Appendix G. Priority Projects to Inform Restoration Planning and Implementation

The main criteria used by the Science Panel and Strategic Planning Team for prioritizing projects was how much the project would help with decision-making about estuarine habitat restoration planning and/or implementation efforts. The top 10 priority projects are underlined below.

A. Are increases in tidal inundation the primary cause of interior marsh loss and degradation?
Project: Evaluate marsh tidal hydrology and inundation. *Purpose:* Find out if the tidal range, duration, and inundation frequencies are the primary mechanism for the spatial patterns of marsh loss. *Funded:* ESNERR will install secondary tide stations. *Unfunded:* Studies to determine if (a) Marsh surface drainage is inhibited in some areas causing marsh plant die-back; (b) If tidal inundation increases upstream such that marsh loss rates are higher in the upper Slough, (c) Increased tidal inundation and/or poor drainage is causing anoxic conditions in subsurface marsh sediment resulting in plant die-back; (d) Groundwater overdraft is/has caused subsidence leading to increased tidal inundation; (e) If increases in sea-level rise in recent decades have resulted in increased inundation, and (f) Compile a document to explain the likely roles of regional sea-level rise, local groundwater extraction, locally increased tidal range, and tectonics on increased tidal inundation.

B. Can changes to sediment supply help explain estuarine habitat loss and degradation? Will restored marshes be sustainable?
Project: Evaluate marsh sediment sources, distribution, and fate. *Purpose:* Understand marsh sedimentation rates and characteristics so that restoration projects can address as many of the driving factors as possible. *Funded:* ESNERR plans to hire a consultant to install sediment elevation table (SET) stations in a small number of areas to compare marsh sediment accretion rates in degrading versus reference areas. *Unfunded:* (a) Measurements of organic/inorganic marsh sediment characteristics; (b) Expansion of SET location monitoring to include potential restoration sites and existing muted tidal flow sites and analysis of SET data with aerial photos to use inundation levels to determine elevation contours; (c) Measurements of marsh sediment cohesion differences.

Project: Create a sediment budget for Elkhorn Slough to understand the current and historical sources of sediment. *Purpose:* Quantify existing and historic sediment sources to determine if marsh restoration (particularly sediment addition) projects would be sustainable in the long-term. *Unfunded:* (a) Collect field samples to quantify suspended sediment loads in tidal waters (*requested)*; (b) Quantify inputs from marine, terrestrial, and fluvial sources; (c) Characterize the current (Old Salinas River channel, Carneros Creek, littoral drift) and past supply (episodic events, Salinas River, Pajaro River) of sediment (field sampling, coring, lab analysis); (d) Report on possible contributions of sediment during episodic events; (e) analyze turbidity data from the LOBO water quality buoys; (f) quantify the sediment plume.

C. Does pollution contribute to estuarine habitat loss and degradation?
Project: Evaluate chemical (i.e. pesticides) and nutrient (i.e. nitrate) pollution. *Purpose:* Understand the role of chemical and nutrient pollution in marsh loss so that restoration projects can address as many of the factors as possible. *Funded:* MBARI and ESNERR monitor real-time and long-term water quality conditions of channel waters. *Unfunded:* (a) Measurements of belowground biomass of marsh vegetation to determine if plant roots are weakened by high nutrient loads; (b) Literature review of vegetation and organism tolerances of chemicals and nutrients; (c) Monitoring levels of chemical pollutants in Elkhorn Slough and field studies with controlled nutrient and herbicide treatments; (d) Literature review of nutrients effects on *Ulva* and smothering effects of *Ulva* on salt marsh.

Project: Analyze benefits of wetland buffers. *Purpose:* Use wetlands as buffers to improve water quality for the estuary. *Funded:* RCD, MLML, and CSUMB. *Unfunded:* (a) Evaluate what ecological and water quality benefits would be improved by using different levels of created/restored wetlands as buffers.

D. What medium and large-scale potential alternatives to conserve, enhance, and restore estuarine habitats are feasible?

Project: Create designs for and predict how muting the tidal prism at the Parsons Slough mouth and/or sediment additions in the project area would impact estuarine habitats in the project area and system-wide. *Purpose:* Build support for a preferred tidal wetland restoration project for Parsons Slough. *Unfunded:* (a) Assessment of current site conditions; (b) Preliminary designs of water control structures; (c) Detailed description of sediment addition strategies to restore marsh elevations; (d) Predictions about changes to the tidal hydrology, estuarine habitats, and water quality both system-wide and for the project area comparing different water control structures and sediment addition strategies (includes no action); (e) Understanding of permitting requirements for sediment additions (*a-e requested*); (f) Study where the productivity is coming from that results in hypoxia in Parsons Slough to understand the effects of muting tidal exchange; (g) Understand how water control structures can be designed to maximize fish access.

Project: Create designs for large-scale restoration alternatives (including no action) and predict how different options would change the tidal hydrology, geomorphology, estuarine habitats, ecology, water quality, and human use. Numeric modeling efforts need to predict geomorphic change to estuarine habitats. *Purpose:* Understand if large-scale restoration alternatives are technically feasible and if the habitat benefits are better than the no action alternative so decisions can be made to pursue them or not. *Funded:* Stanford University constructed and is refining (will be adding tidal velocities from Old Salinas River channel) a 3-D hydrodynamic model for Elkhorn Slough; and ESNERR plans to hire consultants for numeric modeling and cost estimates of potential alternatives, MBARI will predict water quality changes, CSUMB will predict human use changes, ESNERR/TWP SP will predict habitat and ecological changes. *Unfunded:* (a) Expand numeric model to include ecosystem components such as wetland and biogeochemical processes (i.e. also include the role of plants and infauna in trapping and making sediment and increased friction); (b) Literature review of similar projects so that we can learn from the successes and failures of similar estuarine restoration project around the world; (c) Use of hydrodynamic model to predict the 1945 conditions before opening and then after the new harbor to see if it can predict today's bathymetry to verify model and for future predictions about areas of erosion and deposition and velocity under different potential restoration alternatives (including no action); (d) Study if a newly constructed mouth and channel for Elkhorn Slough would seasonally close, and if so, how for how long; (e) Study of changes to sediment loads in the harbor of different restoration options; (f) Understand how wide the mouth of Elkhorn Slough would have to be to slow the velocities, (g) Understand what alternatives would be most adaptable to a future rise in sea level, (h) Consider the unintended consequences of different restoration projects.

Project: Understand the permitting structure for wetland restoration projects that reuse sediment. *Purpose:* Look for opportunities to streamline permitting process to make wetland restoration projects that involve aspects such as sediment additions more feasible. *Funded:* CSUMB will create report on wetland permitting for Elkhorn restoration projects. *Unfunded:* (a) Create report of possible sources and characteristics of sediment that could be used to rebuild marsh elevations perhaps using SF Bay LTMS as a model (*requested*).

Project: Quantify how the head of the Monterey Canyon is changing over time. *Purpose:* Understand the sustainability of large-scale projects at the mouth of Elkhorn Slough. *Funded:* CSUMB

E. What small-scale potential alternatives to conserve, enhance, and restore estuarine habitats are feasible?

Project: Evaluate methods to enhance the functions and long-term sustainability of marsh complexes behind water control structures. *Purpose:* Identify areas and methods where improved tidal flushing could minimize hypersalinity issues or sustain marsh vegetation, tidal erosion and marsh loss could be reduced, and subsided marsh elevations could be built up through sediment additions (so if the system in the long-term becomes less erosive, the water control structures could be removed). *Unfunded:* (a) Measure subsurface salinity levels to understand if salt marsh vegetation in marshes with no tidal exchange will persist; (b) Describe and prioritize

wetland enhancement projects that include the alteration water control structures including Bennett Slough, the Old Salinas River Channel, North Marsh, Estrada Marsh, and Blohm-Porter Marsh (portions east and west of Blohm Road); (c) Describe and prioritize wetland enhancement projects that include sediment additions to build up marsh elevations.

Project: Evaluate methods and conduct restoration experiments to explore the feasibility of adding or retaining sediment behind temporary structures (earthen levees, sediment fences, etc.). Projects could be in areas such as marshes along the main channel in the upper Slough or in the fingers within Parsons Slough. *Purpose:* Find out the feasibility of raising the elevation of marshes through sediment addition or retention methods to reduce marsh degradation and loss in the short and/or long-term. *Unfunded:* (a) Project description and analysis for small-scale sediment additions and/or retention projects; (b) Pilot restoration projects to retain or add sediment to build marsh elevations.

Project: Spartina analysis. *Purpose:* Explore the feasibility of use of *Spartina foliosa* plantings to decrease impacts of tidal erosion. *Unfunded:* (a) Literature surveys and expert analysis to determine 1) whether *Spartina* would be likely to survey if planted at the Slough, and in what sorts of locations/elevations; 2) feasibility of introducing only the native species, without contamination by invasive species or hybrid, 3) predictions of the consequences for depositional processes and habitat extents (would extensive mudflats be lost?).

F. Can historical conditions give us guidance on the types and extent of estuarine habitats to conserve and restore?

Project: Characterize historical estuarine habitat types and salinity conditions (150-5000 years before present). *Purpose:* Inform decisions about which restoration and conservation alternatives to pursue. *Funded:* NERR fellow has taken limited marsh sediment cores to determine the age of marsh in various regions. *Unfunded:* (a) More thorough coring effort to determine the range of past habitat types (150-5000 years before present) which could include a comparison of marsh age and distance from the channel through carbon or pollen dating; (b) Coring efforts to determine if cordgrass was historically present; (c) Studies to determine if the Elkhorn Slough mouth seasonally closed historically; (d) Conceptual model of estuarine geomorphology.

Project: Characterize regional estuarine habitat trends to determine the relative loss rates of different estuarine marsh habitat types for the Central Coast. *Purpose:* Inform decisions about which restoration and conservation alternatives to pursue. *Funded:* State Wetlands Program Demonstration Project. *Unfunded:* (a) Literature review and discussions with regional experts about past and current status of regional estuarine habitats; (b) Field trips for Elkhorn Slough folks to learn about other estuarine systems and restoration projects, (c) Locate and characterize control sites for Elkhorn restoration projects, (d) Finalize National Wetland Inventories for the Elkhorn Slough Watershed.

G. How can characterizing current conditions and past trends of estuarine habitats help predict future ecological changes?

Project: Understand ongoing changes to Elkhorn Slough bathymetry. *Purpose:* Quantify rates of tidal erosion and deepening and widening of main Elkhorn Slough channel to build support for possible restoration actions and help predict future changes under different restoration scenarios. *Funded:* CSUMB to measure bathymetric changes. *Unfunded:* (a) Analyze the spatial patterns of deepening and widening of the tidal channel and creeks to create a five-year projection of bathymetric changes and/or 50-year range of projections.

Project: Quantify changes to invertebrate and macroalgae communities over time. *Purpose:* Understand ecological changes over time and possible causes of those trends and help predict future ecological change under similar conditions. *Funded:* MLML characterizing the benthic and planktonic communities of Elkhorn Slough. *Unfunded:* (a) Quantify the extent of intertidal mudflat along the main channel that has been lost to predict changes from tidal erosion; (b) Describe the effects eroded subtidal habitats have on the amount of prey for southern sea otters and fish species.

Project: Compare functions of different habitat types. Purpose: Describe how the conversion of salt marsh to mudflat or channel habitats effects estuarine indicators. *Funded:* ESNERR GIS habitat analysis, water quality, and ecological research. *Unfunded:* (a) Examine ecosystem services of vegetated versus unvegetated habitats through literature reviews, field studies of particular guilds, or use of isotopes to determine relative contribution of marsh or eelgrass C and N versus algal sources; (b) Compare habitat use of degraded versus healthy estuarine habitats (i.e. sparsely vegetated marshes versus dense marshes, scoured versus less scoured tidal channels); (c) Comprehensive studies and monitoring of Elkhorn Slough's ecological communities over time (both before, during, and after restoration/conservation projects).

Acronyms

ESNERR - Elkhorn Slough National Estuarine Research Reserve, MLML - Moss Landing Marine Laboratories, CSUMB - California State University at Monterey Bay, MBARI - Monterey Bay Aquarium Research Institute, TWP SP – Tidal Wetland Plan Science Panel, RCD-Resource Conservation District