Oregon Community Foundation:
Katherine Bisbee Fund Research Grant Application

RESTORING FRESHWATER WETLANDS IN THE SOUTH SLOUGH NATIONAL ESTUARINE RESEARCH RESERVE: USING SOIL CHARACTERISTICS AND SURFACE HYDROLOGY TO PREDICT PLANT COMMUNITIES AND HABITAT QUALITY

Introduction

This proposal requests $14,954 in support from the Oregon Community Foundation's Katherine Bisbee Fund to investigate freshwater wetland soil characteristics, hydrology and plant communities at three freshwater wetland sites within the South Slough National Estuarine Research Reserve (South Slough NERR), in Coos Bay, OR. This one year project, to be undertaken in a partnership between the University of Oregon Institute of Marine Biology and the South Slough NERR, in Charleston, OR, is designed to address key questions about the affects of anthropogenic disturbances on wetland hydrology and soil characteristics; the recovery of marsh soils after restoration actions; and the relationship between wetland hydrology/soil characteristics and specific wetland plant communities, including invasive exotic plant species. Project data will be collected at one undisturbed freshwater wetland site and two disturbed freshwater wetland sites - one recently restored and one not yet restored- all within the South Slough NERR.

Background

Significant investments have been made by government, private and non-profit organizations in recent years to improve the conservation and restoration of wetland habitats in the Pacific Northwest and the U.S. in general. Compensatory wetland mitigation has been mandated by state and federal law for over 20 years to replace wetlands lost to development. However the success rate for wetland restoration, mitigation projects in particular, has been less than stellar. According to the National Academy of Science (NAS) Report on Wetland Mitigation, the national goal of no net loss of wetlands is not being met (NAS, 2001). Part of the blame for this situation lies in the relatively immature status of restoration science. Only recently have scientists and policy makers begun to develop methods for assessing wetland functions by improving understanding of the relationships between physical and biological processes in wetlands. Improved understanding of wetland functions and the interrelationships of natural processes in wetlands is key to understanding how to improve long term wetland conservation and ensure success of future wetland restoration and compensatory wetland mitigation projects.

Multiple physical processes in wetlands directly affect each other and combine to affect wetland biological processes and functions, which in turn affect physical processes. Wetland hydrology (flood water storage, in particular), is in part controlled by wetland soil characteristics including infiltration rate and subsurface storage potential (pore space). Infiltration rate and subsurface storage potential are strongly influenced by soil texture, bulk density, organic matter content, and soil saturation. The nutrient processing function of wetlands (part of wetlands' water quality function) is controlled in part by soil pH, the depth to the seasonally high water table, soil saturation, and infiltration and storage (Adamus 2001). Wetland vegetation alters the physical environment by contributing organic matter to the soil, loosening soils by root growth and facilitating sediment accumulation, influencing soil texture, bulk density, organic matter content, and ultimately soil saturation. Thus, the ecosystem is a "dynamic interlocking equilibrium" composed of its biological and physical components (Daubenmire, 1968).

Because biological and physical factors interact to provide wetland functions, both biological and physical characteristics need to be measured to determine wetland condition. The most effective way of evaluating the ecological condition of a wetland is to measure the condition of a wetland's biological community and to measure the chemical and physical characteristics of a wetland and its surrounding landscape (EPA 2002).

This project is a logical next step for the Reserve's restoration monitoring program which began approximately 10 years ago with the planning and implementation of a series of experimental estuarine wetland restoration projects on Reserve lands (support for this work included a 1994 Katherine Bisbee Fund grant which enabled the Reserve to establish a sediment dynamics monitoring infrastructure in South Slough). The Reserve has contributed to the science of habitat restoration by disseminating the "lessons learned" from these restoration projects and associated restoration monitoring results. In doing so, the Reserve has endeavored, through deliberate methods supported by the Reserve's mission to improve the understanding and stewardship of Pacific Northwest estuaries and coastal watersheds, to address gaps between academic research and the practical information needs of coastal decision makers and restoration professionals. The results of the proposed project will similarly be disseminated to appropriate audiences using the Reserve's information services function (professional training programs, restoration workshops, issue papers, publications in peer-reviewed journals, verbal presentations, interpretive displays, etc.) to help fill this gap.

Until the Anderson Creek freshwater wetland restoration project was implemented in fall 2002, the Reserve's restoration focus was limited to intertidal salt marsh habitats in which diverse native plant communities developed by natural tidally driven recruitment processes without interference by invasive exotic vegetation (salt marshes in the Coos estuary and South Slough are so far free of major exotic vegetation invasions, such as *Spartina* spp.). In contrast, freshwater wetland restoration project sites are highly susceptible to long-term degradation through the natural recruitment of invasive exotic plant species from adjacent lands. Aggressive and expensive means, including dense seeding, planting, mulching and invasive exotic plant species control, are required to establish native plant communities at these freshwater wetland sites. Native plant communities are desirable to support diverse, high quality fish and wildlife habitat. Gaining a greater understanding of the local soil characteristics and hydrologic processes that directly influence the development and long-term sustainability of native plant communities associated with these project sites will improve chances for restoration success.

Project Description

The proposed project will collect data from the three freshwater wetland sites within the South Slough Reserve: Upper Tom's Creek Marsh (undisturbed); Anderson Creek Marsh (historically disturbed but restored in 2002); and Wasson Creek Marsh (historically disturbed but not yet restored). The following project hypotheses will be tested:

Hypothesis I: Human manipulation of the Wasson Creek site altered the site's soil and water table characteristics.
Null hypothesis I: Human manipulation of the Wasson Creek site had no impact on the site's soils and water table characteristics.

Hypothesis II: Restoration at Anderson Creek is re-establishing the physical soil and water table characteristics that support wetland functions.
Null hypothesis II: Restoration at Anderson Creek is not re-establishing the physical soil and water table characteristics that support wetland functions.

Hypothesis III: There are significant relationships between soil characteristics, hydrology and plant community composition.
Null Hypothesis III: There are no significant relationships found between soil characteristics, hydrology and plant community composition.

One year of project data will confirm or reject Hypothesis I. Data will quantify the expected differences between Wasson Creek Marsh soils/water table and those attributes at the Tom's Creek reference site, helping Reserve staff to plan appropriate future restoration actions at that site. One year of data will also confirm or reject the water table portion of Hypothesis II, helping Reserve staff to quantify the effectiveness of the restoration actions at that site. We don't expect the disturbed soils at the Anderson Creek site to have fully recovered to match undisturbed soil conditions within two years (the site was restored in fall 2002), but when added to data we hope to collect in future years, these data will help quantify the trajectory of soil development at the site. Project data will confirm or reject Hypothesis III. The data enable us to quantify any relationships between soil characteristics, hydrologic regime (water table level or hydroperiod) and the presence of specific vegetation species. If relationships do exist the data should indicate how strong those relationships are and whether further testing is warranted. Based on these results we will determine the utility of the project methodology for use as a predictive tool- i.e. can plant communities, including invasive exotic species, be predicted or ruled out based on physical attributes in a marsh- soil characteristics and hydrologic regime?

The value of the proposed project will be leveraged by combining both sampling and interpretation with existing South Slough NERR restoration monitoring supported by the Oregon Watershed Enhancement Board and NOAA. At Anderson Creek Marsh, existing monitoring includes plant community monitoring, stream profile measurements, stream use by juvenile salmonids, and detailed topographic monitoring to track stream channel migration. The proposed work will take advantage of the existing monitoring, placing sampling locations within the other projects' sampling zones to allow combined interpretation. This embedded sampling and combined interpretation will produce a more complete picture of the interconnection of site physical and biological characteristics than could be gained from a single project. Data will be collected as follows:

<u>Soils</u>: Soil sampling will include assessments of those parameters most closely related to biological functions- total carbon and nitrogen, soil texture, bulk density and pH. Sampling will be focused within zones defined by existing plant community sampling transects and newly established hydrologic monitoring well locations, as well as within topographic monitoring blocks at Anderson Creek Marsh. Since soil sampling will be embedded within these other sampling areas, it will be possible to relate soil characteristics to plant community development, hydrology, and topography/stream channel migration.

<u>Hydrology</u>: Sampling site hydrology will be undertaken by measuring surface water table elevations with monitoring wells or piezometers (depending on soil profile characteristics). Data will be collected at intervals designed to detect soil saturation during periods that are critical for wetland development (particularly early in the growing season). The wells will be

arrayed within existing plant community analysis transects (which are also soil and sedimentation sampling areas), to allow interpretation of plant community responses and soil characteristics related to water table and surface water depth fluctuations.

Sediment dynamics: Sediment accumulation will be measured using sedimentation plates or feldspar markers. As with the monitoring wells and soil samples, the plates or markers will be embedded within existing vegetation transects and topographic monitoring blocks to allow interpretation of the effects of different sedimentation regimes on associated physical and biological parameters. Sediment accumulation will be measured once in spring, after winter flood events have produced the sediment pulses that are typical of these watersheds.

Plant communities: Plant community data are already being collected at Anderson Creek Marsh. Additional vegetation transects will be established at Wasson Creek and Upper Tom's creek Marshes. These data will be collected using the standardized, quantitative (transect-quadrat) methods used at other South Slough NERR sites and wetland research sites throughout the Pacific Northwest.

The experimental design for the proposed study incorporates two powerful statistical methods: BACI (before-after-control-impact) design, and use of reference-restoration site pairs. Both BACI and reference-restoration comparisons are highly recommended for effective analysis of ecological disturbances and human impacts to the environment.

BACI design is a powerful method for testing for impact of human actions (Underwood, 1991; Rybczyk, 2002). In BACI design, environmental impacts are analyzed by taking multiple measurements both before and after the impact, in both a control and impact (or treatment) site. The data are analyzed using a BACI analysis within an ANOVA statistical analysis framework.

The Wasson Creek site will provide a full BACI design for the "impact" of restoration.

Reference-restoration pairs are a requirement for effective analysis of restoration success. Any study that looks at human impacts to the environment requires a "control" or baseline with which to compare affected sites (Simenstad et al, 1991). Since human activities usually impact an entire site, and since restoration is generally applied to (and affects) an entire site, it's usually not possible to have an unimpacted or unrestored control within the restoration site. Therefore, undisturbed reference sites (in this case, Upper Tom's Creek Marsh) are needed to determine the effects of both the original impacts and the restoration actions. In addition, reference sites allow us to detect long-term and large-scale changes in local environmental conditions that may alter both restoration and reference sites. Statistical analysis of reference-restoration site data is via means comparisons (t-tests or ANOVA).

The comparison between the three project sites will provide a three-way reference-impact-restoration comparison: Upper Tom's Creek Marsh (undisturbed), versus Wasson Creek Marsh (disturbed) and Anderson Creek Marsh (disturbed, then restored).

Project monitoring will be conducted by Laura Brophy, a botanist currently working with the South Slough NERR on vegetation monitoring at the Anderson Creek restoration project site. Field assistance will be provided by a University of Oregon Institute of Marine Biology graduate student.

Project results will be incorporated into a technical report to be presented in a variety of formats including verbal presentations to a variety of groups (consisting of the South Slough NERR advisory group restoration professionals, coastal decision makers, students, and community members), published manuscript in a peer-reviewed scientific journal

Budget

Please see detailed budget attached. Additional funds will be applied to this grant by the Oregon Watershed Enhancement Board (OWEB) and the South Slough NERR and NOAA. Approximately $1,300 in OWEB funds will be contributed to personnel, travel expenses and services (including meals, vehicle mileage and photocopying) due to the overlap of tasks between the proposed project and existing OWEB-supported vegetation monitoring at Anderson Creek Marsh. South Slough NERR will contribute approximately $2,400 in NOAA funds to support contracted soil analysis services (pH, total carbon and nitrogen, soil texture, and bulk density) and to support the purchase of project materials (including PVC pipe and caps for wells/piezometers, filter sock material, bentonite, silica sand, plastic mesh, soil staples, tygon tubing, etc.).

The University or Oregon charges indirect costs to the project to cover the administration of the grant at both OIMB and Eugene main campus and for maintenance costs of lab space within the South Slough NERR Estuarine and Coastal Sciences laboratory (located on the OIMB campus) which will be used in the completion of this project.

Literature cited

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