**Parsons Slough Project**

**June 3, 2009 Meeting Reading Material**

Bryan Largay

Reviewers: Kerstin Wasson, Andrea Woolfolk, Kevin Fisher

## Document Summary

This document summarizes the planning process to date for the restoration of Parsons Slough and describes management options that are considered feasible on a timeline of two to five years. Consideration of multiple factors suggest that the project most able to advance the goals of the Tidal Wetland Project Strategic Plan and the Parsons Slough Restoration Plan is the construction of an adjustable submerged tidal barrier (a sill) at the mouth of Parsons Slough. This document lays out some of these considerations.

This structure would reduce tidal scour and increase salt marsh viability, but not without risks and tradeoffs. The more the structure reduces tidal scour, the greater the risk to water quality, and the more mudflat habitat in Parsons Slough would be converted to shallow subtidal habitats. While the adjustable design of the structure would enable these tradeoffs to be characterized ad managed over time, it is important that we have clear management targets prior implementation. This document lays out the considerations to initiate that process at our meeting. Developing specific management targets will be the subject of future discussions.

## Major outcomes of the Parsons Slough Project planning process

The Parsons Slough Restoration Project Team, with membership from the Science Panel and Strategic Planning Team set multiple goals for the project. The planning process identified substantial barriers to achieving the top goal of restoring salt marsh in Parsons Slough, but the proposed project could advance the other goals in a timely and cost effective manner.

### Parsons Slough Restoration Project goals

**Goal 1:** To restore and enhance intertidal marsh habitats and functions within the Parsons Slough tidal wetland complex while addressing the needs of special-status species, estuarine-dependent species, and ongoing human uses.

**Goal 2:** To support the ecological recovery of the larger Elkhorn Slough system to the extent possible while meeting Goal 1.

**Goal 3:** To conserve high quality subtidal and intertidal estuarine habitats and functions within the Parsons Slough tidal wetland complex.

### Findings of the planning process

Restoration of salt marsh, Goal 1, does not appear feasible in the near term for technical and economic reasons, which are detailed in the Draft Parsons Slough Restoration Plan.

Challenges to the restoration of salt marsh at Parsons Slough include

1. Restoration of salt marsh with a full tidal range requires large sediment additions (1.5 million cubic meters, 2 million cubic yards). Large-scale sediment addition is not readily feasible for various reasons, including:
    a. Sufficient quantities of fine sediment are only available from the near shore environment in Monterey Bay or from the Graniterock quarry,
    b. Both sources are expensive (~$250,000 per hectare, $100,000 per acre)
    c. The timeline for evaluating the quarry material prior to a major restoration action is multiple years
2. ESNERR and ESF staff identified other subsided sites in Elkhorn Slough where more marsh can be restored with less sediment. For example, Pick and Pull marsh: 28 hectares (70 acres) with 150,000 cubic meters (200,000 cubic yards) at a cost of about $50,000 to $100,000 per hectare ($20,000 to $40,000/acre)
3. Strongly muting the tidal range, the primary alternative to sediment addition, was not recommended by the Parsons Slough Team because it
    a. compromises wetland functions,
    b. can cause water quality problems,
    c. increases maintenance costs, and
    d. is not resilient to sea level rise

**Parsons Slough Sill Project concept**

However, supporting ecologic recovery of Elkhorn Slough while conserving high quality subtidal and intertidal habitat in Parsons Slough (Goals 2 and 3) could be advanced by building a submerged tidal barrier (a sill) at the mouth of Parsons Slough. Such a project appears technically and economically feasible with a relatively short time horizon of 1.5 to five years.

The project would involve placement of a submerged tidal barrier with the geometry of a sill across the mouth of Parsons Slough. The structure is expected to provide a slight reduction in energy compared to the existing tidal regime , while maintaining sufficient tidal exchange and flushing to provide acceptable water quality. An open channel configuration was selected over a series of pipes to provide better passage for fish and wildlife and to allow for greater flexibility with respect to sea level rise. The crest of the structure would be adjustable over a range of conditions to enable optimization among multiple management objectives.

**Ecologic goals – Parsons Slough Sill**

- Promote recovery of soft subtidal sediments by reducing peak current velocities and tidal scour in Elkhorn Slough, particularly in Parsons Slough and in Lower Elkhorn Slough from Parsons Slough to Moss Landing Harbor
- Promote the recovery of salt marsh in Elkhorn Slough by (1) increasing the retention of sediment in the estuary, making sediment more available to build

marshes deposition on the marsh plain, and by (2) reducing the run up of water at the head of the slough through the reduction in tidal scour

- Improve or sustain ecosystem health with respect to dissolved oxygen and other indicators of eutrophication in Parsons Slough
- Accommodate the movement of fish and wildlife in and out of Parsons Slough, specifically sea otters, harbor seals, flatfish and sharks and rays

### Management goals – Parsons Slough Sill

- Adjustment of the structure will be feasible with existing equipment and staff resources.
- The structure will function with minimal maintenance for at least 30 years, with a lifespan of at least 50 years.
- The structure can be dismantled if its effects are determined to be undesirable.
- Structural failure will not endanger life or property.
- The structure will enable tidal range in Parsons Slough to be managed from unrestricted to a 30 percent reduction compared to existing conditions

## Structure Details

### Concept

The present conceptual design involves 12” and 24” diameter rock placed by barge and/or rail based equipment. Alternatively, sheet piling may be used. The top of the sill will consist of an adjustable crest. The width and elevation of the crest will be adjusted using panels or stop logs supported by steel posts, which can be added or removed using hand labor or a boat-mounted hoist (figures attached.)

The structure would block about 75% of the present channel cross sectional area. A starting point for the elevation of the notch is -1.5 meters (-5 feet) NAVD 88.

### Sill Configurations

The opening of the sill could be configured a variety of ways. The base assumption to date has been that the structure would be a linear feature perpendicular to the channel. Other configurations may warrant exploration, for example, to reduce ebb dominance. An investigation of alternatives for the structure was led by Moffatt and Nichol. The full and half channel width alternatives are discussed in the Draft Parsons Slough Restoration Plan, Section 4.0. The ‘narrow and deep’ option was evaluated in a separate letter report to ESNERR. They found that the width of the sill crest has a marked effect on tidal exchange.

**Effects of sill configurations compared to existing conditions**

| | Crest Width | Crest Elevation | Parsons Slough tidal prism (% change) | Main channel ebb velocity d/s of Parsons (% change) | Main channel ebb velocity u/s of Parsons (% change) |
|---|---|---|---|---|---|
| Full Width | 57 m (188’) | -0.6 m (-2’) | 0% | -3% | +5% |
| Half width | 28 m (94’) | -0.6 m (-2’) | 0%* | -21% | +8% |
| Narrow and Deep | 7.5 m (25’) | -1.5 m (-5’) | -28% | -22%* | +2% |

*Note: discrepancies remain in the model results, specifically we are lacking a physical explanation for how the ‘Half width’ alternative can reduce peak velocity in the main channel without reducing tidal prism in Parsons Slough.

## Optimization of the structure (adaptive management)

The concept is that width and depth of the sill opening would be adjusted through an optimization process based on monitoring the achievement of project goals. This would ensure that currents are reduced but high quality existing habitat is not compromised. The structure would be adjusted through different configurations, with monitoring to compare the results against these targets. That process would last for perhaps five years following construction. The best configuration would then be selected based on criteria determined prior to construction. (Formerly, this approach was described as adaptive management, but since that term is somewhat vague, we will use the term optimization instead.)

After that intensive period, annual or seasonal adjustment is presently viewed as undesirable for cost reasons. The most feasible management scheme would settle on a fixed position after this period of adjustment, and then the structure would be left unchanged for several years at a time. Long term changes to conditions or changed management objectives would be the main reason for adjustments during that time. The preferred design would not require frequent operation or maintenance to provide lasting ecologic benefits.

In order to optimize the performance of the structure, we need to (1) specify numerical management targets and (2) identify feasible means of measuring performance in comparison to those targets. Each management target will require prioritization and specification of both ideal and acceptable values. The monitoring approach must consider temporal and spatial variability, with the challenge that the experiment will not be well controlled.

A variety of management targets and monitoring strategies may be appropriate. The following have been suggested, and other suggestions are requested:

- thalweg depth channel depth, rate of change
- peak current velocity
- change in slough sediment budget
- other changes in slough bathymetry and topography
- dissolved oxygen concentrations
- chlorophyll concentrations
- macroalgal abundance

- salt marsh extent
- salt marsh, rate of accretion
- sharks and rays: abundance or habitat utilization
- harbor seals: abundance or habitat utilization
- sea otters: abundance or habitat utilization
- small invertebrates: abundance or habitat utilization
- large invertebrates: abundance or habitat utilization
- shorebirds: abundance or habitat utilization

## Expected Effects

### Tidal scour

The "Full Width" configuration is not expected to reduce tidal scour in the main channel of Elkhorn Slough, because it does not reduce the tidal prism or substantially reduce main channel velocity. However, it would address tidal scour in Parsons Slough by acting to prevent downcutting, and by retaining sediment.

The "Narrow and Deep" configuration would reduce tidal prism and peak ebb current velocity in the Main Channel of Elkhorn Slough. This would likely reduce tidal scour. The degree of this effect has not been modeled. The analysis of the effect of the Parsons Slough Project on tidal scour by Philip Williams and Associates (posted here) assumed a 50% reduction in the Parsons Slough tidal, but this configuration would reduce it by 28%. They predicted that the Parsons Slough Project would reduce the rate of tidal scour by 40%, so the effect of the most restrictive configuration considered would likely be somewhat less than that.

Upstream of Parsons Slough, ebb tide channel velocities are predicted to *increase*. This would increase tidal scour in that portion of the slough, though the net effect of the structure would be to substantially decrease tidal scour overall.

### Salt marsh viability in Elkhorn Slough

The Parsons Slough Sill would have no direct effect on marsh dieback in Elkhorn Slough, but its indirect effects, while beneficial for salt marsh are difficult to quantify. It would help balance the overall sediment budget for the slough, but with different effects in different areas. It would increase the rate that the upper slough drains, which may decrease the duration of inundation in the upper slough, benefitting marsh there.

### Habitat types in Parsons Slough

The "Full Width" configuration would have minimal effects on habitat types in Parsons Slough, as the tidal range would remain unchanged.

The 'Narrow and Deep' sill configuration would substantially affect the tidal range in Parsons Slough, eliminating the low end of the tidal range and reducing the high end of the tidal range.

Salt marsh extent in Parsons Slough would increase around the perimeter and on islands. The magnitude of that effect would be in the low tens of acres, depending on the sill configuration.

Minimum water levels in the Parsons Slough complex would increase from – 0.6 meters (-2.0 feet) to +0.6 meters (+2.0 feet) in elevation. This would convert large areas of intertidal mudflat to shallow subtidal habitat. Approximately 200 acres of the intertidal mudflat could be affected. Maximum water levels would be reduced by approximately 0.3 meters (1.0 feet), which would promote the establishment of a band of salt marsh around the periphery of Parsons Slough. The acreage has not been determined, but could be about 20 acres. This habitat type conversion would represent a substantial shift in Elkhorn Slough habitats and whether this tradeoff is acceptable should be addressed by the group.

### Effects on species, fish and wildlife habitat use

Harbor seals, sharks and rays use the area for pupping, and the area may be important for the conservation of regional populations of these animals. Sea otters also use the area. Consulted experts with respect to sea otters (Lillian Carswell, USFWS) and sharks (Greg Calliet, MLML, and Aaron Carlisle, Hopkins Marine Station), have indicated that while a more restrictive structure may interfere with movement at some times, it would probably not have a significant effect on the populations. However, monitoring and managing the structure to reduce that risk may be warranted. Habitat conversion from intertidal mudflats to subtidal areas may also affect shark populations, as the intertidal mudflats are the preferred foraging areas, based on detailed data analysis by Aaron Carlisle.

Olympia oysters, other invertebrates and communities dependent on them such as shorebirds, may be adversely affected by the conversion of habitat from low intertidal mudflats to shallow subtidal habitats.

For sharks and Olympia oysters, Parsons supports a substantial fraction of the estuary populations.

### Effects on water quality in Parsons Slough

The 'Full Width" configuration would have little effect on the residence time of water in Parsons Slough, which generally suggests that the water quality would not be adversely affected. However, the structure could impede the export of algal mats from Parsons Slough, which would result in increased benthic oxygen demand over time. The importance of this effect is unknown.

The 'Narrow and Deep' configuration could have several effects on water quality, and would mute the tides to an extent that could impair water quality. The net effect of this configuration on dissolved oxygen and eutrophication is unclear, but could very likely be undesirable. It is affected by several factors:

- It would decrease the tidal prism by 28 percent and increase the residence time of Parsons Slough by 40 percent. This could result in warmer water, higher primary productivity, increased water column and benthic oxygen demand and decreased dissolved oxygen conditions.
- It would also decrease current velocity in Parsons Slough by up to 40 percent and peak tidal range by up to 60 percent, which could increase stratification and reduce dissolved oxygen concentrations near the bed.

- This configuration would convert approximately 200 acres of intertidal mudflat to shallow subtidal habitats. This would increase the average depth of Parsons Slough. The net effect on dissolved oxygen is unclear. The modeling work done by Ken Johnson on the Elkhorn Slough suggests that the deeper water, by providing a larger reservoir of dissolved oxygen, generally results in higher concentrations of water column dissolved oxygen.
- The same work, however, pointed out that mudflats, when exposed to the atmosphere at low tide exert their benthic oxygen demand on the atmosphere rather than the water column. Under this configuration, the sediment oxygen demand from these former mudflats would be exerted entirely on the water column, which could counter the benefits of a deeper water column.

**Project costs**

Estimate of project costs range from $3 million to $4 million, depending on the specific construction methods, the timeline for implementation, the complexity of the regulatory compliance process, the type and intensity of monitoring, and other factors. While funding construction is not likely to be an issue, funding the final design, regulatory compliance and optimization monitoring elements is more challenging.

**Funding efforts**

Tidal Wetland Project staff are pursuing multiple funding sources to preserve the option of moving the project ahead, including the following:

- NOAA Restoration Center via the America Recovery and Reinvestment Act (the fiscal stimulus)
  - Funding request includes all phases of design and implementation, including a robust monitoring program
- NOAA Restoration Center via the Community Restoration Program
  - Includes request for planning, including developing the optimization (adaptive management) plan
- Army Corps of Engineers Estuary Restoration Program
  - Includes request for planning and partial funding of construction
- US Fish and Wildlife Coastal Wetlands Conservation Program
  - To includes request for the final design, permitting and development of the optimization program

These funding requests could cover final planning, construction and/or the optimization and adaptive management monitoring component, depending on the funding source. The timeline for hearing about these sources ranges from June 2009 through January 2010.

**A Critical Partnership: The Union Pacific Railroad**

Restricting tidal exchange into Parsons Slough requires collaboration with the Union Pacific Railroad, which owns part of the site where the sill would be placed. They have written a letter broadly supporting the project but they will require review of the final design. The sill is likely to increase the long term viability of the tracks, which are adversely affected by tidal scour. However, the railroad has specific requirements related to the tracks being overtopped by extremely high tides. The structure would be designed under those constraints. The project would pay for technical review costs incurred by the railroad, and portions of the tracks may be raised as part of the project.

### Questions and comments

Feel free to contact me with any questions or comments: bryan@elkhornslough.org, 831-728-2822, x308.

### Timeline for the Parsons Slough Project

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|---|---|
| Prehistory to 1870 | Site dominated by extensive tracts of tidal marsh |
| 1870 | Southern Pacific Railroad construction separates the area from main channel |
| 1870-1982 | Piecewise, the entire area is diked and drained for agriculture |
| 1982-83 | The intentional and accidental breaching of dikes returns tidal exchange returns to the area. Tidal scour in Elkhorn Slough accelerates |
| 2005 | Tidal Wetland Project specifies Parsons Slough restoration as an important strategy to reduce tidal scour and marsh loss in Elkhorn Slough |
| 2007 | USEPA, the Coastal Conservancy and the David and Lucille Packard Foundation support development of the Parsons Slough Restoration Plan, for completion in March, 2009 |
| 2008, December | The state of California freezes the expenditure of bond funds. The report preparation work by the consultant team halts. |
| 2009 January through present | Tidal Wetland Project Staff continue to collaborate with the consultants using other funds. They develop the adjustable sill concept, and seek new funding for final planning, design and implementation phases of the project |
| 1.5 to 5 years into the future | Construction of the project could be completed, depending on funding and final planning steps |

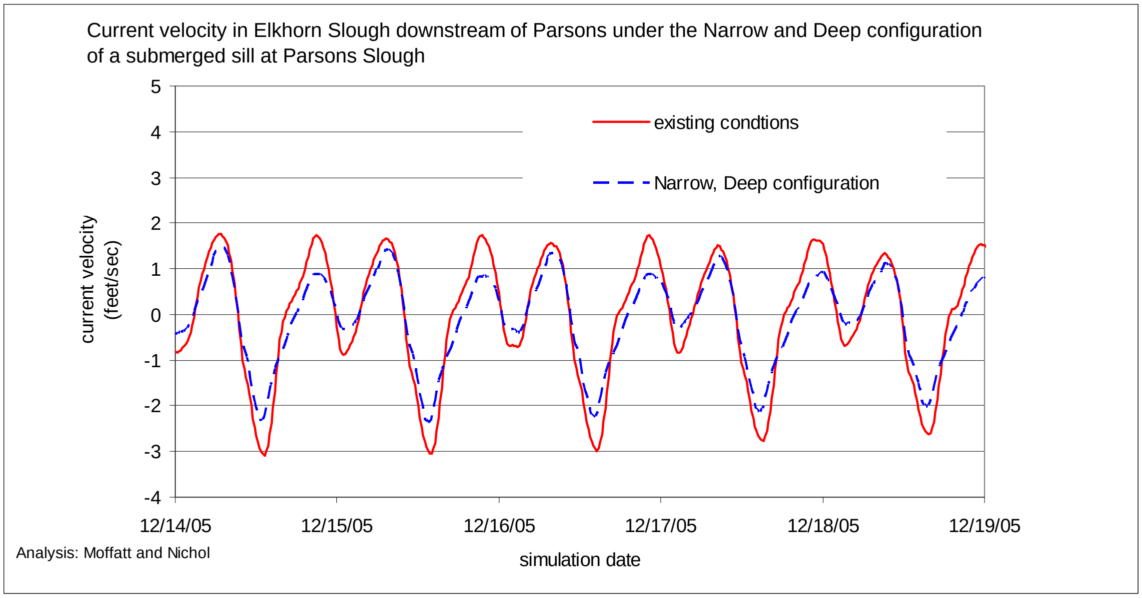


Figure 1. Tidal current velocity in Elkhorn Slough under the most restrictive settings of the adjustable sill. The least restrictive settings would result in negligible reduction in velocity. Based on unpublished modeling results by Moffatt and Nichol.

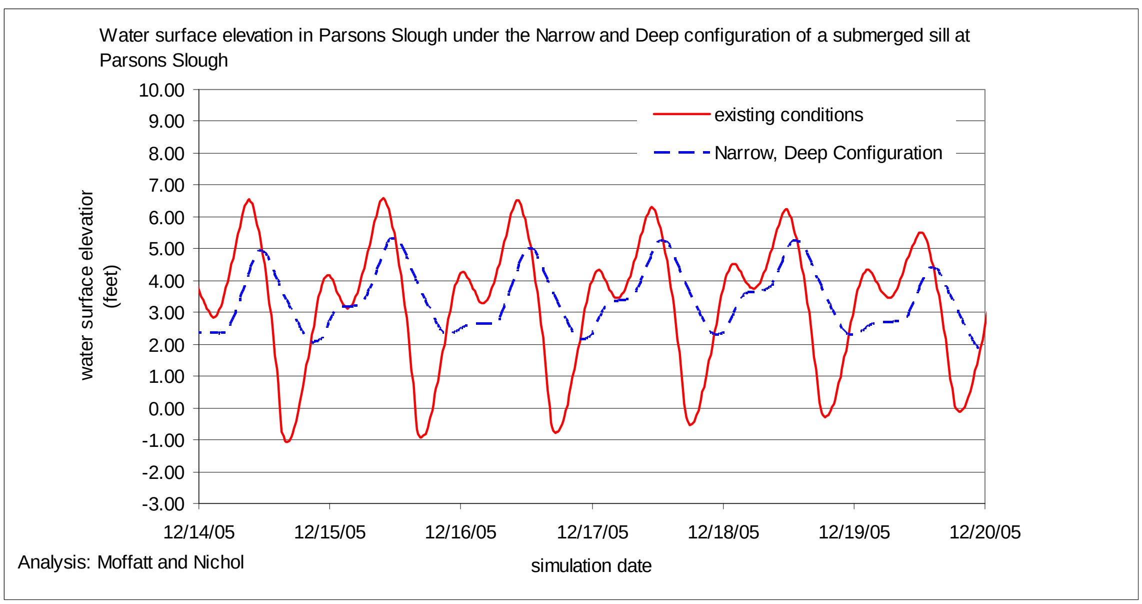


Figure 2. Tidal range in Parsons Slough resulting from the most restrictive setting of the sill. The least restrictive settings would result in no change to tidal range in Parsons Slough. Based on unpublished modeling results by Moffatt and Nichol.

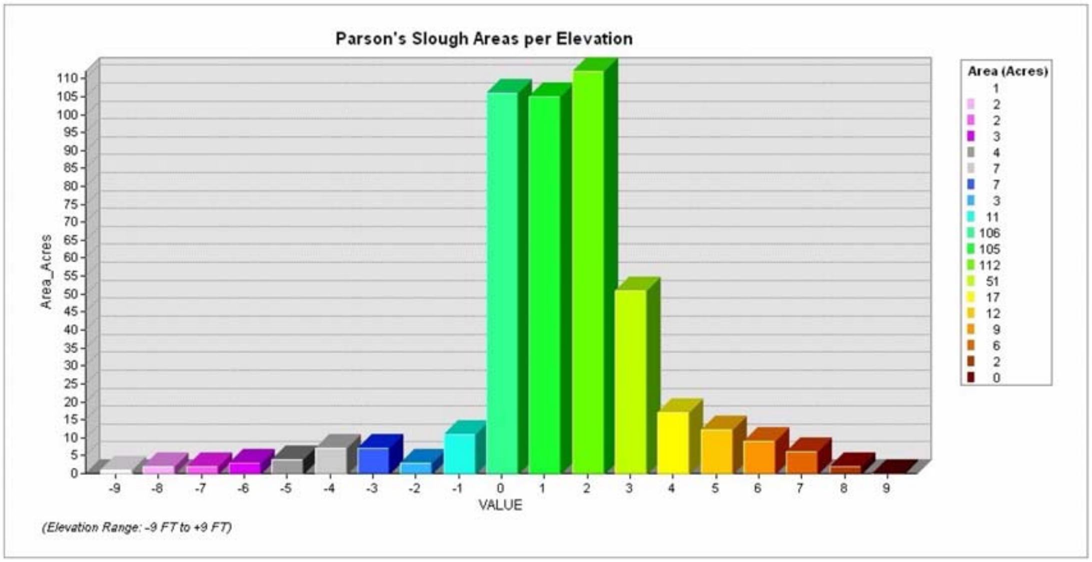


**Figure 11 - Areas at Each Elevation Within the Parsons Complex**

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Figure 3. Areal extent of different elevation classes in Parsons Slough

This figure appears in the Moffat and Nichol Existing conditions report. The most restrictive configuration of the sill would shift the 104 hectares (211 acres) in the 0 and 1 foot elevation band from intertidal mudflat to subtidal habitat. The least restrictive settings would not result in substantial shifts to habitat types.