NOVEMBER 16, 2020

SKAGIT WILDLIFE AREA ISLAND UNIT DRAFT ALTERNATIVES ANALYSIS

Analysis by: Washington Department of Fish and Wildlife Region 4 Staff

Preferred alternative to be selected by: WDFW

Table of Contents

Figures and Tables

Acronyms and Abbreviations

Corps	Army Corps of Engineers
ESA	Endangered Species Act
GSD	Greater Skagit Delta
HDM	Skagit Hydrodynamic Modeling Study
LiDAR	Light Detection and Ranging
NAVD88	North American Vertial Datum 1988
NMFS	National Ocieanic and Atmospheric Administration—National Marine Fisheries
O&M	Service Operations and maintenance costs
RMT	WDFW Regional Management Team
SLR	Sea level rise
SRFB	Salmon Recovery Funding Board
SRKW	Southern Resident Killer Whale
TFI	Tidegate Fish Initiative
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Widlife

1. Executive Summary

The Island Unit is located on two diked islands in a tidally-influenced reach of the South Fork Skagit River. The Washington Department of Fish and Wildlife (WDFW) has owned and managed the Island Unit since the 1950s to produce crops for over-wintering waterfowl. The site is sometimes referred to as the "farmed island" and is used primarily by waterfowl hunters.

WDFW is assessing land management alternatives to determine how best to respond to emerging issues including aging infrastructure on the site, anticipated sea level rise, and changing habitat needs. The Island Unit is a priority area to restore habitat for salmon because it was historically a tidally-influenced estuarine area that provided critical rearing habitat for juvenile Chinook salmon. The Skagit Chinook Recovery Plan[1] identifies estuarine habitat as the highest priority for recovering salmon in the area.

WDFW is conducting an alternatives analysis, which is a planning process used to evaluate a range of choices relative to a set of identified criteria, to assess four possible conceptual designs ("alternatives"). The alternatives range from no restoration to restoration of the entire site. This effort is a high-level analysis using landscape-scale assessment tools and existing data. Criteria are intended to capture the primary considerations WDFW needs to consider when comparing alternatives, and they include WDFW policies, agreements and obligations, costs and funding, fish and wildlife needs, community values and climate change resilience. Criteria are applied to the alternatives using data (where available) as well as qualitative information and best professional judgement of WDFW staff. Technical memos were developed to inform the alternatives analysis and can be found in the appendices of this document.

A project Advisory Group and the public provided input during the process. The Advisory Group was formed to provide input at multiple points during the analysis, and members included stakeholder, tribal and governmental representatives. A 30-day public comment period, virtual meeting and online comment tools provided multiple means for the public to provide input.

2. Project Introduction

2.1 Site Description

The Island Unit is comprised of two islands in a tidally-influenced portion of the lower south fork Skagit River (Figure 1). Key features on the site are presented in Figure 2. The site is currently managed primarily for the production of high calorie crops for winter waterfowl forage. Approximately 141 acres of the 270 acre site is actively managed for waterfowl forage. The remainder of the site is comprised of dikes, trees, shrubs, ponds and ditches. Dikes and tidegates isolate and protect the site from tides and river flows, making it possible to produce forage crops. Water control structures allow for drainage of farmed and managed areas in the spring and summer, and water retention during the fall and winter to optimize foraging for dabbling ducks. Supplies and equipment are barged and boated across Freshwater Slough to the site from a landing at the Headquarters of the Skagit Wildlife Area on Fir Island. Four unimproved boat landings on the site provide the primary points of access for recreational users. A bridge provides access for pedestrians and WDFW vehicles and equipment from the west island to the east island across Deepwater Slough.

Over time issues guiding the management of the site have changed as explained in the background below.

[1] http://skagitcoop.org/wp-content/uploads/Skagit-Chinook-Plan-13.pdf

Figure 1. Project site location in the south fork Skagit River within the Skagit River delta.

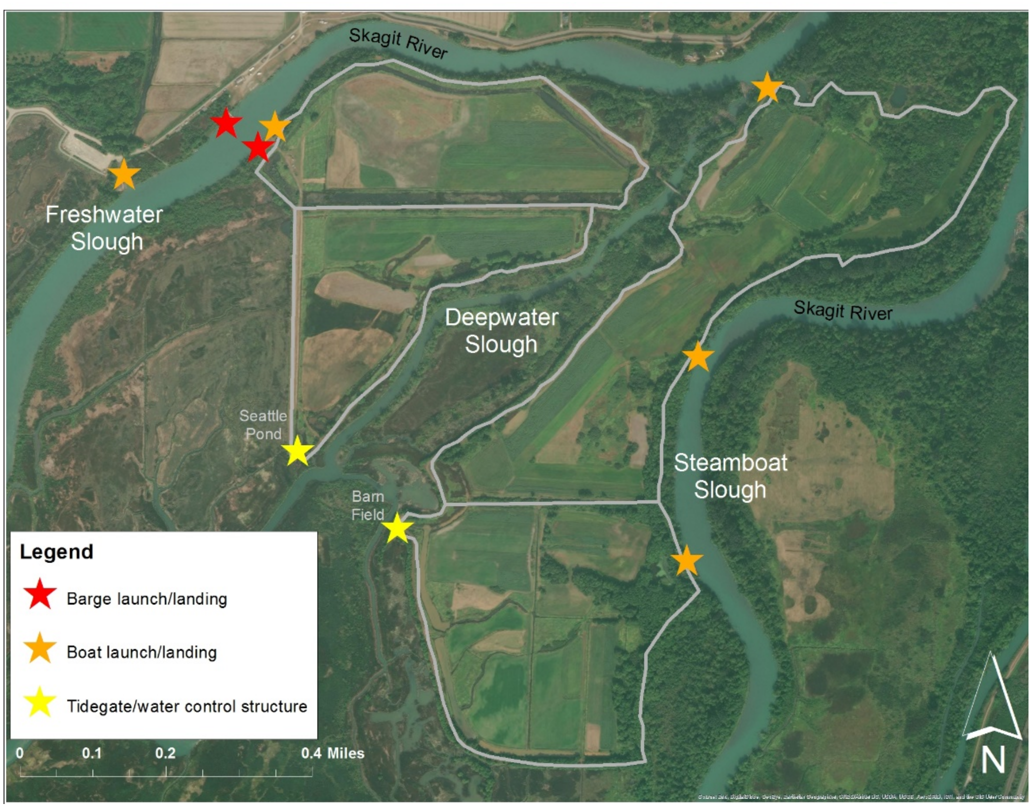


Figure 2. Current site layout.

2.2 Background

The Washington Department of Fish and Wildlife (WDFW) purchased the Island Unit in the 1950s to produce enhanced forage for over-wintering dabbling ducks and geese and as a hunting area. At the time it was purchased the diked area was approximately 470 acres. For many decades after it was purchased by WDFW portions of the diked area were used to produce enhanced and managed winter waterfowl forage.

Since the 1950's, additional considerations related to site management have arisen. In the late 1990's, when Chinook salmon populations were recognized as declining, an alternatives analysis was completed to assess restoration of the site. At the time the site was comprised of approximately 470 acres that were isolated from tides and river flows behind dikes and tidegates. WDFW selected an alternative to restore a portion of the site to estuary and maintain the remainder of the site in enhanced winter waterfowl forage production. In 2000, the Deepwater Slough project was completed and approximately 200 acres were restored to estuary. This project was authorized under Section 1135 of the Water Resources Development Act of 1986, which allows the Army Corps of Engineers (Corps) to plan, design and build modifications to existing Corps projects, or areas degraded by Corps projects, to restore aquatic habitats for fish and wildlife. Completion of the past project does not preclude future restoration at this site.

Since 2000 additional issues have arisen that WDFW must respond to. First, infrastructure on the site has aged; some no longer work as designed, is difficult to repair or replace and, in some cases, is at risk of failure. Dikes have been damaged by floods, and dike repairs have become more difficult to fund and permit. Tidegates and water control structures are not performing as designed, and are at risk of failure.

Due to concerns about the tidegate and water control structure at the southwest end of the east island (called the Barn Field tidegate), starting in 2014 WDFW sought permits and funding for replacement. Through the permitting process, tribes raised concerns about continuing to cut off access to historic habitats for Endangered Species Act (ESA)-listed Chinook salmon and asserted that replacement of the tidegates should require compensatory mitigation. These concerns were not resolved and WDFW withdrew permit applications. WDFW and tribal interests met to determine a pathway forward. The decision was made to conduct an alternatives analysis to look at future potential management options for the site. Concurrent attempts to obtain funding for replacement of the Barn Field structures were not successful. Additional details on the tidegate and water control infrastructure function, condition and attempt at replacement (including mitigation requirements) are outlined in Appendix A.

Second, the listing of Puget Sound Chinook as threatened under the Endangered Species Act, and the identification of estuary as a limiting factor for recovery, raised the importance of estuary restoration in the Skagit delta. In response to this listing, the Island Unit was identified as a priority area for estuary restoration in several planning documents and agreements. Additional ESA-listings of species directly and indirectly tied to estuary habitats have occurred since 2000, namely bull trout, steelhead trout, and Southern Resident killer whale.

Lastly, the effects of climate change have become better understood in the past few decades, and anticipated changes will affect WDFW lands. At the Island Unit, sea level rise and changing river flows are anticipated to put additional strain on infrastructure, potentially causing more frequent and severe damage to dikes and tidegates, and changing the conditions under which tidegates were designed to operate. This is likely to result in reduced drainage capacity and a greater need for repairs.

As WDFW began this alternatives analysis, it was important that the implications of all potential management options were understood. We acknowledge that there are trade-offs to any decision that is made regarding management of lands owned by WDFW. The intent of this alternatives analysis is to consider the range of issues that affect a decision and to understand the trade-offs that would result from a given alternative so that WDFW could make a fully informed decision. We compiled existing information and engaged interested and affected parties in order to better understand the issues and trade-offs that would result from a given decision. We considered both site-scale and landscape-scale issues. This document outlines the process and considerations that were used for the alternatives analysis.

2.3 Decision-Making Process

WDFW assesses and makes decisions about restoration on agency-owned lands through a process called the restoration pathway. The restoration pathway outlines a process that is intended to ensure that major restoration project decisions on WDFW land are reviewed by WDFW staff with a diversity of expertise and that stakeholders and external parties have opportunity to provide input. To follow the restoration pathway, WDFW organized the following decision-making process specific to this project:

- A WDFW core project team consisting of regional staff from Habitat and Wildlife programs is responsible for day-to-day management of the project and execution of the project process. This team is also responsible for drafting project documents, compiling input, and recommending a preferred alternative to the WDFW Regional Management Team (RMT).
- A WDFW Skagit District Team consisting of staff from all programs provides input at key points in the project.
- A project advisory group consisting of stakeholders with diverse interests, government agencies and tribes provides input at key points in the project (the group specific to this project is described in detail in Section 2.4 and Appendix B).
- A broader portion of the public not on the advisory committee has an opportunity to comment.
- The Regional Management Team (RMT) consisting of local managers of each of the WDFW programs and the Regional Director reviews the core project team's recommendation and decides on a preferred alternative.
- The Regional Director decides whether to elevate the preferred alternative decision to relevant Program Directors within the agency.
- Upon completion of this decision process, the preferred alternative moves forward to the subsequent project phase.

2.4 Stakeholder and Public Engagement

Stakeholder and public engagement is an important aspect of the alternatives analysis process. Part of the restoration pathway process, described above, includes hearing from affected stakeholders, tribes and governments and addressing, to the degree possible, their input and concerns regarding the issues and considerations used to develop and select a preferred alternative.

WDFW hired Ross Strategic to guide and support staff in developing and carrying out a stakeholder and public engagement process for the project.

Advisory Group

A project advisory group was convened to provide input to WDFW on several aspects of the alternatives analysis.

In addition a number of ex officio members were invited to participate in the advisory group process. An ex officio member is someone who is a member by virtue of their position or office, so these members did not go through an application and review process. In addition, five WDFW staff that served as the project team members also participated in the advisory group as ex officio participants.

Advisory Group members agreed to reach out to their broader community of interest and strived to represent their community's perspective in Advisory Group discussions. Meeting materials can be found on the advisory group website[2] (under "meeting calendar." More detail on the advisory group selection process, charter, and meeting summaries can be found in Appendix B.

Public Comment

The publication of this Draft Alternatives Anaysis Report initiates the public comment period, and WDFW invites the public to comment on the content of this draft report. The 30 day public comment period will be from November 16, 2020 to December 16, 2020. The public will have the following opportunities to comment:

- Online public comment portal available at WDFW Island Unit project website
- Email public comments to SkagitWLA@dfw.wa.gov
- By mail to: WDFW North Puget Sound Regional Office
Attn: Seth Ballhorn
16018 Mill Creek Boulevard
Mill Creek, WA 98012-1541
- Virtual open house meeting via Zoom Webinar on December 2nd, 6-8pm. Members of the public will have the opportunity to provide public comments via webinar with a call-in option. Registration for the virtual open house is available online[3]

Public comments should refer to the content of the Draft Alternatives Analysis Report and frame comments as statements rather than questions.

After the comment period ends, WDFW will review comments. The Final Alternatives Analysis Report that identifies a preferred alternative will then be prepared that contains a summary of comments and updated information, as appropriate, to the analysis.

3. Conceptual Design Alternatives

The grant that funded the alternatives analysis was scoped to include an assessment of 3-4 alternatives ranging from no restoration to full restoration. This meant 1-2 partial restoration alternatives were included. This effort is a high-level analysis using landscape-scale assessment tools and existing data; analysis of detailed engineering solutions and structures is not within the scope of this analysis. Current site layout and features, elevation and actively managed field acreages are shown in Figures 2, 3 and 4. Potential actions considered for each alternative as part of this project phase include:

- Removing or replacing tidegates/water control structures.
- Removing, repairing, or setting back dikes.

Additional design components can be included after the preferred alternative is selected in order to provide the best outcome for all interests within the selected alternative.

As previously described, infrastructure that supports current management of the Island Unit is in disrepair and at risk of failing. When it fails, it will not be possible to manage the Island Unit as it is currently managed for enhanced and managed winter waterfowl forage, and it will not be fully functional estuary habitat for Chinook and other fish and wildlife. In order to maintain current management, some action will be required. For these reasons "No Action" was not considered viable and instead a "No Restoration" alternative was considered. This is represented and described below as Alternative 1 (Figure 5).

[2] https://wdfw.wa.gov/about/advisory/iuag

[3] https://rossstrategic.zoom.us/webinar/register/WN_VhgBSuDhToC0rPZaJZB8uw

Other considerations include features that can be seen in elevation data from the site (Figure 3). Perimeter dikes protect the east and west islands from high river flows and tides, two dikes bisect the west island and a low berm bisects the east island. Elevations inside the dikes (managed fields) generally range from 5 to 9.5 feet NAVD88; dike tops range from 13 to 20 feet NAVD88. Perimeter dikes isolate the site from tidal and riverine flows that would otherwise create and maintain estuary habitats. Water surface elevations outside the dikes range from approximately 3.5 to 13 feet NAVD88.

For development of partial restoration alternatives, we considered the following:

- In order to maintain enhanced and managed winter waterfowl forage and manage water levels the barge landing must remain in the same location on the west island.
- Flood protection and water level management structures must be maintained and improved (dikes, tidegates and water control structures). As noted in Appendix A, the existing tidegates and water control structures are aging and in need of replacement and the existing dikes have experienced minor overtopping. When considering sea level rise projections, dikes will need to be raised in order to withstand future conditions.
- Making use of existing features is assumed to reduce construction cost.
- Differences in elevation across the site affect drainage when farmed and potential habitat types when restored.
- Natural water flow (tides and river) and sediment movement that forms and maintains channels, moves nutrients, seeds, and wood around and supports native vegetation must be restored in order to provide sustainable estuary and salmon rearing habitat.

Tidal channel length and area was predicted for alternatives that include partial or full restoration (Alternatives 2-4). The best locations for where channels should be constructed as well as breaches to connect constructed channels through the dike footprint were also determined for Alternatives 2-4 (Appendix C).

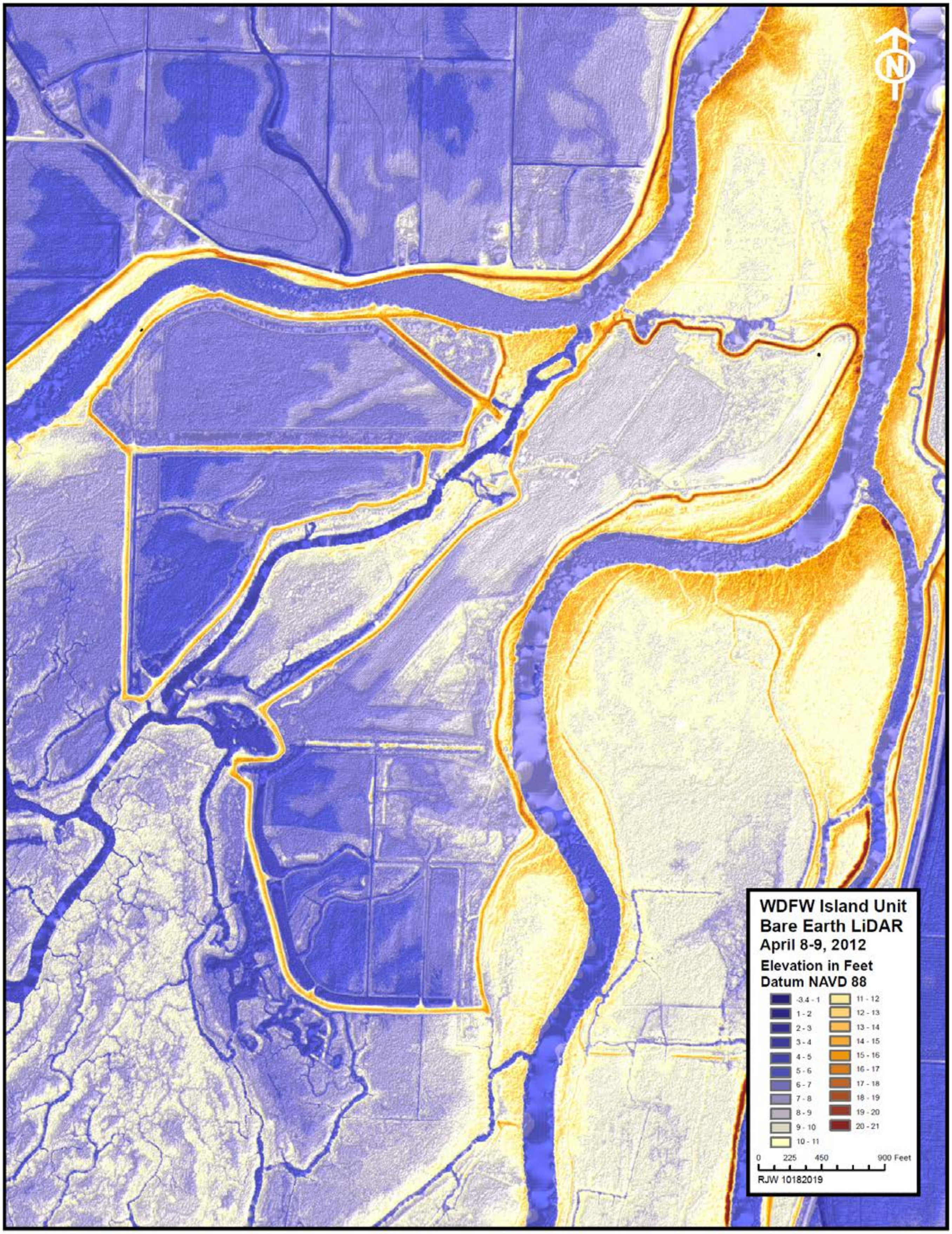


Figure 3. LiDAR elevation data on the site.

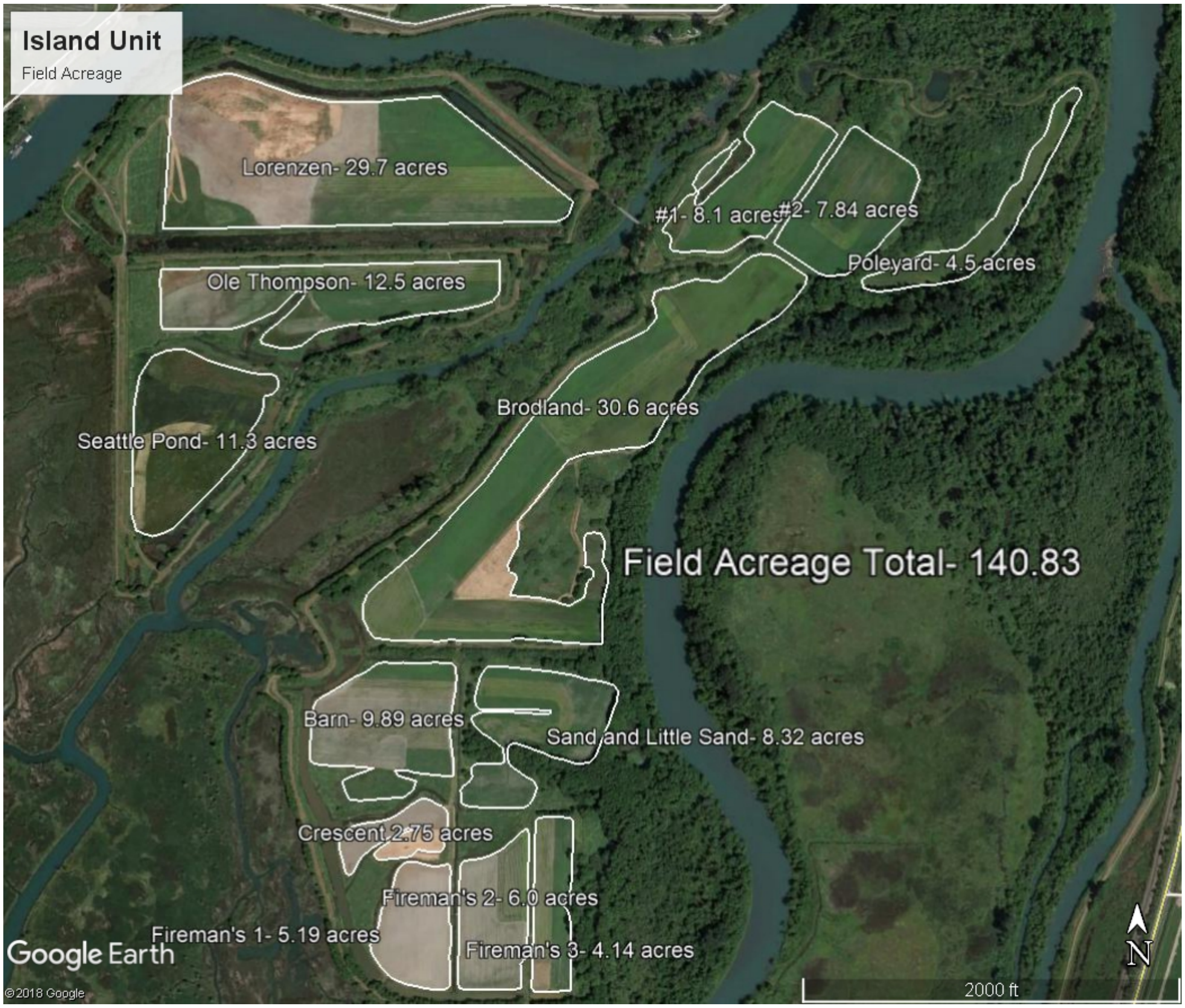


Figure 4. Approximate acreages of actively managed fields on the Island Unit in 2019. Field acreages are not equal to the total acreage of the site. Portions of the site are vegetated with trees and shrubs, some are too wet to be farmed, or are comprised of drainage ditches and cross-dikes, and some are permanent and seasonal freshwater wetlands. In fields where conditions are too wet to till and plant crops, pasture grasses are mowed. The total farmed acreage is different each year, depending on staff resources, drainage conditions, infrastructure function and progress toward increased acres of enhanced/managed winter waterfowl forage production over time.

3.1 Alternative 1: No Restoration

Alternative 1 (Figure 5) would involve replacing both the Seattle Pond and Barn Field tidegates (tidegates on west and east islands, respectively) and water control structures. All dikes would be raised to ensure they can withstand near-term sea level rise, and erosion areas would be addressed. In this alternative 0 acres are restored to estuary, and 270 acres are maintained under current management, including 141 acres of enhanced/managed winter waterfowl forage production. Mitigation would be required for areas that continue to be isolated from tidal and riverine processes by tidegates.

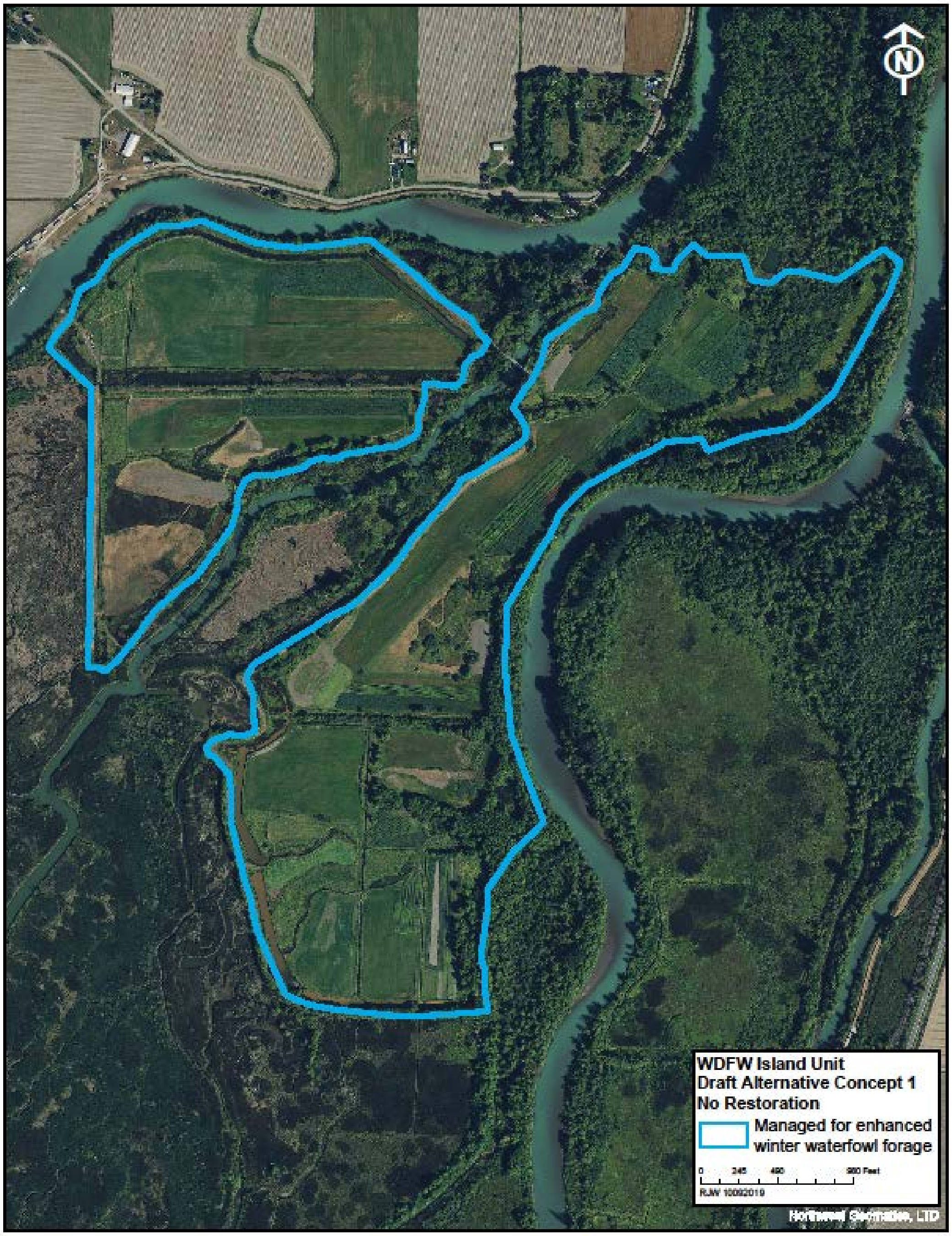


Figure 5. Alternative 1: no restoration.

3.2 Alternative 2: Partial Restoration—East Island

In Alternative 2 (Figure 6) the Seattle Pond tidegate and water control structure on the west island would be replaced; dikes on the west island would be raised to ensure they withstand near-term sea level rise, and problem erosion areas would be addressed. The east island would be restored to tidal and riverine influence by removing 50-100% of the dike length and constructing channels (Figure 7). In this alternative 170 acres would be restored to estuary and 100 acres would be maintained under current management, including 54 acres of enhanced/managed winter waterfowl forage production. Mitigation would be required for areas that continue to be isolated from tidal and riverine processes by tidegates.

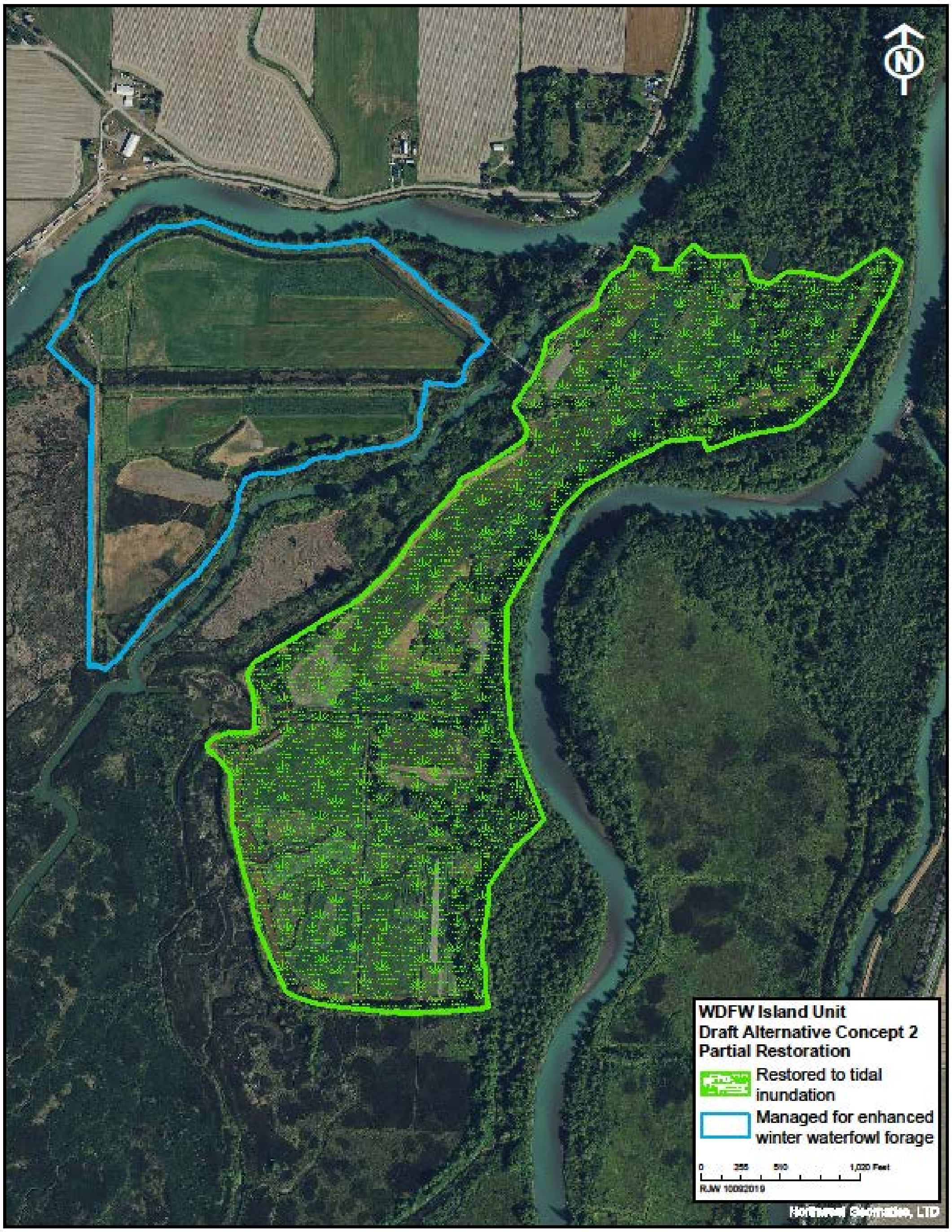


Figure 6. Alternative 2: partial restoration—east island.

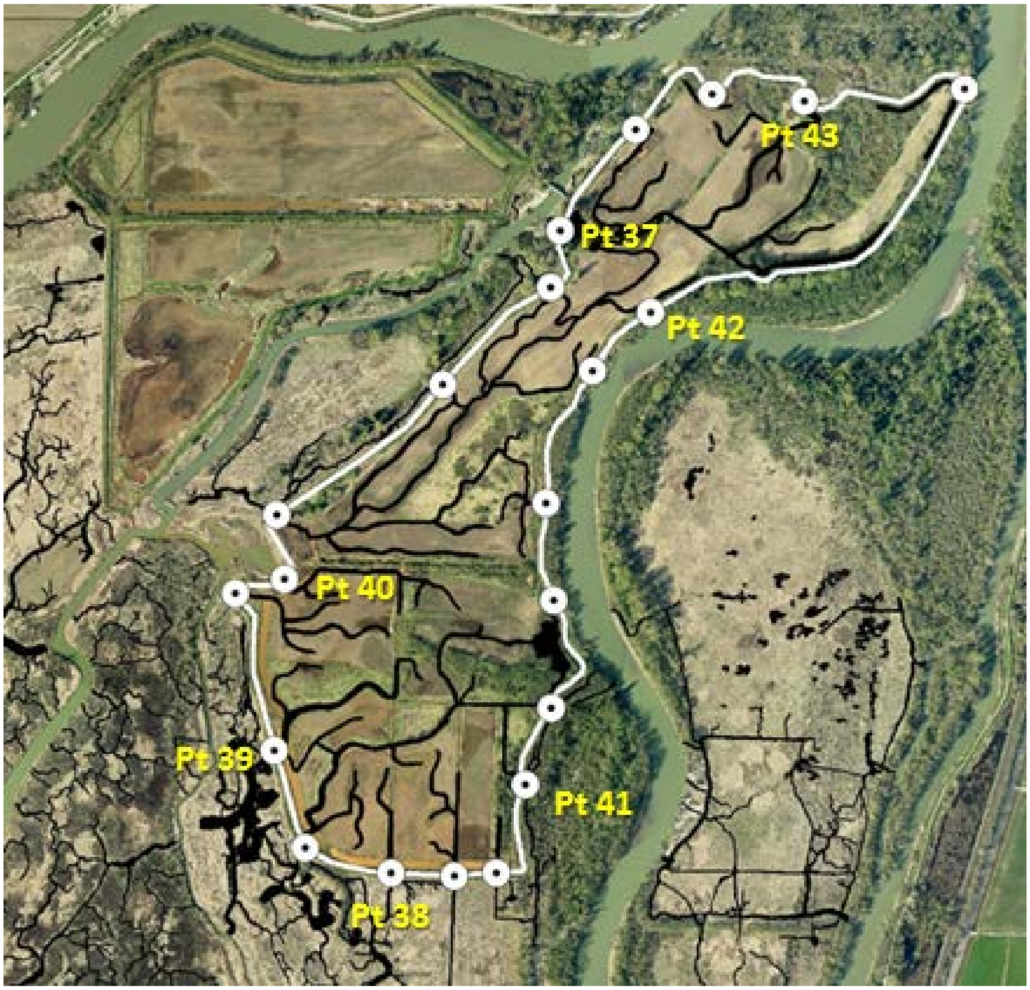


Figure 7. Channel locations and outlets for Alternative 2.Tidal channels are black lines. Tidal channel outlets are shown as white dots with a black center. "Pt ##" labels are related to Chinook smolt estimating methods and are explained in Appendix C. (From Beamer and Hood, 2020)

3.3 Alternative 3: Partial Restoration—Levee Setback

Alternative 3 (Figure 8) maintains current management on a portion of each island and makes use of existing features for setback dikes. Dikes would be removed over 50-100% of their length in areas to be restored to tidal and riverine influence, and tidegates and water control structures would be replaced on both islands within setback dikes. All remaining dikes would be raised to ensure they withstand near-term sea level rise, and erosion areas on the dikes that are not moved would be addressed. This would restore estuary on the lowest elevation areas. Channels would be constructed in areas restored to tidal and riverine influence (Figure 9). In this alternative 110 acres would be restored to estuary and 160 acres would be maintained under current management, including 81 acres of enhanced and managed winter waterfowl forage production. Mitigation would be required for areas that continue to be isolated from tidal and riverine processes by tidegates.

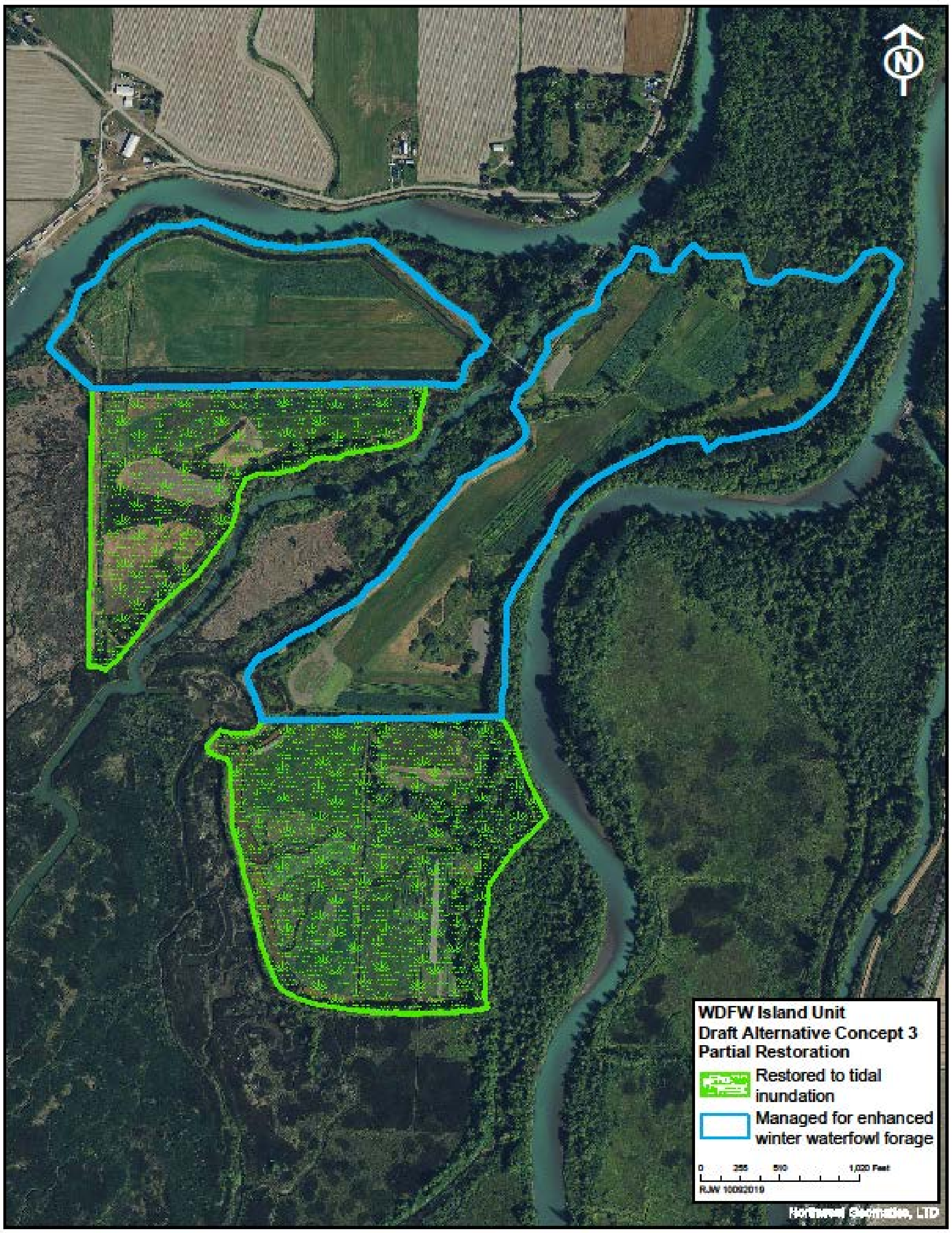


Figure 8. Alternative 3: partial restoration – levee setback

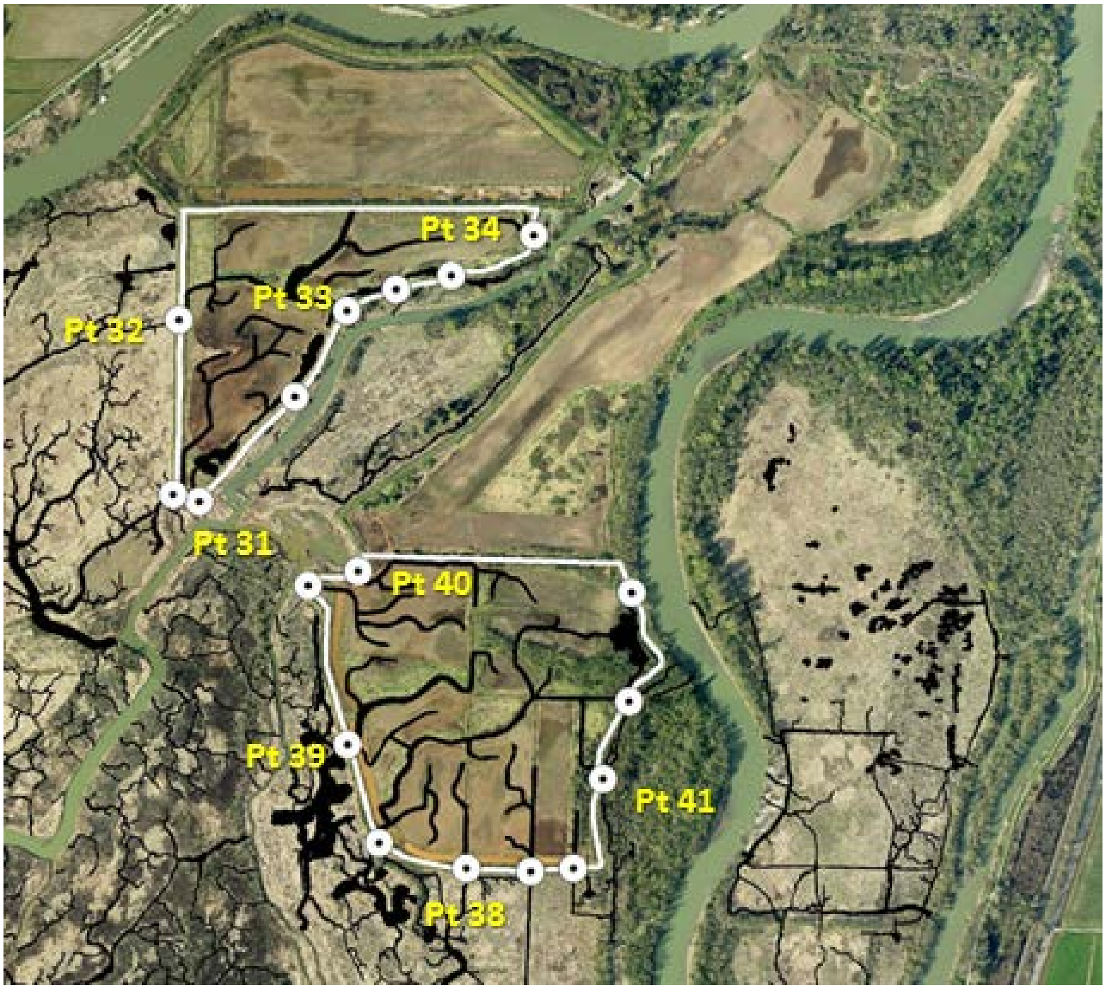


Figure 9. Channel locations and outlets for Alternative 3.Tidal channels are black lines. Tidal channel outlets are shown as white dots with a black center. "Pt ##" labels are related to Chinook smolt estimating methods and are explained in Appendix C. (From Beamer and Hood, 2020)

3.4 Alternative 4: Full Restoration

Alternative 4 (Figure 10) would involve removing all tidegates, water control structures and 50-100% of the dike length to restore tides and river flows to both islands. Channels would be constructed throughout the site (Figure 11). In this alternative 270 acres would be restored to estuary and 0 acres would be maintained under current management. No mitigation would be required.

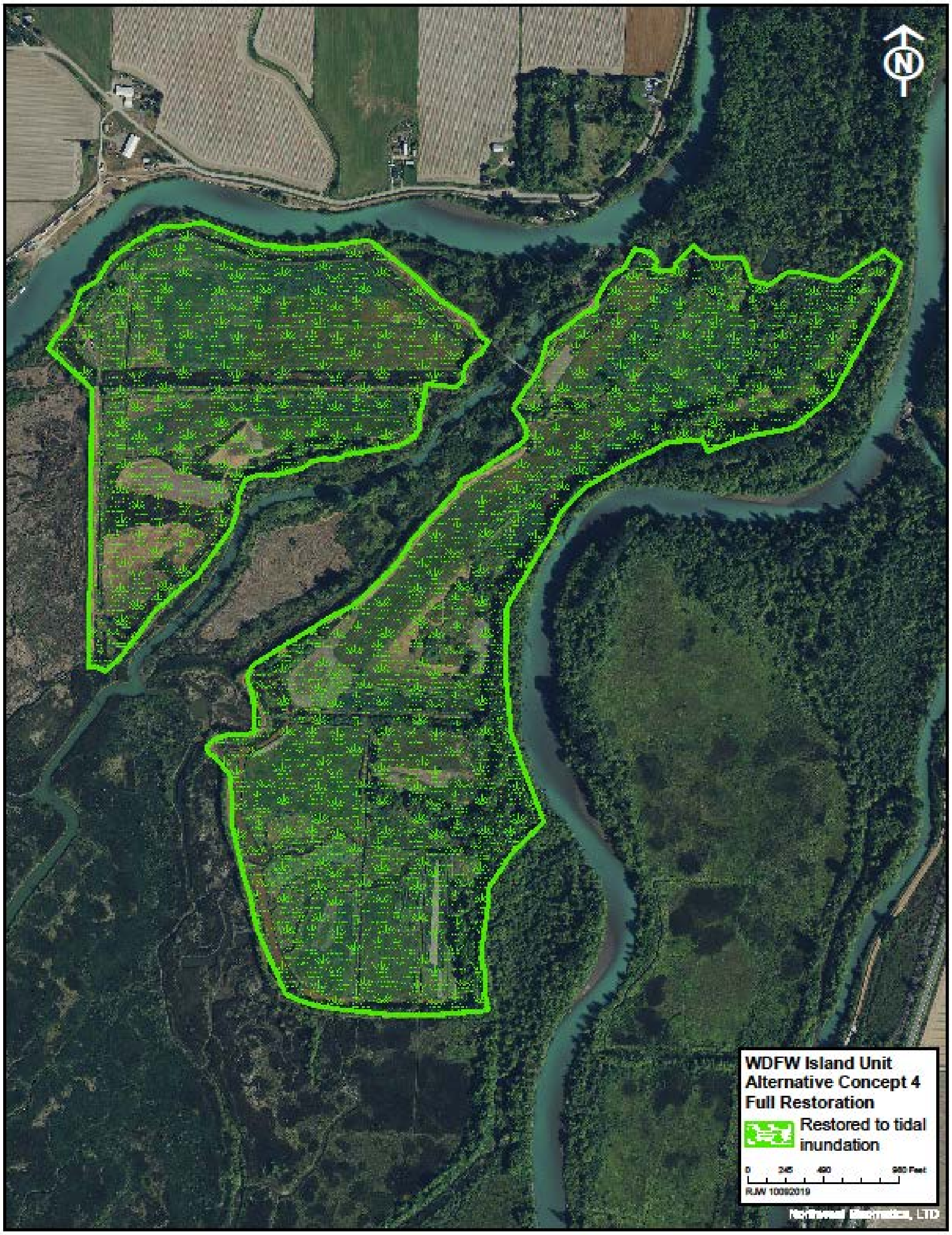


Figure 10. Alternative 4: full restoration.

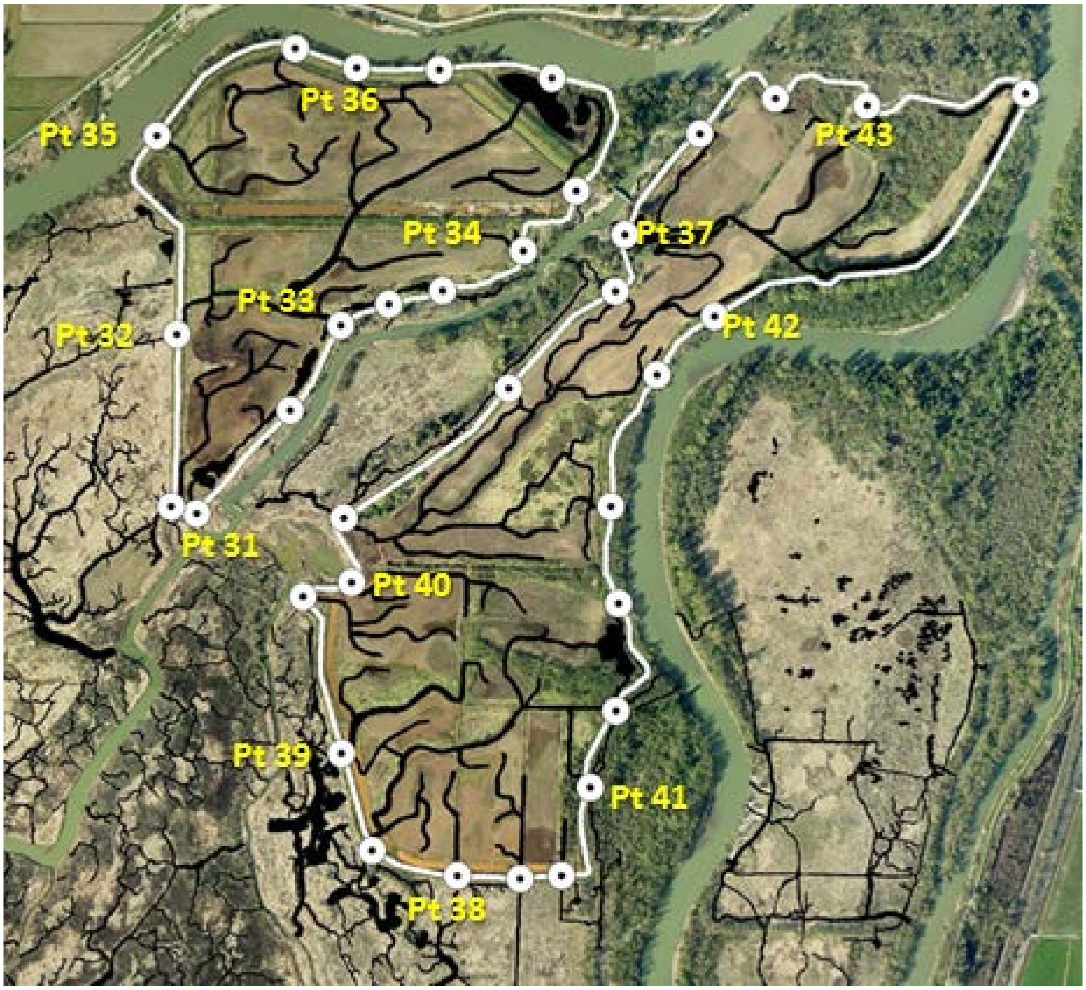


Figure 11. Channel locations and outlets for Alternative 4. Tidal channels are black lines. Tidal channel outlets are shown as white dots with a black center. "Pt ##" labels are related to Chinook smolt estimating methods and are explained in Appendix C. (From Beamer and Hood, 2020)

4. Criteria

This effort is a high-level analysis using landscape - scale assessment tools and existing data. Criteria are intended to capture the primary considerations WDFW used to compare alternatives.

Not all criteria have quantifiable metrics associated with them. This is due to a lack of data for a given topic or because the topic is value-based and therefore difficult to quantify. In these cases best professional judgement of WDFW staff was used after collecting input from the advisory committee. All criteria are qualitative unless otherwise noted.

A note about tribal treaty rights: WDFW jointly manages fisheries resources and collaborates with tribes to recover depleted fisheries resources including the habitats on which they depend. Although this is not included as a criterion below, this is an overarching principle that guides our work. Tribal treaty rights are explained by the Northwest Indian Fisheries Commission[4] as follows:

[4] https://nwifc.org/about-us/fisheries-management/

> *"The tribes in Western Washington fish commercially, and for subsistence and ceremonial purposes. They fish for all species of salmon and steelhead in marine and freshwater areas of Puget Sound and the Washington coast.*
>
> *US v. Washington (the "Boldt Decision") in 1974 reaffirmed tribes as co-managers, along with the State of Washington, of fisheries resources. Co-management means that the tribes and the State of Washington, through the Washington Department of Fish and Wildlife (WDFW), are jointly responsible for managing fisheries and hatchery programs, and that they collaborate in regional efforts to recover depleted fisheries resources.*

4.1 Management, Regulatory & Policy Considerations

4.1.1 WDFW Policies

Declaration of purpose—Department lands: WAC 220-500-010[5]

"The primary purpose of department lands is the preservation, protection, perpetuation and management of fish and wildlife and their habitats. Public use of department lands may include fishing, hunting, fish and wildlife appreciation, and other outdoor recreational opportunities when compatible with healthy and diverse fish and wildlife populations."

This language implies that conservation of fish and wildlife and their habitats is the priority purpose of WDFW lands.

Policy 5003: Managing the 21st Century Salmon and Steelhead Initiative[6]

Relevant sections: "*WDFW lands provide opportunities for salmon recovery; WDFW lands have historically been purchased and managed for big game, waterfowl, fish and upland birds. Management of these lands has not always addressed the needs of salmon and steelhead. WDFW must develop and implement management plans for WDFW lands with additional emphasis on habitat needs for salmon and steelhead*." (pg. 6)

This language implies that salmon and steelhead habitat needs are a component of land management decisions on WDFW lands.

Policy 5004: Department's Conservation Initiative and Guiding Principles[7]

Relevant sections: "*We practice conservation by managing, protecting, and restoring ecosystems for the long term benefit of people, and for fish, wildlife, and their habitat; We work across disciplines to solve problems; We integrate ecological, social, economic, and institutional perspectives; We embrace new knowledge and apply best science; and we collaborate with our co-managers and conservation and community partners."* (pg. 2-3)

This language implies that we work collaboratively, using best available science from across a range of disciplines and interests to accomplish our work.

---

[5] https://apps.leg.wa.gov/wac/default.aspx?cite=220-500-010
[6] https://wdfw.wa.gov/publications/00036
[7] https://wdfw.wa.gov/sites/default/files/about/advisory/hcicag/documents/implementation_guidance/pol-5004.pdf

Policy 5211: Protecting and Restoring Wetlands

Relevant sections: *"WDFW will accomplish long-term gain of properly functioning wetlands where both ecologically and financially feasible on WDFW-owned or WDFW-controlled properties; WDFW will promote the restoration of original hydrology, elevations and native plant communities."*

This language puts a clear focus on providing functional wetlands that rely on natural processes. We will consider the geomorphic setting and ability of a given alternative to support and sustain habitats over the long-term. Information from the geomorphic assessment and water surface elevation technical memo (Appendix D) will be used to evaluate alternatives relative to this criterion.

Washington State Wildlife Area Goals 1 – 3[8]

- Goal 1: *"restore and protect the integrity of priority ecological systems and sites"*
- Goal 2: *"sustain individual species through habitat and population management actions where consistent with site purpose and funding"*
- Goal 3: *"provide fishing, hunting and wildlife related recreational opportunities where consistent with goals 1 and 2"*

This language mirrors the purpose of state lands with the additional caveat that actions must be consistent with site purpose and funding. Site purpose for the Island Unit is being determined now through this alternatives analysis process, and will be based on past obligations and current needs as reflected in the full range of criteria presented in this document.

4.1.2 Obligations and Agreements

Acquisition Funding Obligations

The Pittman-Robertson Act, also known as the Federal Aid in Wildlife Restoration Act, was approved by Congress in 1937. The purpose of the Act is to provide funding for restoration of wild birds and mammals and to acquire, develop, and manage their habitats. Funds are derived from an 11% federal excise tax on sporting arms, ammunition, and archery equipment, and a 10% tax on handguns. These funds are collected from the manufacturers by the Department of the Treasury and are apportioned each year to the states by the U.S. Fish and Wildlife Service (USFWS) on the basis of formulas that consider the total area of the state and the number of licensed hunters in the state. WDFW purchased portions of the Island Unit with federal Pittman-Robertson (P-R) funds in 1951[9]. Specifically, the acquired land was intended "for the propagation of game and as a public hunting area." The remaining parcels on the Island Unit were acquired in the early 1950's using state wildlife funds, generated from the sale of fishing and hunting licenses. State wildlife funds have no identified management agreement as a part of the acquisition process.

While P-R funds were used to acquire portions of the Island Unit, WDFW cannot currently use P-R funds to complete some of the activities required to manage enhanced forage on the Island Unit, as USFWS does not permit the use of these funds for activities that have the potential to injure or take an endangered species. P-R funds cannot be used for activites such as chemical treatments for crop production or weed control. Although agricultural activities may not have a direct impact on ESA-listed salmon, steelhead and bull trout, federal funds cannot be used without a Habitat Conservation Plan approving the specific agricultural activities.

---

[8] https://wdfw.wa.gov/sites/default/files/publications/01810/wdfw01810.pdf

[9] P-R Project Agreement W-45-L

As part of the alternatives analysis, WDFW developed a waterfowl and shorebird technical memo (Appendix E) described in section 4.2.3 and evaluates site and landscape scale hunting access as described in section 4.3.4. Information in these sections is intended to inform the WDFW and USFWS determination of compatibility of the selected alternative with P-R funding. If the preferred alternative includes restoration, WDFW and USFWS will make this determination in the subsequent phase of project planning.

Alternatives Analysis Funding Obligations

The alternatives analysis must be consistent with contractual obligations associated with the Salmon Recovery Funding Board (SRFB) grant[10], which is funding the alternatives analysis. It must be consistent with the grant scope, which includes considering 3-4 alternatives that range from no restoration to full restoration.

House Bill 1418

- House Bill language[11]
- House Bill 1418 Report: Tidegates and Intertidal Salmon Habitat in the Skagit Basin[12]

House Bill 1418 was passed by the state legislature during the 2003 Regular Session. This bill is also known as the Tidegates and Intertidal Salmon Habitat in the Skagit Basin bill. House Bill 1418 was passed specifically to exempt tidegates and drainage infrastructure from fish passage requirements. The legislation provides that if a limiting factors analysis finds that there is insuffcent intertidal habitat for salmon recovery, WDFW and the County may jointly initiate a salmon intertidal habitat restoration planning process. This bill specifies that the planning process result in a "long-term plan for intertidal salmon habitat enhancement to meet the goals of salmon recovery and protection of agricultural lands" and that the plan "shall consider all other means to achieve salmon recovery without converting farmland" and finally that the "proposal shall include methods to increase fish passage and otherwise enhance intertidal habitat on public lands…". The task force established by this house bill developed a plan that identified Wiley Slough, Leque Island, Milltown Island, and Deepwater Slough Phase 2 (Island Unit) as Tier 1 areas for future restoration.

Migratory Bird Management

Migratory birds are cooperatively managed between state, federal and international entities. All migratory birds (a total of 1,093 species) are protected under the Migratory Bird Treaty Act (1918), and associated treaties between the United States with Canada, Mexico, Japan and Russia. It is acknowledged in these agreements that wetland habitats during different seasons (breeding, wintering and migration) are needed to achieve and maintain long-term conservation of population levels, distributions, and patterns of migration for the protection of migratory birds. It is under this framework that state law and regulations must consider proposed actions and activities to be consistent with agreed upon protections.

Coordination among partners related to the Migratory Bird Treaty Act (1918) and four international treaties, include:

- Flyway Councils that serve as the interface between state, federal and international entities for all regulatory decisions. The four flyway councils facilitate state, federal, and international coordination of migratory bird conservation and management, including development of conservation plans to serve as guiding documents.
- The four international migratory bird plans, the North American Waterfowl Management Plan, the United States Shorebird Conservation Plan, the North American Waterbird Conservation Plan, and the Partners In

[10] RCO agreement #17-1159P

[11] http://lawfilesext.leg.wa.gov/biennium/2003-04/Pdf/Bills/House%20Passed%20Legislature/1418-S2.PL.pdf?q=20200915082107

[12] https://wdfw.wa.gov/sites/default/files/about/advisory/iuag/smith_et_al_2005_tide_gate_salmon_recovery_analysis_skagit.pdf

Flight Conservation Plans serve as the guiding principles to align MBTA, the treaties and the North American Wetland Conservation Act.

- The North American Wetland Conservation Act (1989) encourages partnerships among public agencies and other interests to: 1) protect, enhance, restore, and manage an appropriate distribution and diversity of wetland ecosystems and habitats associated fish and wildlife in North America; 2) maintain current or improved distributions of wetlands associated migratory bird populations; and 3) sustain an abundance of waterfowl and other wetland associated migratory birds.
- Migratory Bird Joint Ventures, in coordination with the flyway council's state agencies, are cooperative, regional partnerships that work to conserve habitat for the benefit of birds, other wildlife, and people addressing the bird habitat conservation issues found within their geographic area. Each joint venture has a Strategic Plan that outlines habitat acreage goals to fulfill objectives and agreements of the four migratory bird plans. The south fork delta of the Skagit River falls within the High Priority areas identified in all four migratory bird plans (see USFWS mapping tool[13])

Skagit Tidegate Fish Initiative Implementation Agreement[14]

The Skagit Tidegate Fish Initiative (TFI) is a signed agreement between WDFW, Western Washington Agricultural Association, National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS), USFWS and commissioners from each of the twelve Skagit Diking, Drainage and Irrigation Districts that manage tidegates. The TFI includes 1) an implementation agreement to achieve functional estuary restoration by linking estuary restoration with long term drainage maintenance needs through a system of credits and debits, and 2) a biological opinion from the NMFS. The implementation agreement was developed by staff from the signatories as well as the US Army Corps of Engineers, Washington State Department of Ecology, and the Governor's Office. The implementing agreement is based on the Skagit Chinook Recovery Plan, House Bill 1418, and the need to maintain and replace tidegates. The agreement is a "collaborative effort by the participating parties to support estuarine restoration projects within the Restoration Area that are consistent with and provide a direct contribution to achieving the goals and objectives of the Skagit Chinook Recovery Plan" and that the agreement "will provide a system of checks and balances to assure that mutually supportive actions will occur in a timely and cooperative manner throughout the 25-year duration of this Agreement." Island Unit/Deepwater 2 is identified as a potential project that contributes to the goals outlined in the agreement.

4.1.3 Future Cost and Funding

Funding availability and relative implementation and construction cost

The total cost and likelihood of funding for construction is considered. Cost estimates include all design, permitting, mitigation and construction costs. Infrastructure design will reflect climate change predictions such as sea level rise, and take site limitations, such as power not being available, into account. Implementation cost is a quantitative metric and prediction of funding availability is a qualitative metric. Implementation costs are assessed in the Opinion of Probable Construction Cost technical memorandum (Appendix F).

Funding availability and relative cost for operations and maintenance (O&M)

The total annualized cost and likelihood of funding for operation and maintenance will be considered. Cost estimates will include operation and maintenance of dikes, tidegates, blinds and other infrastructure; farming and moist soils management; and control of weeds and other undesirable species. Major repairs to dikes and

[13] https://fws.maps.arcgis.com/apps/MapSeries/index.html?appid=632303c8dd8547e19b2b3198fac45078
[14] https://wdfw.wa.gov/sites/default/files/about/advisory/iuag/tfi_ia_final_4_21_10.pdf

tidegates will not be included. O&M costs are a quantitative metric and prediction of funding availability is a qualitative metric.

4.2 Fish and Wildlife Needs

4.2.1 ESA-Listed Chinook and Southern Resident Killer Whale Recovery

Endangered Species Act – Background

Congress passed the Endangered Species Act (ESA) in 1973, recognizing that the natural heritage of the United States was of "aesthetic, ecological, educational, recreational, and scientific value to our Nation and its people." It was understood that, without protection, many of our nation's living resources would become extinct.

The listing of a species as endangered makes it illegal to "take" (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to do these things) that species. Similar prohibitions usually extend to threatened species. Federal agencies may be allowed limited take of species through interagency consultations with NMFS or USFWS. Non-federal individuals, agencies, or organizations may have limited take through special permits with conservation plans. WDFW's ability to manage both recreational and commercial fisheries is directly impacted by the ESA listing of Chinook salmon and Southern Resident Killer Whales. There are individual criteria for ESA-listed Chinook and Southern Resident Killer Whales below. Other species of ESA-listed fish are captured below under Food fish and game fish in section 4.2.2.

ESA-Listed Puget Sound Chinook salmon

Puget Sound Chinook were listed as Threatened under ESA in 1999. In response to Chinook salmon being listed under the Federal Endangered Species Act, WDFW co-authored the Skagit Chinook Recovery Plan (SCRP) with the Skagit River System Cooperative, which represents the Swinomish Indian Tribal Community and Sauk-Suiattle Indian Tribe. The SCRP identifies estuary habitat as a limiting factor for Chinook recovery and places estuary habitat in the highest priority category for restoration. The plan also identifies Deepwater Slough Phase 2 (Island Unit) as a high priority project.

The Skagit Chinook Recovery Plan goal for the estuary is to provide space for an additional 1.35 million smolts, which is a gain of approximately 2,700 acres of estuary. Large sites that support extensive channel area and are located close to migration pathways provide the greatest value toward Skagit Chinook recovery. The Island Unit is identified as a potential estuary restoration site in the Skagit Chinook Recovery Plan (referred to as the Deepwater 2 project). The following reports provide background information:

- Skagit Chinook Recovery Plan[15]
- Estuary appendix[16]

Alternatives are assessed based on their alignment with recommendations in the Skagit Chinook Recovery Plan, and their ability to provide habitat for rearing juvenile Chinook. Quantifiable metrics that will be included are:

- Predicted acres of estuary (project footprint)

[15] https://wdfw.wa.gov/sites/default/files/about/advisory/iuag/skagit-chinook-recovery-plan.pdf
[16] https://wdfw.wa.gov/sites/default/files/about/advisory/iuag/skagitchinookrecoveryplanappendix-d-estuary.pdf

- Predicted acres of channel habitat (allometric model)
- Smolt carrying capacity (Skagit Chinook carrying capacity model)

Information from the tidal channel and Chinook salmon technical memo (Appendix C) is part of what is used to evaluate alternatives relative to this criterion.

ESA-Listed Southern Resident Killer Whale (orca)

Southern Resident Killer Whales (SRKW) have been listed as Endangered since 2005 and a recovery plan[18] was completed in 2008. While other populations of killer whales feed primarily on harbor seals or sharks, the primary prey species of SRKW is Chinook salmon. Several factors have been determined to be contributing to the decline of SRKW including prey availability, chemical contaminants, oil spills, vessel interactions and vessel sound. The Southern Resident Orca Task Force identified Chinook production as a core strategy for SRKW recovery. As the largest producer of Puget Sound Chinook, the Skagit River is considered especially important for the production of wild Chinook. NOAA and WDFW found fall Chinook from the Skagit River to be among the top priority stocks for SRKW (see Southern Resident Killer Whale Priority Chinook Stocks Report[19]) Recovery of fall Chinook in the Skagit is limited by the lack of estuary habitat and would benefit from estuary restoration.

4.2.2 Food fish and Game fish[20]

Estuary restoration is generally driven by the need to protect or recover a species listed under the Endangered Species Act (ESA) and in the Skagit Delta estuary restoration is focused on ESA-listed Chinook. ESA listed bull trout and steelhead are also found in Skagit estuary habitats along with many fish species that are not ESA listed. Pink, chum, and coho salmon, coastal cutthroat trout, and sturgeon are among the food fish and game fish species found occupying estuary habitats in addition to ESA listed Chinook, steelhead, and bull trout.

Skagit estuary research methods have been specifically desiged to capture and address questions about Chinook. Because of the limited scope of the research relatively little has been learned about the roles and estuary life histories of other foodfish and gamefish species. However researchers have gleaned new information that has shed additional light on food fish and gamefish use of the estuary. Below is a summary of our current understanding.

Bull trout were listed as threatened throughout Washington in November 1999. Research done on bull trout has shown a complex life history with individuals observed hundreds of miles from their natal streams entering estuarine and freshwater habitats to forage. The Skagit estuary provides high value foraging for juvenile bull trout originating from the Skagit as well as adult bull trout from the Skagit and other Puget Sound stocks.

Puget Sound Steelhead were listed as threatened under the ESA in 2007. The understanding of how steelhead use the estuary is limited and until recently they were not thought to use the estuary beyond passing through it as smolts migrating to the ocean and returning as adults to spawn. Recent estuary research using new trapping methods has found parr stage juvenile steelhead in estuary habitats. Parr stage steelhead in Puget Sound steelhead populations are known to be rearing fish as opposed to actively migrating.

---

[18] https://repository.library.noaa.gov/view/noaa/15975

[19] https://www.fisheries.noaa.gov/webdam/download/103504571

[20] *What are Food fish and Game fish? Food fish include salmon, sturgeon, halibut, bottomfish (such as rockfish and lingcod), forage fish (such as anchovy, herring and sardine), common carp, shad, tuna, mackerel, and others. Game fish include bass, burbot, catfish, crappie, grayling, perch, northern pike, tiger musky, suckers, sunfish, trout (including steelhead), landlocked salmon (such as chinook and coho salmon, and kokanee in designated waters listed in the Sport Fishing Pamphlet), walleye, whitefish and others.*

Coastal cutthroat trout (searun and resident forms) are a popular fishery, but not much is known about the abundance and life history of the species in the Skagit. We do know that estuary habitats are used by both juvenile and adult coastal cutthroat.

Coho are found in freshwater tidal estuary habitats of the Skagit River where juvenile coho rear for an extended period prior to outmigrating as smolts. Chum and pink salmon are known to occupy Skagit estuary habitats for about a week during the seaward migration and research from other river systems has suggested they may occupy estuary habitats for up to three weeks.

There is much to be learned about estuary habitat use by fish species other than Chinook. Despite what is not known about use by other food fish and game fish species, all species share the fact that while present in estuaries, regardless of how briefly, they benefit from access to these habitats.

4.2.3 Shorebird and Waterfowl Conservation

Migratory birds travel vast distances, and their habitats and populations are managed and monitored at multiple scales. For waterfowl, continental habitat needs are agreed to by the U.S., Canada and Mexico under the Pacific Flyway Council. Management and population objectives are developed and described in the North American Waterfowl Management Plan, and then broken down into regional and smaller planning areas. Washington State is part of the Pacific Coast Joint Venture which is broken down into sub-basin planning areas; the Skagit is in the North Puget Sound Lowlands sub-basin. Breeding population surveys, harvest data and local waterfowl flights all inform population status and management actions for waterfowl.

The U.S. Shorebird Management Plan was completed by USFWS in 2000. The goal of this plan is to ensure that adequate quantity and quality of *shorebird* habitat is maintained at the local level and to maintain or restore *shorebird* populations at the continental and hemispheric levels. The Greater Skagit Delta is designated as a site of Regional Importance under the Western Hemisphere Shorebird Reserve Network.

Wintering waterfowl and shorebirds use the Greater Skagit Delta (Samish, Padilla, Skagit and Port Susan Bays), including the Island Unit, for resting and feeding. The effect of restoring estuary habitat on waterfowl and shorebirds is not well-documented or understood. The limited studies and data that are available related to the value of managed upland vs. tidal estuarine habitats for waterfowl and shorebird conservation in the Greater Skagit Delta is described in the waterfowl and shorebird technical memo (Appendix E).

For this criterion we consider the importance of the Island Unit and how it is managed to waterfowl and shorebirds that winter in the Greater Skagit Delta. Information from the waterfowl and shorebird technical memo (Appendix E) is used to qualitatively evaluate alternatives relative to this criterion.

4.3 Community Interests

4.3.1 Agriculture

Both House Bill 1418 and the Tidegate Fish Initiative (TFI) are key considerations for the agricultural community. Links and descriptions of these agreements are included above. HB1418 required that a plan be developed to recover Chinook salmon with the least impact to private commercial farmland. The TFI identifies the restoration of the Island Unit as a project that would generate credits and therefore provides a benefit to the agricultural community and their need to maintain drainage infrastructure.

In addition to HB1418 and TFI, which provide benefits to agricultural interests, the Skagit Hydrodynamic Modeling (SHDM) Project[21] also highlighted the importance of certain projects to agriculture for a variety of reasons. This study is another key consideration for the agricultural community related to Island Unit.

Acknowledging that not all restoration projects hold the same value in terms of Chinook recovery or other community values, the HDM project sought to prioritize potential projects using a quantitative, multiple-interest framework and applying the best available science. Agricultural, flood risk and Chinook recovery interests were included in the assessment. The project evaluated 23 projects for their relative benefits and negative impacts to farm, fish and flood interests. Based on the results, the Island Unit project is in the highest priority group of projects.

4.3.2 Passive Recreation

It is important to note that this site is not used by many passive recreational users due to access being by boat only. Because passive recreational use is limited, the specific users and their preferences are relatively unknown. We assume some enjoy wildlife viewing and bird watching; others enjoy walking, photography or kayaking. We assume that some value ease of access by boat and then on foot as described below in the waterfowl hunting section, while others may prefer native estuarine habitats where dynamic processes shape landforms and conditions change frequently. A variety of habitats, species and experiences are likely valued by limited numbers of passive recreational users on and around the site.

For these reasons, passive recreational use will be considered, but we did not conduct detailed analysis of this topic related to the alternatives.

4.3.3 Recreational Fishing

The primary consideration for recreational fishing is whether proposed actions support the recovery and health of fishable populations. The ESA-listing of Puget Sound Chinook salmon, in particular, has constrained fishing seasons internationally, nationally, and within Washington coastal and Puget Sound waters, and river systems. There are six identified unique Chinook populations in the Skagit system and all of those have specific limits on how much harvest from each population or summed populations is allowable. When fishery managers model fisheries, harvest levels for each and every Chinook population from the Skagit and all Washington Chinook populations are estimated to make sure no population is over-fished. If a stock falls into critical status, it gets even more protection which often leads to severe curtailment of opportunities because all fisheries are managed to minimize impacts to the critical stock. Actions that support the recovery of Chinook, including restoring estuary habitat for juvenile rearing, can preserve and increase fishing opportunities in the Skagit River, Puget Sound, and beyond.

Ease of access on the site is not included in this criterion since recreational fishing is primarily boat-based or from marine shorelines in Puget Sound and not from riverine or estuarine shorelines at the site.

4.3.4 Waterfowl Hunting

There are both site-scale and landscape-scale considerations when it comes to assessing waterfowl hunting opportunity.

At a site scale, considerations that are taken into account when assessing this category are the type and variability of forage that is grown to attract waterfowl throughout the season and the number of hunting parties the site can support at any given time based on the layout of the site. Another consideration at the site scale is ease of access, which includes boat access to the site and ease of walking on the site. In terms of boat access, the primary consideration is the number and location of boat landings for a variety of watercraft (kayaks, trailered boats, etc.). Ease of walking includes the character of the walking surface (mostly mowed dikes, managed fields and ditches

[21] https://wdfw.wa.gov/publications/02123

with predictable water levels vs. evolving channels, vegetated marsh and logs with changing water levels), which influences the predictability of walking conditions. Each of these site scale metrics is assessed qualitatively by WDFW staff with input from the advisory group.

On a landscape scale, the availability of similar huntable forage types and acreages throughout the Skagit delta and broader North Puget Sound region is a consideration within the waterfowl hunting criteria. WDFW completed an inventory of all lands managed through its Wildlife Areas and Private Lands Access Program within Region 4 and specifically in the Skagit delta, comparing acreage numbers between 2000 (prior to salmon recovery projects) and 2016. The habitat type categories are: enhanced forage, managed forage, non-forested upland, intertidal, and riparian (tree/brush). This method is proposed because it is an easily measured and objective way to assess how WDFW's contribution to habitats that support hunting opportunities have changed on a landscape scale.

Additionally, existing data is compiled to evaluate the amount of hunt days statewide, county-wide and at the site scale to give a rough characterization of how the Island Unit and Skagit County relate to Objective 104 in the July 2015-June 2021 WDFW Game Management Plan[22], which statewide is to "Maintain hunter numbers between 35,000-45,000 and recreational use days between 300,000-500,000, consistent with population objectives."

4.4 Climate Change Resilience

Long-term resilience to climate change effects such as sea level rise and changing weather patterns and river hydrology are considered. While sea level rise predictions for a 50-year time horizon is incorporated into how construction costs are developed, this criterion considers whether each alternative is resilient to the anticipated effects of climate change over a longer time frame and ways each alternative is resilient given that there is uncertainty in how factors affecting the Island Unit will change. The ability for habitats to migrate and the potential for flood risk reduction will be part of this criterion. Information from the geomorphic assessment and water surface elevation technical memo (Appendix D) is used to assess this criterion.

[22] https://wdfw.wa.gov/sites/default/files/publications/01676/wdfw01676.pdf

5. Analysis of Conceptual Design Alternatives

Alternatives are rated for each criterion using the summary rating system in Table 1. Ratings are determined relative to current conditions. Some criteria did not "fit" the rating system. In those cases alternate rating systems are explained in individual criterion sections below. As noted above in the introduction to section 4, some criteria are assessed based on quantitative information and data, and some criteria are assessed based on qualitative information and best professional judgement of WDFW staff.

Table 1. Summary system used to rate alternatives relative to each criterion.

Substantial positive change	+ +
Positive change	+
Some positive effects, some negative effects	+/-
Comparable to existing conditions	√
Negative change	-
Substantial negative change	- -

The summary ratings for each alternative and each criterion are provided in Table 2 and explained in the text below. Ratings provide a summary only and not a complete understanding of all implications of a particular alternative relative to a criterion. The detailed implications are described in the the text throughout section 5. Also, please note that a negative change (-) or substantial negative change (--) does not mean that the alternative provides no remaining value or benefit for the criterion in question.

Lastly, the table is intended to capture the primary issues (criteria) that affect a decision regarding future management of the Island Unit. The ratings in the table will not be summed to provide a "total rating" per alternative, or to rank the alternatives from highest to lowest.

Table 2. Summary ratings for each alternative relative to each criterion.

	WDFW policies					Agreements & obligations					Costs and funding			Fish and wildlife needs							Community interests				Resi-lience
NOTE: the ratings in this table are a summary only; for a complete understanding of the ramifications of each alternative to a criterion, please read the entirety of Section 5	purpose of dept lands	policy 5003: salmon & steelhead	policy 5004: conservation initiative	policy 5211: protecting & restoring	state wildlife area goals	Acquisition funding obligations	Alt analysis funding obligations	House Bill 1418	Migratory bird management	Skagit tidegate fish initiative	cost and likelihood of implementation funding	likelihood of O&M funding	relative cost of O&M	ESA-listed Chinook	ESA-listed orca/SRKW	Food fish & game fish	shorebirds - site scale	shorebirds - GSD scale	waterfowl - site scale	waterfowl - GSD scale	Agriculture	Passive Recreation	Recreational fishing	Waterfowl hunting	Climate change resilience
Alt 1: No Restoration	+/-	-	+/-	-	+/-	yes	Yes	-	+/-	-	not likely	un-certain	√	-	-	-	√	√	+	√	-	√	-	+	-
Alt 2: Partial Restoration (east island)	+/-	+	+/-	+	+/-	TBD	Yes	+	+/-	+	un-known	un-certain	√	+	+	+	+	+	+/-	√	+	+/-	+	-	+
Alt 3: Partial restoration (levee setback)	+/-	+	+/-	+	+/-	TBD	Yes	+	+/-	+	un-known	un-certain	√	+	+	+	+	+	+/-	√	+	+/-	+	-	+/-
Alt 4: Full restoration	+/-	++	+/-	++	+/-	TBD	Yes	++	+/-	++	very likely	un-certain	√	++	++	+	++	++	--	-	++	+/-	++	--	++

5.1 Management, Regulatory & Policy Considerations

5.1.1 WDFW Policies

Declaration of purpose—Department lands: WAC 232-13-020

Conservation of fish and wildlife and their habitats are the priority purposes of WDFW lands. Hunting and fishing and other recreational opportunities are allowed when compatible with the primary uses. Each alternative will conserve habitats for a different suite of species. All alternatives will provide hunting, fishing and other recreational opportunities. For this reason all alternatives received a "+/-".

Policy 5003: Managing the 21st Century Salmon and Steelhead Initiative

Alternatives differ in their ability to contribute to salmon and steelhead habitat needs, which are a component of land management decisions on WDFW lands.

- Alt 1 does not provide any habitat for salmon and steelhead. Although Alternative 1 does not decrease the habitat value for salmon compared to the baseline condition, by rebuilding infrastructure to restrict salmon access it would commit WDFW to continuing the current management for a longer period of time than current infrastructure supports. For these reasons Alternative 1 received a "-".
- Alt 2 provides 170 acres of additional habitat for salmon and steelhead so it received a "+".
- Alt 3 provides 110 acres of additional habitat for salmon and steelhead so it received a "+".
- Alt 4 provides 270 acres of additional habitat for salmon and steelhead so it received a "++".

Policy 5004: Department's Conservation Initiative and Guiding Principles

All alternatives involve working collaboratively and using best available science from across a range of disciplines and interests to accomplish our work. For this reason all alternatives received a "+/-".

Policy 5211: Protecting and Restoring Wetlands

Alternatives differ in their ability to provide functional wetlands that rely on natural processes and are appropriate for the geomorphic setting where the site is located. Additional information related to this criterion can be found in the Geomorphic Assessment Technical Memo (Appendix D).

- Alternative 1 provides important freshwater wetlands that have been lost from the landscape. Providing them at this location, however, is not consistent with the natural processes or geomorphic setting of the site. Current site infrastructure and management specifically excludes original hydrology, processes that shape elevation and native plant communities. In this location, tidal and riverine processes allowing the flow of sediment, nutrients, organisms and wood are the natural processes that shape functional wetlands appropriate to the site. Alternative 1 would continue to exclude original hydrology, processes that shape elevation and native plant communities. For these reasons, Alternative 1 received a "-".
- Alternative 2 provides 170 acres of additional area subject to natural processes appropriate for the site location. For this reason, Alternative 2 received a "+". Additionally, with restoration of the entire east island, more natural hydrology is possible for the lower south fork Skagit. In essence, the "plug" in the lower river caused by Island Unit levees is reduced.
- Alternative 3 provides 110 acres of additional area subject to natural processes appropriate for the site location. For this reason, Alternative 3 also received "+". Note that the natural hydrology is not restored at a reach level to the same degree it would be with Alternative 2 because more of a "plug" would remain with Alternative 3.
- Alternative 4 provides 270 acres of additional area subject to natural processes appropriate for the site location and maximizes the functional wetland appropriate for this location. Additionally Alternative 4 removes all barriers (levees) to natural hydrology in the lower south fork at the Island Unit. For these reasons, Alternative 4 received a "++".

Washington State Wildlife Area Goals 1-3

Similar to the purpose of state lands, wildlife area goals focus on restoring and protecting the integrity of priority ecological systems and sites, and sustaining species through management actions. All alternatives will restore, protect and manage priority ecological systems for some species and preclude ecological systems for other. For these reasons all alternatives received a “+/-“.

5.1.2 Obligations and agreements

Acquisition funding obligations

Pittman-Robertson funds are the only funds used for acquisition of the Island Unit that have specific obligations. In this case the property was purchased with P-R funds “for the propagation of game and as a public hunting area.” The system developed for rating alternatives relative to a particular topic/criterion compares relative benefit or impact of a proposed action with existing conditions. In this case, we are asking whether a particular action is compatible with funding obligations.

Because Alternative 1 is comparable to current conditions, there is certainty that it is compatible with P-R obligations so it was given a “yes”. Alternatives 2-4 would provide habitat for game species and be open for public hunting, and so appear to be consistent with P-R obligations. However, because these scenarios would involve changes to each of these elements, additional discussion with USFWS will be needed in the subsequent project planning phase if one of these alternatives is selected. Due to the need for this additional discussion , Alternatives 2-4 were given “to be determined.”

Although there is uncertainty in this element at this phase of the project, there is certainty that WDFW must confirm compliance with this criterion in the next project phase if a restoration alternative is selected.

Alternatives analysis funding obligations

SRFB funds for this project require considering 3-4 alternatives that range from no restoration to full restoration. Alternatives that are being considered as part of the analysis meet this requirement. Similar to the P-R rating discussion, we are asking whether a particular action is compatible with funding obligations. For this reason, all alternatives were given a “yes.”

House Bill 1418

Estuary restoration on public lands in support of Chinook recovery is a key feature of HB 1418, and the subsequent report identified restoration at the Island Unit (Deepwater 2) as a Tier 1 priority for restoration. It is the only Tier 1 project that has not been restored.

- Alternative 1 does not restore estuary on public lands and does not restore any portion of a Tier 1 project. Because new infrastructure has a longer life-span than current infrastructure, we assume the opportunity for restoration is not possible for many years. For these reasons Alternative 1 received a “-“.
- Alternative 2 provides 170 acres of additional estuary habitat on public lands within a Tier 1 project footprint. For this reason Alternative 2 received a “+”. Because new infrastructure has a longer life-span, we assume the opportunity for additional restoration would not be possible for many years.
- Alternative 3 provides 110 acres of additional estuary habitat on public lands within a Tier 1 project footprint. For this reason Alternative 3 received “+”. Because new infrastructure has a longer life-span, we assume the opportunity for additional restoration would not be possible for many years.
- Alternative 4 provides 270 acres of additional estuary habitat on public lands and maximizes restoration within a Tier 1 project footprint. For these reasons Alternative 4 received “++”.

Migratory Bird Management

Changes to wetland habitats have implications for migratory birds that are managed under the migratory bird treaty act and subsequent treaties and plans. Because specific site-management requirements are not outlined in the agreements that come from the Migratory Bird Treaty Act, site management decisions are not vetted with the state and federal agencies involved. It is unknown how the proposed changes would be viewed by various state and international partners. Elsewhere in this document we evaluated shorebird and waterfowl needs, two of the classes of migratory birds. In general waterfowl are thought to benefit from enhanced and managed waterfowl and shorebirds are thought to benefit from estuarine habitat.

- Alternative 1 continues management similar to existing conditions except that replacing infrastructure improves conditions for management activities associated with enhanced and managed waterfowl forage and at the same time precludes restoration of estuarine habitats important for shorebirds for a longer period of time. For these reasons, it received a "+/-".
- Alternative 2 changes management of a portion of the site to native estuarine wetlands. Because waterfowl and shorebirds have different habitats needs, Alternative 2 received a "+/-".
- Alternative 3 changes management of a portion of the site to native estuarine wetlands. Because waterfowl and shorebirds have different habitats needs, Alternative 3 received a "+/-".
- Alternative 4 changes management of the site to native estuarine wetlands. Because waterfowl and shorebirds have different habitats needs, Alternative 4 received a "+/-".

Skagit Tidegate Fish Initiative Implementation Agreement

The Tidegate Fish Initiative Implementation Agreement ("TFI") balances the needs of districts that manage and maintain tidegates with progress toward estuary restoration goals for Chinook recovery. Estuary restoration benefits both salmon recovery and those that rely on drainage. Through the TFI agreement, estuary restoration results in credits that can be used when tidegate maintenance or repairs are needed.

- Alternative 1 does not restore estuary and generate credits. Because new infrastructure has a longer design life than current infrastructure, we assume the opportunity for restoration and credits is not likely for many years. For these reasons Alternative 1 received a "-".
- Alternative 2 provides 170 acres of additional estuary habitat and generates approximately 170 credits. Although Alternative 2 does not maximize the number of acres restored and credits generated, it is still a significant gain. For these reasons Alternative 2 received a "+".
- Alternative 3 provides 110 acres of additional estuary habitat and generates approximately 110 credits. Although Alternative 3 does not maximize the number of acres restored and credits generated, it is still a significant gain. For these reasons Alternative 3 received a "+".
- Alternative 4 provides 270 acres of additional estuary habitat and generates approximately 270 credits. For these reasons Alternative 4 received a "++".

5.1.3 Future Costs and Funding

Funding availability and relative implementation and construction cost

The likelihood of funding and cost of implementation have been combined into a single criterion.

The “Opinion of Probable Construction Costs” was developed by WDFW’s Region 4 Habitat Engineer (Appendix F). Because alternatives are conceptual at this stage, construction costs are provided as a general basis for comparison only, and are considered in combination with the likelihood that funding could be obtained for a particular alternative. Estimated costs were derived from actual costs from similar nearby projects and adjusted for inflation to the year 2020. Cost estimates include design, permitting, construction, construction inspection and oversight, mitigation and contingencies. For partial and full alternatives, natural estuarine hydrology may be restored by removing less than 100% of the dike length. For this reason a range of costs is provided that represents removal of 50-100% of the dike length.

Funding for any of the alternatives will be done through competitive processes and will target funding sources that focus on the type of management that a particular alternative supports. Funding for alternatives that have ecosystem benefits such as estuary restoration, natural processes restoration and restoration of habitats for ESA-listed species is available. Numerous state and federal grant programs fund actions that have ecosystem benefits. These funding sources prioritize actions that maximize restored acreages, fully restore natural process, are cost-effective, provide climate resilience and are supported in local and regional plans such as the Skagit Chinook Recovery Plan, Puget Sound Action Agenda and assessments associated with the Puget Sound Nearshore Ecosystem Restoration Project, among others. Estuary restoration on WDFW-owned land has ranked very well and been funded in the past.

Funding for the “no restoration” alternative is uncertain. Based on past experience, obtaining funding through WDFW’s capital budget process for infrastructure replacement in support of current site management at Island Unit is not likely. Other funding sources that could be used to replace infrastructure and allow for current management to continue are sources such as Duck Stamp and WWRP State Lands Development funds. However, these sources generally provide a much smaller amount of funding relative to salmon and ecosystem funding sources, and increasingly value actions that provide long term sustainability. Similar to the funding obligations rating discussion above, this is not a benefit or impact relative to existing conditions. Instead we are using a system of relative likelihood, ranging from very likely to very unlikely.

- The opinion of probable construction cost for Alternative 1 is $6.5M. Alternative 1 actions support management that does not meet ecosystem or salmon funding sources’ priorities, and so would not be funded by salmon and ecosystem sources. It is also very unlikely to be funded through non-salmon and ecosystem funding sources due to the low dollar amounts of funding provided through these sources relative to the cost and also due to questions about long-term sustainability. For these reasons, funding for Alternative 1 is considered “very unlikely.”
- The opinion of probable construction cost for Alternative 2 is $8.2-10.4M.
  Alternative 2 is the lower-cost partial restoration alternative and provides 170 acres of estuary. The cost of removing infrastructure on the east portion of the site is relatively low compared with setback levees and tidegates on both islands. In addition, Alternatives 2 provides greater process restoration and climate resilience and is, therefore, likely to be funded by salmon recovery and ecosystem restoration sources. However, funding to upgrade infrastructure on the west island in support of enhanced winter waterfowl forage production is not consistent with ecosystem and salmon recovery funding priorities and is more costly than non-salmon sources can provide. For these reasons, funding for Alternative 2 is considered “unknown.”
- The opinion of probable construction cost for Alternative 3 is $9.9-11.7M. Alternative 3 is the higher-cost partial restoration alternative and provides fewer (110) acres of restored estuary, less process restoration and less climate resilience than Alternative 2 or 4. In addition, the cost of building a setback levees on both the east and west islands increases the cost-benefit ratio compared to Alternative 2 from a salmon

recovery and ecosystem restoration perspective. Funding for setback dikes as part of restoring the southern portions of each island could be covered by salmon and ecosystem restoration sources, but the likelihood of funding for other site upgrades through these sources is unknown. Funding these site upgrades is more costly than non-salmon sources can provide. For these reasons, funding for Alternative 3 is considered “unknown.”

- The opinion of probable construction cost for Alternative 4 is $9.3-13.0M.
  Alternative 4 provides full process restoration, maximizes the restored acres, provides the greatest climate resilience and has the lowest cost-benefit ratio from a salmon recovery and ecosystem restoration perspective because infrastructure is removed and not upgraded. All of these factors mean Alternative 4 is well-aligned with ecosystem restoration and salmon recovery funding priorities. For these reasons, funding for Alternative 4 is considered “very likely.”

Funding availability and relative cost for operations and maintenance (O&M)

Current operation and maintenance funding for the Island Unit comes through the wildlife program budgeting process. It is a combination of funding from Wildlife General Fund and program-generated income, and a very small amount of P-R funds for select activities. O&M funding levels through the Wildlife General Fund and P-R are difficult to predict in any given biennium. Although O&M funding levels over the past decade have been adequate to manage the site for enhanced and managed winter waterfowl forage, projected state budget shortfalls for the FY21-23 biennium could impact O&M funding levels for the Skagit Wildlife Area. Funding for O&M activities such as cattail control have historically been funded with competitive grants. Funds for O&M activities associated with any of the alternatives comes with some degree of uncertainty as it relates to the source and amount of funds. For this reason, all alternatives received a rating of “uncertain.”

Relative cost of O&M

Cost estimates were developed by WDFW Wildlife Area and Weed Crew staff (O&M costs: Appendix G). Operation and maintenance funding costs include applicable current site management costs and/or the cost of future estuary management actions such as weed control, depending on the alternative. Cost estimates include labor, materials and equipment for the following categories: administration, ferrying/prep/miscellaneous, field prep/planting/spraying, dike and field mowing/maintenance, equipment maintenance, drainage/water control, blind construction/ maintenance, noxious weed survey and noxious weed control.

Current management relies on arrangements that allow WDFW to manage the site for less cost than fair market value for similar services. These arrangements include the lease of a barge for $1/year and a dedicated and skilled volunteer labor force that contributes well over 100 hours per year (136 hours in 2019). These arrangements may or may not continue into the foreseeable future. Management costs in the year 2019 were $41,382, which includes $7,670 in volunteer labor.

For future O&M cost-estimating purposes, a range of costs is provided for each alternative. For each alternative we provide a range of costs that considers the following:

- Because the certainty of the current barge and volunteer labor arrangements into the future is unknown, costs for alternatives that include current management on all or a portion of the site are also unknown. We developed a range of costs where the low end of the range assumes current arrangements continue and the high end assumes WDFW would have to pay more for barging and equipment. We did not include fair market rates in the high end of the range for services currently provided by volunteers.
- Because the amount of weed establishment in restored areas is uncertain, the amount of weed control that might be needed is also uncertain. As such, the O&M costs for alternatives that include partial or full

restoration include a range where the low end of the range includes weed survey only and no weed control and the higher end of the range includes survey and control of weeds on all restored acres.

The ranges and ratings for each alternative are as follows:

- Annual O&M costs for Alternative 1 are estimated to be $41,382 to $54,836. This is similar to the amount that is currently spent on O&M at the site so Alternative 1 received a "√".
- Annual O&M costs for Alternative 2 are estimated to be $25,890 to $58,860. This is similar to the amount that is currently spent on O&M at the site so Alternative 1 received a "√"Annual O&M costs for Alternative 3 are estimated to be $35,643 to $60,459. This is similar to the amount that is currently spent on O&M at the site so Alternative 1 received a "√".
- Annual O&M costs for Alternative 4 are estimated to be $7,862 to $52,600. This is similar to the amount that is currently spent on O&M at the site so Alternative 1 received a "√".

5.2 Fish and Wildlife Needs

5.2.2 ESA-listed Chinook and Southern Resident Killer Whale Recovery

ESA-listed Puget Sound Chinook salmon

Recommendations from the Skagit Chinook Recovery Plan include increased estuary habitat (area and smolt carrying capacity). Quantitative metrics used to compare the alternatives are predicted acres of estuary, predicted acres of channel habitat and predicted smolt carrying capacity. Channel acres and smolt carrying capacity numbers are taken from the Tidal Channel and Chinook Salmon Technical Memo (Appendix C).

- Alternative 1 would provide no gain in estuary acres, channel acres or smolt carrying capacity. Because infrastructure would be updated, we assume no restoration is likely for some period of time. For these reasons, Alternative 1 received a "-".
- Alternative 2 would provide 170 acres of estuary, 6.79 acres of channel and room for 45,776 (predicted range = 37,371 - 53,692) additional smolts. For these reasons, Alternative 2 received a "+".
- Alternative 3 would provide 110 acres of estuary, 4.47 acres of channel and room for 29,135 (predicted range = 26,116 - 32,309) additional smolts. For these reasons, Alternative 3 received a "+".
- Alternative 4 would provide 270 acres of estuary, 10.31 acres of channel and room for 72,820 (predicted range = 59,377 - 86,035) additional smolts. It would also maximize outcomes for Chinook on the site. For these reasons, Alternative 4 received a "++".

ESA-listed Southern Resident Killer Whale (SRKW)

This criterion considers estuary restoration to increase the availability of the SRKW primary prey (Chinook), and the importance of Skagit Chinook, in particular, for SRKW. The rationale for rating alternatives using the SRKW criterion mirrors the rationale and rating for the Puget Sound Chinook salmon criterion above. Although the relationship between increases in estuary and benefits to SRKW is not direct, ratings took into consideration that prey availability is a key strategy for SRKW recovery and Skagit Chinook's particular importance amongst Chinook stocks for SRKW.

- Alternative 1 would provide no gain in estuary acres, channel acres or smolt carrying capacity. Because infrastructure would be updated, we assume no restoration is likely for some period of time. For these reasons, Alternative 1 received a "-".

- Alternative 2 would provide 170 acres of estuary, 6.79 acres of channel and room for 45,776 (predicted range = 37,371 - 53,692) additional smolts. For these reasons, Alternative 2 received a "+".
- Alternative 3 would provide 110 acres of estuary, 4.47 acres of channel and room for 29,135 (predicted range = 26,116 - 32,309) additional smolts. For these reasons, Alternative 3 received a "+".
- Alternative 4 would provide 270 acres of estuary, 10.31 acres of channel and room for 72,820 (predicted range = 59,377 - 86,035) additional smolts. It would also maximize outcomes for Chinook on the site. For these reasons, Alternative 4 received a "++".

5.2.1 Food fish and Game fish

Since all species described in this criterion spend time in estuaries, we assume they derive some benefit from access to these habitats.

- Alternative 1 does not provide any habitat for food fish and game fish. Although Alternative 1 does not decrease the habitat value compared to the baseline condition, by rebuilding infrastructure to restrict fish access it would commit WDFW to continuing the current management for a longer period of time than current infrastructure supports. For these reasons Alternative 1 received a "-".
- Alternative 2 provides 170 acres of additional estuary habitat so it received a "+".
- Alternative 3 provides 110 acres of additional estuary habitat so it received a "+".
- Alternative 4 provides 270 acres of additional estuary habitat. While this is more habitat than in alternatives 2 and 3, the relative amount of benefit food fish and game fish experience from additional estuary habitat is unknown, so Alternative 4 also received a "+".

5.2.3 Shorebird and waterfowl conservation

Refer to the Waterfowl and Shorebird Technical Memo (Appendix E) for information related to this section.

Shorebirds – site scale

Although shorebirds use the Island Unit under certain conditions provided by current management (wet, unvegetated soils), shorebirds are primarily tied to intertidal marshes and mudflats. Any increase in estuarine habitats at the site scale will benefit shorebirds.

- Alternative 1 would not provide any additional estuary habitat, which is similar to existing management. For this reason, Alternative 1 received a rating of "√".
- Alternative 2 would provide 170 acres of additional estuary habitat. For this reason, Alternative 2 received a rating of "+".
- Alternative 3 would provide 110 acres of additional estuary habitat. For this reason, Alternative 3 received a rating of "+".
- Alternative 4 would provide 270 acres of additional estuary habitat. For this reason, Alternative 4 received a rating of "++".

Shorebirds – GSD scale

Shorebirds are highly mobile and routinely move within the GSD. The habitats they use are primarily estuary and adjacent farmland; many species do not venture inland as far as waterfowl to seek foraging and resting habitats. In addition, estuary habitat losses continue to occur due to coastal erosion and human impacts. Consequently, as estuary is restored and intertidal shorebird habitat increases, shorebird populations will likely also benefit at the GSD scale. As such the ratings for this criterion are the same as those for the site-scale shorebird criterion.

- Alternative 1 would not provide any additional estuary habitat, which is similar to existing management. For this reason, Alternative 1 received a rating of "√".
- Alternative 2 would provide 170 acres of additional estuary habitat. For this reason, Alternative 2 received a rating of "+".
- Alternative 3 would provide 110 acres of additional estuary habitat. For this reason, Alternative 3 received a rating of "+".
- Alternative 4 would provide 270 acres of additional estuary habitat. For this reason, Alternative 4 received a rating of "++".

Waterfowl – site scale

At the site scale, waterfowl benefit from farmed forage (enhanced and managed winter waterfowl forage) and carefully managed water levels that optimize ducks' ability to access the forage. A reduction in acres managed as they are currently managed on the Island Unit will reduce the calories available to waterfowl at the site scale and reduce waterfowl numbers that congregate on the site. It is important to note that for partial and full restoration alternatives, a change from managed and enhanced winter waterfowl forage to estuary forage is not a total loss of forage value, but a reduction in forage value. The caloric value of estuarine systems for waterfowl in the Pacific Northwest has not been quantified, but is thought to be significantly lower than enhanced and managed forage.

Managed and enhanced forage result in concentrated waterfowl use and therefore increased hunting pressure which is a source of disturbance. Current management and hunting disturbance have changed waterfowl behavior so that the majority of foraging and resting activity on site occurs during non-hunting hours (hours of darkness) from mid-October until the end of January. Conversely, estuarine habitats experience less hunting disturbance per acre because concentrations of waterfowl are lower. Hunter use and disturbance would likely be reduced in areas restored to estuary.

Because forage availability (caloric value and water levels that support foraging) are thought to be the largest drivers in waterfowl conservation at the site, those factors were the ones used to develop the summary ratings below.

- Alternative 1 maintains 270 acres as is, including 141 acres in enhanced/managed winter waterfowl forage production. With updated infrastructure that provides more reliable water control, water level management at the site will be improved. For these reasons, Alternative 1 received a rating of "+".
- Alternative 2 maintains 100 acres as is, including 54 acres of enhanced/managed winter waterfowl forage production. Similar to Alternative 1, with updated infrastructure water level management at the site will be improved. 170 acres of the site will be restored to estuary, resulting in a loss of 87 acres of forage production. Waterfowl forage is available in the restored estuary but has lower forage plant density and caloric content. Access to food resources is only available at certain tides. For these reasons, Alternative 2 received a rating of "+/-".
- Alternative 3 maintains 160 acres as is, including 81 acres of enhanced/managed winter waterfowl forage production. Similar to Alternative 1, with updated infrastructure water level management at the site will be improved. 110 acres of the site will be restored to estuary, resulting in a loss of 60 acres of forage production. Waterfowl forage is available in the restored estuary but has lower forage plant density and caloric content. Access to food resources is only available at certain tides. For these reasons, Alternative 3 received a rating of "+/-".
- Alternative 4 does not maintain any portion of the site in enhanced/managed winter waterfowl forage production and water levels are no longer managed. Waterfowl forage is available in the restored estuary

but has lower forage plant density and caloric content. Access to food resources is only available at certain tides. For these reasons, Alternative 4 received a "--".

Waterfowl – Greater Skagit Delta (GSD) scale

Waterfowl use many habitat types and food resources across the greater Skagit delta (GSD). Because the Island Unit is small relative to areas that waterfowl use within the GSD, changes in management at the Island Unit are unlikely to result in a decline in the winter waterfowl population at the GSD scale, but rather shift the number of dabbling ducks to disperse across the larger landscape. We assume at a landscape scale that any loss in forage value at the site will be made up for on the larger landscape, but WDFW does not control the management of the larger landscape, which adds uncertainty to the outcome of all alternatives.

- Under alternatives 1-3, the Island Unit will continue to contribute to production of waterfowl forage with the highest caloric content within the GSD. For these reasons, alternatives 1-3 received a rating of "√".
- Alternative 4 received a "-" because under this scenario, the Island Unit provides a reduced contribution to waterfowl forage at the landscape scale, and waterfowl would rely more heavily on the ability of surrounding lands that are not controlled by WDFW to provide forage. Note that waterfowl populations are not expected to decline at the landscape scale under this scenario.

5.3 Community values

5.3.1 Agriculture

In addition to HB1418 and TFI (captured above), the Skagit Hydrodynamic Modeling (HDM) Project also highlighted the importance of certain projects to agriculture. The Island Unit project is in the highest priority group of projects based, in part, on maximizing benefits and minimizing negative impacts to agriculture. For these reasons restoration of the site is considered positive for agriculture.

- Alternative 1 would not provide any restoration at Island Unit and infrastructure upgrades ensure the site is not restored to estuary for the foreseeable future. For these reasons, Alternative 1 received a "-".
- Alternative 2 would provide partial restoration of the Island Unit site. For this reason, Alternative 2 received a "+".
- Alternative 3 would provide partial restoration of the Island Unit site. For this reason, Alternative 2 received a "+".
- Alternative 4 would provide full restoration of the Island Unit site, maximizing the benefits and minimizing the negative impacts of restoration on agriculture. For these reasons, Alternative 4 received a "++".

5.3.2 Passive recreation

Passive recreational users enjoy a variety of activities and experiences (e.g. birdwatching, photography, etc.) and value different habitat types. We assume that updating infrastructure maintains the status quo for recreational users, and any change provides benefits for some users and negatively impacts others. For these reasons, Alternative 1 received a "√" and all others alternatives received a "+/-".

5.3.3 Recreational fishing

Estuary habitat restoration that provides additional rearing habitat is an important action in the recovery of Puget Sound Chinook salmon. Gains in Puget Sound Chinook numbers are closely linked to increased fishing opportunities within Washington coastal and Puget Sound waters and river systems, including recreational fisheries. Increased estuary habitat also supports the health of other food fish and game fish that provide important recreational fisheries. As a result, the ratings and rationale in this criterion mirror those for the

"Chinook salmon" criterion above: gains in estuary habitat (including predicted acres of estuary, predicted acres of channel habitat and predicted Chinook smolt carrying capacity) are positive; continuing to isolate areas is negative.

- Alternative 1 received a "-".
- Alternative 2 received a "+".
- Alternative 3 received a "+".
- Alternative 4 received a "++".

5.3.4 Waterfowl hunting

Site scale considerations: Preferences on the type and style of waterfowl hunting are very subjective and personal. However, as it relates to this alternatives analysis WDFW staff and waterfowl hunters suggested that the following factors should be considered: 1) The availability of enhanced winter waterfowl forage which attracts high concentrations of waterfowl use through the whole hunting season. 2) The number of hunting parties supported by the site which can include number of blinds and non-blind-based hunting opportunities. 3) Site access which includes the number of boat landing sites and predictability of walking conditions.

Although factors 1-3 would be reduced or altered in alternatives that reduce the amount of acres under current management, hunting in native and restored estuary is valued and preferred by some hunters and would be allowed on any portion of the site that is restored.

Landscape scale considerations: The availability of similar huntable forage types and acreages throughout the Skagit delta and broader North Puget Sound region was also considered. The forage types considered include: enhanced forage, managed forage, non-forested upland, intertidal, and riparian (tree/brush). An inventory of WDFW-managed lands within the Skagit delta that are open for public hunting compared how habitat types within those lands have changed since 2000 (refer to the Hunted Habitats memo in appendix H). The summary finding of that inventory is that WDFW has continued to provide a diverse portfolio of waterfowl hunting land in the Skagit delta and huntable habitat acreages have increased in every category since the year 2000 except for the "enhanced waterfowl forage", which has decreased by 547 acres, and a slight decrease in "riparian/brush" and "non-forested upland" habitat, which aren't preferred by waterfowl hunters.

In addition to the considerations listed above, WDFW compiled existing data to help contextualize the contribution of the Island Unit in its current management regime with Skagit County and statewide numbers. Recent estimates from WDFW's Small Game Questionnaire indicates that total waterfowl hunter days afield is below the 300,000 statewide objective stated in the WDFW Game Management Plan (Objective 104). Skagit County ranks 2nd amount Washington counties, providing an average of 20,000 waterfowl hunter days afield. This ranks Skagit County 36th out of 3,115 counties nationally. A considerable portion of this hunting effort occurs on public lands, with 64.7% of hunters within the Pacific Flyway indicating they hunt on public land with 64.3% indicating the lack of public places is a moderate to very severe problem and 26.3% indicating it is a very severe problem (National Survey of Waterfowl Hunters: Summary Report for the Pacific Flyway[23]).

WDFW has counted boat trailers parked at the two nearest boat launches to the Island Unit at Headquarters and Conway between 2016-2019 during waterfowl hunting season. These counts total 5,253 boat trailers over four hunt seasons, which averages as 1,313 boats per season. The percentage of these boats that hunt at the Island Unit as opposed to other sites nearby is uncertain, as is the number of hunters per boat. However, these numbers

---

[23] https://nawmp.org/sites/default/files/2018-03/National%20Survey%20of%20Waterfowl%20Hunters%20Pacific%20Flyway_1_0.pdf

do indicate that a meaningful percentage of hunting effort within Skagit County occurs at the Island Unit and vicinity.

- Alternative 1 at the site scale would maintain or slightly increase the acreage in managed and enhanced waterfowl forage production (141 acres) to attract high concentrations of waterfowl, support the same number of hunting parties and provide similar access as current conditions. Updated infrastructure would provide more reliable drainage and water level management. At the landscape scale, this alternative would maintain the “enhanced waterfowl forage” category in the broader greater Skagit delta area. For these reasons Alternative 1 received a “+”.
- Alternative 2 at the site scale would provide fewer acres of managed and enhanced waterfowl forage production, support fewer hunting parties and provide fewer boat landings. However, updated infrastructure on the west island would provide more reliable drainage in support of forage production and more reliable water level management in winter for hunters. At the landscape scale, this alternative would reduce the “enhanced waterfowl forage” category by 54 acres and would add 170 acres of intertidal habitat. For these reasons, Alternative 2 received a “-“.
- Alternative 3 at the site scale would provide fewer acres of managed and enhanced waterfowl forage production, support fewer hunting parties and provide fewer access points. However, updated infrastructure on the northern portions of each island would provide more reliable drainage in support of forage production and more reliable water level management in winter for hunters. At the landscape scale, this alternative would reduce the “enhanced waterfowl forage” category by 81 acres and would add 110 acres of intertidal habitat. For these reasons, Alternative 3 received a “-“.
- Alternative 4 at the site scale would eliminate managed and enhanced winter waterfowl forage production from the site meaning high concentrations of waterfowl would be unlikely to congregate on the site. The number of hunting parties the site could support would likely be reduced. Boat in access would not be provided at established landings. Walkability and boat access of the site would be less predictable since it would be controlled by tides and river flow/flood conditions. Wood and debris have the potential to block channels. At the landscape scale, this alternative would reduce the “enhanced waterfowl forage” category by 141 acres in the greater Skagit delta and would add 270 acres of intertidal habitat. Hunters who prefer “enhanced waterfowl forage” habitats would likely use alternative WDFW sites on the landscape, and this could lead to higher hunter pressure on existing sites. For these reasons, Alternative 4 received a “--“.

5.4 Climate change resilience

There are three considerations included in the application of this criterion: the potential for habitat migration; long-term climate resilience to changing river hydrology and sea level rise; effect on flood risk in the lower south fork Skagit River. In general isolating areas behind levees does not provide space for habitats to migrate. River hydrology that is anticipated to become more “flashy” (including higher and more frequent flood flows) in combination with long-term sea level rise (SLR) predictions will put infrastructure at risk. And leaving structures in the lower south fork creates a “plug” that backs up flood waters and increases water levels in this reach of the river. Removing structures that block flow reduces flood risk and makes the larger system more resilient to changing hydrology. For more information, refer to the Geomorphic Assessment Technical Memo (Appendix D).

- Alternative 1 would not provide any space for habitats to migrate because it would continue to isolate 270 acres of uplands behind levees and tidegates. Infrastructure would be at risk of damage from larger and more frequent river floods in combination with SLR. Leaving both the east and west islands surrounded by levees leaves a large plug in the lower south fork Skagit, which backs water up during floods and puts upstream areas at higher risk of flooding. Updated infrastructure would ensure these issues persist for a longer period of time. For these reasons, Alternative 1 received “-“.

- Alternatives 2 is the more resilient of the partial restoration alternatives. Alternative 2 would leave infrastructure on site, which would be at risk from higher and more frequent flood flows and SLR, but Alternative 2 would also provide improved resilience in a couple of ways. Alternative 2 would provide 170 acres of restored estuary containing a wide range of elevations where habitats could migrate over a long timeframe, and it would remove part of the “plug” that blocks flood flows passing through the lower south fork Skagit. For these reasons, Alternative 2 received a “+”.
- Alternatives 3 is the less resilient of the partial restoration alternatives. Alternative 3 would provide 110 acres where habitats could migrate but these areas are relatively similar in elevation so would not provide for migration over as long a timeframe. Infrastructure left on site would be at risk from higher and more frequent flood flows and SLR. Lastly, Alternative 3 does not remove the “plug” that blocks flood flows passing through the lower south fork Skagit; in this way it is essentially the same as Alternative 1. For these reasons, Alternative 3 received a “+/-“.
- Alternative 4 would provide significantly more climate change resilience than existing conditions. This alternative would provide 270 acres of restored estuary containing a wide range of land elevations for habitat migration over a long timeframe. Alternative 4 also removes all infrastructure from the site, which removes barriers to flood flows in the south fork Skagit and eliminates the risk of damage to infrastructure on site associated with higher and more frequent flood flows and SLR. For these reasons, Alternative 4 received a “++”.

APPENDIX A: BARN FIELD AND SEATTLE POND TIDEGATES AND WATER CONTROL STRUCTURES

Barn Field and Seattle Pond tidegates and water control structures

This document is intended to outline the current tidegates with no change to the designed function of current structures.

Overview

The Island Unit is comprised of two islands, each of which is protected from tides and high river flows by dikes. Tidegates and water control structures located on each island were designed and built to manage water surface elevations. Tidegates allow drainage in support of farming (i.e. enhanced/managed winter waterfowl forage production) and water control structures provide the ability to flood these crops to improve access for waterfowl to feed. The structure on the west island is known as the Seattle Pond tidegate and the one on the east island is known as the Barn Field tidegate.

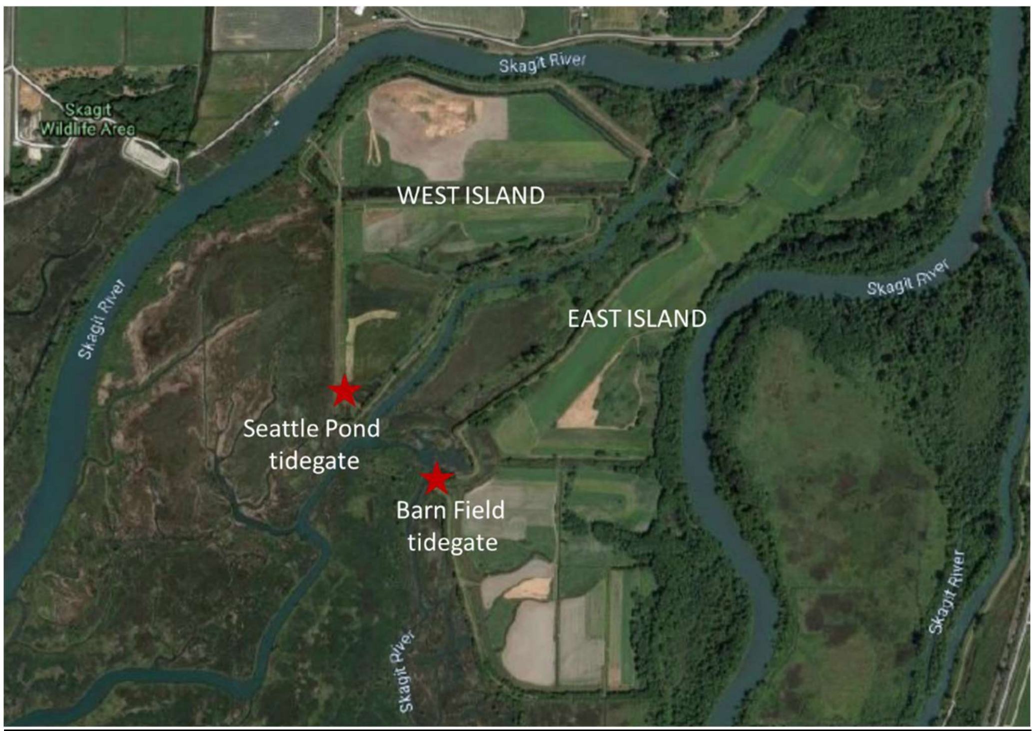


Figure 1. Location of tidegates and water control structures on the Island Unit site.

Over the decades since they were built, these structures have performed well but now have exceeded their projected life expectancy and are currently not functioning as designed. The current condition of the tidegates and water control structures restrict the management options on the Island. WDFW land managers have adapted planting and management to accommodate the restricted water management capacity. Active management of the site (mowing and cropping) is still possible, however, as the system continues to degrade this may become more difficult. Failure of one or both tidegates or culverts could result in dike failure. It is unknown whether WDFW would be able to farm any portion of the site if dikes failed, but given the elevation of the site relative to tidal elevations it seems unlikely that any portion of it could be farmed, and it is certain that WDFW would not be able to farm as much of the site as is now possible.

Structure Description:

The water control structures on the Island Unit combine multiple features that allow for control of water movement both onto and off the site. At both the Seattle Pond and Barn Field tidegates, there is a culvert that extends through the dike. On the exterior of the dike (tidal side), there is a top-hinge flapgate-style tidegate attached to the culvert. This gate is closed except when interior water surfaces are high enough relative to exterior water surfaces to push the gate open. As such, each gate keeps tidal water from entering the site but allows water to drain out when the tides drops below a certain level. Each tidegate is also connected to a threaded rod (known as a screw gate), which can be used to raise the tidegate above the culvert opening and allow water onto the site.

On the opposite end of each culvert (interior of the dike), there is a flashboard riser. The flashboard riser allows land managers to add and remove boards to control the water levels on the interior of the dike. Added boards retain water on the site; fewer boards allow water to drain out.

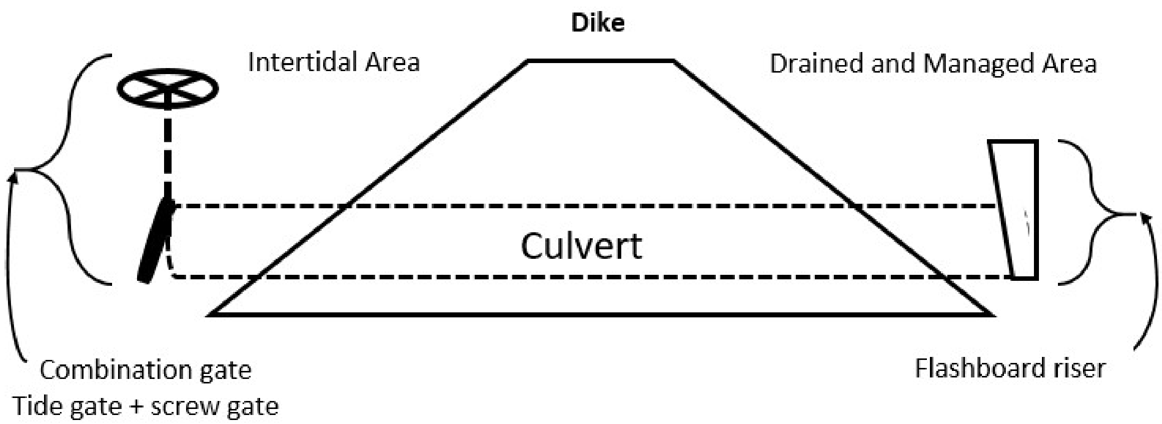


Figure 2. Schematic of Barn Field and Seattle Pond tidegates and water control structures.

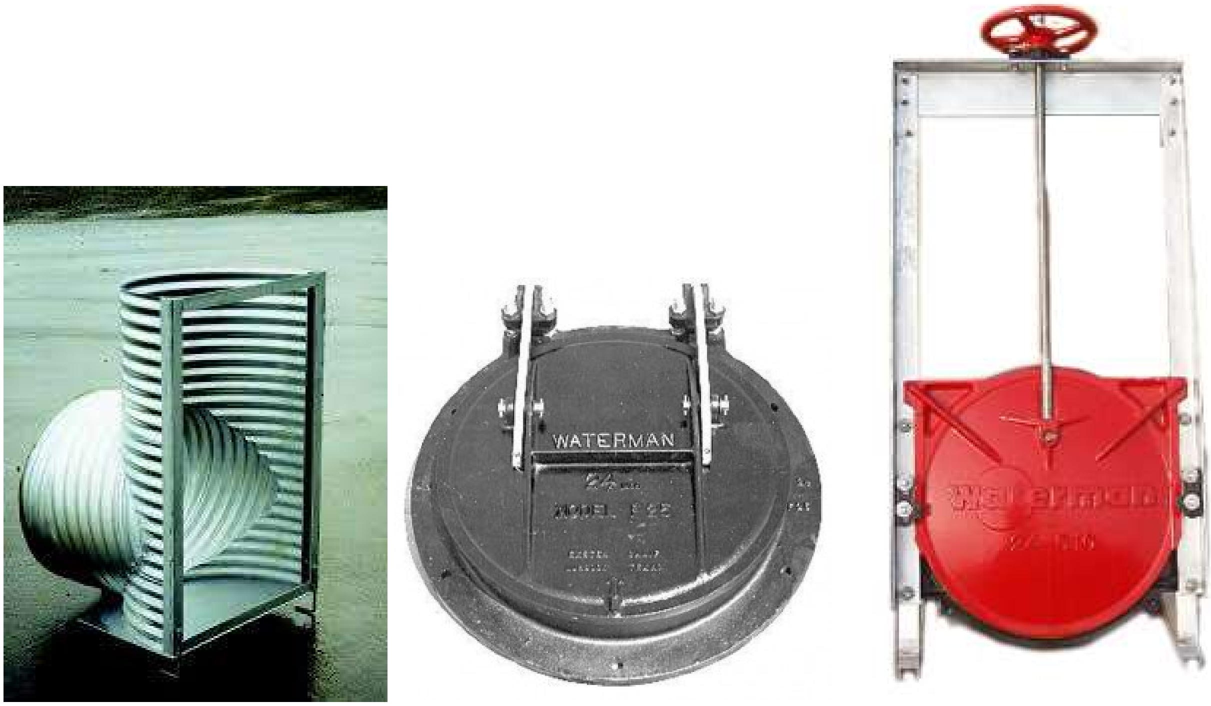


Figure 3. Typical flashboard riser with metal channel for addition of boards to control water levels on site (left), typical top-hinge flapgate-style tidegate which is pushed open when interior water is higher than exterior/tidal water (middle), and typical screw gate with frame to raise or lower gate over culvert opening (right).

<u>Barn Field tidegate and water control structures:</u>

The Barn Field tidegate has been leaking for a number of years. Since the structure is under water on all tides it is difficult to determine the exact cause of the leak. An attempt to examine the structure with an underwater camera did not yield any definitive information due to the cloudy water conditions. It could be that the tidegate is not sealing completely, that the culvert is corroded and allowing water to enter through holes in the culvert between the tidegate and the dike, or that water is piping along the sides of the culvert through the dike. The screw gate has not been used for several years due to the concern of failure. As such the gate has not been raised to allow free flow of water onto the site. The flashboard riser appears to slow water draining from the site but does not restrict water entering during some higher tides and high river levels.

The assumption is that to repair the structure would require the removal and replacement of the combination tidegate, culvert and flashboard riser with a similar or improved design.

Figure 4. Barn Field water control structures on waterward side of the dike. Footbridge to platform with screw gate controls.

Figure 5. Barn Field water control structures on waterward side of the dike. Culvert with tidegate on end and frame for raising with screw mechanism.

Figure 6. Barn Field water control structures on landward side of the dike. Flashboard riser with foot bridge.

<u>Seattle Pond tidegate and water control structures:</u>

The Seattle Pond tidegate functions as intended with the flapgate opening when water levels on the site are high enough to push it open and closing at all other times. It does not allow tidal water on to the site. The screw gate, however, has not been used for several years due to the concern of failure. As such the gate has not been raised to allow free flow of water onto the site. Additionally, the interior flashboard riser is not working properly. The riser is not connected to the culvert passing through the dike so it does not hold water on the site when boards are inserted.

The assumption is that to repair the structure would require the removal and replacement of the combination tidegate, culvert and flashboard riser with a similar or improved design.

Figure 7. Seattle Pond water control structures on waterward side of the dike. Footbridge to platform with screw gate controls

Figure 8. Seattle Pond water control structures on landward side of the dike. Flashboard riser with foot bridge and hand rail.

<u>Tidegate Replacement</u>

Replacement of the culverts and tidegates have been identified as a WDFW capital need for many years. Replacement was proposed as part of the Deepwater Slough restoration project. However once the two-island alternative was selected, meaning water would once again flow through Deepwater Slough, the need for a bridge became essential. There was not enough project funding available to replace the drainage infrastructure and build the bridge, and so funding was used to build the bridge.

Since that time, Skagit Wildlife Area staff have developed funding requests for the tidegate replacement through the WDFW capital budget and the Migratory Bird Stamp processes. The capital funding requests did not rank well when compared to the other agency capital needs. WDFW received funding through the Migratory Bird Stamp process for design and planning, but other project obstacles led to the design and planning being abandoned (more on obstacles below). In addition the estimated full replacement cost was more than the Migratory Bird Stamp process alone could fund.

In 2014, a local waterfowl hunting supporter, who had grown up hunting the Island, was aware of the need for tidegate replacement and the lack of funding to do so. This supporter proposed that his construction company provide the equipment and the operators to perform the tidegate replacement at no charge. WDFW Wildlife Program staff supported examination of how WDFW could work with a private contractor in this way. The decision was made to apply for permits to replace the Barn Field tidegate (more details below) based on a preliminary design completed by WDFW's Capital Asset Management Program (construction group) staff. CAMP had some discussions with the private construction company but ultimately WDFW could not move forward with the project due to a lack of funding for design, permitting, mitigation, materials and construction oversight.

Starting in 2014 WDFW attempted to obtain permits for replacing the Barn Field tidegate. Below are key milestones in the permitting process:

- A State Environmental Policy Act (SEPA) application was submitted to replace the Barn Field Tidegate with no mitigation and a Determination of Non-Significance was issued (DNS 15-004, January 2015)
- Skagit River System Cooperative (SRSC) opposed the DNS (January 2015) suggesting that a replacement structure would need to allow fish passage and tidal exchange; WDFW subsequently withdrew the SEPA application (January 2016)
- WDFW assessed the feasibility of installing a self-regulating tidegate to support management of the site for farmed waterfowl forage production while also providing juvenile salmon habitat and determined that it would not be feasible due to conflicting water management objectives in spring and early summer (April 2016).
- Conversations began with SRSC about what mitigation would be sufficient if the tidegate were replaced with a standard tidegate (not self-regulating).
- WDFW and SRSC tried to negotiate a path forward. WDFW proposed that North Leque be used as mitigation for tidegate replacement. However, SRSC was not willing to support the continued exclusion of salmon from the site for an underdetermined period. SRSC was willing to support the temporary replacement of the tidegate if the Island Unit design and permitting was underway and restoration happened within 10 years. An MOU was drafted (September 2016)

but never signed because WDFW was not comfortable committing to the cost of a temporary replacement or the eventual restoration project without a public process.

- WDFW wrote a letter to SRSC outlining its path forward, which was to move forward with permitting using North Leque as mitigation.
- WDFW applied for SEPA again, applying the Tidegate Fish Initiative formula to calculate required mitigation acreage with North Leque proposed as mitigation, and a DNS was issued (DNS 16-074, December 2016).
- SRSC didn't agree with using North Leque because it was already intertidal and too far away from pathways used by Skagit juvenile Chinook. They wrote another SEPA response outlining why they didn't believe it was sufficient mitigation and requesting an Environmental Impact Statement (January 2017). WDFW withdrew SEPA again (April 2017).
- NOAA advised WDFW not to apply for federal permits without coming to agreement with the tribes (SRSC).
- An email dated April 14, 2017 contained points of agreement from a meeting between Larry Carpenter (WDFW Commission), Larry Wasserman (Swinomish Tribe) and Bob Everitt (WDFW Region 4 Director). It documents an agreement that WDFW will apply for funding to complete a feasibility study (currently described as an alternatives analysis), and outlines a potential short term solution where if a full restoration design is selected in the feasibility study, the tidegates may be replaced until they are removed during the restoration project within seven years of their repair.
- WDFW applied for and received a Salmon Recovery Funding Board grant (January 2018) to complete a feasibility study.
- In September 2019, WDFW reached out to SRSC staff to review their position on tidegate replacement. Their position has not changed.

<u>Findings</u>

At this time, issues around replacement of the tidegates have not changed.

- The tidegates and water control structures are in disrepair and at risk of failing.
- Funding is not available for replacement.
- Skagit River System Cooperative supports full restoration of the site and does not support repair or replacement of infrastructure on the site, including tidegates and water control structures.

APPENDIX B: STAKEHOLDER AND PUBLIC ENGAGEMENT

Appendix B: Stakeholder and Public Engagement

Background

Stakeholder and public engagement was an important aspect of the Island Unit alternatives analysis process. The intent of stakeholder and public engagement was to gather feedback from affected stakeholders, tribes and local governments and to address, where possible, their input and concerns regarding the issues and considerations used to develop and select a preferred alternative. WDFW hired Ross Strategic, an independent consulting firm, to guide and support WDFW staff in developing and carrying out the stakeholder and public engagement process for the project. WDFW convened an Advisory Group as the principle stakeholder engagement mechanism and held a virtual public meeting to gather public feedback on Island Unit management alternatives.

Stakeholder Engagement

Stakeholder engagement for the Island Unit alternatives analysis process was primarily via inclusion of stakeholder representatives on the project Advisory Group. [Tribal and government agency representatives were also part of the Advisory Group as described in the next section.] This group met several times at key points throughout the project to provide their feedback and perspectives to WDFW. The Advisory Group included representatives from various interests in WDFW natural resource policy in general and management of the Island Unit in particular.

Advisory Group Formation

WDFW posted a public announcement on July 29, 2019 regarding the upcoming alternatives analysis process and soliciting applicants for the stakeholder Advisory Group. WDFW received 27 applications prior to the deadline of 5:00 pm on August 19. Several applications and inquiries received after the deadline were not considered. The project team and Ross Strategic reviewed the individual's applications based on the following criteria:

- Have experience collaborating with people who have different perspectives or values to work together toward consensus.
- Can commit to attending approximately four in-person meetings (2-3 hours each) from September 2019 through August 2020*, with potential for additional public meetings/open houses to hear public input.
- Are well connected to their respective interest group, agree to reach out to their broader community of interest, and strive to represent their community's perspective in deliberations.
- Are willing to learn about issues relevant to the Island Unit and have an openness to new information.
- Have a background in a subject area relevant to management of the Island Unit (e.g. waterfowl, salmon recovery, hunting/recreation, and agriculture.)

**Note: The project timeline was subsequently modified to reflect a later start date (late 2019) and end date (early 2021)*

Advisory Group Members

After reviewing applications, 17 individuals were recommended for an interview by Ross Strategic. Ross Strategic met with these applicants in-person, mostly in Skagit County, and interviewed each applicant using a set of pre-written questions. Information from the interviews was used to further narrow the potential members of the Advisory Group. Interview information also provided initial stakeholder insight on current and proposed Island Unit management.

WDFW regional and senior management in the habitat and wildlife programs reviewed the list of proposed stakeholder members to the Advisory Group and the acting WDFW Region 4 Director approved the final list. WDFW invited the following 13 people, representing a wide range of interests, to participate as stakeholder representatives in the Advisory Group:

- Amber Parmenter, conservation
- Bob Cooper, recreational fishing
- Brandon Roozen, agriculture
- Darrell Tawes, waterfowl hunting
- Greg Green, conservation*
- James Ono, waterfowl hunting
- Jed Holmes, birding
- Jeff Osmundson, birding
- John Stein, salmon recovery
- Reb Broker, waterfowl hunting
- Richard Brocksmith, salmon recovery
- Rick Billieu, waterfowl hunting
- Roger Goodan, recreational fishing

**Note: Greg Green withdrew from the Advisory Group for personal reasons*

In addition, WDFW invited several individuals to participate in the Advisory Group as ex oficio members. These individuals were eligible to participate as ex oficio members by virtue of their position or office, so these members did not go through the application and review process. WDFW reached out to the Swinomish Indian Tribal Community, Samish Indian Nation, Upper Skagit Indian Tribe and the Sauk-Suiattle Indian Tribe to invite their participation and input in the process. One of the options presented to tribes was to participate as ex oficio members of Advisory Group. Tribal representatives that chose to participate included:

- Greg Hood, Skagit River System Cooperative (representing Swinomish and Sauk-Suiattle)
- Rick Hartson, Upper Skagit
- Scott Schuyler, Upper Skagit

WDFW invited governmental representatives to participate as ex oficio members of the Advisory Group, with the following individuals and organizations expressing interest:

- Dana Dysart, US Corps of Engineers
- Erin Murray, Puget Sound Partnership
- Janet Curran, NOAA
- Jenna Friebel, SCDIDC (special purpose districts)
- Karina Siliverstova, Skagit County
- Laurel Jennings, NOAA
- Michael See, Skagit County
- Rich Carlson, USFWS

Lastly, five WDFW staff participated in the Advisory Group in an ex oficio capacity:

- Belinda Rotton
- Bob Warinner
- Jenny Baker
- Loren Brokaw
- Seth Ballhorn

Advisory Group Charter

The Island Unit Advisory Group adopted a charter as both a reference document and guide for Advisory Group members. The Charter provided background information and details around the Advisory Group's purpose, described as follows:

> *WDFW is convening the Island Unit Advisory Group to get input and feedback related to changing land management challenges and opportunities at the Island Unit from diverse interests. The Advisory Group will provide input as WDFW develops and assesses alternatives ranging from no restoration to full restoration to address failing infrastructure and balance WDFW's obligations, objectives and community needs.*

The charter also described membership, member expectations, and Advisory Group input and WDFW decision-making authority.

Advisory Group Ground Rules

The Advisory Group adopted a set of 11 ground rules to provide a framework for interacting with one another throughout the process. The ground rules affirmed Advisory Group members' agreement to work together in good faith, strive for honest and direct communication, attend all scheduled meetings, and focus on interests in lieu of taking positions. The ground rules described Ross Strategic's role as a neutral, third party facilitator during the process.

Advisory Group Meetings

The Advisory Group met between November 2019 and November 2020, with a final meeting anticipated in early 2021. The first two meetings were in-person, with subsequent meetings (post March 2020) held virtually due to COVID-19 restrictions. During these meetings the Advisory Group was asked to provide the following:

- Time to do cross-interest learning to understand all the issues WDFW would need to consider
- Input on draft alternatives
- Input on draft criteria that were used to compare alternatives
- Input on application of the criteria
- Ideas for maximizing multiple stakeholder values within the preferred alternative

WDFW also invited Advisory Group members to tour the Island Unit on October 31st 2019. Most Advisory Group members participated with WDFW staff.

Prior to each meeting, Ross Strategic distributed an agenda and supporting materials for Advisory Group members to review and WDFW posted these materials to the Advisory Group website. At the end of each meeting, the facilitators invited members of the public to provide comments to the Advisory Group. Ross Strategic drafted a summary of each Advisory Group meeting and WDFW posted all meeting summaries and presentations to the Advisory Group website. A brief description of Advisory Group meetings is provided below.

Meeting 1 (November 1, 2019 at Padilla Bay Interpretive Center, Mount Vernon)

During Meeting 1, Advisory Group members introduced themselves. WDFW provided a presentation on the Island Unit project background and goals, and rationale for convening the Advisory Group. Ross Strategic provided a summary of themes from the interview process, and the Advisory Group reviewed a proposed calendar of meeting dates and topics. The Advisory Group also considered a list of information requests developed by Ross Strategic and based on discussions with Advisory Group members. WDFW presented four draft alternatives for Island Unit management and Advisory Committee members provided initial feedback. The four draft alternatives included:

1. No restoration actions at Island Unit and entire 270 acres maintained as is with a focus on enhanced winter waterfowl forage production.
2. Partial restoration, with 170 acres of the east “lobe” restored to estuary and 100 acres maintained as is with a focus on enhanced winter waterfowl forage production.
3. Partial restoration, with 110 acres total on the bottom of each “lobe” restored to estuary and 160 acres maintained as is with a focus on enhanced winter waterfowl forage production.
4. Full restoration with 270 acres restored to estuary.

Meeting 2 (February 3, 2020 at Skagit Station Meeting Room, Mount Vernon)
For Meeting 2, WDFW reviewed the management alternatives introduced during Meeting 1 and heard additional feedback from Advisory Committee members. WDFW then introduced the draft criteria which the WDFW project team intended to apply to the four management alternatives as part of its analysis. WDFW also coordinated a series of presentations to Advisory Group members with the goal of providing the most accurate, up-to-date information on the following key areas of interest:

- Chinook and Estuaries
- Chinook Harvest Policy and Management
- Waterfowl Conservation
- Hunt Access and Habitats
- Agricultural Agreements and Assessments
- Infrastructure Condition and Management

These presentations were prepared by subject matter experts from WDFW and other organizations. Advisory Group members had the opportunity to ask questions after each presentation.

Meeting 3 (March 16, 2020 remote via conference call and video)
Meeting 3 was dedicated to Advisory Group discussion and feedback on the draft criteria for evaluating the Island Unit management alternatives. Advisory Group members considered several questions as a starting point for this discussion:

- Are there any categories missing?
- Are there details within categories that are missing?
- Is there anything else WDFW should consider related to criteria?

WDFW noted Advisory Committee members’ comments on the draft criteria for consideration and Ross Strategic summarized the comments in the meeting notes. Prior to and following Meeting 3, Ross Strategic and WDFW participated in several conference calls with groups of Advisory Committee members to ensure they understood the draft criteria, how they criteria would be used, and any feedback on the draft criteria. At the request of Advisory Group members, WDFW also distributed a document with further detail on the draft criteria.

Meeting 4 (October 26 and November 4, 2020 remote via conference call and video)
Meeting 4 consisted of two parts. Part one took place on October 26 and involved WDFW providing a presentation regarding application of the criteria to the four Island Unit management alternatives. Advisory Group members asked clarifying questions as needed. Part two of the meeting took place on November 4 and featured in-depth Advisory Group questions and observations about the WDFW project team’s application of the criteria. Meeting notes are available on the Advisory Group website.

SEPTEMBER 24, 2020

APPENDIX C: TIDAL CHANNEL AND CHINOOK SALMON TECHNICAL MEMORANDUM

Habitat and juvenile Chinook benefit predictions Deepwater Phase 2 Restoration Alternatives

ERIC BEAMER AND GREG HOOD
SKAGIT RIVER SYSTEM COOPERATIVE RESEARCH PROGRAM

Skagit River System Cooperative
11426 Moorage Way · P.O. Box 368 LaConner, WA 98257-0368
Phone: 360-466-7228 · Fax: 360-466-4047 · www.skagitcoop.org

Memorandum

To: Jenny Baker, Washington Department of Fish and Wildlife

From: Eric Beamer and Greg Hood, Skagit River System Cooperative Research Program

Date: September 24, 2020

Subject: Habitat and juvenile Chinook benefit predictions Deepwater Phase 2 Restoration Alternatives

This memo is fulfillment of an agreement between the Skagit River System Cooperative Research Program and the Washington Department of Fish and Wildlife (WDFW) under WDFW Contract No. 20-15696 where we make predictions of (1) the length, number, and area of tidal channels that will result from three Island Unit of the Skagit Wildlife Area restoration alternatives (Full Restoration, Alternative 2, Alternative 3); (2) landscape connectivity calculations for their conceptual tidal channel restoration designs; and (3) a carrying capacity estimate for juvenile Chinook salmon for each alternative.

Contents

Introduction

In this memo we make predictions of (1) the length, number, and area of tidal channels that will result from three Island Unit of the Skagit Wildlife Area restoration alternatives (Full Restoration, Alternative 2, Alternative 3); (2) landscape connectivity calculations for their conceptual tidal channel restoration designs; and (3) a carrying capacity estimate for juvenile Chinook salmon for each alternative. Making these predictions required development of a conceptual restoration design for each alternative, which are also presented here. It should be noted that the conceptual restoration design for the chosen alternative will be subject to future modification as it is transformed into a final restoration design, depending on project constraints that may be encountered by engineers and biologists in the course of project development. This is standard procedure for tidal marsh restoration projects. Consequently, the estimates of juvenile Chinook carrying capacity made in this memo are preliminary and should be used only for the purposes of comparing the three restoration alternatives. Final estimates of carrying capacity will depend on the final restoration design and as-built surveys.

Methods

We predicted tidal channel habitat, landscape connectivity, and juvenile Chinook carrying capacity for three Island Unit of the Skagit Wildlife Area restoration alternatives (Full Restoration, Alternative 2, Alternative 3).

Tidal Channel Habitat

<u>Restoration Alternative Footprint</u>: We predicted channel habitat metrics for the restoration footprint of each alternative using three different methods 1) Standard Allometric Prediction (Hood 2007), 2) Tide Range-Adjusted (TRA) Allometric Prediction (Hood 2015), and 3) Conceptual Design. The standard (Hood 2007) and TRA (Hood 2015) allometric methods are empirical regression models, i.e., patterns in reference marshes are used to predict outcomes in restoration marshes. The standard allometric model uses marsh area alone to predict channel metrics. The TRA allometric model is a more recent method reflecting that geographic variation in tidal channel allometry is also influenced by tide range, storm wave fetch, and sediment supply. Both allometric models are scaling logarithmic relationships, so confidence intervals for predictions have wide margins of uncertainty. To reduce uncertainty in predictions we also used a conceptual design method which identifies channel planform locations using historical aerial photos/surveys and topography. The conceptual design method produces design-specified values of channel metrics, rather than statistical predictions. Thus, there are no statistical uncertainties in the design. Tidal channel metrics for each of the three methods are 1) total channel length, 2) number of channel outlets, and 3) channel area.

<u>Adjacent Downstream Marshes</u>: Tidal marsh restoration through dike breaching or removal can have direct effects on channel network geometry in the restored site, as well as indirect effects on the channel network of the existing adjacent tidal marsh (Hood 2004). Restoration of upstream tidal prism via new tidal channels or restored tidal marsh surface drainage area will typically increase the width and surface area of downstream tidal channels in existing adjacent downstream

marsh as the channels adjust (erode) to accommodate the increased tidal prism contributed by the newly restored site. Channel length is less likely to be increased unless new tidal channels develop in the downstream marsh. To quantify new channel area that would likely be created in adjacent downstream marshes as a result of the alternatives, we compared downstream channel changes (before vs. after restoration) influenced by the Wiley Slough Restoration and Deepwater Phase 1 Restoration projects. We found in the twelve mainstem tidal channels, downstream tidal channel mainstem widths increased by 29% on average, while surface areas increased 31%. We applied the 31% value for channel area increase to existing tidal channel mainstems in adjacent downstream marsh polygons for each of the Island Unit restoration alternatives.

Landscape connectivity

Landscape connectivity, or large-scale connectivity, refers to the relative distances and pathways that salmon must travel to find habitat over a very large area. As this concept is applied in the Skagit River delta, landscape connectivity is a function of both the distance and complexity of the pathway that salmon must follow to specific habitat areas (e.g., candidate restoration sites). Connectivity decreases as complexity of the route the fish must swim increases and the distance the fish must swim increases. Within the delta, the complexity of the route fish must take to find habitat is measured by the distributary bifurcation order and distance traveled. Habitat that is less connected to the source of fish has lower densities of fish. We use landscape connectivity to help predict juvenile Chinook benefits for candidate restoration areas and to interpret juvenile Chinook monitoring results from sites throughout the Skagit tidal delta.

Landscape connectivity was calculated adequately for potential fish migration pathways to the three Island Unit of the Skagit Wildlife Area restoration alternatives (Full Restoration, Alternative 2, Alternative 3) as part of the SHDM projects. Detailed methods are described in Beamer et al. (2016). Maps, showing fish migration pathways, used to calculate landscape connectivity values are attached as Appendix 1.

Juvenile Chinook carrying capacity predictions

Juvenile Chinook carrying capacity was predicted using an empirical model developed for the Skagit Chinook Recovery Plan that predicts carrying capacity estimates for candidate restoration projects within the Skagit tidal delta based on channel area and landscape connectivity. Overall, the model explained 68% of the variation in seasonal Chinook density at six sites over eleven years. The habitat factor (i.e., landscape connectivity) explained 37% of the variation while density dependence (outmigrants) explained the remaining 31%. The methods are described in Beamer et al. (2005) (pages 89-94). Juvenile Chinook salmon carrying capacity is based on two variables: 1) wetted area available to fish; and 2) landscape connectivity. Both variables are positively correlated with juvenile Chinook abundance (i.e., larger habitat areas and higher connectivity values result in higher estimates of juvenile Chinook carrying capacity).

We calculated juvenile Chinook carrying capacity based on the average (and range) landscape connectivity estimates and predicted channel area using the Conceptual Design method.

Results

Full Restoration

Channel predictions: The Full Restoration alternative is comprised of two hydrologically distinct areas, a 67.6 ha area on the east side of Deepwater Slough and a 40.6 area on the west side of Deepwater Slough (Figure 1). The standard allometric predictions for the Full Restoration alternative for channel length, channel outlets, and channel area are 22,525 m, 45, and 4.682 ha., respectively (Table 1). The tide range-adjusted allometric predictions for channel length, channel outlets, and channel area are 8,110 m, 24, and 1.846 ha., respectively. The conceptual design predictions for channel length, channel outlets, and channel area are 16,900 m, 35, and 3.519 ha., respectively. Additionally, the Full Restoration alternative is predicted to create 0.653 ha of new channel habitat in adjacent downstream marsh areas (Table 1).

Landscape Connectivity: Landscape connectivity values for the Full Restoration alternative will vary by the 35 different channel outlet locations (Table 4, Figure 1). Average landscape connectivity estimates for the Full Restoration alternative is 0.039582 (range: 0.032273 - 0.047257) in the western polygon and 0.034799 (range: 0.028465 - 0.040754) in the eastern polygon (Table 1).

Chinook Carrying Capacity: Predicted juvenile Chinook carrying capacity for the Full Restoration alternative is 72,820 (range: 59,377 - 86,035) smolts per year when including fish benefits for channel area formed due to indirect effects of the project in adjacent marshes downstream (Table 1).

Alternative 2

Channel predictions: Alternative 2 is comprised of one hydrologically distinct area, a 67.6 ha area on the east side of Deepwater Slough (Figure 2). The standard allometric predictions for Alternative 2 for channel length, channel outlets, and channel area are 14,760 m, 26, and 3.205 ha., respectively (Table 2). The tide range-adjusted allometric predictions for channel length, channel outlets, and channel area are 5,285 m, 14, and 1.254 ha., respectively. The conceptual design predictions for channel length, channel outlets, and channel area are 11,320 m, 21, and 2.458 ha., respectively. Alternative 2 is predicted to create 0.289 ha of new channel habitat in its adjacent downstream marsh area (Table 2).

Landscape Connectivity: Landscape connectivity values for Alternative 2 will vary by the 21 different channel outlet locations (Table 5, Figure 2). Average landscape connectivity estimates for Alternative 2 is 0.034799 (range: 0.028465 - 0.040754) (Table 2).

Chinook Carrying Capacity: Predicted juvenile Chinook carrying capacity for Alternative 2 is 45,776 (range: 37,371 - 53,692) smolts per year when including fish benefits for channel area formed due to indirect effects of the project in adjacent marshes downstream (Table 2).

Alternative 3

Channel predictions: Alternative 3 is comprised of two hydrologically distinct areas, a 16.5 ha northern area on the west side of Deepwater Slough and a 28.1 ha southern area on the east side of Deepwater Slough (Figure 3). The standard allometric predictions for Alternative 3 for channel length, channel outlets, and channel area are 7,380 m, 26, and 1.220 ha., respectively (Table 3). The tide range-adjusted allometric predictions for channel length, channel outlets, and channel area are 2,754 m, 14, and 0.505 ha., respectively. The conceptual design predictions for channel length, channel outlets, and channel area are 7,594 m, 18, and 1.248 ha., respectively. Alternative 2 is predicted to create 0.563 ha of new channel habitat in its adjacent downstream marsh areas (Table 3).

<u>Landscape Connectivity</u>: Landscape connectivity values for Alternative 3 will vary by the 18 different channel outlet locations (Table 6, Figure 3). Average landscape connectivity estimates for Alternative 3 is 0.036688 (0.032273 - 0.041236) in the northern polygon and 0.031145 (range: 0.028465 - 0.034031) in the southern polygon (Table 3).

<u>Chinook Carrying Capacity</u>: Predicted juvenile Chinook carrying capacity for Alternative 3 is 29,135 (range: 26,116 - 32,309) smolts per year when including fish benefits for channel area formed due to indirect effects of the project in adjacent marshes downstream (Table 3).

Discussion

In this section we discuss differences in the habitat prediction methods for the Island Unit of the Skagit Wildlife Area restoration alternative footprints, and their use in three planning documents: Skagit Chinook Recovery Plan (SRSC and WDFW 2005), Skagit Hydrodynamic Model Project (Beamer et al 2016), and this memo.

Differences between habitat prediction methods

<u>Restoration Alternative Footprint</u>: As one moves upstream from the bay along the Skagit River's large distributaries, tide range declines, so the tidal energy available to scour tidal channels also declines. Tidal geomorphological processes gradually transition to fluvial geomorphological processes, until at the head of tide (near Mount Vernon) tidal processes disappear and fluvial processes completely take over. The standard allometric model does not take the effect of varying tidal range within deltas into account, so it may over-estimate tidal channel count, length, and area in marshes that are located in more landward (upstream) portions of the tidal-fluvial energy gradient where tidal energy is diminished. To account for tides, the TRA-allometric model interpolates tide range from the bay (full range expression) to the head of tide (zero tide) according to the distance along the distributary channels from the bay. It then applies results from comparisons between tidal river delta marshes in Puget Sound with varying tide ranges (Hood 2015). However, these results could not entirely distinguish the effects of tide range and fetch, which were autocorrelated. Thus, while the logic of accounting for tide range seems sensible, there is uncertainty about the interaction between tide range and fetch. Additionally, extrapolating from differences between Puget Sound river deltas and applying those patterns to a tidal-fluvial gradient within a large river delta, like the Skagit, violates a basic principle of regression analysis, i.e., thou shalt not extrapolate outside of your range of observations. Or in other words, differences between river delta systems may be different and controlled by different processes than differences within a river delta system along a tidal-fluvial process gradient. Thus, there are concerns about indiscriminately applying either allometric model (standard or TRA) to the Island Unit alternatives analysis, because the proposed restoration site is located farther upstream than are any of the Skagit

Delta reference tidal marshes and so it may be affected by tidal and fluvial processes to a different degree than downstream reference marshes, and in a way that is challenging to predict.

To bound our predictions for the Island Unit alternatives analysis, we applied both the standard allometric model and the TRA-allometric model to the proposed alternatives (Tables 1-3). The result was that the TRA-allometric model predicted approximately half the tidal channel count, length, and area as did the standard allometric model, with the difference between the two models increasing as marsh area increased. This large discrepancy leads to two risks: overpredicting vs. underpredicting the amount of tidal channel that should result from tidal marsh restoration. The ecological and socio-political consequences of these risks are asymmetrical. If we over-predict channel geometry, the consequence will be that the over-excavated tidal channel networks will resize (partially fill with sediment to become smaller) over time to reach their appropriate equilibrium condition. During this period of adjustment to equilibrium, salmon production will be higher than the eventual equilibrium, but decline until equilibrium conditions are met. From observations of over-excavated systems in the Skagit Delta, it appears that the time required for such an adjustment could be on the order of a couple of decades (unpublished observations). However, if we underpredict channel geometry, the consequence will be that the under-excavated tidal channel network could take many decades, perhaps as many as 7 or 8 decades, to erode to a larger equilibrium size (Hood 2019), during which time salmon production will be impaired relative to equilibrium conditions. The reason for this asymmetry in adjustment to equilibrium is that formerly agricultural soils can be resistant to tidal erosion, often containing a clay-dominated plow pan, i.e., a hard pan formed by plowing that sorts the sediment by grain size so that fine sediments cohere into clay, by compression of the sediment by heavy farm machinery, and by loss of sediment organic material to oxidative decomposition. If it is determined that underprediction has occurred there will be pressure for additional rounds of restoration on the site to more rapidly achieve appropriate levels of salmon production. Further rounds of restoration will entail greater economic and political costs. Clearly, overprediction is preferable to underprediction.

Our third approach, conceptual planform channel design, was implemented and compared to the standard and TRA allometric models in this memo (Tables 1-3). This approach consisted of identifying historical tidal channel remnants within the restoration site, identifying topographic lows from 2012 and 2019 lidar and from ponded areas in aerial photographs, and incorporating existing excavated drainage ditches and ponds where this seemed appropriate. These features were all included in a conceptual planform design to identify the potential locations of future restoration site tidal channels. Historical channel remnants were identified by their sinuous form, which contrasts with typically straight drainage ditches that intersect each other at right angles. Topographic lows were used to site locations where tidal channels could be excavated. The resulting tidal channel network was then compared to the standard and TRA allometric model predictions. The aim of this approach was to produce a channel network design responsive to site conditions, and intermediate between both allometric predictions so that an appropriate estimate of fish production could be facilitated. However, the conceptual design was also intentionally biased in favor of the standard allometric prediction to reduce the risk of underprediction. It should be noted that the conceptual planform design can be used to estimate channel network length, but not to directly estimate planform channel widths. Channel widths and depths will be calculated during later engineering design stages once a final restoration alternative has been chosen. The purpose of the conceptual design is to site the potential restoration channels and allow estimation of channel network lengths. Consequently, channel network areas for the conceptual designs were estimated with reference to the standard allometric prediction using the following equation: conceptual design channel area = standard allometric channel area prediction x conceptual design channel length/standard allometric channel length prediction.

Some existing ponds and drainage ditches were retained in the conceptual restoration design for several reasons: 1) they can provide habitat to salmon in their existing location, 2) the ponds, which were excavated to provide waterfowl habitat, can continue to do so if retained, 3) retaining, rather than filling, the ponds and ditches can reduce excavation and filling costs, and 4) retaining these features in the conceptual design can provide some flexibility to engineers in their final design if they require places to dispose of dike sediments to balance cut/fill estimates. It should be noted, that while retained ponds can provide habitat for juvenile salmon (and waterfowl), once connected to the tidal channel network and associated sediment supply the ponds are likely to fill with sediment over the course of several decades and be converted to tidal channels. This process has been observed at several locations in the South Fork Skagit Delta tidal marshes (unpublished observations).

<u>Adjacent Downstream Marshes</u>: Not all of the proposed new channels openings in the restoration design connect to downstream channels (Figure 1). Many connect directly to large river distributaries, e.g., Freshwater Slough, Deepwater Slough, Steamboat Slough. These large distributaries will be minimally affected by site restoration, river discharge being the overwhelmingly dominant force structuring the distributaries, so potential downstream effects on river distributaries were not calculated. However, direct connection of restoration site tidal channels to river distributaries greatly increases site connectivity for salmon accessibility. Other proposed tidal channel openings connect to large downstream ponds that were historically excavated to provide waterfowl habitat. These ponds are slowly filling with sediment and this will continue even with a new connection to a restored upstream tidal channel, as has been observed for the Deepwater Slough restoration project implemented in 2000. Thus, downstream effects of tidal channel restoration were only calculated when the downstream (off-site) connection was to a blind tidal channel, and the effects were only calculated for the mainstem channels of the downstream blind tidal channels, not for any tributaries to the mainstem channel, which were deemed to be minimally influenced by project site restoration.

We believe the approach described above, based on observed channel widening after restoration results applied to specific blind channel in adjacent downstream marshes, is more accurate than the standard allometry model approach used for the Skagit Hydrodynamic Model Project described in Beamer et al. (2016).

History of juvenile Chinook capacity estimates

Predicted habitat areas and fish benefits for the Island Unit of the Skagit Wildlife Area have been included in at least two prior documents related to Skagit estuary restoration: 1) the 2005 Skagit Chinook Recovery Plan (SRSC and WDFW 2005) (herein, SRP) and 2) the 2016 Skagit Hydrodynamic Model Project (herein, SHDM). A main purpose of the SRP and SHDM was to list candidate restoration projects that would contribute to the SRP's overall goal for estuary restoration. SRP and SHDM listed projects were largely at a conceptual stage so it should be recognized that many factors could change as individual projects are developed and move through various stages from "conceptual" to "fully designed" and ultimately "built." The 2005 SRP was the first presentation of the Deepwater Slough Phase 2 project concept. The SHDM project, in 2016, further developed the full restoration concept by completing an estuary-wide update of landscape connectivity to reflect changes that had occurred within the Skagit's distributary channel network and to include an estimate of the indirect (downstream) benefits of restoration which were inferred by Hood (2004). The Island Unit Alternatives Analysis is a next step toward refining habitat and juvenile Chinook salmon estimates for the three alternatives portrayed in this memo.

Below, and in Table 7, are summaries of the SRP and SHDM estimates for Deepwater Slough Phase 2 in contrast to results predicted for the IUAA full restoration alternative in this memo.

<u>SRP</u>: The SRP's estimates for the Deepwater Slough Phase 2 project used a preliminary version of the standard allometric model (Hood 2007 was not published yet) applied to a 108.5 ha footprint. The SRP a) did not account for adjacent downstream marsh effects and (b) only used one landscape connectivity value for the entire footprint area.

<u>SHDM</u>: The SHDM estimates for the Deepwater Slough Phase 2 project used the published version of the standard allometric model (Hood 2007) applied to a 108.57 ha footprint. The biggest difference between the SHDM and SRP Chinook carrying capacity estimates are because the SHDM project a) included an adjacent downstream marsh effect using the standard allometry method applied to 61.17 ha of adjacent marsh, (b) used updated landscape connectivity values for the Skagit delta, and (c) used a range of landscape connectivity values applied to the project footprint to reflect variability in how fish migration pathways vary across such a large area.

<u>IUAA (Conceptual Design method)</u>: For reasons stated in the discussion section above, we believe the Conceptual Design method and our presented downstream effects method based on observed channel widening after restoration provide the best estimates for predicted habitat for the Island Unit Area. Additionally, we point out there is no change in landscape connectivity results between the IUAA (this memo) and SHDM documents and the SRP, SHDM, and IUAA all used the same juvenile Chinook carrying capacity model so no variance in estimated fish benefit between documents is due to a changing fish model.

Table 1. Channel, landscape connectivity, and juvenile Chinook carrying capacity predictions for the Deepwater Slough Phase 2 ***Full Restoration Alternative.*** Channel predictions are shown for three methods: standard allometric prediction (SA), tide range-adjusted allometric prediction (TRA), and conceptual design (CD) methods. Chinook carrying capacity is shown for the channel prediction from the CD method.

Polygon (from Figure 1)	Marsh Area (ha)	Method	Channel Predictions			Landscape Connectivity			Chinook carrying capacity (smolts/yr)		
			Count	Length (m)	Area (ha)	ave	low	high	ave	low	high
Western polygon	40.6	SA	19	7,765	1.477	0.039582	0.032273	0.047257			
		TRA	10	2,824	0.592						
		CD	14	5,580	1.061				20,136	16,385	24,082
downstream of west (new channel)					0.364				6,908	5,621	8,262
Eastern polygon	67.6	SA	26	14,760	3.205	0.034799	0.028465	0.040754			
		TRA	14	5,285	1.254						
		CD	21	11,320	2.458				40,961	33,439	48,044
downstream of east (new channel)					0.289				4,816	3,931	5,648
Total (within restoration footprint)									61,096	49,824	72,125
Grand Total (footprint + downstream)									72,820	59,377	86,035

Table 2. Channel, landscape connectivity, and juvenile Chinook carrying capacity predictions for the Deepwater Slough Phase 2 ***Alternative 2.*** Channel predictions are shown for three methods: standard allometric prediction (SA), tide range-adjusted allometric prediction (TRA), and conceptual design (CD) methods. Chinook carrying capacity is shown for the channel prediction from the CD method.

Polygon (from Figure 2)	Marsh Area (ha)	Method	Channel Predictions			Landscape Connectivity			Chinook carrying capacity (smolts/yr)		
			Count	Length (m)	Area (ha)	ave	low	high	ave	low	high
Eastern polygon from "Full" alternative	67.6	SA	26	14,760	3.205	0.034799	0.028465	0.040754			
		TRA	14	5,285	1.254						
		CD	21	11,320	2.458				40,961	33,439	48,044
downstream of east (new channel)					0.289				4,816	3,931	5,648
						Total (within restoration footprint)			40,961	33,439	48,044
						Grand Total (footprint + downstream)			45,776	37,371	53,692

Table 3. Channel, landscape connectivity, and juvenile Chinook carrying capacity predictions for the Deepwater Slough Phase 2 ***Alternative 3.*** Channel predictions are shown for three methods: standard allometric prediction (SA), tide range-adjusted allometric prediction (TRA), and conceptual design (CD) methods. Chinook carrying capacity is shown for the channel prediction from the CD method.

Polygon (from Figure 3)	Marsh Area (ha)	Method	Channel Predictions			Landscape Connectivity			Chinook carrying capacity (smolts/yr)		
			Count	Length (m)	Area (ha)	ave	low	high	ave	low	high
Northern polygon	16.5	SA	11	2,497	0.376	0.036688	0.032273	0.041236			
		TRA	6	1,001	0.170						
		CD	8	2,920	0.440				7,729	6,790	8,697
Downstream of north (new channel)					0.363				6,387	5,612	7,187
Southern polygon	28.1	SA	15	4,883	0.844	0.031145	0.028465	0.034031			
		TRA	8	1,753	0.335						
		CD	10	4,674	0.808				12,036	10,990	13,162
downstream of south (new channel)					0.200				2,983	2,724	3,262
						Total (within restoration footprint)			19,765	17,781	21,859
						Grand Total (footprint + downstream)			29,135	26,116	32,309

Table 4. Summary of landscape connectivity for the Full Restoration alternative.

Polygon (from Figure 1)	**Fish migration pathway used (See Figure 1 for point locations)**	
	Point name	**Landscape connectivity**
Western polygon	Point 31	0.032273
	Point 32	0.033263
	Point 33	0.039979
	Point 34	0.041236
	Point 35	0.043482
	Point 36	0.047257
Eastern polygon	Point 37	0.0375828
	Point 38	0.028572
	Point 39	0.028465
	Point 40	0.033513
	Point 41	0.034031
	Point 42	0.040754
	Point 43	0.040676

Table 5. Summary of landscape connectivity for the Alternative 2.

Polygon (from Figure 2)	**Fish migration pathway used (See Figure 2 for point locations)**	
	Point name	**Landscape connectivity**
Eastern polygon from “Full” alternative	Point 37	0.0375828
	Point 38	0.028572
	Point 39	0.028465
	Point 40	0.033513
	Point 41	0.034031
	Point 42	0.040754
	Point 43	0.040676

Table 6. Summary of landscape connectivity for the Alternative 3.

Polygon (from Figure 3)	**Fish migration pathway used (See Figure 3 for point locations)**	
	Point name	**Landscape connectivity**
Northern polygon	Point 31	0.032273
	Point 32	0.033263
	Point 33	0.039979
	Point 34	0.041236
Southern Polygon	Point 38	0.028572
	Point 39	0.028465
	Point 40	0.033513
	Point 41	0.034031

Table 7. Summary of habitat and juvenile Chinook carrying capacity predictions for the Island Unit Area of the Skagit Wildlife Area. SRP is the 2005 Skagit Chinook Recovery Plan, SHDM is the 2016 Skagit Hydrodynamic Model Project, and IUAA is the Island Unit Alternatives Analysis (results from Table 1 in this memo).

Planning Document (habitat prediction method)	**Predicted Channel area (mid-point)**	**Landscape connectivity**	**Chinook carrying capacity (smolts/year) (mid-point)**
SRP (Standard)	4.5 ha	0.045[a]	95,516
SHDM (Standard)	9.1 ha (includes 4.37 ha downstream effect)	range 0.028-0.047	160,000
IUAA (Conceptual Design method)	4.172 ha (includes 0.653 ha downstream effect)	range 0.028-0.047	72,820

[a] The SRP (page 189) erroneously reports connectivity as 0.026. Beamer et al (2005) reports the correct connectivity estimate as 0.045 (see Table 7.1 on page 43).

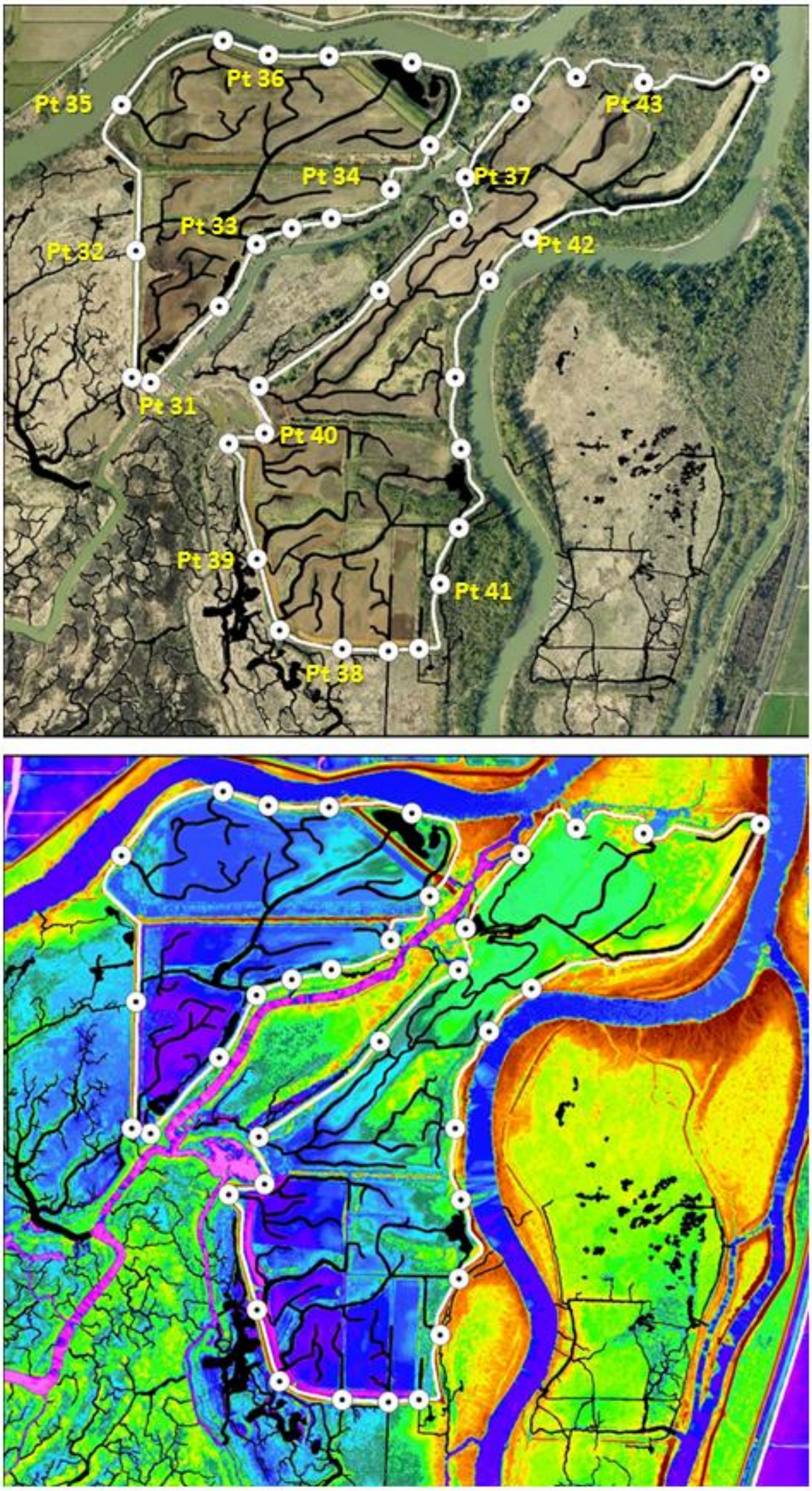


Figure 1. Map of the conceptual design method for the ***Full Restoration Alternative*** depicting locations of channel outlets and channel. The top panel is shown over an orthophoto; the bottom panel over 2012 LiDAR. Hydrologically distinct polygons are bounded by white outlines. Tidal channel outlet points are shown as white dots with a black center. The channel outlet points used to calculate Landscape Connectivity values are labeled. Channels are shown as black lines.

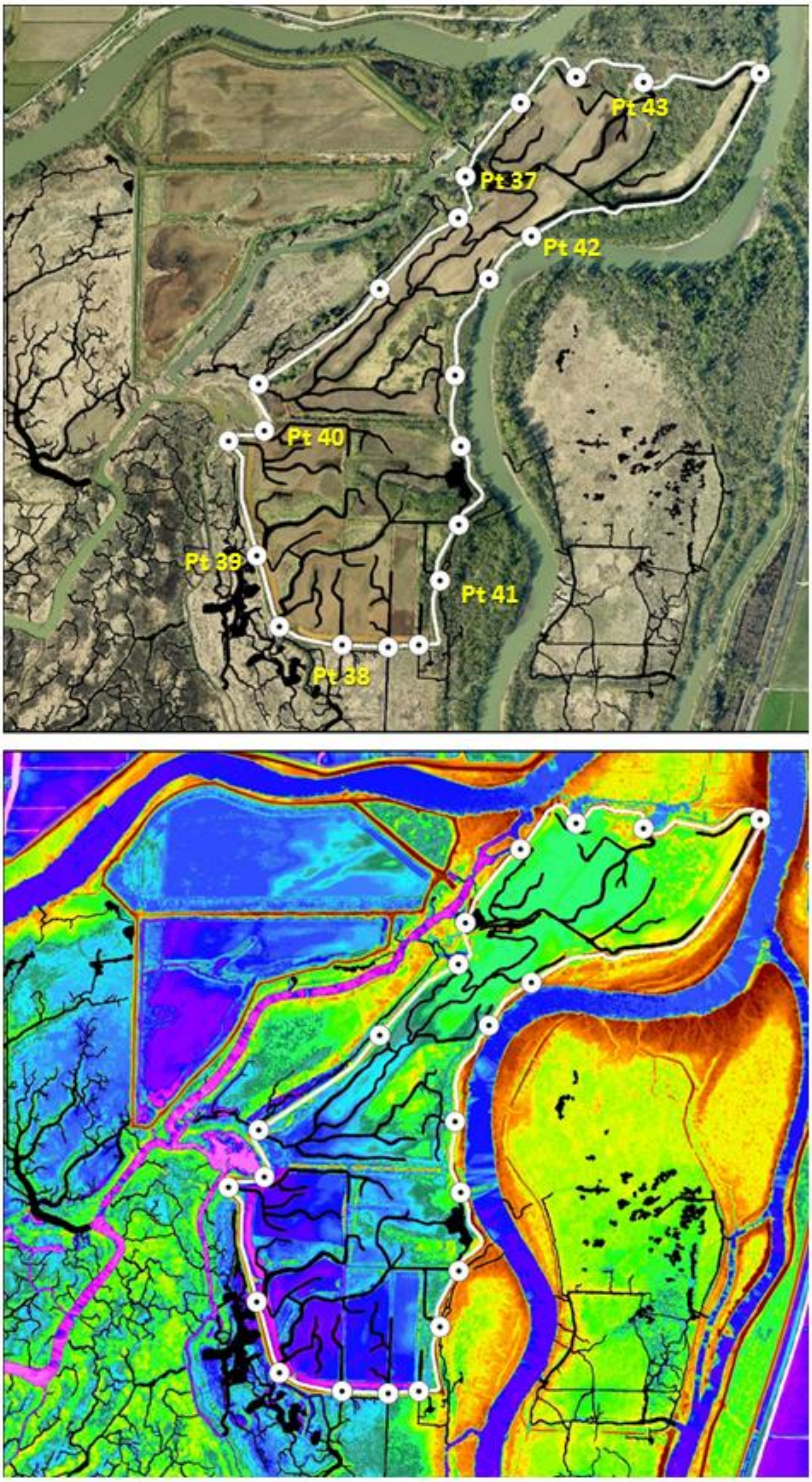


Figure 2. Map of the conceptual design method for ***Alternative 2*** depicting locations of channel outlets and channel. The top panel is shown over an orthophoto; the bottom panel over 2012 LiDAR. Hydrologically distinct polygons are bounded by white outlines. Tidal channel outlet points are shown as white dots with a black center. The channel outlet points used to calculate Landscape Connectivity values are labeled. Channels are shown as black lines.

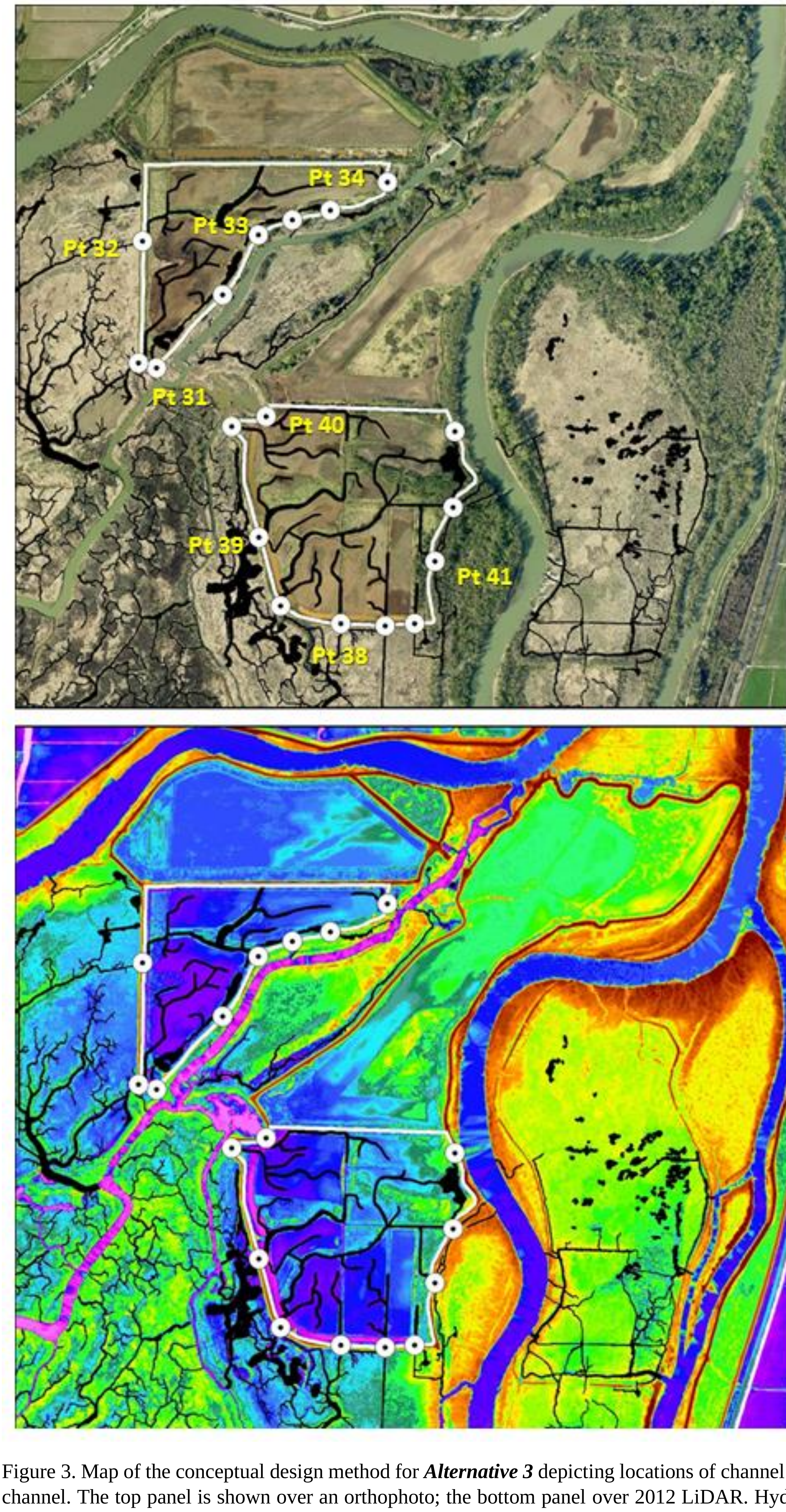


Figure 3. Map of the conceptual design method for ***Alternative 3*** depicting locations of channel outlets and channel. The top panel is shown over an orthophoto; the bottom panel over 2012 LiDAR. Hydrologically distinct polygons are bounded by white outlines. Tidal channel outlet points are shown as white dots with a black center. The channel outlet points used to calculate Landscape Connectivity values are labeled. Channels are shown as black lines.

References

Beamer, E., G. Hood, and K. Wolf. 2016. Technical Memo to Polly Hicks (NOAA Restoration Center), Jenny Baker (TNC), Jenna Friebel (WDFW) on December 27, 2016 regarding Habitat and juvenile Chinook benefit predictions of candidate restoration projects within the Skagit tidal delta. Work completed under NOAA/WRCO SRFB Skagit Hydrodynamic Model (SHDM) Project (P104051-A102542-n/a). Skagit River System Cooperative, La Conner, WA 98257. http://skagitcoop.org/wp-content/uploads/HabitatandJuvenileChinookBenefitPredictionsofCandidateRestorationProjectswithintheSkagitTidalDelta.pdf

Beamer, E.M., A. McBride, C. Greene, R. Henderson, G. Hood, K. Wolf, K. Larsen, C. Rice, and K. Fresh. 2005. Delta and nearshore restoration for the recovery of wild Skagit River Chinook salmon: linking estuary restoration to wild Chinook salmon populations. Appendix to the Skagit Chinook Recovery Plan. Skagit River System Cooperative, LaConner, WA. http://skagitcoop.org/wp-content/uploads/Appendix-D-Estuary1.pdf

Hood, W.G. 2004. Indirect environmental effects of dikes on estuarine tidal channels: thinking outside of the dike for habitat restoration and monitoring. Estuaries 27:273-282.

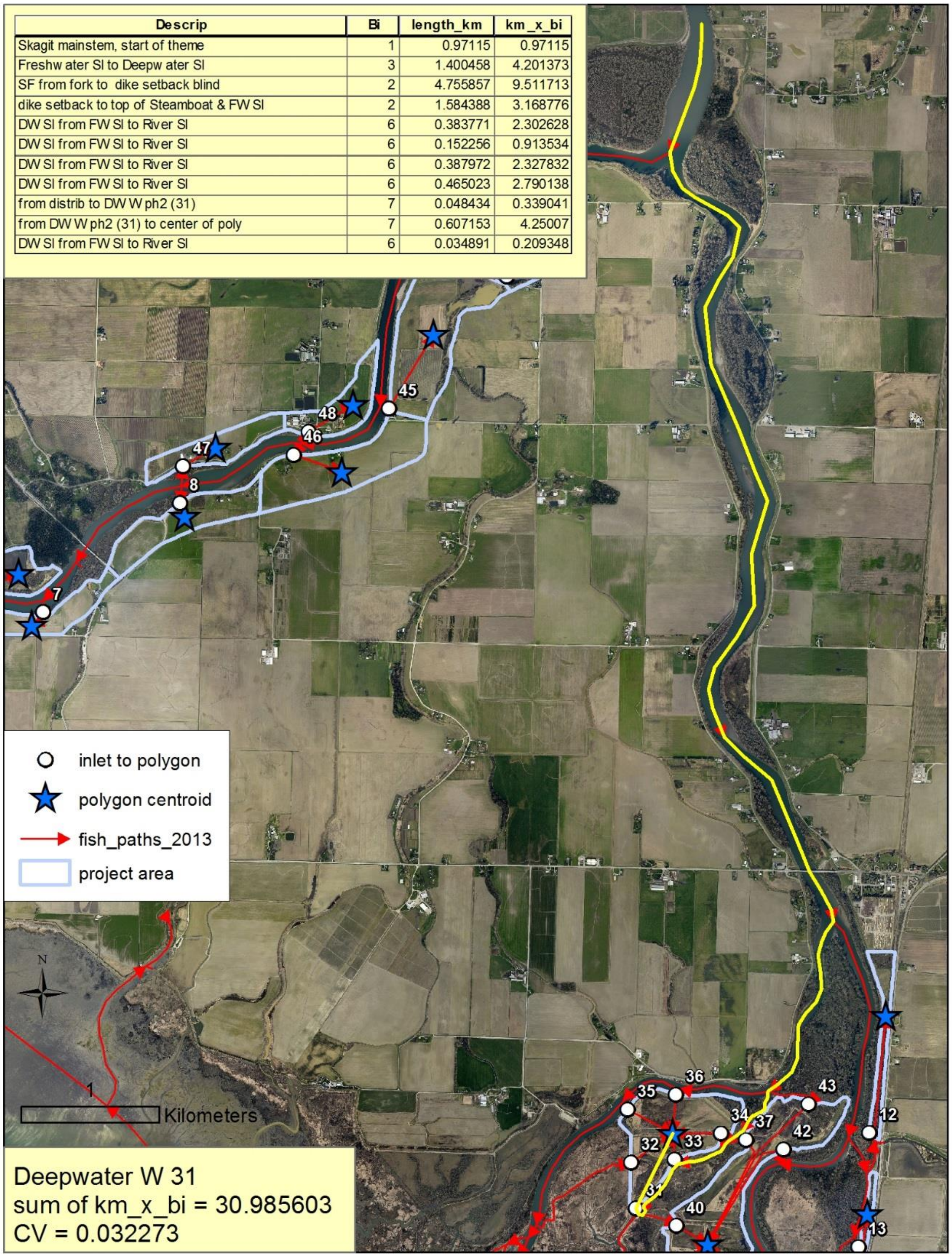
Hood, W.G. 2007. Scaling tidal channel geometry with marsh island area: a tool for habitat restoration, linked to channel formation process. Water Resources Research 43, W03409, doi:10.1029/2006WR005083.

Hood, W.G. 2015. Geographic variation in Puget Sound tidal channel planform geometry. Geomorphology 230:98-108.

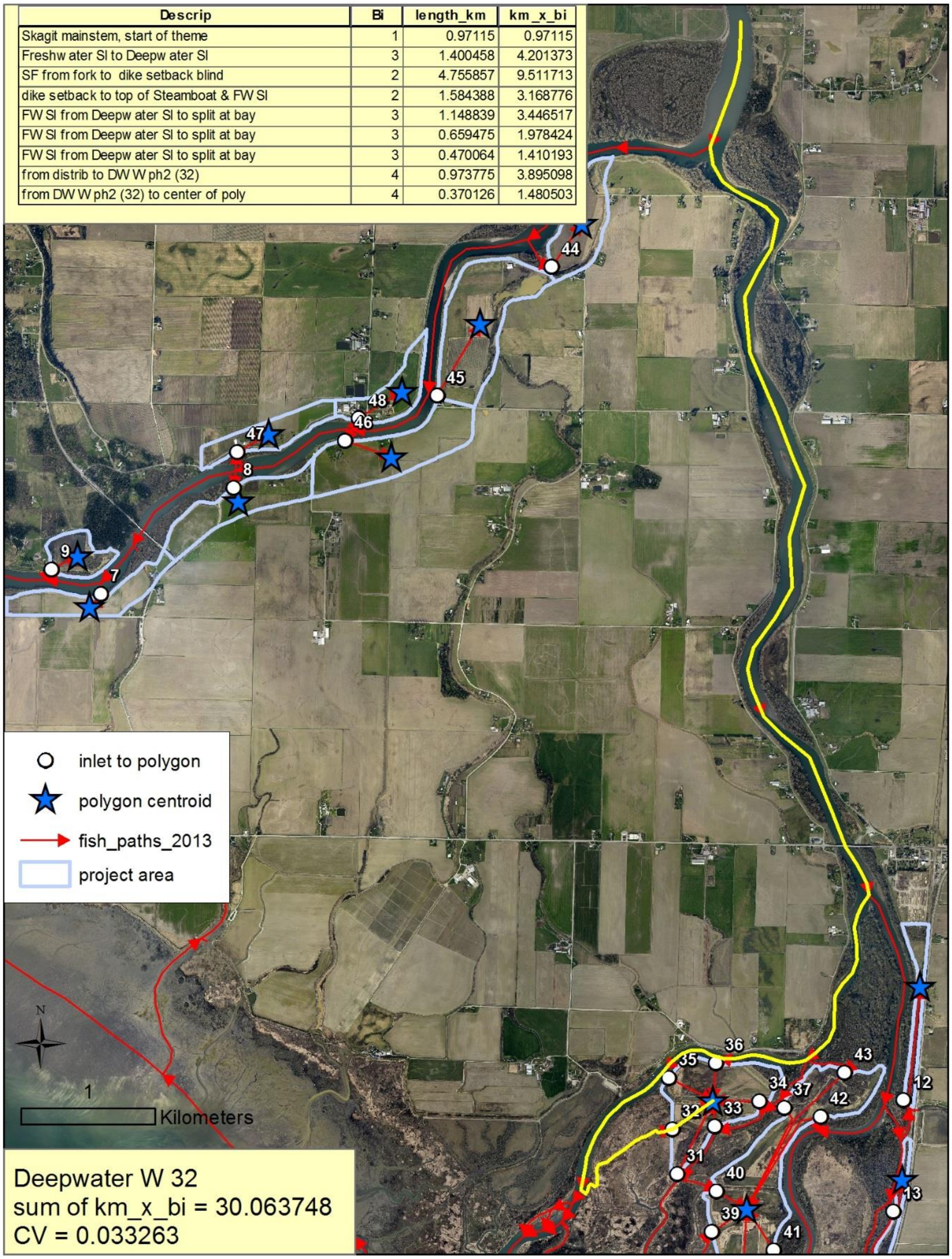
Hood, W.G. 2019. Tidal Channel Erosion Rates Depend on Marsh Restoration Site Size. Technical Report to the Estuary and Salmon Restoration Program. Skagit River System Cooperative, LaConner, WA.

Skagit River System Cooperative and Washington Department of Fish and Wildlife. 2005. Skagit Chinook Recovery Plan. Skagit River System Cooperative, La Conner, WA. http://skagitcoop.org/wp-content/uploads/Skagit-Chinook-Plan-13.pdf

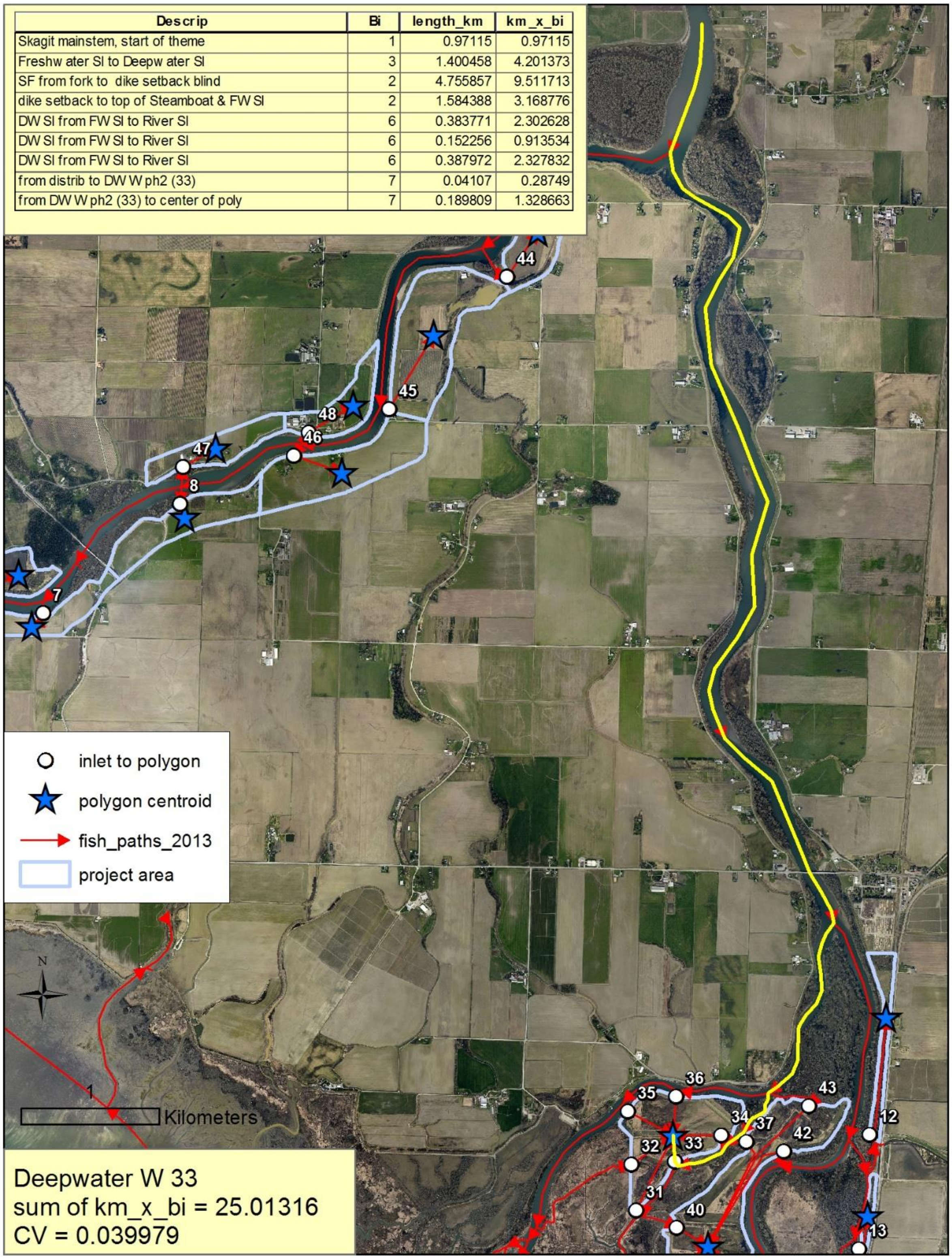
Appendix1. Fish migration pathways and landscape connectivity calculations.



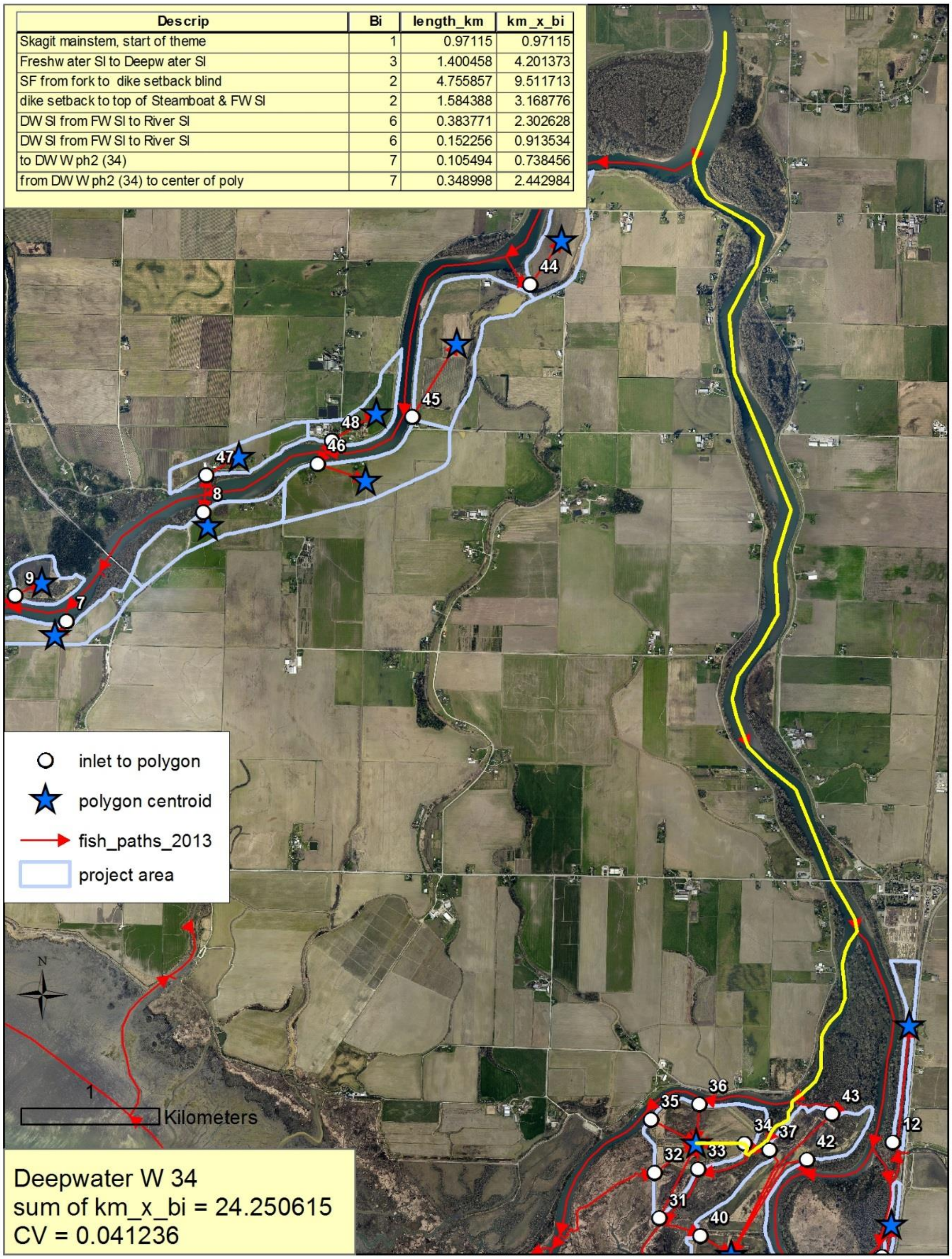
Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.97115	0.97115
Freshw ater Sl to Deepw ater Sl	3	1.400458	4.201373
SF from fork to dike setback blind	2	4.755857	9.511713
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
DW Sl from FW Sl to River Sl	6	0.383771	2.302628
DW Sl from FW Sl to River Sl	6	0.152256	0.913534
DW Sl from FW Sl to River Sl	6	0.387972	2.327832
DW Sl from FW Sl to River Sl	6	0.465023	2.790138
from distrib to DW W ph2 (31)	7	0.048434	0.339041
from DW W ph2 (31) to center of poly	7	0.607153	4.25007
DW Sl from FW Sl to River Sl	6	0.034891	0.209348



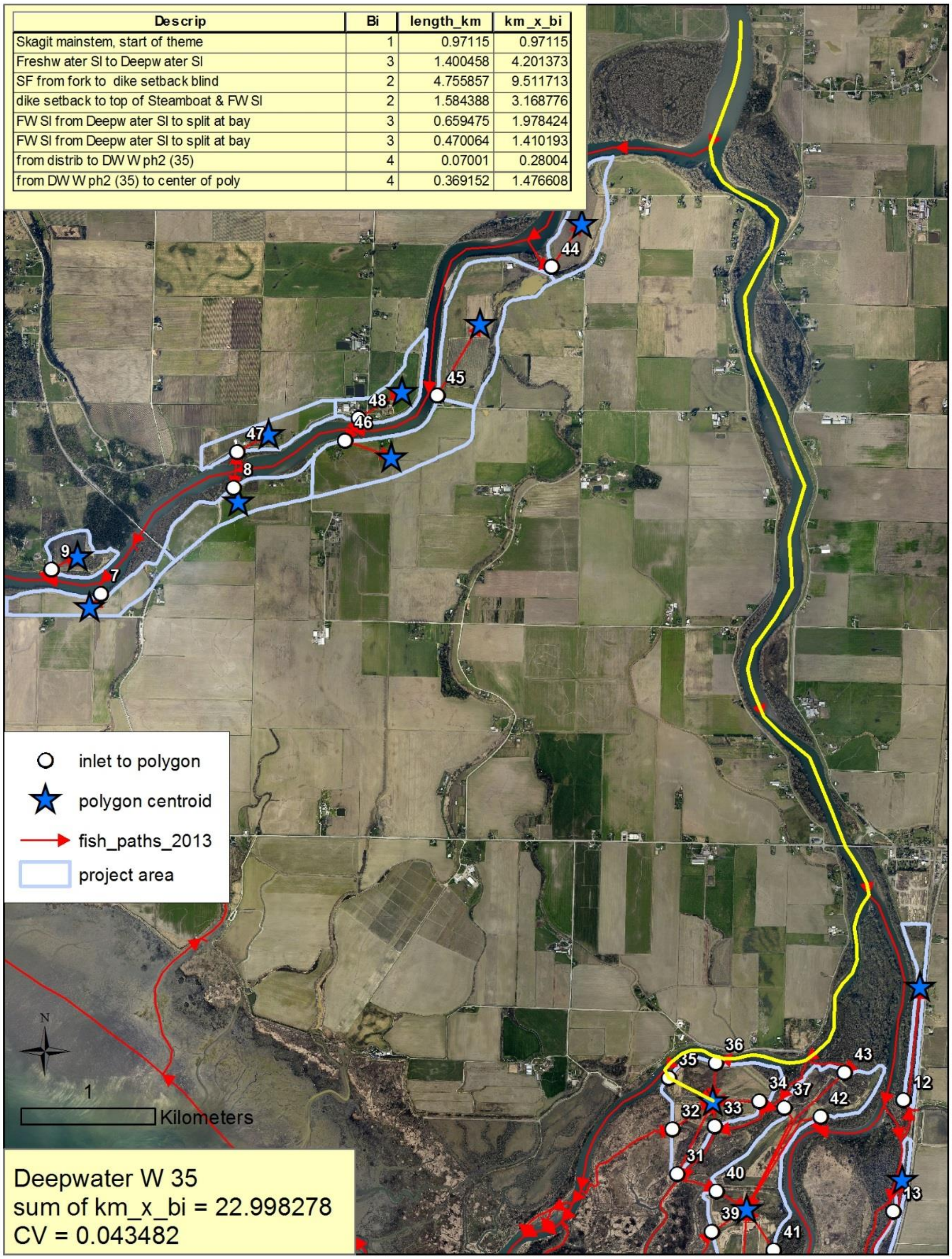
Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.97115	0.97115
Freshw ater Sl to Deepw ater Sl	3	1.400458	4.201373
SF from fork to dike setback blind	2	4.755857	9.511713
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
FW Sl from Deepw ater Sl to split at bay	3	1.148839	3.446517
FW Sl from Deepw ater Sl to split at bay	3	0.659475	1.978424
FW Sl from Deepw ater Sl to split at bay	3	0.470064	1.410193
from distrib to DW W ph2 (32)	4	0.973775	3.895098
from DW W ph2 (32) to center of poly	4	0.370126	1.480503



Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.97115	0.97115
Freshw ater Sl to Deepw ater Sl	3	1.400458	4.201373
SF from fork to dike setback blind	2	4.755857	9.511713
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
DW Sl from FW Sl to River Sl	6	0.383771	2.302628
DW Sl from FW Sl to River Sl	6	0.152256	0.913534
DW Sl from FW Sl to River Sl	6	0.387972	2.327832
from distrib to DW W ph2 (33)	7	0.04107	0.28749
from DW W ph2 (33) to center of poly	7	0.189809	1.328663

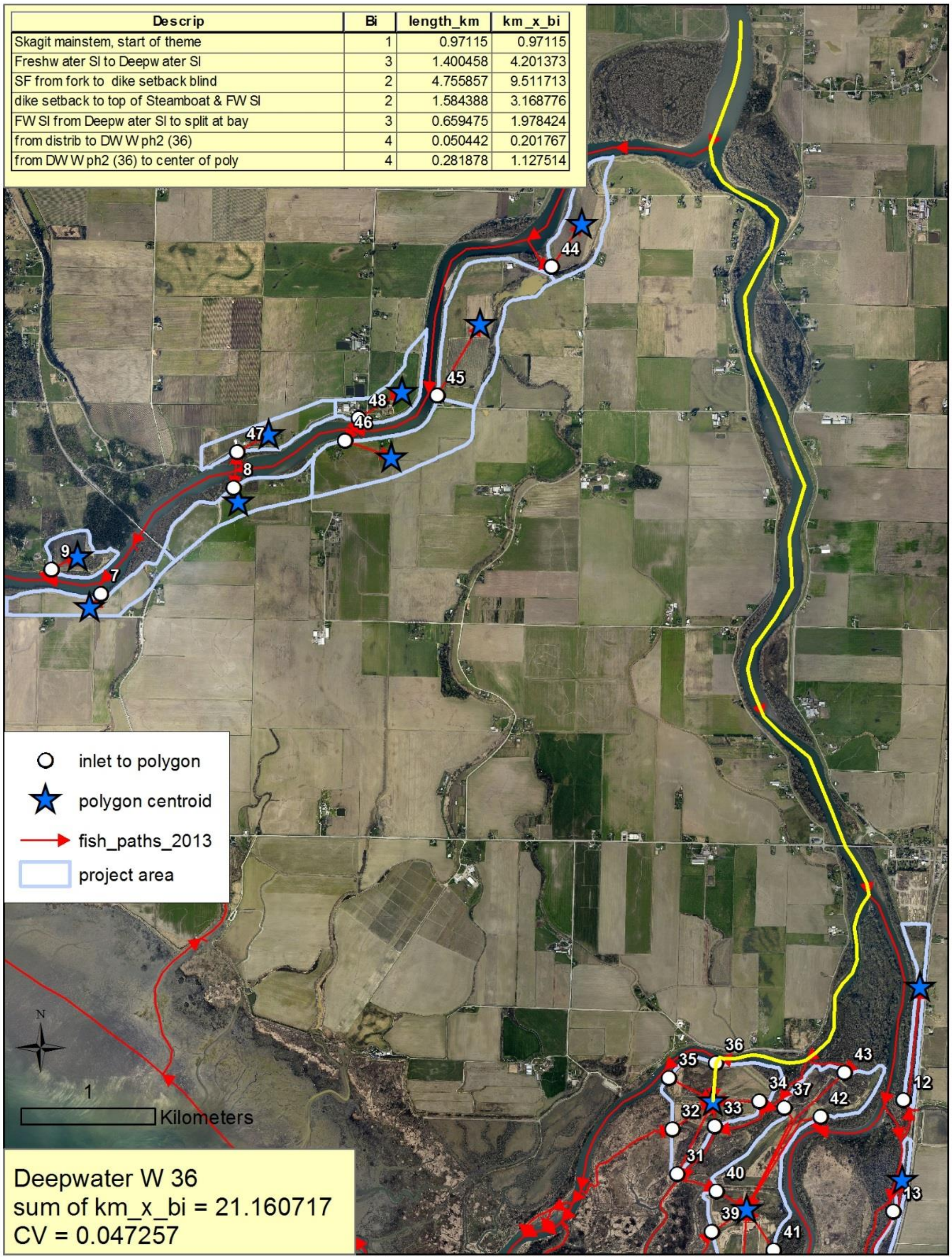


Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.97115	0.97115
Freshw ater Sl to Deepw ater Sl	3	1.400458	4.201373
SF from fork to dike setback blind	2	4.755857	9.511713
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
DW Sl from FW Sl to River Sl	6	0.383771	2.302628
DW Sl from FW Sl to River Sl	6	0.152256	0.913534
to DW W ph2 (34)	7	0.105494	0.738456
from DW W ph2 (34) to center of poly	7	0.348998	2.442984

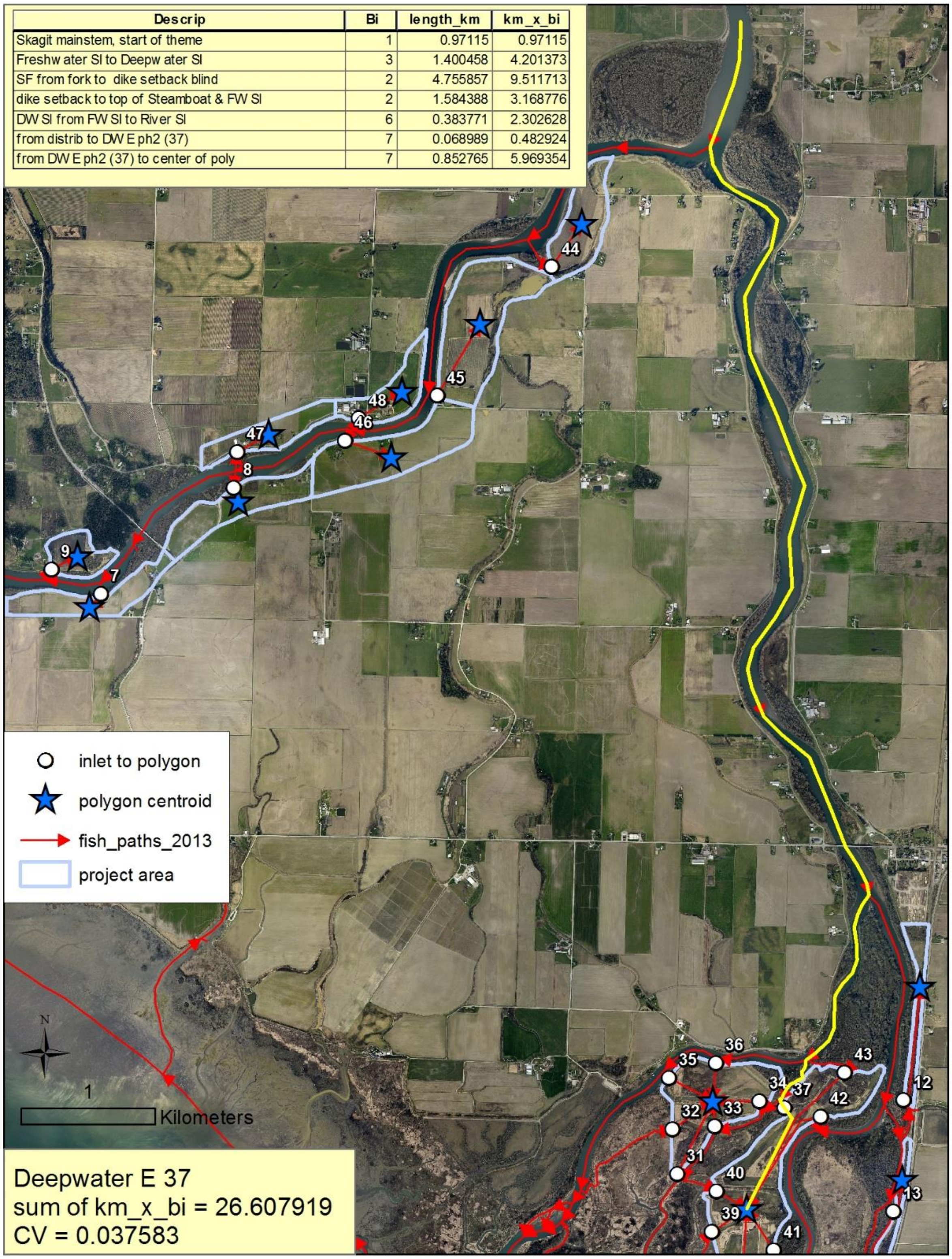


Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.97115	0.97115
Freshw ater Sl to Deepw ater Sl	3	1.400458	4.201373
SF from fork to dike setback blind	2	4.755857	9.511713
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
FW Sl from Deepw ater Sl to split at bay	3	0.659475	1.978424
FW Sl from Deepw ater Sl to split at bay	3	0.470064	1.410193
from distrib to DW W ph2 (35)	4	0.07001	0.28004
from DW W ph2 (35) to center of poly	4	0.369152	1.476608

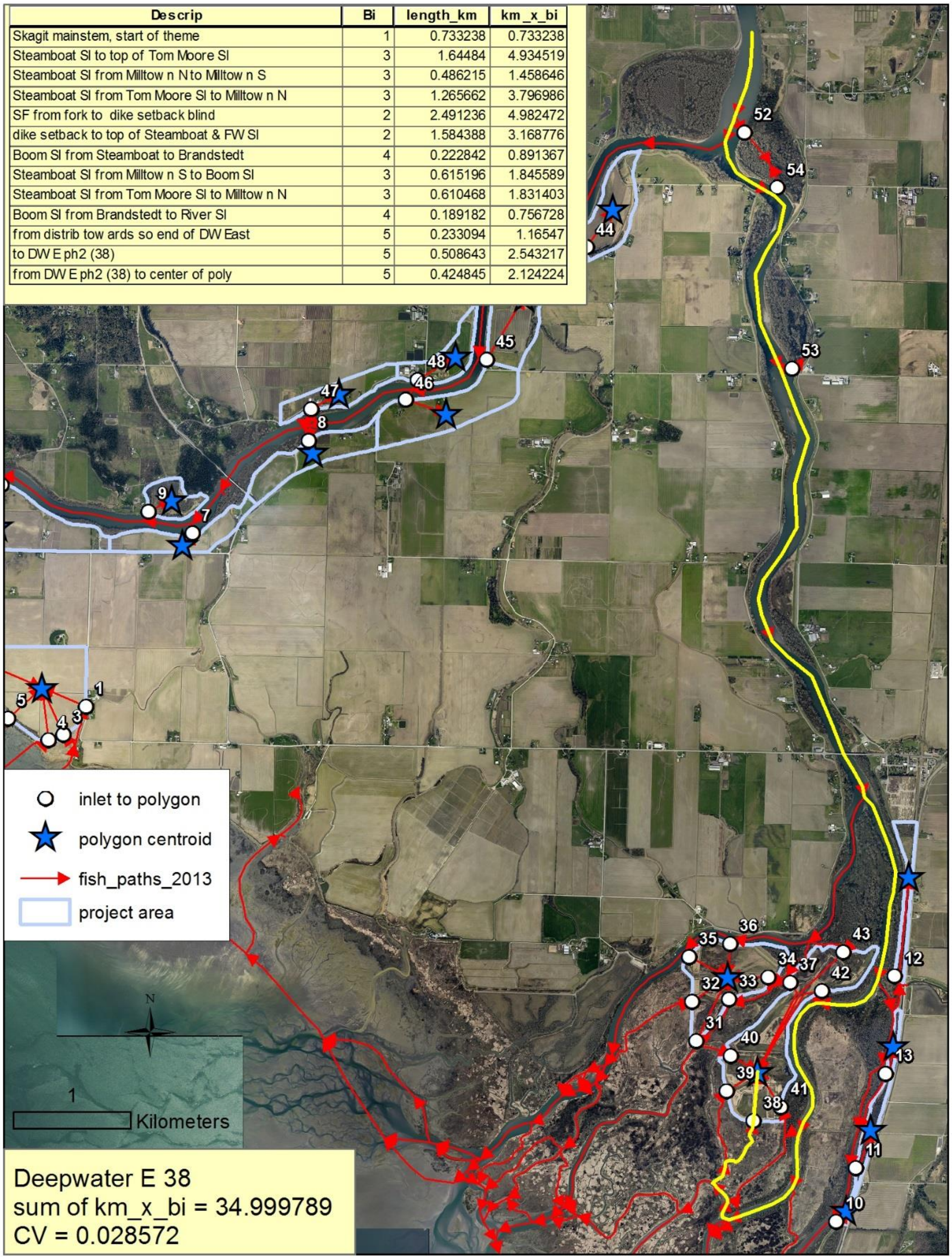
inlet to polygon
polygon centroid
fish_paths_2013
project area
N
1
Kilometers
Deepwater W 35
sum of km_x_bi = 22.998278
CV = 0.043482



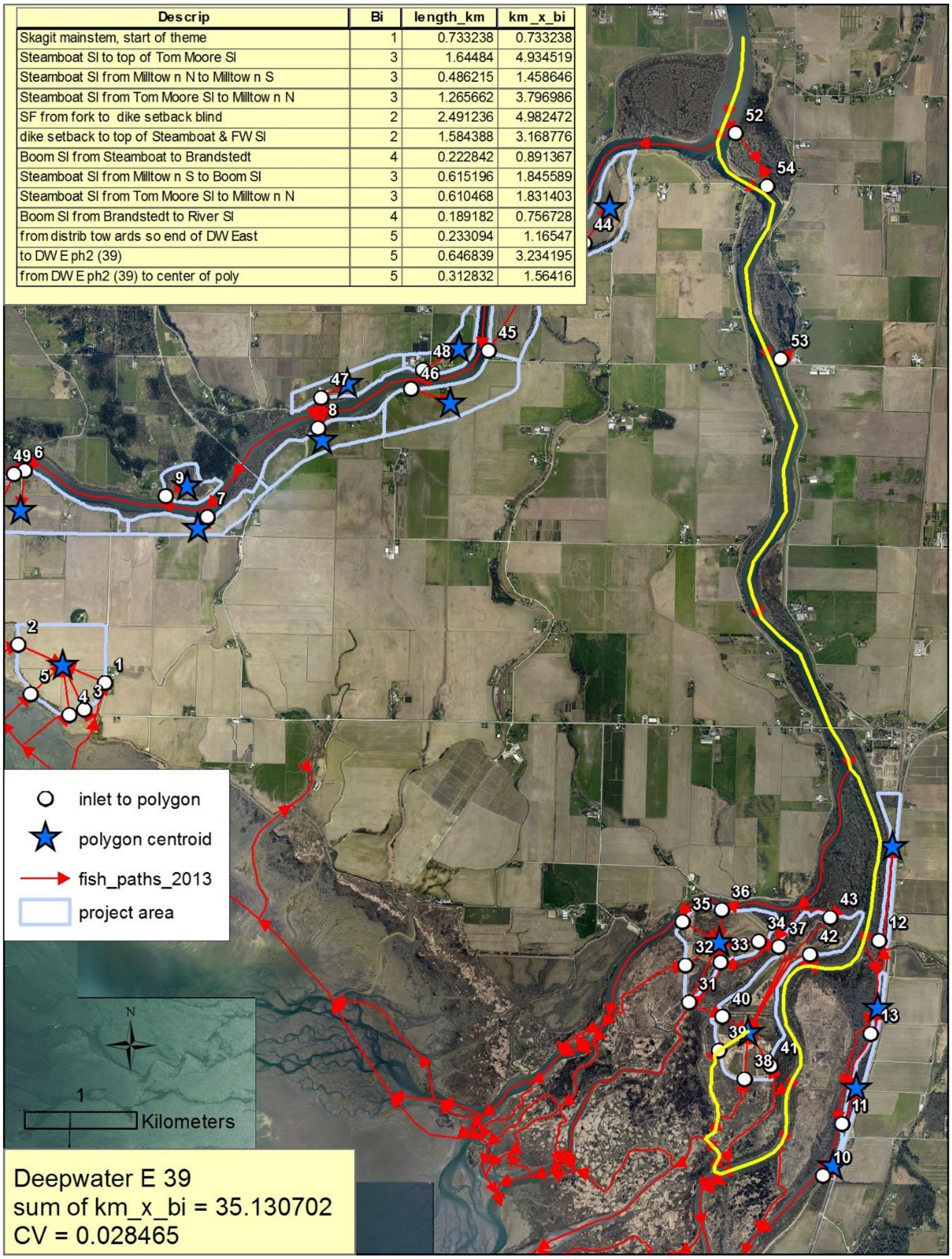
Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.97115	0.97115
Freshw ater Sl to Deepw ater Sl	3	1.400458	4.201373
SF from fork to dike setback blind	2	4.755857	9.511713
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
FW Sl from Deepw ater Sl to split at bay	3	0.659475	1.978424
from distrib to DW W ph2 (36)	4	0.050442	0.201767
from DW W ph2 (36) to center of poly	4	0.281878	1.127514



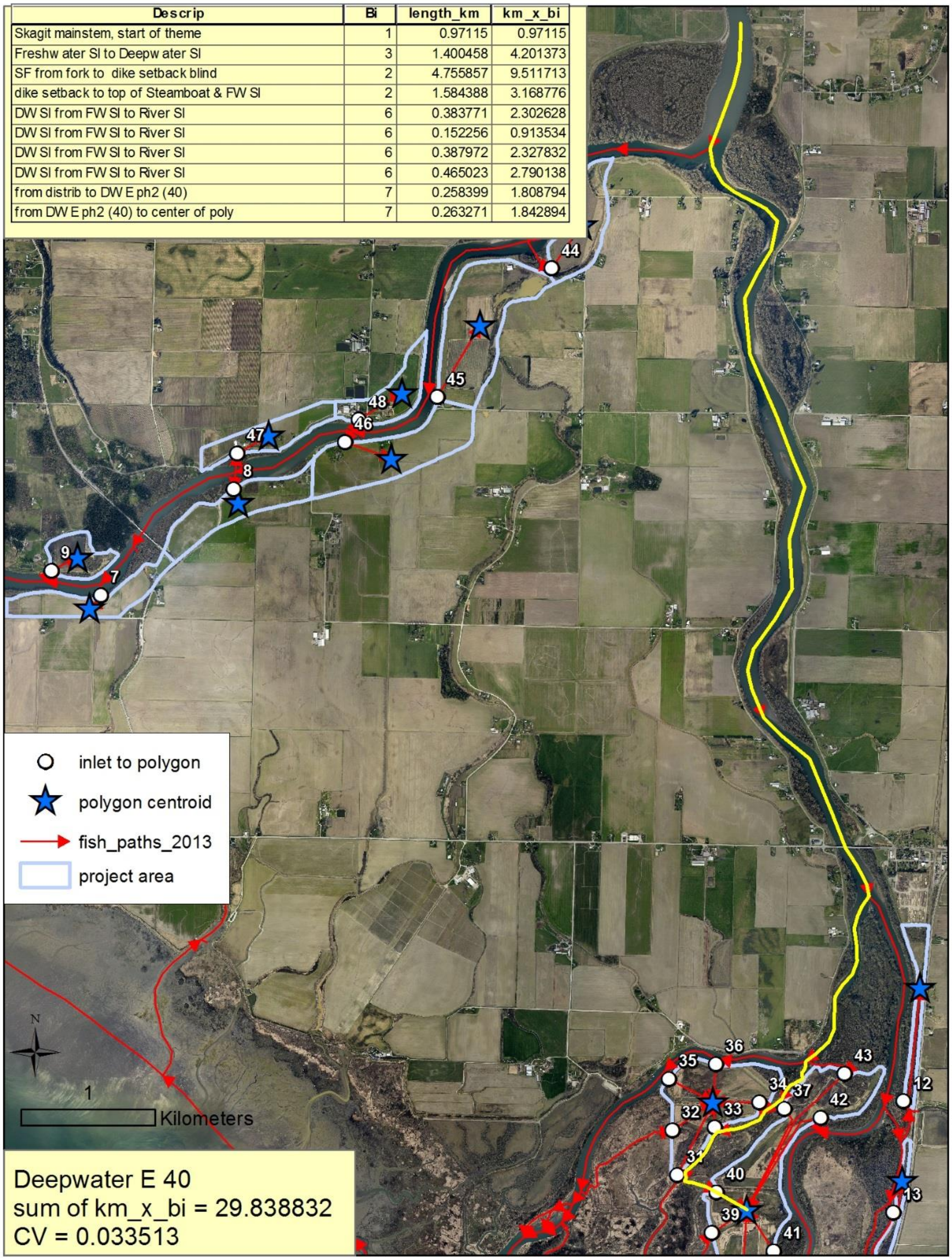
Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.97115	0.97115
Freshwater Sl to Deepwater Sl	3	1.400458	4.201373
SF from fork to dike setback blind	2	4.755857	9.511713
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
DW Sl from FW Sl to River Sl	6	0.383771	2.302628
from distrib to DW E ph2 (37)	7	0.068989	0.482924
from DW E ph2 (37) to center of poly	7	0.852765	5.969354



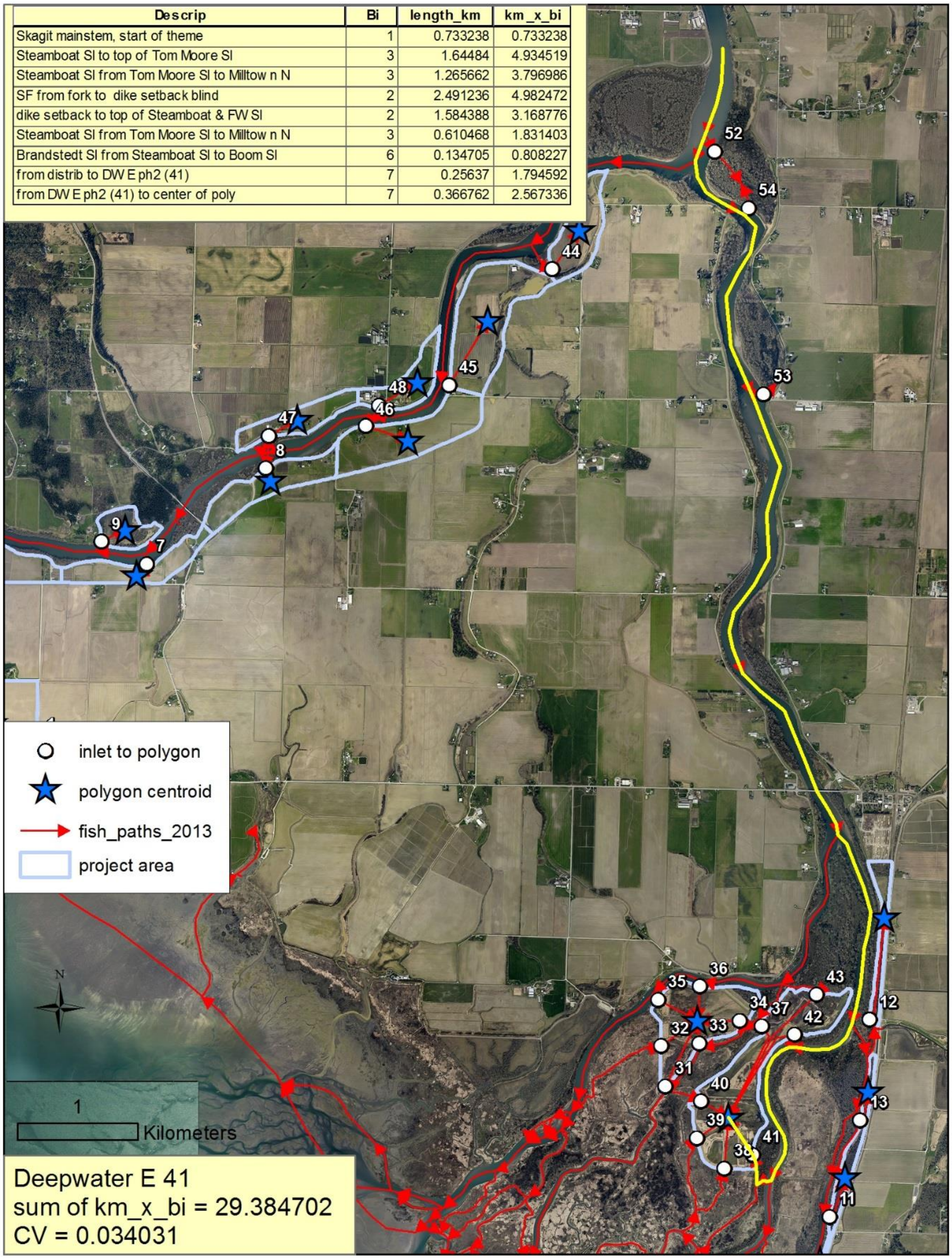
Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.733238	0.733238
Steamboat Sl to top of Tom Moore Sl	3	1.64484	4.934519
Steamboat Sl from Milltow n N to Milltow n S	3	0.486215	1.458646
Steamboat Sl from Tom Moore Sl to Milltow n N	3	1.265662	3.796986
SF from fork to dike setback blind	2	2.491236	4.982472
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
Boom Sl from Steamboat to Brandstedt	4	0.222842	0.891367
Steamboat Sl from Milltow n S to Boom Sl	3	0.615196	1.845589
Steamboat Sl from Tom Moore Sl to Milltow n N	3	0.610468	1.831403
Boom Sl from Brandstedt to River Sl	4	0.189182	0.756728
from distrib tow ards so end of DW East	5	0.233094	1.16547
to DW E ph2 (38)	5	0.508643	2.543217
from DW E ph2 (38) to center of poly	5	0.424845	2.124224



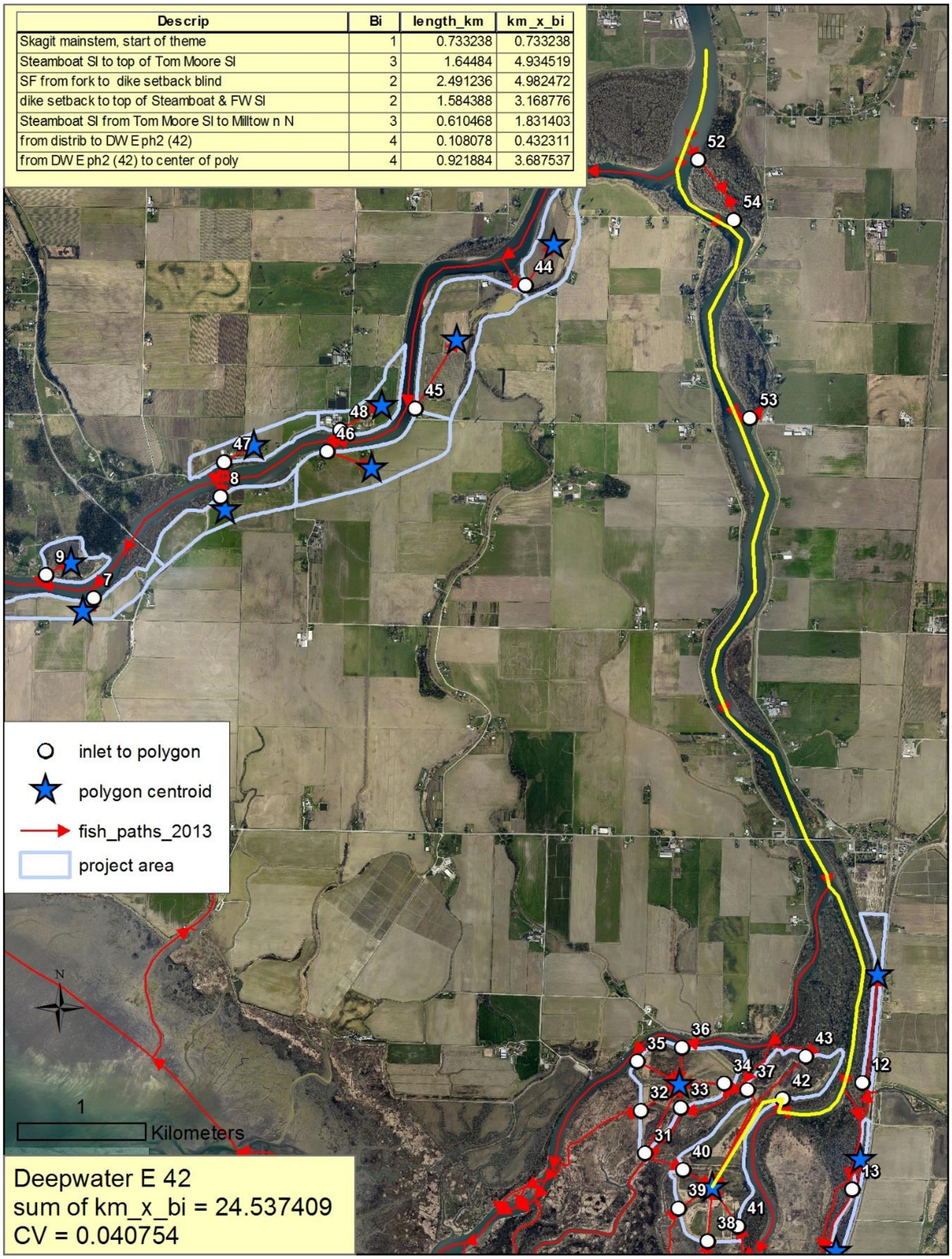
Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.733238	0.733238
Steamboat Sl to top of Tom Moore Sl	3	1.64484	4.934519
Steamboat Sl from Milltow n N to Milltow n S	3	0.486215	1.458646
Steamboat Sl from Tom Moore Sl to Milltow n N	3	1.265662	3.796986
SF from fork to dike setback blind	2	2.491236	4.982472
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
Boom Sl from Steamboat to Brandstedt	4	0.222842	0.891367
Steamboat Sl from Milltow n S to Boom Sl	3	0.615196	1.845589
Steamboat Sl from Tom Moore Sl to Milltow n N	3	0.610468	1.831403
Boom Sl from Brandstedt to River Sl	4	0.189182	0.756728
from distrib tow ards so end of DW East	5	0.233094	1.16547
to DW E ph2 (39)	5	0.646839	3.234195
from DW E ph2 (39) to center of poly	5	0.312832	1.56416



Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.97115	0.97115
Freshw ater Sl to Deepw ater Sl	3	1.400458	4.201373
SF from fork to dike setback blind	2	4.755857	9.511713
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
DW Sl from FW Sl to River Sl	6	0.383771	2.302628
DW Sl from FW Sl to River Sl	6	0.152256	0.913534
DW Sl from FW Sl to River Sl	6	0.387972	2.327832
DW Sl from FW Sl to River Sl	6	0.465023	2.790138
from distrib to DW E ph2 (40)	7	0.258399	1.808794
from DW E ph2 (40) to center of poly	7	0.263271	1.842894

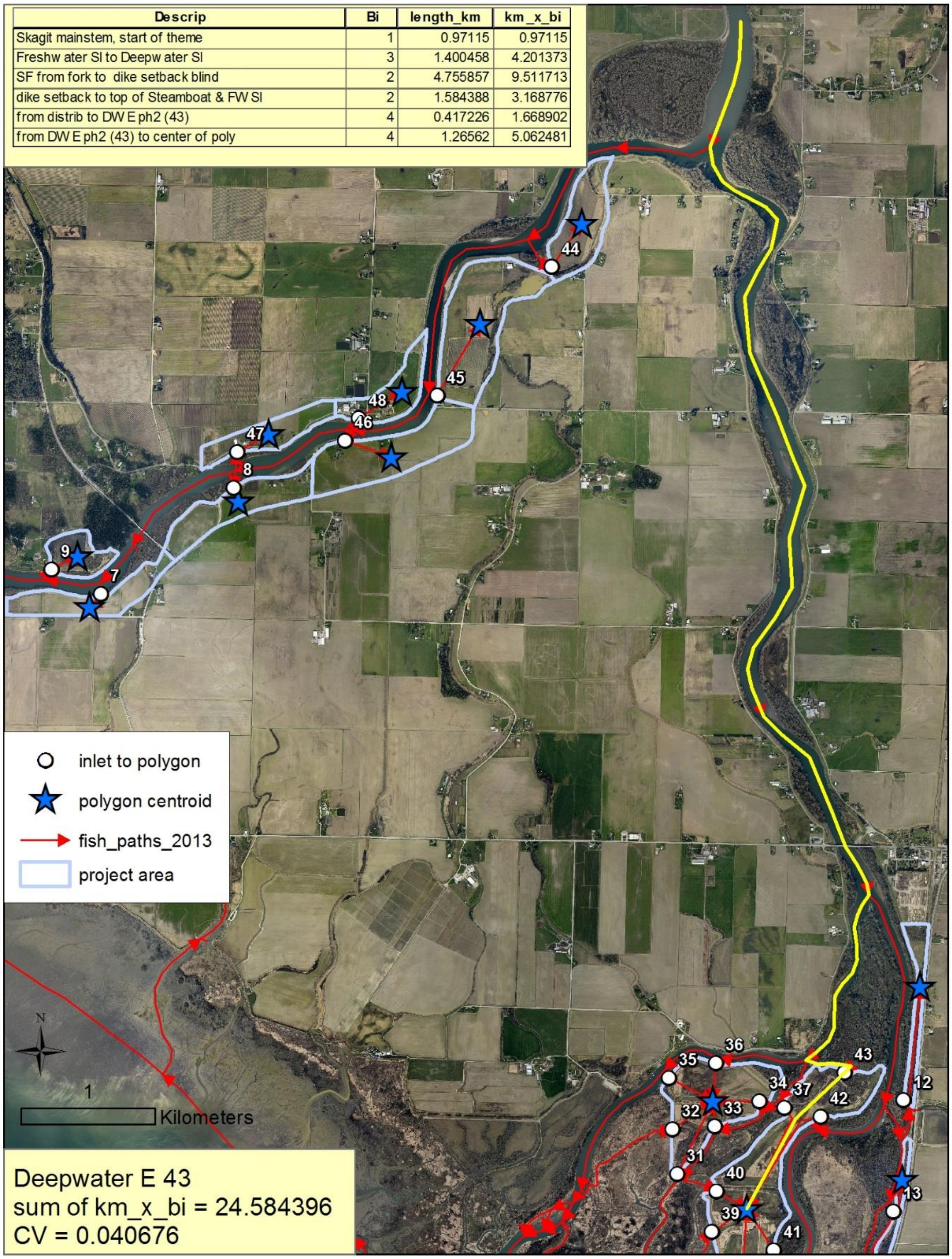


Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.733238	0.733238
Steamboat Sl to top of Tom Moore Sl	3	1.64484	4.934519
Steamboat Sl from Tom Moore Sl to Milltow n N	3	1.265662	3.796986
SF from fork to dike setback blind	2	2.491236	4.982472
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
Steamboat Sl from Tom Moore Sl to Milltow n N	3	0.610468	1.831403
Brandstedt Sl from Steamboat Sl to Boom Sl	6	0.134705	0.808227
from distrib to DW E ph2 (41)	7	0.25637	1.794592
from DW E ph2 (41) to center of poly	7	0.366762	2.567336



Descrip	Bi	length_km	km_x_bi
Skagit mainstem, start of theme	1	0.733238	0.733238
Steamboat Sl to top of Tom Moore Sl	3	1.64484	4.934519
SF from fork to dike setback blind	2	2.491236	4.982472
dike setback to top of Steamboat & FW Sl	2	1.584388	3.168776
Steamboat Sl from Tom Moore Sl to Milltow n N	3	0.610468	1.831403
from distrib to DW E ph2 (42)	4	0.108078	0.432311
from DW E ph2 (42) to center of poly	4	0.921884	3.687537

inlet to polygon
polygon centroid
fish_paths_2013
project area
N
1
Kilometers
Deepwater E 42
sum of km_x_bi = 24.537409
CV = 0.040754



Descrip | Bi | length_km | km_x_bi
Skagit mainstem, start of theme | 1 | 0.97115 | 0.97115
Freshwater Sl to Deepwater Sl | 3 | 1.400458 | 4.201373
SF from fork to dike setback blind | 2 | 4.755857 | 9.511713
dike setback to top of Steamboat & FW Sl | 2 | 1.584388 | 3.168776
from distrib to DWE ph2 (43) | 4 | 0.417226 | 1.668902
from DWE ph2 (43) to center of poly | 4 | 1.26562 | 5.062481
inlet to polygon
polygon centroid
fish_paths_2013
project area
N
1
Kilometers
Deepwater E 43
sum of km_x_bi = 24.584396
CV = 0.040676

APPENDIX D: GEOMORPHIC TECHNICAL MEMORANDUM

ISLAND UNIT PRELIMINARY GEOMORPHOLOGY ASSESSMENT

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

Contents

Introduction/Purpose

The Island Unit is a part of the Skagit Wildlife Area. The Island Unit is located between Freshwater Slough and Steamboat Slough in the delta of the South Fork of the Skagit River and consists of two separate islands divided by Deepwater Slough (Figure 1). Portions of each island are ringed by dikes that isolate these areas from tides and river flows. The length of the site spans a key transition zone between the fluvial (riverine) environment of the South Fork Skagit River and the tide dominated Skagit Bay. Elevations on the site range from approximately 5-9.5 feet NAVD88.

Much of this area was converted to agriculture prior to the General Land Office Survey (GLO) in 1889, and subsequent navigation projects in the south fork Skagit blocked distributary channels and diked off tidal marsh and blind tidal channels. A portion of the site was restored to estuary in 2000. The remaining 270-acre diked area is currently used to produce managed and enhanced winter waterfowl forage. Areas outside the dikes support emergent and scrub-shrub plant communities to the south and forested floodplain wetlands to the north. The Skagit Chinook Recovery Plan identifies estuary rearing area as a limiting factor for recovery of Chinook salmon and the remaining diked area of the Island Unit is identified as a potential restoration project.

The purpose of this report is to provide information about the geomorphic setting of the site and complete a preliminary geomorphic analysis of possible restoration scenarios. This memo is also intended to provide information related to criteria, including:

- WDFW's wetland policy (policy 5211), which includes the following relevant sections:
    - *WDFW will accomplish long-term gain of properly functioning wetlands where both ecologically and financially feasible on WDFW-owned or WDFW-controlled properties;*
    - *WDFW will promote the restoration of original hydrology, elevations and native plant communities*
- Climate change resilience, which includes the following considerations:
    - infrastructure resiliency in the face of sea level rise and changing river flows
    - habitat migration
    - flood risk reduction

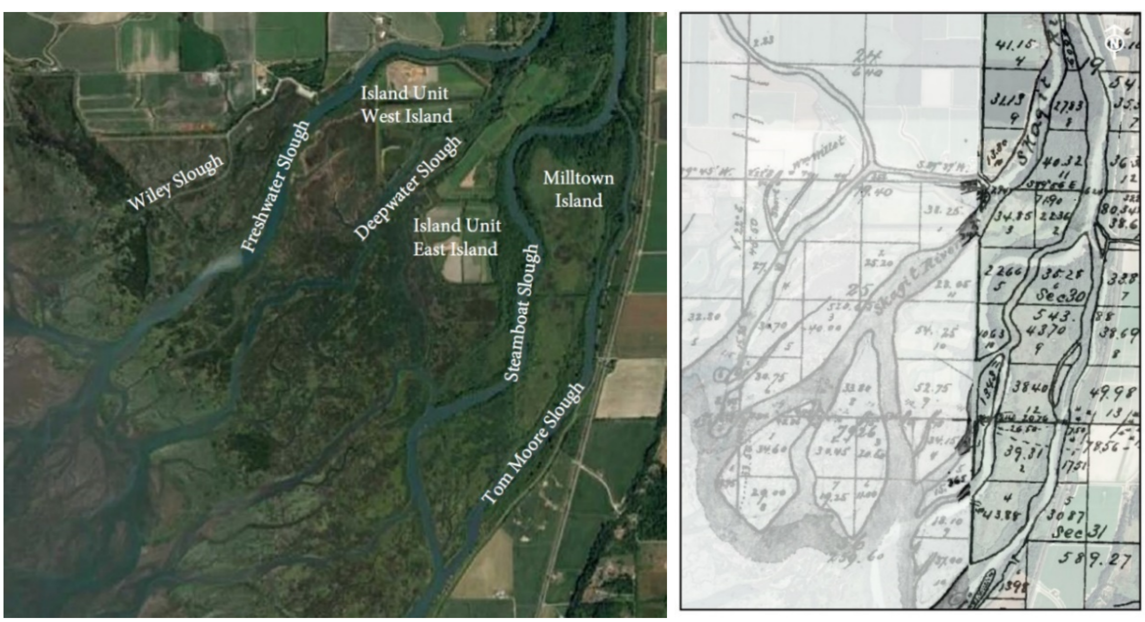


Figure 1 – Location Map and GLO Survey Circa 1889

Alternatives

Four different alternatives are being assessed through an alternatives analysis for the Island Unit (Figure 2). Alternative 1 assumes only infrastructure upgrades with no dike/levee removal. Alternative 2 assumes removal of all dike/ levees on the east island. Alternative 3 assumes removal of dikes/ levees on the southern portions of both islands with setbacks to connect the existing dikes/ levees. Alternative 4 removes all dikes/ levees.

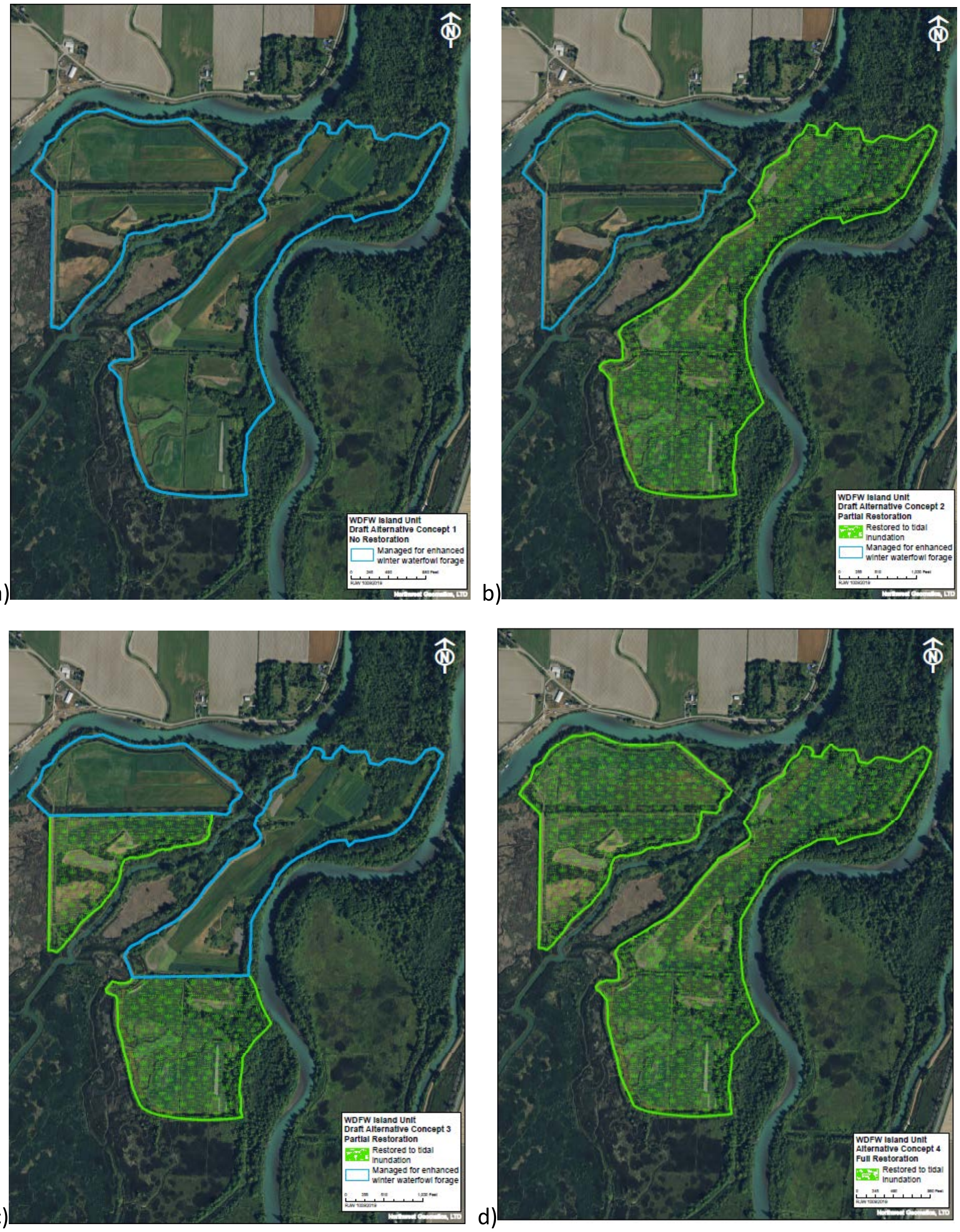


Figure 2 – Alternatives being assessed for the Island Unit site. a) No Restoration/Alternative 1 b) Restoration of the East Island/Alternative 2 c) Restoration of the Southern Half of Each Island/Alternative 3 d) Full Restoration/Alternative 4

Historical context

Historically, the Skagit River delta was formed by river-borne sediment deposits, and lahars from volcanic eruptions of Glacier Peak. The main river channel changed course and occupied several different paths to saltwater, from Samish and Padilla Bays to Skagit Bay. Once formed, the delta continued to prograde slowly and consisted of a mosaic of diverse floodplain and estuarine features that were shaped by river flows and tides, and the wood and sediment they carried. This mosaic included distributary and blind tidal channels, freshwater and brackish wetlands, unvegetated mudflats and sandflats, and floodplain and marshplain vegetation communities ranging from emergent to shrub-scrub to forested.

Post-settlement diking, dredging, and filling in the delta have changed the processes that shape and maintain landforms and habitats. Channels in the Skagit River delta were historically dredged and manipulated for navigational purposes. In 1910 a project to improve Skagit River navigation was authorized in the River and Harbor Act. The US Army Corps of Engineers (USACOE) completed construction in 1911. Construction activities directed most of the river flow into the South Fork mainstem. A sill was installed at the head of the North Fork to direct the majority of flow down the South Fork, and most distributary channels across Fir Island and within the delta were plugged. The dredge spoils were sidecast onto the banks to create levees. The maintenance of the navigational channel included further dredging and plugging of sloughs to assist in navigation, as well as dike maintenance, including emergency flood repairs. The maintenance of the navigation project was stopped in the 1950s and deauthorized in 1978. The navigation project significantly impacted the surrounding estuary by disconnecting portions of the delta from the main river flow and from tides through diking and dredging.

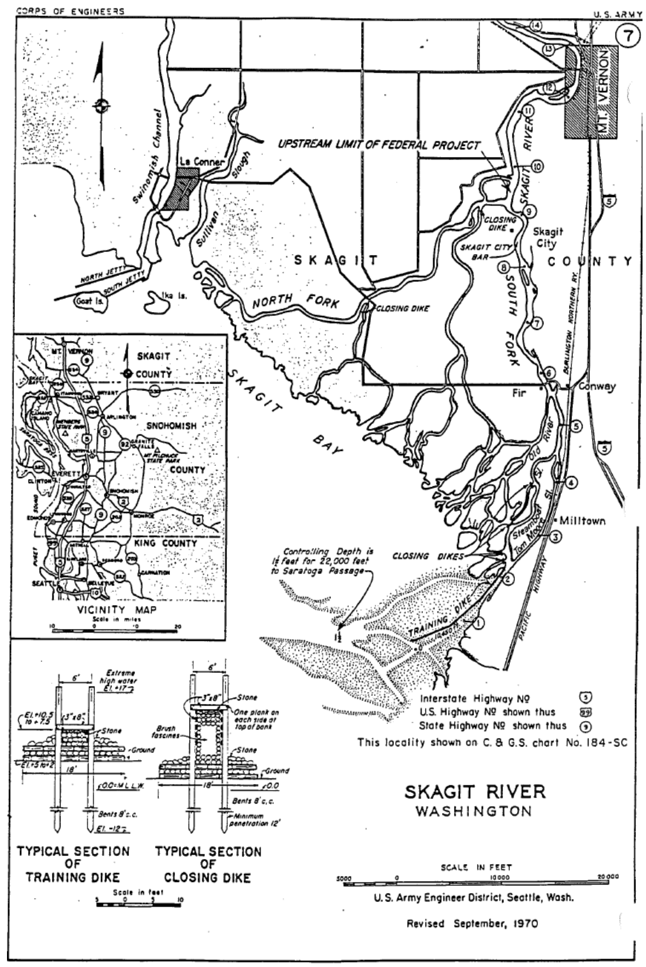


Figure 3 - Activities authorized and constructed under the river and harbor act of 1910 in the Skagit River delta to improve navigation.

Post settlement diking, dredging, and filling in the delta have severely limited the historic extent of delta habitat. Comparison of a historic reconstruction of the Skagit delta by Collins (2000) with mapping done from 1991 aerial photos by Skagit River System Cooperative (Beamer et al. 2000) shows a net loss of 74.6% of tidal delta estuarine habitat area (Figure 4).

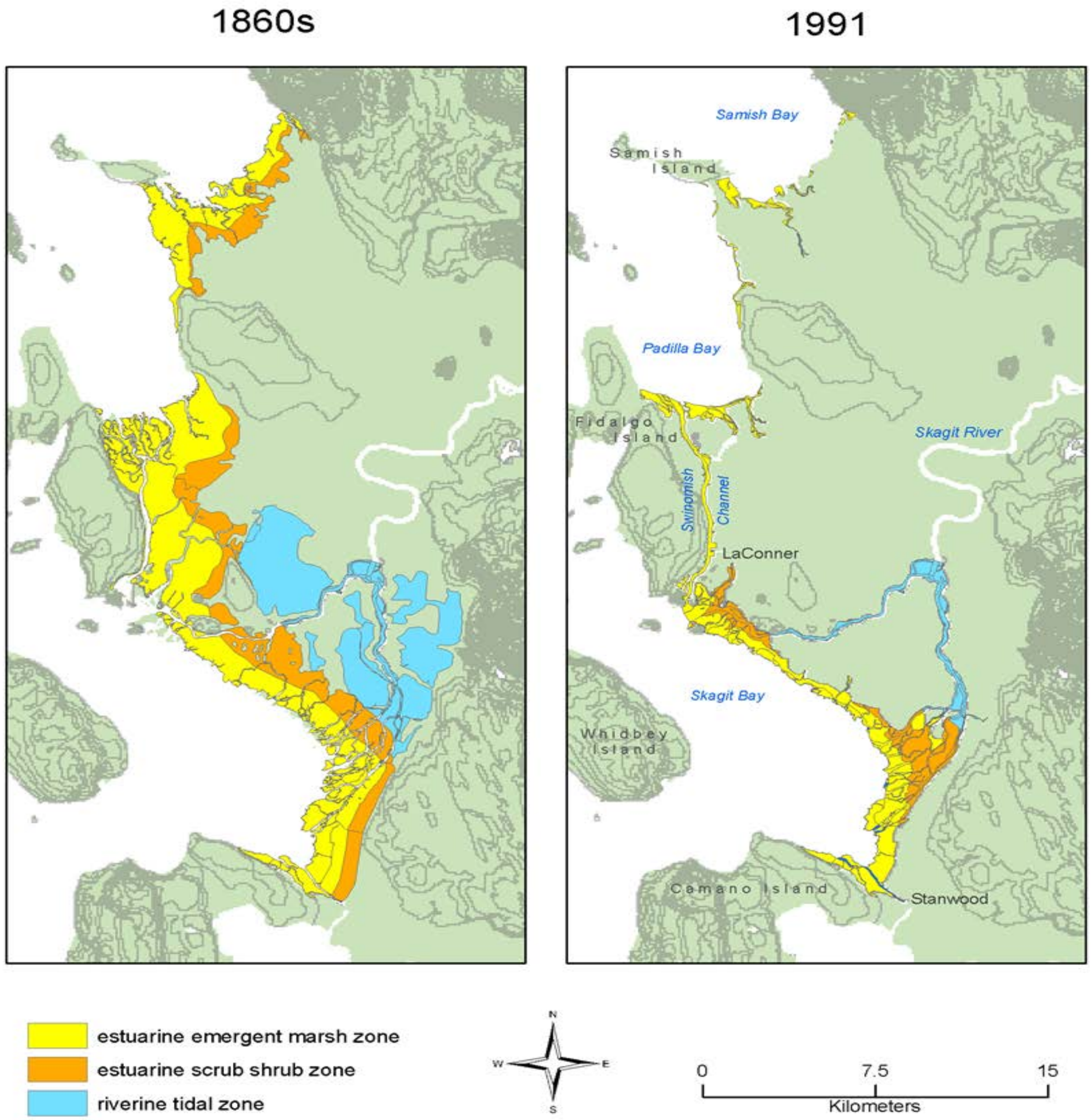


Figure 4 - Changes in estuarine habitats, 1860s to 1991. From Beamer et al, 2005 (http://skagitcoop.org/wp-content/uploads/Appendix-D-Estuary1.pdf).

An estuary restoration project completed in 2000 removed portions of the dike around the perimeter of each island and removed dikes that had extended across the upstream and downstream ends of Deepwater Slough (Figure 5). As a result, natural hydrology was restored to portions of each island, and riverine and tidal flows were reestablished through Deepwater Slough. This project was authorized under Section 1135 of the Water Resources Development Act of 1986, which allows the Corps to plan, design and build modifications to existing Corps projects, or areas degraded by Corps projects, to restore aquatic habitats for fish and wildlife.

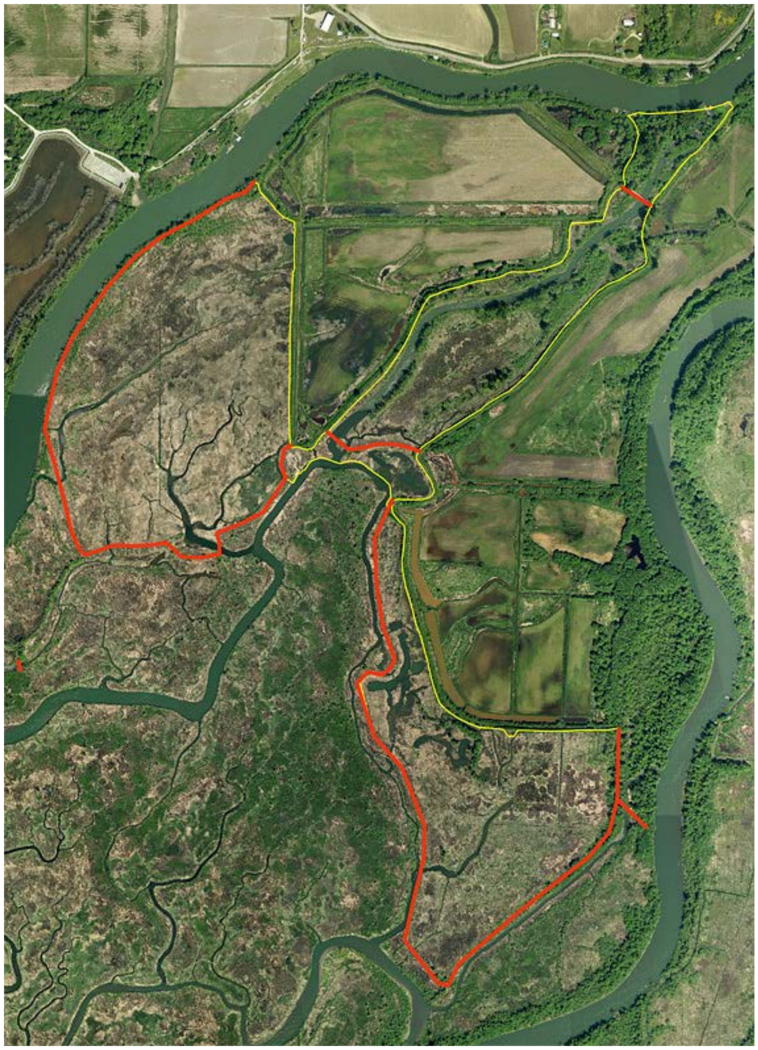


Figure 5 - Restoration actions completed in 2000. (Figure from http://skagitcoop.org/programs/restoration/deepwater-slough/)

Water Surface Elevation Summary

The Island Unit is located in a tidally influenced reach of the lower south fork Skagit River where both river flows and tides affect the water surface elevation at any given time. Water surface data has been collected for two separate projects in this reach. Data was collected in support of the Skagit Hydrodynamic Modeling (HDM) project at multiple sites including in both Steamboat Slough (HDM 5) and Freshwater Slough (HDM 4) adjacent to the Island Unit (Figure 6). The Milltown Island Restoration Feasibility project included eight data collection sites, and four of those are in main channels close to the Island Unit (Figure 7). The water surface data at all sites presented in this memo ranged from 3.5 feet to 13 feet NAVD88 within the periods of record, with a few outliers (Table 1). Island Unit project site ground elevations inside the dikes generally range from 5 feet to 9.5 feet NAVD88, and dike elevations range from approximately 13 feet to 20 feet NAVD88 (Figure 8). Although no water surface elevation data is available from within the dikes, the site is isolated from natural riverine and tidal hydrology by dikes and tidegates.

Water surface elevation data was analyzed using RStudio to calculate average, maximum and minimum daily water surface elevations (Figures 9, 10, and 11) for the HDM 4, HDM 5, and Milltown S2 data, which have the longest period of record of any sites in the project area.

Figure 6- Water surface elevation data collection points associated with the Skagit HDM project.

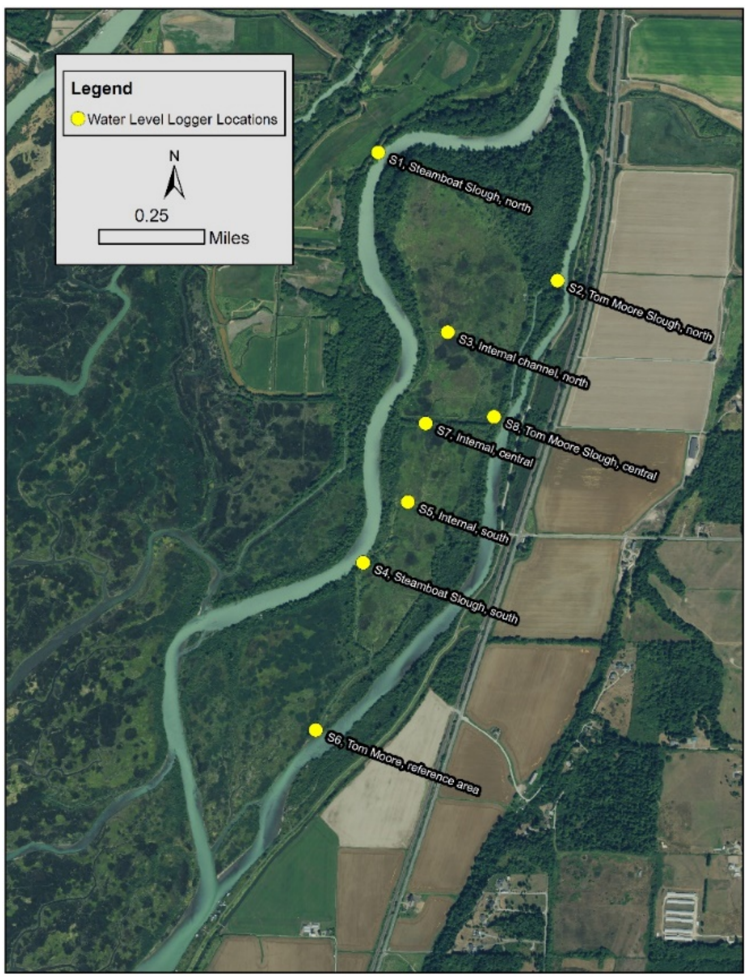


Figure 7 - Water surface elevation data collection points associated with the Milltown Island Restoration Feasibility project

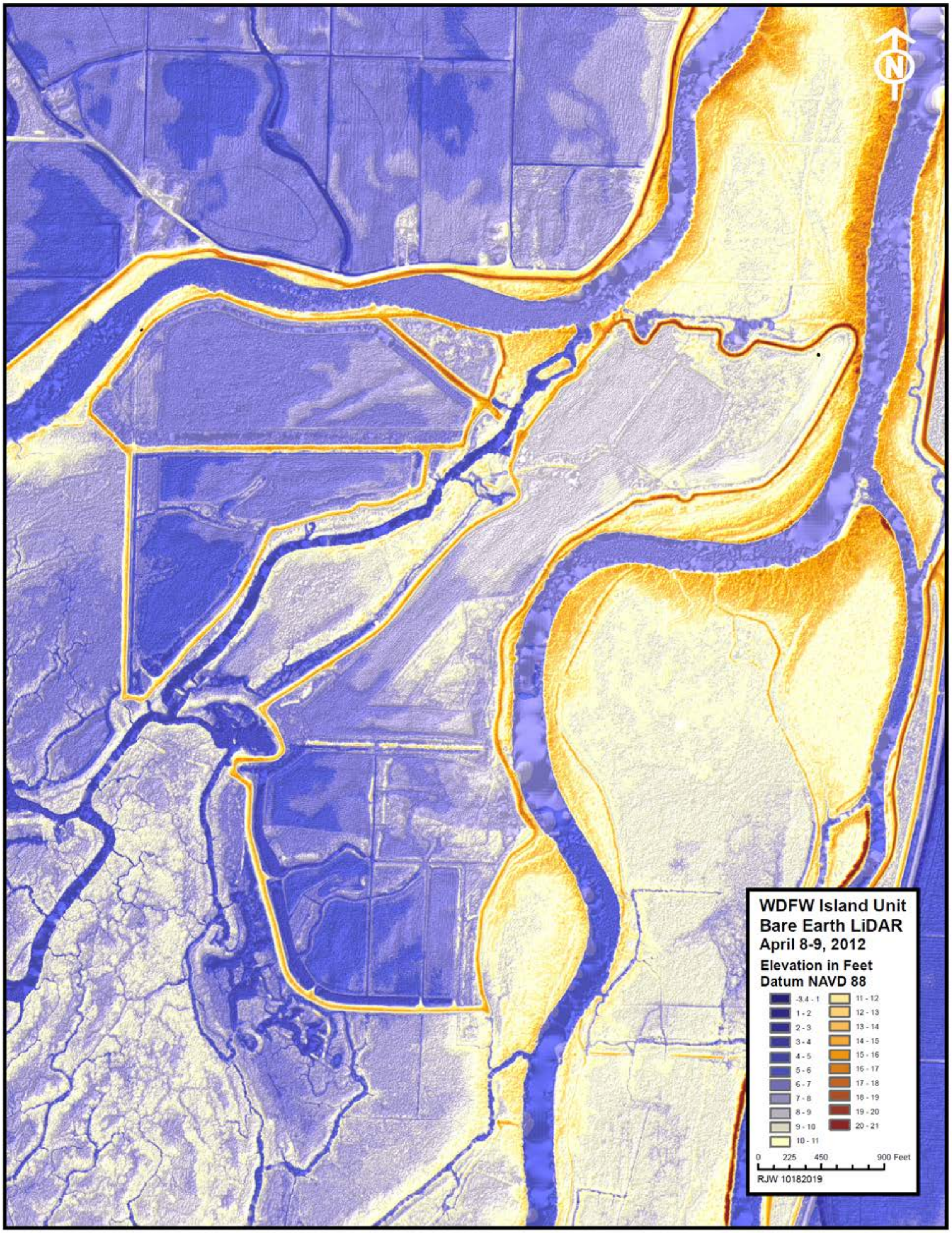


Figure 8 - Island Unit Ground Elevations

Table 1 - Summary statistics and dates for water surface elevation data collected at several points near the Island Unit. WSE data is presented in feet NAVD88.

Site	HDM 4	HDM 5[1]	Milltown S1 Steamboat N[1]	Milltown S2 Tom Moore N	Milltown S4 Steamboat S	Milltown S8 Tom Moore S
Average WSE	8.2	7.7	7.9	7.4	7.2	6.0
Minimum WSE	5.6	4.2	3.8	3.7	3.7	1.1
Maximum WSE	13.5	13.9	12.3	14.0	11.9	11.9
Data Start Date	11/5/2014	11/5/2014	1/25/2017	1/26/2017[2]	1/25/2017	1/26/2017
Data End Date	5/27/2015	5/27/2015	3/22/2017	12/15/2017	2/22/2017	12/15/2017

1. *HDM Site 5 and Site S1 are at the same location. The HDM dataset is from 2014/2015 and the S1 dataset is from 2017.*
2. *Data is unavailable between 5/15/2017 and 8/27/2017.*

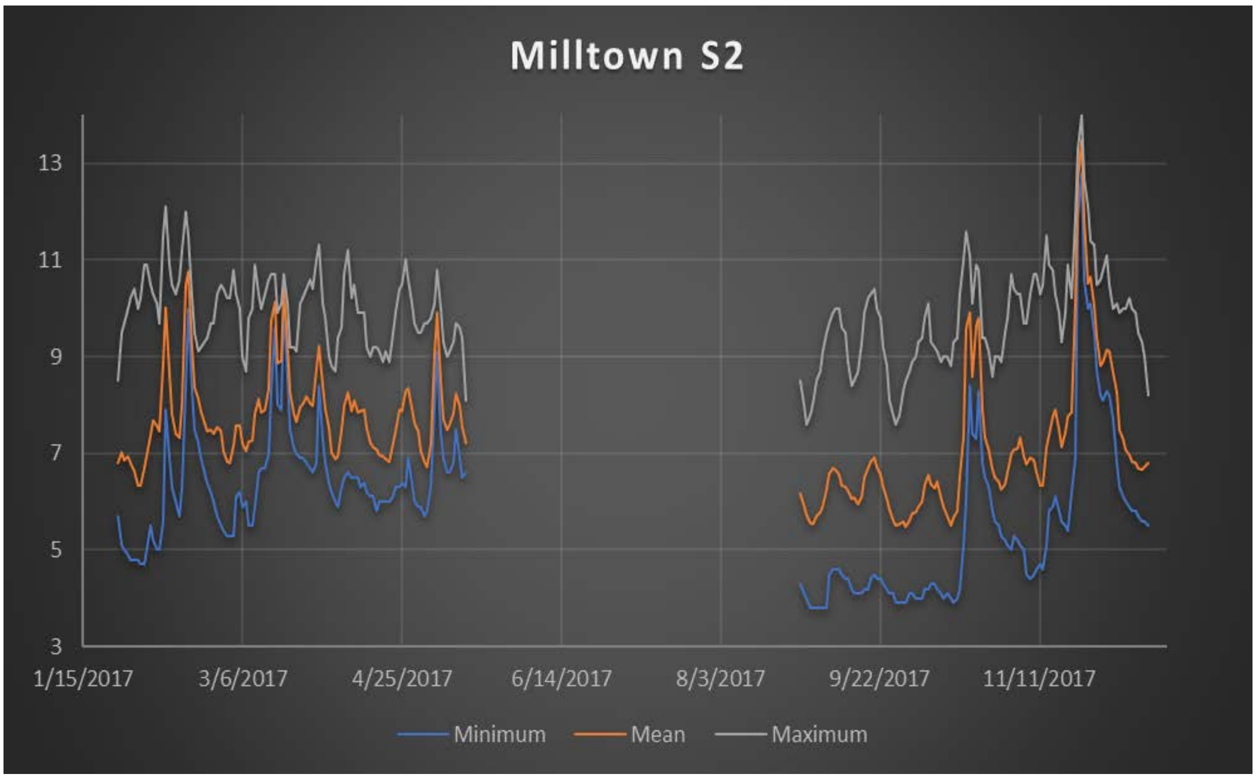


Figure 9 - Mean, Minimum, and Maximum Daily water surface elevations (in feet NAVD88) at Milltown S2

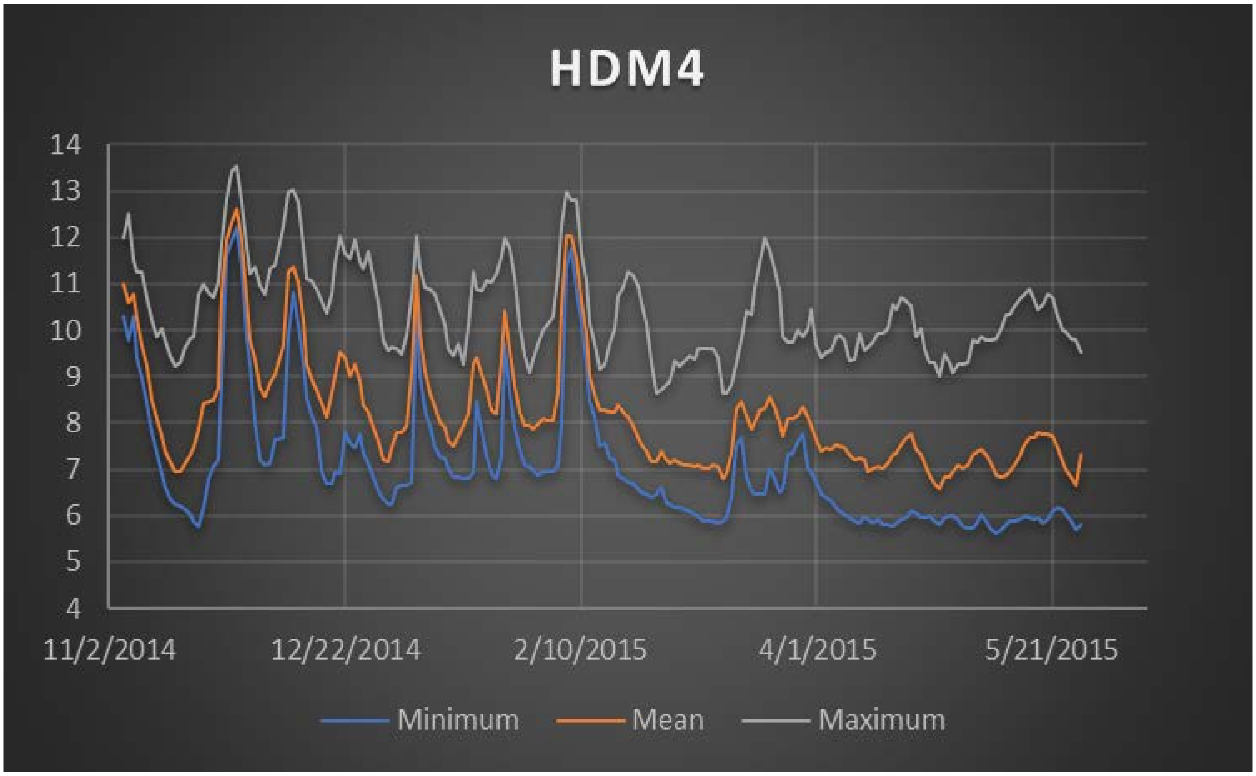


Figure 10 - Mean, Minimum, and Maximum Daily water surface elevations (in feet NAVD88) at HDM Site 4

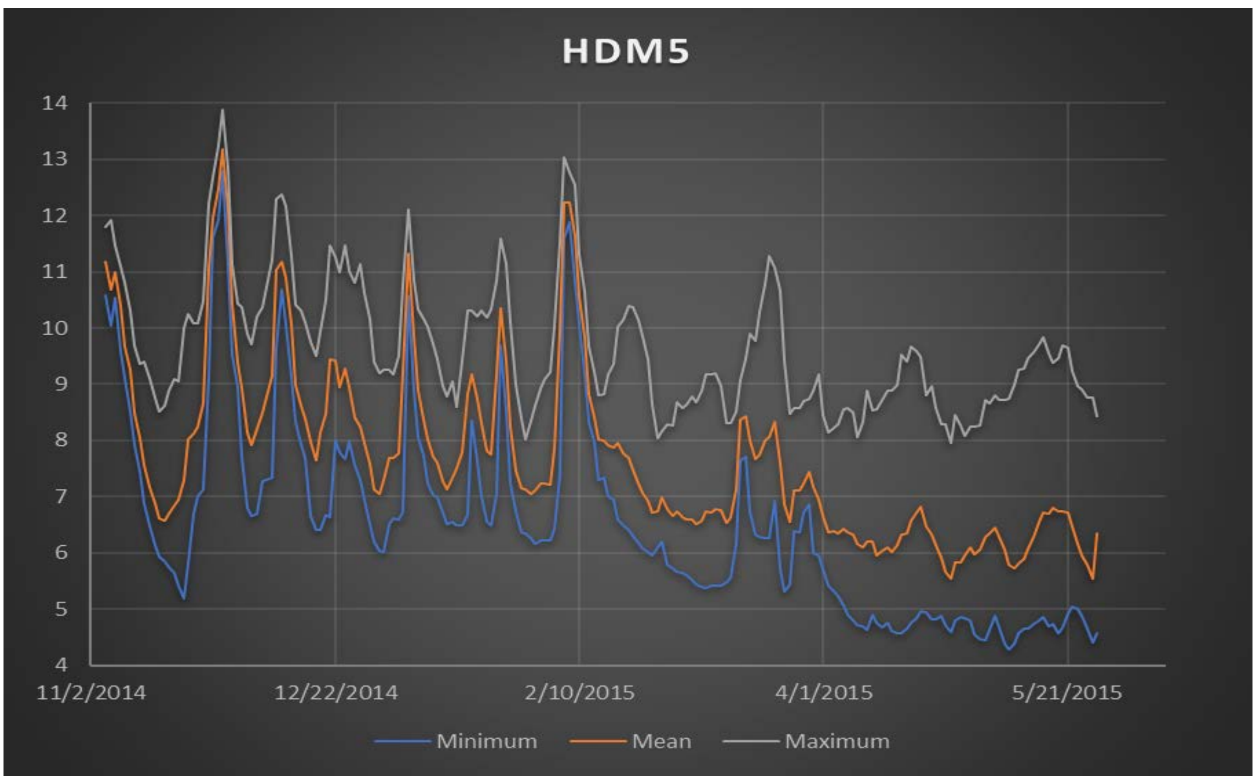


Figure 11 - Mean, Minimum, and Maximum Daily water surface elevations (in feet NAVD88) at HDM Site 5

Evaluation of Tidal Inundation

This section provides an analysis of water surface elevations in the lower south fork Skagit River and the depth and duration of inundation that could occur if a portion or all of the footprint of the Island Unit were reconnected to natural hydrology. Existing recent water surface elevation data was used in the analysis.

Sites HDM 4 and HDM 5 contained the longest record of water surface elevation data for the locations closest to the Island Unit and were used to evaluate the amount of time the site would likely be inundated with water under partial or full restoration scenarios. The data is comparable to the other sites for other years, as can be seen in Table 1. Although the HDM data does not span a full year with all seasons represented, it provides water surface elevations through much of the wintering waterfowl and juvenile Chinook migration season so it provides useful data for understanding water surface elevation at the site.

Table 2 summarizes the percentage of time the water surface will be higher than a given elevation. Figure 12 provides a histogram of the percent of time water surfaces exceed a given elevation from November to May.

Table 2- Percent of time water surface is above given elevation by month based on data collected at site HDM 4 and HDM 5 during Nov 2014-May 2015. Ground elevations are in feet NAVD88.

Ground elevation	November	December	January	February	March	April	May	Total
4	100%	100%	100%	100%	100%	94%	100%	100%
6	96%	100%	100%	99%	88%	45%	68%	88%
8	63%	68%	54%	52%	31%	17%	20%	44%
10	35%	27%	16%	21%	3%	1%	1%	15%
12	11%	2%	0%	5%	0%	0%	0%	2%

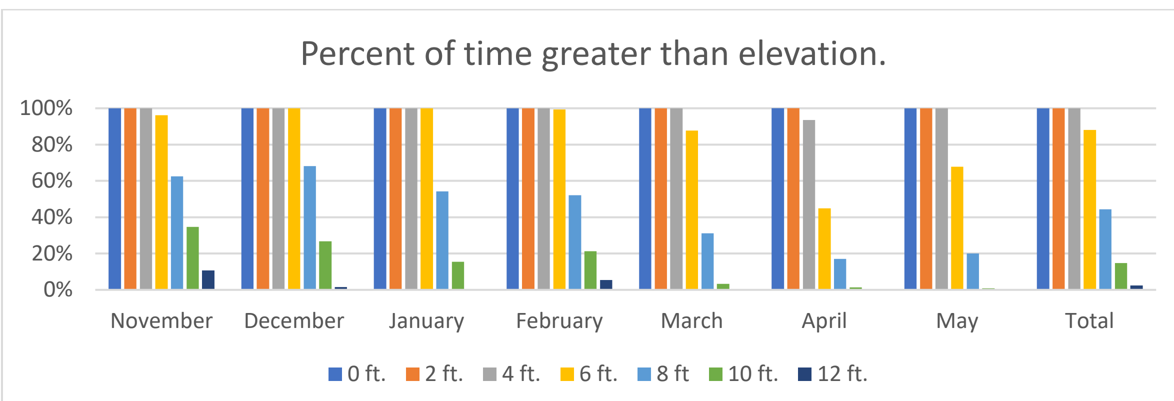


Figure 12 - Histogram of HDM 4 and HDM 5 data showing the percent of time a given elevation is inundated at Island Unit.

Based on the data that has been collected at the HDM 4 and HDM 5 sites, which span November 2014 to May 2015, predictions can be made about what to expect in terms of inundation of the Island Unit under partial or full restoration scenarios (Figures 13-16). The data from 2014-2015 is similar to that in 2017 (Table 1). The Mount Vernon Gage shows that the two seasons presented here fall within a “normal” year. The southern halves of the west island and the east island are nearly all less than 8 feet NAVD88 and are likely to be under water over half of the time from November to February if dikes are removed (Figure 14). Nearly the entirety of both islands are less than 10 feet (Figure 15). Areas less than 10 feet will likely be submerged for over 25% of the time in November and December if dikes are removed.

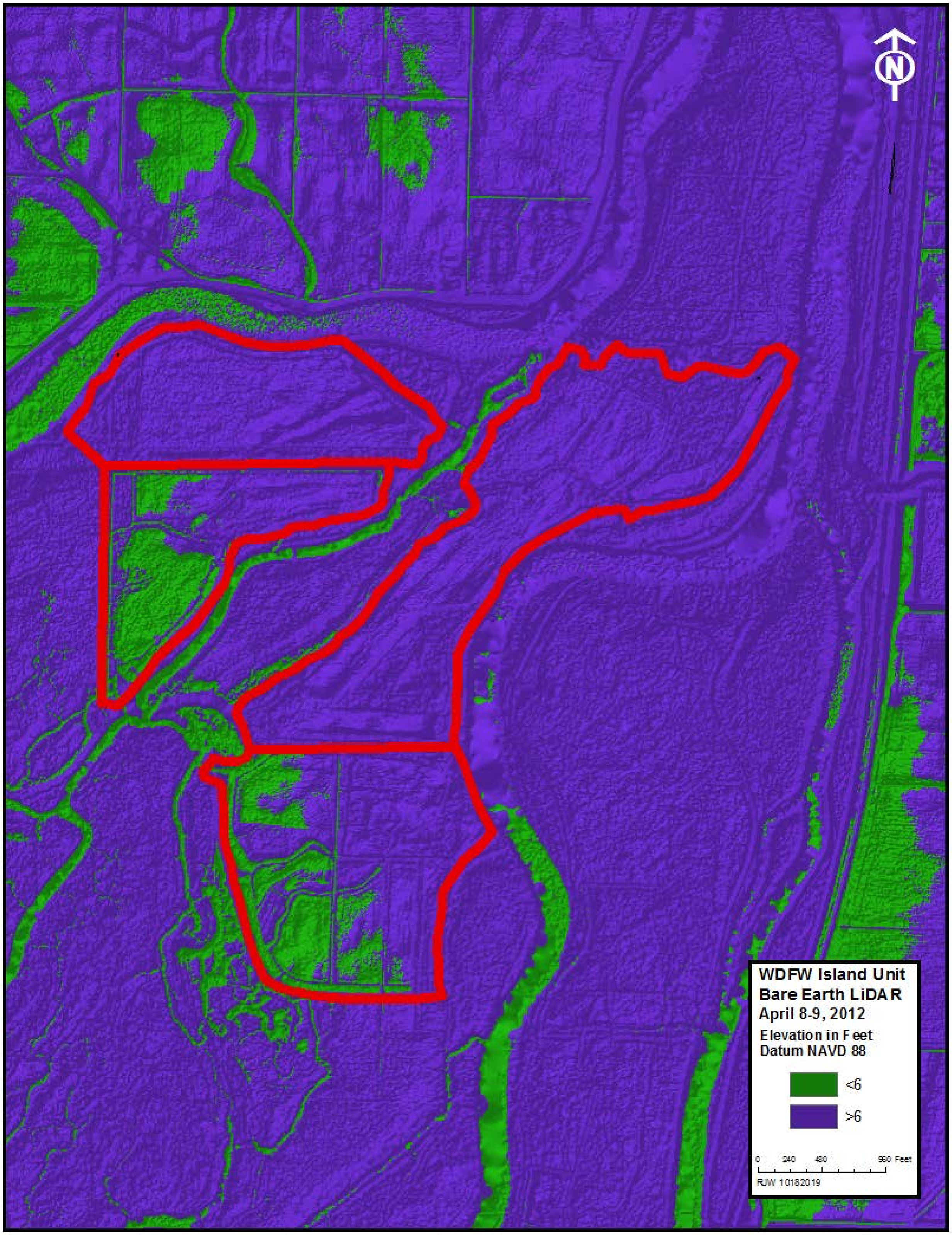


Figure 13 - Inundated Areas when water surface is at 6 feet NAVD88

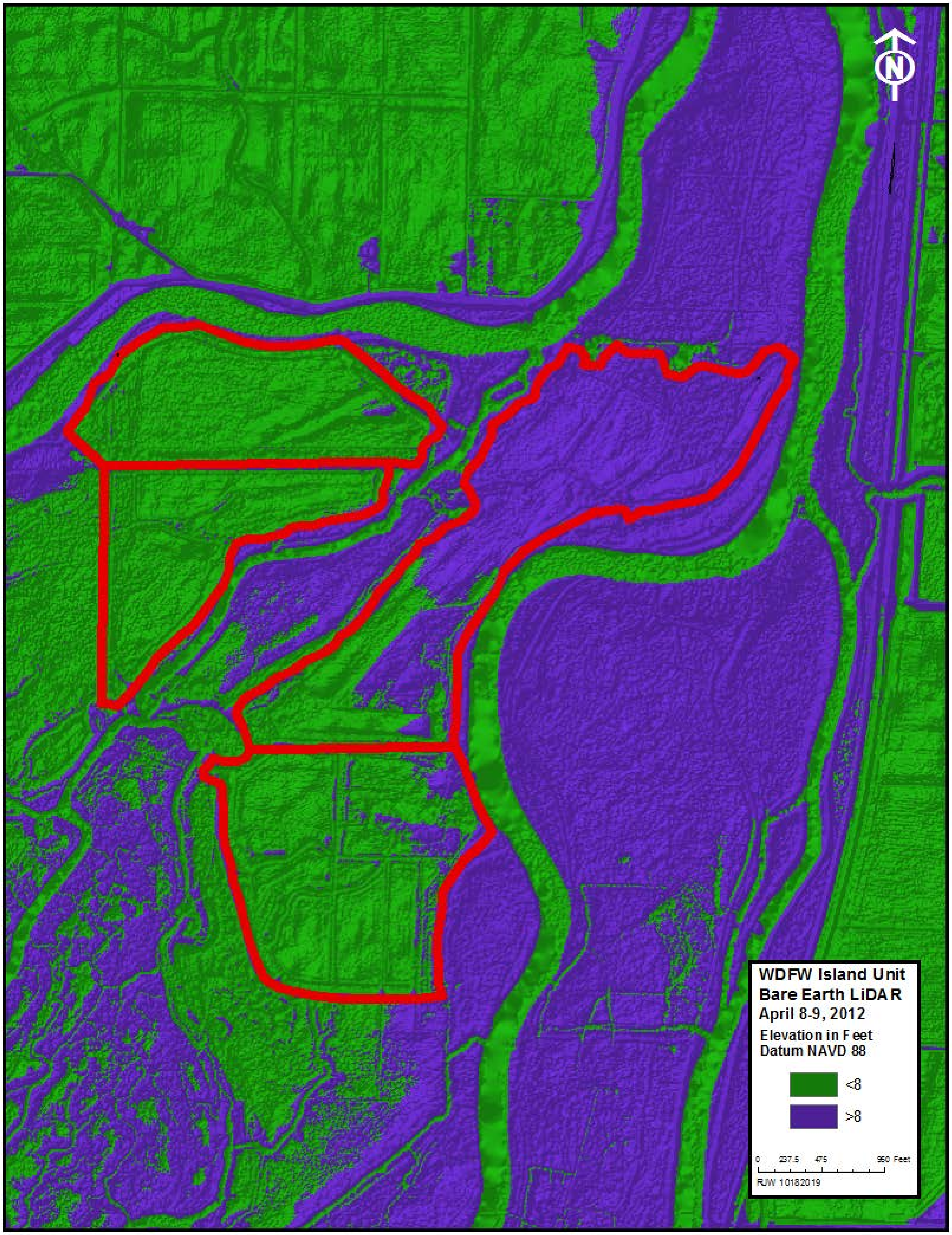


Figure 14 -Inundated Areas when water surface is at 8 feet NAVD88

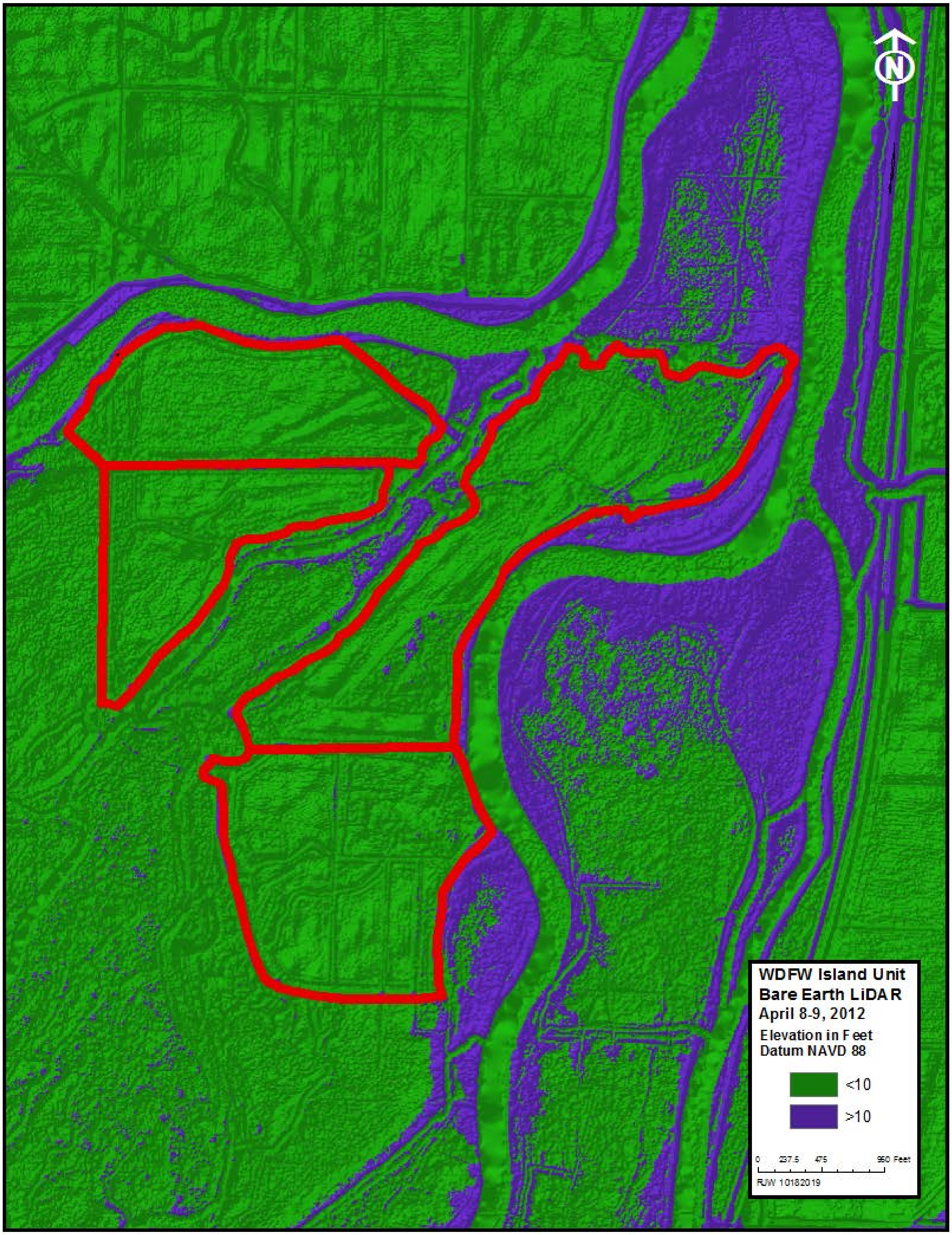


Figure 15 -Inundated Areas when water surface is at 10 feet NAVD88

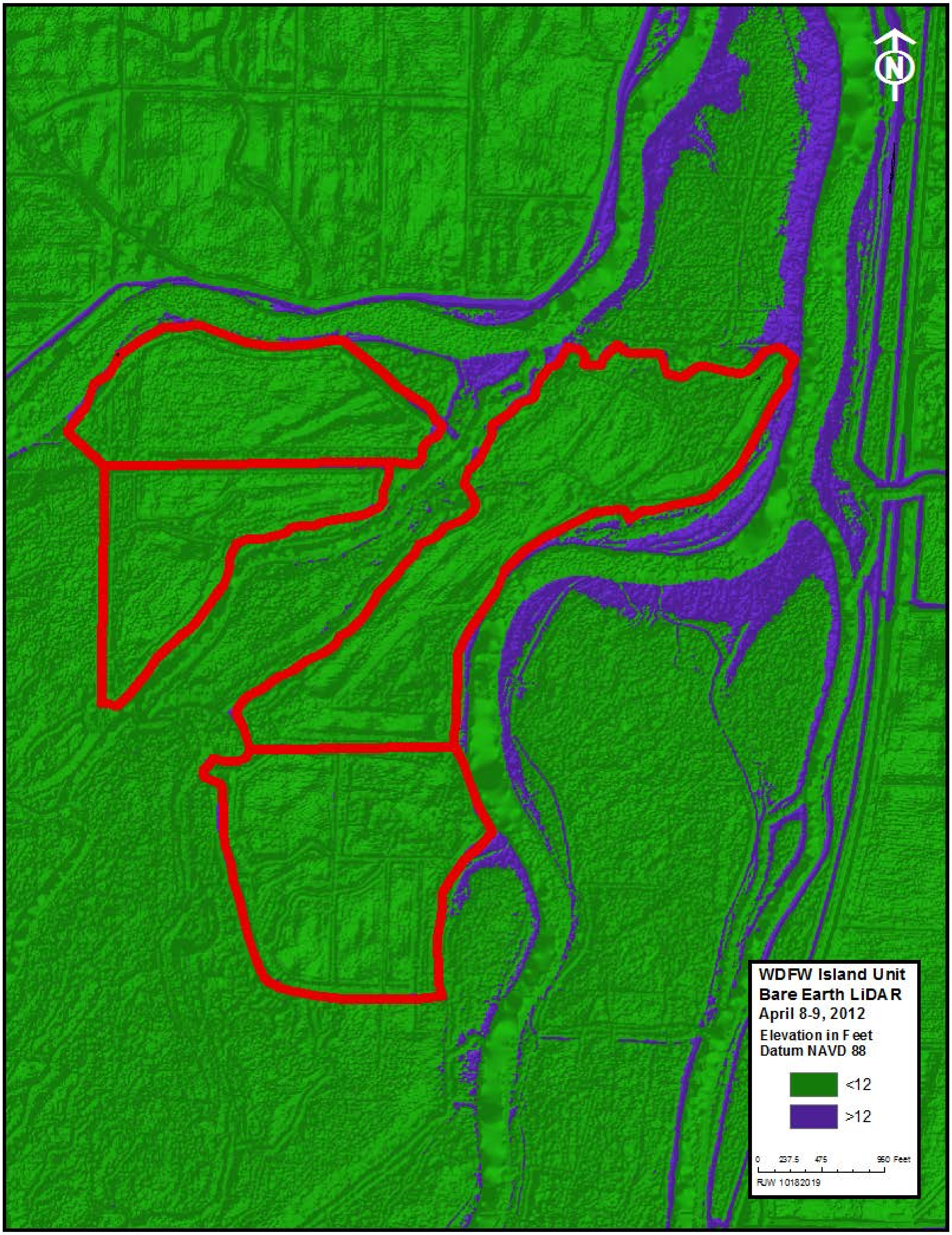


Figure 16 - Inundated Areas when water surface is at 12 feet NAVD88

Tidal Channels and Breaches

Tidal channel length and area was estimated by Greg Hood, PhD at Skagit River System Cooperative (SRSC) (Beamer 2020). SRSC used a conceptual design method based on habitat created at neighboring projects and reference natural marshes to estimate tidal channel length and area (Table 3). Figure 17 provides a schematic layout of the tidal channels.

Table 3 - Predicted Tidal Channel Length and Area

	Predicted Channel Area (ac)	Predicted Channel Area (SF)	Predicted Channel Length (ft)
Alternative 2	6.07	264,571	37,129
Alternative 3	3.08	134,331	24,908
Alternative 4	8.70	378,774	55,432

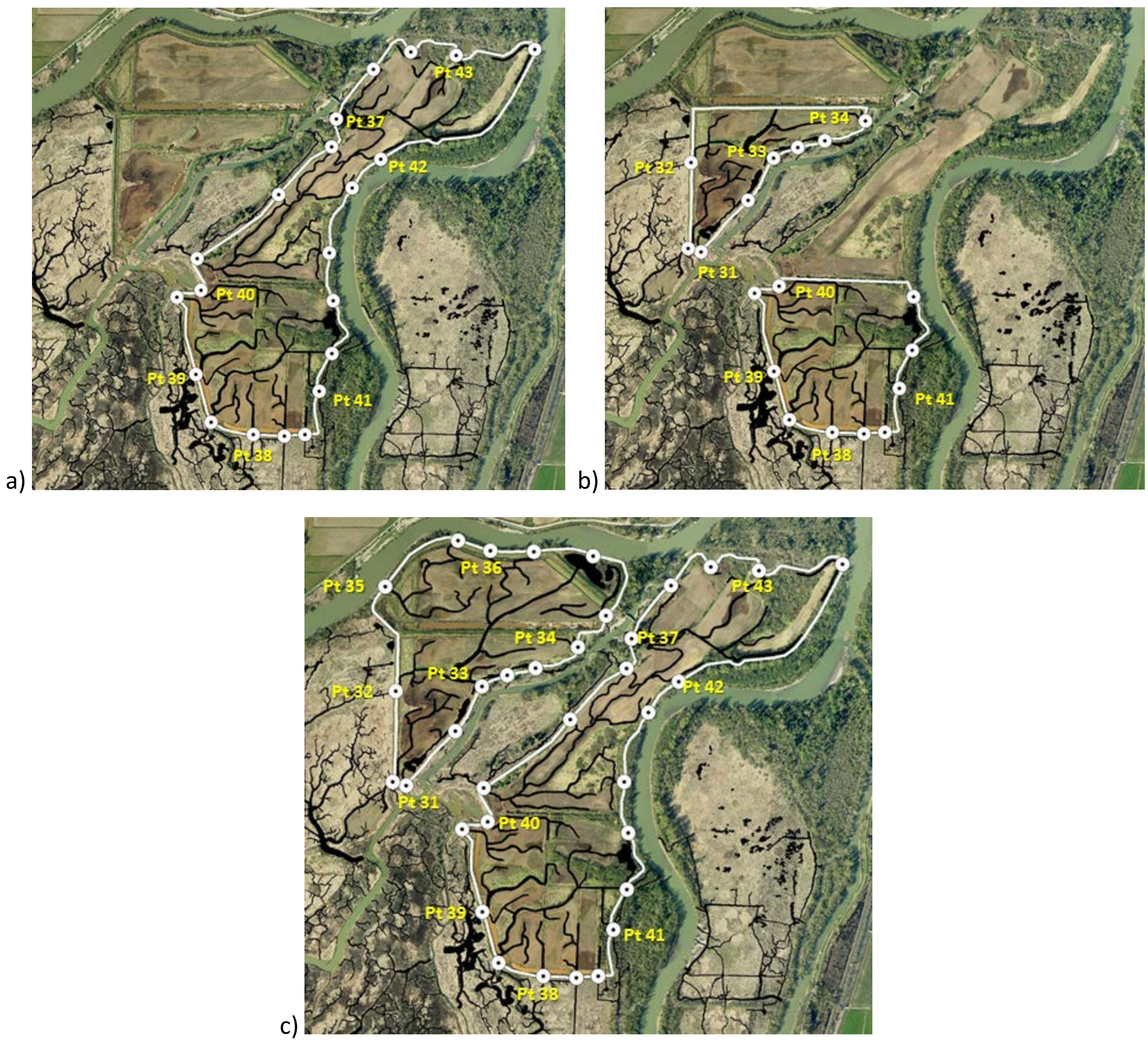


Figure 17 – Conceptual tidal channel layout and channel connections. a) Alternative 2, b) Alternative 3, and c) Alternative 4. Tidal channels are black lines. Tidal channel outlets are shown as white dots with a black center. "Pt ##" labels are related to Chinook smolt estimating methods and are explained in Beamer and Hood 2020.

Sediment Dynamics

The Skagit River is generally aggrading from Sedro Woolley to Skagit Bay (Grossman, in prep). Georeferenced survey data from 1999 to 2014 was analyzed to show that in the North Fork of the Skagit River, the bed has aggraded between 2 and 5 feet, which continues a trajectory seen prior to that time period as well. The South Fork Skagit River does not have an equal period of data but has been characterized as a moderate aggradation reach (Figure 18). At the time of the analysis the south fork conveyed approximately 40% of the river sediment, had a lower gradient than the north fork, and had equal tidal influence. These factors promote sediment trapping.

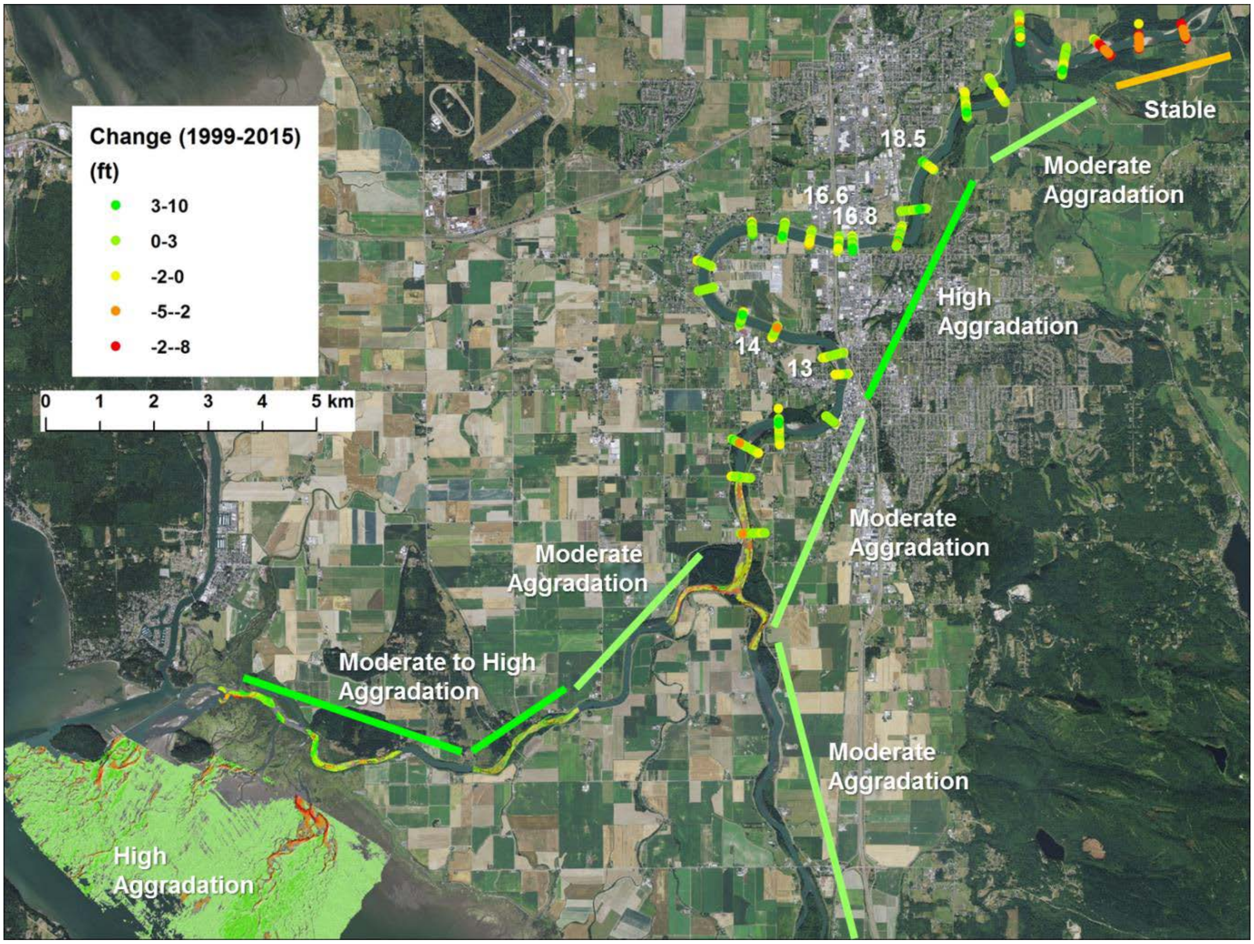


Figure 18 - Map showing the sediment aggradation regime of the lower Skagit River and delta (from Grossman, in prep)

Skagit Hydrodynamic Model

The Skagit HDM project included modeling restoration scenarios throughout the delta to understand the impact of restoration on several factors related to salmon habitat and flooding. Two model outputs are relevant to this geomorphic memo: change in flood water elevations and changes in shear stress (erosion/deposition potential). In both cases current conditions (equivalent to “no restoration/alternative 1”) are compared with a full restoration scenario (Alternative 4). The model run that included Island Unit also included two other restoration projects that were far enough away that the impacts of each project were distinct from each other. The other two projects were in the North Fork of the Skagit River and in the Swinomish Channel. Models are predictive tools that estimate changes, but there is some degree of uncertainty in the results.

Changes in Flood Water Elevation

Model runs were done to look at how full restoration at the Island Unit would impact water surface elevations (WSE's) during two river flow and tide conditions: 1) a 50% annual possible exceedance high flow (Q2 = 62,000 CFS) and a low spring tide (-3.3 ft), and 2) river flood flows (QFlood = 93,200 CFS) and high spring tide (10.4 ft NAVD88). Under both scenarios there were decreases in water surface elevations over significant distances of the river (Figures 19 and 20). Below are details on the flood flow/high tide scenario.

The flood flow scenario was defined as a peak discharge rate at the Mount Vernon gage of 93,200 CFS and a spring high tide of 10.4 ft. Under this combination of river flow and tidal elevation, the model predicted the WSE to be near the top the river levees. When comparing no restoration with full restoration, there was a WSE reduction of 0.3 feet at the North Fork split to over 3 feet at the upstream end of the Island Unit (approximately 4.5 miles). This is due to removal of the "plug" in the outlet of the south fork Skagit River that is formed by the dikes at Island Unit. Partial restoration alternatives were not modeled. However, the "plug" effect would be somewhat reduced with Alternative 2; it would likely not reduced with Alternative 3. During discharge less than Q2 on the river water surface elevations will only be minimally changed downstream of the project site (Figure 18).

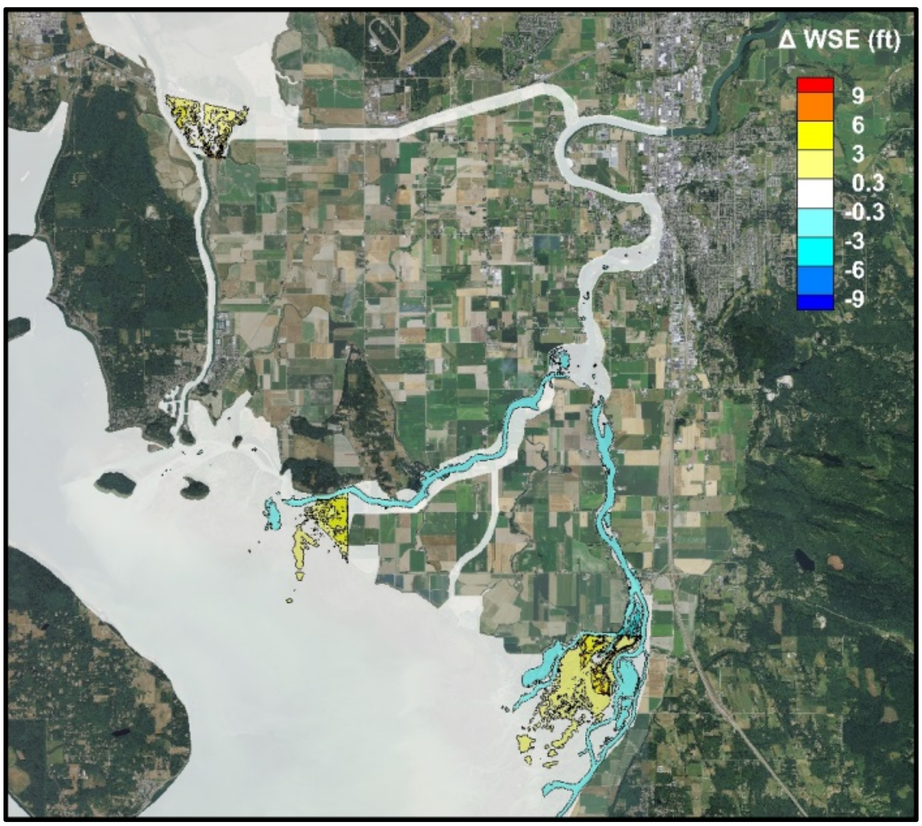


Figure 19 - Contour map of change in WSE from baseline to full restoration with Q2 river flow and low tide. (Whiting et al, 2017)

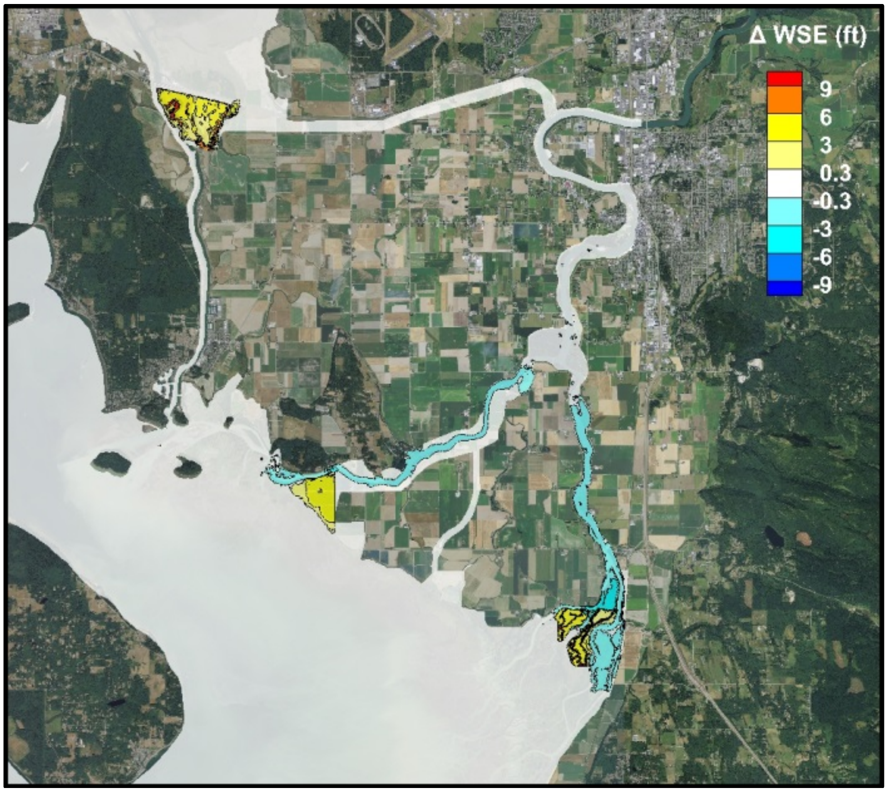


Figure 20 - Contour map of change in WSE from baseline to full restoration with flood flow in the river and high tide. (Whiting et al, 2017)

Changes in Shear Stress

Modeling was done to look at how full restoration at the Island Unit would impact shear stress, which is a measure of river energy used to predict sediment transport and meandering. Two model runs were completed for baseline/no restoration conditions and two model runs were completed that allowed a comparison of existing conditions (no restoration) with full restoration. For each pair of runs, the following conditions were modelled: (1) peak shear stress during a full tidal cycle and low river flow (12,000 CFS) and (2) shear stress during Q2 flow (62,000 CFS) and low spring tide (-3.3 ft). Figure 21 provide the shear stress predicted by the model under a no restoration scenario and Figure 22 provides the change in shear stress that is predicted by the model under conditions mentioned above due to the removal of the dikes/levees at the Island Unit.

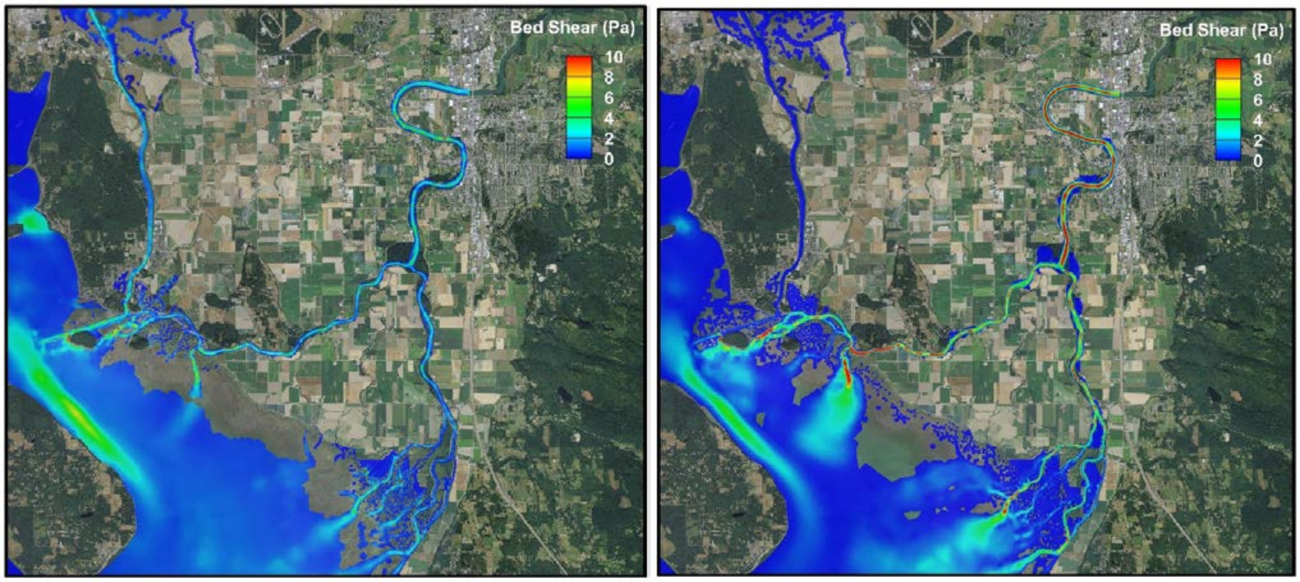


Figure 21 - Contour maps showing shear stress under existing conditions (no restoration) during two conditions: (left) peak shear stress during a full tidal cycle and low river flow, and (right) Q2 river flow and low spring tide. (Whiting et al, 2017)

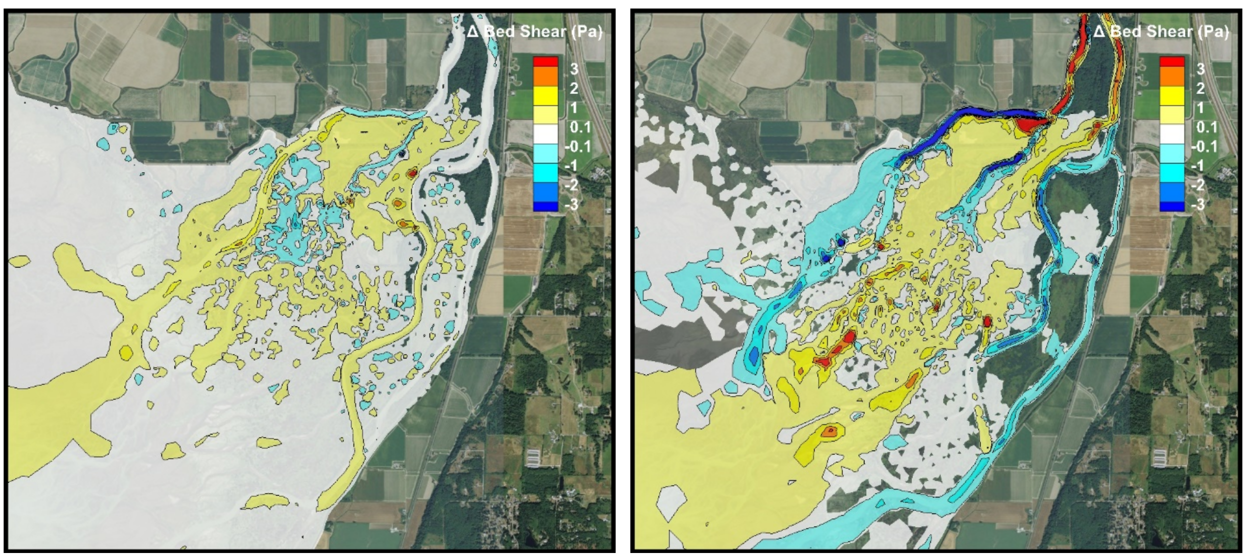


Figure 22 - Contour maps showing change in bed shear stress between existing conditions to "with project" conditions during two conditions: (left) peak shear stress during a full tidal cycle and low flow, and (right) Q2 river flow and low spring tide. (Whiting et al, 2017)

During the 2 year (Q2) river flow and low spring tide with full restoration, the predicted shear stress increases at the inlet to Deepwater Slough and decreases by 2 to 3 Pascals within Freshwater Slough. The Skagit Delta consists of fine-grained material of silts and very fine sands. A consistent 2 Pascal increase in shear stress could change sediment mobilization from silts to very small gravels (<4mm). These results indicate that energy in the channels could change as a result of dike removal at Island Unit. If this predicted change did occur, over time it is possible that the discharge within Freshwater Slough could decrease and the discharge in Deepwater Slough could increase However, modeling results represent a finite point in time under particular conditions and do not account for consistent changes in dynamics that would shape the channels in this reach. Shear stress and other factors that shape channels in this part of the river should be investigated further during the next phase of design.

Elevation and Vegetation

In tidal marsh systems, specific vegetation species and plant communities correlate with marsh surface elevation resulting from changes in salinity, inundation frequency and duration, and other factors. Vegetation currently on the Island Unit is supported by diking and drainage and is not reflective of native estuarine vegetation communities that would be expected at the site. Vegetation community predictions for full restoration of the Island Unit were completed as part of the Skagit HDM project as well. Complete methods and sources are provided in the final report (Friebel et al, 2017). The vegetation zone elevation ranges (in feet NAVD88) used in the HDM analysis were:

- Mudflat: Less than 3.0
- Emergent Marsh: 3.0 – 7.9
- Shrub-Scrub: 8.0 – 9.9
- Floodplain Riparian: Greater than 10

Mudflat is unvegetated; emergent marsh is vegetated by non-woody plants, scrub-shrub zones support woody shrubs and non-woody vegetation, and floodplain riparian supports trees and shrubs. The acreages on the Island Unit within each vegetation elevation zone are provided in Table 4. There is no predicted mudflat but there are significant acreages predicted in each of the three other vegetation zones. This means the site would provide a wide range of habitats under the full restoration scenario (Alternative 4).

Table 4 - Acreages within the Island Unit that are predicted to support different vegetation communities for Alternative 4 (Full restoration)

mudflat or submerged	emergent marsh	scrub-shrub	floodplain riparian
0	149.1	66.6	52.1

No analysis was done for partial restoration alternatives, the only vegetation zone information we have for those alternatives is what can be interpreted from viewing elevation LiDAR maps (Figure 8). Alternative 2, which involves restoring the east island, contains a range of elevations and would support a range of vegetation communities. Alternative 3, which involves restoring the lower elevation southern portions of both islands, would mean only lower elevation vegetation zones would be restored.

Existing Levee/Dike Condition and Impacts

On the north side of the west island Freshwater Slough is migrating into the left bank and the levee is currently in poor condition there (Figure 23). If Alternative 1, 2 or 3 are selected as the preferred alternative, the levee will need to be fortified or set back to ensure it is not damaged further and potentially breached. The other dikes and levees are visually in acceptable condition, but should be evaluated during design.

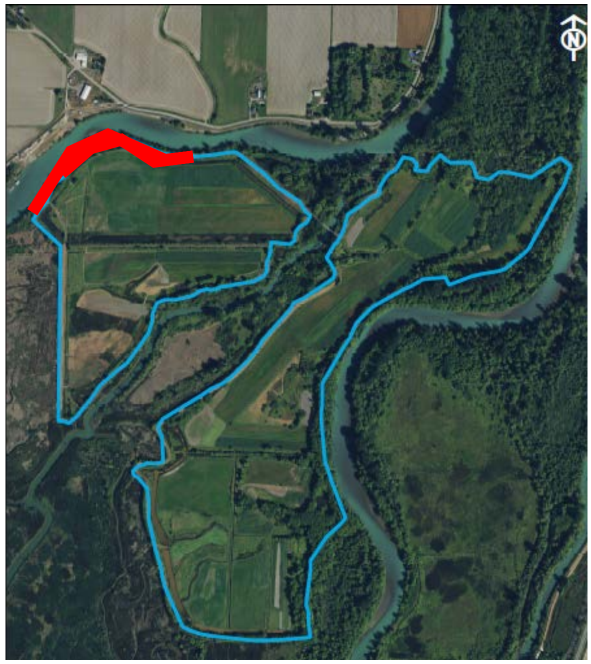


Figure 23 – Levee erosion area (in red)

Climate Change

Current models predict that both sea level rise and changes in river hydrology are occurring at a progressively faster rate over time. Island Unit infrastructure and management will be affected by these changes.

Sea Level

The predicted sea level rise for 2070 for the Puget Sound was calculated with the US Army Corps of Engineers Sea Level Curve Calculator (USACOE 2019). The intermediate estimated sea level rise is 0.81 feet. The low estimated rise is 0.34 feet and the high estimated rise is 2.30 feet.

River Hydrology

Table 5 presents the predicted change in hydrology in the Skagit River estimated by Lee et al, 2016. They predict that Q2 discharge will increase by a factor of 1.7 by 2080. The effect of increased hydrology has not been modeled, but this would be a significant change in water surface. Removal of the dikes within the Island Unit could possibly decrease the effect of the increase in discharge.

Table 5 - Skagit River 2080 Q2 predicted discharge (Lee et al. 2016).

Recurrence	Units	2015	2080
2-year Discharge	Cubic Feet per Second	62,000	103,237

Long Term Sustainability

Channels in the lower Skagit River are changing under current conditions/no restoration. Channels migrate naturally (which is why we see bank/dike erosion issues on the northern side of the west island) and data shows that it is an aggrading reach (Grossman, in prep). Changes in SLR and river flows will cause channel changes even without changes at Island Unit. More frequent and severe high flows will increase the energy that causes scour and sediment movement. SLR will increase the area over which river flows are backed up and the area over which tidal processes shape the land.

Our understanding of what might happen under partial or full restoration scenarios is limited. Modelling results from a single point in time indicate that dike removal will change where channel energy might increase and decrease. However channel changes are a result of energy acting over time and not a single point in time. Further investigation is needed to fully understand how channels might change under any of the alternatives. Using the best available current data, predictions have been made and are included below.

Tidal Channels

Daily WSE rarely drop below 6 feet NAVD88 during winter (Figure 8 and 9) , presumably due to higher river flows at this time of year, constructed tidal channels in areas below elevation 6 feet NAVD 88 (Figure 13) may infill during winter with sediment from the bay. Primarily these areas are found in Alternatives 3 and 4. These areas will likely be ponded and provide habitat over a larger area than just in the channels during this time as has been seen on other restoration projects such as the Wiley Slough Restoration Project (Beamer, 2015). The channels will likely redevelop during spring when river flows are lower and WSE drops below 6 feet NAVD88 on low tides.

Slough Avulsion

The removal of the dikes/levees in Alternative 4 and to a lesser extent in Alternative 2 is predicted to change shear stress in this reach during certain conditions, which may increase the chance of a higher discharge into Deepwater Slough. The predicted decrease in shear stress within Freshwater Slough may aggrade the slough and decrease scour risk on the right bank levees of the Skagit River. This reach of the Skagit River is generally aggrading and, although sediment transport may increase through the reach immediately after construction, it is possible that the delta will respond and the river will generally trend towards aggradation with local changes in channels within the delta.

Vegetation

Under full or partial restoration scenarios the vegetation community within the Island Unit would likely develop as predicted by the vegetation zones associated with ground elevations described above. As sea level rises, sediment is likely to deposit on the marsh surface and may keep pace with SLR. If sedimentation does not keep pace with SLR, the vegetation communities are likely to migrate to higher elevations.

Infrastructure

Climate change may have substantial impacts on the dike system. Sea level rise (SLR) would increase the need for raising the elevation of the dikes and could result in increased damages. Water levels will reach dike-top elevations more frequently, which would result in more frequent overtopping. More frequent and higher water levels against the dikes also increases dike saturation and seepage. Overtopping, saturation and seepage contribute to dike instability, erosion and failure. In addition, increases in the frequency and size of river flood flows due to climate change may increase the shear stress within the Skagit River. The increased shear stress would increase scour and require fortification of the dike system. Improvements to the dike system in the case of no restoration or partial restoration should be considered.

Climate change impacts will also likely have significant impacts on operation of the tidegates. The tidegates work on gravity so water drains out when water outside the dikes is lower than water on the land side of the dikes. As SLR occurs, there will be less time during each tidal cycle when water is low enough on the bay side of the dikes to drain via gravity. This will result in reduced drainage capacity, which will likely limit management activities such as mowing and crop production.

Conclusions and Recommendations

This preliminary geomorphic assessment provides limited information about geomorphic changes that might be expected as a result of full or partial restoration at the Island Unit site. Preliminary conclusions include:

- The project area is in a dynamic geomorphic and hydraulic setting that is appropriate for restoring estuarine processes.
- This reach of the river will experience changes due to ongoing geomorphic processes as well as climate change even without a change in management at Island Unit.
- Removal of dikes may change flow and sediment conditions within the estuary.
- Dike removal and channel construction is anticipated to restore natural hydrology, elevations and native plant communities.
- Restoration would allow vegetation communities and habitats to adapt and migrate with sea level rise.
- Removing sections of the “plug” in the lower river caused by dikes would likely reduce flood risk during certain events.
- Infrastructure in this location will face increasing challenges in the face of sea level rise and changing river flows.
- Increasing frequency and size of floods and higher tides could result in more frequent and severe dike damages.
- Gravity operated tidegates will provide reduced drainage capacity as SLR reduces the amount of time water can flow off the site.

If full or partial restoration is pursued, it is recommended that additional analysis be completed in the subsequent design phase related to:

- Potential for channel changes (avulsion, scour and sedimentation)
- Inventory of dike condition

References

Beamer, E.M., T. Beechie, B. Perkowski, and J. Klochak. 2000. Application of the Skagit Watershed Council's Strategy: river basin analysis of the Skagit and Samish Basins and tools for salmon habitat restoration and protection. Report to the Skagit Watershed Council. Mount Vernon, Washington.

Beamer, E, A. McBride, C. Greene, R. Henderson, G. Hood, K. Wolf, K. Larsen, C. Rice, and K. Fresh. 2005. Delta and Nearshore Restoration for the Recovery of Wild Skagit River Chinook Salmon: Linking Estuary Restoration to Wild Chinook Salmon Populations. Appendix D of the Skagit Chinook Recovery Plan.

Beamer, EM, and R Henderson, B Brown. 2015. Juvenile Chinook Salmon Utilization of Habitat Associated with the Wiley Slough Restoration Project, 2012-2013

Beamer, E, G. Hood. 2020. Habitat and juvenile Chinook benefit predictions Deepwater Phase 2 Restoration Alternatives.

Collins, B. 2000. Mid-19th century stream channels and wetlands interpreted from archival sources for three north Puget Sound estuaries. Report prepared for Skagit System Cooperative, Skagit Watershed Council, and The Bullitt Foundation. University of Washington, Seattle.

Friebel, J. P Hicks and J Baker. 2017. An Alternatives Analysis of Restoration Project Concepts across Farm, Fish and Flood Interests: Skagit Hydrodynamic Model Project, Phase 2 Report.

Grossman, E. E. In prep. Bathymetric Change to Inform Sediment Impact Pathways to Communities and Ecosystems in the lower Skagit River and Estuary, Washington. U.S. Geological Survey, Open-File Report XXXX-XXXX, pp. 47.

Lee S, A Hamlet, E Grossman. 2016. Impacts of Climate Change on Regulated Streamflow, Hydrologic Extremes, Hydropower Production, and Sediment Discharge in the Skagit River Basin. Northwest Science, 90(1): 23-43.

US Army Corps of Engineers (USACOE). 2019. http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html

Whiting, J, T. Wang and T. Khangaonkar. 2017. Hydrodynamic Model Development and Application for Restoration Alternatives Assessment – Skagit Delta Hydrodynamic Modeling Project (SHDM). Prepared for The Nature Conservancy through MSOF Agreement No 66266 under contract DE-AC05-76RL01830. Pacific Northwest National Laboratory. Seattle, Washington 98109.

JULY 15, 2020

APPENDIX E: WATERFOWL AND SHOREBIRD TECHNICAL MEMORANDUM

MONITORING AVIAN RESPONSE TO ESTUARY RESTORATIONS IN THE GREATER SKAGIT DELTA: A REVIEW OF RELEVANT PROJECTS

RUTH MILNER, KYLE SPRAGENS, BELINDA ROTTON
WILDLIFE PROGRAM, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

Monitoring Avian Responses to Estuary Restorations in the Greater Skagit Delta: A Review of Relevant Projects

Ruth Milner, Kyle Spragens, Belinda Rotton
Wildlife Program, Washington Department of Fish and Wildlife

July 15,2020

Contents:

1.0 Introduction and Background

In this document, we summarize research, survey, and broad-scale management information relevant to the questions below:

- What consequence would restoring part/all of the Island Unit have on waterfowl and shorebirds at the Island Unit?
- What consequence would restoring part/all of the Island Unit have on waterfowl and shorebirds within the Greater Skagit Delta (Samish, Padilla, Skagit, Port Susan Bays and adjacent lands and intertidal areas?
- At what geographic scale(s) do we see measurable impacts (positive or negative) to waterfowl and shorebird populations by changing management at the Island Unit?

Site-specific data do not exist regarding precise habitat functions or food resources available for any species in either agricultural lands or the estuary in the Greater Skagit Delta (GSD), which is comprised of Port Susan, Skagit, Padilla and Samish bays and their associated uplands. Decisions regarding the effects of restoration alternatives for the Island Unit must therefore be based on inferences from limited research that has occurred in the GSD and other relevant information.

The questions posed by the project are focused on the site and GSD scale, and specifically on the potential impacts of changes in site management on the waterfowl and shorebirds that use the Island Unit and the GSD.

We've structured the document to discuss waterfowl and shorebird ecology in separate sections, although we recognize that species use of the area overlaps. Where possible, we discuss relevant material at the GSD or larger scale first and step down to smaller scales as appropriate.

1.1 Broad-scale Waterfowl Management

Migratory birds travel vast distances, and their habitats and populations are managed and monitored at multiple scales. All migratory birds are protected by federal law (Migratory Bird Treaty Act 1918), and under federal authorization, waterfowl harvest is allowable through coordination with state, federal, and international entities via the Pacific Flyway Council. Waterfowl hunting is conditioned upon sustainable populations and monitoring to inform decisions. For waterfowl, continental management and population objectives are developed and described in the North American Waterfowl Management Plan agreed to by the U.S., Canada, and Mexico. Continental objectives are then broken down into regional and smaller planning areas. Washington State is part of the Pacific Birds Habitat Joint Venture, which is broken down into sub-basin planning focus areas based on Level III Ecoregions designated by the Environmental Protection Agency; the Greater Skagit Delta is in the North Puget Sound Lowlands sub-basin. Breeding population surveys, banding operations, harvest data, and local waterfowl flights all inform population status and small and large-scale management actions for waterfowl.

In the waterfowl conservation community, public lands, many of which were purchased for specific waterfowl habitat purposes, are viewed as the primary stable source that meets a small, but vital, component of the seasonal habitat needs and energy requirements of migratory waterfowl throughout the year. Joint Ventures, striving for habitat goals to sustain continental waterfowl populations, have demonstrated it takes much more than public lands to meet the annual food requirements of waterfowl in a particular region. However, waterfowl foods on private lands are not consistent, as they are not purposefully planted for waterfowl benefits to offset losses of historic habitats, and therefore should not be relied upon to provide the primary resources to meet continental, state or regional population objectives. Thus, current management relies on food and habitat resources that come from a variety of land management and cooperative partnership actions.

1.2 Broad-scale Shorebird Management

Shorebird management across regional and international boundaries is also considered under the Pacific Flyway Council, and conservation plans are developed by technical committees convened by the Council. The US Shorebird Conservation Plan (Senner et al. 2016) provides a scientific framework to determine species, sites, and habitats that most urgently need conservation action. These national assessments were used to step down goals and objectives into 11 regional conservation plans, of which the Northern Pacific Coast Plan pertains to Washington (Drut and Buchanan 2000). The primary goals of these plans are to increase and stabilize shorebird populations by protecting and restoring estuarine, beach, rocky intertidal and freshwater wetlands. Management strategies are recommendations and do not commit agencies to specific actions or schedules.

Winter surveys intended to monitor population trends at the flyway scale have been conducted annually through the Pacific Flyway Shorebird Survey, administered by Point Blue Conservation Science, since the winter of 2012-2013. In the GSD, these surveys are conducted from several estuarine sites among the bays. However, these surveys are designed to determine population trends at the flyway geographic scale and should not be applied at a site specific, or GSD level. Surveys to determine overall shorebird numbers in the GSD have not occurred in over a decade.

1.3 Island Unit and GSD Description

The Island Unit is managed within the Skagit Wildlife Area, which is located within the GSD. The GSD includes Samish, Padilla, Skagit and Port Susan Bays and contains a mix of unmanaged habitats (estuary) and managed (agriculture). The GSD is a very large area comprised of *approximately* 5,450 acres of nearshore emergent estuarine marsh and 42,300 acres of associated upland areas that are generally managed as farm crops, berry production or pasture (Hamer, unpublished data using available GIS layers and limited to ≤ 5m in elevation). The value of the GSD for waterfowl was identified in the 1940s by the US Fish and Wildlife Service, who acquired large portions of the lower Skagit River delta.

The diked areas are former tidal marsh that was converted in the late 1800s to establish agricultural lands. In the 1950s, Washington Department of Fish and Wildlife (WDFW) acquired lands owned by the US Fish and Wildlife Service (USFWS) in the GSD, creating the Skagit Wildlife Area. The current diked portions of the Skagit Wildlife Area that front Skagit and Padilla Bays include 810 acres that are actively managed to produce enhanced/managed winter waterfowl forage; this includes the Island Unit.

The Island Unit covers approximately 268 acres on two islands in a tidally-influenced reach of the South Fork Skagit River within the Skagit River delta and adjacent to Skagit Bay. Currently, WDFW manages approximately 140 acres of agricultural fields on this site to produce enhanced (seed-bearing) and managed (non-seed bearing) waterfowl forage. This forage consists of a variety of "agricultural" food sources (e.g., corn, barley, millet, fava beans, buckwheat) as well as moist-soil or naturally occurring vegetation (e.g, smartweed, yellow nutsedge, Bidens). Water control structures allow for the retention of water within the fields to improve food availability for dabbling ducks and other water birds in the winter. Although peak use of the site by waterfowl occurs from early November until late December, the variety of forage types provides for easily accessible food resources from early October through spring return-migration in March and April. As a popular waterfowl hunting site, the Island Unit is a highly disturbed area during daylight hours from October through January, which forces nearly all of the waterfowl feeding at this site to occur at night during these months. Consequently, it is difficult to monitor waterfowl use of the Island Unit during the time of year when use is at its greatest, and no attempts have been made to quantify waterfowl numbers there.

Estuary restoration projects in Washington, and specifically in the GSD, have been designed to address habitat objectives for listed salmonid species, especially Puget Sound Chinook, identified in federal recovery plans under the Endangered Species Act. Avian responses to estuary restoration projects where diked habitats are restored to intertidal conditions, usually by removing all or part of dikes, are not well documented.

1.4 General Large-Scale Summary of Avian Monitoring Projects Relative to Estuary Restoration Projects

Although there are several projects associated with river deltas in Puget Sound that altered or removed dikes or berms to improve intertidal habitats for fish, none funded long-term avian response monitoring and very few surveyed birds to establish baselines prior to executing the restoration actions. These omissions result from grant sources focused on salmonid responses, of which very few provide funds to address birds whose populations are generally not considered critically imperiled. Recognizing this information gap, the Puget Sound Partnership conducted a survey to understand the scope of avian monitoring that has occurred to date (Koberstein et al. 2017). This paper looked at 21 berm and/or dike removal projects initiated in Puget Sound between 1994 and 2016, of which 14 incorporated some form of bird monitoring. The primary objective of the paper was to collate methods these projects used as a precursor to developing standardized research and monitoring techniques that can be incorporated into future estuary restoration projects to help inform avian conservation actions. Secondarily, the authors looked for inferences that could be drawn from the projects and found a variety of responses, likely linked to the variety of assessment methods each employed, as well as the many differences among the sites themselves.

Projects that completed post-restoration monitoring reported mixed effects relating to bird use of the restoration area immediately after restoration. For examples, Port Susan Bay Preserve reported changes in community composition post restoration, from passerines and dabbling ducks as the dominant taxa groups to dabbling ducks, shorebirds and geese. JimmyComeLately Creek Estuary reported a decrease in overall abundance and no change in species richness, but saw an increase in some groups of waterbirds, such as dabbling ducks. Nisqually Refuge found an increase in waterbird abundance post restoration. Lastly, monitoring in Wiley and Deepwater Sloughs found that waterfowl and shorebirds used large, well-drained channels at low tide, but avoided large channels that did not drain. This inventory revealed a mix of patterns in bird response to estuary restoration.

Koberstein (2017) documents the fact that avian monitoring has not been performed in a consistent manner on restoration sites pre- and/or post-project. Without site specific data related to habitat conditions and use of habitat resources throughout the year, we cannot state with certainty how bird use may be affected by the restoration activity at a site-specific or larger scale. Habitats (freshwater wetland and upland vs. tidal marsh) as well as food resources (enhanced winter waterfowl forage vs. tidal marsh vegetation) will change with restoration. The impact of this change would depend on the scale of consideration (site, local, and regional) as it relates to habitat type, function, and availability to specific avian species pre- and post-project. The size and extent of the habitats available to ducks/shorebirds annually, the highly dynamic nature of both farming practices and natural conditions in the intertidal habitats, weather, animal behaviors, etc. make designing studies to determine the effects of restoration projects on all the species that rely on the GSD problematic.

The amount of food resources available is one metric that determines how birds will use a particular site. Current quantitative data that compare waterfowl and other avian species use to food availability in the estuary or agricultural areas in the North Puget Sound Lowlands, including the GSD, do not exist. However, the primary objective for the Island Unit currently is to manage the site to maximize the amount of planted forage food available to ducks when the largest numbers are present in the Skagit delta (fall/spring migration and winter). Asking how the proposed alternatives affect this management objective may be helpful in predicting whether each alternative will be negative, positive, or neutral for birds at three geographic scales: Island Unit, Skagit Bay, and the Greater Skagit Delta. In general, waterfowl life history and annual energetic requirements are probably better researched than shorebirds and some of this information is discussed below.

2.0 Waterfowl Ecology

2.1 Midwinter Waterfowl Surveys

It's important to recognize that bird distributions within and among the bays of the GSD are influenced by many factors, such as weather, tides, food resources, predators, social bonds, and human disturbance.

WDFW staff have conducted periodic aerial surveys of open water portions of the four bays of the GSD since the 1954-55 waterfowl season. These surveys have been conducted once per month from October through January, when possible, but the January count has been the most consistently conducted. Caution should be used in making comparisons between years of data (Eggeman and Johnson 1989) because of uncertainty related to:

- non-defined transects (however, in tidal regions there are reasons to not have set transects as the underlying "available habitat" is highly dynamic and constantly changing),
- as a northern latitude wintering area, annual variation in counts can be influenced by temperature and open-water conditions on the landscape (Lovvorn and Baldwin 1996), and
- the role of hunting pressure on waterfowl distribution in the GSD.

These local surveys have been a long-term component of the Midwinter Waterfowl Survey (MWS), a nationwide effort to survey the number of waterfowl in areas of major concentrations on their wintering grounds and were the primary survey to determine the status of wintering waterfowl throughout the Pacific Flyway. At the local level, they provide insights into whether population targets, established within the framework of the North American Waterfowl Management Plan (NAWMP) and the Pacific Birds Habitat Joint Venture (PBHJV) are being met within available habitat for specific counties or landscape planning areas. The PBHJV has established waterfowl management zones at the ecoregional scale. The Island Unit is located within the North Puget Lowlands (NPL) ecoregion that includes Whatcom, Skagit, Island, San Juan and Snohomish counties and is defined by the west slope of the Cascade Mountains, the floodplains of major Puget Sound Rivers, the northern part of Puget Sound, the large islands of San Juan and Island counties, and the straits that encircle the San Juan Islands and connect the inland waters of British Columbia to the Strait of Juan de Fuca (Petrie 2013). Management units are then stepped down and delineated along county boundaries and population objectives are set and assessed by county. For Skagit County, waterfowl counts are recorded for each bay (Skagit, Padilla and Samish), and population trends are assessed by combining those counts.

In the summary figures below, the January MWS counts for the four most prevalent dabbling ducks, mallard, northern pintail, American wigeon, and green-winged teal are compared against the species-specific regional population objectives for Skagit County. The 1955-2014 data are used to develop the long-term average populations of breeding ducks (LTA), and the 80th-percentile of the LTA (80-LTA). Waterfowl are subject to highly variable reproduction cycles, relative to weather and other environmental factors. To account for periodic fluctuations in production on the breeding grounds, it is useful to examine both the LTA and 80-LTA to clarify these cycles when accounting for population changes (NAWMP 2014 Addendum, Fleming et al. 2019).

We present data for the period following 1986, as several key policy and conservation efforts were initiated then. The figures and text below provide Skagit County summaries of species-specific long-term averages, most recent 10-year average, and the number of years the count has been above both the LTA and 80-LTA during the span of survey years. Statistics for each of the dabbling duck species is as follows:

Mallard (MALL): The long-term average count for mallard in Skagit County bays is 80,345, with a recent 10-year average of 87,047. Annual counts have exceeded the LTA in 17 of 30 years and 8 of the past 10 years. Annual counts have exceeded the 80-LTA in 13 of 30 years and 5 of the past 10 years (Figure 1).

Northern Pintail (NOPI): The long-term average count for Northern pintail in Skagit County bays is 37,432, with a recent 10-year average of 41,223. Annual counts have exceeded the LTA in 10 of 30 years and 5 of the past 10 years. Annual counts have exceeded the 80-LTA in 3 of 30 years and 1 of the past 10 years (Figure 2).

American Wigeon (AMWI): The long-term average count for American wigeon in Skagit County bays is 48,318, with a recent 10-year average of 45,862. Annual counts have exceeded the LTA in 19 of 30 years and 7 of the past 10 years. Annual counts have exceeded the 80-LTA in 7 of 30 years and 4 of the past 10 years (Figure 3).

Green-winged Teal (AGWT): The long-term average count for Green-winged teal in Skagit County bays is 6,300, with a recent 10-year average of 10,146. Annual counts have exceeded the LTA in 11 of 30 years and 8 of the past 10 years. Annual counts have exceeded the 80-LTA in 6 of 30 years and 4 of the past 10 years (Figure 4).

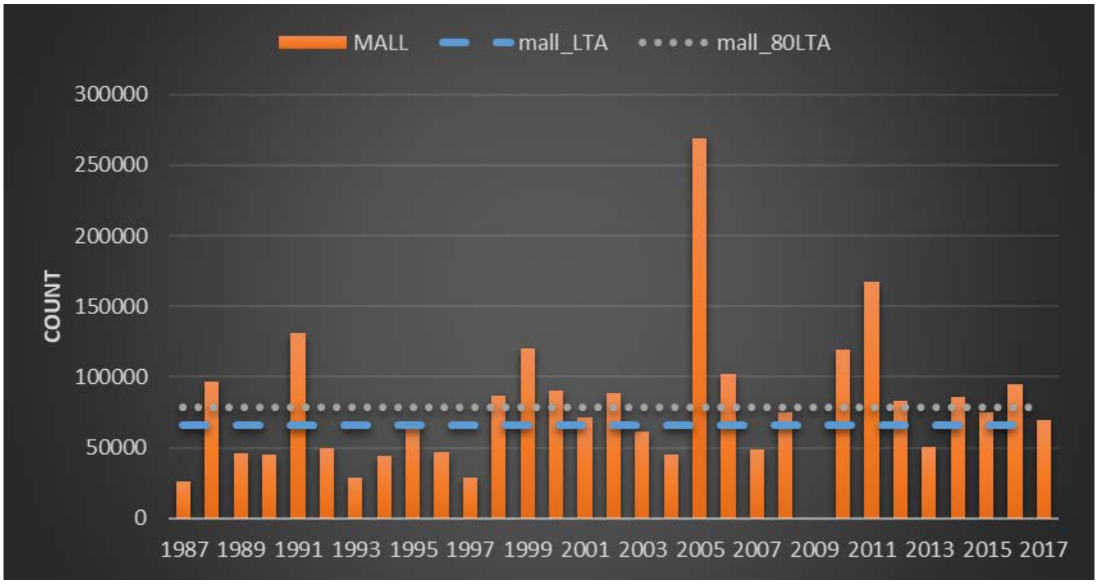


Figure 1. Average mallard numbers for Skagit County bays

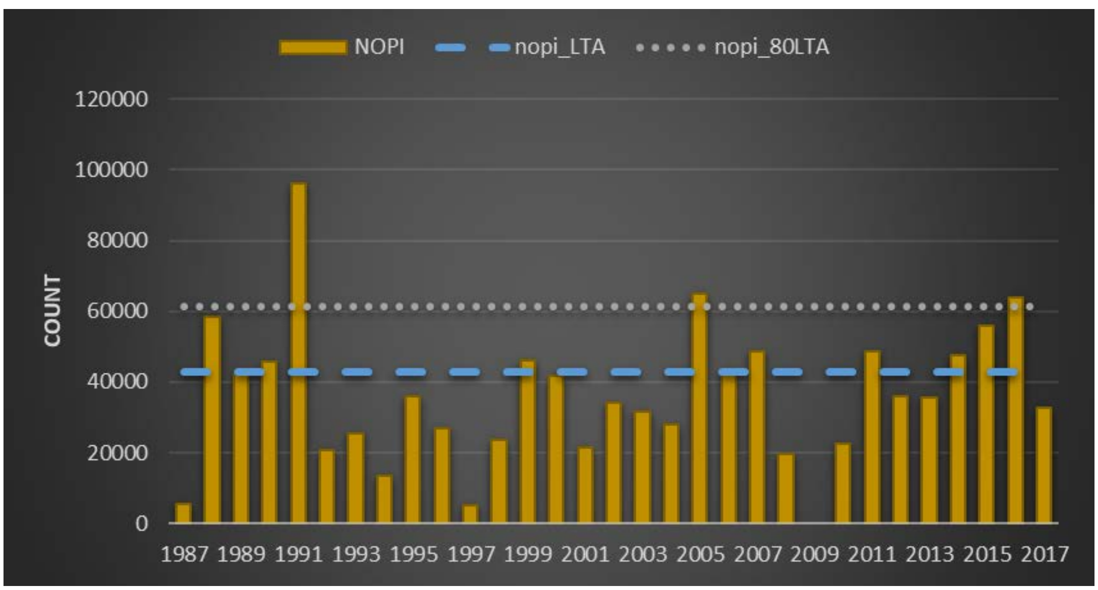


Figure 2. Average northern pintail numbers for Skagit County bays

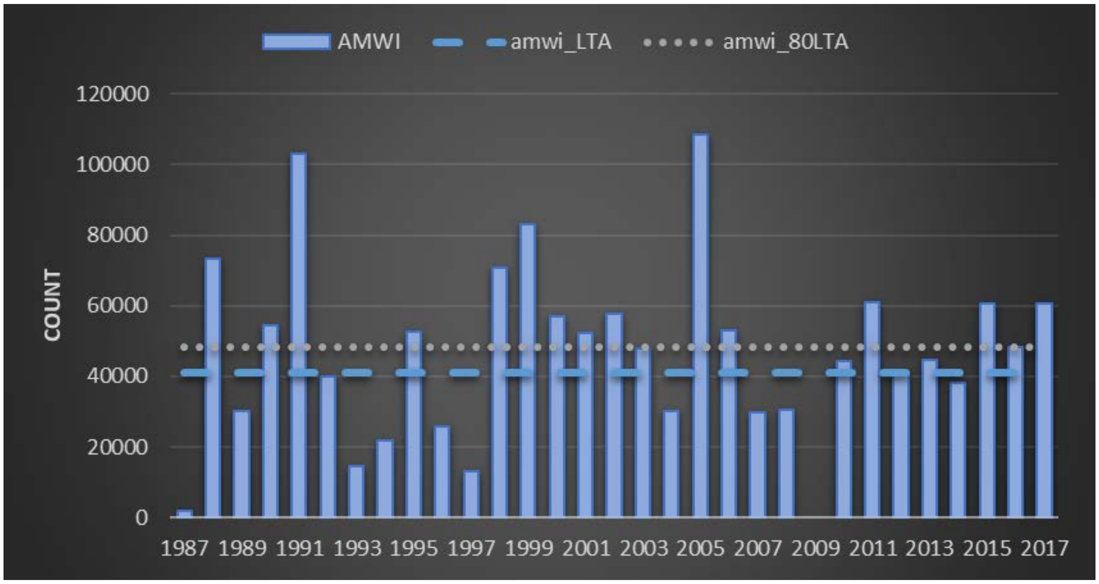


Figure 3. Average American wigeon numbers for Skagit County bays

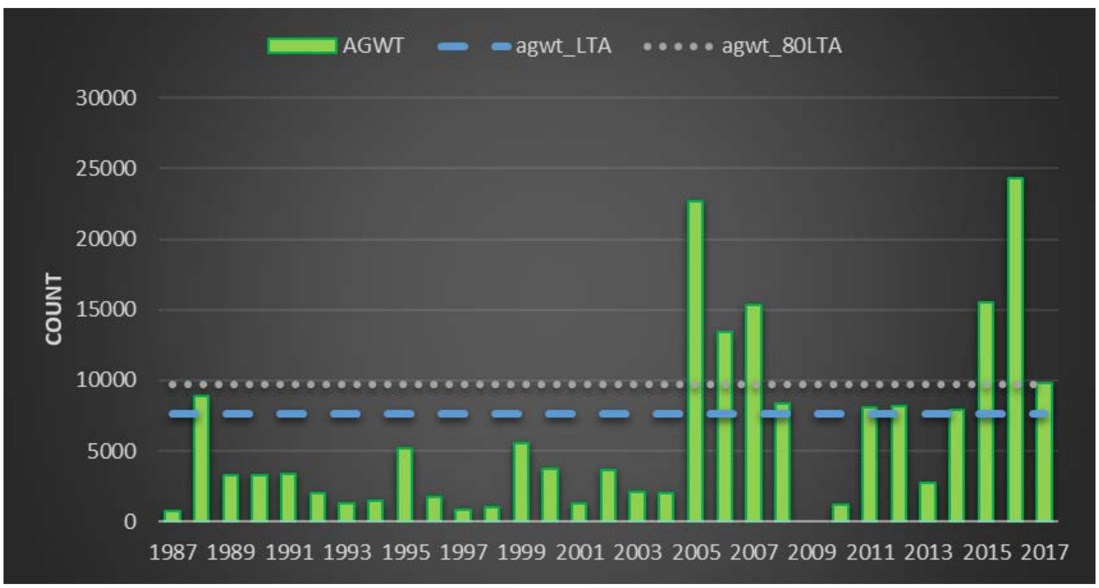


Figure 4. Average green-winged teal numbers for Skagit County bays

2.2 How to Apply the Skagit County Bays Midwinter Waterfowl Counts

We've been asked whether these survey data could be used to show the impact on wintering waterfowl populations for dike setback/removal projects completed in the GSD since 2000 due to the long-term nature of the data set. This survey was not designed to examine habitat changes or effects on waterfowl use and distribution. There are several factors in, and outside of, the GSD that result in changes in waterfowl population numbers. The long-term result of site-specific restoration projects to waterfowl is a complex question that cannot be answered with waterfowl trend data alone.

The most appropriate application of these data is as a check on the “carrying-capacity,” defined as the ability of the landscape to meet food and habitat needs of a certain number of waterfowl, of the system as a whole. As such, the North American Waterfowl Management Plan (NAWMP 1986, 2014, 2018 Update) and the Migratory Bird habitat Joint Ventures have set waterfowl population objectives and targeted conservation efforts to improve wetlands and other habitats important to the persistence of migratory bird populations (Andres et al. 2020). Recently, Fleming et al. (2019) developed regional population objectives for waterfowl during the non-breeding season. Petrie et al. (2011), combined population objectives with migration chronology data to calculate “duck-energy-days” (DEDs). These calculations are then used to determine the amount of food needed to sustain a specified number of ducks in a given area, and allow landscape conservation planners and regional land managers to factor these needs into management actions. The North Puget Lowlands accounts for 17,982,386, 26,659,750, and 11,317,284 DEDs during the fall, winter, and spring period, respectively, representing 39.9%, 57.4%, and 51.5% of the western Washington total duck-energy-day demands (Figure 5). Clearly, the North Puget Lowlands, and by inference, the contributions of the GSD are highly important in maintaining robust waterfowl populations in Washington.

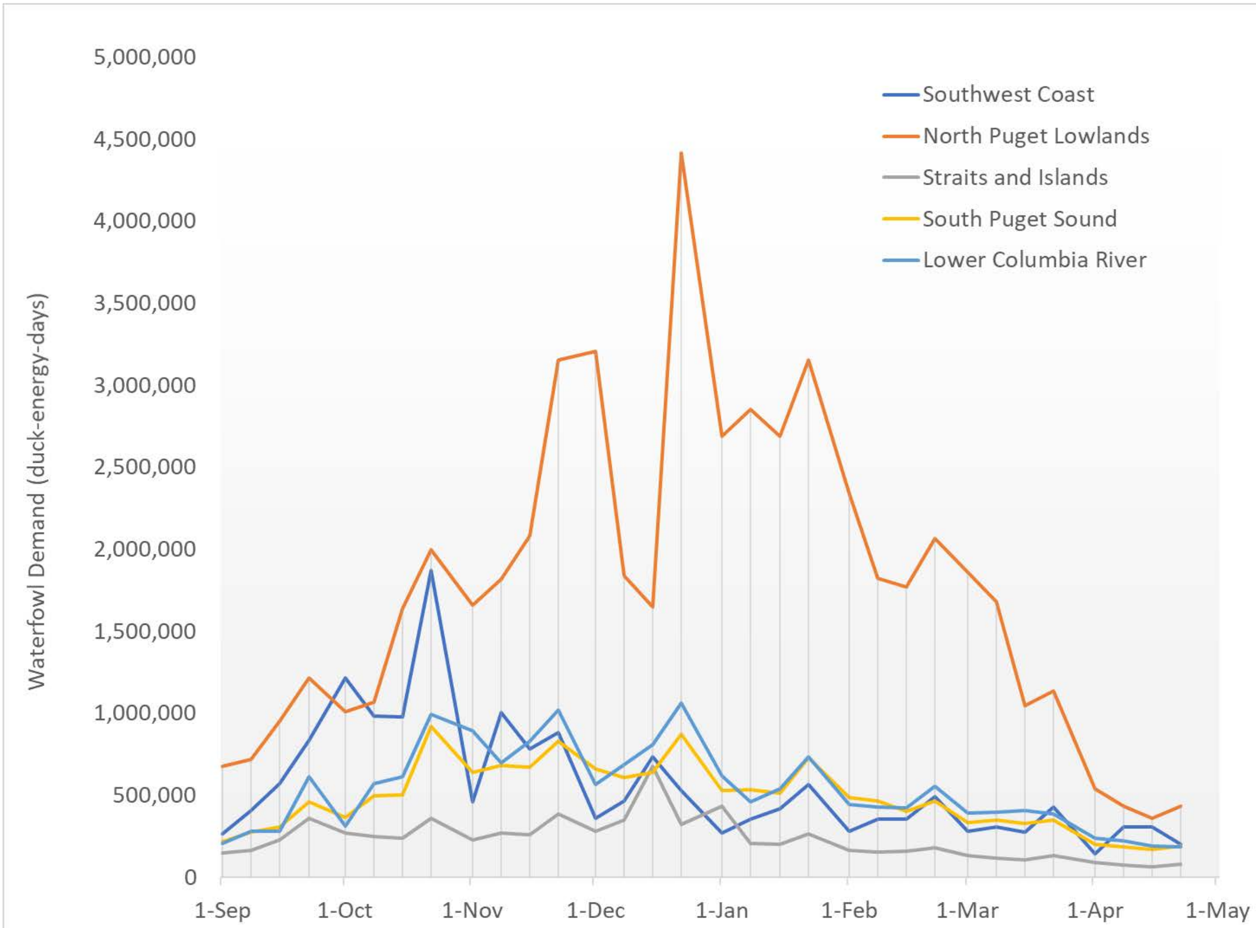


Figure 5: Comparison of duck energy days among 5 geographic management areas in western Washington

2.3 Waterfowl Food Resources

Waterfowl have a minimum daily energy requirement (resting metabolic rate) that must be maintained for survival (Miller and Eadie 2006). The daily energy requirement for a dabbling duck is approximately 312 kilocalories per day, compared to 614 kilocalories per day for a snow goose and 1,106 kilocalories per day for a swan (Petrie et al. 2012). It is well documented that waterfowl forage requirements shift from more plant-based food items in the fall and winter (e.g., seeds, leaves, tubers) to more animal or protein-based food items in the spring (e.g., invertebrates, fresh-growth leaves). Thus, waterfowl require a mixture of habitat types on the same landscape to facilitate longer lengths-of-stay in a particular region (Lovvorn and Baldwin 1996).

Many waterfowl forage items or habitat types have values for biomass and true metabolic energy documented in peer-reviewed literature. However, there may be regional or site-level differences in these values. In general, natural plant types produce lower yields (biomass) and are of lower digestible energy content compared to plant types in managed systems or agricultural production. Agricultural plants typically provide more kilocalories of energy per gram and occur at higher density (grams/acre) than native plants. Thus, dabbling ducks seeking 312 kilocalories of food would need to forage in larger areas or for longer periods of time on natural plant types than on agricultural plants. Under a natural plant foraging scenario, the need for low disturbance areas increases in order to allow ducks more time to forage. Hunting is a form of disturbance that occurs during daylight hours. In managed systems that allow hunting, large numbers of birds forage at night when disturbance is low and high calorie foods are available.

If enough food is not available on the landscape when waterfowl need to access it, individuals will seek food elsewhere. How far they seek that food is dependent on proximity of alternate sources and the ability to access those sites. However, a consequence of having to seek foods further away from their previous distribution is an increase in the base food energy required for flight - the most energetically expensive activity.

2.4 Local Waterfowl Research and Monitoring Projects

Aside from the waterfowl surveys described above, funding for avian monitoring projects in the GSD has been limited. However, a few local studies have been conducted in the GSD and are summarized below. Because they were conducted at the GSD scale or smaller, these projects provide insight into how ducks might respond to potential changes to current management of the Island Unit.

Slater (2004) conducted avian surveys at three habitat types associated with Skagit and Port Susan Bays: mudflat, intertidal marsh, and agricultural fields, from late winter to early spring in 2003 and 2004. Sampling occurred over four periods: February 9 – 21, March 8 – 21, April 5 – 18, and April 26 – May 9. Each site was surveyed during a low and a high tide event in each sampling period. During the time period surveyed, they found that mean duck density appeared to be higher on agricultural sites managed for wildlife compared to commercial agricultural sites, and duck density did not appear to vary in response to tide on either the commercial or wildlife-managed agricultural sites. Duck density declined on agricultural sites during their spring sampling periods coinciding with the initiation of migration and increased farm activity. Within the agricultural sites, Slater (2004) found that ducks were most frequently observed in flooded fields and low vegetation, and were seen less often in human-made ditches and ponds, high vegetation or bare soil. Duck density was significantly correlated with the percent of standing water surveyed. The proportion of observations in flooded habitats for the most common dabbling duck species was substantially higher than what was available, suggesting that agricultural habitats with standing water were preferentially selected by dabbling ducks, probably because flooded conditions allow for easier access to seed and invertebrate foods.

Within intertidal marsh habitats, Slater (2004) found four species represented 95% of the individuals counted: mallard, American wigeon, northern pintail, or green-winged teal. Mean duck density on marshes was generally higher during high tide and exhibited a declining trend over the tidal cycle. Duck density was significantly correlated with the percent of standing water in the marshes. Green-winged teal, northern pintail and American wigeon were observed in flooded marshes in greater proportion than was available; mallards used flooded marsh habitats in proportion to what was available. Mallards were the most abundant species, although high densities of northern pintail were seen in the first two sampling periods. Both mallard and northern pintail were usually more abundant on marsh transects at high tide, but their numbers declined substantially during spring sampling periods. In contrast, green-winged teal density increased in the spring periods, which may have coincided with southern populations migrating north and using the GSD as a staging area. American wigeon were moderately abundant and did not appear to be as strongly influenced by tide.

Slater (2004) detected nine species of ducks on tide flats, and the four most common birds were mallard, American wigeon, northern pintail and green-winged teal. Mean relative abundance was substantially higher at low tide than high tide, and this pattern was seen for all the major species. Ducks used flooded tide flats as well as exposed flat, supporting observations that ducks congregate near the tideline.

Conclusions from Slater (2004):

- Dabbling ducks appeared to partition agricultural habitats with respect to commercial and wildlife-managed areas, a likely result of differences among species in food preferences and foraging strategies.

- Gadwall and northern shoveler, the two flooded specialists, preferred the stable water levels at TNC's upland site adjacent to Port Susan Bay [which was a flooded impoundment at the time of the surveys] and were rarely seen in other agricultural or estuarine habitats. Both species prefer muddy, freshwater wetlands and are rarely associated with brackish habitats (Ehrlich et al. 1988 in Slater 2004).

- Mallard and wigeon did not exhibit a preference between commercial and wildlife-managed agricultural habitats. Wigeon are grazers and prefer stems and leafy parts of plants, which makes them particularly adapted to agricultural landscapes. Mallards are omnivorous, opportunistic, and a generalist feeder, allowing them to utilize a variety of agricultural and urban landscapes (Drilling et al. 2002 in Slater 2004).

- Pintail and green-winged teal appeared to avoid commercial agricultural habitats. Both species utilize commercial agricultural habitats (Lovvorn and Baldwin 1996 in Slater 2004), so it is unclear why they avoided it here. In this study, both species were strongly associated with flooded fields, and the wildlife-managed sites may have been more flooded than commercial lands.

- Duck density was generally lower in agricultural than emergent marsh habitats in the GSD, and this pattern was observed for each of the four most common dabbling ducks: mallard, American wigeon, northern pintail, and green-winged teal. Slater states: *"This result suggests that any perceived cost to duck populations by marsh restoration is unwarranted, and that, in fact, marsh restoration would be beneficial to ducks. Moreover, there is little compelling evidence to support the notion that marsh restoration is detrimental to duck populations. In the northwest, wintering mallard, northern pintail, and green-winged teal feed on seeds of abundant marsh plants (Carex, S. amercanus, S. validus), and on animal matter including insect larva and gastropods (Burgess 1970, Eamer 1985); wigeon feed on Carex roots, filamentous algae, and leaves and seeds of other marsh plants. Although Lovvorn and Baldwin (1996) found that tidal flat habitats alone could not support wintering duck populations, they acknowledge that dabbling ducks can feed in areas of tidal marsh instead of farmland as long as areas are available."*

- Slater further states: *"With the extensive losses of tidal and non-tidal wetlands across the Pacific Northwest and in the GSD, we recognize that agricultural habitats are important in supporting the large duck populations in this area."*

Virzi et al. (2017) censused birds prior to, and immediately after, the dike was removed at Fir Island Farm in August 2016. This study was of relatively short duration and spanned one survey season for winter, spring and summer pre-restoration and one fall, spring and summer period post-restoration. During this study's timeframe, the numbers of birds at Fir Island Farm declined substantially immediately after dike removal and they saw a change in species composition between pre- and post-restoration. Reduced site use by waterfowl accounted for the drop in overall bird numbers. Waterfowl counts decreased by 93% at Fir Island Farm while at the same time counts increased by 138% at Leque Island.

> *"Counts of abundant species at Fir Island Farm pre-restoration (e.g., mallard and American wigeon) declined substantially post-restoration. Other notable waterfowl declines included*

bufflehead, green-winged teal and pintails. snow geese counts were also substantially lower at Fir Island Farm post-restoration, and trumpeter swans were not observed at all. One explanation for the observed change in waterfowl abundance at these sites could be that waterfowl use at Fir Island Farm decreased in response to local site conditions immediately post-restoration".

They also noted that the waterfowl species that declined at Fir Island Farm post-restoration also declined at their reference site at Wiley Slough during the same period, which might indicate other factors contributed towards the observed patterns of site use. The difference in duck numbers seen at post-restoration Fir Island Farms compared to unrestored conditions at Leque Island may reflect the variety of food resources within the GSD (including wildlife-managed sites like the Island Unit) and birds' abilities to exploit them, but the scope of this study was too limited to explore that concept further.

In contrast to Virzi et al. (2017), Woo et al. (2015a) saw a 30-fold increase in snow goose numbers within two years post-restoration at Port Susan Bay Preserve compared to pre-restoration numbers. They also saw a shift in community structure from freshwater-preferring ducks to generalist dabbling ducks such as mallards.

3.0 Shorebirds

3.1 Local Shorebird Research and Monitoring Projects

Slater (2004) found that shorebirds were substantially more abundant in estuarine habitats compared to agricultural habitats, but observed distinct patterns of habitat use between marsh and tidal flat habitats in relation to season. In the marsh, shorebird density was low during the winter period, but high during spring migration when marsh specialists, such as least sandpipers and greater yellowlegs, were abundant. In contrast, shorebirds were abundant on tidal flats in the wintering period when large flocks of dunlin were observed. Shorebirds were only observed on large channels that drained, similar to observations of waterfowl in channel habitats. These types of channels provide important habitat to marsh specialists: greater yellowlegs, dowitchers, and least sandpipers because they provide foraging opportunities and safe harbor when the marsh is dry. During a two-hour survey of channels in the South Fork Skagit River area on an ebb tide in the fall more than 50 individuals of yellowlegs and dowitchers were counted.

Slater and Lloyd (2010) examined shorebird response to flooded agricultural fields designed to mimic freshwater wetland availability. They found the wetlands that resulted from maintaining flooded fields supported more shorebirds than two other traditional agricultural practices, grazing and forage harvest, both of which may provide habitat for shorebirds when vegetation is kept short. They saw seasonal variations in the response of shorebirds to flooding, likely related to soil moisture and the availability of standing water across the landscape, and crop heights. Fall migration by shorebirds corresponds with the peak of the growing season and with generally warm and dry weather in the Pacific Northwest. During this period, agricultural fields have low soil moisture and no standing water, high levels of farm activity, and crops that are at their peak in height, all factors likely to dissuade shorebirds from using agricultural fields.

Slater et al. (2011) looked at winter habitat selection by dunlin in the GSD by following radio-equipped birds during three winter sampling periods. Tidal flat and marsh habitats were the highest ranked habitats selected by dunlin in the GSD. Foraging efficiency was presumed to be highest for dunlin in estuarine habitats in both the Skagit and Stillaguamish River deltas, as tidal flats in nearby regions have been shown to support high densities of shorebird prey (Baldwin and Lovvorn 1994, Shepherd 2001 *in* Slater et al. 2011).

Tidal flat areas characterized by finer sediments such as south Skagit Bay supported the highest concentrations of foraging dunlin. An area downstream of the largest remaining area of estuarine marsh in the Skagit River Delta Marsh habitat followed tidal flat in importance. Within the marsh, dunlin were restricted to low marsh habitats and were regularly observed foraging in low marsh substrates in areas where vegetation had died back or in areas where both vegetation cover and height was low and bare patches of mud were present. Some of the heavily used marsh habitats appeared to contain sediments with a greater proportion of organic matter and finer-grained particles than areas of tidal flats that were apparently avoided. For example, dunlin were regularly observed foraging in marsh habitats along the bayfront of Fir Island, but rarely ventured beyond the marsh edge where tidal flat substrates were dominated by sand (Slater et al. 2011).

From Slater et al. (2011):

> "*The importance of marsh habitats to dunlin in the estuarine environment likely extends beyond simply providing habitat for foraging or roosting. Marsh habitats are a primary driver of food webs in the estuarine environment, contributing large amounts of detritus as vegetation dies back annually*.
>
> *Tidal flats are the recipients of this influx of productivity, and the quality of tidal flat habitats to species like dunlin and other shorebirds may be driven, in part, by the amount of intact marsh habitat. If so, estuaries with large areas of intact marsh should have higher quality tidal flats*

> *that support great numbers of individuals. In the Skagit and Stillaguamish River deltas, the area of tidal flats has remained stable. In contrast, marsh habitats have been severely reduced in the area due to diking and drainage for human development. Consequently, we suggest that marsh restoration activities will contribute significantly to the conservation of dunlin and other shorebird species both directly, by providing foraging and roosting habitat, and indirectly by increasing habitat quality of adjacent tidal flat habitats."*

Agricultural habitats are known to be important to dunlin as high tide foraging and refugia habitats in coastal habitats, particularly at night (Colwell and Dodd 1997, Shepherd 2001, Evans Ogden 2002, Conklin and Colwell 2007 *in* Slater et al. 2011). Slater et al. (2011) also found that dunlin used agricultural habitats in the Skagit and Stillaguamish River deltas. Dunlin locations in agricultural habitats were > 23% in each year of the study, and all marked individuals had home ranges that included some agricultural habitats. Agricultural habitats were usually used by dunlin at night, were close to the estuary, and few locations were found > 6 km from the shoreline. "*Stable isotope (δ13C, δ15N) measurements of whole dunlin blood and their prey revealed that while dunlin used primarily estuarine habitats, they also depended to a large degree on adjacent agricultural lands. These findings are similar to those found for dunlin wintering on the Fraser River Estuary, Canada, and are consistent with several studies of shorebirds using estuaries in Europe (reviewed in Evans - Ogden et al. 2005).*" (Slater et al. 2011). Thus, we know that shorebirds will seek invertebrate prey when wet upland habitats are available, and do not only forage in tidally influenced habitats.

In agricultural habitats, Slater et al. (2011) found that dunlin used bare soil, winter cover crops, and crop residue habitats in similar proportions; the use of pasture, other agriculture and woody agriculture was extremely rare. The most apparent feature of agricultural fields associated with use by wintering dunlin was the presence of saturated soils. In general, observations of Dunlin using agricultural habitats were infrequent until winter precipitation resulted in saturated soils and patches of standing water on fields. From Slater et al. (2011): "*Overall, this study reinforces the importance of both marsh and agriculture habitats, and suggests that different strategies may need to be encouraged for each region. Restoration of estuarine habitats will likely provide the greatest benefit to dunlin by creating new habitat and by increasing the quality of existing habitats. However, under the current landscape, agricultural habitats remain important as alternative foraging and refugia sites, particularly those fields that are adjacent to the estuary. Results from this study suggest that saturated agricultural fields with bare ground or low levels of vegetation cover are important habitat features for wintering dunlin, but additional research to identify the specific characteristics that dunlin favor is needed to refine conservation strategies on agricultural land*".

At Fir Island Farms, Virzi et al. (2017) saw an increase in shorebirds post-restoration. Dunlin counts increased by 85% at Fir Island Farm, while counts at Leque Island and Wiley Slough decreased by 50%. Western sandpiper counts increased by 67% at Fir Island Farm, while counts at Leque Island decreased by 70%. Shorebirds began using Fir Island Farm in greater numbers almost immediately following restoration. Post-restoration Virzi observed foraging shorebirds of nine species in much higher numbers than previously seen at this site during a visit on 23 September 2017.

Woo et al. (2015a) saw increases in shorebird use of the restored marsh and mudflats at Port Susan Preserve 2-3 years after dike removal. They also saw changes in the restored area's sediment quality there post-restoration. Percentages of silt and clay increased, while sand decreased. Densities of amphipods, polychaetes, oligochaetes and, to a lesser extent, bivalves also increased in the restored area (Woo et al. 2015b), which probably influenced the increased numbers of foraging shorebirds seen in their surveys.

Site use by secretive marshbirds remained low post-restoration at Fir Island Farms. However, two species that were not detected during line transect surveys at Fir Island Farm pre-restoration were seen post-restoration: Sora and Virginia rail. It is possible that detection probability increased post-restoration due to increased visibility at this site resulting in these observations. However, the authors did not have enough detections to draw conclusions regarding the effects of dike restoration actions on secretive marshbirds (Virzi et al. 2017).

4.0 Conclusions

4.1 Waterfowl

Public land managers recognize the importance and timing of the various habitats that our state provides to fulfill the annual life cycle requirements of migratory birds. Waterfowl distributions are not uniform across the landscape and, given significant losses of tidal and non-tidal wetlands in the coastal wetlands of the Pacific Flyway (Brophy et al. 2019), management of the Skagit Wildlife Area strives to contribute to the annual energy demands of waterfowl. Habitat quality and quantity is unequivocally the most important ecological component affecting populations of waterfowl and managed lands can be especially effective when the abundance, availability, and spatial distribution of food, cover, and water resources coincide with specific events in the life history of waterfowl (Baldassarre and Bolen 2006).

Changes from managed forage to intertidal estuary will change the abundance, variety and availability of resources at the Island Unit scale. Current management of the Island Unit is designed to optimize waterfowl access to unharvested agricultural and wetland plants. A shift in management under any of the restoration alternatives will alter “managed” freshwater wetlands to more dynamic water depths and salinity. Clearly, reducing farmed forage at the site scale will reduce the number of birds that congregate there.

However, there are other food resources available within the GSD, including commercial agricultural fields, remaining WDFW or private managed forage plots, and vegetation and invertebrates in the intertidal marshes and flats. These resources are dynamic, and the quality and quantity of food they provide are unknown. The proportion of the food resources the current management of the Island Unit provides compared to food available in the GSD is unknown. We know that ducks will move farther from the site to find equivalent nutrition under the restoration alternatives. However, given the size of the Island Unit compared to the estuary and agricultural fields within the four bays of the GSD, it is unlikely that reducing farmed forage at the Island Unit will result in a decline in the winter waterfowl population at the GSD scale, but rather shift the number of dabbling ducks to disperse across the larger landscape and potentially compete for forage with snow geese and swans. How waterfowl populations might change in the long term due to the alternatives considered for the Island Unit is unknown. Factors that will influence future waterfowl populations and distributions could include increasing intertidal marsh habitats, changing commercial agricultural practices that could either increase, but are more likely to reduce, food available for ducks, increasing the amount of managed forage for ducks by increasing public ownership or through partnerships with private landowners.

4.2 Shorebirds

Although the Island Unit is not regarded as a site of high shorebird use compared to other habitats in the GSD, it supports some birds under certain conditions as currently managed. As discussed above, shorebirds are primarily tied to intertidal marshes and mudflats. Agricultural habitats with saturated soils are secondarily important and this habitat type is available at the Island Unit during wet periods when vegetative cover is low or absent. However, any addition of estuarine habitat in the GSD will increase shorebird habitat and thus benefit shorebirds if all or part of the Island Unit is converted to intertidal conditions. Shorebird use in the immediate vicinity of the Island Unit will likely increase. Shorebirds are highly mobile and routinely move within the GSD (Slater 2011; Milner, unpublished data). Consequently, as intertidal shorebird habitat increases through any of the restoration alternatives, shorebird populations will likely also benefit at the GSD scale.

Citations

Andres, B.A., B.L. Altman, A.M. Bartuszevige, C.J. Beardmore, R. Dettmers, D.T. Jones-Farrand, E.J. Laurent, R.S. Mordecai, J.M. Tirpak, W. Vermillion, and J.A. Wheeler. 2020. Considerations for establishing bird population and habitat objectives to further conservation within habitat Joint Ventures. Partners in Flight Technical Series No.9. Partners in Flight website: https://partnersinflight.org/resources/pif-tech-series/

Baldassarre, G.A., and E.G. Bolen. 2006. Waterfowl ecology and management. Second edition. Krieger Publishing Company, Malabar, Florida, USA.

Brophy, L.S., C.M. Green, V.C. Hare, B. Holycross, A. Lanier, W.N. Heady, K. O'Connor, H. Imaki, T. Haddad, and R. Dana. 2019. Insights into estuary habitat loss in the western United States using a new mothod for mapping maximum extent of tidal wetlands. PloS one. 14:e0218558.

Drut, M. S. and J. B. Buchanan. 2000. Northern Pacific Coast Regional Shorebird Management Plan.
Eggeman, D. R. and F. A. Johnson. 1989. Variation in effort and methodology for the midwinter waterfowl inventory in the Atlantic Flyway. Wildlife Society Bulletin 17:227-233.

Fleming, K.K., M.K. Mitchell, M.G. Brasher, J.M. Coluccy, J.D. James, M.J. Petrie, D.D. Humburg, and G.J. Soulliere. 2019. Derivation of regional, non-breeding duck population abundance objectives to inform conservation planning – 2019 Revision. North American Waterfowl Management Plan Science Support Team Technical Report 2019-01. 44pp.

Lovvorn, J.R., and J.R. Baldwin. 1996. Intertidal and farmland habitats of ducks in the Puget Sound region: a landscape perspective. Biological Conservation 77: 97-114.

Koberstein M., G. Slater, T. Bayard and T. Haas. 2017. Avian Monitoring in Support of the Estuaries Vital Sign in Puget Sound: Inventory and Assessment. Report prepared for Puget Sound Partnership.

Petrie, M.J. 2013. Habitat and Population Objectives Wetland Birds and Waterbirds North Puget Lowlands Ecoregion. Report prepared for the Pacific coast Joint Venture.

Petrie, M.J., M.G. Brasher, G.J. Soulliere, J.M. Tirpak, D.B. Pool, and R.R. Reker. 2011. Guidelines for establishing Joint Venture waterfowl population abundance objectives. North American Waterfowl Management Plan Science Support Team Technical Report No. 2011-1. 34pp.

Miller, M.R., and J. M. Eadie. 2006.The allometric relationship between resting metabolic rate and body mass in wild waterfowl (Anatidae) and an application to estimation of winter habitat requirements. The Condor 108: 166-177.

Senner, S. E., B. A. Andres and H. R. Gates (Eds.). 2016. Pacific Americas shorebird conservation strategy. National Audubon Society, New York, New York, USA. Available at: http://www.shorebirdplan.org.

Slater, G.L. 2004. Waterbird abundance and habitat use in estuarine and agricultural habitats of the Skagit and Stillaguamish River Deltas. Report to the US Fish and Wildlife Service, Skagit System River Cooperative and The Nature Conservancy.

Slater, G.L., R.L. Milner and R. Borkhateria. 2011. Space use and habitat selection by wintering Dunlin in the Skagit River Delta. Final Report to Seattle City Light – Environmental Affairs Division.

Virzi, T. L. Rensel, R. Milner and G. Slater. 2017. ssessing restoration effects on bird populations following tidal restoration at Fir Island Farm and other sites in the Skagit-Stillaguamish river Delta, WA. Final Report to the Washington Department of Fish and Wildlife (La Conner, WA).

Woo, I., S. De La Cruz and M. Davis. 2015. Data Summary Report: Restoration monitoring at Port Susan Bay and the Stillaguamish River Delta. USGS Report.

Woo, I., S. De La Cruz and M. Davis. 2015. Data Summary Report: Restoration monitoring at Port Susan Bay and the Stillaguamish River Delta Addendum: Benthic Invertebrate community Structure and biomass. USGS Report.

APPENDIX F: OPINION OF PROPABLE CONSTRUCTION COSTS

CHANNING SYMS
WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

Opinion of Probable Construction Costs

The “opinion of probable construction costs” was developed by WDFW’s Region 4 Habitat Engineer. Because alternatives are conceptual at this stage, construction costs are provided as a general basis for comparison only. Estimated costs were derived from actual costs from similar nearby projects and adjusted for inflation to the year 2020. Costs include design, permitting, mitigation, construction oversight, construction, taxes and fees, and contingency.

For all alternatives that include dike removal, there is a range of costs provided. Table 1 contains detailed cost information assuming 50% of the dike length is removed for full and partial restoration alternatives and Table 2 contains detailed cost information assuming 100% of the dike length is removed. In summary, the cost for each alternative is:

- Alternative 1: $6.5M
- Alternative 2: $8.2-10.4M
- Alternative 3: $9.9-11.7M
- Alternative 4: $9.3-13.0M

Table 1. Opinion of Probable Construction Cost for the Island Unit (50% dike removal per alternative that include dike removal)

Date: *9/28/2020*

By: *Syms*

			Alternative 1 - No Restoration		Alternative 2 - East Island Restoration[12]		Alternative 3 - Both Island Levee Setback		Alternative 4 - Full Restoration[12]	
Description	**Unit**	**Unit Price**	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**
Demolition/ Site Prep										
Clearing and Grubbing	AC	$3,000	7.06	$21,193.39	2.53	$7,582.64	3.22	$9,647.11	270.00	$810,000.00
Excavation[1,2,3]	CY	$15	0.00	$0.00	63405.65	$951,084.75	53788.35	$806,825.25	108354.40	$1,625,316.00
Excavation, mucky or wet[4]	CY	$5	0.00	$0.00	12681.13	$63,405.65	10757.67	$53,788.35	21670.88	$108,354.40
Remove Existing Bridge	EA	$20,000	0.00	$0.00	1.00	$20,000.00	0.00	$0.00	1.00	$20,000.00
Levee Construction										
Dike Select Fill[5,6]	C.Y.	$30	28208.40	$846,252.00	10092.50	$302,775.00	40560.30	$1,216,809.00	0.00	$0.00
Levee Repairs										
Riprap[7]	CY	$300	1500.00	$450,000.00	1500.00	$450,000.00	1500.00	$450,000.00	0.00	$0.00
Tidal Channel Work and Breaches										
Excavation[8]	C.Y.	$25	0.00	$0.00	48994.66	$1,224,866.46	24876.05	$621,901.28	70143.29	$1,753,582.22
Tidegate Replacement										
New Side Hinge Tidegates[9]	EA	$500,000	2.00	$1,000,000.00	1.00	$500,000.00	2.00	$1,000,000.00	0.00	$0.00
SUB CONSTRUCTION				**$2,317,445.39**		**$3,519,714.51**		**$4,158,970.99**		**$4,317,252.62**
Other Construction Costs										
Seeding or Planting[10]	AC	$4,000	7.06	$28,257.85	2.53	$10,110.19	3.22	$12,862.81	0.00	$0.00
Dewatering/ Defishing Site	%	10%		$231,744.54		$351,971.45		$415,897.10		$431,725.26
Mobilization	%	30%		$695,233.62		$1,055,914.35		$1,247,691.30		$1,295,175.78
APPROXIMATE TOTAL CONSTRUCTION COST				**$3,272,681.40**		**$4,937,710.50**		**$5,835,422.19**		**$6,044,153.66**
Design, Permitting, Contingency and Mitigation										
Design and Permitting	%	20%		$463,489.08		$703,942.90		$831,794.20		$863,450.52
Construction Inspection & Oversight	%	15%		$347,616.81		$527,957.18		$623,845.65		$647,587.89
Taxes and Fees	%	10%		$231,744.54		$351,971.45		$415,897.10		$431,725.26
Contingency	%	30%		$695,233.62		$1,055,914.35		$1,247,691.30		$1,295,175.78
Loss of Estuary - Mitigation[11]	AC	$135,000	270.00	$1,514,862.00	110.00	$617,166.00	159.00	$892,085.40	0.00	$0.00
APPROXIMATE TOTAL COST				**$6,525,627.44**		**$8,194,662.38**		**$9,846,735.83**		**$9,282,093.12**

Assumptions

1. In full and partial restoration alternatives, 50% of levees not left in place are completely removed to elevation of surrounding ground.
2. Existing levees average 8 feet above the farm field surface.
3. When levees are removed, levee material will be sidecast or used to fill ditches and ponds landward of the levee.
4. 20% of excavation is assumed to be muck. This cost is in addition to the excavation cost.
5. Levee will be raised by 1' on all levees left in place to account for 0.8 feet of sea level rise and 0.2 feet of settlement.
6. New levee will be constructed to 9 feet above ground surface for Alternative 3 cross-dikes.
7. Existing levee on northwest portion of west island is in need of repair/ armoring for no restoration and partial restoration alternatives. 1500 feet of repair assumed.
8. Tidal channel areas from SRSC analysis. Assumed an average of 5 feet deep. Cost assumes sidecast of material.
9. Tidegates/water control structures must be replaced for alternatives 1-3. Existing structures are replaced with concrete headwall/wingwalls and side hinge gate & associated water control
10. Seeding or Planting includes all disturbed area on sides of dike after raising.
11. Continued loss of habitat with tidegate repair is multiplied by 0.04156 per the TFI accounting formula to calculate the acres of mitigation required.
12. Bridge removal is included with alternatives 2 and 4.

Table 2. Opinion of Probable Construction Cost for the Island Unit (100% dike removal per alternative that include dike removal)

Date: *9/28/2020*

By: *Syms*

			Alternative 1 - No Restoration		Alternative 2 - East Island Restoration[12]		Alternative 3 - Both Island Levee Setback		Alternative 4 - Full Restoration[12]	
Description	**Unit**	**Unit Price**	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**	**Quantity**	**Cost**
Demolition/ Site Prep										
Clearing and Grubbing	AC	$3,000	7.06	$21,193.39	2.53	$7,582.64	3.22	$9,647.11	270.00	$810,000.00
Excavation[1,2,3]	CY	$15	0.00	$0.00	126811.30	$1,902,169.50	107576.70	$1,613,650.50	216708.80	$3,250,632.00
Excavation, mucky or wet[4]	CY	$5	0.00	$0.00	25362.26	$126,811.30	21515.34	$107,576.70	43341.76	$216,708.80
Remove Existing Bridge	EA	$20,000	0.00	$0.00	1.00	$20,000.00	0.00	$0.00	1.00	$20,000.00
Levee Construction										
Dike Select Fill[5,6]	C.Y.	$30	28208.40	$846,252.00	10092.50	$302,775.00	40560.30	$1,216,809.00	0.00	$0.00
Levee Repairs										
Riprap[7]	CY	$300	1500.00	$450,000.00	1500.00	$450,000.00	1500.00	$450,000.00	0.00	$0.00
Tidal Channel Work and Breaches										
Excavation[8]	C.Y.	$25	0.00	$0.00	48994.66	$1,224,866.46	24876.05	$621,901.28	70143.29	$1,753,582.22
Tidegate Replacement										
New Side Hinge Tidegates[9]	EA	$500,000	2.00	$1,000,000.00	1.00	$500,000.00	2.00	$1,000,000.00	0.00	$0.00
SUB CONSTRUCTION				**$2,317,445.39**		**$4,534,204.91**		**$5,019,584.59**		**$6,050,923.02**
Other Construction Costs										
Seeding or Planting[10]	AC	$4,000	7.06	$28,257.85	2.53	$10,110.19	3.22	$12,862.81	0.00	$0.00
Dewatering/ Defishing Site	%	10%		$231,744.54		$453,420.49		$501,958.46		$605,092.30
Mobilization	%	30%		$695,233.62		$1,360,261.47		$1,505,875.38		$1,815,276.90
APPROXIMATE TOTAL CONSTRUCTION COST				**$3,272,681.40**		**$6,357,997.06**		**$7,040,281.23**		**$8,471,292.22**
Design, Permitting, Contingency and Mitigation										
Design and Permitting	%	20%		$463,489.08		$906,840.98		$1,003,916.92		$1,210,184.60
Construction Inspection & Oversight	%	15%		$347,616.81		$680,130.74		$752,937.69		$907,638.45
Taxes and Fees	%	10%		$231,744.54		$453,420.49		$501,958.46		$605,092.30
Contingency	%	30%		$695,233.62		$1,360,261.47		$1,505,875.38		$1,815,276.90
Loss of Estuary - Mitigation[11]	AC	$135,000	270.00	$1,514,862.00	110.00	$617,166.00	159.00	$892,085.40	0.00	$0.00
APPROXIMATE TOTAL COST				**$6,525,627.44**		**$10,375,816.74**		**$11,697,055.07**		**$13,009,484.48**

Assumptions

1. In full and partial restoration alternatives, 100% of levees not left in place are completely removed to elevation of surrounding ground.
2. Existing levees average 8 feet above the farm field surface.
3. When levees are removed, levee material will be sidecast or used to fill ditches and ponds landward of the levee.
4. 20% of excavation is assumed to be muck. This cost is in addition to the excavation cost.
5. Levee will be raised by 1' on all levees left in place to account for 0.8 feet of sea level rise and 0.2 feet of settlement.
6. New levee will be constructed to 9 feet above ground surface for Alternative 3 cross-dikes.
7. Existing levee on northwest portion of west island is in need of repair/ armoring for no restoration and partial restoration alternatives. 1500 feet of repair assumed.
8. Tidal channel areas from SRSC analysis. Assumed an average of 5 feet deep. Cost assumes sidecast of material.
9. Tidegates/water control structures must be replaced for alternatives 1-3. Existing structures are replaced with concrete headwall/wingwalls and side hinge gate & associated water control
10. Seeding or Planting includes all disturbed area on sides of dike after raising.
11. Continued loss of habitat with tidegate repair is multiplied by 0.04156 per the TFI accounting formula to calculate the acres of mitigation required.
12. Bridge removal is included with alternatives 2 and 4.

APPENDIX G: COSTS ESTIMATES FOR ANNUAL OPERATIONS AND MAITENANCE COSTS AT THE ISLAND UNIT

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

Cost estimates for annual O&M at Island Unit

costs include labor, materials and equipment

	current management	alternative 1/no restoration		alternative 2/east island		alternative 3/south ends		alternative 4/full restoration	
description of management	141 acres of enhanced & managed forage; 0 acres of estuary	270 acres diked including 141 acres of enhanced & managed forage; 0 acres of estuary		100 acres diked including 54 acres of enhanced & managed forage; 170 acres of estuary		160 acres diked including 81 acres of enhanced & managed forage; 110 acres of estuary		0 acres diked; 0 acres enhanced & managed forage; 270 acres of estuary	
cost category		**low end**	**high end**	**low end**	**high end**	**low end**	**high end**	**low end**	**high end**
ferrying, prep & misc	$ 4,196	$ 4,196	$ 4,196	$ 2,039	$ 2,039	$ 3,275	$ 3,275	$ 1,300	$ 1,300
Field prep, planting & spraying	$ 21,463	$ 21,463	$ 21,463	$ 10,274	$ 10,274	$ 15,493	$ 15,493	$ -	$ -
Dike/field mowing & maintenance	$ 6,685	$ 6,685	$ 6,685	$ 3,109	$ 3,109	$ 4,744	$ 4,744	$ -	$ -
Equipment operation & maintenance	$ 6,727	$ 6,727	$ 20,182	$ 3,716	$ 11,149	$ 4,979	$ 14,937	$ -	$ -
Drainage & water control	$ 650	$ 650	$ 650	$ 370	$ 370	$ 770	$ 770	$ -	$ -
Blind/foot bridge construction & maintenance	$ 1,660	$ 1,660	$ 1,660	$ 1,660	$ 1,660	$ 1,660	$ 1,660	$ 1,660	$ 1,660
Noxious weed survey only	$ -	$ -	$ -	$ 4,722	$ -	$ 4,722	$ -	$ 4,722	$ -
Noxious weed survey & control	$ -	$ -	$ -	$ -	$ 30,260	$ -	$ 19,580	$ -	$ 49,640
TOTAL	**$ 41,382**	**$ 41,382**	**$ 54,836**	**$ 25,890**	**$ 58,860**	**$ 35,643**	**$ 60,459**	**$ 7,682**	**$ 52,600**
Assumptions	based on 2019 costs with volunteer labor rate applied for volunteer hours; 110 acres enhanced & 30 acres managed forage	volunteer labor rate applied for volunteer hours; equipment cost based on WDFW owned, leased, or donated equipment operated and maintained by WDFW	volunteer labor rate applied for volunteer hours; equipment cost is 3 times current cost to account for no barge agreement and equipment replacement and major repairs as needed	volunteer labor rate applied for volunteer hours; equipment cost based on WDFW owned, leased, or donated equipment operated and maintained by WDFW; weed survey only, no treatment on 170 acres estuary	volunteer labor rate applied for volunteer hours; equipment cost is 3 times current cost to account for no barge agreement and equipment replacement and major repairs as needed; weed survey and treatment on 170 acres estuary	volunteer labor rate applied for volunteer hours; equipment cost based on WDFW owned, leased, or donated equipment operated and maintained by WDFW; weed survey only, no treatment on 110 acres estuary	volunteer labor rate applied for volunteer hours; equipment cost is 3 times current cost to account for no barge agreement and equipment replacement and major repairs as needed; weed survey and treatment on 110 acres estuary	weed survey only, no treatment on 270 acres estuary	weed survey and treatment on 270 acres estuary

APPENDIX H: CHANGES IN WDFW-MANAGED LAND AND HABITAT TYPES SINCE 2000

LOREN BROKAW
WILDLIFE PROGRAM, WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

Changes in WDFW-managed lands and habitat types since 2000 within WDFW Region 4 that are available for public hunting

This document contains the results of an inventory of WDFW-managed lands within Region 4 that are available for public hunting. The inventory compared how habitat types within those lands have changed since 2000. Habitat types are defined in the section below. Table 1 provides the results. A map of the properties can be found at: http://www.arcgis.com/home/webmap/viewer.html?webmap=63771693b0ee4b81b949d87d6f58fc0e&extent=-122.7128,48.2096,-122.0399,48.5666

Habitat Types Definitions

Enhanced Forage – Lands that are planted and/or managed to produce high value plants that are generally seed bearing and are left standing for forage. These plants include planted crops: barley, corn, fava beans, millet, buckwheat, and moist soil plants, including wild millet, smartweed, yellow nut-sedge, and Bidens. This also includes cover crops, unharvested crops, and harvested crop areas at the Fir Island Farms and Johnson/DeBay's Slough Game Reserves, which are managed primarily for Snow Geese and Swans, respectively. This management creates high intensity use throughout most of the winter season for waterfowl and recreational users.

Managed Forage – Lands that Wildlife Area Staff or agricultural lessees manipulate through mowing, mid- to late-summer disking, grazing, flooding or other methods to improve habitat forage quality and access, and harvested commercial agricultural crops. This category may not provide the same intensity of use over time as the enhanced category.

Non-forested Upland – Lands within the dike system that are not manipulated to produce forage.

Intertidal Native Vegetation – Lands within the intertidal zone of the Lower Skagit River and Skagit and Port Susan Bays offering a mix of native and non-native emergent marsh species.

Riparian(tree/brush) – Lands that are made up primarily of mixed coniferous and deciduous trees, scrub/shrub, and other woody or rank vegetation consider less desirable for waterfowl hunting or forage. These areas can be located within or outside of the diked uplands.

Table 1. Changes in WDFW-managed lands and habitat types since 2000 in Region 4 (continues on next page).

	Total Unit Acres		**Enhanced Forage**		**Managed Forage**		**Non-forested Upland**		**Intertidal**		**Riparian (tree/brush)**		**Hunted Acres**		**Non-Hunted Acres**	
Unit Name	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016
SKAGIT WILDLIFE AREA																
Big Ditch Access	115	115	0	0	0	0	0	0	113	113	0	0	113	113	0	2
Cottonwood Island	164	164	0	0	12	12	0	0	0	0	152	152	0	0	164	164
DeBay's Slough Unit	359	359	60	60	73	73	0	0	0	0	226	226	47	47	312	312
Fir Island Farms*	297	297	249	95	0	5	0	0	27	193	21	0	0	0	297	297
Headquarters*	193	193	78	0	4	0	0	0	0	183	111	10	168	168	25	25
Island*	477	477	162	125	86	10	0	14	0	209	229	119	477	477	0	0
Jensen Access	21	21	0	0	0	0	0	0	20	20	0	0	20	20	1	1
South Leque**	317	317	222	0	0	0	0	0	60	317	0	0	297	297	20	20
North Leque*	109	109	36	0	0	0	25	0	73	73	0	0	96	96	13	13
Milltown Island*	299	299	0	0	0	0	0	0	201	201	98	98	299	299	0	0
North Fork Access	163	163	0	0	0	0	0	0	163	163	0	0	163	163	0	0
Samish	410	410	230	190	0	180	180	0	0	0	0	30	373	373	37	37
Samish River	0	104	0	0	0	10	0	94	0	0	0	0	0	10	0	94
Skagit Delta Game Reserv	329	329	0	0	0	0	0	0	329	329	0	0	0	0	329	329
Skagit Forks	0	61	0	0	0	0	0	0	0	0	0	61	0	61	0	0
South Skagit Forks	0	5	0	0	0	0	0	0	0	0	0	5	0	5	0	0
South Padilla Bay	0	245	0	20	0	225	0	0	0	0	0	0	0	20	0	225
South Telegraph	46	46	0	0	0	0	0	0	0	0	46	46	45	45	1	1
North Telegraph	14	14	0	0	0	0	0	0	14	14	0	0	14	14	0	0
Skagit Bay Estuary	10003	10003	0	0	0	0	0	0	10003	10003	0	0	10003	10003	0	0
Skagit Totals	**13316**	**13731**	**1037**	**490**	**175**	**515**	**205**	**108**	**11003**	**11818**	**883**	**747**	**12115**	**12211**	**1199**	**1520**
Skagit Net Change	415		-547		340		-97		815		-136		96		321	

* Denotes Units where an estuary restoration project has been implemented since Year 2000.

**The acreages reflect the Year 2020 total, since an estuary restoration project was implemented in 2019.

Note: This table accompanies an online map titled "Changes in Habitat Type of WDFW Skagit Wildlife Area Units".

Table 1. Changes in WDFW-managed lands and habitat types since 2000 in Region 4 (continued from previous page).

	Total Unit Acres		Enhanced Forage		Managed Forage		Non-forested Upland		Intertidal		Riparian (tree/brush)		Hunted Acres		Non-Hunted Acres	
Unit Name	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016	Year 2000	Year 2016
SNOQUALMIE WILDLIFE AREA																
Cherry Valley	392	392	0	60	104	30	113	113	0	0	175	189	323	323	69	69
Spencer Island	174	174	0	0	0	0	0	0	0	0	174	174	174	174	0	0
Ebey Island	420	1249	0	13	0	287	0	242	0	0	420	707	0	789	420	483
Crescent Lake	359	359	110	110	0	43	3	3	0	0	246	203	349	349	10	10
Stillwater	456	456	0	60	0	73	139	6	0	0	317	317	434	434	22	22
Corson	167	167	0	6	0	0	0	0	0	0	167	161	0	0	167	167
Snoqualmie Totals	**1968**	**2797**	**110**	**249**	**104**	**433**	**255**	**364**	**0**	**0**	**1499**	**1751**	**1280**	**2069**	**688**	**751**
Snoqualmie Net Change	829		139		329		109		0		252		789		63	
WHATCOM WILDLIFE AREA																
Nooksack	627	627	12	12	118	118	397	397	0	0	100	100	500	500	127	127
Tennant Lake	360	360	0	0	0	20	125	105	0	0	115	115	40	40	320	320
Lake Terrell	1500	1500	60	60	40	40	600	600	0	0	300	300	500	500	1000	1000
Intalco	1000	1000	0	0	200	200	500	500	0	0	100	100	850	850	150	150
British Petroleum	1000	1000	20	20	100	400	400	100	0	0	500	500	800	800	200	200
Whatcom Totals	**4487**	**4487**	**92**	**92**	**458**	**778**	**2022**	**1702**	**0**	**0**	**1115**	**1115**	**2690**	**2690**	**1797**	**1797**
Whatcom Net Change	**0**		**0**		320		-320		**0**		**0**		**0**		**0**	
REGION 4 PRIVATE LANDS ACCESS PROGRAM (PLAP)																
Skagit County	0	579	0	148	0	417	0	0	0	14	0	0	0	579	0	0
Snohomish County	0	602	0	54	0	548	0	0	0	0	0	0	0	602	0	0
Whatcom County	0	771	0	20	0	751	0	0	0	0	0	0	0	771	0	0
PLAP Totals	**0**	**1952**	**0**	**222**	**0**	**1716**	**0**	**0**	**0**	**14**	**0**	**0**	**0**	**1952**	**0**	**0**
PLAP Net Change	1952		222		1716		**0**		14		**0**		1952		**0**	
REGION 4 TOTAL NET CHANGE	**Total Unit Acres**		**Enhanced Forage**		**Managed Forage**		**Non-forested Upland**		**Intertidal**		**Riparian (tree/brush)**		**Hunted Acres**		**Non-Hunted Acres**	
	3196		**-186**		**2705**		**-308**		**829**		**116**		**2837**		**384**	

Note: This table accompanies an online map titled "Changes in Habitat Type of WDFW Skagit Wildlife Area Units".