

Elkhorn Slough National Estuarine Research Reserve

Research Questions

The following are the major questions that ESNERR scientists are currently addressing through long-term monitoring and short-term applied research. These represent questions whose answers are critically needed for improving Elkhorn Slough area conservation, and which lend themselves to the expertise and resources of ESNERR.

1) ESTUARINE HABITATS

What are the spatial and temporal dynamics of estuarine water quality and weather?

Background: Water quality is considered one of the best indicators of estuarine ecosystem health. We want to detect long-term changes over time, short-term changes related to diurnal effects, tides, and weather, and spatial patterns.

Approach: Conduct continuous in-situ monitoring of water quality at four stations in Elkhorn Slough, collect weather data at one of these, and nutrient data monthly at these four stations. Sample water quality and nutrients monthly at four stations in the Elkhorn Slough area. Synthesize these data into annual water quality report cards. Analyze data to determine factors that predict low oxygen events.

Who: Haskins, Preisler (with G. Lessa, M. Rodriguez, L. Mercado)

What are sources of nutrient loading to the estuary?

Background: High nitrate concentrations are measured in the South Moss Landing Harbor at the Potrero tide gates. But which tributaries contribute the most to these loads and concentrations? And how are these sources changing over time? Are management changes resulting in water quality improvement?

Approach: Deploy ADCPs to measure flow and use these data along with nutrient data to model nutrient sources and loading.

Who: Haskins, Hughes

How can hypoxia be reduced in managed wetlands?

Background: Some wetlands managed by ESNERR and ESF must remain behind water control structures. These areas typically experience frequent low oxygen conditions.

Approach: Adaptive management experiments, monitoring water quality in response to manipulations of water control structures or deployment of additional structures to direct flow.

Who: Haskins (and other staff and volunteers)

How does climate and hypoxia affect fish production in the estuary?

Background: Fish abundance and diversity appears sensitivity to interannual differences in weather and in oxygen conditions. This can result in large differences in fish production.

Approach: Correlate fish data to water quality and weather data.

Who: Hughes, Fountain (with M. Levey, M. Gleason)

How sensitive are different estuarine indicators to climate change?

Background: With 10+ years of monitoring data for multiple indicators, we can determine how much interannual variation in responses is driven by changes in climatic variables

such as temperature and rainfall. Indicators that are responsive to interannual differences in weather will be sensitive to predicted climate change.

Approach: Correlate abundance of estuarine organisms and conditions of estuarine habitats from long-term monitoring programs to weather data.

Who: Wasson, Fork, Haskins, Preisler, Endris, D'Amore, Hughes

How is extent and distribution of wetland habitats changing over time?

Background: We have detected major changes in the distribution and abundance of estuarine habitat types over the past century. We continue to follow changes to inform restoration and management strategies.

Approach: Monitor changes to extent of different intertidal estuarine habitat types with aerial imagery, and broad intertidal elevation with LiDAR.

Who: Endris

What were historical conditions of estuarine wetlands at Elkhorn Slough?

Background: Human activities have greatly changed the extent and conditions of estuarine habitats at Elkhorn Slough. Better understanding of baselines can guide restoration targets and inform feasibility.

Approach: Synthesize historical documents and maps to characterize historical conditions.

Who: Woolfolk

What are the major causes of salt marsh degradation in undiked areas?

Background: There has been extensive dieback of salt marsh in some Slough regions in recent decades, while other regions have been quite stable. Understanding the causes of marsh loss will help us to better conserve and restore it.

Approach: Characterize drivers of marsh stability vs. health, including sediment deposition rates, marsh plain elevation, and tidal inundation patterns to better understand patterns and mechanisms of marsh loss. Examine role of below-ground decomposition. Conduct field experiments to examine role of biological factors such as macroalgal mats and crab burrowing in contributing to marsh loss, particularly at bank edges.

Who: Endris, Woolfolk, Wasson, Preisler, Fountain (with R. Eby, E. Watson)

How can sediment addition best be used to restore subsided salt marshes?

Background: Diked marshes subsided so much that when tidal water was returned, the areas were too low (inundated too much of the time) to support marsh. We can restore some of these formerly diked areas through beneficial re-use of sediments, but many questions remain about best methods in this estuary, with faster currents and lower sediment concentrations than other areas where sediment addition has been successfully conducted.

Approach: Use science-based approach to inform design of marsh restoration projects, and then conduct extensive monitoring of indicators of restoration success to inform adaptive management.

Who: Fountain, Endris, Woolfolk, Wasson, Haskins

Are Slough mudflats and banks undergoing deposition or erosion?

Background: Subtidal habitats in the estuary have been shown to be eroding rapidly in the lower estuary. What is happening in intertidal habitats, and how does this vary by Slough region?

Approach: Terrestrial laser scanning provides detailed analysis of changes in topography at long-term monitoring sites. These results can be compared to more crude measures from field bank erosion measurements or analysis of aerial photographs.

Who: Endris (with I. Aiello)

How is the boundary between estuarine wetlands and uplands migrating over time?

Background: The marsh-upland ecotone harbors the greatest diversity of native marsh plants, yet is potentially very susceptible to human disturbances from the upland as well as from changes to tidal hydrology.

Approach: Track changes in ecotone width and location over time, and correlate changes to inundation frequency.

Who: Wasson, Woolfolk (with C. Fresquez)

What is distribution of brackish plants?

Background: Brackish plant communities have declined in abundance at Elkhorn Slough over time. We know little about the remaining patches.

Approach: GPS brackish plant communities and attempt to correlate their abundance with physical factors using GIS analysis.

Who: Woolfolk

What are spatial and temporal trends of waterbird use of Elkhorn Slough area habitats?

Background: Wetlands provide key habitat for migratory shorebirds and other waterbirds. We want to better understand spatial variation in habitat use within the Slough and between the Slough and other wetlands in the region, and we want to detect any marked declines in any species in order to mobilize further research into geographical scope and possible causes of the decline.

Approach: We carry out Slough-wide monitoring of waterbirds twice during fall and twice during spring migration, and will compare our findings to those of Morro Bay and eventually other regional estuaries. We carry out monthly monitoring of waterbirds on the Reserve.

Who: Fork, Murphy (and many volunteers)

How is habitat use by breeding egrets, herons, and cormorants changing over time?

Background: We are interested in tracking the numbers of nesting birds over time, as well as changes to their reproductive timing. We also want to detect any major breeding failures.

Approach: Monitor nesting numbers, reproductive success.

Who: Wasson, Murphy (and other volunteers)

How are mudflat communities near the mouth changing over time?

Background: The mudflats near the Elkhorn Slough mouth are potentially affected by numerous anthropogenic alterations (tidal erosion, power plant intake, harvesting, pollution). We want to be able to detect declines in abundance of key species.

Approach: Annually monitor permanent transects at four sites near the mouth (and one on the Reserve) for large clams, worms, eelgrass, and macroalgal cover.

Who: Fork, Wasson, Preisler (with volunteers)

How are crab communities in the estuary changing over time?

Background: The European green crab invaded Elkhorn Slough in 1994. We are interested in potential effects of this species on native crabs. We also wish to detect new crab invasions (e.g., Mitten Crab), ideally early enough to allow for eradication.

Approach: Annually monitor crab abundance using minnow traps at two permanent sites in the Slough.

Who: Fork, Preisler

What conditions favor native oysters in Elkhorn Slough?

Background: Native oysters increase biodiversity and water quality, but have declined precipitously at most Pacific estuaries. Oysters show great spatial and temporal variability in abundance.

Approach: Conduct correlative field studies and small-scale restoration experiments to determine the factors that favor native oysters vs. non-native fouling invertebrates in Slough habitats.

Who: Wasson, Fork (with C. Zabin)

How do sea otters use estuarine habitats, and how is this changing over time?

Background: Otters colonized Elkhorn Slough in the 1980s. Since then, their numbers have increased, and so has the extent of the estuary that they are using. The estuary appears to support especially dense mother-pup pairs, perhaps due to benign conditions (marshes for hauling out, abundant food, etc.). However, otters also face threats from contaminants.

Approach: Track distribution, abundance, behavior and foraging of otters in the estuary, at a basic level for long-term monitoring, and intensely from 2013-2015 as a grant-funded collaboration led by UCSC/USGS/MBA.

Who: Eby, Scoles, Wasson (with T. Tinker, M. Staedler, B. Weitzman and others)

How do sea otters affect estuarine vegetation?

Background: Otters consume crabs, which can have strong effects on seagrass through consumption of grazers. Crabs also appear to contribute to bank erosion and may lead to marsh loss.

Approach: Conduct experiments to assess effects of crabs and otters on seagrass/macroalgal boundaries and marsh/mudflat boundaries.

Who: Hughes, Eby, Wasson, Woolfolk (and K. Beheshti)

What are appropriate educational programs to effect beneficial changes in policy and management that will benefit the health and sustainability of the Elkhorn Slough?

Background: There have been a number of approaches to educating decision makers about the Slough, and there have been a variety of means employed to evaluate the success of these programs or the types of educational needs of the decision makers for future programs. Evaluation and needs assessment data have not been systematically analyzed, and medium-long term evaluations are needed to further improve our approaches.

Approach: collect existing evaluation and assessment data, analyze these, and build a new evaluation system for medium to long term assessment. Second step to perform programmatic evaluation of the Coastal Training Program and other efforts for tidal wetlands training foci and recommend future steps.

Who: Hayes

2) FRESHWATER AND RIPARIAN HABITATS

What restoration strategies can support a habitat corridor for Santa Cruz Long-toed Salamanders and California Red-legged Frogs in the eastern Elkhorn Slough watershed?

Background: Federally endangered Santa Cruz Long-toed Salamanders have a highly restricted range, breeding in only about a dozen wetlands, including three in the eastern Elkhorn watershed. Enhancement of these wetlands and restoration of other wetlands and terrestrial habitats between them can support these endangered populations and facilitate dispersal between them. This will also help to benefit federally threatened California red-legged frog populations.

Approach: Bring together regional partners in land management and conservation to design, implement and monitor restoration of freshwater habitat and habitat enhancement strategies in this corridor.

Who: D'Amore, Candiloro (with K. Hayes)

How are patterns of amphibian and reptile usage of Reserve ponds changing over time?

Background: To inform management of Reserve ponds, we want to understand temporal and spatial trends in species usage in pond and guzzler habitat.

Approach: Monitor amphibians and reptiles using visual encounter surveys and surveys for egg masses and larvae.

Who: D'Amore, Fork, Candiloro (with V. Hemingway).

What are appropriate educational programs to effect beneficial changes in policy and management that will benefit the sensitive amphibians and reptiles on California' central coast?

Background: There have been a number of approaches to educating decision makers about sensitive amphibians and reptiles, and there have been a variety of means employed to evaluate the success of these programs or the types of educational needs of the decision makers for future programs. Evaluation and needs assessment data have not been systematically analyzed, and medium-long term evaluations are needed to further improve our approaches.

Approach: collect existing evaluation and assessment data, analyze these, and build a new evaluation system for medium to long term assessment. Second step to perform programmatic evaluation of the Coastal Training Program and other efforts for sensitive amphibian and reptile training foci and recommend future steps.

Who: Hayes

3) COASTAL PRAIRIE

What strategies are most effective for enhancing native prairie assemblages on the Reserve?

Background: The Reserve grasslands are highly invaded due to changes in disturbance regimes, introduction of invasive species, and earlier agricultural management of the lands. We

wish to better understand the consequences for a variety of conservation targets (native grasses, annual forbs, perennial forbs) of differing management strategies.

Approach: Restoration experiments examining effects of strategies such as planting, mowing, and grazing on different indicators. Monitor effects of a recent prairie fire.

Who: Woolfolk, Hayes, Hamza

What are appropriate educational programs to effect beneficial changes in policy and management that will benefit coastal prairie on California' central coast?

Background: There have been a number of approaches to educating decision makers about coastal prairie, and there have been a variety of means employed to evaluate the success of these programs or the types of educational needs of the decision makers for future programs. Evaluation and needs assessment data have not been systematically analyzed, and medium-long term evaluations are needed to further improve our approaches.

Approach: collect existing evaluation and assessment data, analyze these, and build a new evaluation system for medium to long term assessment. Second step to perform programmatic evaluation of the Coastal Training Program and other efforts for coastal prairie training foci and recommend future steps.

Who: Hayes

4) MARITIME CHAPARRAL

What are appropriate educational programs to effect beneficial changes in policy and management that will benefit maritime chaparral on California' central coast?

Background: There have been a number of approaches to educating decision makers about maritime chaparral, and there have been a variety of means employed to evaluate the success of these programs or the types of educational needs of the decision makers for future programs. Evaluation and needs assessment data have not been systematically analyzed, and medium-long term evaluations are needed to further improve our approaches.

Approach: collect existing evaluation and assessment data, analyze these, and build a new evaluation system for medium to long term assessment. Second step to perform programmatic evaluation of the Coastal Training Program and other efforts for maritime chaparral training foci and recommend future steps.

Who: Hayes

5) COAST LIVE OAK

What are the costs and benefits of pocket understory restoration projects?

Background: Volunteers have begun "adopting" small areas of oak woodland, removing non-native species and planting natives.

Approach: Assess the value of these small-scale citizen-restoration projects to the participants themselves as well as to wildlife use and to native plant abundance and diversity both within and adjacent to the pocket restoration sites.

Who: Candiloro, Fork, Wasson (and volunteers)

What are the long-term trends in cavity nesters?

Background: As an indication of oak woodland health, we are interested in cavity nesting birds. Long-term trends might result from climate change (earlier breeding), sudden oak death epidemic (low breeding success), etc.

Approach: Monitor 150 nestboxes in oak woodlands to determine which species occupy them, fledging success, parasitism, and timing of reproduction.

Who: Fork, Murphy (with other volunteers)

What are appropriate educational programs to effect beneficial changes in policy and management that will benefit coast live oak woodland on California' central coast?

Background: We have not yet formed a program to educate decision makers about coast live oak woodland, although we have clear methodologies for evaluating the educational needs of the decision makers for future programs that will be required to increase conservation of this target.

Approach: Use existing audience needs assessment methodologies to inform a plan to proceed with training programs focusing on coast live oak woodland.

Who: Hayes

How does cattle grazing affect plant cover and composition in coast live oak understory?

Background: A cattle grazing experiment in Reserve grasslands extends into adjacent oak woodlands. In order to assess the effects of cattle in this habitat, we are monitoring understory plants.

Approach: Sample and compare plant cover and composition in paired grazed and ungrazed transects.

Who: Candiloro

Feel free to contact the lead ESNERR scientist for each question if you want to learn more about our work:

Candiloro, Bree (bree@elkhornslough.org)
D'Amore, Antonia (Nina) (nina@elkhornslough.org)
Eby, Ron (roneby3@gmail.com)
Endris, Charlie (charlie@elkhornslough.org)
Fork, Susie (skfork@gmail.com)
Hamza, Corey (corey@elkhornslough.org)
Haskins, John (john@elkhornslough.org)
Hayes, Grey (grey@elkhornslough.org)
Hughes, Brent (brent@elkhornslough.org)
Murphy, Shirley (smurpbird@gmail.com)
Preisler, Rikke (rikke@elkhornslough.org)
Wasson, Kerstin (kerstin.wasson@gmail.com)
Woolfolk, Andrea (amwoolfolk@gmail.com)

There is also another document available from the research homepage of www.elkhornslough.org that lists high priority questions suitable for students and other researchers to address – those are the questions we're not tackling, but hope someone does!