



Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208-3621

ENVIRONMENT, FISH AND WILDLIFE

In reply refer to:

Mr. Tony Grover, Fish and Wildlife Division Director
Northwest Power & Conservation Council
851 S.W. Sixth Avenue, Suite 1100
Portland, OR 97204-1348

RE: Columbia Land Trust Estuarine Restoration, project #2010-073-00

Dear Mr. Grover:

In response to Independent Scientific Review Panel (ISRP) review, the Columbia Land Trust (CLT) is submitting a revised narrative of their Estuarine Restoration project. The narrative includes the additional information requested by the ISRP in their review of the project. The CLT project supports implementation of the 2008 Federal Columbia River Power System Biological Opinion under the Reasonable and Prudent Alternative 37, which is focused on improving juvenile and adult fish survival in the estuary habitat.

Attached please find the revised CLT narrative. If you have questions or concerns, please contact the project sponsor, Glen Lamb, glamb@columbialandtrust.org or Scott McEwen smcewen@columbialandtrust.org, or at BPA, Tracey Yerxa tyerxa@bpa.gov or Marchelle Foster mmfoster@bpa.gov who are helping to coordinate ISRP responses.

Thank you for your assistance, we look forward to working closely with you and your staff as we implement BiOp projects.

Sincerely,

/s/ William C. Maslen

William C. Maslen
Director, Fish and Wildlife

Enclosure:
CLT Estuarine Restoration Project Narrative

cc:

Mr. Glen Lamb, CLT (electronic mail)

Mr. Scott McEwen (electronic mail)

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The 2008 Federal Columbia River Power System (FCRPS) Biological Opinion (2008 BiOp) is a ten-year operations and configuration plan to mitigate for the adverse effects of the hydrosystem on the 13 listed Columbia/Snake salmon and steelhead under the Endangered Species Act (ESA). The 2008 BiOp provides mitigation actions that are required of the FCRPS action agencies to avoid jeopardy and adverse modification of the critical habitat of ESA listed Columbia River fish. Ongoing projects supported and new projects developed are designed to contribute to hydro, habitat, hatchery and predation management activities required under the 2008 FCRPS Biological Opinion. Additionally, the projects assist the Bonneville Power Administration (BPA) in meeting its protection, mitigation, and enhancement objectives and responsibilities in support of the Columbia Basin Fish and Wildlife Program adopted pursuant of the Northwest Power Act.

Project Title: Columbia Land Trust Estuarine Restoration

Table 1. Proposal Metadata:

Project Number	2010-073-00
Title	Columbia Land Trust Estuarine Restoration
Proposer	Columbia Land Trust
Brief Description	Restoration of T/E Juvenile Salmon Off-Channel Rearing Habitat
Province(s)	Lower Columbia River and Estuary
Subbasin(s)	Columbia Estuary, Elochoman, Grays, Youngs, Lewis & Clark, Columbia Lower, Cowlitz, Sandy, Lewis, Kalama, Washougal, & Willamette
Contact Name	Glenn Lamb
Contact email	glamb@columbialandtrust.org
Projected Start Date	October 1, 2010

A. ABSTRACT

Columbia Land Trust seeks to accelerate the development, design and construction of on-the-ground habitat restoration actions in the Columbia River Estuary that benefit threatened and endangered salmonid species and help meet survival benefit targets/goals required under the 2008 Federal Columbia River Power System (FCRPS) Biological Opinion (BiOp). The Columbia Land Trust Estuarine Restoration Project is intended to implement the following RPA required by the FCRPS BiOp. RPA action 37 states:

“Estuary Habitat Implementation 2010-2018 - Achieving Habitat Quality and Survival Improvement Targets. The AAs will provide funding to implement additional specific projects as needed to achieve the total estuary survival benefits identified in the FCRPS BA.”

All restoration actions conceived of and implemented within this project are intended to benefit threatened and endangered salmonid species rearing and migrating in main stem and tidal habitats of the Columbia River estuary. As a principle implementer of restoration in the Columbia Estuary, Columbia Land Trust has conserved over four thousand acres of Columbia Estuary floodplain over the last nine years. Columbia Land Trust accomplished this by permanently securing a land base from willing land owners through fair market processes. These lands now serve as a platform from which on-the-ground restoration projects are able to be implemented. Columbia Land Trust restoration projects result in some of the highest survival benefits for threatened and endangered salmon in the estuary (Johnson et al. 2007).

Columbia Land Trust helps its public and private partners achieve their specific land protection and restoration goals by working closely with land owners, local, state and federal agencies, providing risk capital through a

revolving transaction fund, negotiation capacity, legal expertise and an ability to leverage significant sources of project funding. This approach enables Columbia Land Trust to act quickly and effectively to meet estuary habitat restoration goals and allows Columbia Land Trust to accomplish restoration where other practitioners may not be able to. Columbia Land Trust has identified and is developing numerous estuary habitat acquisition and restoration projects within priority areas identified within the that this proposal seeks to support.

The project types developed within this program are largely tidal reconnection actions that restore full or near full tidal influence to areas that have been historically disconnected from tidal and fluvial hydrologic processes by levees, roads, dredge material and railroad causeways. These restoration actions intend to restore such natural habitat forming processes as tidal hydrology, sediment accretion, and the movement of macro-detritus that shape and maintain estuarine wetland habitats. Specific restoration objectives are to: 1) Restore connectivity between river and floodplain, as well as in-river habitats; 2) Increase shallow water peripheral and side channel habitats toward historic levels. In addition to the ISRP review of this proposal there are two levels of scientific review for all estuary habitat restoration projects identified and implemented under this project.

Columbia Land Trust will coordinate closely with, and utilize the Lower Columbia River Estuary Partnership's Science Work Group for the initial level of scientific review for on-the-ground habitat projects. The second level of scientific review will be done by the RPA 37 Expert Regional Technical Group as required in the 2008 BiOp; this review will be conducted in coordination with the Science Work Group.

The recovery of Columbia River salmonids requires that a sufficient amount and diversity of habitat opportunity is provided in the estuary to accommodate the full spectrum of stocks and life history types in the basin. To accomplish this, the primary objective of this project is to increase the diversity, extent, and spatial distribution of habitats capable of supporting multiple salmon ESUs and life history types.

B. PROBLEM STATEMENT: TECHNICAL AND/OR SCIENTIFIC BACKGROUND

Background

It is understood that the lower Columbia River and estuary (LCRE) is important to viability of anadromous salmon populations for the entire Columbia Basin (Bottom et al. 2005). The Columbia River estuary is essential for adult salmon migrating to upstream spawning areas, for juvenile salmon making the physiological transition between life in freshwater and marine habitats, and as a nursery ground where many young salmon feed and grow to sizes that may increase their chances of surviving in the ocean (e.g., Simenstad et al. 1982, Fresh et al. 2005).

Juvenile salmon are found in the LCRE all months of the year, as different species, size classes, and life-histories as they enter tidal waters from multiple upstream sources (Rich 1920; Bottom et al. 2005, Sather et al. 2009). Healey (1982) concluded that the most estuarine dependent salmon species are Chinook (*Oncorhynchus tshawytscha*) since virtually all life-history types spend some time feeding and growing in estuaries, and fry migrants depend entirely on the estuary for nursery habitats. Chum salmon (*O. keta*) spawn in the mainstem of the Columbia River and rear in estuaries for several weeks and Chum have been classified as the second most estuarine dependent species.

During their out migration juvenile salmonids, especially juvenile Chinook and Chum salmon, reside and feed for lengthy periods in the shallow, tidal-fluvial channels and wetlands that comprise the estuary and floodplain (Fresh, et al 2005). The importance of these habitat types is highlighted in studies in the lower Sacramento River where tagged juvenile Chinook salmon released in the seasonally inundated floodplain had higher consumption rates, greater growth, and improved survival compared with others released into the main river channel (Sommer et al. 2001). The value of estuarine feeding and refuge areas also holds true for species that move more quickly through the estuary as well. Prey items found in the majority of stomachs of salmon smolts known to migrate through the Columbia estuary quickly (i.e., days) indicate that juveniles are utilizing estuarine resources (Dawley et al. 1989).

The patterns of estuarine habitat use by juvenile salmon are related to age class and fish size. The smallest size classes tend to be the most closely associated with shallow water. Ocean-type salmon, Chinook and chum subyearlings (fry) generally occupy shallow, nearshore habitats, including salt marshes, tidal creeks, forested wetlands and intertidal flats (Levy and Northcote 1982; Myers and Horton 1982; Simenstad et al. 1982). As subyearlings grow to fingerling and smolt stages, their distribution typically shifts toward subtidal habitats farther from shore (Healey 1982; 1991; Myers and Horton 1982). Size-related patterns of habitat use have been reported for subyearling Chinook in the Columbia (e.g., Dawley et al. 1986). Smaller juvenile salmon use the more peripheral side channel areas associated with the more shallow water habitats including tidal emergent marsh and forested marsh habitats (McCabe et al. 1986). Subyearling Chinook salmon may occupy estuarine marsh and other shallow-water habitats until they exceed 100 mm fork length (Healey 1982, Levy and Northcote 1982). Recent NOAA Fisheries surveys have found Chinook and chum salmon fry and fingerlings (but few individuals >90 mm) rearing in wetland habitats from March to July (Lott 2004).

Columbia River Estuary and Lower Mainstem Subbasin Assessment

Planners in Washington and Oregon submitted a subbasin plan for the Columbia River Estuary and Lower Mainstem to the Northwest Power and Conservation Council. The plan, along with nine additional subbasin plans, were reviewed by the Independent Science Advisory Board (ISAB) and approved by the Council on February, 2005. The subbasin plan was developed using the NPCC's *Technical Guide for Subbasin Planners* (Council Document 2001-20). An assessment was developed that provides an overview of the subbasins (Section 2.1.1), description of the focal species (Section 2.1.2), environmental conditions (Section 2.1.3), and ecological relationships (Sections 2.1.4 and 2.1.5). From this body of knowledge, limiting factors were developed (Sections

2.1.3, 2.1.4, and 2.1.6). Finally, Section 2.1.7 is a synthesis of the assessment components (identified above) developed in the form of working hypothesis.

The subbasin plan identifies ocean-type (fall chinook and chum) and stream-type (spring Chinook, winter steelhead, summer steelhead, and coho salmon) as focal species. Table 2 from the subbasin plan demonstrates focal species utilization of various habitats in the two subbasins. Specifically, the table indicates the relationship between ocean- and stream-type juvenile salmonids between their preferred habitats and the percentage change from historical (~1870) to current (~1983) of these habitats.

Table 2. Species and Habitat Relationships – Percent Habitat Change

Species	Primary Life Stage	Level of Use	Primary Season of Use	Riverine/Estuarine Habitat			Transition Habitat			Upland Habitat					
				Estuary Habitat Classification (Thomas 1983, Johnson et al. 2003b)						WDFW Priority Habitat Classification					
				Deep Water	Medium Depth Water	Tidal Flats	Tidal Marsh	Tidal Swamp	Riparian	Old Growth/Mature Forest (see Note below)	Freshwater Wetland (i.e. isolated from river corridor)	Rural Natural Open Space			
				Percent Habitat Change from 1870 to 1983 (Thomas 1983, Johnson et al. 2003b)											
				-13	-19	+10	-49	-74	-	-	-	-			
Ocean-type salmonid ^a	Subyearling Juveniles	Migratory	Spring-Fall												
Stream-type salmonid ^a	Yearling Smolt	Migratory	Summer												
Pacific Lamprey ^b	Ammocoetes or Macrothalmi ^a	Migratory or Resident	Potentially Year-round												
White Sturgeon ^c	Juveniles and Adults	Migratory or Resident	Year-round												
Northern Pikeminnow ^d	Juveniles and Adults	Migratory or Resident	Year-round												
River Otter ^e	Juveniles and Adults	Resident	Year-round												
Caspian Tern ^f	Juveniles and Adults	Resident	Spring to Fall												
Bald Eagle/Osprey ^g	Juveniles and Adults	Resident	Spring to Fall												
Yellow Warbler ^h	Juveniles and Adults	Resident	Spring to Fall												
Red-eyed Vireo ⁱ	Juveniles and Adults	Resident	Spring to Fall												
Sandhill Crane ^j	Juveniles and Adults	Resident	Winter												
Columbian White-tailed Deer ^k	Juveniles and Adults	Resident	Year-round												

Qualitative Scale of Habitat Use:

- Critical
- High
- Medium
- Low
- None

(From Table A-1 Columbia River Estuary and Lower Mainstem Subbasin Plan)

Table 3, also from the subbasin plan, shows the relative changes from the historical template to contemporary conditions by key geographic areas. Note: the University of Washington and the US Geological Service, in conjunction with the Estuary Partnership, are collaborating to develop a GIS-based ecosystem classification. With the completion of all eight reaches in late 2011, a more robust analysis of historical versus current habitat loss/gain analysis will be possible. This analysis indicates major losses of tidal marshes and swamps in all of the geographic areas identified.

Table 3. Qualitative Change in Habitat Characteristics

Area	Tidal Exchange	Bathymetry	Salinity
Entrance	<i>L</i> -only a small area of historical marshes and swamps	<i>H</i> -very large increases in deep water area, and loss of medium and shallow depth areas	<i>L</i> -probably somewhat less dynamic, but still ocean-dominated
Mixing Zone	<i>L</i> -only a small area of historical marshes and swamps	<i>L</i> -little change in area, although high degree of shifting of locations	<i>M</i> -very dynamic salinity zone, probably altered by flow regulation
Youngs Bay	<i>H</i> -substantial loss of tidal marsh and swamp	<i>M</i> -loss of medium and shallow depth areas	<i>M</i> -very dynamic salinity zone, probably altered by flow regulation
Baker Bay	<i>H</i> -substantial loss of tidal marsh and swamp	<i>H</i> -substantial loss of deep and medium deep areas, and increase in shallow areas	<i>M</i> -very dynamic salinity zone, probably altered by flow regulation
Grays Bay	<i>H</i> -substantial loss of tidal swamp	<i>M</i> -shift from deepwater area to shallow flats	<i>L</i> -a small change in dilute salinity dynamics
Cathlamet Bay	<i>M</i> -loss of tidal swamps, but gain in tidal marsh	<i>M</i> -loss of deep and medium deep areas	<i>L</i> -a small change in dilute salinity dynamics
Upper Estuary	<i>H</i> -substantial loss of tidal swamp and marsh	<i>H</i> -loss of deep and gain in medium deep area, and substantial increase in shallow areas	<i>L</i> -a small change in dilute salinity dynamics
Tidal Freshwater Middle Reach (RM46-102)	<i>H</i> -substantial loss of tidal swamp and marsh, and non-tidal wetland	<i>H</i> -loss of shallow area, and gain in deep area	<i>L</i> -salinity not a factor
Tidal Freshwater Upper Reach (RM 102-146)	<i>H</i> -substantial loss of tidal swamp and marsh suspected, and gain in non-tidal wetland	<i>H</i> -loss of shallow area, and gain in deep area	<i>L</i> -salinity not a factor

(From Table A-2 Columbia River Estuary and Lower Mainstem Subbasin Plan). Qualitative description of the change in habitat characteristics from historical to current conditions by area, including a judgment of relative importance (adapted from Johnson et al. 2003b; L, M, and H refer to Low, Medium, and High).

Areas of Biological Significance

The Columbia River Estuary and Lower Mainstem subbasin plan identifies areas of biological significance for the focal species identified in the plan (Section 2.1.1.8). The Columbia Land Trust has targeted 3 of these areas of biological significance for developing key land bases for ecosystem and salmonid restoration efforts. Table 4 below shows the intersection of areas of biological significance and the Columbia Land Trusts priority restoration areas.

Table 4. Areas of Biological Significance and Relationship to Columbia Land Trust Priority Areas

<i>Areas of Biological Significance (from Section 2.1.1.8)</i>	<i>Relationship to Columbia Land Trust Restoration Area</i>
Baker Bay , Youngs Bay, Trestle Bay, Grays Bay and Cathlamet Bay are especially productive areas for benthic organisms, anadromous fish and waterfowl	The mouth of the Chinook River restoration project is found within Baker Bay and located within this area of biological significance.
Baker Bay, Youngs Bay, Trestle Bay, Grays Bay and Cathlamet Bay are especially productive areas for benthic organisms, anadromous fish and waterfowl	The Crooked Creek restoration area is found within Grays Bay and located within this area of biological significance.
Baker Bay, Youngs Bay , Trestle Bay, Grays Bay and Cathlamet Bay are especially productive areas for benthic organisms, anadromous fish and waterfowl	The Walluski River restoration area is found within Youngs Bay and located within this area of biological significance.
Baker Bay, Youngs Bay , Trestle Bay, Grays Bay and Cathlamet Bay are especially productive areas for benthic organisms, anadromous fish and waterfowl	The Haven Island restoration area is found within Youngs Bay and located within this area of biological significance.
High-quality wetlands in Pacific County	The mouth of the Chinook River restoration project is found within this area of biological significance.
Julia Butler Hansen National Wildlife Refuge, which includes the lower Elochoman River area in Washington	The lower Elochoman River restoration area is found within this area of biological significance.

Limiting Factors

Critical habitat designated for Columbia River chum and Chinook includes all Columbia River estuarine areas and the tidal portions of tributary river reaches (NMFS 2005b). In the lower Columbia River and its tributaries, major factors affecting chum and Chinook salmon are altered channel morphology and stability, lost/degraded floodplain connectivity, loss of habitat diversity, excessive sediment, degraded water quality, increased stream temperatures, reduced stream flow, and reduced access to spawning and rearing areas (LCFRB 2004, ODFW 2006b, PCSRF 2006).

Over the past one hundred and fifty years there have been extensive alterations in the quantity, composition, and distribution of tidal wetland habitats in the LCRE. The result of this fragmentation and habitat shrinkage is less exchange of materials and species among habitats, and a corresponding loss of productivity and survival rates. These changes are largely the result of modifications intended to claim tidelands for agricultural and other development, improve river navigation, and generate electrical power. It is estimated that an area of over 80,000 acres of historic floodplain and wetlands are now positioned behind an extensive system of dikes and tide gates; and urbanization and its associated filling and shoreline armoring account for an additional 20,000 acres of habitat loss (US ACOE, 2001). An extensive literature describes how dikes affect marsh surface subsidence, sediment accretion, soil density, and soil organic content (Thom 1992; Bryant and Chabreck 1998; Anisfeld et al. 1999).

In the lower Columbia River and estuary, historic wetland types, such as emergent and forested wetlands and their network of tidal channels and sloughs have been greatly diminished. It is estimated that approximately 77% of the total area of tidal marshes (wetlands dominated by herbaceous vegetation) and 62% of the tidal swamps (wetlands dominated by forest cover) have been lost in the area from the mouth of the river to Puget Island (Thomas 1983). To the extent that survival and productivity of juvenile salmonids is related to shallow water wetland habitats, the loss of these habitats adversely affect juvenile salmonids in the Columbia estuary (LCFRB 2004).

No single limiting factor or threat is solely responsible for the current viability or health of salmon and steelhead nor can all recovery goals be achieved based solely on improvements in any one factor. Numerous other entities are working on other limiting factors at other life stages. The technical appendices found in the Lower Columbia Subbasin and Recovery Plan confirm that many different factors and threats have contributed to salmon declines and significant improvements in multiple factors will be needed for recovery (LCFRB 2004). Some of the key limiting factors for Columbia River chum and Chinook salmon that will determine the recovery of these species include river flow, circulation, and contaminants.

NOAA Fisheries' *Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead* also identified limiting factors. The identification of these limiting factors was based upon the *Columbia River Estuary and Lower Mainstem Subbasin Plan* and other technical documents (e.g., Bottom et. al. 2005) published after the subbasin plans were developed. Table 4 from the Estuary Module shows 18 limiting factors and their relative importance to salmon recovery efforts in the estuary. For a more detailed explanation of the limiting factors, see Chapter 3 Limiting Factors, in the Estuary Module. The Columbia Land Trust targets threats (the underlying cause of limiting factors) that address the highlighted limiting factors in Table 5.

Table 5. Limiting Factor Prioritization

TABLE 3-2 (FROM ESTUARY MODULE) Limiting Factor Prioritization		
Limiting Factor	Limiting Factor Score ^a	Limiting Factor Priority ^b
Flow-related estuary habitat changes	8	
Flow-related changes in access to off-channel habitat	8	
Reduced macrodetrital inputs	8	Top
Water temperature	8	
Flow-related plume changes	8	
Bankfull elevation changes	7	
Sediment/nutrient-related estuary habitat changes	7	
Native pinnipeds	7	High
Short-term toxicity	7	
Native birds	7	
Bioaccumulation toxicity	6	Medium
Native fish	6	
Increased microdetrital inputs	5	
Sediment/nutrient-related plume changes	5	Low
Stranding	5	
Exotic plants	4	
Introduced invertebrates	4	Lowest
Exotic fish	4	

^aFrom Table 3-1 (see p. 3-24 of the Estuary Module)

Habitat Opportunity

Habitat opportunity involves the capability of juvenile salmon to access and benefit from occupying a habitat (Simenstad and Cordell 2000). In estuaries, habitat opportunity is controlled by bathymetry, river flow, and tides (Bottom 2005). A significant factor influencing the number and quality of life history strategies present within a population will be the distribution and quality of habitats that can potentially be used (NRC 1996). Habitat opportunity metrics are usually defined as physical and chemical in nature such as tidal elevation, temperature, and location of habitat (Figure 1). High water temperatures or diminished flows, for example, can constrain accessibility of shallow water habitat.

Physical	Physiological/ behavioral	Water characteristics and quality	Ecological
Tidal flooding Depth Duration	Water velocity Turbidity	Temperature Salinity Dissolved oxygen Turbidity Toxicants	Proximity to disturbance (e.g., noise, movement, etc.) Refugia from predation (e.g., extent of overhanging vegetation, marsh vegetation height, proximity to deepwater habitats)
Fluvial flooding Frequency Depth Duration Timing			
Distributary and tidal channel structure			

Figure 1. Factors influencing habitat opportunity (Bottom et al 2005)

The two principal factors limiting the amount of habitat opportunity in the Columbia River estuary include: 1) the extensive loss of historic estuarine wetlands in the Columbia River estuary through diking and filling (Thomas 1983); and 2) the reduction in the spring freshets due to hydropower system operation that reduces the amount of seasonal overbank flooding and floodplain connectivity. Accessibility to some estuarine habitats depends on the frequency of tidal or seasonal inundation and whether changes in physical or chemical conditions at a site are within a suitable range of physiological tolerance for juvenile salmon. Within the freshwater tidally influenced portion of the Columbia River estuary, flow reductions and floodplain levees have reduced the amount of shallow water habitat by 52% and 29%, respectively (Bottom et al. 2005). This reduction in available estuarine habitat may have reduced and eliminated some subyearling migrant life histories that have been linked to the availability of shallow marsh habitats (Levy and Northcote 1981; 1982).

Habitat Capacity

Habitat capacity is described as the quality of estuarine habitat for salmon (Simenstad and Cordell 2000). Habitat capacity refers to habitat qualities that can influence biological and energetic interactions such as the type and availability of prey species or the ability of individuals to successfully elude predators (i.e., acquiring food and avoiding being eaten). Habitat capacity is also time dependent, since prey production can be punctuated, and predation intensity may vary with alternative prey availability, food demands, etc. Salmon performance, as indicated by feeding success, growth, or survival, is thus a product of both habitat opportunity and habitat capacity (Simenstad and Cordell 2000).

The shift from historic macrodetrital to microdetrital food web in the estuary stems, in part, from the diking and filling of intertidal wetlands as well as the creation of impoundments behind the mainstem dams (Fresh et al. 2005). While changes in the quality and quantity of prey resources could be a factor affecting the productive

capacity of the estuary, the ultimate cause is the physical removal of vegetated habitats that supported macrodetrital production and associated epibenthic food webs (Simenstad 1990).

The loss of wetlands in the estuary has altered the amount and character of habitat capacity (Sherwood et al. 1990). The decline in wetland primary production eliminated approximately 15,800 mt carbon year⁻¹ (84%) of macrodetritus that historically supported estuarine food webs. This macrodetritus originated from the vascular plants and algae produced within the estuary's wetlands. The loss of macrodetritus was accompanied by an increase of approximately 31,000 t carbon year⁻¹ of microdetritus from upriver sources from increased phytoplankton production in the reservoirs behind the mainstem dams (Sherwood et al. 1990). This shift in the detritus available may have altered estuarine food webs, including those for juvenile salmon. For example, the epibenthic-pelagic food web supported by microdetrital sources favors production of calanoid copepods and other pelagic organisms that typically are not consumed by juvenile salmon (Bottom and Jones 1990, Sherwood et al. 1990, Simenstad et al. 1990). As a result of the loss of habitat, altering the spatial distribution of food webs may also be an important determinant of habitat capacity in the estuary.

Habitat Opportunity and Capacity: The Landscape Perspective

Our increased knowledge of the behavioral patterns of ocean type juvenile salmon is thus helping to improve restoration site selection and design. For example, efforts are now underway to track tagged juvenile salmonids in and through the estuary (EST-P-02-01). Research on the use of the tidal channels within marsh and forested wetland habitats within Cathlamet Bay (2003-010-00) and the Grays River (EST-P-04-04) has significantly improved our understanding of the diet and foraging patterns of juvenile Chinook. Russian Island in particular has received a great amount of research related to salmon residency and consumption in the estuary. Research questions are now being investigated about the importance of tidal circulation in regulating habitat opportunities (as defined by depth, temperature, and velocity metrics) and salmonid migration and residency through the dendritic channel network of these large marsh-island complexes.

The landscape arrangement and connectivity of shallow water habitats and their associated channels in the lower river and estuary is important to juvenile salmon. Individual juveniles continually adjust their position as tidal fluctuations alter the distribution of wetted areas, depths, velocities, and chemical gradients. Salmon interact dynamically with this changing mosaic of habitats along the entire estuarine gradient (Bottom et al. 2005). Their response is to the organization of patches, corridors, and matrix of habitats through which they move and interact, is part of the 'trophic relay' to the ocean (Kneib 1997).

Researchers (project 2003-007-00) are using the principles of landscape ecology and hydrogeomorphology to develop a Columbia River Estuary Ecosystem Classification (CREEC). The goal of CREEC is to present a framework to understand habitat fragmentation in the lower Columbia River and model potential restoration scenarios (Simenstad 2004). Progress made on these fronts is increasing our ability to be strategic in locating restoration projects at a landscape scale.

Concurrent with these broader research efforts is the applied research being conducted at a number of Columbia Land Trust and other tidal restoration efforts. NOAA and University of Washington are using experimental studies in Grays River in collaboration with Columbia Land Trust and CREST to compare responses to observed habitat-use patterns to those in the mainstem estuary (2003-010-00). Applied research at Columbia Land Trust projects by NOAA, CREST and PNPL (EST-P-04-04) will inform restoration site selection and design in an adaptive context (Johnson et al. 2007).

Subbasin Plan Working Hypothesis

The Mainstem Lower Columbia River and Columbia River Estuary Subbasin Plan contains hypothesis statements which are the culmination of all physical and biological information found in the plan. Hypothesis statement 7, 8,

and 12 directly support the acquisition and restoration efforts conducted by Columbia Land Trust and others in selection of restoration methods and project types.

Hypothesis Statement 7 – The Columbia River estuary and lower mainstem ecosystem is critical to expression of salmon life history diversity and spatial structure which support population resilience and production.

Juxtaposition of high-energy areas with ample food availability and sufficient refuge habitat is a key habitat structure necessary for high salmonid production in the estuary. In particular, tidal marsh habitats, tidal creeks and associated complex dendritic channel networks may be especially important to subyearlings as areas of both high insect prey density, and as potential refuge from predators afforded by sinuous channels, overhanging vegetation and undercut banks (McIvor and Odum 1988). Furthermore, areas of adjacent habitat types distributed across the estuarine salinity gradient may be necessary to support annual migrations of juvenile salmonids (Simenstad et al. *in press* as cited in Bottom et al. 2001). For example, as subyearlings grow they move across a spectrum of salinities, depths, and water velocities. For species like chum and ocean type Chinook salmon that rear in the estuary for extended time periods, a broad range of habitat types in the proper proximities to one another may be necessary to satisfy feeding and refuge requirements within each salinity zone. Additionally, the connectedness of these habitats likely determines whether juvenile salmonids are able to access the full spectrum of habitats they require (Bottom et al. 1998). Juvenile salmonids must continually adjust their habitat distribution in relation to twice daily tidal fluctuations as well as seasonal and anthropogenic variations in river flow. Juveniles have been observed to move from low-tide refuge areas in deeper channels to salt marsh habitats at high tide and back again (Healey 1982). These patterns of movement reinforce the belief that access to suitable low-tide refuge near marsh habitat is an important factor in production and survival of salmonid juveniles in the Columbia River estuary.

Hypothesis Statement 8 – Changes in Columbia River estuary and lower mainstem habitat have decreased the productivity of the ecosystem for salmonids and contributed to their imperiled status.

Natural and anthropogenic factors have negatively altered the habitat-forming processes, available habitat types, and the estuarine food web, resulting in decreased salmonid survival and production. Studies conducted by Emmett and Schiewe (1997) in the early 1980s have shown that favorable estuarine conditions translate into higher salmonid survival. The most significant habitat effects have resulted from modified river flow, channel manipulations, and contaminant effects. River flow, although influenced by many factors, will be discussed in detail in the next hypothesis statement addressing hydropower system effects; the other habitat effects will be addressed below.

Salmonid production in estuaries is supported by detrital food chains (Healey 1982). Therefore habitats that produce and/or retain detritus, such as tidal wetlands emergent vegetation, eelgrass beds, macro algae beds and epibenthic algae beds, are particularly important (Sherwood et al. 1990). Diking and filling activities in the estuary have likely reduced the rearing capacity for juvenile salmonids by decreasing the tidal prism and eliminating emergent and forested wetlands and floodplain habitats adjacent to shore (Bottom et al. 2001). Dikes throughout the lower Columbia River and estuary have disconnected the main channel from a significant portion of the wetland and floodplain habitats. Further, filling activities (i.e. for agriculture, development, or dredge material disposal) have eliminated many wetland and floodplain habitats. Thus, diking and filling activities have eliminated the emergent and forested wetlands and floodplain habitats that many juvenile salmonids rely on for food and refugia. These activities also eliminated the primary recruitment source of large woody debris that served as the base of the historical food chain. The current estuary food web is microdetritus based, primarily in the form of imported phytoplankton production from upriver reservoirs that dies upon exposure to salinity in the estuary (Bottom and Jones 1990 as cited in Nez Perce et al. 1995, Bottom et al. 2001, USACE 2001).

Hypothesis Statement 12 – Habitat restoration efforts are capable of significantly improving conditions for fish and wildlife species in the Columbia River estuary and lower mainstem.

Habitat actions proposed in the NMFS (2000c) also suggested examples of acceptable habitat improvement efforts, including but not limited to: acquiring diked lands, breaching levees, improving plant communities, reestablishing flow patterns, or enhancing connections between lakes, sloughs, side channels, and the main channel. Dike removal could provide a sizable increase in shallow water habitat, even without restoration of historical flow regimes (Kukulka and Jay 2003). Dike removal alone provided more of an increase in shallow water habitat than flow restoration without dike removal. Restoration of natural flows increases the duration of shallow water habitat inundation in high flow years, but individually does not restore the large size of the area historically inundated.

Location

Project work will occur within the lower Columbia River and estuary. The *estuary* is delineated in this proposal by that which encompasses the entire complex of gradients ranging from fluvial to nearshore ocean ecosystems and includes the tidally influenced portions of the Columbia River mainstem and its tributaries and floodplain from the River's mouth to Bonneville Dam and the Willamette Falls. This definition is based on tidal variation, rather than salinity. This definition follows the CREEC system (Simenstad et al. 2004) being developed by the Lower Columbia River Estuary Partnership (2003-007-00) for monitoring sampling design and restoration planning in this region.

Monitoring & Evaluation

Columbia Land Trust partners with every major entity involved in estuary research and monitoring, including CREST, National Oceanic and Atmospheric Agency (NOAA), Pacific Northwest National Labs (PNNL), University of Washington, USGS, etc. The evaluation and implementation monitoring proposed within this project is within the framework described in the Implementation and Compliance monitoring sections of the Research, Monitoring, and Evaluation for the Federal Columbia River Estuary Program (Johnson et al. 2008). This Program describes in detail the monitoring approaches recommended to the action agencies for their restoration work in the estuary. The Program details monitoring approaches related to status and trend, action effectiveness, critical uncertainties research, implementation and compliance monitoring, and synthesis and evaluation.

This evaluation will determine whether projects are being managed and implemented as planned, measure the amount of estuary habitat being conserved and restored annually and address one component of the Estuary RME Plan (Johnson et al. 2008). Implementation monitoring will include monitoring during the implementation phase as well as after. This monitoring will compare the "as-built" project to the planned project according to project-specific criteria established before construction. The intent is to ensure that engineering designs for the project were carried out correctly and to document any variances.

1. ICM 1. Determine whether restoration projects were carried out as planned, i.e., whether specified project criteria were met ("Implementation Monitoring").
2. ICM 2. Total the amount of estuary habitat conserved and restored annually by habitat type.

This ICM will entail routine tracking of habitat restoration and protection actions. The monitored indicators for ICM will be specific to a project. ICM monitored indicators will include:

1. On-site review by project managers;
2. Verification of construction by licensed, bonded contractors;
3. Land and water level surveys to determine elevations relative to specifications;

4. Engineering surveys to determine as-built and compare to the project's engineering plan.

A more extensive discussion on project monitoring and regional coordination is found in Section G. Monitoring and Evaluation.

C. RATIONALE AND SIGNIFICANCE TO REGIONAL PROGRAMS

There are numerous management programs that identify restoration of the Columbia River estuary as vital to rebuilding productivity of salmon and steelhead runs in the Columbia River Basin. The following management plans all emphasize the following: (1) the importance of the estuary and lower river to fish and wildlife populations of the Columbia basin; (2) the potential impact of the Columbia River hydroelectric system and habitat changes on these environments; and (3) the need for basic ecological information to guide management decisions affecting the estuary. Implementation of this proposal will contribute to on-the-ground actions in support of these regional programs.

Columbia River Basin Fish and Wildlife Program (Northwest Power and Conservation Council, 2009)

The Northwest Power and Conservation Council adopted subbasin plans into the Columbia River Basin Fish & Wildlife Program in 2005. In February 2009 the Council completed a two-year process to amend its Columbia River Basin Fish & Wildlife Program. Specific implementation of habitat actions in the estuary, and monitoring and evaluation of these actions, will occur through the adopted Columbia River Estuary and Lower Columbia subbasin plans. The Columbia River Basin Fish and Wildlife Program summarize key estuary strategies which have been suggested to improve survival benefits. This proposal is designed to target two strategies identified in Section V.A, page 32, of the program.

- Habitat restoration work to reconnect ecosystem functions such as removal or lowering of dikes and levees that block access to habitat or installation of fish-friendly tide gates, protection or restoration of riparian areas and off-channel habitat, and removal of pile dikes
- Recognition and encouragement of continued partnerships in planning, monitoring, evaluating, and implementing activities in the estuary and lower Columbia River

Columbia Land Trust is one of the primary implementers of estuary strategies identified in the Council's Subbasin Planning program and Columbia Land Trust Estuarine Restoration project is integral to accomplishing the goals of this plan.

Lower Columbia River and Estuary Subbasin Plan (Northwest Power and Conservation Council, 2004)

The Lower Columbia River subbasin planning effort describes a number of strategies related to estuary restoration. This proposal addresses the following strategies and measures:

E.S3. Protect functioning habitats while also restoring impaired habitats to properly functioning conditions.

Explanation: Important habitats in the Columbia River estuary and lower mainstem that are currently functioning for fish and wildlife species should be protected, where feasible. Important habitats that are isolated or impaired should be restored, when it can be demonstrated that the activities will provide benefits to fish and wildlife species while habitat-forming processes are improving.

E.S4. Strive to understand, protect, and restore habitat-forming processes in the Columbia River estuary and lower mainstem.

Explanation: Habitat conditions important to fish and wildlife species are governed by opposing hydrologic forces, including ocean processes (tides) and river processes (discharge). Changes to habitat forming processes are due to natural events and human actions (e.g., storm events and changes to the hydrograph as a result of the Columbia River hydro system, etc.).

E.S5. Improve understanding of how salmonids utilize estuary and lower mainstem habitats and develop a scientific basis for estimating species responses to habitat quantity and quality.

Explanation: Emerging research and understanding about how physical processes affect habitat conditions for salmonids in the estuary and lower mainstem are promising tools potentially available in the foreseeable future. Just as critical is an increased understanding of how salmonid populations use and respond to the changing habitat conditions in the estuary and lower mainstem.

Measures

E.M1. Restore tidal swamp and marsh habitat in the estuary and tidal freshwater portion of the lower Columbia River. (Category C)

Explanation: Loss of tidal swamp and marsh habitat has respectively resulted in an estimated 62% and 94% loss of these habitat types since the 1800s. The substantial acreage loss of the tidal swamp and tidal marsh habitat types has important implications on juvenile salmonid survival in the estuary because evidence suggests salmonids, particularly ocean-type salmonids, depend on these habitats for food and cover requirements.

E.M2. Protect and restore riparian condition and function. (Category A)

Explanation: Riparian and upland zones are critical habitats for many naturally-spawning species. This includes a variety of tools including; local land use regulatory actions, acquisition, and restoration activities.

E.M7. Restore connectedness between river and floodplain. (Category C)

Explanation: Restoring the access to the floodplain addresses the following juvenile rearing limiting factors: shallow water, low velocity, and peripheral habitats.

Columbia River Estuary Recovery Plan Module (National Oceanic and Atmospheric Administration, 2008)

The Action Agency's 2007 Biological Assessment for the continued operations of the Federal Columbia River Power System used the Estuary Module as a framework for estimating the contribution of actions implemented in the estuary toward meeting their commitments in the 2008 BiOp. Columbia Land Trust's estuary work will focus heavily on meeting recovery goals as stated in the NOAA Estuary Module. The estuary recovery module is one element of a larger planning effort led by the National Marine Fisheries Service to develop recovery plans for Endangered Species Act-listed salmon and steelhead trout in the Columbia River basin. The goal of the estuary module is to identify management actions that, if implemented, would address threats designed to reduce the impacts of the limiting factors that salmon and steelhead encounter during migration and rearing in the estuary and plume ecosystems. The module identifies restoring off-channel habitat by breaching (or lowering dikes) one of the highest priority actions in the estuary. Columbia Land Trust is one of the primary implementers of estuary strategies identified in the Module and the Columbia Land Trust Estuarine Restoration project is integral to accomplishing the following sub-actions of this plan.

The following subset of Estuary Module actions and subactions are directly related to implementation of the 2008 BiOp and the mission of the Columbia Land Trust:

CRE-1.1: Educate landowners about the ecosystem benefits of intact riparian areas and the costs of degraded riparian areas.

CRE-1.2: Encourage and provide incentives for local, state, and federal regulatory entities to maintain, improve (where needed), and enforce consistent riparian area protections throughout the lower Columbia region.

CRE-1.3: Actively purchase riparian areas from willing landowners in urban and rural settings when the riparian areas cannot be effectively protected through regulation or voluntary or incentive programs and (1) are intact, or (2) are degraded but have good restoration potential.

CRE-1.4: Restore and maintain ecological benefits in riparian areas; this includes managing vegetation on dikes and levees to enhance ecological function and adding shoreline/instream complexity for juvenile salmonid refugia.

CRE-9.1: Educate landowners about the ecosystem benefits of protecting and stewarding intact offchannel areas and the costs of restoring degraded areas.

CRE-9.3: Actively purchase off-channel habitats in urban and rural settings that (1) cannot be effectively protected through regulation, (2) are degraded but have good restoration potential, or (3) are highly degraded but could benefit from long-term restoration solutions.

CRE-9.4: Restore degraded off-channel habitats with high intrinsic potential for increasing habitat quality.

CRE-10.1: Breach or lower the elevation of dikes and levees; create and/or restore tidal marshes, shallow-water habitats, and tide channels.

CRE-10.2: Remove tide gates to improve the hydrology between wetlands and the channel and to provide juveniles with physical access to off-channel habitat; use a habitat connectivity index to prioritize projects.

CRE-15.1: Increase public awareness of exotic plant species and proper stewardship techniques.

CRE-15.2: Inventory exotic plant species infestations and develop a GIS layer with detailed metadata files.

CRE-15.3: Implement projects to address infestations on public and private lands.

CRE-15.4: Monitor infestation sites.

Bonneville Power Administration Estuary Program

Bonneville Power Administration's (BPA) estuary program supports entities such as Columbia Land Trust to acquire and restore habitats and to accomplish estuary RM&E activities. BPA began funding projects to benefit salmonid recovery in the estuary as part of the 2000 Biological Opinion (BiOp). The goal of BPA's Estuary Program is to meet the juvenile salmonid survival commitments outlined in the 2008 FCRPS BiOp. The strategy is to increase access to historical habitats found within the historic tidal floodplain of the Columbia River that have been cut off from the system (habitat opportunity) and improve the quality of available habitats (habitat capacity) for juvenile salmonids. These habitats include, among others, tidally-influenced spruce swamps and freshwater tidal marshes in the lower and upper reaches of the estuary, respectively. The specific Action Agency commitments are expressed as the estuary Reasonable and Prudent Alternatives (RPAs) found below.

BPA is working directly with Columbia Land Trust to increase Columbia Land Trust's capacity to identify, acquire (when necessary), develop, design, and construct restoration projects. Achievement of the 2008 FCRPS BiOp commitments necessitate these types of investments in order to increase the capacity essential to developing and implementing salmonid habitat restoration projects in the estuary. This increased capacity is expected to translate into additional opportunities to expand the land base required to implement restoration actions and to develop key partnerships to multiply the number and quality of salmonid habitat restoration projects in the estuary.

Reasonable and Prudent Action 36 - Estuary Habitat Implementation 2007 to 2009

"The Action Agencies will provide funding to implement specific actions identified for implementation in 2007-2009 as part of a 10 year estuary habitat program to achieve the estimated ESU survival benefits of 9.0% and 6.0% for ocean type and stream-type ESUs respectively. Projects in an early state of development such that quantitative physical metrics have not been related to estimated survival benefits will be selected per Action 37. If projects identified for implementation in 2007-2009 prove infeasible, in whole or in part, the Action Agencies will implement comparable replacement projects in 2010-2013 to provide equivalent habitat benefits needed to achieve equivalent survival benefits. Replacement projects will be selected per Action 37."

***Reasonable and Prudent Action (RPA) 37 - Estuary Habitat Implementation 2010 - 2018—
Achieving Habitat Quality and Survival Improvement Targets***

“The Action Agencies will provide funding to implement additional specific projects as needed to achieve the total estuary survival benefits identified in the FCRPS BA Attachment B.2.2. Projects will identify location, treatment of limiting factor, targeted ESU/DPS or ESUs/DPSs, appropriate reporting metrics, and estimated biological benefits based on the achieving of those metrics. Pertinent new information on climate change and potential effects of that information on limiting factors will be considered.

Action Agencies will actively engage the LCREP Science workgroup to identify project benefits in coordination with other regional experts, using recovery planning products and the modified LCREP project selection criteria to identify projects that will benefit salmon considered in this RPA.

Agencies will convene an expert regional technical group. This group will use the habitat metrics to determine the estimated change in survival which would result from full implementation. Project proposals will clearly describe the completed project in terms of quantitative habitat metrics which can be used to quantitatively evaluate progress and completion of individual projects. The expert regional technical group will use the approach originally applied in the FCRPS BA (Estimated Benefits of Federal Agency Habitat Projects in the Lower Columbia River Estuary) and all subsequent information on the relationship between actions, habitat and salmon productivity models developed through the FCRPS RM&E to estimate the change in overall estuary habitat and resultant change in population survival.

If actions from the previous cycle prove infeasible, in whole or in part, the Action Agencies will ensure implementation of comparable replacement estuary projects in the next implementation plan cycle to maintain estimated habitat quality improvements at the ESU/DPS level and achieve equivalent survival benefits. Selection of replacement projects, to ensure comparable survival benefits, will be made based on input from expert panels, regional recovery planning groups, the Northwest Power and Conservation Council, and NOAA Fisheries. FCRPS RM&E results will actively inform the relationship between actions, estuary habitat change and salmon productivity and new scientific information will be applied to estimate benefits for future implementation.

If new scientific or other information (except incomplete implementation of project modification) suggests that habitat quality improvement estimates for projects from the previous cycle were significantly in error, the Action Agencies will examine the information and review the project or projects in question and their estimated benefits. This review will occur as part of the 2009 Annual Report and the Comprehensive RPA Evaluations in 2013 and 2016 and will be performed in conjunction with NOAA Fisheries. In the event such review find that habitat based survival improvement were significantly overstated, the Action Agencies will implement replacement projects (selected as per new projects above) to provide benefits sufficient to achieve the ESU/DPS-specific survival benefit estimated for each affected project.”

Comprehensive Conservation Management Plan (Lower Columbia River Estuary Partnership, 1999)

This project is consistent with Actions 5 of the Lower Columbia River Estuary Partnership’s Management Plan (CCMP). This proposal addresses the following actions:

Action 1. Inventory and prioritize habitat types and attributes needing protection and conservation. Identify habitats and environmentally sensitive lands that should not be altered.

Action 2. Protect, conserve and enhance identified habitats, particularly wetlands, on the mainstem of the lower Columbia River.

Action 4. Preserve and/or restore buffer areas in appropriate locations along tributaries and the mainstem to a condition that is adequate to maintain a healthy, functioning riparian zone for the lower river and estuary.

Action 5. Restore 3,000 acres of tidal wetlands along the lower 46 river miles to return tidal wetlands to 50% of the 1948 level.

D. RELATIONSHIPS TO OTHER PROJECTS

Throughout the time period of this project, Columbia Land Trust will continue to participate in regional efforts to coordinate estuary restoration efforts. The Columbia Land Trust currently collaborates with the Pacific Coast Joint Venture, Lower Columbia River Estuary Partnership (LCREP), Lower Columbia Fish Recovery Board, Oregon Watershed Enhancement Board, the FCRPS Action Agencies and the State of Washington/Action Agency Memorandum of Agreement. The specific projects that the Columbia Land Trust is coordinate with include:

LCREP Columbia River and Estuary Habitat Restoration (2003–11–00)

For ten years the Columbia Land Trust has participated in LCREPs Science Work Group. LCREP's role is to convene and provide coordination among restoration implementers such as the Columbia Land Trust and CREST. LCREP uses a prioritized granting process in conjunction with a Science Workgroup to select projects for funding to project sponsors. Columbia Land Trust has received funding for some of its acquisition and restoration projects through LCREP annual funding cycle through the years. The Land Trust was an early user of the Restoration Prioritization Framework that was developed by the Pacific Northwest National Laboratory to evaluate where watershed processes are likely to support habitat restoration and protection.

WDFW Washington Estuary Memorandum of Agreement Plan (2009–016–00)

Columbia Land Trust is working closely with WDFW to identify and move projects towards implementation as part of the MOA. One of the proposed MOA projects on the Lower Elochoman River is a Columbia Land Trust property. Three other Columbia Land Trust projects have been identified in the preliminary stages of the project with a total of 974 acres to be restored if all projects are completed as proposed. Projects primarily consist of reconnection of historic habitats. Partners include LCFRB and Action Agencies.

Historic Habitat Opportunities and Food-Web Linkages of Juvenile Salmon in the Columbia River Estuary and Their Implications for Managing River Flows and Restoring Estuarine Habitat (2003–010–00)

NOAA and the University of Washington are using experimental studies in Grays River in collaboration with Columbia River Estuary Study Taskforce (CREST) and the Columbia Land Trust to assess effects of multiple tidal wetland restoration projects on various life histories of juvenile salmon and to compare responses to observed habitat-use patterns in the mainstem estuary. This research is being conducted, in part, at Columbia Land Trust projects. Columbia Land Trust is utilizing digitized historic T-sheets developed by this project to define the historic floodplain and hydrogeomorphic complexes to guide restoration development and design.

Evaluating Cumulative Ecosystem Response to Restoration Projects in the Columbia River Estuary (EST-P-04-04)

The Army Corps of Engineers is funding a Cumulative Effects projects to assess the cumulative effects of restoration projects on ecosystem function. The Columbia Land Trust's Grays River tidal reconnection projects are where many of the cumulative effects protocols are being tested and where a good deal of the cumulative effects monitoring is occurring. This project has created a standardized means of evaluating the effectiveness of individual projects, and methods for assessing estuary-wide cumulative effects. A priority has been to develop a protocol manual for minimum monitoring of physical and biological metrics, intended to standardize data collection critical for analyzing changes following restoration treatments. Columbia Land Trust utilizes these monitoring protocols as part of its effectiveness monitoring at select restoration sites.

USFWS Preserve and Restore Columbia River Estuary (2003–008–00)

Columbia Land Trust served as the transaction and negotiation agent for the acquisition of Crims Island. The goals of this project included acquiring or restoring 600 acres of tidal emergent marsh, swamp, slough, and riparian forest habitat in the Columbia Estuary to benefit salmon, Columbia white tailed deer, and other wildlife. Elements of the project included acquisition, fish and vegetation surveys, invasive weed removals, and

restoration of tidal marsh. The project was accomplished with BPA, Corps, WDFW, and USFWS funding. This project demonstrates a large partnership working towards main stem tidal wetland protection and restoration of critical habitats.

Grays River Restoration Project (2003-013-00)

CREST partnered with Columbia Land Trust and other private landowners to complete a restoration project in the response reach of the Grays River under this project. One of three remaining natural Lower Columbia River Chum spawning locations is found at the Crazy Johnson Creek property (purchased by Columbia Land Trust in 2009) where CREST installed a series of engineered log jams on Columbia Land Trust property. The project was completed in 2009.

Lower Columbia River Ecosystem Monitoring (2003-007-00)

As part of this project the University of Washington and US Geological Survey is developing a Columbia River Estuary Ecosystem Classification (CREEC). The CREEC, when completed in 2011, will be able to describe the distribution, connectivity, abundance, size, and shape of estuarine habitat that affect the diversity and the spatial structure of a salmon population. The CREEC will allow the Columbia Land Trust and other restoration implementers to access a GIS driven hierarchical ecosystem classification that partitions the lower river into ecosystem types, then further into hydrogeomorphic reaches, complexes, then finally cover types. Understanding and describing the physical and biological characteristics of these varied habitats is critical to our understanding of where to site restoration projects and what the restoration trajectory may look like based on the natural processes available. In 2009, BPA funded a five-year project that is use statistical tools to analyze CREEC landscape classes (historical/present) to derive metrics for describing optimal juvenile salmonid habitats for each of the eight estuary reaches. The project is supported technically by an expert panel with products vetted through estuary restoration practitioners. Columbia Land Trust participated in the expert panel session in October, 2009 and is helping shape the use of CREEC products as they emerge over the next three years.

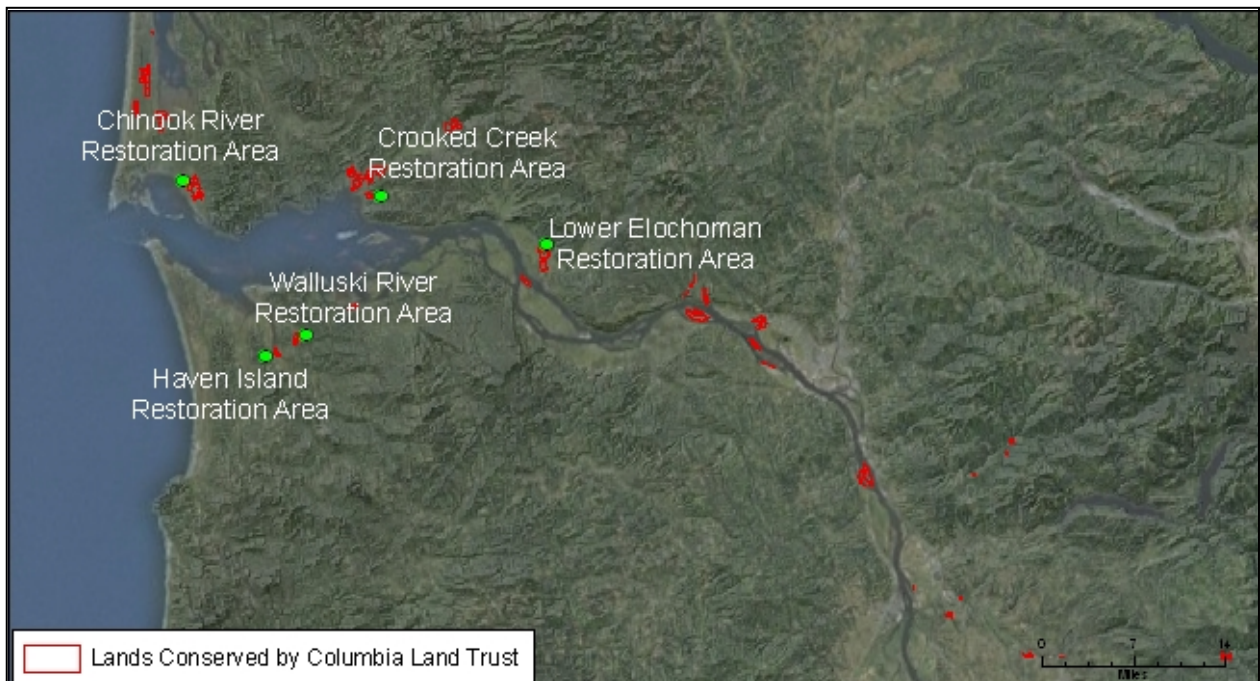
CREST Estuary Habitat Restoration (2010-004-00)

As the two principle estuary habitat restoration implementers, Columbia Land Trust and CREST have a long and productive history of collaboration in effectiveness monitoring, uncertainties research and restoration design and implementation. This collaboration is described (in part) projects 2003-013-00, EST-P-04-04, 2003-010-00. Similar to the physical and biological objectives of the CREST project the Columbia Land Trust's project will continue to develop, design and construct on-the-ground habitat restoration actions that benefit threatened and endangered salmonid species in the Lower Columbia and Estuary, specifically the 2008 BiOp RPA 37, *Achieving Habitat Quality and Survival Improvement Targets*. Moving forward, Columbia Land Trust will continue to adaptively coordinate and collaborate with CREST on estuary recovery actions.

E. PROJECT HISTORY

Columbia Land Trust has an extensive history of collaboration with BPA in the estuary. Columbia Land Trust is a 501(c)(3) non-profit organization formed in 1990 to conserve signature landscapes and vital habitat together with the communities of the Columbia River region. Columbia Land Trust works with private landowners and public entities to achieve common conservation goals. Columbia Land Trust has grown from an all volunteer effort to a professional organization with 21 full-time staff. As part of its conservation program, Columbia Land Trust has established a science-based restoration program dedicated to ensuring the long-term maintenance and enhancement of the conservation values on all of its protected and restored properties.

Since 2000, Columbia Land Trust has protected and/or restored over 4,000 acres of estuarine habitat in the Columbia River estuary for the purpose of salmon recovery. The Trust accomplished this by permanently securing a land base from willing land owners. These lands now serve as a platform from which on-the-ground restoration projects are able to be implemented. These restoration projects have resulted in some of the highest survival benefits for threatened and endangered salmon in the estuary (NMFS 2008). Building this network of restoration areas is essential in our collective efforts to increase the survival benefits for threatened and endangered salmon in the Columbia River basin.



Map 1.

It is rare for private land owners to find an economic incentive to allow estuarine restoration on their lands due to the daily inundation that results from tidal reconnection projects, so securing a land base from willing owners through fair market processes is recognized as an essential component in estuarine restoration. This strategy has allowed Columbia Land Trust to accomplish restoration where other practitioners cannot. To date, Columbia Land Trust has established six restoration opportunity areas and is working to secure two more. This proposal covers some of the work in five of those restoration areas. It is anticipated that with funding for this project the pace and scope of additional estuarine restoration will significantly increase. Existing restoration opportunity areas that are part of this proposal are displayed on the Map 1.

Columbia Land Trust's estuarine restoration program involves developing and implementing restoration on its extensive conservation holdings. Assembling the properties required to make a restoration project viable can take a number of years. Columbia Land Trust is uniquely positioned for this role due to: 1) its long view on restoration and conservation - perpetual; 2) its long standing relationships with some of the largest landowners in the estuary; 3) a stewardship fund that it maintains to support, in part, the long term operations and management that this land base requires; and, 4) its reputation as an engaged land owner in its own right in estuary communities. These factors require Columbia Land Trust to stay actively involved in projects, working with local communities and project partners to restore and steward these tidal habitats. Acquiring these lands comes with a perpetual responsibility to maintain and defend the conservation values of these properties. This approach of working incrementally with willing landowners is fundamental to success in the estuary since no entity is contemplating using eminent domain to secure land for salmon recovery.

As a means to illustrate the types of restoration actions that are anticipated within this proposal one can review a subset of completed and pending restoration projects of Columbia Land Trust:

Tidal Enhancement Projects – COMPLETED

Secret River (invasive plant species control) – 25 acres
Crooked Creek (invasive plant species control) – 60 acres

Tidal Reconnection Projects - COMPLETED

Grays River Peterson (road removal, revegetation, invasive plant species control) – 116 acres
Deep River (dike breaching, invasive plant species control) – 155 acres
Kandoll Farm (dike breaching, invasive plant species control, revegetation) – 163 acres
Johnson Farm (dike breaching, invasive plant species control) – 88 acres
Walluski River (dike breaching, large wood placement, revegetation) – 55 acres
Crims Island (acquisition and transfer to USFWS for restoration) – 451 acres

Tidal Reconnection Projects – PENDING

Chinook River Mouth (road prism removal for tidal reconnection) – 20 acres
Mill Road, Grays River (dike breaching, invasive plant species control, revegetation) – 50 acres
Haven Island, Young's River (dike breaching, invasive plant species control, revegetation) – 79 acres
Germany Creek (revegetation, invasive plant species control, large wood placement) – 7 acres

Tidal Reconnection Projects – UNDER DEVELOPMENT

Wallacut River mouth – 50 acres
Crooked Creek – 40 acres
Chinook River Estuary – 871 acres
Walluski River – 100 acres
Columbia River near Rainer – 550 acres
Lower Elochoman River – 300 acres

Columbia Land Trust Tidal Reconnection Efforts: What We Have Learned

Columbia Land Trust has implemented five tidal reconnection projects over the previous five years and is poised to implement an additional four projects. The central goal of these projects is to restore rearing habitat for juvenile salmon through the reestablishment of the tidal processes that promote habitat opportunity and eventually increased habitat capacity. At three of the completed projects we have intensively measured hydrologic changes that resulted from the removal of tide gates and dikes from diked pastureland and in two cases (Roegner 2010) the subsequent time series of salmonid abundance and size frequency in the restoring marshes was determined.

Kandoll Farm and Johnson Farm: Findings

Researchers from NOAA and PNNL, with funding from the USACE, have monitored two Columbia Land Trust restoration projects for five years (project EST-P-02-04). These two projects, the Kandoll and Johnson Farms, are situated between the confluence of Grays River and Seal Slough in Wahkiakum County, Washington. Both sites had flood control levees and tide gates constructed in the early 20th century to create pastureland for dairy

production. Restoration actions at the two sites included removal of the tide gate structures and constructing breaches in the levees. At the Johnson Farm restoration site, a dike along the Grays River was breached in 2004. At Kandoll Farm, two 4.2-m-diameter culverts were installed in the dike during 2005 to reconnect Seal Slough, an arm of the Grays River. Both treatments reestablished connections to relic tidal channel networks and resulted in tidal flooding on the pasture surface.

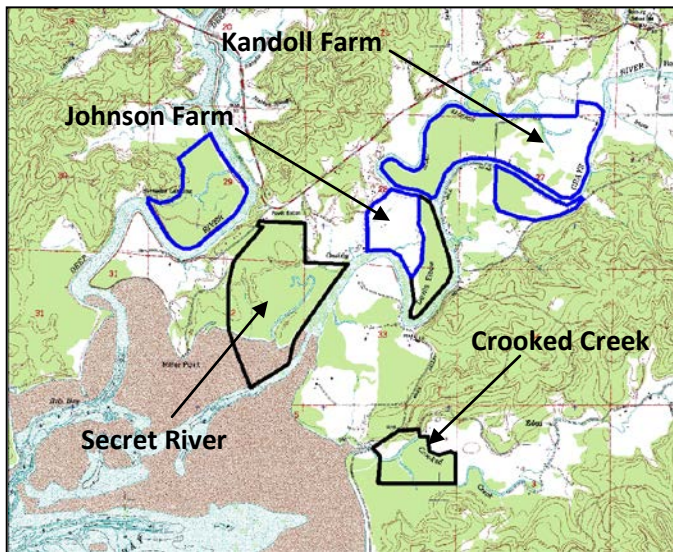


Figure 2. Restoration and reference sites in the Grays River conservation area.

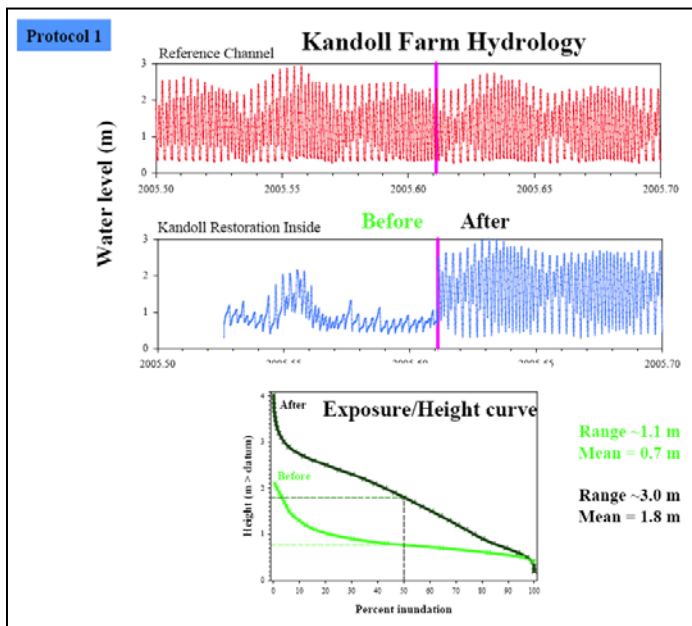


Figure 3. Hydrologic response to tidal reconnection at Columbia Land Trust's Kandoll Farm (from Roegner et al. 2010)

from about 2.0 to 3.0 m, although pre-connection water levels were less than 1.0 m for 85% of the time period evaluated, and mean water level increased from 0.6 to 1.5 m in the 2-week period around the tide gate removal. These results show that habitat opportunity at both sites were increased for juvenile salmonids.

Hydrology

Tidal forcing is the principal controlling factor affecting wetland structure and function and is the main driver in the control of water characteristics (Ritter et al. 2008), topographic evolution (Williams and Orr 2002), and vegetation community development (Cornu and Sadro 2002). Water elevation associated with tidal variation also determines the period in which fish can successfully access and use wetland habitats (habitat opportunity). Juvenile salmonids enter tidal wetlands during high water to forage on emergent insects and other wetland-derived prey (Healey 1980). With hydraulic reconnection, tidal forces shape wetland drainage and vegetation patterns. The restoration actions at the Kandoll and Johnson Farm restoration projects included tidegate removal and dike breaching. At each site pre-breach water level fluctuations moved from a highly muted tidal signal to a full semidiurnal tidal prism.

Tide gate removal immediately effected water level fluctuations within the Kandoll Farm site (Figure 3). Pre-breach water level fluctuations changed from a weak tidal signal to a fully semidiurnal tidal pattern. Exposure–height curves indicated that maximum amplitudes increased

Tidal Channel Development

The following describes the cross-sectional area, shape, and depth relative to surveys before restoration and enhancement actions and in some intervening years at the Kandoll Farm restoration site shows Seal Slough above the culvert replacement on Kandoll Farm. As described by Diefenderfer et al. (2008), the largest rate of change is seen in the cross sections located most proximal to the restoration action. Increases in cross-sectional areas seen up-channel from restoration actions in some cases most likely are morphological responses to the need to convey increased flow volumes associated with subsidence of the sites during diked years, but these flows are expected to lessen as the sites accrete. Reference sites trend toward accretion, and explanations accounting for this include the beaver activity at the Kandoll reference site (Diefenderfer et al.

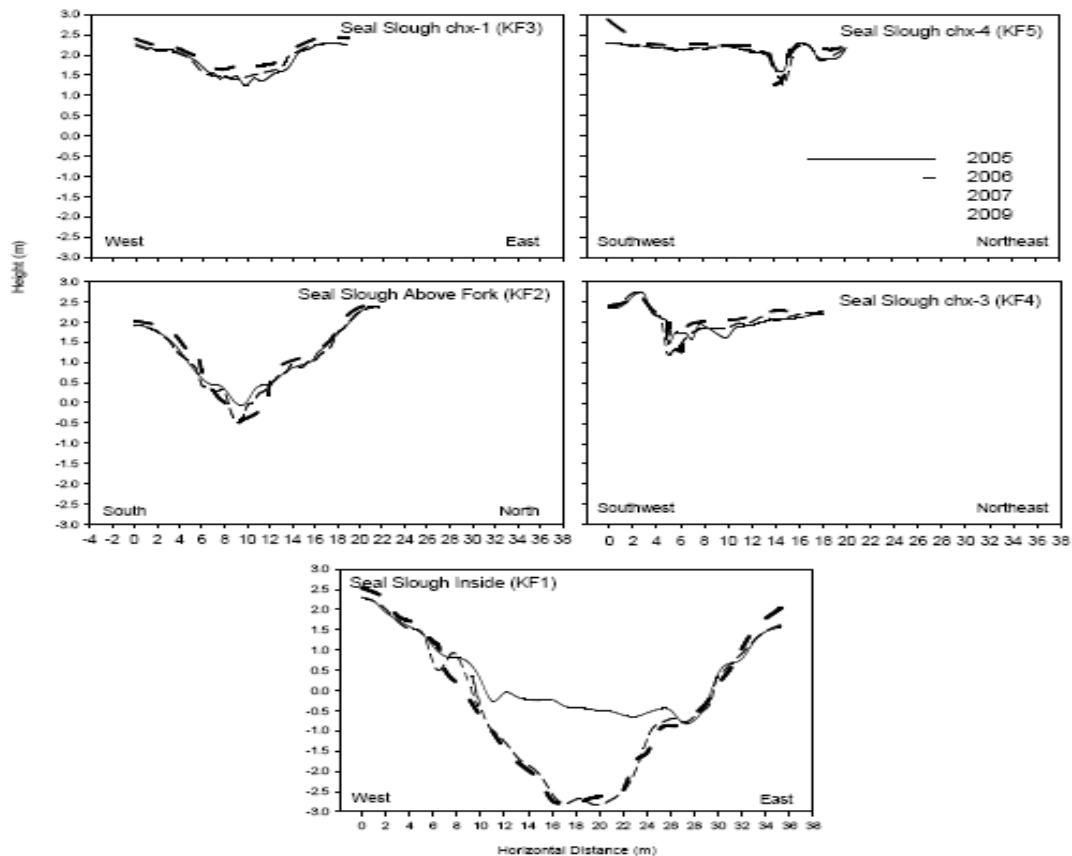


Figure 4. Tidal channel cross section before and after tidal reconnection. (Johnson and Diefenderfer 2010)

Fish Monitoring

It was hypothesized by researchers from NOAA and PNNL that increased hydraulic connectivity would lead to increased habitat opportunity by juvenile salmonids. An objective of the monitoring was to conduct assessments of fish community structure and salmon abundance, size, and diet in wetland and adjacent riverine habitats. At the Kandoll Farm site fish communities were sampled before (2005) and after (2006 and 2007) tide gate removal. Reference sites not directly affected by the restoration activity (Seal Slough and the Grays River) were

sampled. At Johnson Farm, fish populations were monitored after the tide gate removal (2005–2007), which occurred in summer 2004.

Dike breaching at Kandoll and Johnson Farms resulted in an immediate return of full semidiurnal tidal fluctuations to what had been diked pasturelands. Juvenile Pacific salmonids quickly expanded into this newly available habitat and used prey items that were presumably produced within the marshes (Roegner et al. 2010).

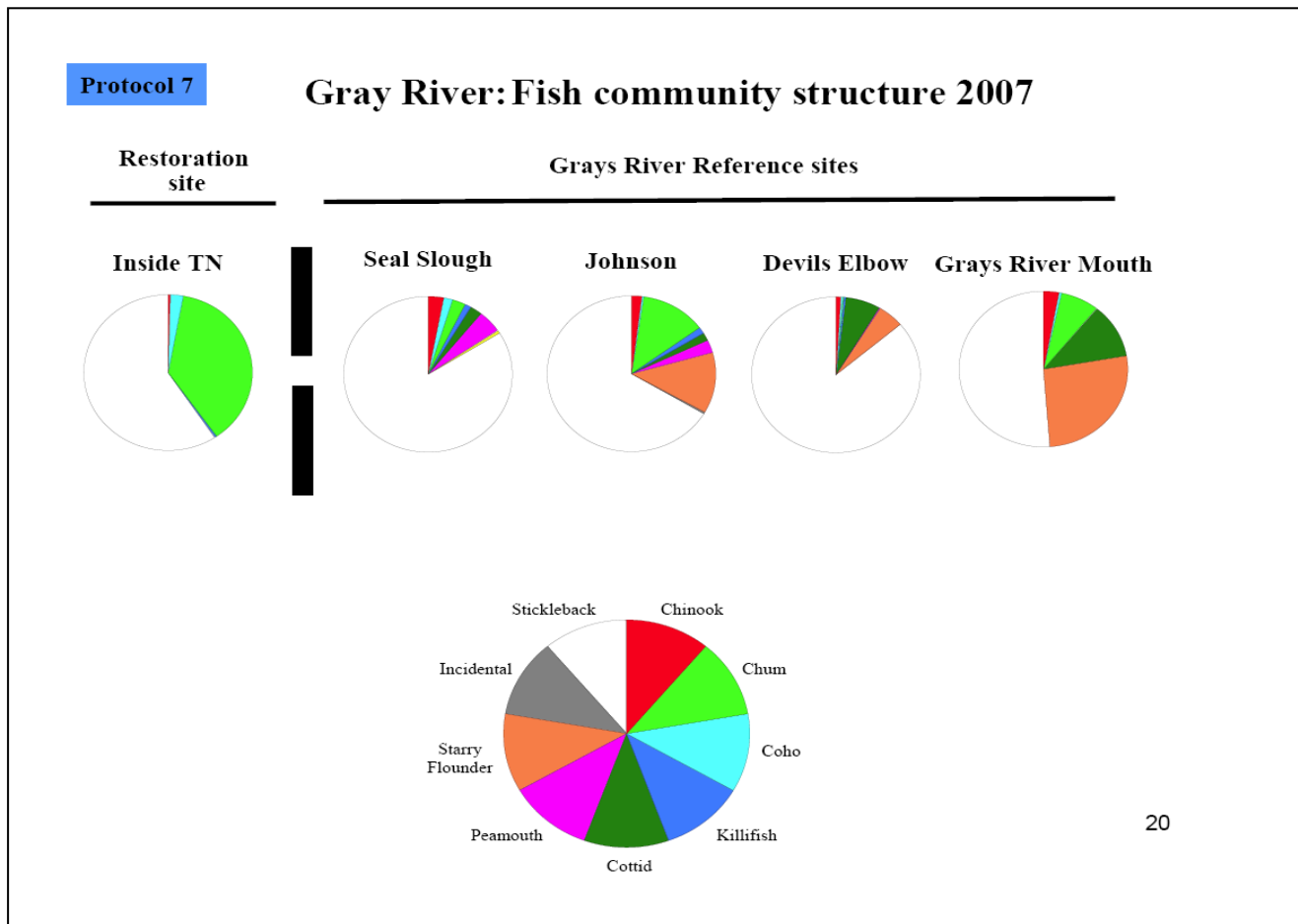


Figure 5. Community fish structure at Grays River Columbia Land Trust restoration and reference sites.

At the Kandoll Farm restoration site 15 tides were sampled by trap net in 2006 and 2007, and 25 tides were sampled at the Johnson Farm restoration site from 2005 to 2007. Nearly 52,000 individual fish were identified. Threespine sticklebacks dominated most samples (93.6% of total). The next most abundant species was chum salmon (2.1%) followed by the introduced banded killifish (1.6%), coho salmon (0.9%), prickly sculpin (0.5%), Chinook salmon (0.5%), and peamouth (0.5%) (Roegner 2010).

The habitat use varied by species and life history stage. The fry of chum salmon migrated rapidly through the system, whereas populations of Chinook salmon resided from March to at least July and were composed of fry, fingerlings, and (for coho salmon) yearlings. The presence of adipose-fin-clipped Chinook indicates that hatchery-raised fish from beyond the Grays River system are also using the restored wetland site. Large numbers of juvenile chum salmon were sampled in the tidal channels at the Kandoll Farm restoration site, implying the sampling covered the main outmigration (Roegner 2010).

The goal of the 2007–2009 fish sampling was to explore the spatial-temporal distribution of salmonid habitat use in the Kandoll Farm restoration site. During 2009, biweekly trap net sampling was continued for fish species, abundance, and size at two adjacent intertidal channels. The study was initiated in May 2007, and sampling during 2008 and 2009 extended from early February through the end of June. Three years of data from trap net site 1 (TN1) and 2.5 years of data from trap net site 2 (TN2) have been collected.

Result of Research and Monitoring

Findings from this research on Columbia Land Trust restoration and reference sites by researchers from PNNL, CREST and NOAA (reported by Johnson et al. 2007, pp. vii – viii) include:

- *“Hydraulic Geometry and Channel Morphology Relationships* – There were strong, positive correlations between the three monitored indicators: catchment area, total channel length, and cross-sectional area at outlet. Measurement of these indicators in hydraulic geometry and channel morphology at restoration sites may now be compared with these established relationships to assess the restoration trajectory.
- *Elevation-Vegetation Relationships* – Data from several locations in the estuary reveal differences between habitat types (e.g., marsh versus swamp), as well as locations in the floodplain (e.g., island versus tributary floodplain area). Information about plant species tolerances in a given region of the estuary floodplain, coupled with pre-restoration data about elevations in restoration sites, provides managers with the ability to forecast the plant communities that may develop based on existing conditions or to elect to alter existing elevations to support desired plant communities.
- *Sediment Accretion Rates in Tidal Wetlands* – The sediment accretion rate was 2.4 cm/yr for Columbia Land Trust Johnson and Kandoll restoration sites combined over 2005 through 2007. Comparison of sediment accretion rates with the initial elevation of restoration sites and with the elevations of reference sites supporting target plant communities can help restoration managers predict the length of time it will take for ecological processes in a watershed to increase land elevations sufficiently to achieve project goals; if necessary, the process can be augmented through adaptive management with active restoration techniques.
- *Similarity Indices of Vegetation* – An example shows very little similarity between indices of vegetation at restoration and reference sites (13.1–53.2%) before and in the first year after restoration. Managers can assess the rate of change and whether change is occurring in the direction of the plant community target using similarity indices.
- *Juvenile Salmon Use of Tidal Reconnection Sites* – At Columbia Land Trust Kandoll and Devils Elbow sites, Chinook salmon were eating Chironomidae. Chum and coho diets included Chironomidae, Heteroptera, and other insects. Species collected in insect traps and benthic cores at the sites included Chironomidae and Corophium, respectively. This key result supports management decisions to restore tidal wetlands and supports future restoration actions of this kind. “

Findings reported by Johnson et al (2008, pp. iv – vi) include:

- *“Water Elevation and Wetted Area Relationship* – Frequency of floodplain inundation at a restoration site, the Kandoll Farm, was 54% compared with 18% at the associated Kandoll Reference site. This was because the mean floodplain elevation of the restoration site was 0.7 m lower than the adjacent reference swamp; further, the microtopography was greater at the reference swamp. This implies that the area inundated on a particular recurrence interval will decrease as land surfaces rise due to

sediment accretion. Thus the typical use of wetted area as an indicator of the effective size of tidal floodplain restoration projects, for the purpose of measuring available fish habitat, is likely to overestimate the areal extent of the inundation that will be seen some decades after implementation.

- *Water Temperature and Fish Abundance Relationship* – Chinook salmon catch per unit effort (CPUE) was greatest at temperatures 11 to 16 °C, although Chinook salmon were present in water up to 20 °C. CPUE for chum salmon was highest during temperatures 9 to 12 °C. Coho salmon CPUE peaked at 12 to 18 °C. Water temperature is a key indicator to monitor at habitat restoration sites.
- Large numbers of juvenile chum salmon were sampled in the tidal channels at the Kandoll restoration site, implying the sampling covered the main outmigration.
- As in previous years, juvenile Chinook salmon were present in the trap-net samples in low numbers
- Coho salmon sampling included fry, subyearling, and yearling fishes. Marked fish from the Grays hatchery were captured at the Kandoll Farm.
- The elevations of vegetation are higher at the restoration site than at the reference site at Kandoll Farm
- Accretions rates are higher at restoration sites than at reference sites.
- All tidal wetlands examined in this study exist within a 3-m vertical range, which increases as longitudinal distance upstream from the Columbia River mouth increases.
- Channel density is not likely a good indicator of habitat development where preexisting channels are present, but it may be a useful indicator for constructed wetlands.
- Channel cross-sectional area typically changes most at the mouth proximal to the restoration action.
- Line-intercept data from Kandoll Farm during 2009 show 26 herbaceous plant species that were not present in 2005–2006.”

Columbia Land Trust Reference Sites: Seal Slough, Crooked Creek and Secret River

From 2006 – 2009 researchers from PNNL, CREST and NOAA conducted monitoring at three Columbia Land Trust reference sites. Secret River monitored both a All three of these remnant Sitka spruce (*Picea sitchensis*) swamps contain the same dominant tree species: Sitka spruce, red alder, Western red cedar, western hemlock. The Secret River reference site monitored both a spruce swamp and a tidal marsh (Figure 6).

Findings from their research have implications for practitioners involved in designing and monitoring tidal reconnection projects. Those reported by Diefenderfer and Montgomery (2009, pp.166):

- “Large wood in forested tidal channels can produce a forced step-pool channel type, regulating pool spacing as well as associated habitat functions, hydrodynamics, and bidirectional material fluxes.
- Restoration project designs need to be informed by reach-scale data and research on pool forming factors in forested reference areas subject to similar hydrodynamics following restoration actions, pool spacing and large wood can serve as monitoring indicators.

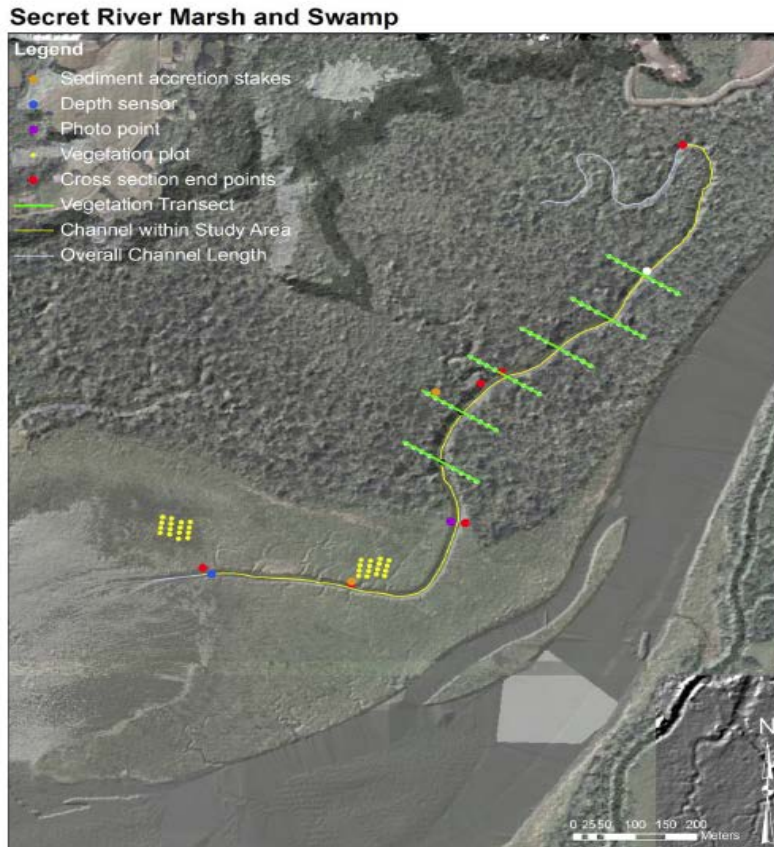


Figure 6. Example of monitoring approaches at Columbia Land Trust reference sites.

- Although wood can become available to previously diked restoration sites through tree fall and reexposure of previously buried wood due to changing hydrodynamics, alternative sources may be required to meet restoration goals.
- The ecohydrological processes that provide large wood and produce ecosystem structures in tidal channels may be important in the restoration of hitherto uninvestigated, historically or prehistorically forested tidal environments.”

Monitoring Considerations Based on Action Effectiveness Monitoring

The following recommendations related to monitoring estuarine restoration projects include the following (from Johnson et al. 2009, p. 6.3)

- “It is important to apply the effectiveness monitoring protocols (Roegner et al. 2009) when and wherever possible as it allows valid analysis across multiple restoration sites and times. Applying the protocols, however, may require onsite adjustments in many cases to adapt to the conditions of the site.
- Access to sites for pre- and post-monitoring can be very difficult. Water-level variations affect the ability to sample sites at times.
- Hydrology is critically important to monitor, as is vegetation, because these parameters are a primary ecosystem controlling factor and structure, respectively.

- Changes happen rapidly within the first few years following tidal reconnection; therefore, sampling should be designed accordingly.
- Subsidence seems to be common in the diked former wetlands in the LCRE. This means more than one sediment accretion station per site will be necessary.”

Action effectiveness and validation monitoring conducted at Columbia Land Trust restoration and reference sites in the estuary is critical to developing an adaptive process for effective implementation of restoration in the Columbia River estuary. This project, in conjunction and in coordination with other ongoing work described more completely in Section D. will ensure that restoration implementation provides the maximum benefit to salmonid species transiting the estuary.

F. PROPOSAL BIOLOGICAL/PHYSICAL OBJECTIVES, METHODS, WORK ELEMENTS AND METRICS

The Columbia Land Trust has been acquiring land for protection and restoration in the Columbia River estuary and elsewhere in the Pacific Northwest for the past 20 years. This proposal focuses primarily on meeting the biological and physical objectives identified in the Columbia River Estuary and Lower Mainstem Subbasin Plan, the Estuary Module, and the commitments identified in the 2008 BiOp. The scientific basis for these plans, as well as the management objectives found in these plans, provide a framework and context for this proposal. The Columbia Land Trust's mission and goals are consistent with this framework.

One of the goals of Columbia Land Trust is to establish and maintain a science-based restoration and monitoring program dedicated to ensuring the long-term maintenance and enhancement of the conservation values on all of its protected and restored properties. This is accomplished by permanently securing a land base in priority habitat areas. These lands serve as landscape where on-the-ground restoration projects can be implemented. Columbia Land Trust has established six restoration opportunity areas in the Columbia River estuary and is working to secure two more. This proposal covers some of the work in five of those restoration areas.

Physical Objective 1: Increase shallow water peripheral and side channel habitats to levels identified in the recovery plans

Hypothesis Statement; If shallow water habitat is increased, then juvenile rearing capacity in the estuary and mainstem will increase.

Justification; Rearing juvenile fall Chinook and chum are closely associated with shallow water habitats in the estuary and lower mainstem.

Physical Objective 2: Restore connectivity between river and floodplain, as well as in-river habitats.

Hypothesis Statement; If connectivity with floodplain is restored, then juvenile salmonid productivity in the estuary and lower mainstem will increase.

Justification; Connectivity with the floodplain will restore macrodetrital inputs and alter the current food web. A macrodetritus-based food w

Methods

Task 1: Identify and prioritize mainstem and tidal tributary projects in a scientific and systematic manner which will directly benefit ocean - and stream- type salmonids

Figure 7. provides an overview of how estuary restoration projects are prioritized, reviewed and ultimately implemented.

Project Prioritization and Review

This proposal uses the assessment and prioritization framework established in the Mainstem Lower Columbia River and Columbia River Estuary Subbasin Plan assessment and the Estuary Module as a basis for biological and physical assessment to guide restoration actions. Prioritization of specific restoration actions occurs on multiple levels. The Columbia Land Trust identifies these areas using the internal processes described in Task 2. Specific parcels of land are identified through targeted outreach and through existing and on-going relationships with the community. Once parcels have been identified internally, the following external processes help determine the appropriateness of a specific project to a program (e.g., BPA Estuary Program):

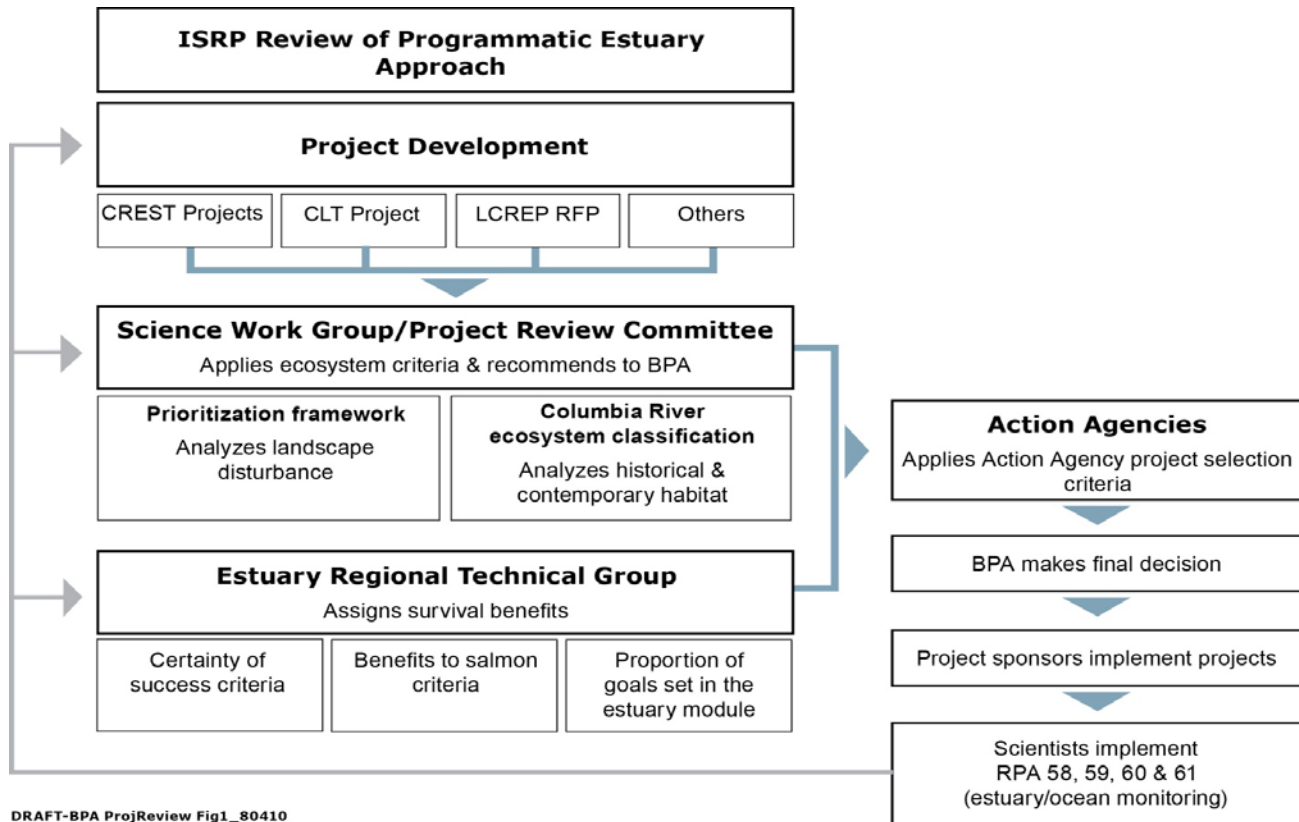


Figure 7.

LCREP Science Work Group's Project Review Committee

LCREP's Science Work Group and Project Review Committee evaluate the relative value of acquisition or restoration projects using ecosystem criteria. Projects are reviewed and evaluated in terms of implementation certainty, ecosystem-scale benefits, and monitoring sufficiency. The LCREP process (see middle box of flow chart in Figure 7) includes science review and selection based on ecosystem criteria. To prioritize proposed projects LCREP conducts a multi-phased assessment and review process. That process includes the following steps:

1) Initial Review and Screening: Project proposals received from project sponsors are reviewed by LCREP's Science Work Group (SWG). This evaluation focuses on the overall quality of the proposals and includes identifying key issues, gaps, and concerns with the proposals. Project sponsors present projects and respond to questions raised by SWG members, including written questions supplied to proponents subsequent to the meeting. This initial screening yields a sub-population of projects with a high certainty to occur and high likelihood of providing fish benefits.

2) Site Visits—Site visits then occur with members of the Project Review Committee. At the site visits, project sponsors lead tours of the project sites and answer questions raised by reviewers. After the SWG meeting, site visits, and design review, requests for clarifying information are sent to project sponsors. These responses are provided to the Project Review Committee members. Current members of the Project Review Committee include:

Ms. Amy Horstman – Ms. Horstman has worked for United States Fish and Wildlife Service in the Pacific Northwest since 2000. She works in the Service's habitat restoration programs assisting with habitat improvement project design, permitting, and implementation in the Lower Columbia River and along

Oregon's northern coast. Her work is primarily with private landowners who voluntarily wish to restore habitat through the Service's Partners for Fish and Wildlife and Coastal Programs. She served the Oregon statewide coordinator for the Partners for Fish and Wildlife program from 2003 through 2009, overseeing the program's strategic planning and focus area development.

Ms. Kathy Roberts – Is a biologist with the United States Fish and Wildlife Service's Oregon Fish and Wildlife Office.

Ms. Bernadette Graham-Hudson – Ms. Graham-Hudson is the Salmon Recovery and Watershed Program Manager for the Lower Columbia Fish Recovery Board.

Mr. Gary Johnson (M.S., Biological Oceanography, Oregon State University, 1981) Mr. Johnson is currently serving out of Battelle's office in Portland, Oregon. He works on research, monitoring, and evaluation in the lower Columbia River and estuary for Pacific Northwest National Laboratory, as well as juvenile fish passage issues at mainstem Columbia and Snake River dams. Research Interests include ecology of juvenile salmon in estuaries and the nearshore ocean, endangered salmonids, hydroacoustics, surface flow outlets, juvenile salmon migration, and hydroacoustics to study fish passage at dams and power plants.

Ms. Yvonne Vallette – Is a Regional Coordinator for the Environmental Protection Agency, Region 10. Ms. Vallette is a Wetlands Ecologist at the EPA Oregon Operations Office in Portland where she supports the Wetlands Protection Program for Region 10. She has spent the last 10 years as an ecologist in EPA's Region 6 office in Dallas, Texas

Mr. Robert Anderson – Is a biologist for the National Marine Fisheries Service in the Oregon State Habitat Conservation Division.

Mr. Tom Murtagh – Is a district biologist for the North Willamette watershed. The North Willamette Watershed District (NWWD) covers fish management duties primarily on the west-side of the Willamette basin from the Columbia River south to the upper reaches of the Yamhill River. This new district was established to better manage the fisheries resources, improve angling opportunities and access.

Ms. Donna Bighouse – Ms. Bighouse has been a member of Washington Department of Fish and Wildlife's Watershed Stewardship Team for seven years. She is a professional fish biologist with over 20 years of experience working in SW Washington on the Lower Columbia River. Donna is a member of several local watershed groups from Wahkiakum to Skamania counties, providing technical assistance and fostering partnerships with local communities, state and federal agencies, tribes, private businesses and the Lower Columbia Fish Recovery Board. Washington Department of Fish and Wildlife

Mr. Evan Haas – Mr. Haas is a Habitat Restoration Coordinator for the Lower Columbia River Estuary Partnership. As the Habitat Restoration Coordinator he is responsible to review, implement, and coordinate habitat restoration projects in the lower Columbia River and estuary.

3) Prioritization of Projects in the LCRE: The prioritization framework for the lower Columbia River was informed by the Subbasin plan assessment and the more deeply developed by scientists at the Pacific Northwest National Laboratory (PNNL)

(Evans et al., 2006). This framework uses a disturbance model to predict the locations where habitat restoration is most likely to succeed. The framework improves our understanding of how restoration projects are nested within the changing mosaic of habitats (and stressors) along the estuarine gradient through the matrix of patches and corridors that juvenile salmon move and interact.

Using GIS layers, the Restoration Prioritization Framework provides an analysis of landscape-scale disturbances at a “management area” scale and the “site” scale to predict the degree to which physical processes are likely to support a specific project. The development and maintenance of habitats at a site is dependent on disturbances at the site scale and at the landscape scale within which the site resides. If there are high levels of disturbance (elevated water temperature, poor sediment of water quality, invasive plant species) in the landscape it will affect the quality of the processes that support the restoration trajectory at an individual site (Thom 2000).

This prioritization framework is broken into 2 tiers. Within tier

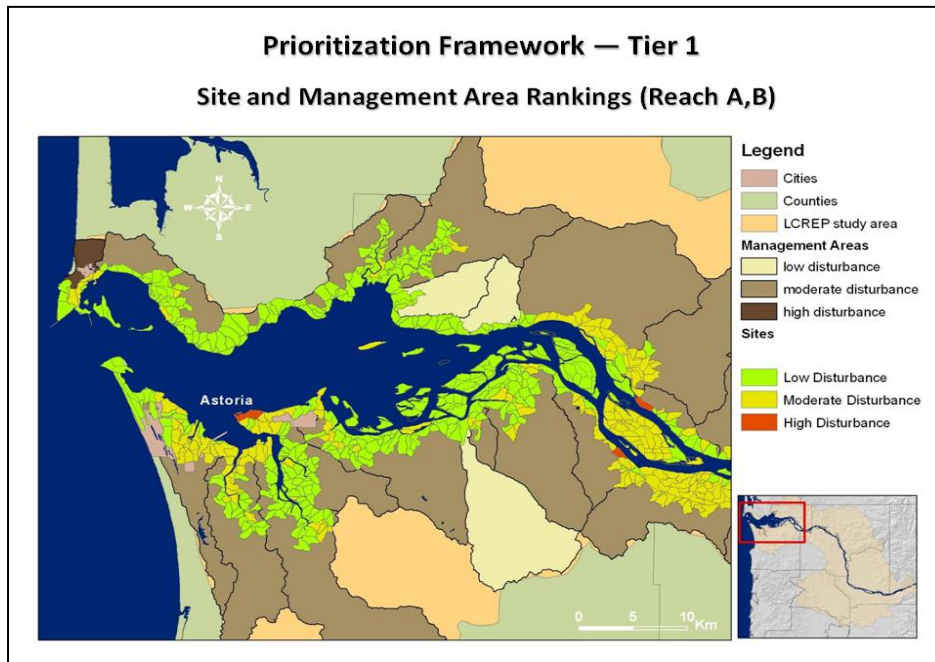


Figure 8.

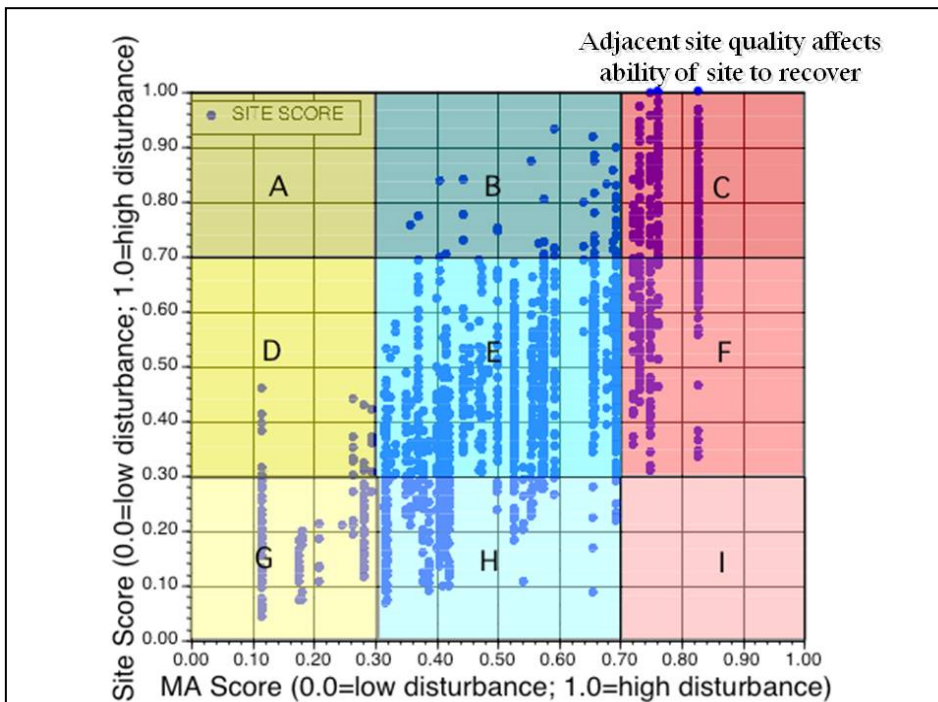


Figure 9.

1 the lower Columbia River is broken into two scales: 1) Management Areas (HUC 6 watersheds); and 2) Sites that average 130 acres in size (Figure 8). Management Areas and Sites were analyzed for a breadth of stressors and limiting factors. At the Management Area scale the principal stressors analyzed included road density, land use disturbance, hydrologic barriers, point source dischargers and contamination sites. At the site scale the

principal stressor analyzed included flood control dikes, dredge material placement, pile dikes, over water structures, and known locations of water quality or sediment impairment. These stressors are directly related to juvenile salmon habitat opportunity and habitat capacity. The management areas and sites were ranked as “low”, “moderate” or “high” disturbance based on results of this model. This evaluation is useful in determining the types of restoration approaches (preservation, conservation, enhancement, restoration or creation) that is appropriate for each location. For example, where site and management area disturbance scores are low, portraying sites with low disturbance surrounded by a relatively intact landscape (Box G in Figure 9), preservation through acquisition or simple enhancement techniques may be the most appropriate. In comparison, where site and management area disturbance scores are both high, portraying highly disturbed sites surrounded by a highly disturbed landscape (Box C in Figure 9), habitat creation may be the only option. The site and management area scores are used in the Tier 2 evaluation process.

Tier 2 of the Prioritization Framework provides an approach to evaluating projects using predicted changes in ecosystem function, likelihood of success, size of project and cost. Evaluators complete a spreadsheet for each project (Figure 10), assessing predicted changes in multiple ecosystem functions (e.g., organic matter flux, primary production, habitat opportunity, capacity) and metrics indicating potential success of project (e.g., long term maintenance, resilience). The Tier 1 scores are included in the latter assessment. The project scores are ranked according to their raw scores and resulting information provided to the Project Review Committee.

4) Design Review of Prescriptions—LCREP contracts outside technical expertise to provide an objective technical review of projects. Engineers, modelers and landscape architects trained in designing, permitting and

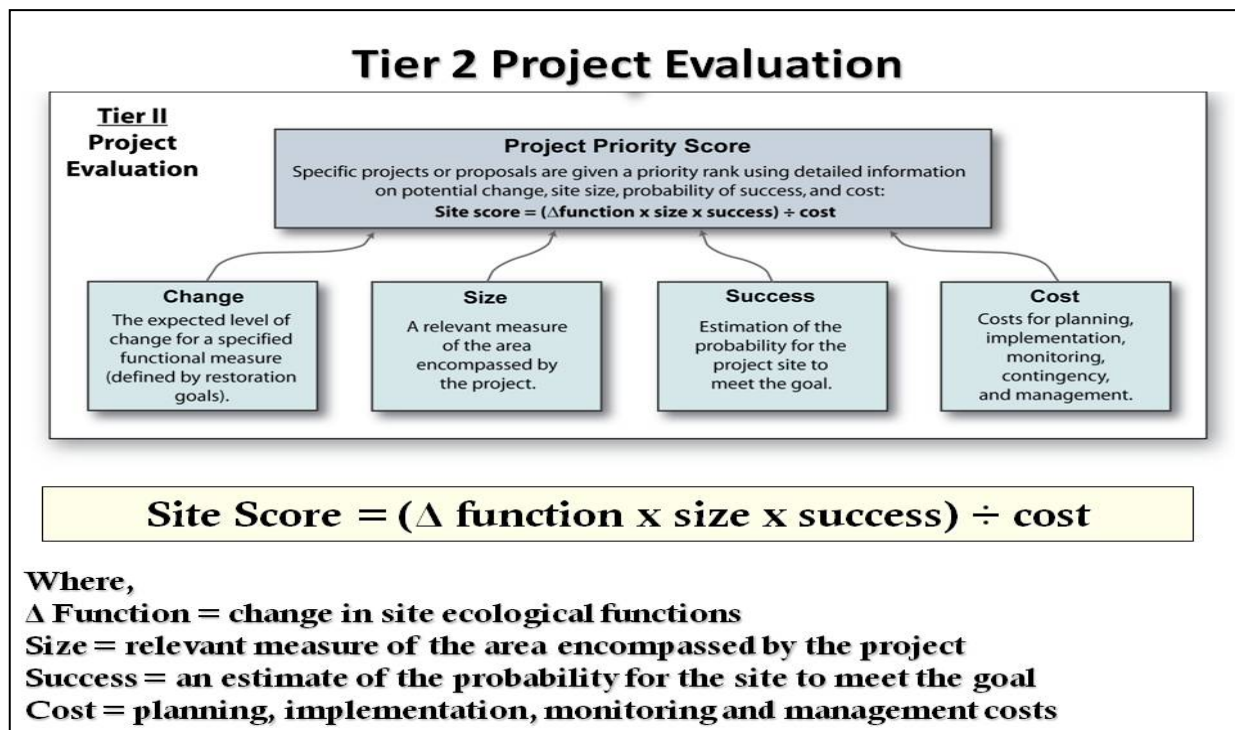


Figure 10. Tier 2 provides a scientific framework for evaluating projects across each other using predicted changes in ecosystem function, likelihood of success, size of project and cost.

implementing restoration and mitigation projects review project proposals, attend site visits, and provide a list of questions for project sponsors. These outside technical experts evaluate the projects from an implementation, engineering and cost over-run perspective. They then provide a final assessment of each project to Project Review Committee members.

5) Scoring—The Project Review Committee “scores” the proposals using the following LCREP’s ecosystem criteria . These criteria have been reviewed by the Independent Scientific Review Panel and are included within the 2008 Federal Columbia River Hydropower System Biological Assessment. After consideration of the Tier 2 evaluation results, design review findings and lengthy discussion of individual projects, Committee members complete an evaluation form for the projects (Figure 11).

Project Score = (function change x size x probability of success)					
offsite effect = >1	high=.67 to 1	mod=.34 to .66	low=0 to .33		
Project Analysis Results			Prioritization Framework Data		
Proj. Name	Otter Point		Sites	1890	
Proj. Score	0.78		MA	1840	
Cost/Proj. score	321,428.57		Site score	0.397	
Cost/Functional Acre	7,462.69		MA score	0.482	
			Avg. Adj sites score	0.285	
A. Analysis of change in function, process, value					
<u>Functions</u>	<u>Preserved</u>	<u>Increase</u>	<u>Decrease</u>	<u>No change</u>	<u>Unsure</u>
Primary production		1			
OM Flux		1			
Sediment Trapping		1			
Nutrient Processing		1			
Flood Attenuation		1			
Food Web Support		1			
Opportunity		1			
Capacity		1			
Natural Complexity		1			
Natural Biodiversity		1			
<u>Sum Score</u>	0	10	0	0	0
<u>Analysis score</u>	1.00				
B. Analysis of change in size of functional area					
Total Area of project	33.5	acres			
Area of function restored or preserved	33.5	acres			
<u>Prop. of Tot. Area</u>	1.00				
C. Analysis of predicted success of project					
<u>Factor</u>	<u>High</u>	<u>Moderate</u>	<u>Low</u>	<u>Unsure</u>	<u>Notes</u>
Case studies	1				appropriate techniques for site score/ management area score relationship
Restoration strategy	1				
Habitat forming processes	1				
Landscape features		1			moderate disturbance (from Tier 1)
Site condition		1			moderate disturbance (from Tier 1)
Adjacent habitat condition	1				low disturbance (from Tier 1)
Self-maintenance		1			
Resilience		1			
Time frame	1				
<u>Sum Score</u>	5	4	0	0	
<u>Analysis score</u>	0.78				

Figure 31. Example of a completed Tier 2 evaluation for an individual project.

These scores are tallied and ranked by median scores, resulting in the final ranking of that year's proposed projects. Recommendations are provided to BPA where projects are reviewed and assigned survival benefit unit scores by the RPA 37 Expert Regional Technical Group.

RPA 37 Expert Regional Technical Group on Estuary Habitat Actions

The second science-based group is the ERTG. RPA 37 requires ERTG to assign survival benefits to specific projects to meet 2008 FCRPS Biop commitments. ERTG was created in 2009 and assigns survival benefits based upon certainty of success, project benefit criteria, and project contribution to the Estuary Module action targets. ERTG members are actively working to improve the existing method used in the 2007 FCRPS BA by making the assignment of survival benefits more quantitative and repeatable. Expert Regional Technical Group membership is provided below:

Dr. Ed Casillas (Ph.D. University of Washington) has worked for NOAA Fisheries for more than 20 years. He has evaluated the effect of human use of toxic compounds in coastal environments on marine fishes, invertebrates and salmon, and the role of natural climate change on growth and survival of juvenile salmon in the estuarine and coastal marine environments of the Pacific Northwest. Dr. Casillas background is in physiological ecology, receiving his B.A. in environmental biology from the University of California, Santa Barbara, and his Ph.D. in fisheries biology from the University of Washington. After conducting a post-doctoral fellowship in clinical chemistry at the University of Washington School of Medicine, Ed began his career at the NWFSC in 1981.

Dr. Greg Hood (Ph.D. University of Washington) is a senior research scientist with the Skagit River System Cooperative. He is an expert on estuarine ecosystems. He collects and analyzes data on fish habitat use with a focus on juvenile Chinook salmon, fish response to recovery efforts including habitat restoration, and linkages between habitat conditions, landscape processes, and land uses.

Mr. Kim Jones is the project leader for Aquatic Inventories within the Conservation and Recovery Program of the Oregon Department of Fish and Wildlife. He assesses aquatic habitat, conducts fish presence/absence surveys, monitors fish populations, establishes salmonid watershed prioritization, monitors habitat restoration projects, and reconstructs historical salmonid life history. He has performed research in the Columbia River estuary and coastal watersheds in Oregon for over 25 years.

Dr. Kirk Krueger is a research scientist at the Washington Department of Fish and Wildlife. Kirk Krueger received a Ph.D. in Fisheries and Wildlife Sciences from Virginia Tech, a Master's in Zoology and Physiology from the University of Wyoming and a B.A. in Biology from the Minnesota State University at Moorhead. He is a Research Scientist with the Washington Department of Fish and Wildlife, Habitat Program. In this position he provides guidance regarding the design of field studies, monitoring plans, experiments, collection and analysis of remotely sensed data, and statistical analysis.

Dr. Ron Thom (Ph.D. University of Washington) leads the Coastal Assessment and Restoration technical group at the Marine Sciences Laboratory of the Pacific Northwest National Laboratory in Sequim, Washington. He has conducted research in coastal and estuarine ecosystems since 1971, including habitat construction and restoration; adaptive management of restored systems; effects of pollution; benthic primary production; climate change; and ecology of fisheries resources. Dr. Thom's research includes benthic primary production; the effects of pollution on nearshore marine systems in California, Washington, and Alaska; habitat construction and restoration of marine and estuarine systems; effects of climate change on estuarine systems; and ecology of fisheries resources in nearshore systems.

Work Elements for Task 1

1. **Work Element 119: Manage and Administer Projects** - Columbia Land Trust financial staff will administer financial and project management activities and technical work by the contractor to fulfill BPA's programmatic and contractual requirements such as financial reporting (accruals), and development of an SOW package (includes SOW, budget, property inventory).
2. **Work Element 114: Identify and Select Projects** - Columbia Land Trust will work with Estuary Partnership Science Work Group, BPA and ERTG as described in Task 1 to prioritize and select projects.
3. **Work Element 132: Produce (Annual) Progress Report** - Columbia Land Trust staff will develop and complete an annual report in compliance with BPA standards and timelines for each restoration project.
4. **Work Element 185: Produce PISCES Status Reports** - Columbia Land Trust staff will complete status reports for restoration projects in PISCES in a timely fashion.

Task 2. Engage with willing land owners to secure restoration land base in restoration areas

While the Action Agencies and policy makers others desire a strategic approach toward the placement of restoration projects in the estuary, the reality is that a large portion of lower Columbia's floodplain lies in private ownership. Ownership where, how and when we can progress as it relates to restoration. Willing land owners emerge sporadically and opportunistically. Columbia Land Trust is able to readily respond as opportunities arise. Columbia Land Trust helps its public partners achieve their land protection and restoration goals by providing risk capital, negotiation and legal skills, and an ability to leverage a variety of sources of funding. This approach enables Columbia Land Trust to act quickly and effectively to meet estuary restoration goals. Columbia Land Trust intends to continue to work in a systematic manner over the coming years to build these restoration opportunity areas and secure additional properties within key restoration areas to fully realize the restoration potential. Looking forward, Columbia Land Trust outlines below the acquisition and restoration objectives and tasks that it seeks to achieve under this proposal.

One of the most effective approaches to permanently securing restoration in the Columbia River estuary is through private land acquisition -- both fee simple acquisition and conservation easements. Columbia Land Trust helps its public and private partners achieve their specific land protection and restoration goals by working closely with land owners, local, state and federal agencies providing risk capital, negotiation skill, legal expertise and an ability to leverage additional project funding. This approach enables Columbia Land Trust to act quickly and effectively to meet estuary restoration goals. Columbia Land Trust structures, negotiates, and completes land transactions as an independent agent, buying land from willing landowners using fair market processes. Landowners often utilize this method of land protection because they are assured their family lands will be protected in perpetuity and they receive income from the sale of the land. The two principal approaches that are used in acquisition include:

1. **Fee Simple Acquisition:** Fee simple acquisition for restoration purposes involves Columbia Land Trust purchasing title to a property that merits conservation. After the title transfers the land is permanently maintained as habitat and open space by Columbia Land Trust or is transferred to an appropriate public entity (two transfer examples include 871 acres acquired by Columbia Land Trust and transferred to the Washington Department of Fish and Wildlife in the Chinook estuary in the Columbia River's Baker Bay and the acquisition and subsequent transfer of 451 acres on Crims Island to the United States Fish and Wildlife Service).
2. **Conservation Easements:** A voluntary conservation easement is a legal agreement between a willing land owner and Columbia Land Trust, or a government agency, which permanently limits uses of land in order to protect important habitat values or allow for restoration. Landowners grant conservation easements to restrict developments and to protect resources, while retaining rights of private ownership. All of the conservation easements that Columbia Land Trust has developed have been perpetual in term.

Columbia Land Trust has a long track record of working with the Bonneville Power Administration's land acquisition staff to complete land acquisitions in the estuary. Land acquisition steps for restoration include:

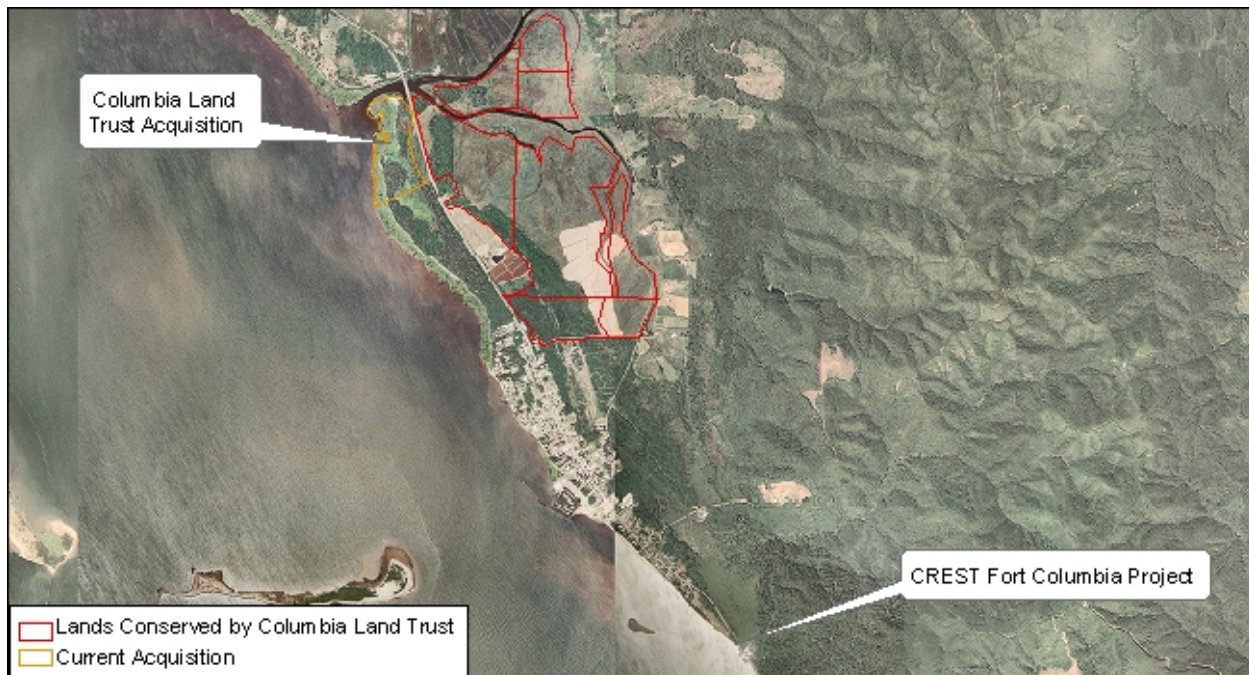
1. Map the property with existing LiDAR http://pugetsoundlidar.ess.washington.edu/lidardata/metadata/pslc2005Columbia/columbia05_ascii.html and conduct field surveys for consistency with estuarine restoration goals and quantify habitat opportunity (access) as it relates to juvenile salmonids. This includes:
 - a. Elevation
 - b. Subsidence
 - c. Tidal channel configuration
 - d. Size of parcel

- e. Context of property in relation to other estuarine restoration projects and reference conditions
- f. Context of the property in relation to existing habitat forming processes
 - i. Sediment accretion
 - ii. Tidal flux
 - iii. Fluvial hydrology
2. Map the property with georeferenced and classified T-sheets (U.S. Coast and Geodetic topographic survey: 1861-1901) in GIS to conduct historic comparative analyses
3. Identify restoration actions including the mapping of the following:
 - a. Tidegates
 - b. Culverts
 - c. Levees
 - d. Road and railway infrastructure
 - e. Drainage ditching
 - f. Dredge material
 - g. Invasive plant species
4. Identify proximal reference sites
5. Conduct environmental studies (phase 1) of the property and historical uses of the property
6. Examine title reports and property condition to determine the project's feasibility
7. Develop baseline assessment
8. Develop management/restoration plan
9. Present the acquisition and management/restoration plan to:
 - a. Columbia Land Trust's external project review committee (Lands Committee)
 - b. LCREP's Science Work Group
 - c. Action Agencies' RPA 37 Expert Regional Technical Group
 - d. Other technical review committees (i.e. Lower Columbia Fish Recovery Board)
 - e. Columbia Land Trust's Board of Directors for final approval
10. Identify stewardship concerns (encroachments, potential for off-site flooding, cost of construction and maintenance of cross-dikes or setback levees)
11. Contract for an appraisal to determine fair market value using the *Uniform Standards for Federal Land Acquisitions* (Yellow Book appraisal)
12. Negotiate acquisition terms and price with landowner
13. Sign purchase and sale agreements
14. Coordinate development of documentation and fund transfers, opening escrow
15. Signing and notarizing documents, placing in escrow and closing the transaction
16. Contract for boundary survey

Work Element 172: Conduct Pre-Acquisition Activities - This work element includes the majority of the steps that are required before fee title or a conservation easement can be acquired for a tract of land. The steps are: perform appraisal, perform title searches, perform land boundary surveys, provide legal descriptions, perform hazardous waste assessment, and identify minimum habitat units. For easements, this work element would also include the definition of the easement terms and conditions.

Subtask a. Develop property acquisition projects with willing land owners to secure restoration land base in Chinook River restoration area

In 2003, Columbia Land Trust secured 871 acres in the Chinook River Restoration Area from a willing land owner and transferred the title to Washington State Department of Fish and Wildlife (WDFW). This action was in anticipation of a large estuary reconnection project that has yet to be completed. Since then, and as part of this project, Columbia Land Trust has continued to approach land owners in the area to identify additional lands that could be added to the restoration area to help achieve the restoration. It is the ultimate goal of Columbia Land Trust and other project partners to fully reconnect this estuary to Columbia River processes.



Map 2.

As part of this project Columbia Land Trust is currently working with a land owner to secure an additional 75 acres of potential restoration land (Map 2). This property is at the confluence of Columbia River estuary (~RM 5) and the Chinook River. The site is within the Baker Bay embayment of the estuary, a high priority habitat area for salmonids due to its habitat function and location within the salinity gradient.

The property contains 0.65 mile of Columbia River frontage, .25 miles of Chinook River frontage and 0.5 mile of side channels. It is composed of 20 acres of forested estuarine wetlands, 50 acres of emergent estuarine wetlands, and 5 acres of mature Sitka spruce-forested uplands. The property is adjacent to the 850-acre WDFW Chinook Wildlife Area, providing valuable habitat connectivity. Conservation of this site will enable future restoration of the site and improve habitat connectivity and accessibility to offsite habitats for all 13 ESA-listed ESUs. **(See Task 3, Subtask a. for restoration approach)**

Metrics

Anticipated Estuary Module Management Actions (Reach A) include:

- CRE 1.3: protection with future restoration of 75 acres of tidally influenced floodplain and riparian habitat.

Subtask b. Develop property acquisition projects with willing land owners to secure restoration land base in Crooked Creek restoration area

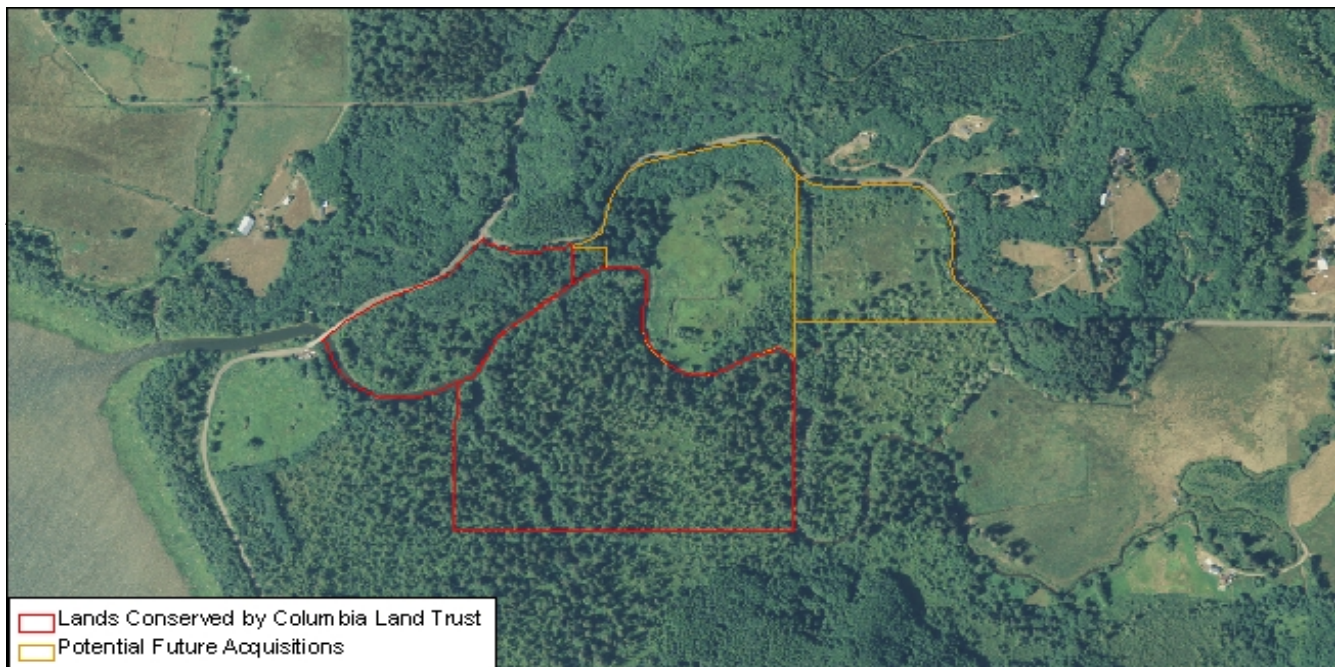
In 2004, Columbia Land Trust secured its first property (60 acres in red) in the Crooked Creek watershed in Grays Bay (Map 3.) with funding from Bonneville Power Administration. Columbia Land Trust is in active negotiations with two adjacent neighbors to secure their partially diked property to build the restoration footprint.

The historic spruce swamp (Thomas, 1983) has been diked and ditched and at one time was converted to pasture. The existing habitat conditions are poor. The historic tidal channel has been disconnected and altered by sediment accretion and backwater vegetation growth. A parcel immediately north of Columbia Land Trust property is a 40 acre parcel that Columbia Land Trust currently has under appraisal. Additionally, the land owner of the property furthest to the east has approached Columbia Land Trust with an interest in selling an additional 20 acre property. Removal of the dike infrastructure will facilitate tidal restoration. **(See Task 3, Subtask c. for restoration approach)**

Metrics

Anticipated Estuary Module Management Actions (Reach A) include:

- CRE 1.3: protection with future restoration of 60 acres of tidally influenced floodplain and riparian habitat.



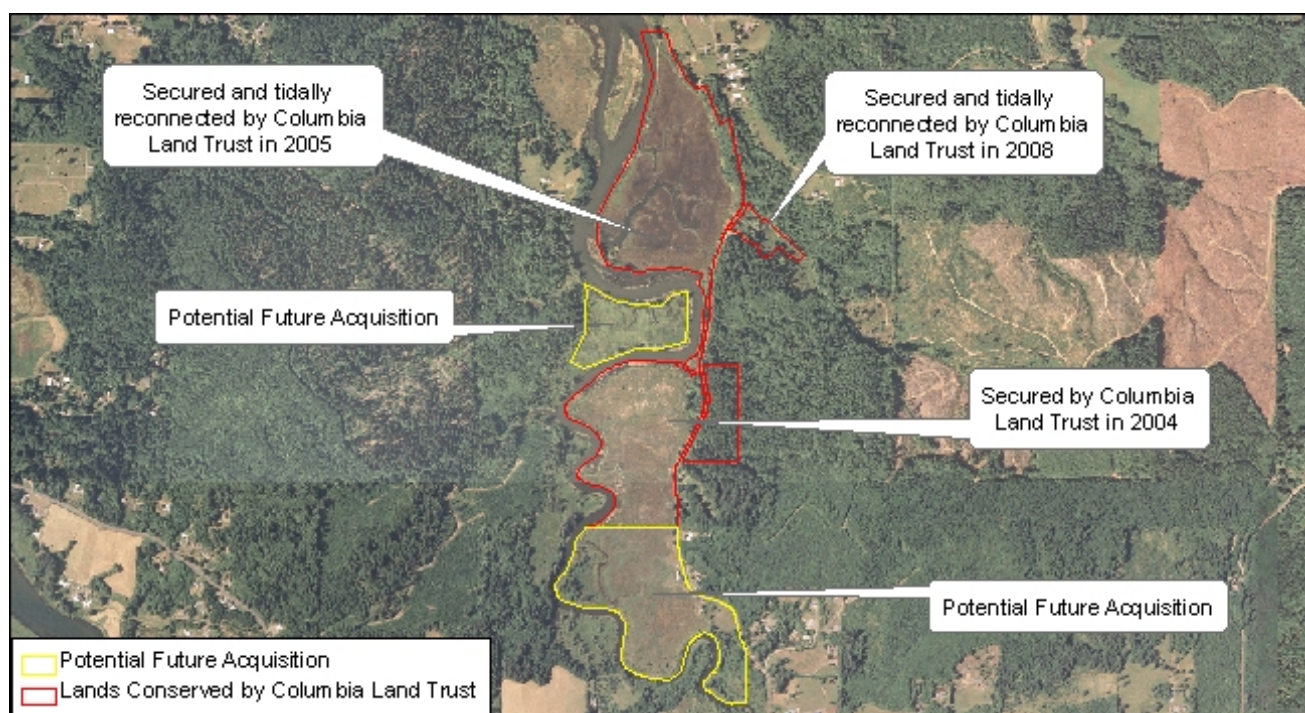
Map 3.

Subtask c. Develop property acquisition projects with willing land owners to secure restoration land base in Walluski River restoration area

Columbia Land Trust currently owns 90 acres of tidal floodplain on the Walluski River. In 2004, Columbia Land Trust acquired a 40 acre property in anticipation that the adjacent floodplain property would become available. In 2005, Columbia Land Trust secured a 55 acre property which was breached in 2005.

The historic spruce swamp in this reach of the Walluski River has been diked, drained and converted to pasture. The condition of the habitat is poor due to flooding of the site over the past several years caused by dike and tidegate failure. The historic tidal channels have been disconnected and altered by sediment accretion and filling. Columbia Land Trust is working with adjacent landowners to determine their willingness to sell. This land acquisition would lead to a 90 acre dike breach project.

(See Task 3, Subtask d. for restoration approach)



Map 4.

Metrics

Anticipated Estuary Module Management Actions (Reach A) include:

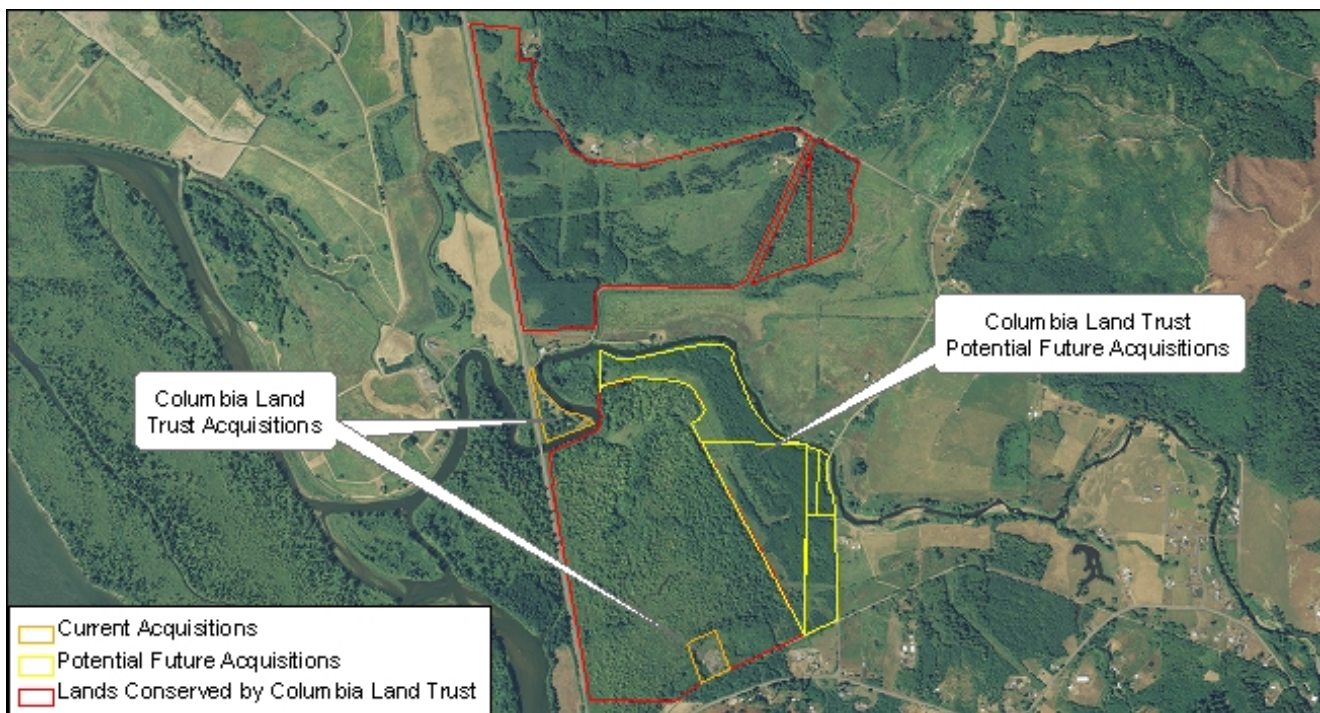
- CRE 1.3: 50 acres of habitat protection, including 0.65 mile of riparian shoreline. An additional 10 acres of potential intact habitat protection in the future would add to the Walluski conservation area;
- CRE 9.3: Over one mile and approximately 2.3 acres of off-channel habitat protection once restored;

Subtask d. Develop property acquisition projects with willing land owners to secure restoration land base in the Lower Elochoman Restoration Area

Columbia Land Trust has permanently secured 200 acres in the Lower Elochoman River Restoration Area at River Mile 38 of the Columbia River. The property is on Highway 4 near the mouth of Elochoman River. The wetlands provide habitat for a variety of species, including migrating ocean-type juvenile salmon, particularly in this portion of the river where much of the historical floodplain and off-channel areas have been altered by diking and filling.

Restoration activities will likely involve removing ditching and road fill, replacing or removing several culverts and a tide gate, planting conifers to help re-establish spruce swamp, and invasive plant species control. If future acquisitions are successful dike leveling options will be considered. The restoration of this site will fall, in part, under project 2009–016–00 of the Washington MOA, with the Army Corps of Engineers initiating a feasibility analysis in the coming year.

Columbia Land Trust currently has two adjacent properties under appraisal to consolidate land holdings in this restoration and is engaging with another landowner to secure an additional 105 acres of wetland property for restoration. One of the barriers related to acquiring the priority adjacent property is a 10 year timber lease between an industrial forestry company and the private landowner. Using acquisition funding to secure this timber lease may expedite acquisition of the property. Finally, Columbia Land Trust has secured funding through the North American Wetland Conservation Act to secure some of these adjacent properties.



Map 5.

Metrics

Anticipated Estuary Module Management Actions (Reach B) include:

- CRE 1.3: Acquire an additional 105 acres of tidally influenced floodplain.

Work Elements for Task 2

1. **Work Element 119: Manage and Administer Projects** - Columbia Land Trust financial staff will administer financial and project management activities and technical work by the contractor to fulfill BPA's programmatic and contractual requirements such as financial reporting (accruals), and development of an SOW package (includes SOW, budget, property inventory).
2. **Work Element 165: Produce Environmental Compliance Documentation** - Columbia Land Trust project management staff will complete, submit, and obtain environmental compliance documents with all

necessary federal, state, and local agencies, and in compliance with federal laws for each restoration project.

3. **Work Element 132: Produce (Annual) Progress Report** - Columbia Land Trust staff will develop and complete an annual report in compliance with BPA standards and timelines for each restoration project.
4. **Work Element 185: Produce PISCES Status Reports** - Columbia Land Trust staff will complete status reports for restoration projects in PISCES in a timely fashion.

Task 3. Develop construction designs and implement tidal reconnection projects which follow best available science and provide most benefit to species, while being cost-effective and constructible.

With funds provided through this proposal Columbia Land Trust will complete project engineering designs and initiate implementation. Project restoration will focus on restoring the natural habitat forming and sustaining processes that best achieve habitat goals. Projects will be moved through a design process to minimize design costs while maximizing product delivery. Final level of design will be determined by standard professional practice and staff expertise. Columbia Land Trust staff regularly engages in technical discourse through regular engagement with agencies and professionals. Review is typically conducted at 30/60/90/100% design levels. Columbia Land Trust works early in the process with regulatory agencies, engineers, and members of the public to review the design from multiple angles.

Permitting documentation will be prepared during the design phases and submitted as soon as feasible to the necessary permitting agencies and reviewing bodies. Permitting is typically submitted at 30% design. Permitting is streamlined and efficient and all permitting documents will be secured prior to starting work. An element of design is collaborating with regional partners and utilizing existing metrics to develop individualized monitoring plans to evaluate effectiveness monitoring and project success to improve future restoration planning. Outreach and coordination with local leadership and affected neighbors is a critical part of successful restoration work in the estuary. Columbia Land Trust has a long history of involving critical stakeholders as part of its restoration efforts. These work elements are part of the project development process, and will be adapted as required to the needs of specific projects.

Subtask a. Develop construction designs for tidal reconnection project in the Chinook River Restoration Area which follows best available science and provide most benefit to species, while being cost-effective and constructible.

Mouth of Chinook River Restoration Area

Existing Conditions

This restoration area is a 73.3-acre site located in hydrogeomorphic Reach A at river mile 5. The site is located on the northern bank of the Columbia River in Baker Bay. Salmonids and other fish have no direct access to portions of this site and connectivity to interior wetlands is restricted. The site includes 1,400 feet of Chinook River and 8,100 feet (1.5 miles) Columbia River frontage. The site is primarily composed of tidal estuarine and palustrine wetlands of which approximately half of the property is composed of forested and scrub-shrub wetlands.

These estuarine wetland systems provide benefits to juvenile salmonids from throughout the Columbia River basin in the form of refugia during outmigration, and productive foraging habitat.

- **Vegetation Type** – This site has considerable interspersed vegetation cover types. In upland inclusions a forest canopy is found dominated by *Thuja plicata* and *Alnus rubra*. The invasive species *Ulex europaeus*, *Rubus laciniatus*, and *Rubus discolor* are also present in uplands. The disconnected wetlands are dominated by *Typha latifolia*. In the coastal *tidelands* *Scripus americana*, *Carex lyngbeii*, *Festuca arundinacea* and *Lotus corniculatus* are dominant.
- **Habitat Features** – The average growing season for this site is 200 to 240 days. The average annual rainfall is 90 inches. Depending on tidal and fluvial flows the salinity of the water column range from mesohaline to oligohaline. Estuarine and palustrine (forested and scrub-shrub) wetlands dominate the site. Small upland inclusions are interspersed throughout the site. Two significant tidal channels are present near the mouth of the Chinook. Small side channels punctuate the tideland portion of the shoreline bordering Baker Bay.

Reference Site Trap Net Monitoring (see site map for location of trap net)

1. **Migration Timing and Abundance** - Chum dominated the catches during estuary trap netting in 2006. Chum numbers peaked at 83 in late March, and steadily declined until fish were absent from catches in late May (Figure 28). Chinook numbers peaked at 45 fish in early March, and slowly tapered off over the next month until only three fish were caught in late June. A total of three coho were caught during trap netting, one in late April, and two during May sampling. In 2005, trapping started in June. Therefore, very few salmonids were caught. Four Chinook were caught in early June and one in early September. These fish measured 62, 44, 51, 48, and 48 mm, respectively.
2. **Length Frequency Distribution**
 - a. Chinook salmon - Mean lengths increased from 41 mm in early February to 51 mm at the end of March. A peak mean length of 62 mm was seen in late April. Sample sizes were very low for May and June with a mix of fish ranging in size from 40 mm to 83 mm.
 - b. Chum salmon - Mean lengths showed a small increase from 43 mm in early March to 47 mm in late April. Only a few chum fry were caught in early February and early May ranging in size from 38 mm in February to 40 mm in May.
 - c. Coho salmon - Only three coho were caught during trap netting in the estuary, therefore mean lengths were not calculated. These fish measured 135, 76, and 76 mm.

Site Opportunities

- Hydraulic tidal reconnection to an isolated wetland via road fill removal
- A Columbia River mainstem project will provide benefits to multiple ESUs
- Reintroduction of native riparian forest
- Riparian enhancement through invasive plant species control
- High-visibility restoration opportunity adjacent to SR 101.

Site Constraints

Potential restoration, enhancement, and preservation activities are constrained at this site due to:

- Protection of the SR 101 road prism from increased tidal velocities.

Site Prescription

Refer to the Restoration Design Map

- Hydraulic connection of disconnect wetland via road removal to restore tidal flow hydraulics.
- Enhancement of site vegetation through invasive plant removal
- Planting of appropriate native vegetation

Metrics

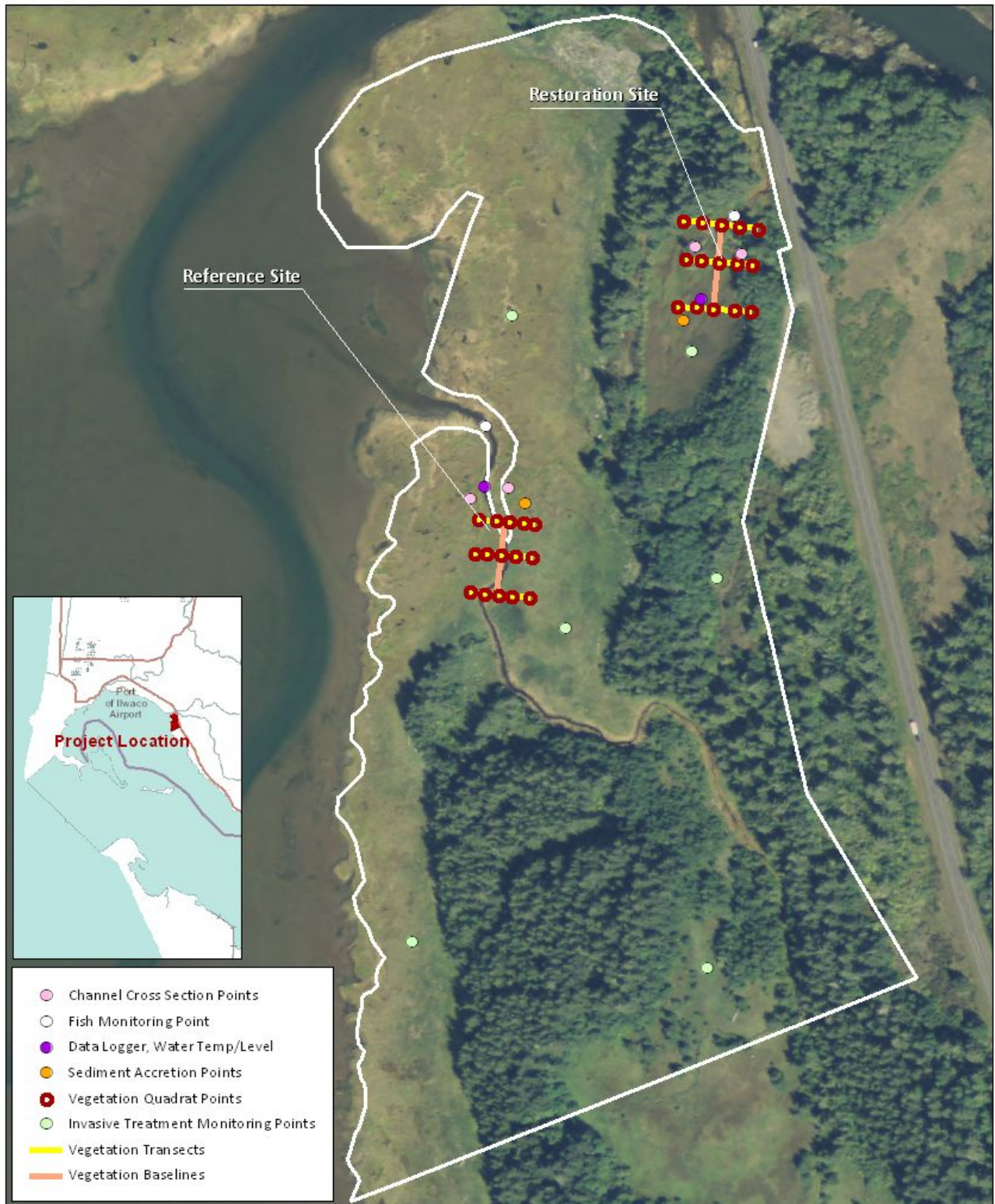
Anticipated Estuary Module Management Actions (Reach A) include:

- CRE 1.4: 75 acres of habitat restoration, including over two miles of riparian and channel shoreline;
- CRE 9.3: 0.5 mile and 1.5 acres of off-channel habitat protection;
- CRE 10.1 and 10.2: 550 feet of road prism and associated tidegate removal restoring connectivity to 3 acres of tidal wetlands and 500 feet of tidal channel; and
- CRE 15.3: Invasive plant species control and planting on 5 acres

Chinook River - Project Activity	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Consult LCREP Prioritization Framework and CREEC	■															
Construct site maps with LiDAR and T-sheets																
Site visit to scope restoration actions and reference conditions		■														
Landowner Contact			■													
Conceptual Project Design (Study design, vision)				■												
Grant Funding - Application (Study design, vision)				■												
Review by LCREP SWG (Study design, vision)				■												
Review by ERTG (Study design, vision)				■												
Assignment of Survival Benefit Units				■												
Grant Contracting				■												
Outreach		■				■				■				■		
Acquisition - Appraisal (Study design, vision)						■								■		
Acquisition - Due Diligence (Title reports, Phase I)							■									
Purchase and Sale agreement							■									
Acquisition - Closing							■									
Boundary and elevation Surveying (Prescription)							■									
Pre-construction monitoring							■									
Project Design - 30% (Prescription)								■								
Permitting - Regulatory Approval								■								
Final Design								■								
Construction Contracting								■								
Construction (Implementation)								■								
Post-Construction Monitoring and Maintenance (Monitoring of Outcomes)								■						■		

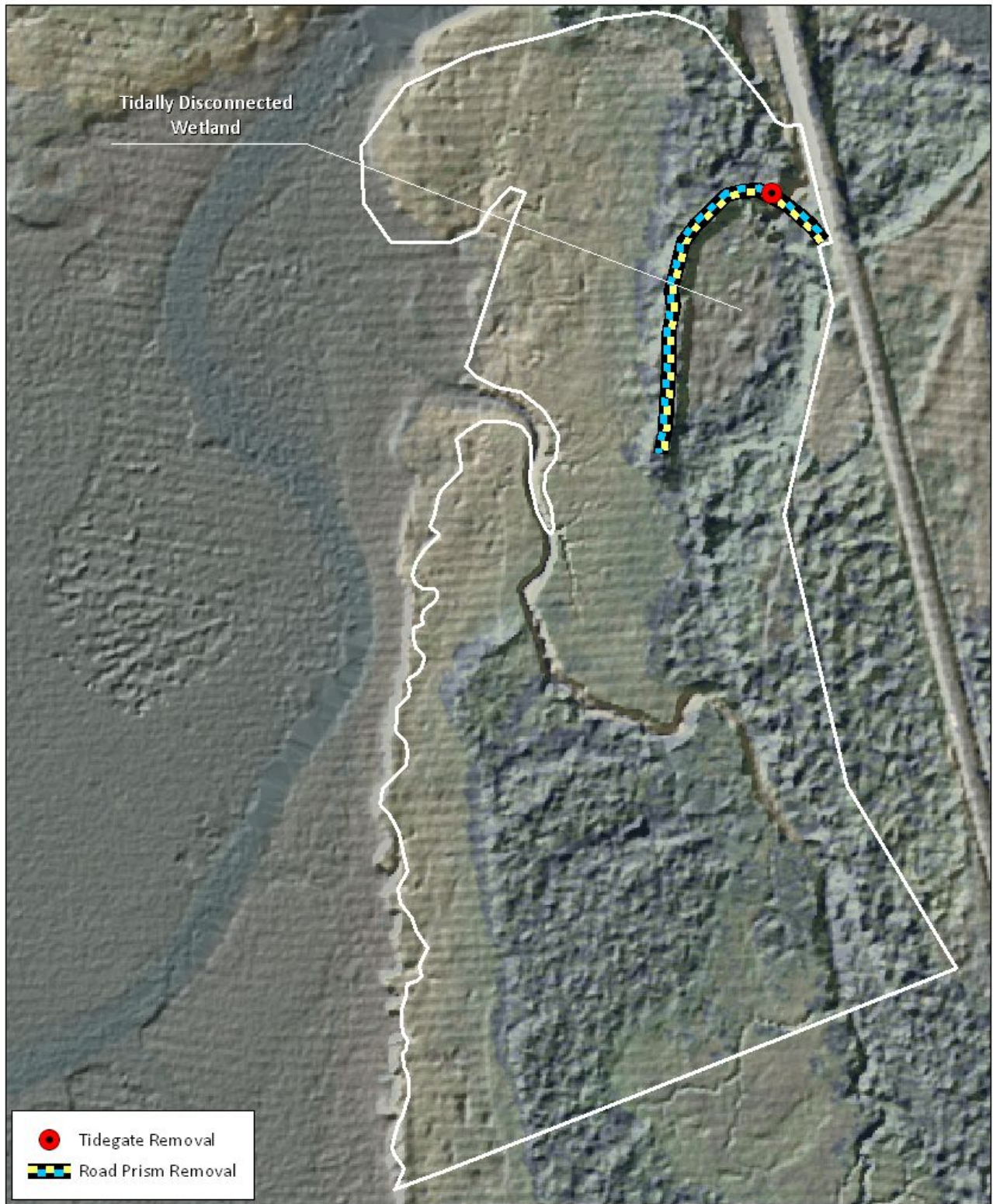
Mouth of Chinook River

Project Monitoring



Mouth of Chinook River

Restoration Design



Subtask b. Develop construction designs for tidal reconnection project in the Haven Island Restoration Area which follow best available science and provide most benefit to species, while being cost-effective and constructible.

Haven Island Restoration Area

Existing Conditions

Haven Island is a partially diked island located in the estuarine portion of the Young’s River. The 80 acre island was acquired by Columbia Land Trust for conservation and restoration in 2006. The historic spruce swamp (based on remnant stumps and snags) had been diked and drained since the early 1900’s and gradually converted to pastureland for cattle grazing. The condition of the floral communities has greatly improved since the creation of the natural breaches and removal of cattle. An abundance of native sedges and rushes occupy the floodplain with a limited abundance of reed canary-grass. Many historic tidal channels are still disconnected (except from the west) from Youngs River by a dike thus altering and limit overbank flooding and sediment accretion. Downed course wood is lacking from the system but will accumulate in the future as the planted materials age, decay and fall. The natural and man-made breaches will also provide an avenue for LWD to enter the project area.

The primary habitat forming process is hydrology which has been disconnected from the site for over 80 years until the formation (about a decade ago) of two natural breaches located on the western edge of the island. As a consequence of this long-term disconnect of natural hydrologic functions, the site has subsided over 1.5’ when compared to neighboring un-diked Grant Island (reference site). Currently, tidal inundation and draining is achieved only through these western breaches. Historically, the myriad of tidal channels would have received inundation with the incoming tide from all cardinal directions, flowed across the floodplain and then drained unrestrictedly back into Youngs River. Due to the disconnection of the property through diking, a 30” tidgegate and tidal fluctuations restricted to the western breaches, the property continues to be compromised of its full potential of maximizing function as a wetland and salmonid habitat.



Figure 12.

- Vegetation Type** – The condition of the floral communities on Haven Island has improved since the creation of the natural breaches and removal of cattle by exhibiting an abundance of native sedges and rushes occupy the floodplain with a limited abundance of reed canary-grass. Figure 12. provides an overview of the vegetation monitoring that has been conducted on the western portion of Haven Island and at the reference site, Grant Island. The legend for Figure 12. the vegetation is as follows: POAN - Pacifica; ATFI - Athyrium filix-femina; CALY - Carex lyngbyei; ELPA - Eleocharis palustris; SCTA - Schoenoplectus tabernaemontani; SASP - Salix spp.

Invasive plant species on Haven Island include *Atropa belladonna*, *Hedera helix*, *Rubus laciniatus*, and *Rubus discolor*.

- **Habitat Features** – The average growing season for this site is 200 to 240 days. Compared to reference conditions found on Grant Island, the floodplain wetland on Haven Island has subsided as much as a 1.5'. A significant number of the historic tidal channels on the eastern side of the Island are presently disconnected from Youngs River tidal hydrology. Downed course wood is lacking from the system.

Site Opportunities

- Improved hydrologic connection with Youngs River and estuarine processes. Diurnal tidal exchange within the tidal channels is anticipated year-round (invert elevation of main tidal channels will be at or below 0 feet msl), and floodplain inundation is expected during a majority of high tide cycles (floodplain elevation is currently 5.8-7.2 feet above msl, within the range of mean high water).
- The site's primary controlling processes (hydrology) will be restored and compliment the natural breaches. The hydrologic connection between Youngs River and the tidal floodplain will maintain habitat structure and function over time to maximize habitat capacity.
- The habitat elements of the project will be self-sustaining once the hydrologic connection is completed. Continued maintenance work related to plant establishment and invasive plant species control will be on-going with a relatively low resource demand.

Site Constraints

Potential restoration, enhancement, and preservation activities are constrained at this site due to:

- Ninety percent of the island is still surrounded by a flood control levee.
- Wetland subsidence has occurred throughout most of the site.
- Shallow nearshore mudflats surrounding the island create challenges related to the mobilization of large machinery.
- The most significant constraints to the project at this point is accessing the site with heavy equipment and supplies, the logistical challenges of removing the failing levee with smaller equipment, regulatory agreement regarding areas suitable for on-site deposition of levee material, seasonal construction restraints and budget.

Site Prescription

The project supplements natural hydrologic connectivity to approximately 80 acres of disconnected tidal floodplain within the Youngs River Estuary. Project elements include removing portions of an historic levee and tidegate, invasive plant species control and planting approximately 3 acres with Sitka spruce and other on-site native shrubs/trees.

Phase I objectives for the project include:

1. 500 feet of existing levee removal/leveling (0.30 acre), thus re-connecting 700 feet of historic tidal channels to the estuary.
2. Removing a tidegate to open up 800 feet of a historic channel to the estuary.
3. 1-acre of native plant restoration that includes 4,750 plants.
4. 70 acres of weed control that include controlling yellow-flagged iris, purple loosestrife, holly and non-native blackberries.
5. Baseline monitoring of channel morphology, photo points, vegetation composition, and water depths (Columbia Land Trust and Pacific Northwest National Lab (PNNL)), and fish utilization/diversity
6. Project effectiveness monitoring

Phase II specific objectives for the project include:

1. Proposing to remove 1,000 feet of existing levee (.60 acres), thus re-connecting over 1000 feet of historic tidal channels to the estuary.
2. 2-acres of native plant restoration that would include over 8,000 plants.
3. Continued invasive plant species control of primarily purple loosestrife, blackberries, and yellow-flagged iris.

Metrics

Anticipated Estuary Module Management Actions (Reach A) include:

- CRE 1.4: Restore approximately 1.2 miles of shoreline vegetation;
- CRE 10.1 and 10.2: Level approximately 500 feet of dike along the island shoreline and remove one tidegate to enhance tidal marsh connectivity; and
- CRE 15.3: Control invasive plant species over 70 acres of tidal marsh.

Haven Island - Project Activity	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Consult LCREP Prioritization Framework and CREEC	■															
Construct site maps with LiDAR and T-sheets																
Site visit to scope restoration actions and reference conditions		■														
Conceptual Project Design (Study design, vision)				■												
Grant Funding - Application (Study design, vision)				■	■											
Review by LCREP SWG (Study design, vision)				■	■											
Review by ERTG (Study design, vision)				■	■											
Assignment of Survival Benefit Units				■	■											
Grant Contracting				■	■											
Pre-construction monitoring			■													
Project Design - 30% (Prescription)				■	■	■										
Permitting - Regulatory Approval				■	■	■	■									
Final Design				■	■	■	■									
Construction Contracting				■	■	■	■									
Construction (Implementation)				■	■	■	■									
Post-Construction Monitoring and Maintenance (Monitoring of Outcomes)										■		■				

Haven Island

Project Area



Haven Island

Project Monitoring

Restoration Area (Inset A)



Grant Island Reference Site (Inset B)



Haven Island West Breach Reference Site (Inset C)



- Channel Cross Section Points
- Sediment Accretion/Vegetation Quadrat Point
- Data Logger, Water Temp/Level
- Fish Monitoring Point
- Sediment Accretion Points
- Vegetation Quadrat Points
- Vegetation Transects
- Vegetation Baselines

Haven Island

Restoration Design



Subtask c. Develop construction designs for tidal reconnection project in the Crooked Creek Restoration Area which follow best available science and provide most benefit to species, while being cost-effective and constructible.

Crooked Creek Restoration Area

Existing Conditions

The Crooked Creek Restoration Area is located on the eastern shore of Grays Bay. The restoration area consists of intact spruce swamp and tidal channel habitat as well as Columbia River floodplain that have been tidally disconnected by diking and converted to pasture land. Much of the historic tidal spruce swamp in the project area has been drained and converted to pasture in the early 20th century. The dike was built with silt fines dredged from the adjacent creek channel.

- **Vegetation Type** – Shrub floodplain, floodplain conifer woodland, floodplain hardwood woodland, and historically grazed pasture. The forested wetland consists of *Picea sitchensis* shared dominance with *Alnus rubra*, and *Thuja plicata* is a subdominant in the overstory. The dominance of *Picea sitchensis* followed by *Alnus rubra* is consistent with the surge plain wetland community type. Introduced plant species include *Juncus effuses*, *Phalaris arundinacea*, *Holcus lanatus* and *Agrostis stolonifera*.
- **Habitat Features** – This is a freshwater environment. The average growing season for this site is 200 to 240 days. The average annual rainfall is approximately 100 inches. Many of native trees and shrubs in the restoration area were removed at that time. There is no evidence of attempts to grow row crops, cattle have been removed for a number of years but there is evidence of soil compaction and subsidence.

Site Opportunities

- Hydraulic tidal reconnection of a partially disconnected floodplain wetland via levee removal
- Reintroduction of native riparian forest
- Riparian enhancement through invasive plant species control

Site Constraints

Potential restoration, enhancement, and preservation activities are constrained at this site due to:

- Site access is difficult
- Partial tidal reconnection already exists.

Site Prescription

Refer to the Restoration Design Map for this Site

- Dike leveling to increase overbank tidal flooding
- Improvement of tidal channel reconnection
- Riparian enhancement planting of the floodplain to restore a forested wetland habitat.
- Invasive plant species control

Metrics

Anticipated Estuary Module Management Actions (Reach B) include:

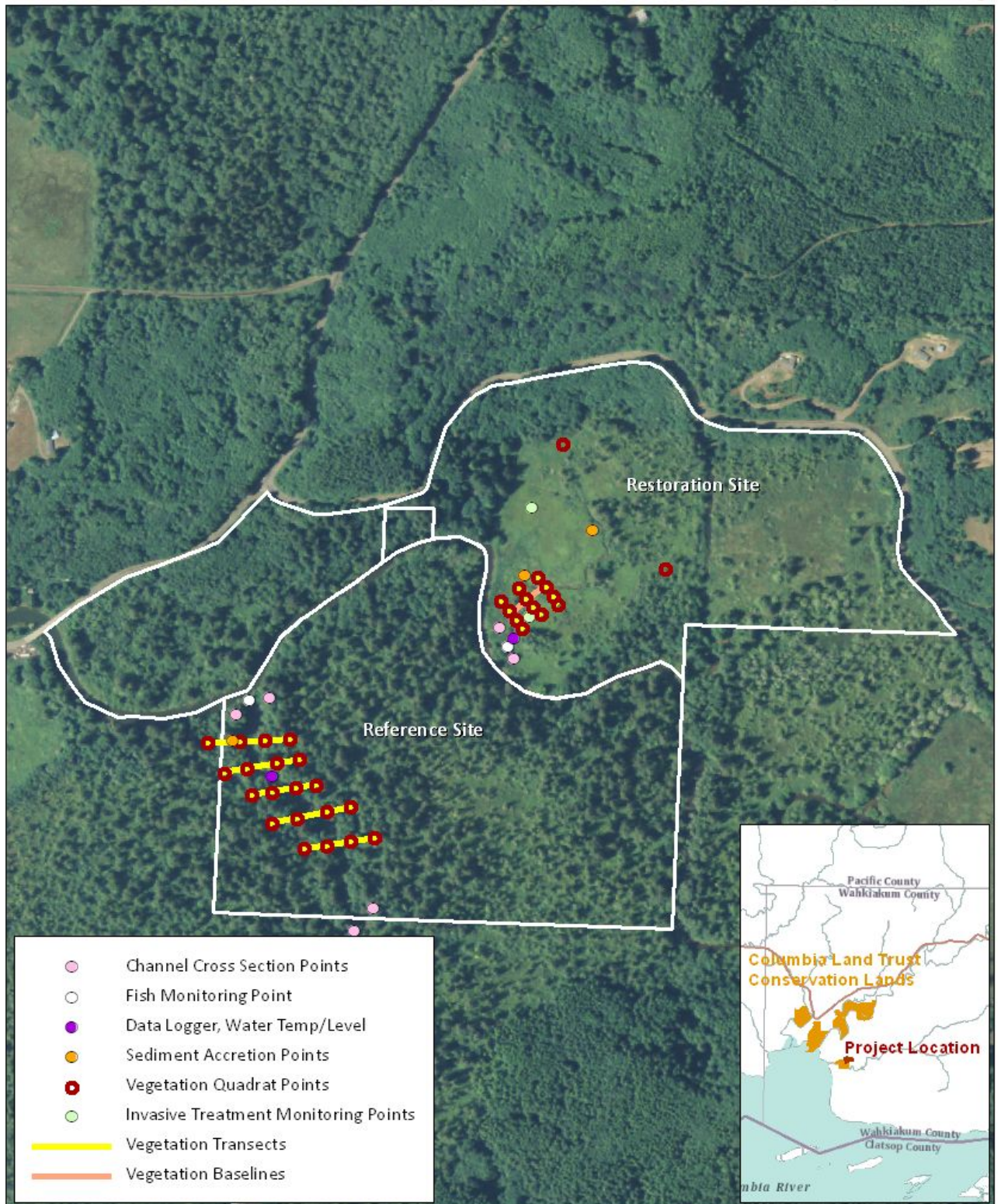
- CRE 1.4: 0.70 mile of riparian and channel shoreline.
- CRE 9.3: 0.5 mile and 1.5 acres of off-channel habitat protection;

- CRE 10.1 and 10.2: 700 feet of dike leveling improving connectivity to 60 acres of tidal wetlands and 1,500 feet of tidal channel; and
- CRE 15.3: Invasive plant species control and planting on 40 acres

Crooked Creek - Project Activity	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Consult LCREP Prioritization Framework and CREEC	■															
Construct site maps with LiDAR and T-sheets	■															
Site visit to scope restoration actions and reference conditions		■	■													
Landowner Contact		■	■													
Conceptual Project Design (Study design, vision)			■	■												
Grant Funding - Application (Study design, vision)			■	■												
Review by LCREP SWG (Study design, vision)			■	■												
Review by ERTG (Study design, vision)			■	■												
Assignment of Survival Benefit Units																
Grant Contracting																
Outreach		■	■			■	■			■	■			■	■	
Acquisition - Appraisal (Study design, vision)		■	■			■	■							■	■	
Acquisition - Due Diligence (Title reports, Phase I)						■	■									
Purchase and Sale agreement						■	■									
Acquisition - Closing						■	■									
Boundary and elevation Surveying (Prescription)						■	■									
Pre-construction monitoring						■	■									
Project Design - 30% (Prescription)						■	■			■	■					
Permitting - Regulatory Approval										■	■					
Final Design										■	■					
Construction Contracting										■	■					
Construction (Implementation)										■	■					
Post-Construction Monitoring and Maintenance (Monitoring of Outcomes)														■	■	

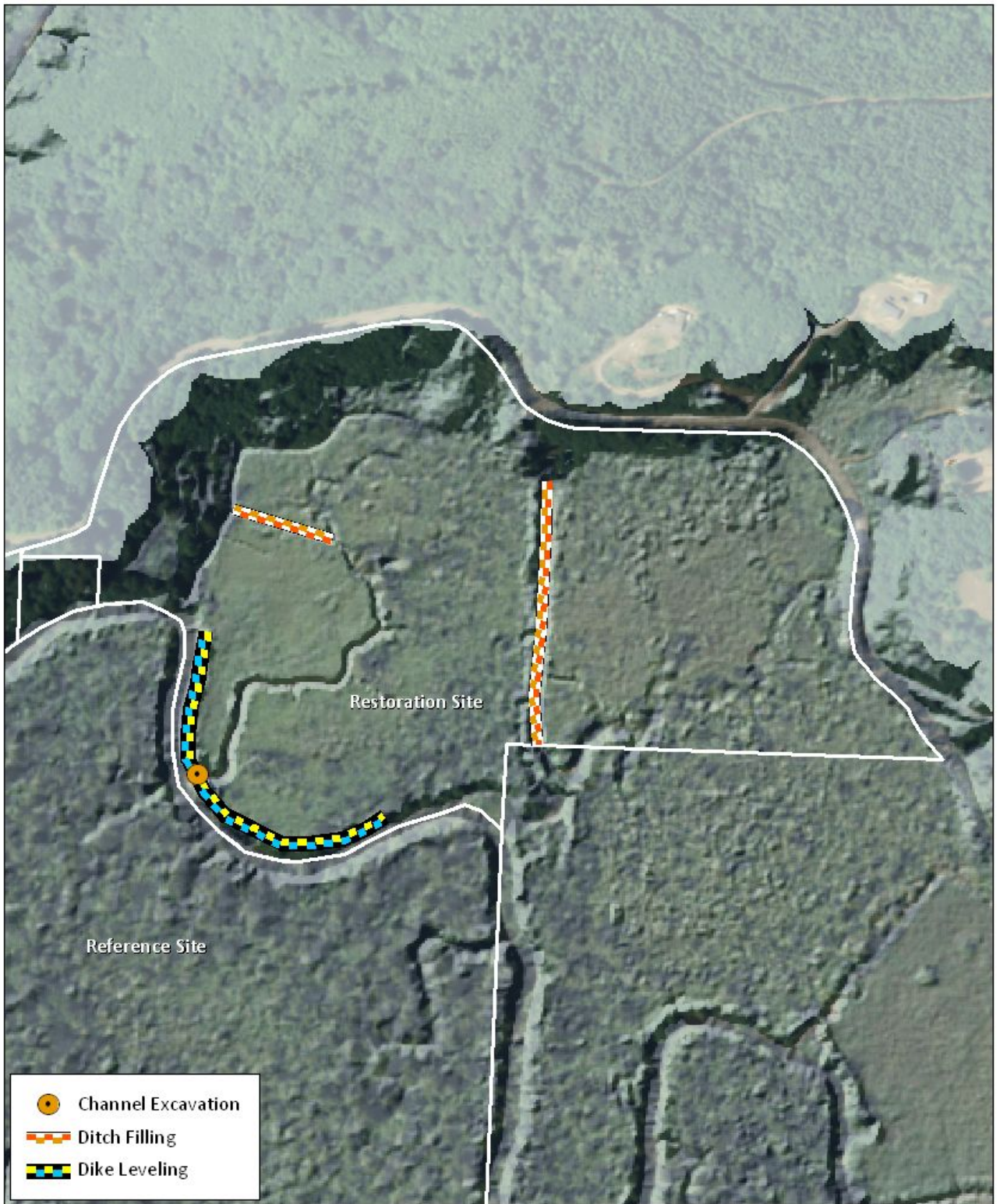
Crooked Creek

Project Monitoring



Crooked Creek

Restoration Design



Subtask d. Develop construction designs for tidal reconnection project in the Walluski River Restoration Area which follow best available science and provide most benefit to species, while being cost-effective and constructible.

Walluski River Restoration Area

Existing Conditions

The historic tidal spruce swamp in this project area has been drained and was converted to pasture in the early 20th century. The native trees and shrubs were removed at that time. There is no evidence of attempts to grow row crops, but cattle have grazed the site for decades, leading to soil compaction. The dike was constructed with fine sediments from the river channel. The soils on the sites are mapped as Coquille silt loam and Clatsop muck. The permeability of these soils is very slow. Connectivity of the interior wetlands to tidal influence does not exist, and as such there is little functional benefit of this habitat area to the overall watershed or to juvenile salmonids. Shoreline vegetation on the dike and in the wetland is altered and no longer provides the same function capacity as the historic spruce swamp habitat. Portions of some of the historic tidal channel network have been filled and there are three ditches excavated across the floodplain that exit to tidegates.

- **Vegetation Type** – Existing vegetation is non-native pasture grasses and some native sedges. Introduced plant species include *Lotus corniculatus*, *Juncus effuses*, *Phalaris arundinacea*, *Holcus lanatus* and *Agrostis stolonifera*. Some small patches of native plants are still found in the dike pasture; typically *Juncus effuses var pacifica* and *Douglas spiraea*.
- **Habitat Features** – Annual rainfall in this area is approximately 90 inches a year. The average growing season for this site is 200 to 240 days. The site presently consists of drained pasture with an existing network of historic remnant tidal channels. These tidal channels are currently disconnected to tidal flux.

Site Opportunities

The proposed project restores natural hydrologic connectivity to approximately 80 acres of disconnected tidal floodplain. The restoration activity is to remove the existing levee and two tide gates along the Walluski River, plant native vegetation appropriate to the habitat, and re-contour interior drainage ditches to match historic channel configuration. The approach to restoration focuses on restoring natural processes using standard construction approaches, particularly for earthwork and flood control infrastructure. Work will be completed using heavy equipment (along the dike for removal and construction), smaller tracked equipment for contouring, and hand crews for planting.

The habitat elements of the project will be substantially self-sustaining once the hydrologic connection is completed. Continued maintenance work related to plant establishment and invasive plant species control will be on-going with a relatively low resource demand. Flood control infrastructure will require somewhat significant near-term maintenance to address settlement issues.

Site opportunities

- Restore reconnection to historic tidal channel networks in two locations through tidegate removal
- Restore conditions for tidal and fluvial overbank flooding by levee removal
- Riparian enhancement planting of the floodplain to restore a forested wetland habitat.
- Invasive plant species control

Site Constraints

Potential restoration, enhancement, and preservation activities are constrained at this site due to:

- Local road system need to be protected from tidal flooding

- Local storm water drainage needs to be adapted to allow upland storm water drainage without allowing off-site flooding

Site Prescription

Refer to the Restoration Design Map Drawing for this Site

- Improve reconnection to historic tidal channel networks in two locations through tide gate removal
- Improve conditions for tidal and fluvial overbank flooding by levee removal

Metrics

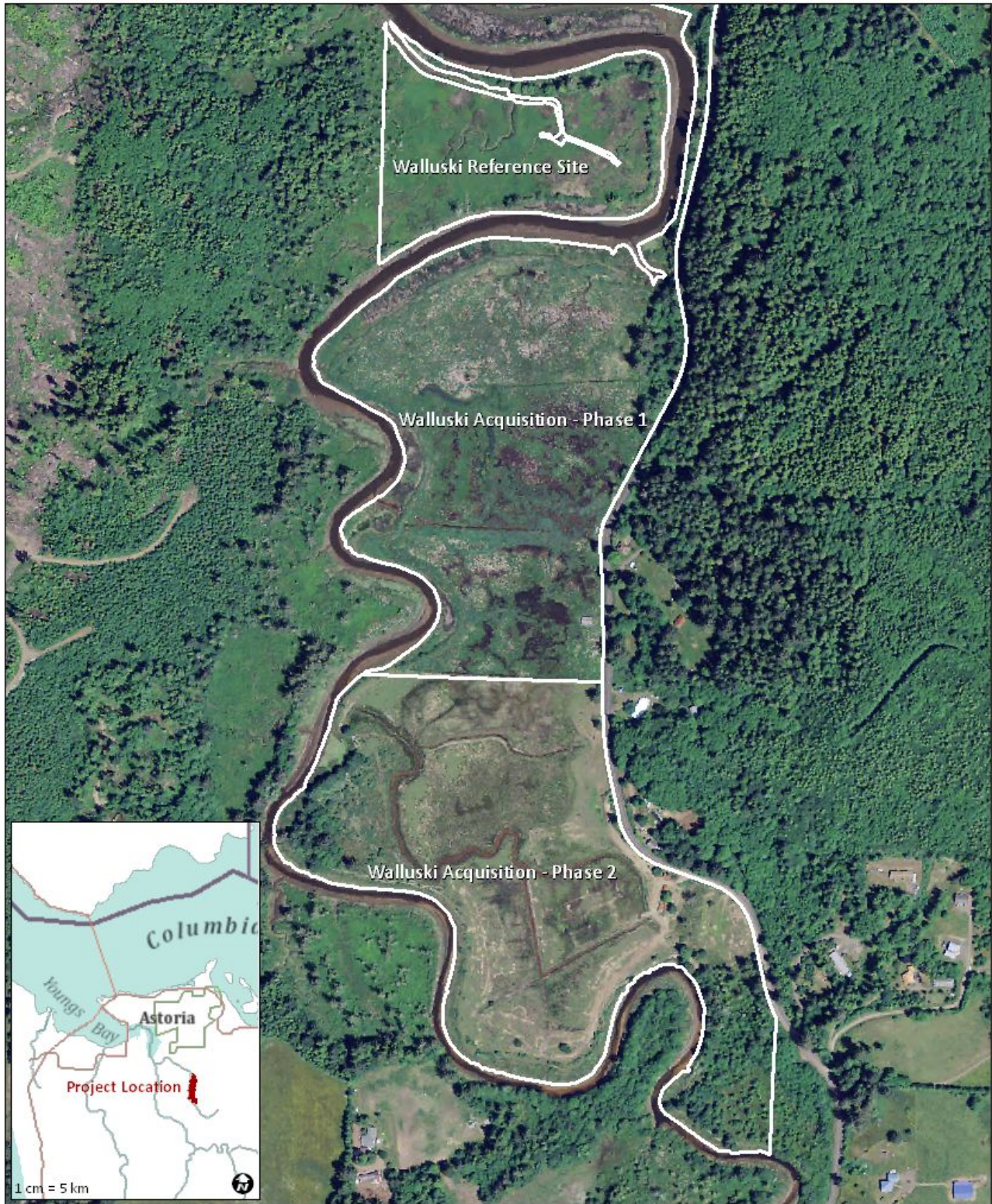
Anticipated Estuary Module Management Actions (Reach A) include:

- CRE 1.4 Restore 0.65 mile of riparian shoreline along the Walluski River;
- CRE 10.1 and 10.2: 6,500 feet of dike leveling restoring connectivity to 80 acres of tidal wetlands and over 5,000 feet of tidal channel; and
- CRE 15.3: Invasive plant species control and planting on 10 acres.

Walluski River - Project Activity	Year 1				Year 2				Year 3				Year 4			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Consult LCREP Prioritization Framework and CREEC	■															
Construct site maps with LiDAR and T-sheets		■														
Site visit to scope restoration actions and reference conditions		■														
Landowner Contact		■														
Conceptual Project Design (Study design, vision)			■													
Grant Funding - Application (Study design, vision)			■	■												
Review by LCREP SWG (Study design, vision)			■	■												
Review by ERTG (Study design, vision)			■	■												
Assignment of Survival Benefit Units			■	■												
Grant Contracting			■	■												
Outreach		■		■		■		■		■		■		■		■
Acquisition - Appraisal (Study design, vision)		■		■		■		■		■		■		■		■
Acquisition - Due Diligence (Title reports, Phase I)						■		■		■		■		■		■
Purchase and Sale agreement						■		■		■		■		■		■
Acquisition - Closing						■		■		■		■		■		■
Boundary and elevation Surveying (Prescription)						■		■		■		■		■		■
Pre-construction monitoring						■		■		■		■		■		■
Project Design - 30% (Prescription)						■		■		■		■		■		■
Permitting - Regulatory Approval						■		■		■		■		■		■
Final Design						■		■		■		■		■		■
Construction Contracting						■		■		■		■		■		■
Construction (Implementation)						■		■		■		■		■		■
Post-Construction Monitoring and Maintenance (Monitoring of Outcomes)						■		■		■		■		■		■

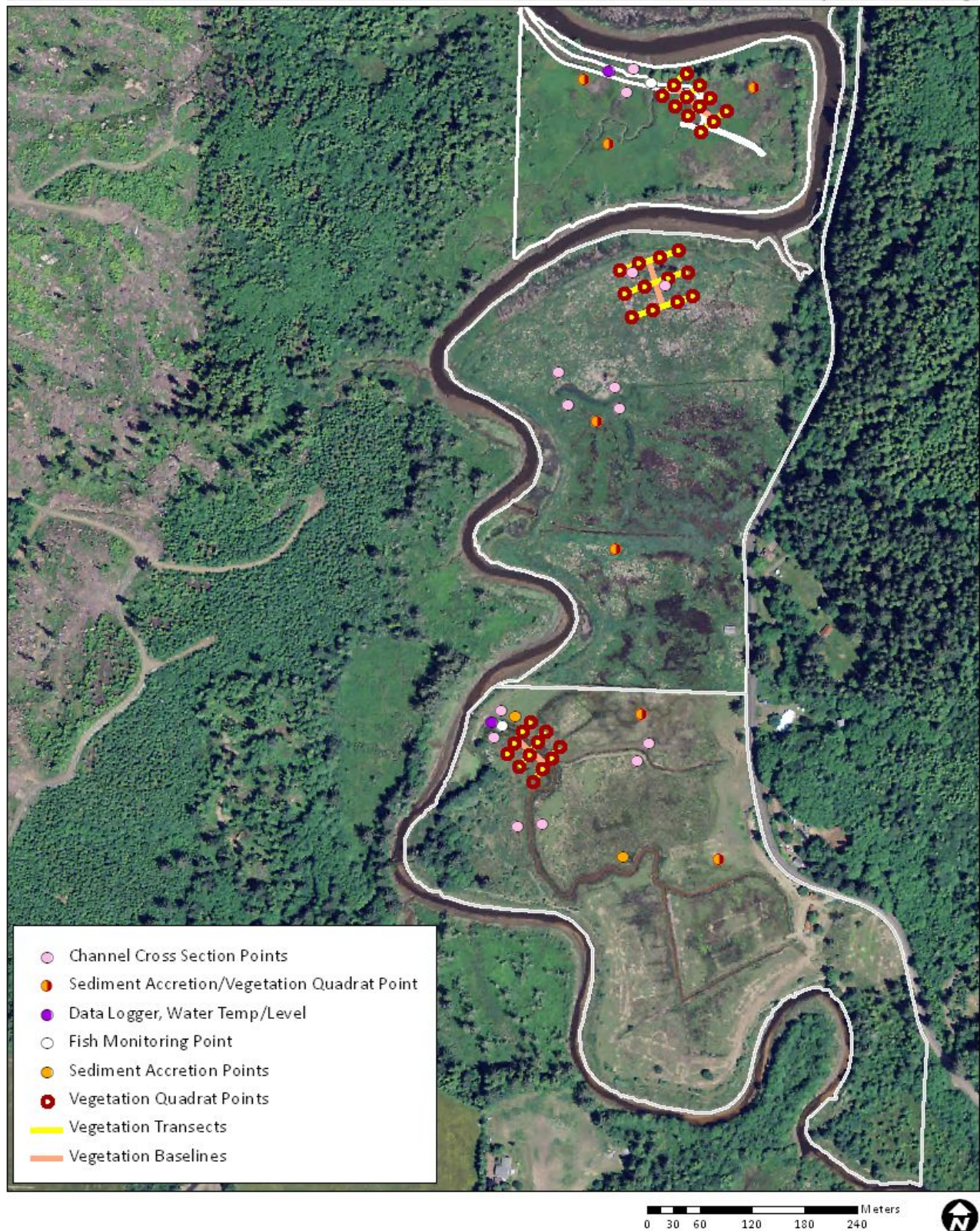
Walluski River

Project Area



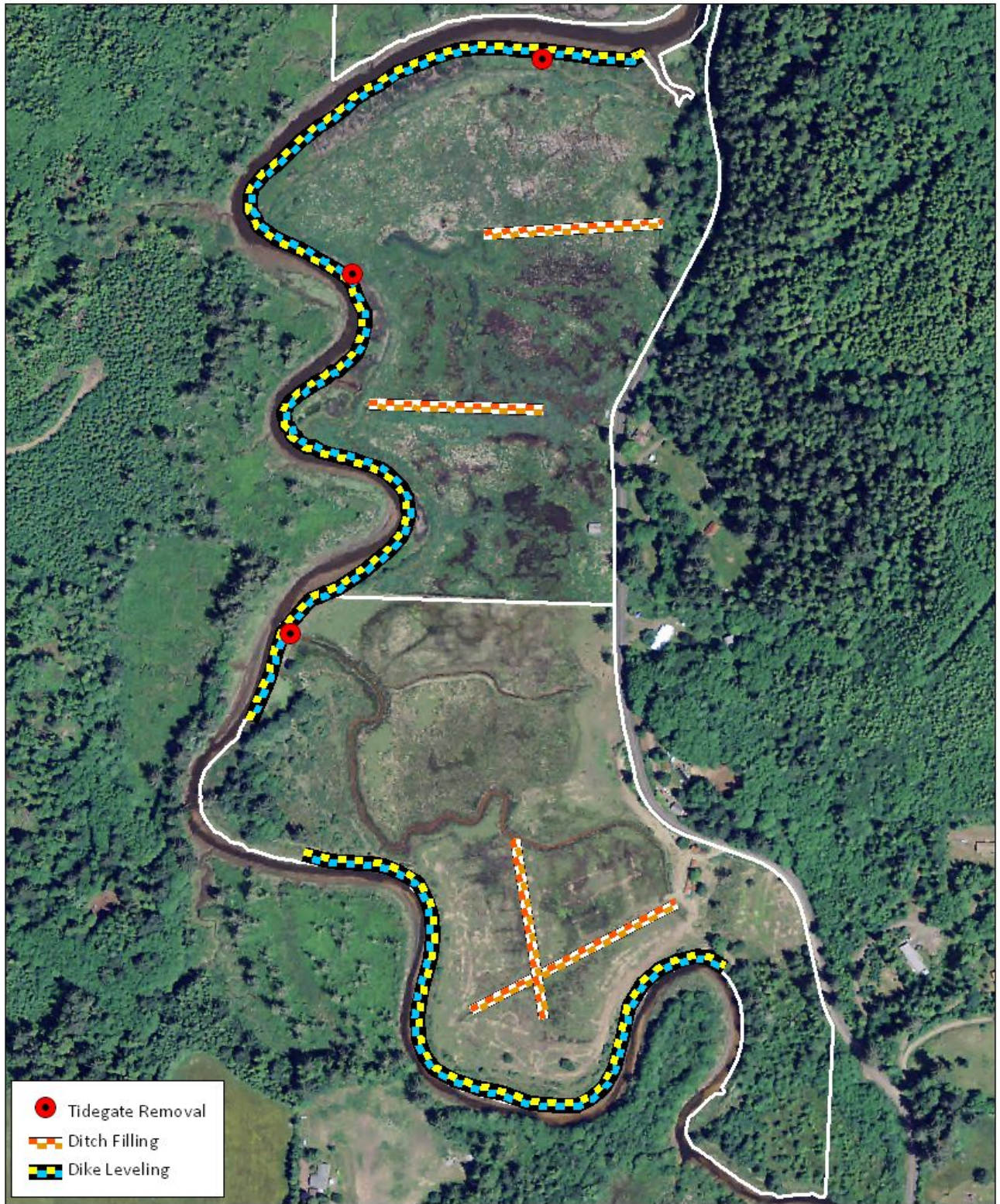
Walluski River

Project Monitoring



Walluski River

Restoration Design



- Tidegate Removal
- ▨ Ditch Filling
- ▨ Dike Leveling

0 25 50 100 150 200 Meters



Work Elements for Task 3

1. **Work Element 100: Construction Management** - Columbia Land Trust project staff will manage construction activities, including contract development and management, coordinating purchasing construction materials, arranging transport to the site, coordinating meetings between contractors and engineers, coordinating contract scheduling, overseeing permit compliance, equipment purchasing, and general oversight.
2. **Work Element 175: Produce Designs and/or Specification** - Columbia Land Trust project management staff will publish an RFP, select an engineering consultant, contract with a consultant, and oversee design and coordination of design plans for restoration projects.
3. **Work Element 30: Realign, Connect and/or Create Channel** - Implementation projects may reconnect, realign, or create channels to increase available rearing or foraging habitat for salmon.
4. **Work Element 47: Plant Vegetation** - Implementation projects will include floodplain or riparian vegetation plantings that benefit the overall ecosystem of the site and improve floodplain, riparian, or instream function.
5. **Work Element 180: Enhance Floodplain/Remove, Modify, Breach Dike** - Implementation projects may include floodplain enhancements such as overflow channel development, excavation to reduce stranding, improved floodplain connectivity, and other elements which increase overall structural, and thus ecosystem, function.
6. **Work Element 181: Create, Restore, and/or Enhance Wetlands** - Implementation projects will include activities which restore or enhance historic wetlands adjacent to or near the mainstem Lower Columbia and Estuary such that they may be utilized by rearing juveniles.
7. **Work Element 165: Produce Environmental Compliance Documentation** - Columbia Land Trust project management staff will complete, submit, and obtain environmental compliance documents with all necessary federal, state, and local agencies, and in compliance with federal laws for each restoration project.

G. MONITORING AND EVALUATION

The monitoring proposed within this project follows the framework described in the Action Effectiveness and Implementation/Compliance monitoring sections of the Research, Monitoring, and Evaluation (RME) for the Federal Columbia River Estuary Program (Johnson 2008). That RME Program describes in detail the monitoring approaches recommended to the action agencies for their restoration work in the estuary. The Program details monitoring approaches related to status and trend, action effectiveness, critical uncertainties research, implementation and compliance monitoring, and synthesis and evaluation.

Projects implemented within this proposal will involve a mix of intensive and extensive action effectiveness monitoring. Inherently a trade-off exists between spatially extensive and locally intensive sampling efforts, as ecosystem restoration monitoring requires spatially extensive sampling to make inferences to broad geographic areas. Resources that might have been used to intensively characterize specific restoration sites are reallocated to provide for greater geographic coverage. The reallocation of effort also may include measuring fewer responses and responses over shorter time periods, such as one or two years post-restoration, when compared with intensively monitored sites.

Intensively studied reference and restoration areas are used to provide guidance about which recovery end points to measure and when. Integrated within extensive estuary-wide monitoring program are intensively sampled areas where sampling protocols are developed and the trajectories of physical and biological responses to restoration mapped. Intensive sites provide a model of the restoration process that can be used to guide the selection of the strategic measurements to be taken at the extensive sites. These intensively monitored reference sites provide the inferential framework to assess the success of restoration from the observations taken over time at the individual restoration projects. The intensively monitored sites will likely be sampled five or more years post-restoration. By developing a restoration program as a proper mix of extensive sites and intensively monitored sites, individual restoration projects may be surveyed with minimal effort while providing maximum opportunities to detect benefits at large spatial scales. The level of intensive or extensive monitoring effort will be determined on a site-specific basis in the context of restoration program needs. Monitoring results from effectiveness monitoring conducted within this program will be shared with others working to restore estuarine habitats.

Approach to Action Effectiveness (AER) Monitoring

The overall purpose of Columbia Land Trust action effectiveness research (AER) is to use quantitative studies to demonstrate how habitat restoration actions affect factors controlling ecosystem structures and processes at site and landscape scales and, in turn, juvenile salmonid performance. This proposal will monitor projects to evaluate the effects of habitat restoration actions in the estuary and address two aspects of the Estuary RME plan:

1. AER 1. Develop a limited number of reference sites for typical habitats, e.g., tidal swamp, marsh, island, and tributary delta, to use in action effectiveness evaluations.
2. AER 2. Evaluate the effects of selected individual habitat restoration actions at project sites relative to reference sites and evaluate post-restoration trajectories based on project-specific goals and objectives.

To restore habitats effectively, researchers and managers require the means to: 1) evaluate the results of individual restoration activities; 2) compare results among projects, and 3) determine the long-term and cumulative effects of habitat restoration on the overall estuary ecosystem. To help achieve this, a standardized set of monitoring protocols were developed. The number of metrics was limited to a “core” set and selected measurement methods that are straightforward and economical to use. By “core,” Roegner et al. (2009) meant an optimum suite of metrics that can adequately detail the results of restoration, depending on the goals of the

restoration action and financial and logistical limitations of comprehensively monitoring ecological change over extended temporal and spatial scales. They selected core metrics based on the following criteria: 1) correspond to commonly held restoration project goals; 2) are applicable to all sites; 3) characterize controlling factors, ecosystem structure, and ecosystem function; 4) are relevant to both present and future investigations; and 5) are practical in terms of level of effort.

The approach to RME for these projects relies on a conceptual ecosystem model for the Columbia River estuary. For the purpose of these projects, the Columbia River Estuary Conceptual Model (Thom et al. 2004) serves to represent the most current thinking as it relates to ecosystem stressors, controlling factors, structures, processes, and functions in the lower Columbia River estuary (Figure 13).

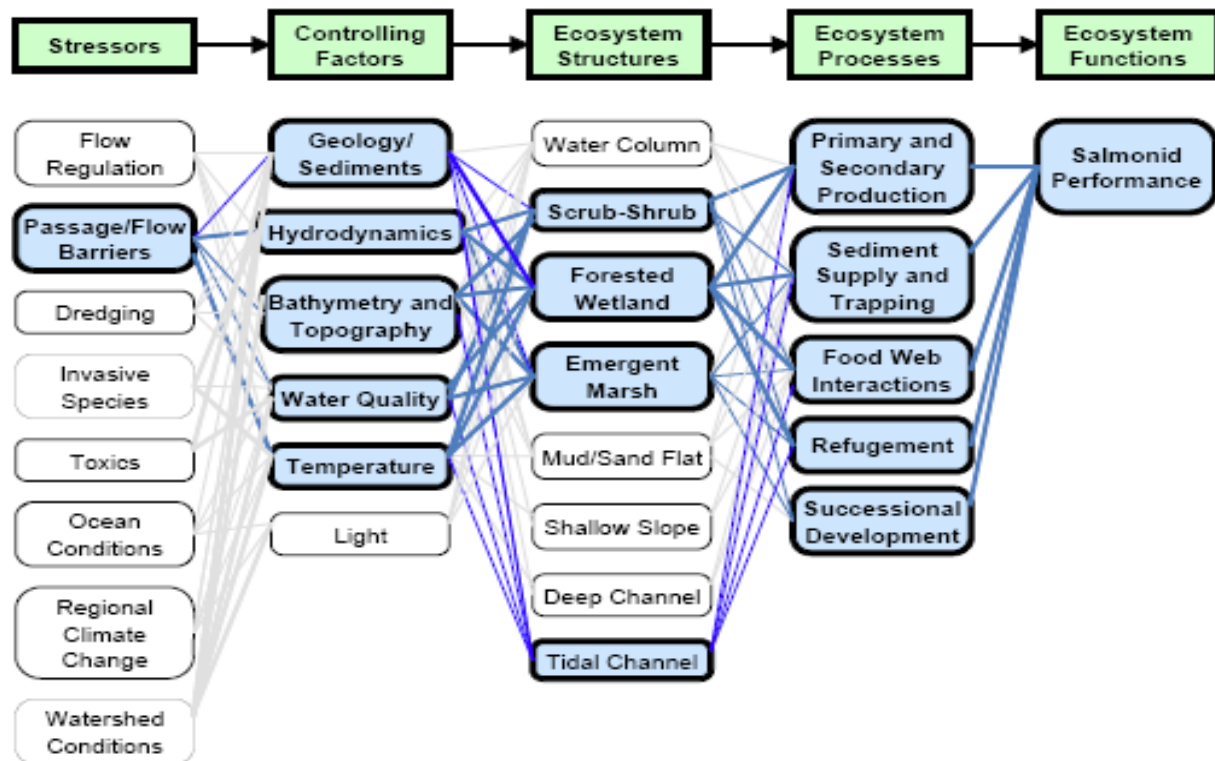


Figure 13. Conceptual ecosystem model highlighting passage barriers as a stressor the effects controlling factors, ecosystems structures, processes and functions (from Johnson et al. 2008).

Monitoring Methods

The goal of Columbia Land Trust's estuarine restoration projects is to restore tidal connectivity and function to floodplain and wetland habitats, and thereby restore habitat opportunity and capacity for juvenile salmon. Columbia Land Trust conducts effectiveness monitoring to evaluate restoration projects' adherence to these goals.

Protocols used in effectiveness monitoring are from "*Monitoring Protocols for Salmon Habitat Restoration Projects in the Lower Columbia River and Estuary*" (Roegner et al. 2009). These protocols were produced as part of the Cumulative Effects (CE) Study funded by the US Army Corps of Engineers through the Anadromous Fish Evaluation Program. The protocols were designed for researchers and managers monitoring the effectiveness of actions to restore degraded wetland habitat in the lower Columbia River and estuary. The intent was to promote a standard set of monitoring protocols to assess and compare habitat restoration projects in the estuary. During the 2011, the final year of the CE Study, the investigators will make recommendations for improvements and

additions to the protocols. It is expected that regional partners, such as CREST, CLT, and LCREP may consider and work to implement these recommendations in a new, updated version of the protocols.

Roegner et al. (2009) summarized the types of restoration strategies being planned and implemented in the estuary. They then proposed a set of metrics and statistical design for restoration monitoring activities based on commonly shared ecological goals. Finally, they provide specific protocols for this set of estuary monitoring metrics. Monitoring protocols are provided for hydrology (water surface elevation); water quality (temperature, salinity); elevation (topography); landscape features (remote sensing); plant community (composition and cover); vegetation plantings (success); and fish community (species, temporal presence, size/age structure).

As noted by Roegner, Diefenderfer et al. (2009), monitoring resource constraints limit the possibility of random sampling. Therefore, our sampling design follows their recommendation to concentrate “...on transects proximal to expected changes...” (p. 13) as the included monitoring design maps indicate. These targeted monitoring plots are supplemented by vegetation and sediment accretion plots stratified across sites. Permanent plot locations are monumented and their locations are gathered using a Trimble GPS unit. Columbia Land Trust uses a combination of data logging instruments, on-site survey and sampling methods, and remote sensing technologies to conduct action effectiveness monitoring. Monitoring is concentrated on transects proximal to expected changes, for example, in a location where a tidegate was removed or a dike breached (Figure 14).

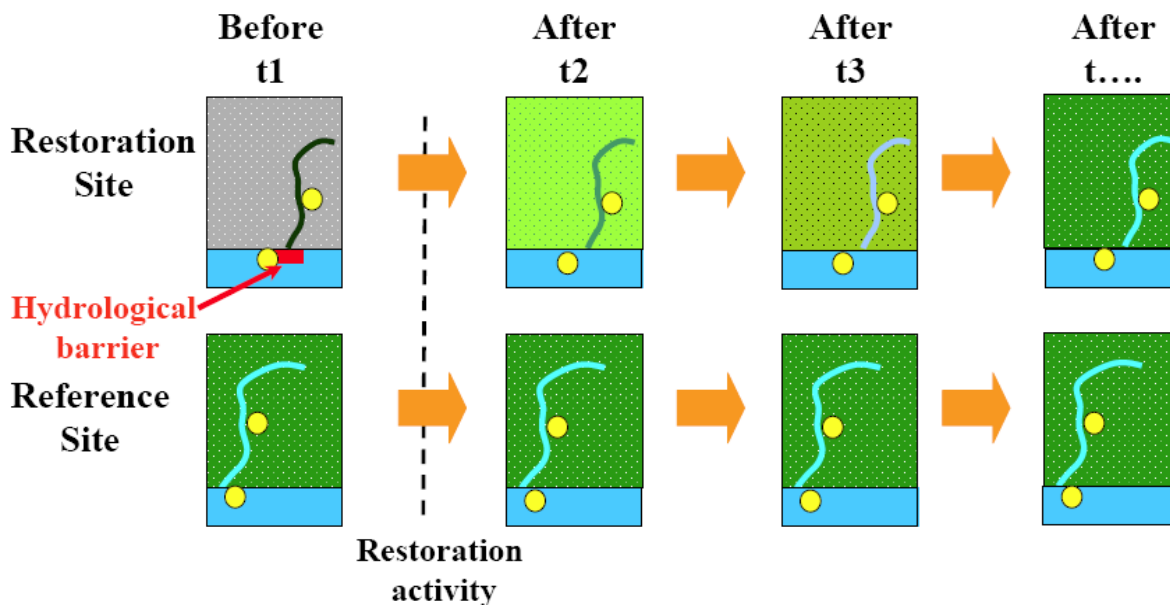


Figure 14.

A before-after-control-impact (BACI) design for this effectiveness monitoring will be used. The procedure for statistical analysis is the paired *t*-test (Sit and Taylor 1998).

The information derived from monitoring is used to evaluate project effectiveness, but ultimately establish future restoration goals and strategies, develop design parameters, predict restoration outcomes in an adaptive context. Columbia Land Trust seeks the input from LCREP’s Science Work Group and the Estuary Review Technical Group as it designs its monitoring approaches. At a minimum, Columbia Land Trust strives to perform one year of pre-project monitoring at both a reference site and the restoration location and two years of post-project monitoring with the following metrics: fish presence, juvenile salmon stock identification (genetics), vegetation changes, landform and hydrology changes, and water quality. The sampling effort for juvenile

salmon will depend on the effectiveness monitoring objectives. If the project is to be intensively monitored then more frequent and widely distributed sampling efforts will occur rather than if the project is extensively monitored. Regardless, we expect high variability in juvenile salmon density estimates because such is the nature of these shallow tidal environments (Sather et al. 2009). Action effectiveness monitoring locations are displayed on the project maps.

Hypotheses

Based on the conceptual model the project objectives and the designated prescriptions, null-hypotheses were developed. (Thom, et. al 1996, Thom et al. 2004, Roegner et al. 2009)

Controlling Factor Hypotheses - Tidal Flow, Salinity, Temperature

Controlling H0 #1: Tidal channel volume will remain constant due to tidal channel reconnection enhancement

Rationale: Hydrology is a main controlling factor of wetland evolution in the CRE, and it influences habitat structure and processes as well as ecological functions (Sanderson et al. 2000, Rice et al. 2005). Measuring water level variation is especially crucial for tidal reconnection restoration projects. Tidal forcing determines such processes as sedimentation and erosion, tidal channel development, inundation periods, and salinity intrusion. While restoration treatments will vary for each of the sites described above, all of the activities share a common thread based on the reestablishment of tidal hydrology. Tidal hydrology is the primary means for the re-establishment of critical pathways for estuarine processes and functions. It allows fish to access the habitat area, causes the bi-directional movement of sediment, and supports vegetation structure and composition. The monitoring of these parameters is critical to understanding the drivers affecting Structural and Functional Hypothesis below.

Suggested Metric: Volume of water over time

Sampling Frequency: Hourly

Method: Protocol #1 – Hydrology

Controlling H0 #2: Salinity intrusion will remain the same after tidal channel enhancement

Rationale: Salinity is a primary driver for both physical and biological processes in the estuary. Unique plant communities thrive under brackish conditions for a spectrum of salinity concentrations. It also affects biochemical reactions in certain soil types and in the water column itself (i.e. flocculation, etc.). Many anadromous species also go through a biological transformation in their lifecycle when they enter the brackish Columbia River estuary on their way to the ocean.

Suggested Metric: Parts/thousand

Sampling Frequency: Hourly

Method: Protocol 2. Water quality

Controlling H0 #3: Temperature will not decrease from tidal reconnection enhancement

Rationale: Temperature is an important limiting factor for many species growth, survival, and reproductive capacity. Increases in stream temperature cause an increase in an organism's metabolic rate. For salmonids growth rates are positive at temperature ranges of 40-66 degrees Fahrenheit. Elevated stream temperature results in increased competition for a limited food supply, potentially displacing juveniles out of their preferred habitat. In addition as stream temperature increases, the amount of dissolved oxygen (DO) available to aquatic biota decreases.

Suggested Metric: Average Temperature; Number of samples ≥ 64 degrees F

Sampling Frequency: Hourly

Method: Protocol 2. Water quality

Structural Factor Hypotheses - Channel Morphology, Vegetation

Structural H0 #4: Channel shape, configuration, and marsh surface elevations will remain unchanged from tidal reconnection enhancement

Rationale: *For Marsh Surface accretion.* Wetlands serve as natural sediment “sinks” due to their inherent topographic position as a deposition area. The vegetation structure interaction with hydrology can also reduce current velocity thereby intercepting suspended sediments. Measuring sediment influx is also an important variable for channel geometry and habitat forming processes. Reconnecting the historic tidal channel increases the level of natural floodplain interaction with the active channel thereby increasing opportunities for sediment in the restored area. Measuring the amount of sediment delivery into reconnected channels helps assess the rate and timing of sediment that is pulsing through a site as well as recovery from subsidence the site may have experienced due to floodplain disconnection. This is an important metric for understanding the long-term trajectory of the restoration work.

Suggested Metric: Transect Area changes, Marsh surface accretion increases/decreases

Sampling Frequency: Annually

Method: Protocol 3. Elevation (topography)

Rationale: *For Channel Evolution Patterns (Morphology).* Tidal channel structure change is a function of tidal velocities, flow patterns, and the source and size of sediment. An understanding of these processes assist in determining the shape, size, and elevation of channels. Surface elevation in turn determines the length and extent of inundation triggering plant community distribution and assemblages such as tidal marsh and swamp habitat types. Restoration actions such as dike removal can be likened to a small, localized disturbance event where energies are suddenly introduced causing an extremely dynamic movement and deposit of sediment. New channel patterns resulting from restoration actions may take years to reach an equilibrium based on sediment size, vegetation, and stream power.

Suggested Metric: Transect Area changes, Marsh surface accretion increases/decreases

Sampling Frequency: Annually

Method: Protocol 3. Elevation (bathymetry)

Structural H0 #5: Vegetation community composition will remain unchanged from tidal reconnection enhancement

Rationale: Plant community composition in the restored areas may change as a result of increased velocities, salinity, introduced sediment, and a more dynamic hydrologic regime. This can change the timing and duration of soil saturation causing some plant species to die off triggering opportunities for other (i.e. hydrophytic) species adapted to brackish, wetted conditions to propagate. In addition, any salinity intrusion could cause fatalities of salt-intolerant species.

Suggested Metric: Dominance Diversity for each Community

Sampling Frequency: Annually

Method: Protocol 5. Plant species composition and cover

Functional H0 #6: No difference in salmonid use or benefits among wetland types

Rationale: Tidal marsh and swamp habitat types are considered important to rearing of juvenile salmon and represent an integral component of the continuum of habitats that salmon occupy for significant periods of time. Changes in the environment and the loss or degradation of habitat have contributed to decreased runs of native fish. Estuaries contain food sources to support the rapid growth of salmon smolts, but adequate natural habitat must exist to support the detritus-based food web. It is generally acknowledged that documenting “realized function” (Simenstad and Cordell 2000) is difficult because of the migratory nature of salmonids, while determining habitat capacity and opportunity are less problematic (Tanner et al. 2002). For minimum effectiveness monitoring, fish sampling should permit the evaluation of changes in community structure in restored locations compared with before-treatment and reference areas.

Suggested Metric: temporal presence, size/age structure, species

Sampling Frequency: Minimum sampling frequency should be one day per month from March through October. More frequent monitoring is optimal, but project budgets rarely allow increased frequency.

Method: Protocol 7. Fish Community

Reference Sites

Reference site/conditions are characterized for all Columbia Land Trust restoration projects. Reference sites in this proposal represent the state of a tidal wetland (marsh, scrub-shrub, and swamp) environment relatively undisturbed by human activity. The reference sites are spatially situated near restoration sites and subjected to similar climatic and environmental (mainly hydrologic) conditions, but independent of activities affecting the restoration site. It is understood by restoration practitioners in the estuary that choosing an appropriate reference site in some highly modified regions presents challenges. In the case of hydrological reconnection of floodplain areas to the mainstem Columbia, a typical reference site would be a tidal wetland, while a typical control site would be a diked pasture. Conditions at the tidal reconnection restoration sites are to be assessed with respect to the trajectory of their development against the target states represented by the reference site. The reference location has been depicted on the restoration area map.

As part of project 2003–11–00 a network of reference sites in tidal marshes, swamps and other estuarine habitats with relatively undisturbed ecosystem structures and processes is being described. These regional reference sites are being monitored to provide a range of target conditions for restoration activities. This effort is in the process of quantifying conditions necessary for wetland plant communities and tidal channel networks to develop. This information is important to designing and evaluating the effectiveness of restoration projects and is presently lacking for the Columbia estuary. This study is providing baseline characterization to address uncertainties regarding the elevation, soil, and inundation ranges required by native tidal wetland vegetation.

This network of reference sites is intended to provide restoration implementers a means for statistically analyzing and comparing projects along a temporal restoration trajectory (see Secret River example in Section D). This study is using standard monitoring protocols (Roegner et al. 2008) to assess vegetation composition and percent cover, water surface elevation, elevation, channel morphology, substrate characteristics, and accretion rates. These monitoring protocols represent the same suite that is used in Columbia Land Trust's effectiveness monitoring.

As part of project EST-P-04-04, researchers are investigating naturally breached diked wetlands. Over the previous fifty years, some dikes have breached naturally due to flooding and storm damage. Most of these accidental breaches have since been repaired, but in a number of cases have remained open to tidal flux and provide researchers an opportunity to observe conditions over a longer arc of time. If the date of breaching can be approximated and the natural habitat forming processes described, the estimated time since "restoration" can be placed in context with other restoration projects for comparison along an ecological trajectory. The natural breach sites chosen with EST-P-04-04 for evaluation in 2008 were Karlson Island, Lewis and Clark River Bend, and Trestle Bay. Miller Sands, Goat Island, and Haven Island were monitored in 2009.

Regional Coordination

Columbia Land Trust's monitoring efforts and the work of others contribute to regional efforts to establish a Columbia River estuary RME and adaptive management framework. Implementation of monitoring efforts provides the means for informed land management by Columbia Land Trust, as well as communication with neighbors and local communities regarding the results of this work. To help maintain consistent, valid data, a database and GIS has been tailored for Columbia Land Trust's monitoring needs, largely guided by Roegner, Diefenderfer et al. (2009) monitoring protocols.

Effort are presently underway within projects 2003-007-00, 2003-11-00 and EST-P-02-04 to compile and analyze a compatible time-series database of physical and biological metrics collected from many individual restoration projects, habitat monitoring locations and reference sites. It is the intent of this database to enable the evaluation of the effectiveness of individual restoration projects, as well as the cumulative effects of many restoration projects, on improving salmon habitat in the CRE. The Estuary Partnership is working to build a data center to house results from status and trends monitoring and action effectiveness research (<http://maps.lcrep.org/>). This data center includes a central, web-accessible repository for estuary data, and a publicly accessible homepage with links to a networked system of databases. The intent is to link this system to basin-wide RM&E data to facilitate basin-wide evaluations. When this framework is in place all effectiveness and reference monitoring the Columbia Land Trust or its contractors collect will be submitted in the appropriate format to the appropriate database managers.

Data specifications for estuary RM&E are being currently being developed through BPA's Taurus system to support a coordinated data management system. Adaptive management for restoration, monitoring and research in the estuary is facilitated through a biennial estuary conference convened to evaluate estuary RM&E efforts, exchange information, and provide input to managers.

1. **Work Element 157: Collect/Generate/Validate Field and Lab Data** - Columbia Land Trust biological staff and partners will collect pre- and post- project raw data on the restoration projects.
2. **Work Element 162: Analyze/Interpret Data** - Columbia Land Trust biological staff and monitoring partners will develop hypotheses prior to conducting work, test hypotheses during work, analyze data, and compile and publish data.
3. **Work Element 159: Transfer/Consolidate Regionally Standardized Data** - Columbia Land Trust biological staff will transfer data from field to office computers and upload to regional data distribution networks.

H. FACILITIES AND EQUIPMENT

The Columbia Land Trust has worked on estuary habitat protection and restoration for over ten years. Columbia Land Trust staff maintains three fully equipped offices: a main office in Vancouver, Washington and field offices in Astoria, Oregon and Hood River, Oregon. All offices are outfitted with state of the art technology including high speed internet, network computers and printers, office space for staff members, and the capacity to facilitate meetings. The Columbia Land Trust also maintains one truck and two boats used in monitoring and fieldwork. A wide variety of sampling gear is available to the Land Trust, including water quality monitoring equipment, depth loggers, field gear and other tools and supplies necessary to implement the work included in this proposal.

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J. KEY PERSONNEL

IAN SINKS

Stewardship Manager, Columbia Land Trust, August 2000 – Present

- Oversees stewardship program responsible for protecting the conservation values on over 7,000 acres of land. Responsibilities include program and budget development, staff hiring and management, coordination with project partners and contractors, conservation project development, site stewardship and monitoring plan development, implementation of stewardship activities and community outreach.
- Hired as the first professional stewardship staff for the Land Trust. Developed program approach and tools for the program, and has worked with staff and board to build the capacity of the program to become one of the most successful in the Pacific Northwest.
- Coordinated restoration work for conservation properties including wetland restoration on over 600 acres of diked tideland, riparian restoration on several miles of river, and oak woodland restoration on the Land Trust's 2,500-acre Klickitat River preserve. Restoration work included the development of comprehensive project effectiveness monitoring plan as part of an adaptive management approach to land stewardship.
- Facilitated GIS-based conservation planning process for the land trust service region covering over 200 miles of the Columbia River. This process builds upon previous efforts to define conservation priorities for the land trust.
- Prepared and was awarded over \$10 million in grant funding from public and private grant sources for habitat protection and restoration projects.
- Presented at Regional and National Land Trust Alliance annual rally events on issues related to conservation planning and stewardship.
- Participates on the LCREP Science Work Group and has presented on estuary restoration work in a variety of venues.

The JD White Company, Inc. - Natural Resource Manager/Senior Ecologist April 1996 – August 2000

- Natural Resource team manager and principle member of company management staff for a 25-person land use planning, public involvement and environmental consulting firm. Directly responsible for staff hiring, workload management, budget development, business development and strategic planning.
- Responsible for preparation and review of technical studies and documentation for environmental projects including biological assessments, habitat surveys, SEPA and NEPA analysis, resource planning assessments, resource protection plans, wetland evaluations and habitat mitigation projects.
- Project manager for biological assessment studies to evaluate potential project effects on listed species for Endangered Species Act compliance. Studies included the evaluation of over 35 species of fish, wildlife and plants. Responsible for scientific literature research, designing and implementing appropriate survey and assessment protocols, preparation of technical documents, coordination with resource agencies and clients, and defending findings before public and agency members.
- Lead biologist and project manager for numerous wetland habitat studies and mitigation projects including wetland creation/enhancement projects. Project work included mitigation planning, grading and planting designs, analysis of site hydrology, preparation of permit applications, constructions specifications, habitat construction and post-construction monitoring.
- Strong understanding of environmental regulations including ESA, Section 404, NEPA and SEPA, state and local land use regulations, and state water rights.
- Responsible for representing firm and clients, and providing expert testimony, for project interviews, public and judicial hearings, and before regulatory agencies.

U.S. Peace Corps - Parks and Wildlife Officer/Volunteer July 1993 – October 1995

- Established Extension Unit for the northern region of the country under the Department of National Parks and Wildlife (DNPW).
- Developed sustainable resource utilization programs for two protected areas (Vwaza Marsh Wildlife Reserve and Nyika National Park) covering over 4,000 square kilometers.
- Completed public needs assessment and resource abundance surveys. Public surveys evaluated resource requirements, crop protection issues, traditional leadership roles and management practices of the DNPW.
- Responsible for facilitating DNPW interactions with local communities located around protected areas. Worked to resolve antagonistic relations resulting from historical management practices and events. Through this facilitation effort, the DNPW was able to form new relationships and partnerships with local communities and traditional leaders.
- Implemented Participatory Rural Appraisal techniques to establish better understanding of protected areas management issues with local communities.
- Served as a principal resource person on a multidisciplinary team for an \$8 million donor funded project to increase resource management capability of the department. Participated in issues analysis and strategic planning for the northern region DNPW units as part of the project.
- Prepared grant applications for funding of small-scale resource projects. Projects included a community operated maize mill and a small game raising operation.
- Facilitated negotiations with local leaders and DNPW staff to realign park boundary and game management fences.
- Developed and implemented technical program for pre-service training of parks and wildlife volunteers.

Otak, Inc. – Biologist March 1992 – May 1993

- Served as primary biologist conducting wetland delineation, resource surveys, habitat assessments and wetland mitigation plans. Prepared technical documentation for project permit applications and land use reviews.
- Coordinated multidisciplinary teams to prepare project plans including civil and structural engineers, landscape architects, land use planners, hydrologists and geotechnical engineers.

OMNI Environmental Service - Environmental Specialist II/Biologist September 1990 – March 1991

- Assisted in a variety of technical studies including wetland assessments, air quality evaluations and hazardous materials assessments.
- Served as field crew leader for completing studies and data collection. Responsible for a crew of four technicians.
- Responsible for establishing test protocols, field methodologies, budget development and monitoring, literature research and preparation of technical reports.

EDUCATION

- Lewis and Clark College 1990
B.S. Biology
- Certificate in Watershed Management (graduate level), 1998. Portland State University, Portland, OR
- Continuing education in ecology, conservation biology, protected areas stewardship, wetland and riparian restoration, environmental regulations.
- U.S. Peace Corps Pre-Service and In-Service training in cross-cultural, language and technical skills (protected areas management, resource conservation, wildlife ecology)

DAN FRIESZ

Stewardship Lead, Columbia Land Trust, February 2010 - Present

Oversees the development, design and implementation of estuary and other restoration projects.

Washington Department of Natural Resources - Fish and Wildlife Biologist 3 June 2007 – January 2010

- Provided timely consultation, analysis, and review of timber harvests and other forest related activities by ensuring that all proposed and implemented activities were consistent with the Region's Habitat Conservation Plan (HCP), Policy for Sustainable Forests, Forestry Handbook, and Forest Practice Rules.
- Created variance/exception recommendations and other supporting documents regarding proposed state land activities that disseminated that all best management practices were consistent with the appropriate policies and procedures recognized by the agency.
- Participated, trained, and mentored field staff to identify, protect, and enhance unique forested habitat types and features such as forested and non-forested wetlands, riparian areas, balds, old growth, species diversity, high wildlife use areas, cliffs, caves, and talus fields. In addition, assisted field staff in creating snags, down woody debris, and in-stream woody debris on a site-by-site basis.
- Actively participated in all pre-sale activities, desired prescriptions, and other forested related activities within the Nesting, Roosting, Foraging, and Dispersal Habitats of the northern spotted owl.
- Assisted engineers and foresters with stream assessments that evaluated for the presence/absence of anadromous or local fish populations, determined appropriate stream typing, analyzed the current status of fish blockages (RMAP), and electrofished particular streams if compliant with federal and state permits.
- Established working relationships with other state, federal, and local agencies, private user groups, and DNR employees in an attempt to fulfill the commitments of the agency by establishing a trustworthy relationship dedicated towards achieving ethical and biological sound stewardship of the state trust lands.
- Assisted with screening, identifying, and protecting cultural resources on all state land proposals in cooperation with local tribes and the Department of Archaeology and Historic Preservation

Ducks Unlimited, Inc. – Regional Biologist December 2005 – June 2007

- Responsible for delivering DU wetland conservation projects throughout SW and western Washington.
- Project coordination, management, and budgeting for over 50 active projects, public and private fundraising, and grant writing.
- Applied for state, local, and federal permits, completed and reviewed SEPA checklists and Biological Assessments, and coordinated with the United States Fish and Wildlife Service regarding the National Historic Preservation Act.
- Developed habitat management plans, agreements, and recommendations for various habitat restoration projects.
- Maintained, developed, and created working relationships with private landowners and other government entities.

Washington Department of Natural Resources-Forester 1 May 2004-November 2005

- Performed pre-sales, reconnaissance, and layout activities of lump sum and thinning timber sales that benefitted state trust beneficiaries. Requested and consulted with resource specialists and managed

forested habitats through the guidance of the State Environmental Policy Act, Forest Practice Applications, and Habitat Conservation Plan.

- Performed contract compliance administration inspections on active timbers sales and road building and abandonment activities. Provided silvicultural plans and prescriptions to maximize reforestation.
- Assisted with biological plans and provided recommendations in the placement of leave tree areas, riparian management zones, and other sensitive habitats. Assisted in the design and enhancement of Nesting, Roosting, Foraging, and Dispersal Habitat management areas for the northern spotted owl.
- Attended and conducted public meetings, completed and reviewed State Environmental Policy Checklists and Forest Practice Applications, created maps, reports, and recommendations through the use ArcGis-ArcMap, PowerPoint, Excel, and Microsoft Word.
- Efficient in the operation of GPS equipment (Garmin, Tremble-TSE 1, and Tremble Recon) and downloading data into ArcGis to create data layers, reports, and maps.

United States Fish and Wildlife Service-Ridgefield National Wildlife Refuge

(1996-2000-Biological Technician, 2000-May 2004-Assistant Wildlife Biologist)

- Responsible for co-designing, surveying, engineering, implementing, and supervising up to seven staff employees and five contracting representatives for over \$300,000 of construction contracts dealing with on-the-ground activities of wetland restoration projects that involve levee restoration, dike removals, swale development, wetland basin disking, and water control structure installation that has benefited over 1700 acres of critical habitat.
- Developed Partners for Fish and Wildlife private landowner management plans and agreements, requirement contractor construction contracts, and cooperative farming agreements. Completed federal, state, and local permits, developed annual and long- range pasture and wetland management guidelines and plans, and formulated various wildlife monitoring and management plans.
- Provided written and verbal recommendations for wetland, pasture, and invasive species management activities, monitored wetland and pasture conditions, assisted private landowners in land base management activities and permitting process, attended and coordinated public meetings, and coordinated with other federal, state, and local agencies regarding biological and managerial activities.
- Created purchase orders, acquisition requests, and work orders in coordination with accounting and budgetary staff employees. Developed and maintained property inventory databases and completed federal, state, and local grant applications.
- Conducted aerial and ground surveys for wintering waterfowl and nesting sandhill cranes, performed point-count bird surveys, monitored various amphibian populations and state endangered species, mist-netted and banded various bird species, collected data on neck and tarsus banded geese, swans, and sandhill cranes, operated hunter check station, and operated telemetry and remote water temperate devices.
- Performed pasture, crop, and wetland vegetation surveys, operated farm machinery and implements to plant, spray, and disk pastures and wetlands.
- Efficient in data entry and analysis through Excel, Statview, Rbase, GPS, and ArcView and efficient with other computer programs such as WordPerfect, Microsoft Word, and PowerPoint.

EDUCATION

Washington State University, Pullman, WA, August 1990 to May 1995. Bachelor of Science degrees in Natural Resource Management and Natural Resource Biology; minor in Range Management (Cum Laude).

NADIA GARDNER**Coast & Estuary Conservation Lead, Columbia Land Trust, October 2007 - Present**

- Serve as the principal staff for conservation projects (acquisition & stewardship) in the *Coast & Estuary* area.
- Assess potential projects for conservation and restoration value and develop priority projects.
- Co-manage salmon restoration projects, including dike breaches, large wood placement, and plantings.
- Develop, write and manage grants for acquisition and restoration projects.

Lower Nehalem Community Trust - Trust Manager April 2006 - 2007

- Acted a lead staff person, managing a budget of \$100,000, staff and contractors, and over 100 volunteers.
- Staffed Board, Land Protection, Fundraising, and Land Stewardship Committees.
- Wrote management plans and developed implementation and funding strategies for conservation properties.
- Developed land acquisition protocol, met with landowners, and coordinated acquisitions.
- Helped to develop organizational and project budgets. Performed accounting and produced budget reports.
- Identified, wrote and managed grants (including OWEB, NAWCA, WRP). Produced funder reports.
- Produced monthly email bulletins, biannual newsletters, and an annual report. Gave community presentations.
- Coordinated volunteer work parties, community/fundraising events, educational workshops, and field trips.

Master of Environmental Science and Management June 2006

Donald Bren School of Environmental Science & Management, University of California, Santa Barbara

Specialization: Political Economy of the Environment

Honors: 2005 Association of Environmental Professionals Fellowship, 2004 Donald Bren Fellowship

Group Thesis Project: *Marine Protected Areas Along California's Central Coast: A Multi-Criteria Analysis of Network Design.*

Bachelor of Arts in Women's Studies, Wesleyan University, Middletown, CT - June 1997

Specialization: Gender, Science & Technology

Study Abroad: International Honors Program: Global Ecology, Bard College (9/95 – 5/96)

Studied environmental impacts of development patterns and more sustainable alternatives in England, India, The Philippines, New Zealand and Mexico.

DAN ROIX**Conservation Lead, Columbia Land Trust, February 2008 - Present**

- Serve as the principal staff for acquisition projects in the *Mid-River (River Mile 60 - 120)* area.
- Assess potential projects for conservation and restoration value and develop priority projects.
- Develop, write and manage grants for acquisition and restoration projects
- Assist stewardship staff with monitoring, issue resolution, and restoration projects
- Manage Columbia Land Trust's *Urban Initiative*

Sierra Foothills Conservancy - Associate Director June 2006 – March 2008

- Responsible for conservation projects in Mariposa County including property
- identification, landowner negotiations, funding acquisition, baseline documentation and
- completion of transactions

- Assist Executive Director on conservation projects in Madera and Fresno counties
- Coordinate planning and budgeting processes for organization
- Coordinate monitoring visits for over 5,000 acres of protected lands
- Work with board and staff on fundraising and membership development projects

Great Valley Center - Program Associate October 2002 – June 2005

- Worked closely with consultants, government agencies and project managers on a variety of projects
- Coordinated grant and project activities for New Valley Connexions, including policy research, report writing and publishing of 10 reports and development and outreach for over 60 public meetings and workshops
- Assist other staff, especially Renewable Energy Program, on grant research, writing, and Administration
- Manage program website, email lists, and database

EDUCATION

Columbia University May 2000

School of Engineering and Applied Science

B.S. Computer Engineering