

Going Native: Evidence that High Flows Expand the Spatial Distribution of Native Fish in the Yolo Bypass

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The Yolo Bypass provides the largest contiguous floodplain habitat for native fishes in the Sacramento-San Joaquin Delta. Previous work has documented the timing of floodplain use by native species, but relatively little analysis has been done on the spatial variation of habitat use within the Bypass. Since 1998, the Yolo Bypass fisheries monitoring program run by the Department of Water Resources (DWR) has conducted a year-round beach seine survey to determine species composition and habitat use in the Bypass. Sites are sampled on a biweekly basis year-round in the Toe Drain, the tidal perennial channel located on the eastern edge of the Bypass. With tributary inputs and a tidal weir (Lisbon Weir), the Toe Drain has substantial spatial and seasonal variation in temperature, conductivity, flow, and tidal influence. Since the project's inception, sampling has consistently occurred below Lisbon Weir with more intensive sampling throughout the Bypass during months of floodplain inundation. In 2011 and 2012, more intensive sampling above and below Lisbon Weir was conducted to improve our understanding of fish community patterns along a broader tidal gradient. Catch data from 1998-2012 showed that native fishes represented 29% of the total catch during the spring months (March-June), but this proportion varied substantially among years. The native fish assemblage was largely dominated by Sacramento splittail *Pogonichthys macrolepidotus* (50%) and Chinook salmon *Oncorhynchus tshawytscha* (14%) in most years, especially during years of substantial floodplain inundation. More extensive surveys in spring 2011 and 2012 indicated that the proportion of native fish was highest during periods with increased flow, with native fish species exhibiting a broader distribution (both above and below Lisbon Weir). Our analyses provide information useful to managers seeking to understand floodplain habitat use for migratory and resident native fishes.

Keywords: Yolo Bypass, Floodplain, Native, Habitat, Flow, Toe Drain, Lisbon Weir, Beach Seine, Inundation, Spatial Distribution

Poster Topic: Species and Communities

Effects on Water Quality and Nutrient Cycling by a Large, Native Unionid Mussel (*Anodonta* spp.) in a San Francisco Bay Watershed and Reservoir

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Freshwater mussels filter phytoplankton, bacteria, and other particulate organic matter from the water column, and excrete nutrients in the form of urine and feces, which contain ammonium and phosphorous compounds; nutrients that often limit primary productivity in aquatic ecosystems. In San Andreas Reservoir, a drinking water reservoir south of San Francisco, relatively dense populations of native freshwater *Anodonta* mussels (belonging to the *californiensis/nuttalliana* clade) are coexisting with invasive clams (*Corbicula fluminea*), among dense invasive aquatic plants (*Myriophyllum spicatum*). *Anodonta* mussels are also found locally in Alameda Creek, the Sacramento River, and in other waterbodies in the Bay-Delta watershed. Although many nutrient cycling experiments have focused on invasive species, fewer studies have focused on native mussels and resource managers want to know what effect these native mussels are having on water quality in the reservoir. To answer this question, *Anodonta* mussels were collected from the reservoir and brought to a temperature-controlled environmental chamber, scrubbed free of biofilms, and placed in deionized water. Water samples were collected at time steps over a period of five days and analyzed for ammonium, orthophosphate, and total phosphorus. Present data, for spring conditions, indicate that at 12°C, larger (~ 8 cm) individual *Anodonta* mussels excrete ammonium at a rate of ~4.8 µg NH₃ / g (shell-free dry weight) / hour, and orthophosphate at a rate of ~1.7 µg PO₄ / g (shell-free dry weight) / hour. These nutrient excretion rates are similar to other unionid mussels such as *Lampsilis radiata siliquoidea* in watersheds of the Eastern United States.

Keywords: Unionidae, *Anodonta*, freshwater mussels, nutrient cycling, water quality

Poster Topic: Species and Communities

Biodiversity Effects of *Spartina* Control

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In 2003, the State Coastal Conservancy's San Francisco Estuary Invasive *Spartina* Project (ISP) began testing use of the herbicide imazapyr for the treatment of the invasive salt marsh grass *Spartina alterniflora x foliosa*. To assess the efficacy of ground and aerial-based treatment by imazapyr, and to identify any non-target impacts on adjacent vegetation, permanent plot monitoring was initiated in 2004 at 22 marshes. Monitoring was expanded to 56 marshes by 2006. Plots were monitored annually for stem counts of invasive *Spartina* (the target of control efforts) and percent cover of all vegetation. Results indicate that imazapyr is effective in reducing the stem count and cover of invasive *Spartina*, and that biodiversity of native vegetation increases within 2-3 cumulative years of treatment. These results indicate that any non-target effects of imazapyr on adjacent vegetation are insignificant to overall recovery of tidal marsh plant biodiversity, even in the short term. This information has been useful in designing effective treatments for and minimizing the non-target effects from invasive *Spartina* control efforts and is relevant as the ISP seeks to complete its goal of eradication of invasive *Spartina* in the coming years.

Keywords: *Spartina*, biodiversity, herbicide, invasive

Poster Topic: Species and Communities

Determining Habitat Relationships and Estimating Abundance of California Clapper Rail in Spartina-Invaded Marshes in the SF-Bay Estuary

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The endangered California clapper rail (*Rallus longirostris obsoletus*) is an obligate tidal marsh bird in the San Francisco Bay Estuary. Loss of tidal wetlands over the past century reduced the abundance of this cryptic rail to critical levels, necessitating the listing of the subspecies as endangered in 1973. Since then, much of the remaining clapper rail habitat has been significantly altered by the invasion and subsequent removal of non-native *Spartina* species, a known ecosystem engineer. Annual survey counts of the California clapper rail are used to inform management decisions as well as estimate temporal population trends in tidal marshes and tidal marsh restoration in the San Francisco Estuary. However, clapper rail survey counts are highly variable, creating a problem for managers trying to understand population trends and the response to management actions such as the control of non-native *Spartina* cordgrass species. We used clapper rail point count survey data collected by the Invasive *Spartina* Project from 2010 to 2012 to identify the factors that contribute to imperfect detection. We used occupancy modeling to determine the habitat relationships of the California clapper rail within the study area. We used repeated counts to determine the relationships between habitat characteristics and estimates of clapper rail abundance. Results of our analysis can be used to monitor changes in abundance over time at marshes undergoing non-native *Spartina* control. By incorporating imperfect detection, determining habitat relationships and estimating abundance, results from our analysis can be used to better inform stakeholders on evaluating management and conservation decisions.

Keywords: California clapper rail, endangered species management, occupancy, abundance, invasive *Spartina*

Poster Topic: Species and Communities

Increased Bird Species Richness and Diversity at Restored Sites within the Sacramento-San Joaquin Delta

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Riparian and wetland habitats of the Sacramento-San Joaquin Delta provide an important but greatly reduced resource for birds. In light of large-scale planning efforts targeting the restoration and enhancement of these habitat types, a region-specific understanding of bird use within the Delta landscape is needed. In an effort to begin to address this information gap, we surveyed bird populations and vegetation characteristics at 18 habitat enhancement project sites within the Delta region during May and June of 2011 and 2012. Bird species occurrence, richness, and diversity were assessed and compared at sample plots located in 7 pre-restoration and 11 post-restoration sites. Land cover at the plots consisted of cropland (n=17), irrigated pasture (n=26), ruderal or fallow land (n=13), and riparian and wetland (n = 59). We found a large shift in species composition of the bird community when comparing pre- to post-restoration sites. Mean species richness at the plot level was significantly higher at riparian and wetland ($6.52 \pm 0.36se$) and ruderal or fallow sites (4.76 ± 0.67) versus sites with cropland ($2.77 \pm 0.36se$) or irrigated pasture ($2.96 \pm 0.32se$). We found similar results for mean species diversity. Riparian and wetland sites with habitat enhancements or mitigation had significantly higher mean richness and mean diversity at the plot level, indicating that these sites provide habitat resources to a richer and more diverse bird community compared to pre-construction sites. All estimates were lower than those found by similar studies in more intact, riparian-wetland systems with higher connectivity, indicating that Delta riparian and wetland habitats can be improved upon. The findings of this study allow us to evaluate the success of habitat restoration and enhancement projects, to understand changes in community composition and abundance due to restoration, and will inform future restoration planning with region-specific information.

Keywords: Avian, Riparian, Delta, Richness, Diversity,

Poster Topic: Species and Communities

Extended Layups of Commercial Vessels Operating in California Waters: Implications for Vessel Biofouling and Nonindigenous Species Introductions

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Fouling of aquatic organisms on the submerged surfaces of vessels can be a potent vector for the introduction of nonindigenous species into new areas, including California. Vessel biofouling has been implicated as a vector in up to 60% of the introductions into California. Additionally, about 65% of California's established nonindigenous species were first documented to occur in San Francisco Bay.

It is believed that the longer and more frequently a ship remains in a single area, the more likely it is to potentially accumulate biofouling organisms on its submerged surfaces. Unfortunately, reports of increased numbers of commercial ships being anchored and laid up across the world have become commonplace over the past few years - one side effect of the current world economic downturn. Since January 2008, the California State Lands Commission (Commission) has been collecting information on the hull husbandry practices and fouling-related voyage characteristics of the commercial fleet operating in California. Preliminary analysis of the data collected in 2008, 2009, 2010 and 2011 suggest sharp increase in both the frequency and length of extended layups from 2008 to 2009 and steady levels in the following years. This increase is being driven by certain vessel classes, including auto carriers, passenger ships, container ships, and barges. These trends of increasing frequency and duration of stationary periods will be discussed, along with an evaluation of the geographic locations where these layups are occurring and implications for species introductions. The Commission will use this information on vessel voyage characteristics and hull husbandry practices in conjunction with Commission-funded fouling research to guide the ongoing development of policy on the management of vessel biofouling in California.

Keywords: Biofouling, Nonindigenous species, commercial vessels, ship layups

Poster Topic: Species and Communities

Investigating Causes of Rarity in the Endemic Suisun Thistle

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The highly urbanized San Francisco Estuary contains 90% of California's remaining coastal wetlands, as well as high concentrations of both invasive and rare species. One rare species, the Federally-listed Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*), is restricted to two populations in which the invasive perennial pepperweed (*Lepidium latifolium*) has an increasing presence. This research explores why the Suisun thistle is rare and which management actions would be appropriate to protect it. We are investigating two potential limitations: competition with pepperweed, and intrinsic constraints during specific life history stages. To address competition with pepperweed, a removal experiment is being conducted and plant and soil responses assessed. To identify key life history stages, seed set, seed dispersal, and seed germination are being quantified under various environmental conditions.

Preliminary results show that monthly pepperweed removal (by clipping) increases cover of native species. Suisun thistle growth did not show a response, but we are continuing to track if there is increased growth, survival, and reproduction in the next generation. Additionally, there is a trend of increasing soil salinity following pepperweed removal, indicating that it may be modifying the soil environment.

In the field, Suisun thistle seed set varied by location and with the presence of an unidentified larval seed predator. In the lab, seeds germinated readily with an inverse response to increasing salinity; seeds also remained viable after two weeks of inundation in tanks. Additional work is underway to quantify wind and water dispersal, determine environmental factors that correlate with seed set, and identify seed predators.

This research will allow managers to protect the Suisun thistle during vulnerable life stages and in critical locations. Additionally, it will allow them to design restoration plans for Suisun Marsh that are informed by the biology and ecology of a sensitive but understudied species.

Keywords: invasive, endangered species, Suisun Marsh, pepperweed, brackish, rare plant, management

Poster Topic: Species and Communities

Regional Distribution and Habitat Associations of California Black Rail (*Laterallus jamaicensis coturniculus*) in the Sacramento-San Joaquin Delta

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Historic survey work aimed at documenting the distribution and status of state threatened California Black Rail (*Laterallus jamaicensis coturniculus*) has largely overlooked the Sacramento - San Joaquin Delta. During March, April, and May of 2010-11, we conducted playback surveys to assess the status of the species within appropriate habitats of the central Delta region. We detected Black Rails at 20 of 46 sites, primarily on in-stream islands with dense vegetative cover. In an effort to begin to understand region-specific habitat and land cover characteristics where the species was found, we analyzed remotely sensed vegetation datasets. We considered land cover at two spatial scales, site-specific and landscape. At the site-specific scale, we found percent cover of freshwater emergent vegetation, valley riparian forest, and size of site to positively affect the probability of detecting rails. On a landscape scale, we found more natural land cover, including freshwater emergent, valley riparian and annual grassland, and less of cropland and riverine cover types surrounding occupied sites. We also found differences in mean site size - sites where Black Rails were detected were significantly larger (13.44 ha, $SE = 2.05$) than locations where no rails were found (4.13 ha $SE = 0.56$). While these results provide increased understanding of Black Rail distribution and habitat associations in the Delta, conservation planning efforts would be better informed with a more comprehensive and robust sampling effort. This should include field measurements of fine-scale habitat characteristics such as vegetative cover, composition, and structure, to provide a clearer understanding of the status of the species within the region.

Keywords: California Black Rail, Sacramento-San Joaquin Delta, habitat associations

Poster Topic: Species and Communities

Vegetation-Associated Macroinvertebrate Communities in the Sacramento-San Joaquin Delta

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The Sacramento-San Joaquin Delta is increasingly plagued with dense swathes of submerged aquatic vegetation. The spread of invasive aquatic macrophytes such as Brazilian water-weed (*Egeria densa*), Eurasian watermilfoil (*Myriophyllum spicatum*), and others has been concomitant with an increase in the importance of littoral food webs and the increases in abundance of littoral fishes such as largemouth bass (*Micropterus salmoides*). Although aquatic vegetation and nearshore fish communities have received increased attention, little is known about the macroinvertebrate communities supported by these introduced species. Using a modified Marklund sampler we collected samples from nine Delta locations in order to characterize the communities of macroinvertebrates that occur in conjunction with submerged aquatic vegetation. We found that amphipods dominated the biomass of nearshore vegetation communities, while chironomid midges and coenagrionid damselflies were the abundant insect contributors. Macroinvertebrate assemblages varied with vegetation communities and with environmental conditions. This study is important because vegetation-associated macroinvertebrates play a large part in littoral food webs and are the dominant diet item for most nearshore juvenile fishes.

Keywords: Delta, macroinvertebrates, submerged aquatic vegetation, amphipods

Poster Topic: Species and Communities