Differential Response in Vegetation Community Dynamics in Riparian and Grassland Communities After Removal of Invasive Perennial Pepperweed Highlights the Importance of Seed Dispersal and Priority Effects

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A primary goal of habitat restoration in Bay-Delta watersheds is to create contiguous and highly functioning ecosystems. Invasions by non-native species can limit the success of restoration efforts and requires ecosystem managers to reconcile community response and restoration techniques. In this study, we examined plant community composition dynamics after invasive species removal in two ecologically unique communities - an abiotically-controlled seasonal riparian zone and abiotically-controlled oak-grassland savanna. We hypothesized that riparian communities would be more invasible post-treatment due to priority effects and invasive propagule pressure while grassland habitats would be colonized by adjacent vegetation and the seed bank.

To determine how community composition trajectories changed through time, we use NMS to analyze plant community composition after invasive species control of perennial pepperweed (*Lepidium latifolium*). We then compared species turnover and composition by calculating inter-annual turnover rates in both communities throughout a seven year period. We found that riparian community turnover rates were significantly higher (Jaccard>0.92) than turnover in grassland communities (Jaccard<0.87, $p<0.0001$) and had fewer ($p<0.0001$) non-native species than grassland communities through time. Inter-annual trends in non-native species diversity were constant ($p>0.05$) in grasslands but drier years resulted in more non-native species in riparian sites when compared to wetter years ($p<0.0001$).

Our data suggests that more open, frequently disturbed communities are more strongly influenced by priority effects – that chance early colonizers control community trajectories – than closed communities, and that seed dispersal plays a dominant role in promoting self-sustaining populations of native vegetation. Thus, understanding specific ecosystem processes – namely seed dispersal in relation to disturbance regime, invasion susceptibility, hydrochorous dispersal, and priority effects – is necessary to reconcile and manage today's ecosystems.

Keywords: *Lepidium latifolium*, perennial pepperweed, invasive species, floodplain restoration

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (I) – Order 1

Salinity and Inundation Effects on the Growth and Interactions of Two Dominant Tidal Marsh Plants

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Climate change is predicted to raise sea level and lower fresh water inputs into the San Francisco Bay Estuary (SFBE). Few studies have looked at how dominant salt and brackish marsh species within SFBE will respond to these changes. We studied two dominant tidal marsh plant species, *Salicornia pacifica* and *Distichlis spicata*, to determine how they grow and compete at different salinity and inundation levels. Cuttings were collected from a brackish marsh, propagated in a greenhouse, and then used for concurrent greenhouse and field experiments. A greenhouse experiment exposed the plants to three different salinity and inundation regimes over three months. The field experiment tested these species under two different salinity and inundation regimes at one salt marsh and one brackish marsh within SFBE. The results show that salinity and inundation significantly affected growth for *S. pacifica* and *D. spicata*. In the greenhouse, *D. spicata* grew best at high inundation (12 hrs/day) and low salinity (12 ppt) and often outcompeted *S. pacifica* at these treatment levels. *S. pacifica* outcompeted *D. spicata* in the low inundation (1.5 hrs/day) at the middle salinity level (23 ppt). However, in the field both *S. pacifica* and *D. spicata* grew poorly in high inundation (6 hrs/day) and both species were unaffected or negatively affected by competition. *Salicornia pacifica* will clearly be negatively impacted by sea-level rise, but may still expand in high marsh areas up the SFBE due to increasing salinity. *Distichlis spicata* may not be negatively impacted by increases in inundation but other factors associated with increased inundation appear to limit its growth. As climate change shifts multiple factors, anticipating how plant distributions might change becomes complex. Understanding how these two plant species might respond to future conditions is important in order to understand how to best restore and manage tidal marshes within SFBE.

Keywords: Climate change, Salinity, Inundation, Tidal marsh, *Salicornia pacifica*, *Distichlis spicata*

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (I) – Order 2

Location, Location, Location: Where is the Best Neighborhood for Olympia Oysters Growing up in San Francisco Bay?

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PROBLEM STATEMENT: The Olympia oyster, *Ostrea lurida*, is a target of restoration efforts in the San Francisco Estuary. Identifying high quality Olympia oyster habitat is key for conservation, but oysters have a complex life cycle with sessile adults and mobile larvae whose habitat requirements may differ. How are the various aspects of oyster population dynamics spatially patterned within the San Francisco Estuary? Our goals were to (1) estimate regional connectivity patterns and (2) link geographic variation in habitat quality and connectivity patterns to recruitment, growth, and survivorship.

APPROACH: We investigated *O. lurida* population dynamics and larval dispersal patterns using population surveys, recruitment monitoring, and trace elemental fingerprinting at sites from San Pablo Bay to the South Bay. We examined oyster populations during 2009 to 2011, a three year period encompassing the end of a three-year drought with low winter freshwater flow conditions (2009), a winter of intermediate flow conditions (2010), and a winter of higher flow conditions (2011).

RESULTS: Oyster abundance and size distribution differed significantly along the salinity gradient; maximum densities occurred in brackish waters near China Camp State Park, with over 1000 oysters / m2 in 2009-2010. Regional variation in temperature and salinity correlated with differences in the onset and peaks of fecundity and settlement. Mortality linked to high freshwater flow levels in early 2011 had the greatest impact in the northern region of the Bay, with near complete mortality in areas that previously had the highest population densities. Regional connectivity data showed some evidence of local recruitment, but also longer dispersal, and connectivity patterns varied between years.

CONCLUSIONS/RELEVANCE: While there is some evidence that different factors may promote fecundity and recruitment, it seems that habitat quality influences both the production and settlement of oyster larvae, with higher quality sites supplying larvae to lower quality sites.

Keywords: Ostrea oyster native population connectivity dispersal habitat quality restoration

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (I)– Order 3

Monitoring to Optimize Invasive Spartina Control

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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. The ISP Monitoring Program was tasked with monitoring the efficacy of treatment efforts. The program uses annual inventory monitoring, combining field and remote sensing techniques as appropriate, to accomplish this task. GIS techniques are used to map and analyze data. Through GIS analysis of data collected from 2005 to present, we are able to track the efficacy of treatment efforts Bay-wide and by site. We have found that Bay-wide invasive *Spartina* acreage has decreased steadily each year, but that the rate of decline within marsh sites can vary. Based on existing information, we believe that degree of efficacy is dependent on multiple factors including timing of herbicide application, application method, thoroughness of treatment, extent of infestation within site, and susceptibility of the site to new propagules. These conclusions have relevance to improving programmatic success and must be addressed through adaptive management techniques. For example, GPS-led treatment monitoring was implemented beginning in 2009 to improve thoroughness of treatment as remaining target plants became more difficult to locate and identify as a result of successful control efforts. The impact of these surveys to treatment success will be analyzed by comparing efficacy of control at sites with and without such treatment monitoring efforts.

Keywords: invasive, Spartina, monitoring, imazapyr, herbicide

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (I)– Order 4

Invasion of San Francisco Bay by *Upogebia major*: A Newly Recognized Non-Native Species with Potentially Large Ecosystem Consequences

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In 2010 large numbers of mud shrimp *Upogebia* sp., second only in abundance to bay shrimp *Crangon* spp., were collected in San Pablo Bay while monitoring for entrainment of longfin smelt *Spirinchus thaleichthys* during channel dredging by the U.S. Army Corps of Engineers hopper dredge *Essayons*. The high abundance of mud shrimp, thought to be *U. pugettensis*, was notable for three reasons. A recent report stated that mud shrimp were not now and perhaps never were abundant in San Francisco Bay, *U. pugettensis* populations have declined on the West Coast likely due to castration by the non-native isopod *Orthione griffenis,* and *U. pugettensis* is an intertidal species that is not known to occur at the subtidal depths where it was collected in 2010. Two 2010 mud shrimp voucher specimens from the dredging collections have been identified as *U. major*, an Asian species. These specimens were not infected with *O. griffenis* although *U. major* is a natural host of *O. griffenis* in Asia with low prevalence rates of the parasite. This first documented occurrence of *U. major* in West Coast estuaries raises several questions. Is this a newly introduced species? Has it been here for years but misidentified as *U. pugettensis*? CDFG trawls and plankton nets may have collected it in 2009 or earlier. Is it a vector or reservoir for *O. griffenis* driving the native *Upogebia* to extinction? What role do these populations of "ecosystem engineers" play in the subtidal trophic ecology of the Bay? Additional subtidal mud shrimp, likely *U. major*, were collected in northern San Francisco Bay in 2011. Basic research and monitoring that includes species level taxonomy is essential to understanding and managing the San Francisco Estuary. The discovery/documentation of *Upogebia major* is a prime example of the need for research to support science-based management.

Keywords*:* *Upogebia*, mudshrimp, non-native species, subtidal ecology, host-parasite, taxonomy, dredging, monitoring

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (I)– Order 5

Habitat Evolution Modeling

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The results of a three year pilot project building a semi-automated model to track the evolution of marsh habitats and mudflats (~30,000 acres) for the South Bay Salt Pond Restoration Project (SBSPRP) will be presented. Habitat mapped as part of the study included mudflats, tidal marshes, and restored ponds; and to a lesser degree, managed marshes, levee tops and uplands. We mapped a total of 24 specific habitat types including 16 vegetation alliances and/or associations representing salt, brackish and freshwater marshes, 6 "abiotic" habitats (e.g. mud), and 2 vegetation types specific to uplands. We utilized a supervised classification (maximum likelihood) of multispectral Ikonos imagery between 2009-2011. We conducted extensive ground truthing (~1000 total field surveys) to best characterize the spatial and taxonomic variability of vegetation throughout the study area as well as for model validation. We achieved 76% overall attribute accuracy for tidal marshes in 2011 and similar results for 2009 and 2010. We also successfully tracked floral colonization within restored ponds (e.g. A21) as well as floral colonization in some fringe marshes (e.g. Calavares marsh, top of Pond A6). Overall, the distribution and extent of marsh habitats appeared to be relatively stable (~10,000 acres) over the three year period, although there was some indication of the growth of invasive (e.g. Perennial Pepperweed) species relative to other habitats. The datasets also provide valuable information regarding the distribution and extent of high marsh (e.g. Pickleweed/Gumplant), especially within localized areas (e.g. Laumeister). Both the methodology and results of our study provide a strong baseline for better understanding the distribution and extent of habitats at a high level of spatial and taxonomic resolution, and ultimately, for tacking changes to these habitats into the future.

Keywords: Vegetation, Modeling, Remote Sensing, GIS, Wetland Restoration, Marsh Habitats, Conservation

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (II) – Order 6

Pepperweed Invasion Increases Soil Nitrogen Cycling Rates and Nitrous Oxide Emissions in a Drained Peatland Pasture

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Perennial pepperweed (*Lepidium latifolium*) is a pervasive exotic species that has spread throughout the western United States, invading natural and agricultural systems including the Bay Delta. Pepperweed has been documented to increase soil microbial enzyme activity associated with nitrogen (N) mineralization, but the effect of pepperweed on soil N cycling has not been determined. We measured gross N cycling rates and net N_2O emissions from replicate plots in a drained peatland pasture on Sherman Island, CA that were dominated by pepperweed versus dominated by an invasive annual grass (*Hordenum murinem*) with no pepperweed present (n= 6 per cover type). We also used trace gas stable isotope pool dilution, a novel technique, to measure gross N_2O production and consumption rates across four landforms in the pasture, only one of which was invaded by pepperweed.
The pepperweed plots exhibited significantly higher soil ammonium (NH_4^+) concentrations, gross N mineralization rates, dissimilatory nitrate (NO_3^-) reduction to NH_4^+ rates, and net N_2O emissions ($p < 0.05$, ANOVAs). Gross mineralization rates in surface soils (0-20 cm) averaged 30.1 ± 4.3 μg g^{-1} d^{-1} in grass-dominated plots and 81.5 ± 15.3 μg g^{-1} d^{-1} in pepperweed-dominated plots. Gross mineralization rates were positively correlated to soil NH_4^+concentrations ($R^2 = 0.54$), which averaged 8.4 ± 4.3 μg g^{-1} in grass-dominated plots and 27.3 ± 4.4 μg g^{-1} in pepperweed-dominated plots. Gross N_2O production rates were high, averaging 8.4 ± 3.2 mg N m^{-2} d^{-1}, and were most strongly correlated to mineral N ($NH_4^+ + NO_3^-$) concentrations and denitrifying enzyme activity ($R^2 = 0.73$). The only pepperweed-invaded landform exhibited the highest N_2O emissions and the highest mineral N concentrations.
Our results suggest that pepperweed has the potential to increase gross mineralization rates to alter soil N cycling and increase N_2O emissions as it spreads through the Bay Delta.

Keywords: ammonium; invasive; Lepidium latifolium; mineralization; nitrogen; nitrous oxide; pepperweed; soil

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (II)– Order 7

Tidal Wetlands Alter Suspend Sediment Composition Through Tidally Driven Exchange

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Tidal wetlands provide valuable ecosystem services such as buffering inland areas from storm surges. However, due to their hydrologic complexity, the role that tidal wetlands play in cycling estuarine particulate matter is unclear. This study employed hydro-optical and hydrodynamic measurements in a tidal wetland channel, Browns Island, located in the western San Francisco Bay Delta. The study period covered a weeklong period in early January, 2006 and coincided with the spring tide. Tides were semidiurnal with a tidal range of 1.5 meters around a mean water depth of four meters. In addition to water depth and current velocity, turbidity, spectral beam attenuation and particle size were measured twice hourly at mid channel depth. Particle information derived from these instruments indicates that changes in both the abundance and size of particulate matter varied coincidentally with the tides, highlighting the link between hydrodynamics and suspended sediment characteristics in tidal wetlands. Assuming linearity between sediment concentration and optical signal, turbidity and beam attenuation were highest during the flood, and were lowest during ebb, indicating a higher concentration of sediment in island flood waters compared to ebb. Size spectra indicated three dominant pools of sediment with relative abundances changing throughout the tidal cycle. D50, or median particle size, increased to nearly 140 um at slack tide following island draining, while it plummeted to<33 um at peak flood velocity, likely due to shear induced floc break-up. The timing of peaks in size and concentration relative to the local hydrodynamics are likely due to the interaction of the tides and bathymetry, marsh flooding and draining as well as flocculation and breakup. Future restoration efforts should consider these findings. Further, this information should be incorporated into sediment transport and marsh inundation models.

Keywords: flocculation, sediment, attenuation, estuary

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Sediment Budget for the Far Southern Reach of San Francisco Bay: Importance of Hydrodynamics to the Supply of Sediment Available for Habitat Restoration

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The South Bay Salt Pond Restoration Project is restoring 6,000 hectares of former commercial salt-evaporation ponds to tidal marsh or managed wetlands in the southern reach of San Francisco Bay (SFB). Sections of the project area have subsided and, given current sea level, will require about 32 million cubic meters of sediment to sufficiently raise bed elevations to appropriate levels for colonization of tidal marsh plants. The two main tributaries to this reach have been gaged for flow and suspended sediment since 2004, but the water and sediment flux at the bayward margin of the reach was unknown. In late 2008, a flow and suspended sediment monitoring station was established on the Dumbarton Bridge, the bayward margin of the southern reach of SFB. This allowed the calculation of daily sediment budgets for 2009-2011 for the reach using the sediment flux data from the tributaries, local waste-water treatment plants, and Dumbarton Bridge. Overall, the sediment budget for this reach is controlled by the sediment flux past Dumbarton Bridge. The tributary sediment loads are important for filling the subsided space on roughly a millennial time-scale, while the tidal load at the Dumbarton Bridge varies dramatically by season and year. Although the net sediment flux during 2009 and 2010 was into far south SFB, the direction of springtime sediment flux was out of far south SFB in 2011, and appears to be determined by the salinity gradient between central SFB and far south SFB. Fresher springtime conditions in central SFB lead to residual flows to the north and the flux of sediment out of the project area. Preliminary results suggest that there is a strong positive relationship between annual freshwater inflow from the Delta and the strength of northward sediment flux past the Dumbarton Bridge.

Keywords: Suspended-sediment flux, tidal, restoration, tributary, San Francisco Bay, sediment transport

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The Influence of Surface Water Mixing on Gas Budgets in Restored Wetlands

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There are three pathways by which gasses (including methane, oxygen, and carbon dioxide) are exchanged between wetland soils and the atmosphere. We show that one of these (dissolved gas transport through the surface water) is often underestimated in importance, and provide a quantitative prediction method for the relevant surface water fluxes. We focus on the specific case of restored wetlands in the Delta, considering a tule marsh in an enclosed basin in which water depth is held constant and the main source of mixing energy is the atmosphere (i.e. wind and thermal forcing). Field studies are used to motivate a set of laboratory measurements, from which we find a parameterization of the air-water gas transfer rate in terms of easily measured environmental variables. This parameterization is intended to support biogeochemical modeling, and a simple biogeochemical model is used to illustrate the importance of surface water mixing on wetland methane emissions.

Keywords: Wetland, Mixing, Budget, Water, Methane, Oxygen, Tule, Marsh, Flux, Budget

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (II)– Order 10

Estimating Abundance of California Clapper Rails: Trends, Spatial Patterns and Effects of Climate Change

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The California Clapper Rail (*Rallus longirostris obsoletus*) is a federally listed endangered subspecies; over-hunting, non-native predators, and habitat loss and degradation throughout the SF Estuary have caused severe declines in the past 250 years. Estimation of population sizes, trends and spatial patterns are imperative for effective management and prioritization of rail habitat for conservation. Sea-level rise poses an imminent threat, potentially degrading or overtaking many current marshlands and should also be considered in decision-making. PRBO and partner institutions conducted surveys of Clapper Rails in 262 sites throughout the Estuary and consolidated 7years (2005-2011) of monitoring data. Because of patchy occurrence and less than 100% detectability, survey counts included a high frequency of zeros reflecting both true absence and failure to detect individuals ('false zeroes'). We used zero-inflation models to produce estimates of Clapper Rail abundance adjusted for imperfect-detection. These models adjusted for the effects of factors such as wind speed, temperature, and time of day on detectability. The resulting statistical models allowed us to better estimate the changes in rail density at survey sites throughout the study period, and the variables most influencing abundance and detection, which will help monitoring, management and marsh restoration efforts. We contrasted the estimated trends for South SF Bay with those for the North Bay and explored reasons for the difference. We then used these estimates as part of a landscape-level model to estimate Clapper Rail abundance throughout the Estuary. We also incorporated effects of future sea-level rise (elevation, proportion of marsh habitats and slope) and changes in salinity to project future population trends and spatial patterns of abundance. The resulting projections (along with those for three other species) are used for a prioritization of tidal marsh restoration and management that incorporates climate change effects.

Keywords: Clapper Rail, abundance, sea-level rise, climate change, endangered

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (III)– Order 11

Macroinvertebrate Colonization and Avian Community Response Following Restoration of Salt Ponds in Northern San Francisco Bay

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The Napa-Sonoma Marshes Wildlife Area is located in the northern reach of San Francisco Bay and comprises more than 6,000 ha of former salt evaporation ponds that have been restored and breached to tidal action. In November 2008, we initiated a study to examine macroinvertebrate colonization and waterbird response to breaching of Ponds 9 and 10 along the Napa River. Because the ponds were formerly used to make salt, the bottoms of the ponds were covered with a salt crust, thus no benthic macroinvertebrates were initially present. However, we found that benthic macroinvertebrates were colonizing the site within seven months following restoration of tidal flows (May 2009). The earliest colonizers were Cumacea, Amphipoda, Polychaeta, Oligochaeta and Diptera larvae that collectively comprised 72% of all individuals. By the spring of 2010, macroinvertebrates in the restoration site were more abundant than in the reference sites in the adjacent river. We then used historical surveys of reference sites and the project area to examine avifaunal changes. No ducks and a monthly mean of <250 shorebirds were counted during the winter in the units prior to restoration from 2006-2008, and all observations were of non-foraging birds. Following restoration breaching, we observed an immediate numerical response by >1,000 waterbirds, and within three years, the mean monthly number of birds observed during the winter increased to >2,000 waterbirds. On high tides, dabbling and diving ducks increased as did small and large shorebirds to a lesser extent, and on low tides, small shorebirds and diving ducks greatly increased. Our study indicated that both macroinvertebrates and waterbirds responded quickly to salt pond restoration, and macroinvertebrate densities in these newly formed habitats exceeded those in reference areas.

Keywords: salt ponds, breach, invertebrate, shorebirds, waterbirds, colonization

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Submerged Surprise in Suisun: Extensive Beds of Native SAV

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Though invasive submerged aquatic vegetation (SAV) in the Delta region of the San Francisco Estuary is known to clog waterways and may enhance predation on native fishes, the abundance and ecology of native SAV beds in the low-salinity waters of Suisun Bay have yet to be examined. In summer 2011 and 2012, we mapped ~1000 acres of the pondweed genus *Stuckenia* in the open waters of Suisun Bay and the west Delta. We collected voucher specimens in each bed, keying them to the native species *S. filiformis* (most specimens) and *S. pectinata* (widespread distribution but fewer specimens). Neither of these species was previously documented in the open waters of this region, although *S. pectinata* was historically an important food for Canvasback ducks in the diked Suisun Marsh. To map the beds, we digitized polygons of suspected SAV based on interpretation of Bing and USGS aerial imagery, then ground-truthed these polygons by boat, adjusting size and shape to match field observations as needed. Because digitization of imagery closely matched field patterns, this was determined to be an effective method for future surveys. Images since 1993 show the characteristic open growth pattern of *Stuckenia* spp. along the west side of Chipps and Winter Islands and a few other locations. However, many beds, such as along Ryer Island and the south side of Chipps Island are not evident in images until ~ 5 years ago; hence, we cautiously suggest that native SAV beds are expanding within Suisun Bay and the west Delta, perhaps in concert with a trend of increasing water clarity. The extent and position of these beds along islands through major migratory paths of native fishes, along with preliminary evidence of abundant invertebrates as potential food resources, suggest that these beds deserve further attention in conservation and management within the region.

Keywords: *Stuckenia*, pondweed, Suisun, SAV, GIS

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (III)– Order 13

Structure of Estuarine Fish Communities: Three Decades of Observation in the San Francisco Estuary, California, USA

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A major focus of ecology has been to generalize ecosystem structure and function. In particular, understanding how and why community structure varies along environmental gradients has provided substantial insights into the roles of local and regional processes affecting ecosystems. A common approach to studying estuarine fish communities involves describing how species composition and distribution vary as a function of salinity. The literature is filled with numerous accounts of how fish communities in various estuaries vary along salinity gradients or how salinity zones could be characterized based on fish distribution. The fundamental role of gross salinity in structuring estuarine fish communities is unquestionable. However, a better understanding of how salinity varies in space and time and how it interacts with other abiotic and biotic factors would provide important improvements in our understanding of how estuaries function and support fish communities. We provide new insights on how fish communities are structured in estuaries based upon an examination of over thirty years of monthly data collected in San Francisco Estuary. This monitoring program, started in 1980 by the Interagency Ecological Program, samples both demersal and pelagic fishes and has resulted in over 30,000 samples containing over 8 million fishes. It is perhaps the most comprehensive estuarine fish data set in the world. The insights we have gained from exploring the data set indicate that ecologists must move beyond the salinity zone paradigm to better understand the structure and function of estuarine fish communities.

Keywords: San Francisco Estuary, fish community, fish assemblage, salinity zones, IEP

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (III)– Order 14

Going to Extremes: Evidence of Refuges for Native Fishes from the Sacramento River to San Francisco Bay

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The San Francisco Estuary is home to a diverse community of native fishes, but has also been heavily invaded by alien fishes over the past 150 years. However, the effects of these alien fishes on the landscape-scale patterns of native fish community composition can be hard to elucidate given multiple covarying impacts. We examined patterns in fish community composition based on a transect from upstream in the Sacramento River to the lower Estuary using data from a long-term, near-shore fish monitoring program. Utilizing catch data from 1998-2011 at 26 stations from Colusa to central San Francisco Bay, we compared native and alien fish abundance and diversity among the various stations and years. We found extremely high abundances of natives in San Francisco and San Pablo bays (93-99% native species), a sharp decrease in native fish abundance in Suisun marsh and the confluence (2-9% native species), and then a progressive increase in native fish abundance moving upstream of the Delta (13-81% native species). Analyses of concurrently collected water temperature and salinity showed that the variance in these environmental variables helped to explain the drop in native abundance Carquinez Strait, but neither temperature nor salinity explained the subsequent increase in natives upstream of the Delta. Additional analyses comparing wet vs. critically dry water-year types indicated that the lower Sacramento River saw increased abundances of natives in wet years while in the upper Sacramento River saw higher abundances of natives during critically dry years. In general, we found decreasing diversity in fish communities in progressively drier water-year types. Our research suggests that the upper Sacramento River and the lower Estuary serve as important refuges for native fishes.

Keywords: Native fish, fish communities, long-term data

Wednesday, October 17, 2012: Room 314, San Francisco Bay Ecology (III)– Order 15