

**DEEPWATER SLOUGH RESTORATION PROJECT
MONITORING PLAN**

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Prepared for: Deepwater Slough Restoration Monitoring Team

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Introduction

Purpose

This plan presents all tasks required to adequately monitor the success of the Deepwater Slough Restoration Project. The plan is based on a conceptual model linking watershed processes to habitat conditions and functions, and biological responses to those functions. Thom and Wellman (1996) suggest using such an ecosystem model to identify linkages between controlling factors, structure and function when developing a restoration monitoring program. We use the general watershed model developed by the Skagit Watershed Council (1998) to link controls, processes, and habitat conditions and then focus the model on our project area.

We link the restoration of disrupted watershed processes to the restoration of habitat conditions, and then to ensuing biological responses. We describe processes and conditions as they historically existed and currently exist at the Deepwater Slough Restoration Project site. We develop a restoration goal and objectives, and describe restoration actions with which we hope to meet them. Finally, we monitor restored processes, habitat conditions, and biological responses in order to determine the success of the project and to recommend adaptive management measures.

The Watershed Model

Within any watershed or river reach, habitat conditions are created and maintained via landscape processes that vary spatially and temporally and fixed controlling factors that do not vary (Naiman et al 1992, Reeves et al 1995, and Beechie 1998). These controlling factors and variable processes act upon the watershed to create and maintain a dynamic mosaic of different habitat conditions.

Watershed size, topography, geology, and climate are controlling factors that dictate the gross morphology of the river network. Processes important in creating and maintaining riparian habitat conditions and functions include river hydrology, sediment supply, vegetation community composition (stand type and age for forested areas), animal activity (i.e., beavers), and large woody debris recruitment. In lower river reaches subject to tidal influence, tidal hydrology is an important process. All processes may be and usually are altered by land use and other human activities.

Processes in turn create and maintain the mosaic of habitat conditions and functions. Habitat conditions include open water habitat areas such as beaver ponds, tidal channel complexes, side channels, and the river channel. Channel features such as LWD accumulations, pools, and gravel substrates, as well as specific riparian vegetation communities and wetland habitats are all varied habitat conditions that result from some combination of processes. Functions that occur within these habitats include food web pathways, detritus production and export, water temperature maintenance, and fish passage.

The Deepwater Slough Restoration Project Site

The Deepwater Slough Restoration Project site is located in northwest Washington State, in Skagit County on the lower Skagit River. The project site is located on the South Fork of the Skagit River, just downstream and south of the town of Conway where the South Fork bifurcates into Freshwater and Steamboat Sloughs as it drains to Skagit Bay (Figure 1). The area totals approximately 673 acres and consists of two separate sections. The Deepwater Slough section is located between Freshwater and Steamboat Sloughs and consists of approximately 450 diked acres of a 1421 acre island bounded by the above sloughs on the west and east and by other lesser sloughs on the southwest. Milltown Island, the other section, is located to the east across Steamboat Slough and consists mostly of diked island bounded by Steamboat Slough to the west and Tom Moore Slough to the east. The project area was diked and hydrologically disconnected from the Skagit River as well as Skagit Bay tides via a series of diking projects beginning in the late 1800's. One of these diking projects was the US Army Corps of Engineers Skagit River Project in 1911. The Washington Department of Fish and Wildlife (WDFW) obtained these lands in the late 1940's and early 1950's. The two sections of the project site, plus additional properties totaling approximately 14,000 acres, are managed by WDFW as the Skagit Wildlife Area. The site has been managed primarily for waterfowl. Some of the diked fields are currently planted with barley and seasonally flooded to provide waterfowl forage and habitat.

The restoration project seeks to restore natural hydrologic processes and ecosystem function to approximately 204 acres of the Deepwater Slough section and all of Milltown Island by breaching some existing dikes and building some new ones (at the Deepwater Slough section only) to enclose a smaller portion of the island. Waterfowl management activities will thus be maintained within the diked area.

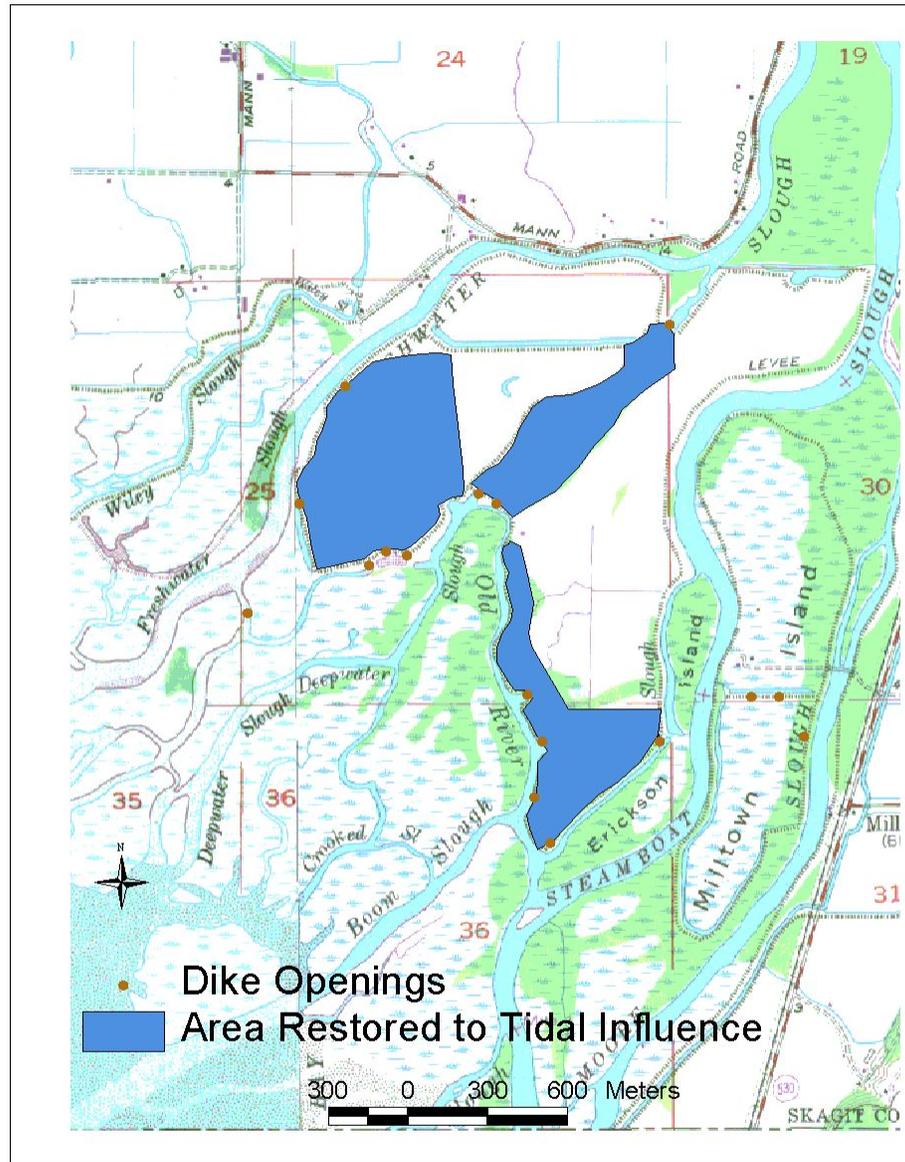


Figure 1. Project site map. Blue shading indicates currently isolated area restored to tidal influence. Dots indicate approximate location of dike openings; no new dike construction is shown.

Key Processes at the Project Site

Introduction

Dikes have isolated the project area from the influence of the river and tides, thus altering natural riverine and tidal hydrology in the project area. Diking has also interrupted the process of sediment transport and storage. These processes are crucial in the formation and maintenance of a number of habitat conditions.

Tidal Hydrology

Tidal hydrology has been altered dramatically at the project site. The Deepwater Slough Project Area is located low in the river system, within the delta of the South Fork of the Skagit River. In this lower river area, tidal hydrology is a very important process that shapes habitat conditions. Tidal energy creates extensive blind channel networks. In the lowest parts of the project area, water salinity, influenced by tidal hydrology, may impact plant community composition and tilt it towards emergent salt tolerant vegetation.

Diking has isolated the project area from tidal influence, altering natural tidal hydrology and the conditions depending upon it. While tidal hydrology functions naturally near the project area (i.e., outside of the dikes), dikes completely prevent natural diurnal tidal inundation within their confines. Tides also were the primary force that created and maintained extensive blind tidal channel networks which are no longer maintained within the project area. These networks are present in adjacent undiked areas. Water quality has also been altered at the project site; among other changes, open water areas within are not subject to free exchange with the river and tides. This may have, for example, seasonally increased water temperatures and reduced dissolved oxygen levels.

River Hydrology

River hydrology functions somewhat naturally throughout the Skagit River Basin, although flows have been altered by flow control through the installation of hydroelectric dams and river hydromodification. However, dikes currently surround the project area, have eliminated Deepwater Slough as an active river channel, and have isolated the remainder of the project area from riverine influence.

Sediment Supply

The amount and rate of sediment supplied to the project area vicinity by river flows has been altered upstream of the project site by hydromodification, removal of the large log jam that was located upriver at Mt. Vernon in the late 1800's, diking, and land use. Within the project area, sediment is not currently imported or exported due to isolation by diking.

Conditions and Biological Responses at the Project Site

Open Water Habitats:

Currently, the site is isolated from the river and tides by a diking system. . The main Deepwater Slough channel is disconnected from the river. Distributary and subsidiary tidal channel networks which formerly were connected to the main channel, as well as other non-mainstem open water, estuarine, palustrine, and riverine habitats are reduced in extent, altered, or obliterated.

Vegetation Communities and Wetland Habitats:

Vegetation and non-open water wetland habitats have been significantly altered from historical conditions. The project area is located in a transition zone between forested riverine tidal and estuarine emergent habitats. All of the project area has been diked. Parts of this isolated area are actively farmed, with cereal grains planted annually. Much of the natural forest, shrub, and herbaceous vegetation has been eliminated. Large, formerly forested areas and other habitats have been replaced with seasonally planted cereal grain cropland that includes weedy and invasive wetland and upland species. These farmed portions are also seasonally flooded via a series of water control structures in order to attract waterfowl. Some areas retain emergent and shrub-scrub wetland conditions, although they are cut off from tidal influence and isolated from use by many native aquatic biota. Forests exist on dike berms and other high areas.

Biological Responses- Fish and Wildlife Use:

All native anadromous fish and most native resident fish that would be expected to use the project site are currently eliminated from the area. Some exotic warmwater species inhabit isolated ponds on the site.

Wildlife use of the site is extensive, although historical species and use is unclear. The site is intensively managed for waterfowl (e.g., cereal grain is produced and seasonally flooded to attract and feed wintering waterfowl) and is used by shorebirds, passerine birds and raptors as well.

Mammal use of the site is extensive, primarily by small mammals but also by larger ones, such as coyote and black tailed deer. However, it is likely that the tidal conditions that existed prior to diking in the project area did not meet small mammal habitat requirements, and therefore use of the area was limited. Current mammal distribution and species composition within the project area is unknown (Thompson et al, 1999). Reptiles and amphibians using the site include garter snakes, rough-skinned newts, and Pacific tree frogs. Non-native bullfrogs are present at the site. Insect and aquatic invertebrate use of the site is unknown; certain aquatic insects and invertebrates have likely been eliminated, while other may have increased.

Project Goal, Objective and Actions:

In keeping with the dynamic nature of river systems, restoration must allow for spatial and temporal variability in habitat conditions appropriate to site-specific natural potential (Beechie, 1998). Sustainable restoration should focus on habitat-forming *processes* rather than on engineered solutions that build specific, designed habitat conditions.

Project Goal:

The goal of the Deepwater Slough Restoration Project is to restore natural processes, functions, conditions and biological responses within a portion of the project area (204 acres of the Deepwater Slough section and all of Milltown Island). Specifically, the project seeks to restore the natural processes and conditions of the area that were disrupted by diking, eliminating the processes of river and tidal hydrology and sediment supply. Secondly, processes are disrupted via elimination of natural vegetation communities by farming. The project seeks to restore natural processes (and ensuing functions, habitat conditions, and biological responses) by removing dikes to restore river and tidal influence and inundation to the restored part of the project area. The project also will eliminate farming in the small part of the currently farmed area to be restored. The remaining farmed area will remain largely unchanged, as it is to be protected by new dikes and is outside of the restored area.

The project goal is rather broad because there is a wide range of acceptable post-construction conditions, provided that natural processes are restored to the restored area. For example, a range of vegetation community composition is expected, and the composition is expected to change over time for many years after project completion.

Restoration Actions:

Restoration actions to accomplish the above will include:

- Removing and breaching dikes in order to restore the connection between the project area, the Skagit River, and Skagit Bay tides.
- Eliminating farming in a part of the currently farmed area..
- In order to allow for continuation of waterfowl management activities in the remaining farmed area, the project also includes construction of some new dikes and reinforcement of certain existing dikes.

Project Objectives:

Some specific restoration project objectives for the restored area can be identified. We hypothesize that, by taking the above actions, the following six project objectives will be met:

- Restore natural tidal and riverine hydrology
- Restore native vegetation species and communities
- Restore tidal channel networks
- Restore anadromous fish access and use to the project area
- Restore detrital import and export and food web support
- Restore other functions supporting anadromous fish
- Continue waterfowl management activities in portions of the area which remain isolated behind dikes.

Monitoring Objective:

We will monitor specific watershed/delta processes, functions/conditions, and biological responses, based on the project goal and more specifically on the restoration actions and the six hypothesized restoration objectives. Two general monitoring objectives, operating at different scales within our "watershed model", will measure the performance of the restoration project relative to project goals and objectives, as recommended by Thom and Wellman (1996):

- To determine whether the restoration actions allow landscape processes to form and maintain habitat conditions and functions supporting natural biota (process level);
- To monitor conditions functions, and biological responses that provide a feedback loop by which the project can be adaptively managed (conditions/functions level).

Additional monitoring objectives to be addressed through monitoring clear reporting (see below) are:

- To develop, implement, and monitor adaptive management measures as determined by monitoring results;
- To learn as much as possible about restoration of lower river/estuarine ecosystems; to apply this knowledge to future projects, and to share what we learn with all interested parties.

The plan evenly stresses measurement of functional attributes (habitat conditions and functions, some processes) and direct measurement of function (biological response- fish and wildlife use). We have the opportunity to directly measure some motile species such as juvenile anadromous salmonids and compare the results with established reference sites and baseline data. However, even when fish and wildlife use are measured directly, some processes, conditions, and functions must also be measured as well in order to determine whether or not a restored system is functioning adequately. For example, absence of fish answers the question: "Are fish using the site?" however, it does not determine why. Monitoring attributes helps answer "why?" so that adaptive management measures can be suggested.

Monitoring Reporting, Responsibility, and Use

Monitoring Responsibility

The overall responsibility for monitoring at Deepwater Slough lies with the project sponsor, WDFW, and ACOE, who is designing and building the project.

A Deepwater Slough Restoration Project Monitoring Team has been established. This team includes scientists representing the above agencies, plus the Skagit System Cooperative (SSC, the fisheries management agency for the Sauk-Suiattle, Upper Skagit, and Swinomish Indian tribes), and the US Fish and Wildlife Service (USFWS). All of these agencies have participated in planning and implementing the project.

The team has taken on approval of this monitoring plan, will finalize plan details, coordinate monitoring tasks, ensure that monitoring is completed, and will collectively prepare a monitoring report for each year of monitoring, and a final report at the end of project monitoring. The team will, by consensus, assign individual monitoring tasks to be conducted or overseen by each

member agency. Agency staff responsible for any given task will also be responsible for preparing the report section for that task.

Reporting Requirements

The above team will collectively prepare a monitoring report for each year of monitoring, and a final report at the end of project monitoring. This report preparation will consist of preparing individual report sections.

An individual agency and staff member or contractor will be selected and assigned to synthesize the monitoring report. This synthesis will consist of developing a format for the report which each section must follow, combining the sections into a coherent single report, and, based on the adequacy of site biological responses, conditions, functions and processes (as described in the restoration goal for each monitoring task), developing/recommending adaptive management measures as part of each annual report and the final report. The synthesized report will be presented to the Deepwater Slough Restoration Project Monitoring Team.

Use of Report

Intent

The intent of monitoring this project and of reporting the monitoring results clearly includes a feedback-adaptive management loop function and an educational function. The report should analyze results and provide adaptive management guidance. The report and its findings should increase our collective knowledge about restoration of lower river/estuarine ecosystems. It should also be made readily available to other restoration groups and used to guide future restoration projects.

Adaptive Management

The Deepwater Slough Deepwater Slough Restoration Project Monitoring Team will use the report recommendations to guide adaptive management at the project site. Upon implementation, adaptive management measures will then be incorporated into the monitoring plan for the following years, in order to assess the success of these measures.

Report Availability and Future Use

The monitoring team will encourage member agencies to use the report and its results to guide future restoration. The team will also make the report readily available to all interested parties.

Reporting Budget

Reporting is covered under a section within the Monitoring Task chapter of this report. A cost estimate for reporting and report synthesis has been included there.

Monitoring Tasks

Introduction:

In order to organize and prioritize monitoring tasks, they are grouped into 3 categories. ***Process*** tasks monitor watershed processes at the project site. These tasks attempt to determine the success of process restoration (i.e., is tidal inundation restored). ***Conditions*** and ***functions*** tasks monitor ecosystem conditions or processes. These tasks attempt to determine the status of conditions and functions in the restored area (i.e., have channel networks been restored?).

Biological response tasks monitor the responses of plant and animal communities to restored processes and conditions/functions. These tasks attempt to determine the status of biological responses to restoration actions (i.e., are anadromous salmonids present?). Report preparation and synthesis is also covered as a separate task.

For each process, condition/function, or biological response to be monitored, baseline, implementation, and post-construction/effectiveness tasks are specified. Baseline monitoring records project site conditions prior to project completion; here, it also includes reference site monitoring. Implementation monitoring determines if the project was constructed in accordance with the design specifications; it is essentially a set of as-built drawings. Post-project/effectiveness monitoring determines if the project provides expected habitat functions and conditions as constructed and designed and may evaluate whether hypotheses regarding the relationship between the restoration action and biological response were correct. Monitoring tasks, schedule, responsibility, and costs per year are shown in Table 1.

Table 1 (continued).

Monitoring Task	Subtasks	Lead Partner	Biol. Cost (per wk.)	Tech Cost (per wk.)	Year 0 Biol. Time (wks.)	Year 0 Tech Time	Year 0 Equip	Year 0 Costs	Year 1 Biol. Time	Year 1 Tech Time	Year 1 Equip	Year 1 Costs	Year 2 Costs	Year 4 Costs	Year 7 Costs	Year 10 Costs	TOTAL
Water Quality		ACOE															
	Monitor DO, turbidity, pH, ppt		\$1,500	\$1,000					2.0	1.0		\$4,000	\$4,000	\$4,000	\$-	\$4,000	
Sediment Quality		ACOE															
	Monitor Pb, Hg, pesticides, PCBs, grain size, TOC		\$1,500	\$1,000					1.0		\$6,000	\$7,500		\$7,500			
Salmonid Access		SSC															
	Monitor fish access & densities		\$1,500	\$1,000					9.0	10.0		\$23,500	\$23,500	\$23,500	\$23,500	\$23,500	
Invertebrates																	
	monitor epibenthic fauna		\$1,500	\$1,000					1.0	1.0		\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	
	monitor drift insects		\$1,500	\$1,000					1.0	1.0		\$2,500	\$2,500	\$2,500	\$2,500	\$2,500	
Amphibians		WDFW															
	Survey for amphibians trap/egg mass search																
Neotropical Migrants		WDFW															
	Census songbirds using strip transects		\$1,667						3.0			\$5,000		\$5,000		\$5,000	
Waterfowl		WDFW															
	Breeding activity surveys		\$1,500						0.3		\$400	\$900		\$900		\$900	
	brood prod surveys		\$1,500						1.0			\$1,500		\$1,500		\$1,500	

Table 1 (continued).

Monitoring Task	Subtasks	Lead Partner	Biol. Cost (per wk.)	Tech Cost (per wk.)	Year 0 Biol. Time (wks.)	Year 0 Tech Time	Year 0 Equip	Year 0 Costs	Year 1 Biol. Time	Year 1 Tech Time	Year 1 Equip	Year 1 Costs	Year 2 Costs	Year 4 Costs	Year 7 Costs	Year 10 Costs	TOTAL
Mammals		WDFW															
	trap small mammals																
Shorebirds		USFWS															
	Literature review		\$1,500						4.0			\$6,000					
Reporting	Report preparation and synthesis		\$1,500						6.0		\$1,000	\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	
Monitoring Program Annual Total								\$22,000				\$94,700	\$63,000	\$77,900	\$59,000	\$70,400	\$387,000

Process Tasks

Tidal and River Hydrology

Historic Conditions

Historically, the project area was more open to and more influenced by both tidal and river flow. Baseline monitoring will include a map of estimated historical conditions.

Current Conditions

Currently, the project area is largely isolated from tidal and river flows. Baseline monitoring will include a map identifying areas isolated from river and tidal influence.

Restoration Goal

Reconnect project area to riverine and tidal flows by breaching and removing dikes in selected locations.

Restoration Hypothesis

Restore natural tidal and river hydraulic/hydrologic connections to the project area. Project area will be freely connected to river and bay, including diurnal tidal fluctuations as predicted. No differences will be detectable between project site and adjacent channels in terms of tidal stage or timing.

Monitoring Tasks

Baseline Monitoring

Monitoring Goal

The questions are:

1. What were historic conditions?
2. What are current conditions?

Methods and Data Analysis

Historic Conditions:

Map project area, showing areas historically influenced by tides. Methods to be determined.

Current Conditions:

Map project area, showing areas currently isolated from tides and river. Use latest DNR or ACOE orthorectified aerial photos. Digitize areas isolated behind dikes.

Schedule, Time/Personnel, and Cost Estimate

Timeline: Baseline in year 0.

Time/Personnel required: 1 ecologist, 2 weeks per year, yrs 0,

Cost: \$3,000/yr +equipment and supplies, year 0.

Implementation Monitoring

Monitoring Goal

The question is:

Has construction proceeded as designed? Document constructed dike breaches and dike removal.

Methods and Data Analysis:

Prepare as -built drawings per standard construction engineering practice. Use as-builts to plan other monitoring tasks, locate instruments (tide gages, fyke traps, etc.). Incorporate into GIS mapping done as part of other tasks.

Schedule, Time/Personnel, and Cost Estimate:

Timeline: Complete immediately after construction

Time/Personnel required: None, part of construction program

Cost: None, included in construction budget.

Post-Project Monitoring

Monitoring Goal

The questions to be answered are:

Is the restored area is freely connected to bay and river? What are maximum and minimum tidal stage, diurnal fluctuation and duration? What is Deepwater Slough stage and discharge?

Methods and Data Analysis:

Per Thom(1994) and Tanner (1996), install standard staff or continuous recording gages adjacent to at least 2 breach sites, one reference site, and in Deepwater Slough. Monitor gages by downloading or site visits. Monitor tidal stage, fluctuation and duration, preferably daily. Monitor flow stage and discharge in Deepwater Slough. Plot tidal elevation .vs. time monthly, compare to predicted values/reference site. Use with other tidal inundation monitoring. Compare gages at breach locations to reference site. Monitor Deepwater Slough gage and compare between years post-project.

Schedule, Time/Personnel, and Cost Estimate

Timeline: years 1 and 3, year 5 if required, based on first 2 years.

Time/Personnel required: 1 ecologist, 2 weeks per year.

Cost: \$3000/yr + \$400 per gauge

Sediment Supply

Not monitored directly. Inferred by monitoring sediment accretion (see below).

Channel/Open Water Habitat Formation/Morphology

Historic Conditions

Historically, the project area included numerous open water and channel habitats that were connected to the river and influenced by tides. A map and/or description estimating historic conditions will be prepared as part of baseline monitoring.

Current Conditions

Currently, the project area contains some isolated remnant channels and open water habitats which will be documented as part of baseline monitoring.

Restoration Goal

Channel morphology is representative of natural system as indicated by attributes of connectedness, areal extent, spatial distribution, and complexity.

Restoration Hypothesis

Channel formation and reconnection will occur as a result of restoration of tidal and river influence via dike breaching/removal. Morphology and formation will mimic natural conditions.

Monitoring Tasks

Baseline Monitoring

Monitoring Goal

The questions to be answered are:

What was the historical extent (area, length, width, depth, morphology, and types) of channels in the project area?

What is the current extent of channels and openwater habitats in the project area?

Methods and Data Analysis

Historical Conditions:

Estimate and map historical channels based on review of reference sites, historical information (Collins, 1998) models (Coats et al 1995), and current conditions. Exact methods to be determined.

Current Conditions:

Conduct aerial photo interpretation using ARCVIEW GIS or CAD and digital orthorectified aerial photos. Digitally calculate channel area within project area prior to restoration.

Select several channels for cross section and long profile. Conduct cross section/long profile survey to determine remnant channel depth, width and overall profile.

Schedule, Time/ Personnel, and Cost Estimate

Timeline: Baseline, year 0

Time/Personnel required: 1 restoration ecologist for 3 weeks, for current and historical conditions mapping and analysis and field channel survey. 1 technician for 1 week.

Cost: \$5500/year

Implementation Monitoring

None. Covered under "Tidal and River Hydrology" (as built drawings)

Post-Project Monitoring

Monitoring Goal

The questions to be answered are:

Is channel morphology representative of natural system and/or as predicted by reference sites and models?

Methods and Data Analysis

Shoot/project new aerial photos in digital orthorectified format. Digitally calculate channel area within project area and in reference sites using new digital orthophotos. Survey of selected channel cross sections and long profiles as described above, years 1,2, 4, 7, 10. Classify channel types. And classify/measure other characteristics as needed. Select reference sites as required; methodology to be determined. Compare channel area, extent, drainage density and morphology determined through photo analysis to model (Coats et al, 1995) of predicted channel networks based on flow, tidal prism, volume and area inundated, and opening size, and/or by comparison to reference locations.

Schedule, Time/Personnel, and Cost Estimate:

Timeline: years 1,2,4,7,10

Time/Personnel required: 1 restoration ecologist for 2 weeks, 1 technician for 1 week, 1 flight/monitoring year.

Cost: \$4000/year plus flight and photography.

Habitat Conditions/Functions Tasks

Topography

Historic Conditions

Historic conditions are unclear. No topographical mapping will be conducted.

Current Conditions

Current conditions will be mapped as part of baseline.

Restoration Goal

Topography is used as a predictor of conditions. No topographic restoration is planned.

Restoration Hypothesis

Existing topography will support restoration objectives.

Monitoring Tasks

Baseline Monitoring

Monitoring Goal

Characterize project area topography.

Methods and Data Analysis

Conduct topographic survey, Use to predict post-project vegetation communities.

Schedule, Time/ Personnel, and Cost Estimate

Timeline: Topographic survey in year 0, pre-construction

Time/Personnel required: Survey crew, 1 week +office time

Cost: @\$3,000 for baseline, similar, if required, in out years.

Implementation Monitoring

None

Post-Project Monitoring

Monitoring planned only if vegetation or other conditions indicate major problem.

Vegetation

Historic Conditions

Historic vegetation conditions are unclear. Conditions can be estimated based on other more pristine areas within our ecoregion. The project site is located in a transitional zone between forested freshwater wetland and estuarine emergent wetland habitats and probably included a mosaic of open water, emergent, shrub-scrub, and forested wetland and some upland areas. Historical conditions will be estimated and described as part of baseline monitoring.

Current Conditions

Vegetation is significantly altered from historical conditions. The project area is located in a transition zone between forested freshwater wetland and estuarine emergent habitats. While historical conditions are uncertain, all of the project area has been diked. Much of the natural forest, shrub, and herbaceous vegetation has been eliminated. Large, formerly forested areas and other habitats have been replaced with seasonally planted cereal grain cropland, that includes weedy and invasive wetland and upland species. Some areas retain emergent and shrub-scrub wetland conditions, although they are cut off from tidal influence and isolated from use by native aquatic fauna. Forests exist on dike berms and other high areas. Current conditions will be described and mapped as part of baseline monitoring tasks.

Restoration Goal

1. Vegetation growth/presence is representative of this kind of ecosystem, or is proceeding along a trajectory towards a natural condition.
2. Communities present are representative of this kind of ecosystem, or are proceeding along a trajectory towards a natural condition.
3. Invasive/exotic species are not present or are successfully controlled.

Restoration Hypothesis

By restoring natural hydrologic conditions and tidal regime and eliminating the anthropogenic disturbances of mowing and cereal grain crop production at the project site, natural vegetation communities will become established. Non-native and invasive species will not threaten habitat integrity.

Monitoring Tasks:

Baseline Monitoring:

Monitoring Goal:

The questions to be answered are:

1. What were historical vegetation conditions? What vegetation communities were present? Where? How large were they? What are the species composition and dominance in each community?
2. What are current vegetation conditions? What vegetation communities are present? Where? How large are they? What are the species composition and dominance in each community? What

relationships between site conditions and vegetation communities can be detected? Can any long-term projections regarding vegetation community types be made?

Methods and Data Analysis:

Current Conditions:

See Tanner (1993). Identify major vegetation and habitat types on an aerial photograph, using latest DNR orthophotos in digital form or ACOE photos as available. for each year of monitoring. Field verify and categorize vegetation communities by species composition, visiting sites to groundtruth vegetation communities and using permanent transects to identify species percent cover. Classification will be per Cowardin et al (1979) or Dethier (1990).

Historical Conditions:

To be determined. Use historical and current information to map likely historical communities. Due to uncertainty, consider lumping communities together in several "zones".

Schedule, Time/ Personnel, and Cost Estimate:

Timeline: Baseline in year 0.

Time/Personnel required: 1 ecologist, 1 technician, 3 weeks per year, yrs 0, 1 ecologist, 2 weeks, for historical conditions description and map.

Cost: \$10,500/yr +equipment and supplies, year 0.

Implementation Monitoring:

Monitoring Goal:

The questions to be answered are:

None- answered as part of other monitoring categories (See "Tidal and River Hydrology")

Methods and Data Analysis:

N/A

Schedule, Time/Personnel, and Cost Estimate:

N/A

Post-Construction Monitoring:

Monitoring Goals:

The questions to be answered are:

1. Is vegetation growing/present as expected in the restored area? Are any invasive species a problem?
2. Are vegetation communities present or developing as anticipated? What vegetation communities are present? Where? How large are they? What are the species composition and dominance in each community?

Methods and Data Analysis:

See Tanner (1993), Shreffler and Thom (1994). Identify major vegetation and habitat types on an aerial photograph for each year of monitoring. Field verify and categorize vegetation communities by species composition, visiting sites to groundtruth vegetation communities and using permanent transects to identify species percent cover. Classification will be per Cowardin et al (1979). Predict succession via tables from feasibility study (Sheldon et al 1996) and topography. Using ARCVIEW, Map communities identified and verified above, compare community size and location from monitoring year to monitoring year and to expected types based on tables and topography.

Schedule, Time/Personnel, and Cost Estimate:

Schedule: Post-construction years 1, 2, 4, 7, 10

Time/Personnel required: 1 ecologist, 1 technician, 3 weeks per year, yrs 1, 2, 4, 7, 10

Cost: \$7500/yr +equipment and supplies, years 1, 2, 4, 7, 10

Sediment Accretion

Historic Conditions

Historic conditions are difficult to assess. It will be assumed that historic sediment accretion rates were similar to literature values. Literature review of sediment accretion will be part of baseline monitoring.

Current Conditions

Accretion is likely lower than natural; however, agricultural activity makes it difficult to measure.

Restoration Goal

By restoring natural hydrology and sediment supply to the project area, sediment accretion will occur within range of natural system/proceed along a trajectory toward natural conditions.

Restoration Hypothesis

Accretion rate will approximate natural based on literature values/reference sites; may be much greater than natural rates at first, then level off.

Monitoring Tasks

Baseline Monitoring

Monitoring Goal

The question to be answered is:

What is the expected range of sediment accretion rates for the project site?

Methods and Data Analysis

Conduct literature review to determine natural range of sediment accretion rates for project area. Summarize findings. Select local reference sites, and, concurrent with project site monitoring in post-project years, install feldspar plots (see below).

Schedule, Time/Personnel, and Cost Estimate:

Included in post-project monitoring below.

Implementation Monitoring

None

Post-Project Monitoring

Monitoring Goal

The question to be answered is:

What is the sediment accretion rate at various sites within the project area? Is it within the expected natural range?

Methods and Data Analysis:

Install Feldspar plots per Cahoon et al, (1996), in appropriate locations on project site and at reference locations. Monitor via cryogenic cores. Determine accretion rate and Compare to literature values and reference sites.

Schedule, Time/Personnel, and Cost Estimate

Timeline: monitoring in years 1, 2, 4, 7, and 10

Time/Personnel required: 1 restoration ecologist, 1 week initially, 4 days per year thereafter.

Cost: \$1500/yr, + equipment and materials.

Water Quality

Historic Conditions

Historic conditions are unclear. It is presumed that water quality in the project area was similar to current water quality in adjacent tidal channels and distributary sloughs.

Current Conditions

Current water quality conditions have not been assessed

Restoration Goal

Restored tidal and river influence will result in project area water quality similar to adjacent areas.

Restoration Hypothesis

Water quality within open water habitats and channels in the project area will be similar to water quality in those habitats in adjacent areas.

Monitoring Tasks

Baseline Monitoring

None. This is a reference approach where measurements are taken on the downstream portion outside the project and then compared to measurements taken within the project area.

Implementation Monitoring

None

Post-Project Monitoring

Monitoring Goal:

The question to be answered is:

What are water quality conditions at the project site?

Methods and Data Analysis:

(see : Standard Methods for Evaluating Water and Wastewater, American Water Works Association (current edition), also Methods for Chemical Analysis of Water and Wastes EPA 600/4-79-020) Parameters to be monitored are: Dissolved oxygen, Turbidity, pH, Conductivity, and Salinity. This can be done by using electronic equipment such as Hydrolabs or similar or by grab samples using Van Doren bottles. If grab samples are done a surface sample and a bottom sample should be obtained. If a Hydrolab is used, do a water column profile in two-foot increments. For the tears monitored, a sample event should occur in winter and one in summer. Within each sample event, both a high tide and low tide should be sampled at all locations. Sampling locations will be selected and mapped. A field log will be kept documenting procedures and field conditions.

Quality Control:

If a Hydrolab or similar instrument is used, it must be calibrated at the beginning of each sampling event per instrument instructions. A grab sample will be taken at the same time and location of a Hydrolab. The grab sample will be sent to an accredited laboratory and analyzed. If results are more than ten percent different, this approach will be rescoped.

Schedule, Time/Personnel, and Cost Estimate

Timeline: Monitor years 1,3,5, 10

Time/Personnel required: two people, a boat, Hydrolab. 1 hr per station total of four stations per tide, two tide cycles per event done twice in a sampling year (one in the summer and one in the winter) total 16 hours per event

Cost: \$4,000 per year.

Sediment Quality

Historic Conditions

Historic conditions are unclear and will not be documented. It is presumed that prior to European settlement, sediments in the project area were free of anthropogenic contamination.

Current Conditions

Current conditions are unknown and will not be sampled.

Restoration Goal:

No specific restoration action is tied to this goal; uptake of contaminants is below chronic effects for organisms utilizing the site.

Restoration Hypothesis:

Uptake of contaminants is below chronic effects for organisms utilizing the site.

Monitoring Tasks

Baseline Monitoring

Monitoring Goal:

The question to be answered is:

What are sediment quality conditions at the project site?

Methods and Data Analysis

See Test Methods for Evaluating Solid Wastes, EPA SW-846, American Society of Testing Methods. Parameters to be monitored are heavy metals (total lead and mercury method EPA method 6020), pesticides and PCBs (EPA method 8081A/8082) grain size analysis (ASTM D 422 (modified), Total Organic Carbon. Following approved sampling methods for State sediment standards, keep chain of custody procedures, have laboratory follow detection limits, analysis and QC per EPA requirements (use EPA certified lab).

Two surface samples in ponded areas should be obtained from areas that are currently diked. These would be compared to surface samples in the newly restored areas (bottom of new tidal channels).

Schedule, Time/ Personnel, and Cost Estimate

Included in Post-Project Monitoring below.

Implementation Monitoring

None

Post-Project Monitoring

Monitoring Goal:

The question to be answered is:

What are sediment quality conditions at the restored project site?

Methods and Data Analysis

See above baseline methods. Take surface sediment samples in the newly restored areas (bottom of new tidal channels). Sample number to be determined. Analyze and compare to baseline samples and to State sediment standards and literature values for bioaccumulation potential for juvenile fish and waterfowl.

Quality Control:

Do 1 field sample duplicate.

Schedule, Time/Personnel, and Cost Estimate

Timeline: year 1 and 5. If no improvement is observed over baseline in five years, re-scope this portion.

Time/Personnel required: 3 days per sampling event two people.

Cost: with analysis, \$7,500/yr

Biological Response Tasks

Fish

Juvenile Anadromous Fish (Salmonid) Access

Historic Conditions

Historic conditions are not known. We assume that juvenile anadromous fish accessed all suitable parts of the project area prior to isolation of the project area. Baseline monitoring will define historical access.

Current Conditions

Currently, the project area is isolated and unavailable for juvenile anadromous fish access. Baseline Monitoring will define this isolation.

Restoration Goal

Through dike breaching and removal, juvenile anadromous fish access will be restored to the project area.

Restoration Hypothesis

Juvenile fish will access the restored area. Expected species will be present in expected densities and at expected times, based on literature values and reference site species and numbers.

Monitoring Tasks

Baseline Monitoring

Monitoring Goal:

The questions to be answered are:

1. What was historical juvenile anadromous fish use? What species were present? Where? When? In what densities?
2. What is current juvenile anadromous fish use? What species are present? Where? When? In what densities? What species and densities are present in adjacent areas?

Methods and Data Analysis

To be determined. Assume that there are no fish present behind dikes, no sampling in project area. Use literature values and existing data from sites in vicinity of project area along with sampling done at these sites concurrently with restoration project site sampling.

Schedule, Time/ Personnel, and Cost Estimate

Included in Post-Project Monitoring below.

Implementation Monitoring

No fish sampling, as-built drawings used to precisely determine sampling locations and predict where fish will be found.

Post-Project Monitoring

Monitoring Goal:

The questions to be answered are:

Are expected species of juvenile anadromous fish present in expected densities, at expected sites, based on literature values and reference site species and numbers?

Methods and Data Analysis:

See Hayman et al, (1996).

1. Are fish accessing the newly opened areas as expected?

Monitor for this by trapping, seining fish (fyke traps and beach seines) in areas that fish would be expected to use- newly opened tidal channels, other open water areas, and low marsh areas.

Sampling will be stratified to include times and locations that fish would be expected to use (i.e., for time, Feb to end July for chinook), at appropriate tides, based on literature and reference sites. Locate trap and seine sites using information from as built drawings and field visits prior to the start of sampling.

2. Are fish present in the expected densities?

Monitor for this using the same methods, plus mark and recapture techniques. Compare species and densities to expected densities based on literature values and control sites.

Schedule, Time/Personnel, and Cost Estimate

Timeline: years 1,2,4,7,10.

Time/Personnel required: 2 technicians, 1 restoration ecologist 4 days/month for 6.25 months, restoration ecologist for 20 additional days per yr.

Cost: \$23,500/yr, plus transportation and equipment.

Macroinvertebrates

Historic Conditions

Historic conditions are unknown. It is assumed that invertebrates were present in natural assemblages and densities prior to isolation of the project area.

Current Conditions:

Current conditions are unknown. It is assumed that certain invertebrates are eliminated in the isolated project area.

Restoration Goal

Restoration of natural hydrologic sediment supply, channel extent and morphology, vegetation communities, etc. will result in restoration of natural invertebrate assemblages and densities.

Restoration Hypothesis

Invertebrate assemblages will be present in densities and compositions appropriate for system or in trajectory towards natural system.

Monitoring Tasks

Baseline Monitoring

Monitoring Goal:

The questions to be answered are:

What are expected species and assemblages of invertebrates for project site, based on literature values and reference site species and numbers?

Methods and Data Analysis

See Post project methodology below. Sample using identical methods in nearby reference sites. Review literature for expected species assemblages and densities.

Schedule, Time/ Personnel, and Cost Estimate

Included in Post-project Monitoring below.

Implementation Monitoring

None.

Post-Project Monitoring

Monitoring Goal:

The questions to be answered are:

Are expected species and assemblages of invertebrates present in expected densities, based on literature values and reference site species and numbers?

Methods and Data Analysis:

Sample for epibenthic fauna and drift invertebrates as described in Simenstad et al (1991), Thom (1994) and, Cordell et al (1998). Stratify sampling location and times to include a variety of habitats at appropriate times. Sampling methods as follows:

- a. epibenthic fauna: cores or vacuum pump sampling.
- b. Drift invertebrates (includes terrestrials): neuston nets placed with diehl periodicity (freshwater and tidal flow cycle-related) and/or fallout traps.

Monitor selected assemblages using above methodology. Standing stock, density, population structure, abundance, diversity are potential parameters. compare to reference sites and literature.

Schedule, Time/Personnel, and Cost Estimate

Timeline: Monitor in years 1,2,4, 7,10

Time/Personnel required: 1 ecologist/biologist, 1 technician, 2 weeks/yr

Cost: \$5000/yr plus equipment, materials, and transportation.

Vegetation

Monitored as a Habitat Condition/Function (acts as substrate for other biological responses)

Wildlife, Birds, Herpetofauna

Amphibians

Historic conditions

Habitat conditions within the project area prior to diking are not known. No historic data on amphibian distribution are available for the area. However, it is likely that the tidal conditions that existed prior to diking in the project area did not meet amphibian habitat requirements, and therefore amphibian use of the area was limited.

Current Conditions

Due to diking on Fir Island, Deepwater Slough has been physically isolated from the Skagit Estuary for about 50 years. Amphibians have not been surveyed previously on any part of the study site, including portions of Deepwater Slough that are currently isolated from tidal influence by dikes, and provide open water habitat. Therefore, distribution and species composition of amphibians within the project area is unknown (Thompson et al, 1999).

Restoration Goal

1. Elimination of potential amphibian habitat within the project area by restoration of tidal influence to diked areas will not displace amphibian species of concern.

Restoration Hypothesis

The portion of the project area where tidal influence will be restored by eliminating and/or breaching dikes does not contain any amphibians that are unusual to western Washington, including Oregon spotted frogs, *Rana pretiosa*; Western Toads, *Bufo boreas*; or any other threatened or endangered amphibian species.

Monitoring Tasks

Baseline Monitoring

Monitoring Goal

The questions to be answered are:

1. What species of amphibians are present within the project area prior to restoration of tidal influence?

2. Are there amphibian species of concern within portions of the project area that will be restored to tidal influence?

Current Conditions

Amphibian surveys were completed during 1999 within the project area. Habitat areas that will be restored to tidal influence, as well as areas that will remain in a diked condition were surveyed using vocalization surveys, egg mass searches, and trapping techniques (see Thompson et al, 1999 for a more detailed description of techniques and data analysis procedures). These data have not yet been reported. It is anticipated that baseline monitoring results will provide information on amphibian species present within the project area, presence of amphibian species of concern, and a comparison of amphibian species abundance and composition between different portions of the project area.

Historical Conditions

No methods for estimating historic (pre-diking) amphibian use of the project area are proposed. However, if this was determined to be an important issue, results of historic condition assessment for vegetation could be used to provide some information for estimating historic amphibian use of the project area.

Schedule, Time/Personnel, and Cost Estimate.

Timeline: Before project implementation; Summer, 1999

Time/Personnel required: Data collection has been completed for Washington Department of Fish and Wildlife under a contract with Skagit Valley College. Data analysis and reporting are in progress.

Cost: No additional resources are necessary to complete this task.

Implementation and Post-Project Monitoring

No implementation or post-project monitoring of amphibian use of the project area is proposed.

Birds

Neotropical Migrants

Historic Conditions

Habitat conditions within the project area prior to diking are not known. No historic data on neotropical migrant bird use of the area is available. However, it is likely that the riparian surge plain forest habitat that probably existed prior to diking in the project area did provide habitat for a variety of birds, including neotropical migrants and other passerine species.

Current Conditions

Quantitative data on the distribution and species composition of neotropical migrants is not available for the project area. The diversity of habitat types within the project area and the larger Skagit River delta ecosystem likely provide the potential for a diversity and abundance of passerine bird use. The parts of the project area that will be returned to tidal influence will change in habitat structure in both the short- and long-term. In turn, these changes will be correlated with changes in associated fauna including neotropical birds and their prey.

Restoration Goal

1. Neotropical migrant use, as measured by species diversity and overall abundance, does not decline following project implementation.
2. Neotropical migrant use of the project area is representative of a tidal riverine ecosystem, or is proceeding along a trajectory towards a natural condition.

Restoration Hypotheses

1. Pre-treatment absolute and relative abundances of neotropical migrant bird species do not differ (a) between habitat types (i.e. wet versus dry) within treatment groups (areas to be restored to tidal influence) versus areas to remain in a diked condition or (b) between treatment groups (habitat types compared separately or combined);
2. Post-treatment absolute and relative abundance of neotropical migrant bird species do not differ (a) between habitat types within treatment groups, or (b) between treatment groups within years or among years(per Thompson et al., 1999).

Monitoring Tasks

Baseline Monitoring

Monitoring Goal

The questions to be addressed are:

1. What is the current (pre-project) condition of neotropical migrant bird use of the project area?
2. Can suitable control areas be identified for use in assessing post-project changes in neotropical migrant bird use?

Methods and Data Analysis

Current Conditions

Many methods exist for census of passerine songbirds (e.g. Bibby et al. 1992, Ralph et al. 1997). The project area is mainly composed of cultivated and non-cultivated fields separated by relatively narrow dikes that are typically well forested. Thus, strip transect surveys along dikes are the most suitable method for censusing songbirds within the project area (Thompson et al, 1999).

The study area is sufficiently heterogeneous in the size and structure of various habitat types, and their proximity to one another, that true “control” areas that will remain in a diked condition after project completion that are similar “treatment” areas where tidal restoration will occur do not exist. However, an effort has been made to develop “control” and “treatment” pairs that are as similar as possible given the overall heterogeneity of habitats within the project area.

Specifically, existing habitat areas that are relatively dry (upland character) and wet (palustrine wetland) that will be changed by project activities have been compared to similar dry and wet areas that will not be restored to tidal influence and will remain largely unaffected by project activities.

Strip transect counts of neotropical migrants along transects through these areas were conducted between mid-June and mid-July 1999. Two replicates of each transect was chosen because it is the minimum number necessary to generate means and standard errors necessary for conducting most statistical tests, but was the maximum that could be afforded given limited resources.

Transect surveys began between sunrise and one hour after sunrise, and finished no later than 12 noon. Each morning, two surveys were conducted: one transect of an area to be restored by the

project, and the other of it's "control." Additional details on survey methods and proposed data analysis are described in Thompson et al (1999).

Historical Conditions

No methods for estimating historic (pre-diking) neotropical migrant bird use of the project area are proposed. However, if this was determined to be an important issue, results of historic condition assessment for vegetation could be used to provide some information for estimating historic bird use of the project area.

Schedule, Time/Personnel, and Cost Estimate

Timeline: Baseline monitoring was completed in 1999. Data from these pre-project transect surveys have not yet been reported.

Time/Personnel required: No additional baseline or historical condition assessment is proposed. No additional resources are required for this task.

Cost: N/A

Implementation Monitoring

No implementation monitoring will be done.

Post-Project Monitoring

Monitoring Goals:

The questions to be answered are

1. What effects did restoration of tidal influence, and subsequent changes in habitat conditions, have on neotropical migrant bird use of the project area?

Methods and Data Analysis:

Transect survey methods are described generally above, and in more detail in Thompson et al. (1999). In years 1, 3 and 5, comparisons between upland and wetland habitats and treatment and control areas will indicate the degree to which the physical structure of the dikes surrounding the restored areas and the bird communities in them, may have changed due to restoration activities and associated habitat changes. For among-year comparisons, each transect will be compared between years (e.g. pre-treatment versus years 1, 3 and 5) using statistical methods (see Thompson et al. 1999 for more detail on proposed data analysis methods) to determine possible

temporal changes in relative and absolute species abundances. Similar analyses will be conducted to compare results between transects within and between treatment groups.

Schedule, Time/Personnel, and Cost Estimate:

Timeline: Years 1, 3 and 5

Time/Personnel: 1 biologist, 3 weeks per year

Cost: \$5,000/year

Shorebirds

Monitoring Tasks

Post-Project Monitoring

For reasons discussed at length in meetings with project partners, we agreed that it is not practical to monitor shorebird abundance and species composition within the project area, or changes in them over time, given the lack of resources. Alternatively, we agreed that data collected from surveying the plant and invertebrate community, and changes in them over time, can be used to extrapolate the potential use of the project area by shorebirds based on our knowledge of shorebird feeding habits.

Schedule, Time/Personnel, and Cost Estimate

Timeline: Year 5

Time/Personnel: 1 biologist, 4 weeks for literature review and model to estimate possible change in shorebird prey population and accessibility to prey.

Cost: \$6,000

Waterfowl

Historic Conditions

Habitat conditions within the project area prior to diking are not known. No historic data on waterfowl distribution is available for the area. However, diking has led to significant changes to habitats within the project area. These changes have likely led to different effects on waterfowl breeding activity and production based on specific habitat requirements of different waterfowl species. Habitat changes due to diking have likely benefited those species that require palustrine wetlands, including open water areas with a stable water level.

Current Conditions

Quantitative data on waterfowl breeding activity and production is not available for the project area. The area is actively managed as waterfowl habitat via the use of water control structures and the production of cereal grain crops. The project area currently supports a popular recreational waterfowl hunting program.

Restoration Goal

No specific goals for waterfowl have been developed for portions of the project area that will be restored to tidal influence. No predictions have been made on what changes will occur in waterfowl species composition or production in these areas, however it is generally assumed that restoration of tidal influence will reduce the habitat value for recreationally important waterfowl species. There is a general lack of available information on broader waterfowl use of intertidal habitats, including the surge plain forest, emergent marsh, and tidal slough habitats that are anticipated to be restored by the project.

For portions of the project area where tidal hydrology is not being restored, the goal is continued waterfowl management activities and no reduction in waterfowl breeding activity and production.

Restoration Hypothesis

Our general hypothesis is that waterfowl breeding activity and production will not change over time in response to dike breaching, dike building, or augmentation, i.e. that pre-treatment waterfowl breeding activity and production will not differ from post-treatment waterfowl breeding activity and production in years 1, 3 and/or 5.

Monitoring Tasks

Baseline Monitoring

Monitoring Goals

The questions to be answered are:

1. What are current levels of waterfowl breeding activity and brood production within the project area?
2. What waterfowl species are present within the project area?

Methods and Data Analysis

Current Conditions

The baseline study was designed to include two components of seasonal habitat use in the project area: (1) breeding activity levels, and (2) brood production. The primary objective of the breeding activity survey was to document mated/breeding pairs of ducks utilizing available habitat. This survey of waterfowl breeding activity was completed during the week of April 26-30, 1999 and followed standard waterfowl inventory methods (Cowardin and Blohm 1992, USFWS and CWS 1987). Brood production surveys (walked transects along selected habitat routes) were completed in portions of the project area and a nearby site that will (currently diked portion of Deepwater Slough and West Site) and will not (Lorenzan Field, within the project area, and Headquarters Area, outside of the project area, but nearby) be restored to tidal influence in order to evaluate pre- and post-treatment changes in waterfowl productivity. Each of the four transects (two project area sites and two control sites) was surveyed three times within each of two time intervals (1-15 June 1999, and 1-15 July 1999) for a total of 12 transects completed in both June and July. June transects were designed to include peak mallard brood production activity and July transects target peak brood production for both teal and wood ducks. For more details on sampling design and survey methodology, see Thompson et al. (1999).

Because breeding activity data will consist only of a single total count of each species of waterfowl encountered, it is not possible to generate means and measures of variance for individual species during the pre-treatment year of this project. In turn, this will preclude us from comparing pre-treatment data to post-treatment data for individual species; instead, single species comparisons will be confined to population trend analyses such as regressions.

Due to low sampling effort, it will not be possible to quantify abundance of waterfowl species within the project area. However, species lists and other qualitative measures of waterfowl diversity can be generated from available data.

Historical Conditions

No methods for estimating historic (pre-diking) waterfowl use of the project area are proposed. However, if this was determined to be an important issue, results of historic condition assessment for vegetation could be used to provide some information for estimating historic waterfowl use of the project area.

Schedule, Time/Personnel, and Cost Estimate

Timeline: Baseline monitoring was completed in 1999. Data from these pre-project transect surveys have not yet been reported.

Time/Personnel required: No additional baseline or historical condition assessment is proposed.

No additional resources are required for this task.

Cost: N/A

Implementation Monitoring

No implementation monitoring will be done.

Post-Project Monitoring

Monitoring Goals

The questions to be answered are

1. What effects did restoration of tidal influence, and subsequent changes in habitat conditions, have on waterfowl breeding activity and brood production within the project area?

Methods and Data Analysis

Breeding activity and brood production survey methods are described generally above, and in more detail in Thompson et al. (1999). In years 1, 3 and 5, protocols used in the baseline study will be repeated. Breeding activity data will consist of a single total count of each species of waterfowl encountered. Brood production surveys will quantify the total number of each species of waterfowl according to water body type (see Appendix 1), age (adult versus young), time interval (1-15 June or 1-15 July), project-impact area (impacted versus not impacted), and site within each project area.

Trend analyses will be performed with breeding activity to determine if increasing or decreasing numbers from pre-treatment through year 5 indicate that those species are responding to activities associated with the project. Brood production data will be analyzed to determine if any changes within areas restored to tidal influence are due to project-related factors.

Changes in waterfowl species occurrence within the project area will also be evaluated using survey data.

Schedule, Time/Personnel, and Cost Estimates.

Timeline: Years 1, 3 and 5

Time/Personnel: 2 biologists @ 2 week each/year

Cost: \$4,000/year; \$400 helicopter time/year

Mammals

Historic Conditions

Habitat conditions within the project area prior to diking are not known. No historic data on small mammal distribution is available for the area. However, it is likely that the tidal conditions that existed prior to diking in the project area did not meet small mammal habitat requirements, and therefore use of the area was limited.

Current Conditions

Small mammals have not been surveyed previously on any part of the study site, therefore, distribution and species composition within the project area is unknown (Thompson et al, 1999). The motivation for collecting data on small mammal species composition, distribution, and abundance at within the project area, especially in areas to be restored to tidal influence, is to insure that no rare or sensitive species are present.

Restoration Goal

1. Elimination of potential small mammal habitat within the project area by restoration of tidal influence to diked areas will not displace species of concern.

Restoration Hypothesis

Portions of the project area to be restored do not contain any rare or sensitive small mammals of management concern.

Monitoring Tasks

Baseline Monitoring

Monitoring Goal

The question to be answered is:

1. Does the project area contain any rare or sensitive small mammals of management concern?

Methods and Data Analysis

Current Conditions

Conduct a one-time survey of the small mammal population at within the project area. Collect data on small mammal species composition, distribution, and abundance during the pre-treatment phase of this project. Small mammals were surveyed for by trapping them in Sherman and Potter traps along fourteen transects (two in each of seven locations) during the summer of 1999. See Thompson et al. (1999) for detailed description of transect locations and survey methods.

At the simplest level, presence/absence data will indicate the various species that exist in each area in which a transect is placed, and the extent to which different species inhabit different areas of the project area, and whether any rare or sensitive species exist in areas to be affected by restoration activities. Because we will have many replicates of each transect and trap type employed, standard parametric and nonparametric analyses can and will be employed to compare differences in absolute and relative abundances of species within and between transects and habitat types. In addition, previous data indicates that these mark-recapture data can accurately estimate population size with as few as 6-8 replicate surveys versus the 14 replicates anticipated in this study. Thus, we may attempt to estimate the total numbers of small mammals within areas to be affected by restoration activities (Thompson et al., 1999).

Historical Conditions

No methods for estimating historic (pre-diking) small mammal use of the project area are proposed. However, if this was determined to be an important issue, results of historic condition assessment for vegetation could be used to provide some information for estimating historic use of the project area.

Schedule, Time/Personnel, and Cost Estimate.

Timeline: Before project implementation; Summer, 1999

Time/Personnel required: Data collection has been completed for Washington Department of Fish and Wildlife under a contract with Skagit Valley College. Data analysis and reporting are in progress.

Cost: No additional resources are necessary to complete this task.

Implementation and Post-Project Monitoring

No post-project monitoring of small mammal use of the project area is proposed.

Reporting Tasks

Report Preparation and Synthesis

Some reporting is covered within the scope of each task. There will be additional time required to prepare a complete annual report for each task and to synthesize these reports into a comprehensive annual monitoring report. Money is also budgeted for report publication.

Schedule, Time/Personnel, and Cost Estimate.

Timeline: Report preparation and synthesis will be required for each monitoring

Time/Personnel required: 1 Biologist/ecologist, 6 weeks, plus \$1000 for publishing.

Cost: \$10,000/yr for years 1, 2, 4, 7, 10.

Monitoring Schedule

1. Draft Plan: November, 1999, Final Plan, December, 1999
2. Baseline Monitoring: Conducted starting Spring 2000 (Some completed in 1999 and earlier)
3. Implementation Monitoring: Immediately post-project
4. Post-Project Monitoring: Years 1, 2, 4, 7,10

Monitoring Quality assurance/Quality Control Measures

The following are project QA/QC guidelines (from Shreffler, and Thom, 1994):

1. a thorough review of relevant field sampling and mapping methodologies is being conducted during the monitoring planning phase. Actual protocols used will be described thoroughly.
2. All sampling procedures will be tested in the field prior to actual sampling.
3. Where applicable (i.e., for vegetation plots), if more than one field crew is used for any discrete monitoring task, comparability of crew data collection will be assured by reviewing procedures and repeating measurements on the same plots until estimations are within 10% for each team.

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