Bay Area Lepidium Science and Management Series

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Presentation Abstracts

Spatiotemporal characteristics of *Lepidium latifolium* invasion in the San Francisco Bay/Sacramento-San Joaquin Delta

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Hyperspectral and LiDAR (light detection and ranging) remote sensing data have the potential to address a wide variety of ecological questions. We have used these remotely sensed data to study the demography of *Lepidium latifolium* (perennial pepperweed) at several sites in the Sacramento-San Joaquin Delta and susceptibility to further invasion at Rush Ranch, in Suisun Marsh. Hyperspectral image data has been used to map *Lepidium* distributions in several sites of the Bay/Delta annually over 2004-2007. Annual distribution maps allow quantification of *Lepidium* spread. For example, on Bouldin Island, existing infestations doubled in size over these three years, with annual rates of increase ranging from 0.94 to 1.70. In contrast, a new infestation that spread from small satellite patches grew 35-fold in just three years, with annual growth rates ranging from 2.58 to 5.22. Habitat suitability modeling at Rush Ranch was performed with presence/absence of *Lepidium* extracted from the hyperspectral distribution map, and predictor variables derived from a high resolution LiDAR DEM (digital elevation model). Aggregate decision tree models found *L. latifolium* to infest two zones: near the marshland-upland margin and along channels within the marsh. Topographical data, which is typically strongly correlated to wetland species distributions, was relatively unimportant to *L. latifolium* occurrence, although relevant microtopography information, particularly relative elevation, was subsumed in the distance to channel variable. The map of potential *L. latifolium* distribution reveals that Rush Ranch contains considerable habitat that it is at risk to continued invasion.

Plant-Soil Relationships of Perennial Pepperweed (*Lepidium latifolium*)

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Perennial pepperweed is a crucifer native to Eurasia aggressively invading wetland and riparian habitats across the western United States. In a relatively short period, it can dominate the plant community forming near monocultures. Perennial pepperweed is adapted to a multitude of soil habitats and readily invades saline and sodic soils. In the Honey Lake Valley of northeastern CA, we have noticed that occupation of sodium-affected soils by perennial pepperweed for a period of 5 to 10 years has caused hard, compact, and root-restricting natric soil horizons to become less distinct and more friable. This amelioration is accomplished through plant biogeochemical cycling. Compared to plant communities being replaced, perennial pepperweed tissue has very high levels of calcium. Mineralization of litter enriches the upper soil in calcium and replaces sodium on clay exchange sites thereby increasing soil aggregation and tilth. Invasion by *L. latifolium* has the potential to alter soil properties and processes to the degree that the trajectory of soil evolution is altered. Positive aspects of *L. latifolium* invasion are offset by loss of species diversity, wildlife habitat, and economic losses to farmers and ranchers.

Impacts of non-native invasive pepperweed (*Lepidium latifolium*) on breeding bird distribution and reproductive success in San Francisco Bay tidal marshes

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Extensive loss and degradation of tidal marsh habitat has resulted in decreases in populations of tidal marsh breeding birds in the San Francisco Estuary. The spread of non-native invasive plants such as pepperweed (*Lepidium latifolium*) has the potential to further impact sensitive bird species by influencing, directly and indirectly, ecological relationships such as habitat choice, food availability, and concealment from predators. We present the results of several studies of San Francisco Estuary tidal marsh birds completed at PRBO that include examination of the effects of the pepperweed invasion, including: 1) whether breeding birds were avoiding or selecting marsh habitat that included pepperweed; and 2) whether nest success was related to the presence or absence of pepperweed. We examined the relationship between pepperweed cover and breeding bird abundance (or presence) at 448 points in 58 marshes throughout the estuary in 2000 and 2001. We also examined the effects of a suite of additional local and landscape variables including vegetation density and habitat configuration, factors that may modify birds' selection of, or avoidance of, pepperweed. We also examined the relationship between the survivorship of over 2000 tidal marsh Song Sparrow (*Melospiza melodia samuelis* and *M. m. maxillaris*) nests and pepperweed cover at 6 marshes between 1996 and 2003. Here also we examined the effects an additional set of local and landscape level variables including ground cover, plant structure, and distance to tidal channels. There was a positive association for some bird species, particularly common yellowthroat, between bird abundance (or presence) and the proportion cover of pepperweed. The implications of this association are not understood, and may or may not be good news. Additional information about the effects of pepperweed on other species in the tidal marsh food web, and other critical ecological parameters, would improve our understanding of the level of ecosystem disruption related to the pepperweed invasion.

Ecological limitations on perennial pepperweed invasion in wetlands

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Perennial pepperweed is a rapidly spreading and highly invasive species with broad environmental tolerance that is invading San Francisco Estuary's tidal wetlands. We synthesized our findings on recruitment dynamics with the work of other researchers to assess ecological limitations to pepperweed invasion. Recruitment is negatively correlated to increasing salinity across development. Within the framework of the strong negative correlation between recruitment and increasing salinity, bare ground and infrequent flooding are consistently the most suitable for pepperweed recruitment. Roots fragment easily and are likely propagule sources though the importance of root fragmentation to invasion success in wetlands has not been well documented. Mature plants exhibit sensitivity to salinity and flooding, and distribution may be highly correlated with roads and channels. This suggests that salinity, flooding, and vegetation are important predictors of the invasion trajectory for a given site. These findings create an emerging picture of a disturbance-favored species that is restricted by flooding frequency and duration, particularly as salinity increases. Seasonal and low salinity wetlands are highly susceptible to invasion. They are at the highest risk of re-infestation and will present the greatest challenge to land managers.

Distributional Patterns of Perennial Pepperweed (*Lepidium latifolium*) in the San Francisco Bay

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Accounts of the extent of perennial pepperweed in San Francisco Bay and the Delta were largely anecdotal and piecemeal, the result of contributions from individuals concerned with particular geography or management objectives. In 2004, ESA began field surveys to map the extent of pepperweed using GPS, focusing our field efforts on the Bay margins. Our main purpose was to provide a substantially updated distribution map. However, in addition to spatial data, we documented environmental variables, such as pepperweed abundance, patch characteristics, associated species, land use, hydrological regime, and general soil type, and compiled the data in GIS. Additional publicly available data layers also were incorporated into the database. Spatial relationships between its distribution and environmental variables were tested for reliability to explain and predict pepperweed distribution. Resulting predictive models identified areas of high risk areas in the San Francisco Bay. Distribution maps created in the study are available on the CDFG Biogeographic Information & Observation System, and can serve as a baseline for future monitoring and control efforts. Prediction maps for areas outside of field survey areas will assist in identifying high risk wetland habitat areas and prioritizing management efforts.

Salt Marsh Harvest Mouse in the Suisun Marsh, What we know

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Salt Marsh Harvest Mice (SMHM) can be found in salt marshes around the San Francisco Bay Area with the northern subspecies, *Reithrodontomys raviventris halicoetes*, occurring in Suisun and San Pablo Bays. Capture rates in the Suisun Marsh exceed numbers found anywhere else in its range. In Suisun, SMHM use both tidal and diked wetlands with similar densities, reproductive potential, and persistence. Habitat plays a key role in where SMHM are found. For the past 30 years stands of *Salicornia* were thought to be the preferred habitat, but SMHM have been documented in a variety of mixed wetland species in Suisun. Surprisingly high numbers have been captured in *Schoenoplectus* and other mixed wetland vegetation comprising less than 50% *Salicornia*. Competition from other rodent species does not appear to affect SMHM success in Suisun; rather the variety of plant species in a habitat does. *Lepidium* is encroaching in all SMHM habitats, public and private, tidal and diked, at a tremendous rate. Triennial vegetation surveys have documented *Lepidium* encroachment in Suisun and on SMHM Conservation Areas. As the native vegetation is reduced, SMHM numbers may be affected. Further research needs to be done to thoroughly understand the effects that *Lepidium* will have on SMHM populations.

The Impacts of Perennial Pepperweed Invasion in Wetlands Along an Inundation Gradient

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Perennial pepperweed (*Lepidium latifolium*) is an aggressive, non-native weed that has invaded wetland and riparian areas throughout California, At Rush Ranch, a brackish marsh in the San Francisco Bay National Estuarine Research Reserve, we have applied a two-pronged approach to understanding and managing pepperweed:

(1) mensurative experiment documenting impacts of perennial pepperweed on the sediment community and food web
(2) eradication experiments evaluating efficacy and non-target impacts of herbicide control in a seasonal wetland.

We examined the effects of perennial pepperweed on the surrounding non-invaded habitat along an inundation gradient from fully tidal to isolated freshwater wetlands. Within a wetland isolated from tidal creeks, the presence of pepperweed significantly altered the abiotic soil properties (increasing humidity) and altered the diversity and composition of the surrounding plant community. In mid and low elevations, the effects of perennial pepperweed are reduced due to constant inundation and soil saturation. We predict that, in addition to altering abiotic and plant community parameters, the presence of perennial pepperweed will also alter the biodiversity of the surrounding animal communities via cascading impacts throughout the entire food web. Our data provide important information about the consequences of perennial pepperweed invasion and are paired with an on-going eradication effort to assist in making informed decisions regarding management and eradication of pepperweed within this marsh reserve.