume Evaluation

Break at appropriate time

12:15 – Lunch

1:00 – Reconvene, Wrap up Evaluation Phase

2:30 – Break

2:45 – Synthesize Work Effort

4:00 – Review Next Steps to Complete Evaluation

- Evaluation Summary Timeline – draft in two weeks for Evaluation team review, one week review time, final one week after; total time to completion is one month after workshop

5:00 – Discussion of Technical Review Strategies for This and Future Restoration Projects

- Workshop debrief amongst expert panels and agency managers
- Near term vs long term restoration planning