Status and Trends of Fish and Invertebrate Assemblages in the South Bay Salt Pond Restoration Programs Restorations Ponds

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Problem statement: Greater than 90% of tidal wetland habitat was reclaimed for urban and agricultural uses in the San Francisco Bay Estuary. Significant efforts are underway to return 15,100 acres of industrial solar evaporation ponds in South San Francisco Bay to tidal wetlands for wildlife.

Approach: The objective of this study was to monitor the spatial and temporal variability of fish species composition and relative abundance in newly restored salt ponds and adjacent slough habitats using boat based trawling (otter trawl), Bimonthly to monthly monitoring was conducted from July 2010 up through March 2013, at 2-3 sites in Alviso Slough, 3-6 sites in Coyote Creek, and 3 sites in A21, and A19 and in 1 site in A6.

Results: For this summary we examined the seasonal variability of the 10 most abundant fish species and the most abundance invertebrates (mysid and Crangon shrimp). Distinct seasonal patterns fish assemblages were apparent with summer species assemblages comprised of juvenile Pacific staghorn Sculpin, Northern anchovies and English sole, while the winter assemblage included Pacific Herring, American Shad and the State threatened Longfin Smelt. The mysid shrimp (comprised of several species) was in greatest rank abundance during the winter and into the early summer, while Crangon shrimp were abundance year round; however a clear pattern of recruitment of juveniles occurred during the spring-summer months.

Conclusions/Relevance: These patterns highlight the value of the Alviso Marsh system as a vital nursery area for several key species of the nearshore marine food web the estuarine food web (Pacific Staghorn Sculpin and crangon shrimp) and winter feeding grounds for Longfin Smelt. This study also observed the greatest abundance of mysid shrimp in the estuary and documents the overall benefits of restoring former salt ponds to tidal marsh habitats.

Keywords: Restoration, longfin smelt, american shad, mysid shrimp South Bay

Poster topic: Species Communities

Summer vs. Winter: Estimating the Conservation Value of Riparian Habitat to Birds throughout the Annual Cycle

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The winter season plays a key role in regulating avian populations, and a large number of species spend the winter in riparian habitat, yet riparian habitat conservation plans remain focused on breeding bird communities. Because a significant proportion of winter bird communities are made up of boreal breeding birds, which are threatened by accelerating rates of development and climate change, there is an important research and conservation opportunity in creating and maintaining high quality riparian habitat for wintering birds. To examine the value of riparian habitat to wintering birds, we compared the species richness and phylogenetic diversity of the summer and winter riparian bird communities in the Cosumnes River and lower Putah Creek watersheds. We found that the winter bird communities were just as species rich and more phylogenetically diverse than the breeding bird communities, suggesting that the value of this riparian habitat is high throughout the year. Further, nearly all of the winter visitors are boreal breeding birds, 32% of which are significantly declining. Thus, the impact of one riparian habitat conservation project could be maximized by considering the needs of winter bird communities. Our results underscore the need for additional research on winter ecology and consideration of how to restore and manage riparian habitat for winter birds.

Keywords: Avian Populations, Winter Season, Riparian Habitat

Poster topic: Species Communities

San Francisco Estuary Invasive Spartina Project Tidal Marsh Restoration Program in Support of California Clapper Rail

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In 2011, the California Coastal Conservancy and U.S. Fish and Wildlife Service San Francisco Estuary Invasive *Spartina* Project (ISP) established a five-year program to rapidly improve habitat for California clapper rail (*Rallus longirostris obsoletus*) in tidal marshes of the San Francisco Estuary. Program goals include: (1) the rapid enhancement of California clapper rail habitat at locations where control of non-native *Spartina* has caused decreases in local populations and (2) the reintroduction of native *Spartina foliosa* (Pacific cordgrass) where locally extirpated or reduced by spread of non-native *Spartina*. The primary objective of the program is to intensively plant native marsh vegetation, primarily marsh gumplant (*Grindelia stricta*) and Pacific cordgrass, in strategic locations at invasive *Spartina* treatment sites to rapidly enhance cover, nesting, and high tide refuge habitat for rails. ISP treatment sites are selected for revegetation primarily where there are existing clapper rail populations that would benefit in the near term from habitat enhancement. As an additional enhancement at some sites, high tide refuge islands are being constructed and densely planted (H.T. Harvey). In the first three seasons the program has installed over 200,000 plants at 36 ISP treatment sites. The most recent monitoring results indicate mean survivorship for *G. stricta* and *S. foliosa* varied among sites. Overall *G. stricta* survivorship was 55% (high of 86%) which surpassed the target survivorship goal of 40%. *S. foliosa* mean survivorship was 36% (high of 66%). Monitoring results of the 2012-2013 plantings indicate higher overall survivorship than the first installation season (2011-2012). Planting designs continue to be adapted each season with the goal of improving overall plant survivorship and enhancing near term clapper rail habitat. Approximately 70,000 plants are being propagated for the 2014-2015 revegetation season.

Keywords: California clapper rail, restoration, revegetation, invasive species, Spartina

Poster topic: Species Communities

Response of Invasive Spartina to Suspended Treatment at 10 San Francisco Bay Marshes

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The State Coastal Conservancy's Invasive *Spartina* Project (ISP) was initiated in 2000 to address the threat of invasive species and hybrids of cordgrass (*Spartina* sp.) in the San Francisco Bay. Full-scale treatment with the herbicide imazapyr was permitted and began in 2005. Annual treatment took place at virtually all infested marshes until regulatory decisions required the discontinuation of treatment at 10 marshes from 2011 to present. Using the annual inventory and monitoring data collected by the ISP, we analyzed the response of the invasive *Spartina* populations in these 10 marshes and compared this to the trajectory of invasive *Spartina* populations treated with herbicide in all other marshes during the same time period. In those areas that have been subject to annual treatment, invasive *Spartina* populations have been reduced from their pre-treatment levels by 95-100%, and populations continue to decline. Our analysis shows that invasive *Spartina* populations in marshes where treatment was discontinued show the same rapid expansion documented by the pre-treatment (2001-2005) monitoring data, though they have not yet reached pre-treatment levels of infestation. Continued non-treatment at these marshes is predicted to result in the accelerated expansion of cover and extent of invasive *Spartina* within these marshes up to pre-treatment levels or beyond, accompanied by spread of pollen, seed, and propagules to other locations.

Keywords: Spartina, invasive, regulatory, marsh, San Francisco Bay, population, herbicide, hybrid

Poster topic: Species Communities

Variation in Oyster Performance between and within Two Restoration Sites in San Francisco Bay

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The native oyster *Ostrea lurida* is increasingly an important focus for shoreline restoration. Nearly all oyster restoration projects involve hard substrate addition, but few projects have quantitatively assessed the relative performance of oysters on different substrate types and configurations. We compared recruitment and percent cover of native oysters on five substrate types at two restoration sites (San Rafael and Hayward) in San Francisco Bay. Four of the five substrate types were constructed from "baycrete" (cement and locally dredged shell) and molded into either: 1) modular interlocking blocks, 2) stacks of small domes, 3) single large domes, or 4) large segmented domes. The fifth substrate type consisted of stacks of Pacific oyster shell in mesh bags. These substrates were deployed at our sites in summer 2012. We collected data on various oyster demographics three times a year from 2012 - 2014, measuring variables on north versus south facing surfaces, at three tidal elevations. We found large variation in oyster recruitment and percent cover between the two sites. However, within each site, oyster densities differed little by substrate type. At the San Rafael site, we found a significant effect of tidal elevation and aspect, oyster numbers were consistently highest on north and vertical faces and at lower tidal elevations, suggesting thermal stress as a factor in oyster recruitment and/or survival. Initial recruitment at the Hayward site also followed this general pattern, however oyster cover differed, with the greatest densities occurring at higher tidal elevations. This was likely the result of predation at lower elevations by the introduced oyster drill *Urosalpinx cinerea,* which was not present at the San Rafael site. These results suggest that key stressors for oysters vary between sites, even within the same estuary, and oyster performance could be enhanced by modifying the configuration and placement of restoration substrates.

Keywords: Oysters, Restoration, San Francisco Bay, Species Communities, Habitat, Ecosystems

Poster topic: Species Communities

Effect of Drought Conditions on the Distribution and Bioaccumulation of Selenium in Two Invasive Clam Species in North San Francisco Bay

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Tissue selenium (Se) concentrations in the invasive species *Potamocorbula amurensis* are the highest among bivalves in north San Francisco Bay (SFB), vary both spatially and seasonally, and often exceed the dietary thresholds for adverse reproductive effects established for surrogate predators. For this reason *P. amurensis* in SFB poses a potential threat to clam eating predators, including sturgeon, Sacramento splittail, Dungeness crab, and waterfowl. During years of low freshwater flow, the greatest Se concentrations are observed and the habitat of *P. amurensis* extends up estuary overlaping with another invasive species of clam, *Corbicula fluminea*. Although both of these clams process large volumes of water and particles, and serve as important food sources for benthivorous predators, they concentrate Se to different levels conferring different levels of risk to predators. During the historically low flow year of 2014, water and clam samples will be collected within and around the overlap zone to determine: 1) how far the overlap zone for these species extends; 2) compare Se concentrations between the two clam species and; 3) determine if there are differences in environmental exposures. Preliminary samples collected in the Fall of 2009 show that despite occupying the same habitat there are significant differences between *P. amurensis* and *C. fluminea* in both Se concentrations (seasonal means 8.0 μg/g and 5.6 μg/g respectively), and stable isotopic values of carbon and nitrogen. While physiological dissimilarities between the two species, such as ingestion rates, can explain some differences in Se concentrations, differences in the $\delta^{13}C$ may indicate the two species are exposed to different sources and environmental concentrations of Se. Information on the extent of the overlap zone, clam tissue Se concentrations, and potential differences in environmental Se exposures, will improve our understanding of the risks of Se exposures from clams to predators during periods of drought.

Keywords: Selenium, Drought, Invasive Species

Poster topic: Species Communities

Communities Of Nitrogen-Cycling Bacteria in the North and Central San Francisco Bay: How Salinity Determines Who's There

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Denitrifying bacteria respire nitrate to form dinitrogen gas. Their activity is one of the most important pathways determining the bioavailability of nitrogen in low-oxygen environments such as estuary sediments. Denitrifiers, like other microorganisms, are known to choose habitats based on salinity: the denitrifiers in the saline Central Bay are genetically more similar to denitrifiers in the open ocean than they are to the denitrifiers just a few miles away in the freshwater regions of the Delta. This community-level effect of salinity has been known for years; however, we know little about how quickly these community changes happen in locations, such as Suisun Bay, where salinity undergoes significant seasonal fluctuations.

This study explores the role that salinity plays in shaping communities of an important functional group of microorganisms—the denitrifying bacteria—across space and time in the sediments of North and Central San Francisco Bay. We used culture-independent sequencing of a specific marker gene, nitrite reductase, to examine the diversity and abundance of denitrifiers at 5 sites, every month for one year. In addition, we conducted laboratory incubations of sediment cores to examine the effect of water with different salinity levels on microbial communities. We found that all denitrifier taxa are essentially present everywhere in the bay, but the relative abundances of the taxa determine a unique community composition at each study site. Sites that see monthly salinity changes do see corresponding community shifts, but each site also maintains a distinctive population signature that remains robust in the face of seasonal fluctuations. We also identified other environmental factors, such as sediment nitrogen content, that contribute significantly to community composition. These results have implications for our understanding of the resilience of microbial communities to seasonal and long-term environmental changes, and to our ability to model ecosystem processes such as nitrogen cycling.

Keywords: nitrogen cycle, microbial ecology, salinity, denitrification

Poster topic: Species Communities

California Clapper Rail Survey Results at Spartina-Invaded Marshes from 2010 to 2014 and the Implications for Eradication of Invasive Spartina from the SF-Bay Estuary

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The State Coastal Conservancy's Invasive *Spartina* Project (ISP) reduced invasive *Spartina* in the San Francisco Estuary by 95% between 2005 and 2012. Also during this time, the number of endangered California clapper rail (*Rallus longirostris obsoletus)*, which uses invasive *Spartina* for cover and nesting substrate, declined substantially at these sites. By the end of 2010, most invasive *Spartina* populations in the Bay had been reduced to insignificant levels that no longer provided adequate cover for clapper rails. ISP evaluated 2010 *Spartina* cover and 2011 California clapper rail data, and identified a subset of marshes where continued removal of invasive *Spartina* would further diminish habitat for clapper rails. Beginning in the fall of 2011, USFWS suspended treatment of invasive *Spartina* at some of these marshes until the number of clapper rails detected bay-wide increased by an average of 80 over 2010 survey numbers for three consecutive years. To determine the 2010 baseline, we assessed available clapper rail survey results from 2010 at *Spartina* treatment sub-areas. Based on this data, we estimated that a minimum of 855 clapper rails were detected in 2010 at 189 sites. In order to meet the goal of an increase of 80 rails, an average of 935 clapper rails must be detected for three consecutive years at the same 189 sites included in the 2010 baseline summary. In 2011, this goal was nearly met when approximately 924 clapper rails were detected in the same survey area. This number has not been exceeded in subsequent years, and in 2013 and 2014, survey results fell below the 2010 baseline number. Because the first year of the required three-year increase has not yet been achieved, resuming full treatment of invasive *Spartina* in the Bay will not occur before 2018 at the earliest, greatly extending the timeline for eradicating non-native *Spartina*.

Keywords: invasive Spartina, California clapper rail

Poster topic: Species Communities

Biomass Distribution of *Potamocorbula amurensis* and *Corbicula fluminea* in the San Francisco Bay and Delta during Several Dry and One Wet Year

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The California Department of Water Resources (DWR) initiated the Generalized Random Tesselation Stratified (GRTS) study in 2007 to further examine the spatial distribution of *the benthic community* in San Francisco Bay and the Sacramento-San Joaquin River Delta. Spatially intensive samples were collected twice a year (May and October) from 2007 through 2012. The study area includes the Bay-Delta from San Pablo Bay in San Francisco Bay to Sacramento and Stockton and to the water pumping stations at Clifton Court in the Delta.

We focused this part of the study on the biomass of these two bivalves in the samples because *Potamocorbula amurensis* and *Corbicula fluminea* are very efficient filter feeders and have the potential to alter the availability of phytoplankton in the system. The biomass and distribution of *C. fluminea* and *P. amurensis* was determined from all GRTS samples collected from 2007 through 2012. We analyzed the spatial and temporal data for each species as well as areas of species overlap and the temporal progressions of the overlap areas. Several distribution patterns persisted through the years, which included both dry and wet hydrologic years: (1) The distributions of the two bivalves overlap in the ecologically sensitive low salinity zone, (2) The lowest total bivalve biomass occurs in this overlap region, (3) *P. amurensis* biomass is greater in fall than in spring and the opposite is true of C. fluminea and (4) *P. amurensis* biomass declined in Suisun Bay during the wet spring of 2011 but rebounded to near normal levels by fall 2011.

We show the spatial and temporal distribution of biomass for each species; and areas of species overlap and the temporal progressions of the overlap areas.

Keywords: Potamocorbula, Corbicula, Invasive Species, Bivlave Biomass

Poster topic: Species Communities

Native Plant Expansion: Historic Imagery Reveals Recent Spread of SAV in the Northern Estuary

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Extensive beds of the native submerged aquatic vegetation (SAV) species *Stuckenia pectinata* and *Stuckenia filiformis* have recently been mapped in the low-salinity regions of the San Francisco Estuary, but little is known about their history in the area. The first mapping effort took place in 2011-12, and found ~485 hectares (1200 acres) of plant coverage, but there was no data on the plants' extent and coverage before that time.

Stuckenia plants form canopies that fan out on the water surface in characteristic shapes, visible in aerial images. Mapping efforts in 2011-12 used aerial imagery combined with ground-truthing, and found that digitizing aerial images is an extremely accurate way to map *Stuckenia* beds. Using this technique on historic imagery, we mapped *Stuckenia* beds from past years.

Quality aerial images from US Geological Survey, accessed on Google Earth, were used to create historic *Stuckenia* coverage maps for 1993 and 2002, which were compared to 2012 maps in ArcMap. Our results show an increase in coverage from 1993-2012, both in total area, and in geographic extent. Some beds appear unchanged since 1993, but many areas (particularly in the western edges of current *Stuckenia* habitat at Ryer and Roe islands in Suisun Bay) had no beds in 1993, and have gained coverage around most shorelines since then. Overall, we mapped an increase of ~80 hectares (200 acres) of *Stuckenia*, with the highest gains from 2002-2012.

Submerged aquatic vegetation provides structure and habitat for many species, and we have found dense invertebrate populations on *Stuckenia* plant shoots. As high abundances of invertebrates on the plants are likely to provide food resources to native fish species of concern along their migratory paths, recent expansion of these beds, and the possibility of continued expansion with increases in salinity and water clarity, are of particular conservation interest.

Keywords: Submerged aquatic vegetation, pondweeds, GIS, historical ecology, Suisun Bay

Poster topic: Species Communities

Habitat Preferences of Fishes in the North Delta: An Electrofishing Study

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Problem. The Cache-Lindsey Complex located in the northern Sacramento San-Joaquin Delta has a high diversity of fish species, both natives and non-natives. *Approach.* To better understand distribution and habitat association of these fishes, an electrofishing study was designed to look at the association of fishes with specific habitats types within the upper and lower reaches of Cache and Lindsey Sloughs. Electrofishing was chosen as a sampling method because it is possible to effectively target near-shore habitats. With a specialized boat, scientists are able to focus efforts on short stretches of the bank categorized by different habitat types. We stratified our sampling based on dominant substrate and structural elements, such as mud and riprap, submerged aquatic vegetation, woody debris, and riparian vegetatin. Additionally, we sampled across diel & tidal cycles to gain more insight on how and when fish use these different habitats. *Results.* This poster summarizes data from our spring sampling bout. It is apparent that electrofishing near-shore habitats is an effective method for exploring fish-habitat relationships, and it resulted in high catch numbers and large sizes of native fish species, like Sacramento splittail and Hitch. Native fishes preferred shallow water, with structurally complex habitat. Many native fishes were more abundant in shallow-waters during the dusk and evening, while many nonnative fishes did not show the same diel patterns. *Conclusion.* A better understanding of fish habitat preferences will help to inform targeted restoration efforts in the Delta.

Keywords: Electrofishing, North Delta

Poster topic: Species Communities

Management Implications of the Diet of Barn Owls Foraging in San Pablo Bay Wetlands

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The San Pablo Bay has some on of the most intact wetland systems in the San Francisco Bay estuary and is home to many federally and California state listed species, including the salt marsh harvest mouse (*Reithrodontomys raviventris*) and Suisun shrew (*Sorex ornatus sinuosus*). Barn owls (*Tyto alba*) have been documented foraging in wetlands if roosting sites are available in nearby trees or human structures. There has been very limited documentation of nocturnal avian predation in San Francisco Bay wetlands. To assess the diet of barn owls foraging in San Pablo Bay wetlands we collected pellets beneath an occupied barn owl nest. Then using the published foraging range of the barn owl, we used aerial imagery to establish that 99% of the owl's foraging range was within wetlands. We assessed diet by identifying skulls found in the pellets. We dissected 117 owl pellets and identified 277 skulls. The following species were present; *Microtus californicus* (64%), *R. raviventris* (25%), *Avian* (4%), *S. ornatus sinuosus* (2%), *Peromyscus maniculatus* (1%), and *Rattus rattus* (1%). These findings highlight the importance owl predation on small mammal populations in marshes and have many management implications including the removal of structures in salt marsh harvest mouse habitat. They also improve upon the limited documentation of nocturnal avian predation in San Pablo Bay.

Keywords: salt marsh harvest mouse, barn owl, nocturnal avian predation

Poster topic: Species Communities