8. GENERAL APPROACH TO HABITAT RESTORATION

8.1. RESTORATION WITHIN THE CHINOOK LIFE CYCLE FRAMEWORK

Salmon productivity depends not on a single habitat or life stage but on all the habitats used by salmon throughout their life. Thus, recovery plans for any species or population must consider a broad range of habitats, from spawning grounds to the ocean. Research shows that Skagit Chinook salmon have multiple juvenile life history strategies. Further, the environment, shaped by both habitat conditions and salmon population size, experienced by an individual fish is largely responsible for determining its actual life history strategy. From this research we conclude that improvements to a variety of habitat types (freshwater rearing and incubation areas, tidal delta, and nearshore pocket estuaries) will benefit all known juvenile life history strategies of wild Skagit Chinook salmon.

Many of the projects within this plan have been developed or identified as part of past and ongoing restoration efforts on the part of numerous interested parties throughout the Skagit Watershed.

8.2. RESTORATION OF LIFE HISTORY AND HABITAT DIVERSITY

Wild Chinook salmon life history diversity and existing habitat conditions in the Skagit Basin and estuary necessitate restoration within many types of habitat to achieve the recovery goals stated in Chapter 4. Not all habitat areas (spawning and egg incubation, freshwater rearing, tidal delta rearing, and nearshore rearing) are similar in their intrinsic fish productivity or geomorphic size. There are areas within the river basin and estuary that are more strategic for Chinook salmon populations than other areas. The limiting factors for each of the Skagit Chinook salmon stocks, and the specific location of existing or potentially restorable habitat largely determine the relative importance of a specific habitat in our salmon recovery plan. For example, our research indicates that existing tidal delta habitat capacity is limiting all Skagit Chinook stocks (see Chapter 5 and Appendix D). Opportunities may exist to restore large areas of tidal delta habitat in Samish Bay, but our plan does not advocate restoration of tidal delta habitat in Samish Bay because Samish Bay is not strategically located for wild Skagit Chinook salmon during the limiting tidal delta rearing life stage. The migratory pathways from the Skagit River to Samish Bay simply do not exist that would allow many juvenile Skagit Chinook to take advantage of tidal delta rearing opportunity in Samish Bay. Our habitat restoration plan must consider the relative value of habitats across the landscape in terms of their strategic importance to wild Skagit Chinook.

8.3. GEOMORPHIC LIMITS TO RESTORATION

Geomorphologically, the Skagit system consists of the river and tributary systems, the lower river floodplain of the geomorphic delta (non-tidal delta—the portion of the geomorphic delta not currently influenced by tidal processes), the tidal delta (currently influenced by tidal hydraulics and mixing), and adjoining nearshore areas (Figure 8.1). These zones are divided based on topography and geomorphic process of formation. The extent of each of these zones and the mode and magnitude of geomorphic processes within these zones determines the natural habitat potential of the system. Restoration potential is ultimately limited by the natural potential of the system.

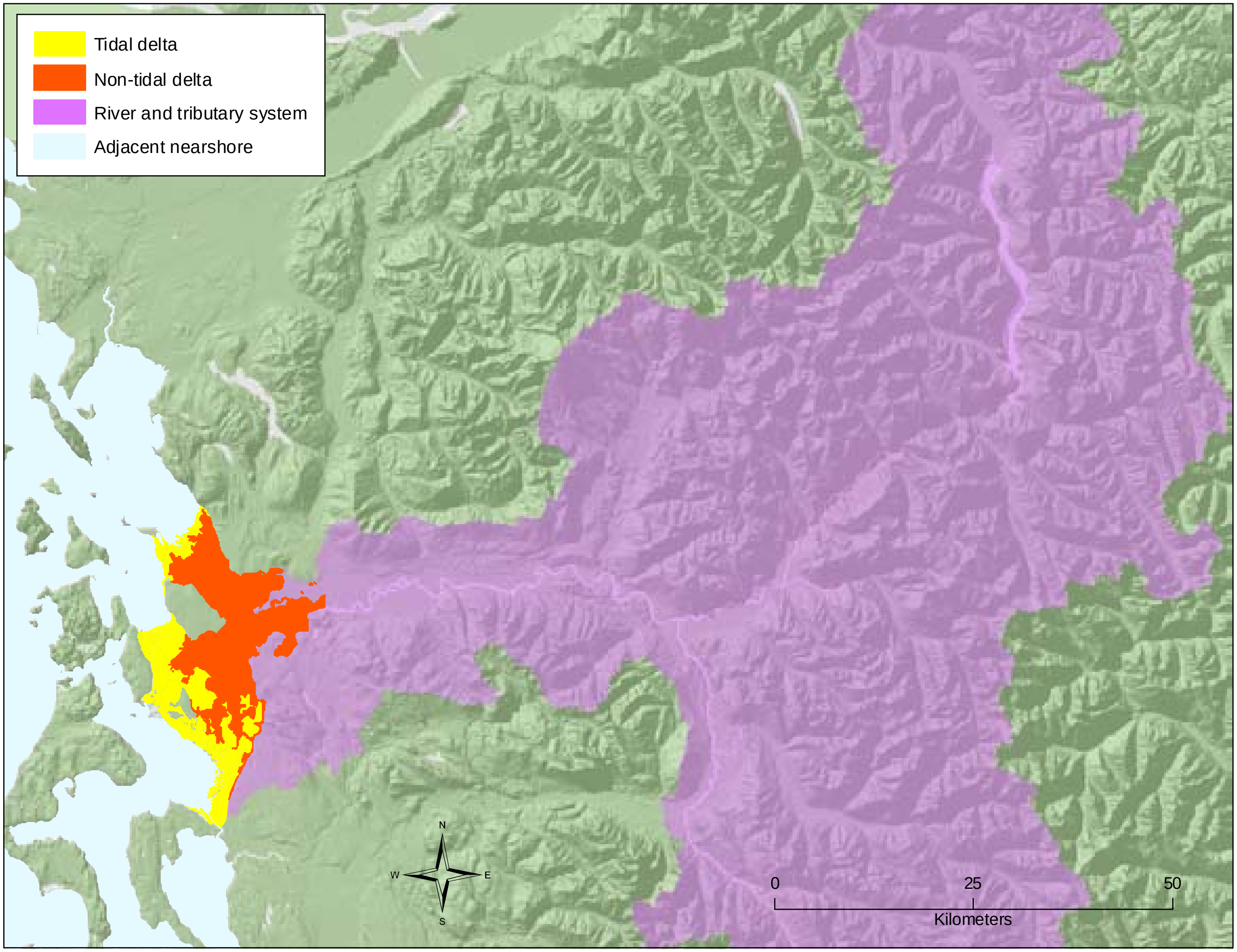

Figure 8.1. *Geomorphic regions of the Skagit Basin.*

The River System

The total area of large river floodplain is approximately 14,293 hectares. This is the area where mainstem and off-channel habitats are formed and maintained by natural riverine processes. Thirty-one percent (31%) the total floodplain area is either isolated or shadowed from natural riverine processes. These are areas where roads or dikes completely cutoff river interaction with its floodplain or roads and hardened stream banks shadow the floodplain from riverine processes. This inventory gives us an initial assessment of the area where process-based restoration could be applied to improve freshwater habitat conditions for Chinook salmon.

The Non-Tidal Delta

For the non-tidal part of the delta, historic wetland area was approximately 5,733 hectares. Current non-tidal delta wetland area is only 67 hectares. Similarly, lower floodplain forest area was approximately 12,297 hectares, while current floodplain forest area is only 314 hectares. Together, this is a net loss of 98% of non-tidal delta area, influenced by lower riverine processes, within which freshwater rearing and refuge habitat could form and persist.

The Tidal Delta

Under present day conditions, the contiguous habitat area of the Skagit delta that is exposed to tidal and river hydrology totals about 3,118 hectares. This represents the area where tidal channels and slough exist for delta rearing life history strategies. This area is mostly the delta area in the vicinity of Fir Island, but it also includes a fringe of estuarine habitat extending from La Conner to the north end of Camano Island. Historically, the contiguous habitat area of the Skagit delta included the same area, but also included the Swinomish Channel corridor and extended to the southern end of Padilla Bay (Collins 2000). The historic area equaled 11,483 hectares. This result in a seventy-three percent (73%) loss of tidal delta footprint.

The Nearshore

In contrast to freshwater and tidal delta rearing habitat opportunity, the intertidal and subtidal footprint of historic pocket estuary area was only 340.7 hectares. These are pocket estuaries in close proximity to the Skagit delta and are largely within Skagit Bay. Under present day conditions these same sites are only 47.5 hectares, resulting in an eighty-six percent (86%) loss. This represents the current pocket estuary rearing opportunity for fry migrant Chinook salmon.

Strictly considering limitations from natural processes and geomorphic controls, tidal delta and freshwater rearing habitat restoration potential may roughly be equal. That is, there are thousands of hectares where tidal delta or freshwater habitats could be restored if disturbances to natural processes were eliminated. However, this is not the case for pocket estuaries. There are only several hundred hectares of habitat that could be pocket estuary habitat.

8.4. HUMAN LIMITS TO HABITAT RESTORATION

We recognize that restoring Chinook salmon productivity within the Skagit Basin and its estuary is further complicated by human disturbances to the natural landscape of which only a portion can reasonably be removed through restoration. We have not quantified the area within the Skagit River Basin or its estuary that can be changed from existing human land uses that exclude Chinook salmon to natural habitat because this is not a scientific question. The answer to this question is a matter of policy and political will that can change as society values or de-values the natural habitats needed for Chinook salmon.

In this plan we have chosen to quantify the amount of habitat needed to achieve the recovery goals presented based on the biological factors known to influence wild Skagit Chinook salmon.

8.5. IDENTIFYING HABITAT RESTORATION OPPORTUNITIES

It is for these above reasons we advocate a diversified habitat restoration approach to recover wild Skagit Chinook salmon populations. We do this based on our understanding of the limits for each Chinook salmon stock and their corresponding life history strategies, but also to present a plan that is balanced across the landscape to not burden any specific land use or governmental jurisdiction. For example, it makes no ecological sense to attempt to achieve the recovery goals by restoration habitat for only one life history strategy – we would risk the entire population with a single catastrophic disturbance. Likewise, it makes no sense to burden one land use or jurisdiction with the majority of the restoration burden. This pathway would limit the ability of a biologically sound recovery plan to be implemented. Therefore, the restoration components of our plan include actions throughout the basin that restore:

1. Spawning habitat and egg incubation conditions
2. Freshwater rearing habitat in large river floodplains, tributaries, and non-tidal delta
3. Tidal delta rearing habitat
4. Nearshore rearing habitat (primarily pocket estuary restoration)

These recovery actions will together increase overall wild Chinook salmon population size and improve the population's resilience to a variety of natural and human caused disturbances. Therefore, this plan attempts to identify a balanced portfolio of actions, selected from areas of identified opportunity across the basin and estuary landscape. Restoration actions improving conditions for spawning and incubation will increase seeding for all juvenile Chinook life history strategies. Large river floodplain restoration seeks to improve freshwater conditions for all Chinook salmon fry, but more expressly for those life history strategies that depend on freshwater habitat for extended rearing such as parr migrants and yearlings. Delta restoration will benefit delta rearing life history strategies while pocket estuary restoration will benefit fry migrants.

Given the broad and diverse landscape, restoration efforts are typically confronted with the very real problem of assessing, identifying and prioritizing restoration opportunities in such a way that account for the realities of existing landscape uses, limited resources, and expanding pressures from human populations. The authors of this plan have attempted to address these realities while accounting for existing landscape processes and geomorphic limitations. While striving to select a balanced portfolio of actions that will address all known juvenile Skagit Chinook life history strategies across a variety of landscape settings. Potential restoration actions are described herein for four broad habitat types that are spatially diverse (both within its type and across types) so all Skagit Chinook populations will be more protected from disturbances that influence only specific habitat types or areas within the river basin and its estuary.

To accomplish our objectives we first evaluated habitat on the basis of its geomorphic site potential. Employing a variety of "screens" that evaluate the relative merits of specific habitats helps to achieve this. With each project described, we attempted to account for landscape processes at work in the Skagit Basin, and identify features that shape those processes. By providing for the geomorphic limitations within the landscape we hope to focus our restoration efforts toward those actions that have the highest probability of achieving recovery.

We have attempted to sequence projects based on 1) known technical feasibility, 2) land ownership, use and or landowner willingness, 3) logistic complexities, 4) synergistic effects and 5) spatial location and connectivity. Projects that are well developed in regard to these criteria have been sequenced for early implementation. Those less well developed are placed in out years. Sequencing is generally described on a twenty year planning horizon with five year increments for implementation.

Beginning with freshwater spawning habitat and moving in downstream order to nearshore rearing habitat, each of the following habitat restoration action sections of this plan (Chapters 9-12) will present a brief description of the tools employed in the evaluation. Specific details concerning these tools and methods can be found in the appendices. Each evaluation summary will be followed by specific habitat restoration actions. Together, implementation of these habitat actions along with the other actions listed in this plan (harvest management - Chapter 6, habitat protection -Chapter 7, and artificial production - Chapter 13) will achieve the recovery goals stated in Chapter 4.

9. RESTORATION ACTIONS IN SPAWNING HABITAT

Restoration actions directed at improving the quality and quantity of available spawning habitat are generally focused toward achieving one of the following objectives:

- Identifying spawning habitats that have been isolated or impaired via anthropogenic disturbance (e.g., road crossings) and restoring connectivity (both physical and biological) to these locations
- Identifying and addressing causal mechanisms for impairment to watershed processes (such as sediment transport or hydrology) that lead to degradation or loss of spawning habitats

9.1. GENERAL SPAWNING HABITAT RESTORATION STRATEGY

Identifying and prioritizing habitats that have been isolated from the spawning range of Skagit Chinook populations has been a priority restoration activity for many groups working in the basin. State agencies funded work in the late 1990s to survey and evaluate all known road crossings within the basin for partial and complete barriers to fish passage. This survey work was completed in the year 2000 and identified over 600 barriers to fish passage (SSC 2000). Analysis of these data indicates that nearly all of these barriers isolate little Chinook spawning habitat but do affect large areas of rearing habitats (SRSC, unpublished). This is likely due to Chinook spawning being concentrated in mainstem channels, and large stream systems and those known to have value for Chinook were often targeted early for restoration. However, in addition to affected rearing habitats, these surveys also identified several inadequate road crossings that limit or restrict the connectivity of physical processes that shape and supply spawning habitats frequented by Chinook. Subsequently, these locations have been targeted for restoration actions and will be described either in this or the rearing habitat section.

Our strategy for addressing the causal mechanisms of watershed impairment focuses on those mechanisms that affect two key processes: hydrology and sediment delivery. Degradation of these two processes are typically related to land use activities that either 1) alter the hydrograph such that the magnitude, timing and/or frequency of flows are significantly changed, or 2) alter the delivery and routing of water and/or sediment through hydromodifications that reduce the habitat quality by such things as increasing gradient, altering channel type, and directing scouring flows. Typical examples of such land uses are road building and development. In those watersheds that are still managed primarily for natural resource productivity (i.e., forestry or agriculture) we are focused on first protecting the landscape from further impairment, and subsequently addressing identified mechanisms of impairment. In forested landscapes these mechanisms are related to logging activities, particularly construction and maintenance of forest roads. In agricultural landscapes these mechanisms are typically related to tilling and drainage activities. In watersheds that have large areas of rural or residential development, impervious surface area from roads and buildings can alter hydrology.

In addition to restoration efforts targeted at forest road systems, special attention has been directed toward locations where alluvial fan geomorphic units have been interrupted by anthropogenic disturbances. We believe restoration projects in these locations could increase spawning capacity by an order of magnitude by converting areas of plane bed channel (caused by hydromodification or LWD removal) to forced pool riffle or pool riffle channel (Montgomery et al. 1999). These projects are also expected to increase egg to fry survival for Chinook salmon that spawn in the restored alluvial fan, because these areas are more hydraulically sheltered than unrestored fans that are dominated by hydromodified mainstem habitat (Montgomery et al. 1999; Hyatt 2003).

If theses strategies can be fully implemented on the landscape, we predict an overall increase in productivity from 341 to 435 migrant fry per Chinook spawner (if all watersheds shown in Figure 9.1 are converted from impaired to functioning). We base the estimated productivity increase on the premise that 100% of the watersheds can be treated given the necessary resources and given this strategy does not propose displacement of existing land uses.

9.2. IMPLEMENTATION

Presently, the spawning range of Chinook is limited in lowland watersheds by intrinsic habitat suitability. Therefore the focus for our priority restoration actions related to spawning habitats is largely on those causal mechanisms related to forested landscapes and the management of forest road networks in mountain basins. Forest roads are the primary concern for habitat restoration for several reasons: 1) roads occupy a relatively small area in a watershed, but can cause substantial increases in sediment supply and impacts to hydrology if poorly designed or maintained; 2) it is possible to greatly reduce sediment impacts and restore natural hydrology in a watershed by upgrading, maintaining, and decommissioning roads; 3) impacts related to timber harvest from other activities (e.g., logging on steep slopes) have been more recently addressed through regulatory controls rather than through active restoration efforts. Implementation of road-related sediment reduction and hydrology improvement projects rests with two primary vehicles: 1) the Road Maintenance and Abandonment Plan (RMAP) process established through the Forest and Fish Agreement, and 2) targeted actions on USFS lands.

The RMAP process, if implemented as directed by the Forest and Fish Agreement, should ultimately result in significant improvements to road systems on private industrial forestlands. However, there are significant road problems on federal lands that are not subject to that Agreement and the USFS does not have sufficient funding to address these problems, so active habitat restoration will be needed. Small landowner exemptions will also need to be addressed through regulatory actions

In work conducted while developing the Skagit watershed Council Strategy and Application, each WAU in the Skagit River Basin was rated as either “functioning” or “impaired” based on sediment supply. Functioning was applied to those WAUs where average sediment supply is <100 m^3 per km^2 per year, or where average sediment supply is >100 m^3 per km^2 per year, but is <1.5 times the natural rate. Where average sediment supply is >100 m^3 per km^2 per year and is >1.5 times the natural rate, the sediment supply process was rated as “impaired”. The sediment supply map developed from this evaluation (Figure 9.1) shows the ratings for sediment supply averaged across WAUs. Areas shown in red are rated “impaired”; areas shown in green are rated functioning.

Using this analysis as our basis we applied an assumption that RMAP requirements detailed in the Forest and Fish Agreement would be implemented within the planning horizon used by this document. In those watersheds in which a majority of existing unpaved roads were covered by the RMAP requirements we reviewed the sediment supply call under this new “restored” condition. In a number of WAUs greater than 50% of the forestland holdings were exempt from the RMAP requirements by virtue of being in Federal Ownership, or small landowner exemptions. In these watersheds additional restoration actions would need to be taken to upgrade or decommission forest roads to meet our functioning sediment supply rating of <$100m^3$ per km^2 per year. Table 9.1 shows the results of our analysis, depicting those WAUs that were converted to functioning as a result of the RMAP requirements.

Projects involving road storm proofing, upgrades and decommissioning have been extensively implemented in several Skagit Basin watersheds. USFS roads have been targeted and funded in the Finney, Sauk Prairie, Dan Creek, Murphy, Goodman, and O'Brien watersheds, and much of the work has been completed. Additional projects on USFS lands have been identified in the Tenas Creek, Day and Lime Creek WAUs. These actions coupled with RMAP implementation should result in improvements to watershed sediment supplies and peak flows. Figure 9.2 summarizes the changes to sediment supply predicted and included as a part of this recovery plan.

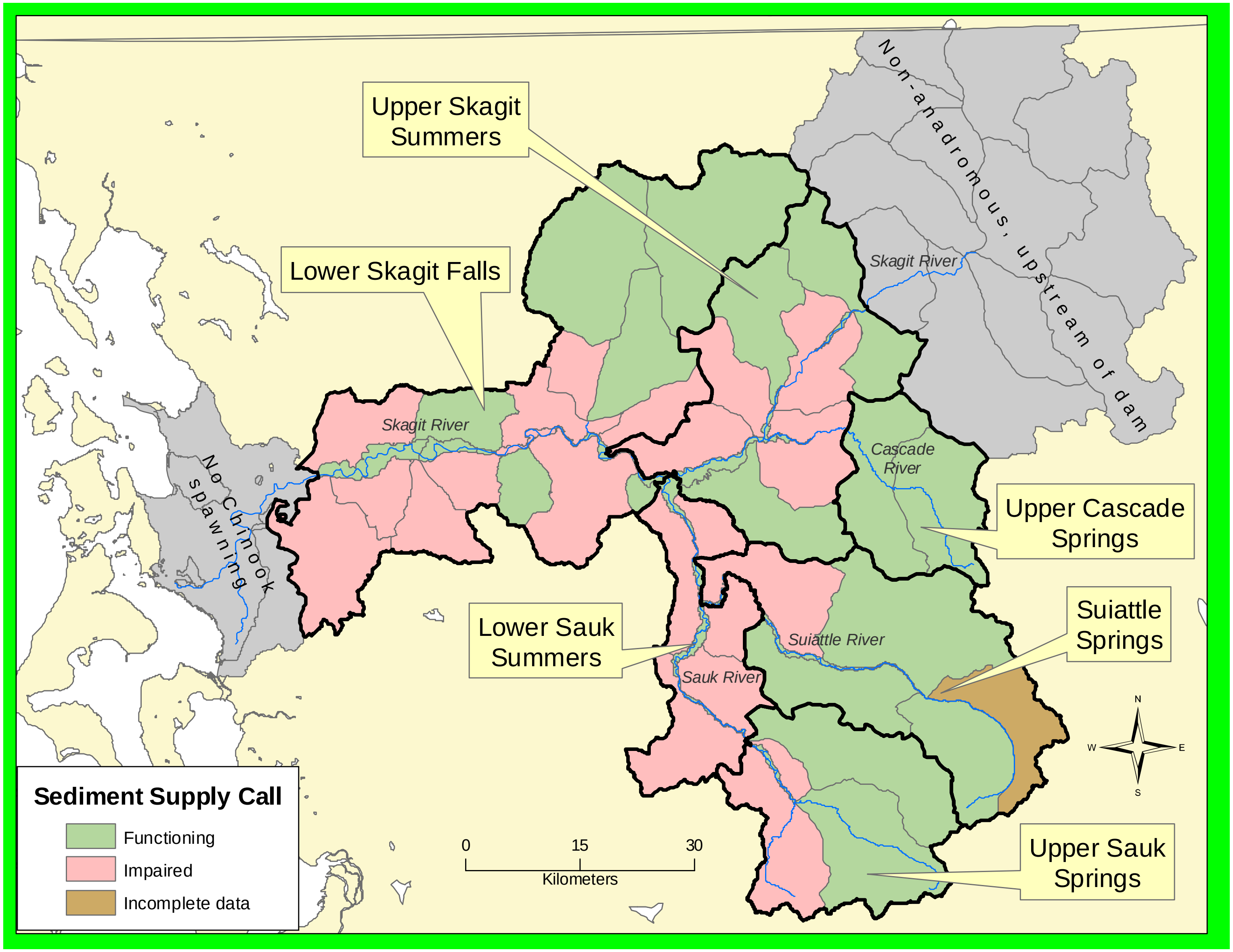

Figure 9.1. *Sediment supply call.* Sediment supply call by WAU shown as being impaired or functioning based on partial sediment budgets completed by Paulson, 1997.

Table 9.1. *Sediment supply call under restored conditions.* Percentage of unpaved roads likely to be improved through the RMAP provisions of the Forest & Fish Agreement.

WAU Name	Area Sq Miles	Unpaved Roads	Miles of Road/square mile	USFS Roads	Percent	RMAP Roads	Percent	Current Call	Change
ALDER	34.4	116.3	3.4		0.0%	98.0	84.2%	Functioning	
BACON CREEK	51.59	31.1	0.6	7.8	25.2%		0.0%	Functioning	
BUCK-DOWNEY-SULPHUR	110.83	16.3	0.1	4.6	28.3%		0.0%	Functioning	
CARPENTER	46.67	155.5	3.3		0.0%	24.5	15.8%	N/A	
CASCADE PASS	66.43	14.2	0.2	1.7	12.1%		0.0%	Functioning	
CASCADE, MIDDLE	71.44	30.8	0.4	7.6	24.8%		0.0%	Functioning	
CHOCOLATE GLACIER	62.84	0.6	0.0	0.1	22.1%		0.0%	Functioning	
CLEAR CREEK	48.45	65.2	1.3	14.8	22.7%	5.0	7.7%	Impaired	no
CORKINDALE	34.42	66.7	1.9	1.1	1.7%	20.0	30.0%	Impaired	no
DAMFINO CREEK	49.93	38.2	0.8	0.2	0.5%	0.9	2.5%	Impaired	no
DAN CREEK	32.01	104.5	3.3	28.2	27.0%	3.3	3.1%	Impaired	no
DAY CREEK	37.22	118.8	3.2	1.6	1.4%	108.8	91.5%	Impaired	yes
DIOBSUD CREEK	36.82	29.1	0.8	2.3	7.8%	0.5	1.9%	Impaired	no
FINNEY	53.8	204.3	3.8	24.9	12.2%	96.9	47.4%	Impaired	yes
FIR IS	45.12	30.7	0.7		0.0%		0.0%	N/A	
FRIDAY CREEK	34.28	147.9	4.3		0.0%	43.8	29.6%	N/A	
GILLIGAN	26.7	70.2	2.6		0.0%	54.9	78.2%	Impaired	yes
GRANDY	30.16	140.8	4.7		0.0%	101.0	71.7%	Impaired	yes
HANSEN CREEK	43.82	137.6	3.1		0.0%	104.1	75.7%	Impaired	yes
HILT	20.17	71.1	3.5	6.7	9.5%	33.5	47.1%	Impaired	no
ILLABOT	60.43	115.2	1.9	7.7	6.6%	33.1	28.8%	Functioning	
IMAGE LAKE	50.2	0.5	0.0	0.2	33.8%		0.0%	Functioning	
JACKMAN	26.26	79.7	3.0	4.5	5.6%	53.4	67.1%	Impaired	yes
JORDAN-BOULDER	51.49	139.2	2.7	1.3	0.9%	89.4	64.2%	Impaired	yes
LIME CREEK	58.69	62.3	1.1	18.4	29.5%	9.8	15.8%	Functioning	
LORETTA	23.3	64.0	2.7	5.3	8.3%	42.4	66.3%	Impaired	yes
MILLER CREEK	15.91	75.9	4.8		0.0%	47.7	62.8%	N/A	
MONTE CRISTO	72.7	56.4	0.8	13.2	23.4%		0.0%	Impaired	no
MT BAKER	105.07	118.8	1.1	35.8	30.1%	2.2	1.8%	Functioning	
NOOKACHAMPS	72.77	295.0	4.1		0.0%	137.8	46.7%	Impaired	no
PADILLA BAY	47.07	74.6	1.6		0.0%		0.0%	N/A	
PRESSENTIN	21.33	33.2	1.6	1.2	3.5%	29.9	89.9%	Functioning	
RINKER	34.09	144.2	4.2	3.9	2.7%	93.4	64.8%	Impaired	yes
SAMISH RIVER	125.87	224.9	1.8		0.0%	100.5	44.7%	N/A	
SAUK PRAIRIE	21.61	90.0	4.2	3.1	3.4%	62.8	69.8%	Impaired	yes
SHANNON, E	57.7	121.4	2.1	7.0	5.8%	78.7	64.8%	Functioning	
SHANNON, W	20.99	77.3	3.7	0.4	0.5%	68.3	88.4%	Impaired	yes
SKAGIT FLATS, LOWER	44.25	178.0	4.0		0.0%		0.0%	N/A	
SLOAN CREEK	81.31	23.4	0.3	5.7	24.3%		0.0%	N/A	
TENAS	57.06	109.7	1.9	13.5	12.3%	52.9	48.2%	Impaired	yes
THUNDER CREEK	125.53	4.0	0.0		0.0%		0.0%	Functioning	
WHITE CHUCK	85.54	47.7	0.6	12.4	26.0%		0.0%	Functioning	

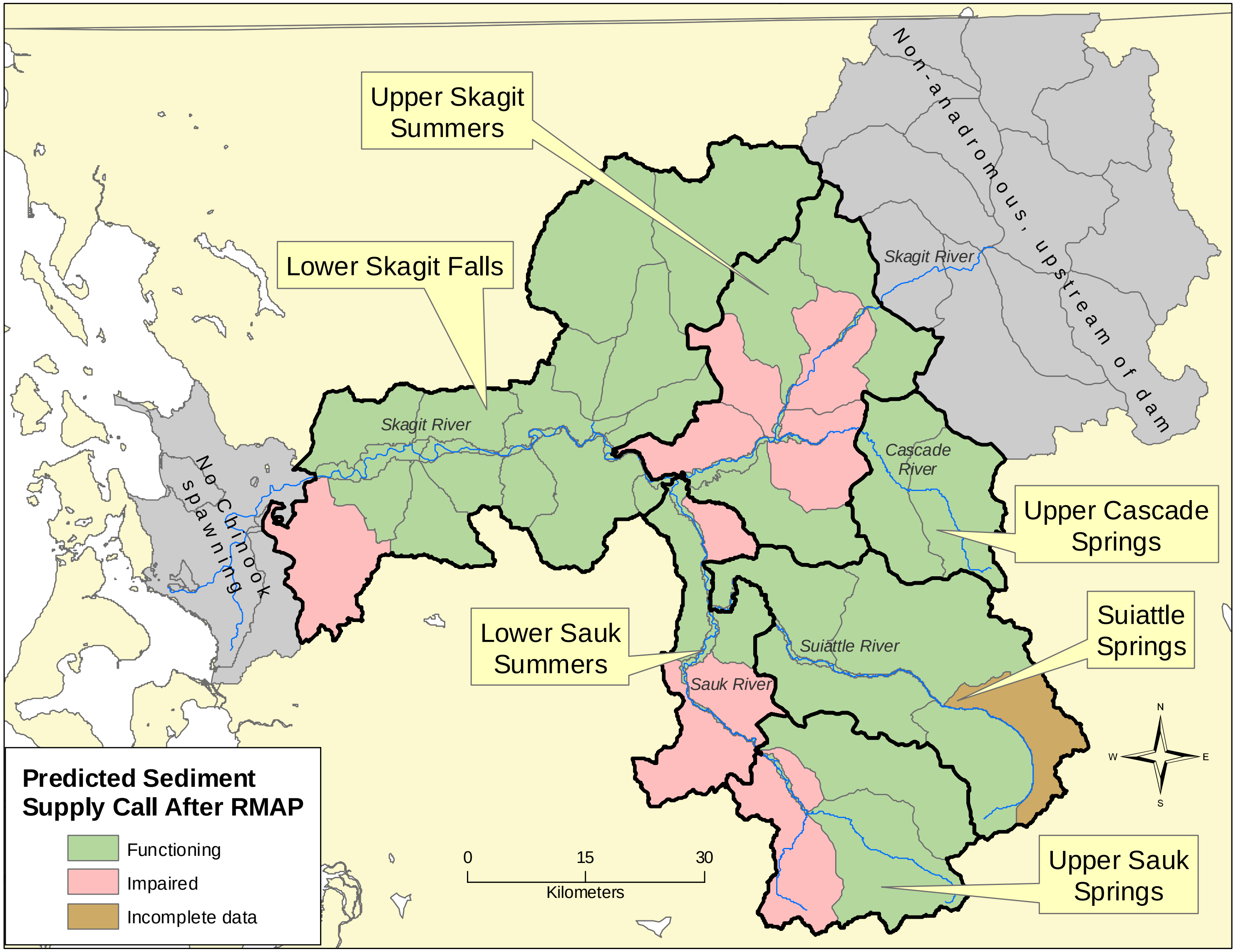

Figure 9.2. *Predicted sediment supply call after RMAP*. Sediment supply call under predicted conditions with RMAP implementation and selected projects on federal lands.

9.3. SPAWNING HABITAT PROJECTS

9.3.1 Sediment Reduction – Sauk Prairie and Dan Creek Watersheds

Project Summary

Poorly designed or maintained forest roads can reduce spawning and rearing habitat quality by increasing sediment delivered to streams through surface erosion and mass wasting processes. Approximately 50 miles of Forest Service roads were identified in the Sauk Prairie and Dan Creek watersheds in the Sauk River Basin that are poorly designed or maintained and have the potential to increase sediment to fish-bearing streams. This project will address sediment impacts by upgrading roads that are needed for access and by decommissioning roads that are no longer needed. Upgrading roads involves increasing the size and number of cross-drain culverts, increasing the size of stream crossings to convey high flows, sediment, and woody debris, dipping and armoring fill material over larger culverts, and reducing or removing fill material on unstable slopes located adjacent to or upslope from streams. Decommissioning roads involves removing culverts, removing fill material from drainage crossings and on unstable slopes located adjacent to or upslope from streams, and restoring natural drainage patterns by excavating drainage crossings in the road fill.

Purpose

The purpose of this project is to reduce or eliminate sediment impacts to streams related to forest roads in the Sauk Prairie and Dan Creek watersheds.

Populations Targeted

Lower Sauk summers

Estimated Cost

The Salmon Recovery Funding Board has already provided $350,000 to decommission and upgrade 25 miles of Forest Service roads in the Sauk Prairie and Dan Creek watersheds. Another $300,000 or more will be needed to complete all of the roadwork in these two watersheds.

Timeframe

With the existing grant, eight miles of road were treated in 2003 and an additional 17 miles will be treated in the summer of 2005. After this is completed additional grants will be needed for the remaining roadwork in these two watersheds. Some work will be completed by the Forest Service in the summer of 2005 in response to flood damage to the road network from the October 2003 flood.

Contingencies

The biggest contingency has to do with permitting and project administration with the Forest Service. The Forest Service has limited staff, so habitat restoration projects often take a long time to move forward. The October 2003 flood event greatly slowed progress on this project because Forest Service staff needed to spend time responding to emergency road damage. This caused some delays, but so far this project has continued to move forward.

Expected Direct Results

Physical: It is expected that improving road drainage conditions will reduce or eliminate sediment delivered to streams from forest roads, which is expected to reduce the amount of fine sediment in spawning gravel, increase pool depth and volume, and reduce channel width and bed instability in downstream areas.
Biological: It is expected that reducing bed instability and fine sediment in spawning gravels should improve the rate of survival-to-emergence for juvenile salmon and that increasing pool depth and volume will increase rearing capacity.

Effectiveness Monitoring
After roadwork is completed, the treated segments will be monitored to ensure that drainage treatments function as designed. Roads will also be monitored after major storm events to evaluate the effectiveness of the treatments in minimizing catastrophic failures.

Backup Actions (if direct results are not achieved)
None identified at this time

9.3.2 Suiattle Sediment Reduction

Project Summary

Poorly designed or maintained forest roads can reduce spawning and rearing habitat quality by increasing sediment delivered to streams through surface erosion and mass wasting processes. This is especially problematic for spawning conditions in the Suiattle River Basin, where the majority of Chinook spawning occurs in the lower reaches of a few larger tributary streams because the mainstem has such a very large fine sediment load as a result of extensive glaciers upstream.

The watersheds in the upper reaches of the Suiattle River Basin have low road densities and so are not likely at risk from road-related sediment impacts. The Circle, Straight, Tenas, and Big Creek watersheds in the lower reaches of the Suiattle River all support at least some Chinook spawning and have higher densities of forest roads. Roads in these watersheds need to be inventoried to evaluate potential impacts to fish habitat and the high hazard roads need to be upgraded or decommissioned. Upgrading roads involves increasing the size and number of cross-drain culverts, increasing the size of stream crossings to convey high flows, sediment, and woody debris, dipping and armoring fill material over larger culverts, and reducing or removing fill material on unstable slopes adjacent to or upslope from streams. Decommissioning roads involves removing culverts, removing fill material from drainage crossings and on unstable slopes adjacent to or upslope from streams, and restoring natural drainage patterns by excavating drainage crossings in the road fill.

Purpose

The purpose of this project is to first identify and then reduce or eliminate sediment impacts to streams related to forest roads in the lower reaches of the Suiattle River Basin.

Populations Targeted

Suiattle springs

Estimated Cost

The Bureau of Indian Affairs (BIA) has provided $60,000 to inventory Forest Service roads in the Circle, Straight, Tenas Creek and Big Creek watersheds and to evaluate the potential for sediment impacts to fish-bearing streams. Once roads with a high risk of sediment delivery are identified, then a budget can be developed and grant funds can be pursued to implement treatments on those roads. It is not known how much this will cost because the road inventory has not yet been completed, but it is expected somewhere between $500,000 and $1.5 million will be needed.

Timeframe

With the existing grant, a forest road inventory will be completed in the summer of 2005. Future grants will be needed to implement treatments on roads that have a high risk of sediment delivery. It is expected that this could be completed by 2010.

Contingencies

The biggest contingency has to do with permitting and project administration with the Forest Service. The Forest Service has limited staff, so habitat restoration projects often take a long time to move forward. Hopefully this project will move forward quickly once the road inventory work in the Suiattle River Basin and road treatment work in the Sauk River Basin are completed.

Expected Direct Results

Physical: It is expected that improving road drainage conditions will reduce or eliminate sediment delivered to streams from forest roads, which is expected to reduce the amount of fine sediment in spawning gravel, increase pool depth and volume, and reduce channel width and bed instability in downstream areas.
Biological: It is expected that reducing bed instability and fine sediment in spawning gravels should improve the rate of survival-to-emergence for juvenile salmon and that increasing pool depth and volume will increase rearing capacity.

Effectiveness Monitoring
After roadwork is completed, the treated segments will be monitored to ensure that drainage treatments function as designed. Roads will also be monitored after major storm events to evaluate the effectiveness of the treatments in minimizing catastrophic failures.

Backup Actions (if direct results are not achieved)
None identified at this time

10. RESTORATION ACTIONS IN FRESHWATER REARING HABITAT

The purpose of this chapter is to catalogue specific freshwater habitat restoration actions that will increase the production of Chinook salmon in the Skagit River Basin. There is recent evidence of limited freshwater habitat rearing capacity for Chinook salmon in the Skagit– fish sampling efforts show an upper limit on the number of parr migrants the river basin produces (~1,300,000 annually), while the rest of the ocean type component head downstream as delta rearing or fry migrants. This appears to be a density-dependent migration response. Therefore, increasing the availability of freshwater rearing habitat should increase the number of parr migrants. The assumption here is that floodplain habitat is critical to the success of parr migrant and stream type life histories because of the length of their residency in freshwater and the growth that occurs during that time. Parr migrants spend several months in freshwater and grow to an average size of 75 mm fork length before migrating seaward. Stream type Chinook salmon spend over one year in freshwater habitat before migrating seaward at an average size of 120 mm fork length.

Floodplain areas are especially important for freshwater rearing because the availability of complex mainstem edge habitat, backwaters, and off-channel habitat is essential for the foraging and refugia of all freshwater life history phases. These habitats can be degraded or eliminated by; 1) hydromodifications (such as dikes and riprap bank armoring structures) that reduce mainstem edge habitat complexity, and 2) hydromodifications or any other structures in the floodplain (such as roads, houses and fills) that limit lateral channel migration and the formation of backwaters and off-channel habitat. For this reason, restoring freshwater rearing habitat generally focuses on removing or upgrading hydromodifications on the main channel, planting riparian vegetation, restoring natural floodplain processes by removing or relocating floodplain modifications, and/or re-connecting historic floodplain channels.

In order to better understand the freshwater rearing habitat restoration opportunities for each Chinook stock, the Skagit River Basin was delineated into rearing ranges based on which stocks could occupy a given area of the system assuming downstream migration of juveniles only. Starting with six different stocks that have unique spawning ranges, the freshwater rearing areas were divided into eight unique rearing ranges. Figure 10.1 shows the mainstem channel and the geomorphic floodplain for each rearing range, which provides an overall footprint for where freshwater rearing habitat restoration could occur in the Skagit River Basin. This figure also shows where gaps were identified in floodplain habitat availability (methods described below and in Appendix C) and the locations of specific restoration projects that are identified in this chapter. Each rearing range was divided into smaller floodplain reaches for more detailed analysis. Table 10.1 shows floodplain characteristics, floodplain impairment, and mainstem edge, backwater, and off-channel habitat conditions for each floodplain reach and Chinook rearing range (methods described below and in Appendix C).

These results show that there is a total of 14,618 hectares of floodplain area in the Skagit River Basin, but that 31% of that area is disconnected from natural river processes. This information will be used in the sections that follow, which describe specific impacts to Chinook salmon from hydromodifications and floodplain impairments, present a general strategy for addressing these impacts to increase Chinook production, discuss a specific implementation plan, and include summaries of floodplain and habitat conditions and specific restoration projects for each rearing range.

Figure 10.1. *Index to rearing range maps.* Location map of figures showing floodplain areas grouped by the freshwater rearing ranges of Skagit Chinook salmon stocks throughout the Skagit River Basin. Also shows location of habitat restoration projects, and where gaps in habitat opportunity have been identified. Figure insets labeled A-E show the freshwater rearing range for all stocks. Figure insets labeled F and G shows the freshwater rearing range for Upper Skagit summers and Upper Cascade springs. Figure insets labeled H and I show the freshwater rearing range for Upper Skagit summers. Figure inset labeled J shows the freshwater rearing range for Upper Cascade springs. Figure insets labeled K and L shows the freshwater rearing range for all Sauk and Suiattle stocks. Figure insets labeled M and N shows the freshwater rearing range for Lower Sauk summers and Upper Sauk springs. Figure inset labeled O shows the freshwater rearing range for Upper Sauk springs. Figure insets labeled P and Q shows the freshwater rearing range for Suiattle springs.

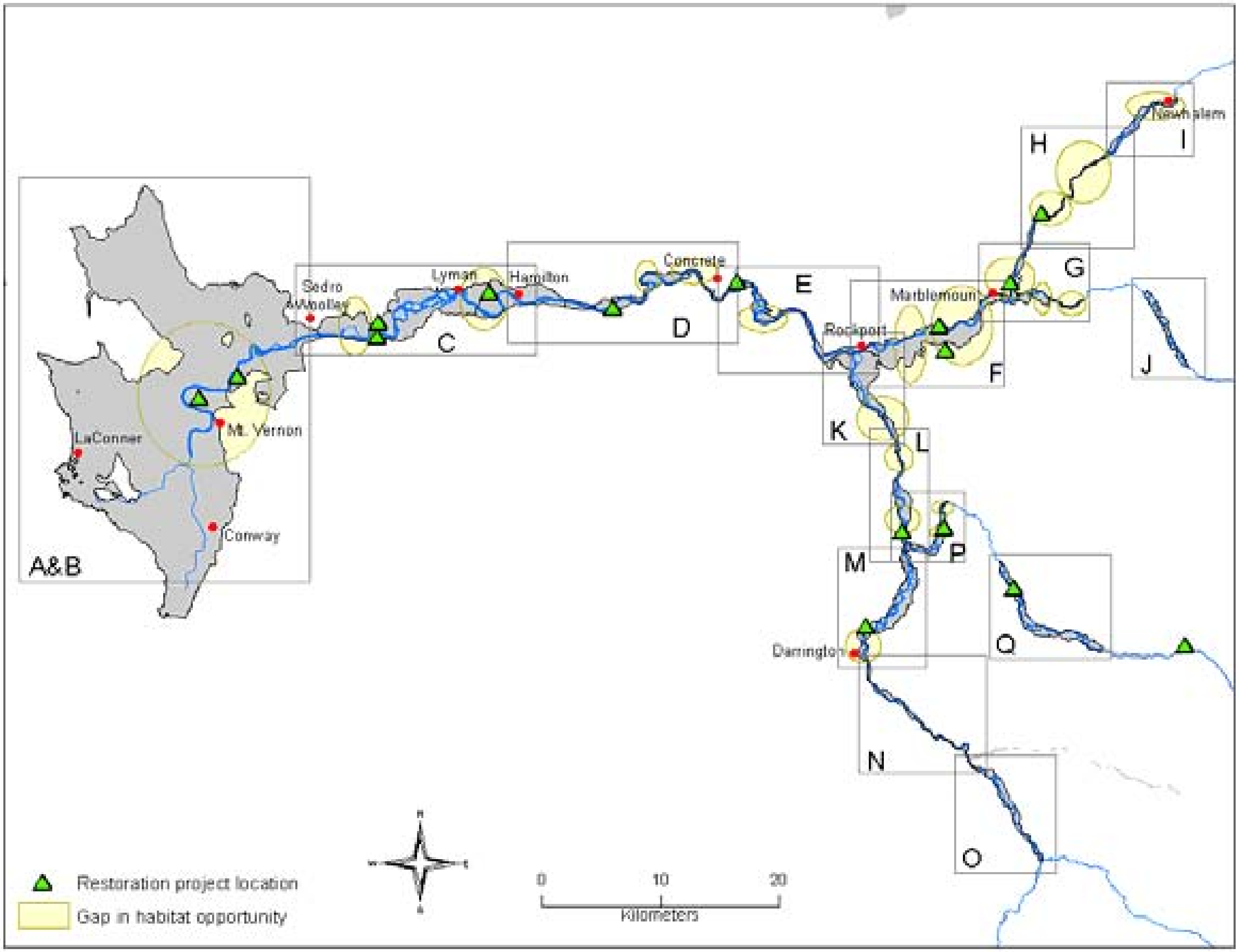

Table 10.1. *Summary of large river floodplain and habitat conditions for Skagit River Basin.*

Spawning Range	Rearing Range	Floodplain Reach	Total Flood-plain Area (ha)	FP Area Dis-connected From River Hydrology (ha)	% Impaired	Average FP Width (m)	Average Effective FP Width (m)	Mainstem Channel Length (m)	Mainstem Channel Area (ha)	Off-channel Habitat Length (m)	Off-channel Length/ Main-stem Length	Back-water Per-imeter (m)
	All Stocks	Non-tidal delta	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lower Skagit fall		SK060A	3312.6	1152.7	35%	2,284	1,567	18,972	287.1	76,665	4.04	13,349
		SK060B	1275.2	862.5	68%	1,766	571	10,201	170.3	16,258	1.59	2,204
		SK070A	136.6	38.9	29%	547	391	2,546	43.5	627	0.25	292
		SK070B	341.3	85.5	25%	761	570	5,026	78.7	6,490	1.29	642
		SK080A	409.1	135.5	33%	916	613	7,686	103.2	3,467	0.45	1,076
		SK080B	332.3	47.7	14%	827	708	5,764	91.7	2,302	0.40	1,295
		SK080C	225.4	27.8	12%	302	265	7,843	103.4	2,038	0.26	379
		SK090	151.4	12.7	8%	301	276	5,133	72.0	598	0.12	1,760
U Skagit summer		SK100	267.6	27.4	10%	505	453	5,513	65.8	10,075	1.74	2,546
		Total	**6451.6**	**2390.7**	**37%**	**1,173**	**739**	**68,685**	**1,016**	**118,521**	**1.73**	**23,542**
Upper Skagit summer	Upper Skagit summer & upper Cascade spring	SK100A	1685.0	890.7	53%	1,537	724	12,230	121.9	33,724	2.76	5,152
		SK110	530.1	187.5	35%	482	311	11,692	96.3	4,089	0.32	2,238
		CA010	206.5	106.7	52%	664	321	3,740	11.5	4,611	1.23	1,287
		CA020	51.1	9.9	19%	164	132	3,234	10.3	1,397	0.43	0
		Total	**2472.7**	**1194.9**	**48%**	**877**	**453**	**30,896**	**240.1**	**43,822**	**1.42**	**8,678**
Upper Skagit summer	Upper Skagit summer	SK120A	53.0	1.5	3%	130	126	4,338	30.0	960	0.22	203
		SK120B	15.9	0.8	5%	62	59	2,547	11.5	0	0.00	0
		SK130A	35.5	1.2	3%	145	140	2,514	14.1	43	0.02	254
		SK130B	300.2	109.1	36%	490	312	6,892	46.0	9,558	1.39	1,867
		Total	**405**	**112**	**28%**	**266**	**192**	**16,292**	**102**	**10,561**	**0.65**	**2,325**
U Cascade spring	U Cascade spring	CA40A-40D	330.3	14.8	4%	453	433	10,114	NA	NA	NA	NA
		Total	**330.3**	**14.8**	**4%**	**453**	**433**	**10,114**	**NA**	**NA**	**NA**	**NA**

Spawning Range	Rearing Range	Floodplain Reach	Total Flood-plain Area (ha)	FP Area Dis-connected From River Hydrology (ha)	% Impaired	Average FP Width (m)	Average Effective FP Width (m)	Mainstem Channel Length (m)	Mainstem Channel Area (ha)	Off-channel Habitat Length (m)	Off-channel Length/ Main-stem Length	Back-water Per-imeter (m)
Lower Sauk summer	All Sauk and Suiattle	SA010	1055.7	364.2	34%	1,732	1,134	6,981	55.7	33,151	4.75	3,758
		SA020A	132.1	65.1	49%	398	202	3,470	27.3	1,155	0.33	200
		SA020B	51.3	1.9	4%	185	178	2,846	18.2	1,315	0.46	279
		SA030	353.4	1.0	0%	864	862	4,935	45.8	15,541	3.15	963
		SA040	64.1	12.6	20%	294	236	2,227	18.8	1,989	0.82	491
		Total	**1656.6**	**444.7**	**27%**	**897**	**657**	**20,459**	**166**	**53,150**	**2.60**	**5,691**
Lower Sauk summer	Lower Sauk summer and upper Sauk spring	SA050	918.2	154.9	17%	1,020	848	11,651	73.4	51,032	4.38	8,407
		SA060A	81.7	10.1	12%	545	477	1,854	9.8	851	0.46	664
		SA060B	333.3	22.9	7%	246	229	14,681	74.1	15,190	1.03	2,120
		SA060C	11.6	2.4	21%	108	86	1,149	4.2	116	0.10	2
		SA060D	47.1	30.9	66%	551	190	977	7.4	135	0.14	0
		Total	**1391.9**	**221.2**	**16%**	**536**	**451**	**30,312**	**169**	**67,324**	**2.22**	**11,192**
U Sauk spring	U Sauk spring	SA070	475.2	26.5	6%	471	444	12,873	43.9	25,368	1.97	2,979
		Total	**475.2**	**26.5**	**6%**	**471**	**444**	**12,873**	**44**	**25,368**	**1.97**	**2,979**
Suiattle spring	Suiattle spring	SU010	239.7	6.6	3%	559	543	5,615	26.2	17,084	3.04	2,599
		SU020A	101.2	10.8	11%	339	302	3,484	18.3	2,178	0.63	507
		SU030	744.4	65.5	9%	586	535	15,593	69.6	33,082	2.12	5,727
		SU040A	215.4	0.0	0%	386	386	6,312	NA	NA	NA	NA
		SU040B	36.7	0.0	0%	205	205	1,972	NA	NA	NA	NA
		SU040C	52.7	0.0	0%	180	180	3,317	NA	NA	NA	NA
		SU050	45.5	0.0	0%	116	116	4,297	NA	NA	NA	NA
		Total	**1435.6**	**83.0**	**6%**	**420**	**395**	**40,588**	**114**	**52,343**	**1.29**	**8,832**
Grand Total			***14,618***	***4,489***	***31%***	***752***	***521***	***230,219***	***1,850***	***371,089***	***1.69***	***63,239***

10.1. GENERAL FRESHWATER HABITAT RESTORATION STRATEGY

A study of hydromodifications in the Skagit (Beamer and Henderson 1998) showed that subyearling juvenile Chinook use natural banks at a density five times greater than riprap (hydromodified) banks. The salmon recovery inference from this study is that wherever riprap banks exist, they should be converted to natural banks (either through removal or mitigation measures like adding complex wood to riprap areas). The projects as recommended should increase capacity for parr migrant and stream type life history strategies. They should also improve habitat quality for fry of other life history strategies that are migrating seaward yet are still using these habitats on a more temporary basis.

Hayman et al. (1996) showed that backwaters were also preferred habitat by sub-yearling Chinook and was used in higher densities than other mainstem edge habitats. Hydromodifications and floodplain disturbances that reduce lateral channel migration (riprap, dikes, floodplain roads and fills) reduce the formation of backwaters and other complex natural habitats. Projects that remove or relocate these kinds of structures should increase parr migrant capacity.

Hayman et al. (1996) also showed that juvenile Chinook (probably parr migrants) were consistently found in the lower ends of off-channel habitat along the Skagit River. This phenomenon was not found in off-channel habitat along the Sauk and Suiattle Rivers. The data were opportunistically collected at coho smolt trapping sites run during the 1980s and early 1990s so caution should be used in drawing conclusions. The implication of the finding for Chinook recovery might be support for reconnecting off-channel habitat, especially along the Skagit River for the benefit of parr migrants.

For the purpose of this report, aerial photographs and Geographic Information Systems (GIS) were used to estimate the total area of floodplain reaches and the area of each floodplain reach that was isolated or shadowed by roads and hydromodifications (see Appendix C). Effective floodplain width was calculated for each floodplain reach, which is the average width of the floodplain that was *not* isolated or shadowed by roads and hydromodifications. The length of off-channel habitat, shoreline perimeter of backwater habitat, length of bank and bar habitat on mainstem edges, and total area of mainstem habitat were also measured for each floodplain reach. Off-channel habitat was classified as flowing in a connected, isolated or shadowed portion of the floodplain.

These data were used to compare total amount of habitat in floodplain reaches with differing characteristics and levels of impairment and to compare the amount of habitat found in connected versus isolated or shadowed floodplain areas. This analysis showed there was significantly more habitat in floodplain reaches that were connected with the river than in reaches that were isolated or shadowed by floodplain modifications. Multiple regression analysis showed that floodplain gradient and effective floodplain width were significant in determining how much habitat was available in each reach (see Appendix C). These results suggest that removing or relocating roads and hydromodifications in large river floodplains should increase the amount of rearing habitat available to Chinook salmon.

As a result of this research, the strategy for floodplain restoration emphasizes reconnecting isolated floodplain areas and restoring mainstem edge habitat and by removing, relocating, or improving hydromodifications and floodplain structures. Hydromodifications that are disconnecting or isolating a portion of the floodplain anywhere in the Skagit River Basin should be removed or relocated unless they are protecting permanent infrastructure that would be too expensive or difficult to relocate. Where hydromodifications are protecting permanent infrastructure or are located near the outside edge of the floodplain, they should be modified to improve mainstem edge habitat conditions with the use of woody debris, complex structures and riparian vegetation. Floodplain areas that currently have functioning floodplain conditions should be acquired or protected though regulatory actions to prevent future isolation or habitat degradation.

In the following sections we have described selected projects that will increase capacity for out migrating salmonids. For each of these projects benefits have been quantified in terms of parr migrants. However, all of these projects have other significant benefits for the survival of out migrating Chinook salmon that were not quantified. These benefits come primarily from two pathways; flood refuge and increased productivity.

<u>Flood refuge conceptual benefit</u>: The freshwater rearing projects that are along the main river corridor will restore a diversity of habitats that include low velocity areas like off channel and backwater habitats. These areas provide Chinook fry with a refuge opportunity during times of high river flow. Research has shown that high stream flow events can displace age 0+ salmonids downstream by reducing the availability of preferred or suitable slow water habitats and increasing competition for space (Seegrist and Gard 1972, Erman et al. 1988, Latterell et al. 1998) causing lower survival. We expect a significant flood refuge benefit from floodplain restoration projects yet we have not attempted quantification of this benefit in the current draft of this plan.

<u>Increased productivity benefit</u>: Floodplain restoration that focuses on reconnection of floodplains to fluvial processes will allow for less restricted movement and deposition of physical elements such as water, wood and sediment. Along with these physically elements, other biological processes are allowed to work within the new floodplain area not only allowing for the formation and maintenance of habitats that Chinook salmon directly live in but also an increased base level of productivity for those habitats. Some of the important smaller scale processes that increase productivity of aquatic habitats within restored floodplain areas include: increased primary production within increased vegetative footprint in the floodplain; increased detritus retention leading to increased secondary productivity; increase hyporheic flow and biotic processes occurring within the hyporheic zone that make nutrients more available to the aquatic system.

10.2. IMPLEMENTATION

A number of projects have already been developed to restore floodplain processes and mainstem edge habitat at various sites in the Skagit River Basin. For the most part, these projects target significant portions of isolated floodplain habitat that have either been recently acquired by conservation interests or have existing support from local political interests. These are described below in the sections for each rearing range.

10.2.1 General Restoration of Hardened Streambanks

In addition to specific projects that are already identified, a more general implementation strategy is to address every hydromodification in the Skagit River Basin due to the benefits from restoring natural mainstem edge habitat conditions for Chinook salmon. Table 10.2 includes information on edge habitat and hydromodification conditions. The location of each hydromodification is included on maps below in the sections for each rearing range. The best alternative for fish would be to restore natural bank conditions by removing these hydromodifications entirely because this would also restore off-channel habitat development. However, where hydromodifications are located near the outside edge of the geomorphic floodplain or are protecting important infrastructure that would be too costly to relocate, then they should be modified to improve mainstem edge habitat conditions with the use of woody debris, complex structures, and riparian vegetation.

Table 10.2**.** *Summary of edge habitat conditions and hydromodifications for each rearing range.*

Rearing Range	Floodplain Reach	Mainstem Channel Length (m)	Total Edge Habitat Length (m)	Hydro-modified Length (m)
All stocks	Non-tidal delta	22,779	57,390	48,796
	SK060A - SK100	68,685	195,606	30,308
Upper Skagit summer and upper Cascade spring	SK100A -SK110 and CA010 -CA020	30,896	76,061	7,884
Upper Skagit summer	SK120A -SK130B	16,292	39,244	3,460
Upper Cascade spring	CA40A - 40D	10,114	NA	48
All Sauk and Suiattle	SA010 - SA040	20,459	49,359	3,160
L Sauk summer & U Sauk spring	SA050 - SA060D	30,312	78,541	2,998
Upper Sauk spring	SA070	12,873	30,137	504
Suiattle spring	SU010 - SU030	24,692	63,068	1,118
	SU040A - SU050	15,898	NA	282
Totals		***230,219***	***589,407***	***98,559***

The net benefit is a gain of 135,000parr migrants per year if all hardened stream banks are removed or modified such that their restored capacity is equal to that of a natural stream bank.

10.2.2 Gaps in Rearing Habitat Opportunity

In order to identify high priority areas for restoration of off-channel habitat, it was assumed that reaches of the river that have gaps in the availability of backwaters or floodplain channels should be considered priority areas for restoration. The spatial distribution of habitat availability was determined by measuring the distance between each backwater and floodplain channel outlet and quantifying the amount of habitat available to fish from each outlet point (described in Appendix C). Gaps in habitat availability were defined as at least one kilometer of mainstem length that provides access to less than 1,000 meters of floodplain channel length or backwater perimeter. Areas with five kilometers or more of contiguous mainstem length with less than 1,000 m of habitat per kilometer of mainstem length are identified as the highest priority. A visual analysis of these gaps was completed to identify priority areas based on these criteria and the results are summarized in Table 10.3. Some of the gaps in habitat that were originally identified were eliminated and not included on this list because they were in areas where the floodplain was naturally relatively narrow and the habitat gap was likely to be a result of natural conditions. It is expected that this habitat gap analysis will help identify new floodplain reaches that are not already targeted for restoration, but it is not intended to exclude other reaches for restoration or protection if good projects are identified in those areas.

Table 10.3. *Priority river reaches identified in floodplain habitat based on gaps in backwater and off channel habitat opportunity.*

River/Rearing Range	Downstream River KM*	Upstream River KM	Possible Actions
Skagit River: all stocks	14.3	26.3	Cottonwood Is., Britt Sl., Nookachamps, Sterling Reach, River Bend, Salem LC
	26.3	28.6	Gilligan Floodplain, Skiyou
	41.6	48.2	Cockreham Island
	61.9	65.5	
	67.9	70.5	
	79.3	85.7	
Skagit River: upper Skagit summers and upper Cascade springs	96.6	98.9	
	100.3	106.6	Car Body Hole
	109.5	113.4	Marblemount Bridge
Skagit River: upper Skagit summers	116.8	120.4	Bacon Creek
	120.5	126.3	
	131.5	135.5	
Cascade River: upper Skagit summers	2.9	4.6	
	6.4	7.9	
Sauk River: All Sauk and Suiattle stocks	5.4	9.3	
	10.1	12.4	
	16.6	19.0	Government Bridge
Sauk River: L. Sauk summers and upper Sauk springs	31.7	35.2	Darrington and vicinity
Suiattle River: Suiattle springs	5.2	6.2	Dearinger Park
	7.9	9.3	

*Note: River KM on the Skagit River is measured upstream from the bifurcation of the North and South Forks located in the delta near Mount Vernon

The data collected on floodplain and habitat conditions has been summarized for each floodplain reach and Chinook rearing range in Table 10.1. These data can be used to prioritize areas for further investigation of floodplain restoration and protection projects. In addition, maps were generated to show the spatial distribution of floodplain conditions in terms of their connection with river hydrology (connected, isolated, or shadowed by roads or hydromodifications), length and location of mainstem, backwater, and off-channel habitat, the location of hydromodifications, and the specific reaches that were identified in the floodplain habitat gap analysis. These maps are provided for each Chinook rearing reach in the sections below to help guide restoration actions. Each section also includes specific restoration actions intended to restore floodplain habitat.

10.3. RESTORATION PROJECTS IN THE NON-TIDAL DELTA (ALL STOCKS)

10.3.1 Habitat Conditions

The non-tidal delta includes the Skagit River and floodplain between the tidal delta and Sedro-Woolley. Detailed channel mapping and measurements of floodplain characteristics were not completed for this section of the river, although available information suggests that the floodplain has been highly impaired and that essentially the entire section is a gap in habitat availability. For the non-tidal part of the delta, historic wetland area was 5,733 hectares while current wetland area is only 67 hectares (Figure 10.2). Similarly, floodplain forest area was 12,297 hectares while current floodplain forest area is 314 hectares. Together, this is a net loss of 98% of the area where lower river delta habitat could form and exist. There are not good estimates for all channels within each area. However, almost all floodplain channels have been isolated from the mainstem and essentially 100% of the mainstem is hydromodified under current conditions.

10.3.2 Restoration Strategy

Other regions can be used to infer something about potentially lost or severely depressed life history strategies due to complete or nearly complete loss of the habitats used by these life history strategies. For example, Burke and Jones (2001) showed that current juvenile Chinook salmon life history strategies differ dramatically from those documented in the early 1900s by Rich (1920). Juvenile Chinook salmon populations historically possessed more complex population structure and showed a broader temporal distribution in the estuary. However, the different cohorts that showed up in the estuary throughout the year show varying degree of estuarine and fluvial residence. It appears that historically there was a life history strategy to occupy essentially every habitat opportunity available in the river basin and its estuary. Of particular note is the fact that historically juvenile Chinook salmon used the lower Columbia River for overwintering. Taking this conclusion as a paradigm for the Skagit, we find historically that the Skagit River had extensive lower river non-tidal wetlands and floodplain channels. Now these extensive habitats are largely gone or are isolated from the mainstem river (Figure 10.2) creating a large gap in habitat opportunity between Sedro-Woolley and the tidal delta. Because freshwater rearing habitat diversity and area is so limited in the non-tidal delta of the Skagit, it is possible we have lost juvenile life history strategies that used this area. These life history strategies were probably some form of stream type or parr migrant. Ongoing research has already shown a significant number of the wild Chinook salmon fry move downstream from egg incubation areas as a response to increasing population size. Flood refuge opportunity for all juvenile life history types has also been lost in this part of the basin. If habitat can be restored in the non-tidal delta, fish will likely attempt to colonize it, thus providing opportunity for historic life history strategies again.

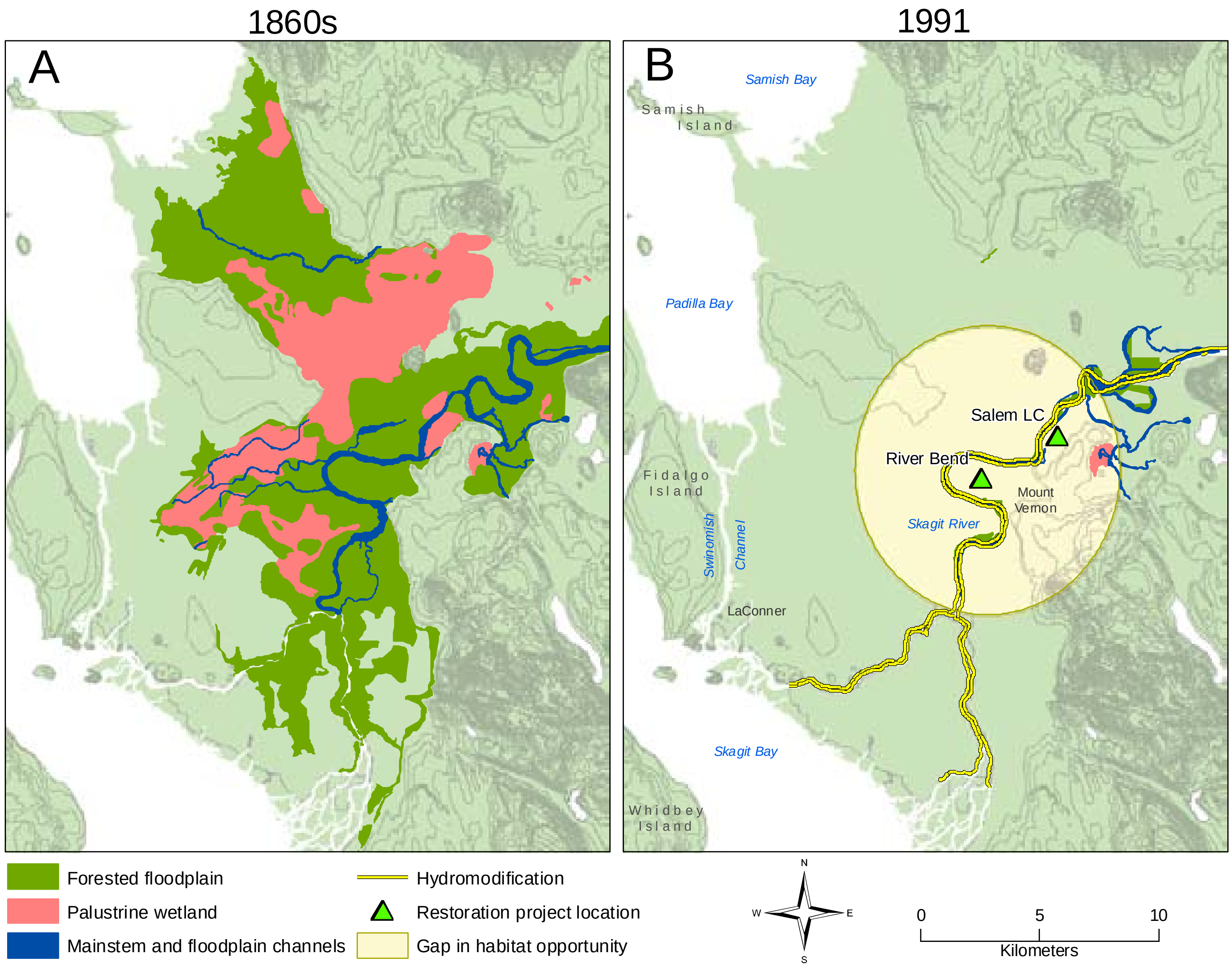

Figure 10.2. *Floodplain areas for the non-tidal delta portion of the Skagit River.* The map shows changes to floodplain and mainstem habitats. Historic conditions (A) were reconstructed by Collins (2000) and current conditions (B) were assessed using 1991 orthophotos by Beamer et al. (2000b).

10.3.3 Salem LC Floodplain

Project Summary

In addition to a hydromodified bank, the site has three anthropogenic features that limit this unit's site potential. A blocking floodgate, a dike located near the confluence with a small stream on site, and the fill associated with Francis Road. All of these anthropogenic features prevent connectivity throughout the unit. The relatively high floodplain levels suggest the site is somewhat limited in its potential to develop more off-channel complexity. However, the existing channel and its relationship with degraded wetlands suggest significant potential related to the development of a riverine wetland complex. This is supported by historic evidence that a riverine wetland was present at this location in 1889.

Populations Targeted

All

Estimated Cost

This site has been recently purchased by Wildlands Incorporated for development as a wetland mitigation bank. Unfortunately, there is no mechanism or incentive for wetland mitigation banks to develop restoration features that are targeted at fish species. Any restoration work commensurate with fisheries goals would necessarily be by design. In the case of Salem LC, Wildlands has no current plans to remove blockages to fish access. However, they will be developing on-site wetland values. If incentives can be provided, there is a high likelihood that fish access to the site could be reestablished.

Timeframe

This site has a high probability of implementation within a five-year timeframe. Restoration actions are already being evaluated through a mitigation bank design and permitting process. Incentives for fish related actions may take some time to develop.

Contingencies

Two properties located at the northern end of the site will restrict the development of the full site potential. If these properties can be included or have localized flooding issues addressed, then restoration can proceed relatively unfettered.

Expected Direct Results

Physical: As reported by the Big Bend Feasibility Study conducted for the City of Mount Vernon (Miller Consulting, 2004) the site has a proposed footprint of 118 hectares (291 ac). Presently it is largely unconstrained by levees. However a small dike does exist at the downstream end of the property that restricts the backwater flow from the Skagit River during flood events. The site is also artificially smaller than it would potentially be if not bisected by Francis Road. There is evidence of past high-water channels eroded from high water events. These subtle channels can be detected in aerial photographs and with ground surveys. However, the relief within these narrow bands is such that water does not appear to be concentrated for any significant length of time. The orientation of these channels suggests that they may represent relic side channels, or perhaps erosion that occurred during a specific major historic flood event, such as the 1921 flood. Most of the site is floodplain terrace, generally six meters above the Mean Water Line (MWL), with some undulations in elevation visible at ground level and on aerial photographs. The swale that supports the stream and associated wetlands appears to be at elevations between 4.5-6.0 meters. Figure 10.3 shows a DEM

contour map of the site. Approximately 18 hectares (45 ac) of the site is in lower elevations that should be conducive to riverine wetlands.
Biological: 17,198 parr migrants per year.

Effectiveness Monitoring
Will be developed as project is advanced

Backup Actions (if direct results are not achieved)
None identified at this time

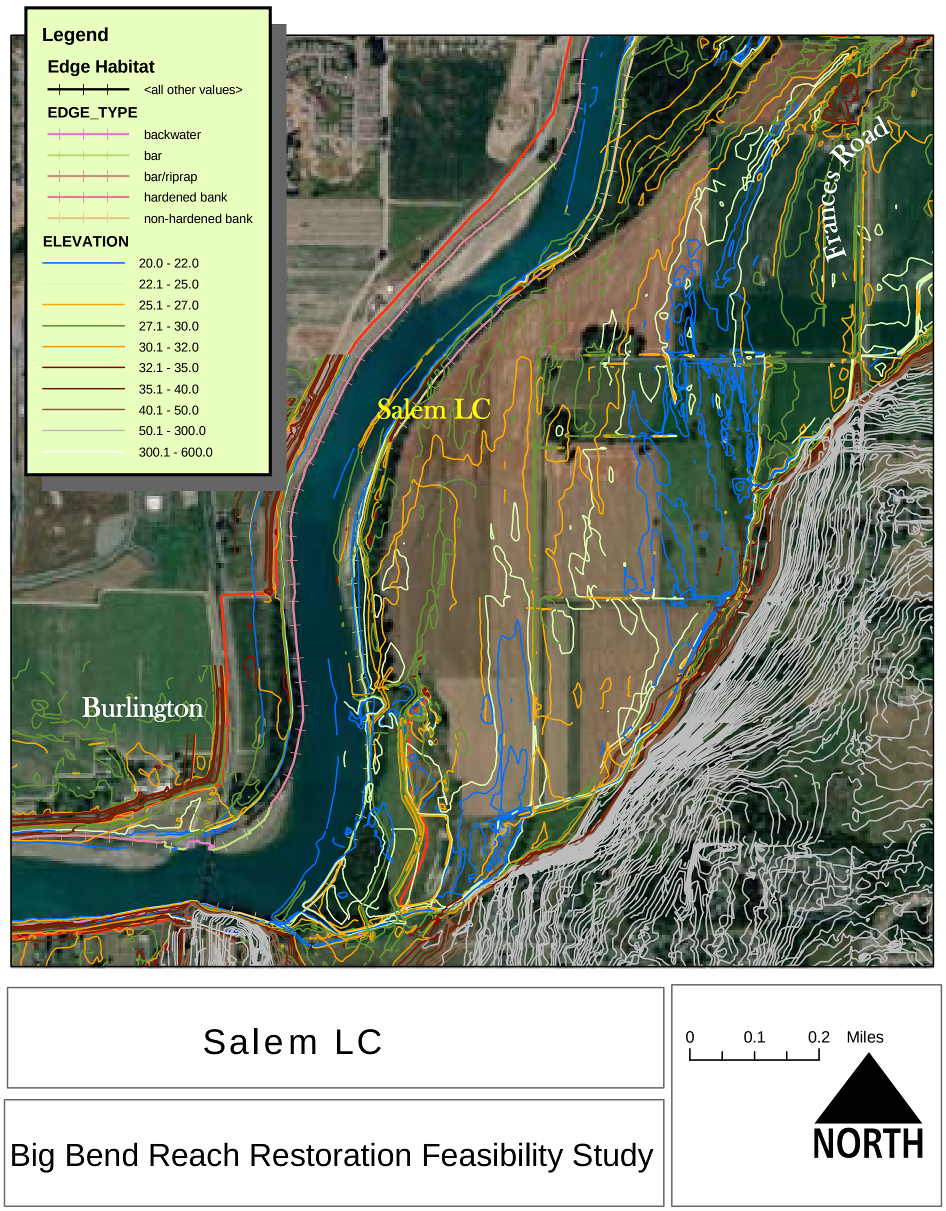

Figure 10.3. *Salem LC floodplain site.* Shows DEM topography as presented in the Big Bend Restoration Feasibility Study by Miller Consulting (2004).

10.3.4 River Bend

Project Summary

Conceptual restoration actions at this site focused on actions that would take advantage of the low topographic depressions, classic oxbow shape and position in the river continuum. River Bend is an area that is extremely prone to flooding and regionally recognized as a high hazard area during large-scale flood events. This high hazard exposure to river forces generally deters development in the area, and marginalizes agricultural productivity in low lying areas, thereby making this location uniquely situated to offer substantial opportunity for fish, wildlife, open space, or recreational uses.

Understanding the need for flood protection, the design considers engineered inlet and outlet structures that will allow passage of both fish and a designed range of flows into a large riverine wetland complex as shown in Figure 10.4. A cross-bend containment levee is also considered. This levee would provide protection to commercial development at the east end of the bend. One important design question is if low flow connections can be maintained in the summer months thereby allowing the site to provide suitable rearing habitat year around.

Populations Targeted

All

Estimated Cost

This project would take considerable resources to implement in terms of engineering, infrastructure relocation and property acquisitions. Costs are not being estimated given the long time horizon for implementation.

Timeframe

Long time horizon because of complexities. This project has numerous social and political hurdles, but does have promise in that it offers some social and community benefits in addition to its value for restoration. We have included this project as a prospect for the 15-20 year time horizon.

Contingencies

Flood protection for greater Mount Vernon would need to be addressed. Also protection of the Anacortes water supply is critical for project consideration. The project would essentially need to be integrated into Flood Management Plans in order to become reality. Large-scale agreement from municipalities and landowners is required.

Expected Direct Results

Physical: Conceptual designs estimate the recoverable habitat at approximately 97 hectares (240 ac). Because this habitat is just above the influence of tidal hydrology we would expect it to function as a floodplain riverine wetland.

Biological: 65,028 parr migrants per year.

Effectiveness Monitoring

Will be developed as project is advanced

Backup Actions (if direct results are not achieved)

None identified at this time

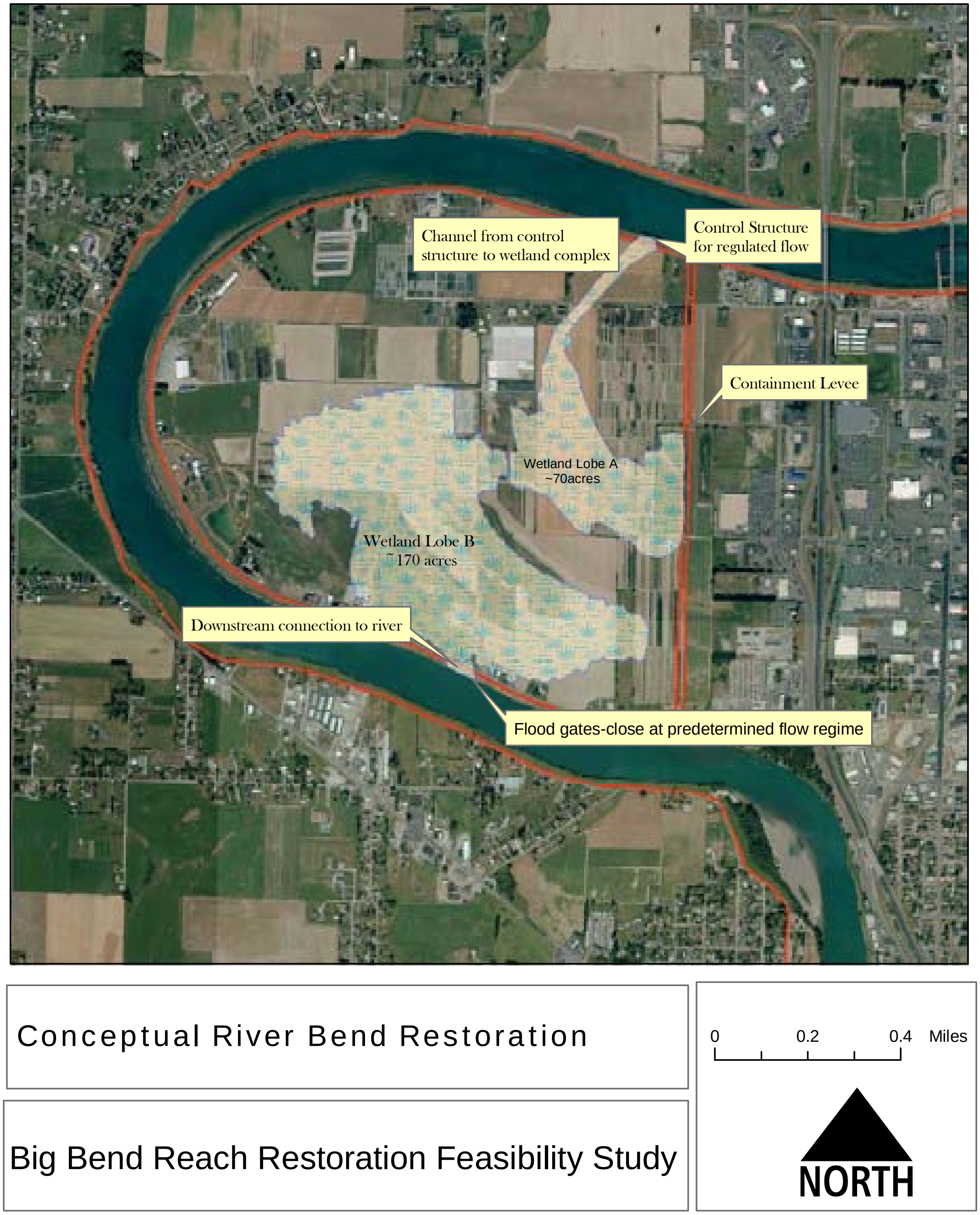

Figure 10.4. *River Bend.* Conceptual River Bend restoration design. Presented in the Big Bend Restoration Feasibility Study by Miller Consulting (2004).

10.3.5 Sterling Reach Restoration

Project Summary:

This project would reestablish hydraulic connections to the mainstem river throughout the historic oxbows in the vicinity of Sterling. These oxbows, now known as Debay's and Hart's sloughs would be reconnected such that mainstem flows could re-establish historic channel networks. Conceptually this would require partial removal of a training levee established by the Army Corps of Engineers south of Highway 9 and the excavation of historic channels in the present day floodplain. Feasibility studies have reviewed potential site reconnections. In addition, land acquisition programs have purchased significant easements and title in the area for fish and wildlife values.

Populations Targeted

All

Estimated Cost

3-5 Million

Timeframe

10-15 years for the entire project. Portions could be phased in starting with Hart's slough restoration within five years. Limited connectivity within Debay's Slough could also be explored.

Contingencies

Competing modern day land uses include some agriculture, urban infrastructure and wildlife management areas. Debay's slough is publicly owned but currently managed as a Swan reserve. Efforts to re-establish flow within this relic oxbow would counter current management techniques that favor quiescent waters. Replacement lands would be required to meet wildlife objectives.

Impacts to flood management strategies would also need to be considered. Especially in the vicinity of Hart's Slough and its interface with urban infrastructure. The northern end of Harts slough meets Highway 20 at a location that historically fed the development of Gages Slough during flood events. Albeit atrophied, this intersection between Hart's Slough and Gages Slough is still a focal point of flood management efforts is large events. Restoration efforts could increase the likelihood of risk to infrastructure unless management of gages slough is considered as well.

Expected Direct Results

Physical: 370.5 hectares of habitat that should yield ~177,700 square meters of off channel area.
Biological: 16,311 parr migrants per year.

Effectiveness Monitoring

Will be developed as project is advanced

Backup Actions (if direct results are not achieved)

None identified at this time

10.3.6 Nookachamps Confluence

Project Summary:
This project would split mainstem flow by excavating a channel through the oxbow at the Nookachamps confluence

Populations Targeted
All

Estimated Cost
$2.5 Million

Timeframe
5 years if owner consent could be secured

Contingencies
Landowner agreement & potential impacts to county roadways. Floodplain area could be improved if county road was realigned.

Expected Direct Results
Physical: 57.5 hectares of habitat
Biological: 8,155 parr migrants per year.

Effectiveness Monitoring
Will be developed as project is advanced

Backup Actions (if direct results are not achieved)
None identified at this time

10.3.7 Britt Slough

Project Summary:
Located on site is the outlet of the relic Britt slough channel. Because this channel has been disconnected from the mainstem river near Eagle Nest bar it no longer functions as an ephemeral distributary. The channel now acts as the drainage system for the watershed area around the old channel. Therefore, this proposal seeks to re-establish what appears to be a historic riverine wetland near the southern portion of the site and examine to potential for a distributary connection to the mainstem using the remaining portion of the historic Britt slough channel.

Populations Targeted
All

Estimated Cost
$500,000

Timeframe
2-3 years if owner consent could be secured

Contingencies
Landowner agreement. Impacts to drainage system if distributary connection is pursued. Levee setback options should be considered.

Expected Direct Results
Physical: 56.8 hectares of floodplain habitat yielding approximately 9,280 square meters of habitat.
Biological: 7,155 parr migrants per year.

Effectiveness Monitoring
Will be developed as project is advanced

Backup Actions (if direct results are not achieved)
None identified at this time

10.3.8 Cottonwood Island

Project Summary:
This project proposes to set back a section of levee located near the WDFW boat ramp access at what is locally known as the "spud house". This project would increase the hydraulic connectivity to the historic Cottonwood channel located at the forks.

Populations Targeted
All

Estimated Cost
$2 million

Timeframe
5 year if owner consent could be secured

Contingencies
Landowner agreement. Relocation of public access point by WDFW. Potential hydraulic impacts to the upper end of Dry Slough.

Expected Direct Results
Physical: 169.8 hectares of floodplain habitat yielding approximately 45,720 square meters of habitat.
Biological: 10,148 parr migrants per year.

Effectiveness Monitoring
Will be developed as project is advanced

Backup Actions (if direct results are not achieved)
None identified at this time

10.4. RESTORATION PROJECTS FROM SEDRO-WOOLLEY TO ROCKPORT (ALL STOCKS)

10.4.1 Habitat Conditions

This rearing range has 6,451 hectares of floodplain with 37% isolated or impaired from roads, hydromodifications, or other floodplain structures (Figure 10.1). The mainstem channel length in this reach is 68.7 km, and the off-channel habitat length is 118.5 km, which is approximately 1.73 km of off-channel habitat length per km of mainstem length. The average floodplain width in this rearing range is relatively high at 1,173 m, but the effective width is only 739 m due to extensive floodplain impairment.

Figure 10.5 shows floodplain characteristics and habitat conditions. Floodplain boundaries are presented and areas that are isolated or shadowed by roads, hydromodifications, or other floodplain impairments are shown. Mainstem channels, backwaters, and off-channel habitats are all shown, along with the location of hydromodifications that may be impairing habitat conditions. Lastly, gaps in habitat availability are marked on the maps as likely areas to emphasize habitat restoration along with the location of specific projects described in this section. There are five gaps that were identified in this rearing range for a total of 21.5 km mainstem channel length.

10.4.2 Restoration Strategy

For the most part, this rearing range is characterized by a relatively wide floodplain and a high level of floodplain disturbance in the section between Sedro-Woolley and Hamilton and a much narrower floodplain but still a high level of floodplain disturbance upstream of Hamilton. Floodplain disturbances are associated with bridges, roads, towns and private property developments. For this reason, it is expected that significant gains can be made in off-channel habitat by removing hydromodifications and floodplain disturbances. The difficulty is that development and infrastructure is relatively high throughout this range, so projects of this nature may be expensive or complex to implement.

The strategy for this rearing range is to extend bridge crossings where they cross the floodplain, remove hydromodifications where they interfere with floodplain functions, and soften hydromodifications with the use of wood and complex structures where they are on the edge of the floodplain. In the lower section, downstream from Hamilton, there are a number of opportunities to provide function to large areas of floodplain with relatively low impact to infrastructure developments by removing hydromodifications. In the upper section, there are quite a few hydromodifications at the outer edge of the floodplain that could be softened without needing to be removed. There are also a number of roads that could be relocated outside or to the edge of the floodplain, although some of them are major highways so the expense may be high. Lastly, it is important to protect existing habitat by keeping roads, hydromodifications and developments out of the floodplain and avoiding timber harvest in the floodplain.

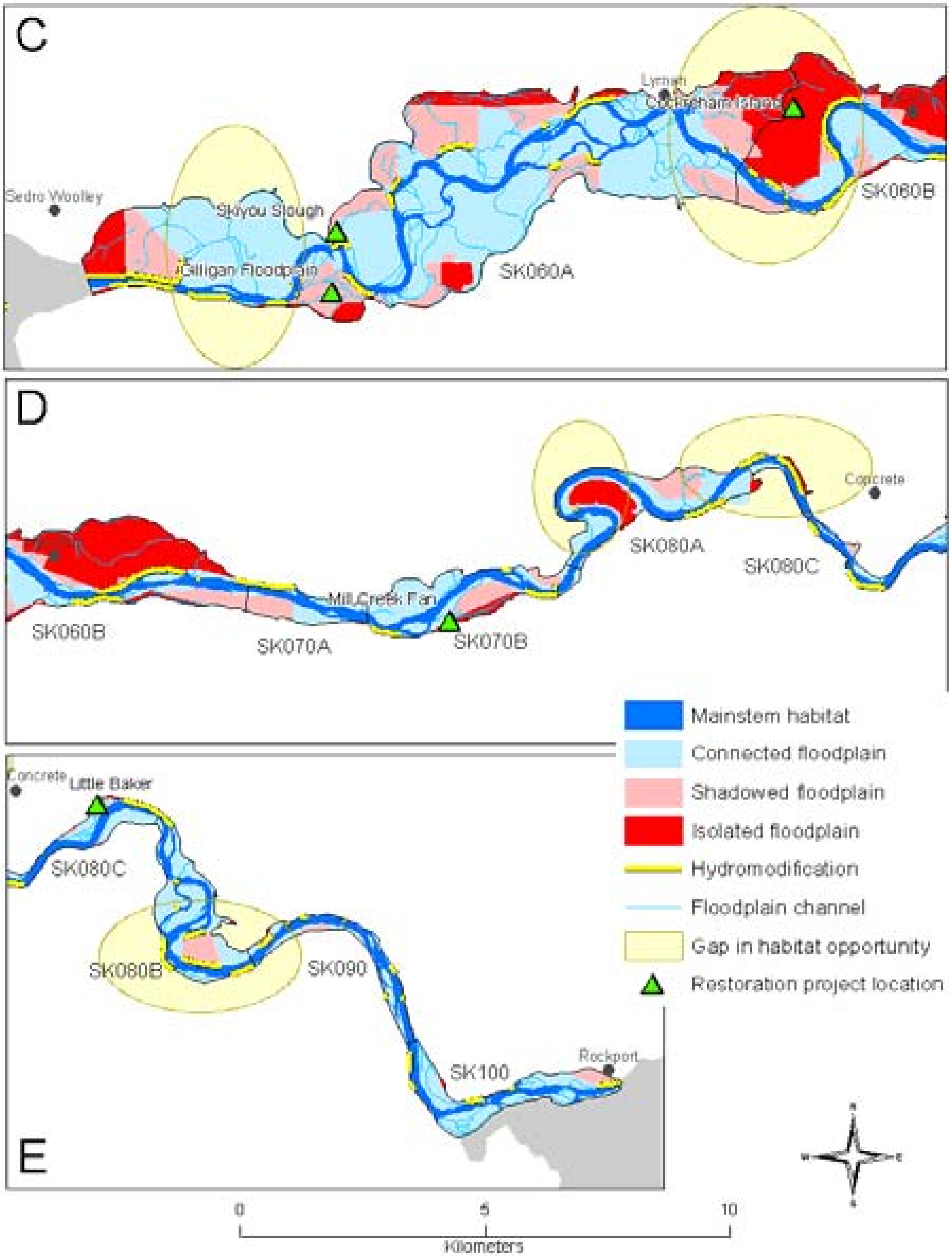

Figure 10.5. *Floodplain and habitat conditions for the Skagit River from Sedro-Woolley to Rockport.* (C) Sedro-Woolley to Hamilton, (D) Hamilton to Concrete, (E) Concrete to Rockport.

10.4.3 Gilligan Floodplain Restoration

Project Summary

Restore side channel and floodplain habitat in the Skagit River downstream from Gilligan Creek by removing 170 linear meters of a flood control dike and associated riprap bank protection, which will restore function to approximately 69 hectares (170 acres) of floodplain. Floodplain vegetation will be improved by removing non-native vegetation and planting native trees.

Populations Targeted

All

Estimated Cost

The cost will be approximately $375,000 and grants have already been secured for approximately half of that cost from the Fraser Panel Southern Fund.

Timeframe

If the project is funded, the planning and design work should take approximately one year, so implementation could occur as early as summer 2006.

Contingencies

Sufficient funding and institutional commitment to relocate infrastructure and acquire floodplain holdings.

Expected Direct Results

Physical: This project is expected to improve edge habitat conditions in the mainstem that have been degraded by rock armoring and to restore natural flows to a significant side channel that was blocked off by the construction of a flood control dike.
Biological: 5,688 parr migrants per year. It is expected that there will be some increase in fish use immediately after project completion as a result of improved edge habitat conditions in the mainstem. It is expected that significant use of side channel and floodplain habitats will take from a few months to a decade or more as these habitats are restored and developed through the process of erosion and channel migration.

Effectiveness Monitoring

Flow conditions and fish utilization will be monitored in the mainstem and the side channel after the dike is removed.

Backup Actions (if Direct Results not achieved)

Removing the dike is expected to restore natural floodplain processes, so there is not a specific flow or habitat target to achieve. However, if the side channel is not wetted as often as it could be due to poor project design, or if fish stranding is occurring, then some additional excavation may be undertaken to improve habitat conditions.

10.4.4 Skiyou Slough

Project Summary
Skiyou Island was recently acquired by the USFS as a part of the Wild and Scenic River Corridor. Over 243 hectares (600 ac) in size, the island was intensively farmed and managed for agricultural purposes. Surrounded by a relic slough channel the site has been the focus of considerable restoration activity aimed at re-establishing the riparian functions of the floodplain and channel corridor. However, little attention has been focused on removing hydraulic restrictions near the upstream inlet to the slough channel. Much of this armoring work has been a direct by product of the Gilligan Dike construction, which forced hydraulic forces toward established landowners at the slough inlet. If the levee at Gilligan can be removed, then hydraulic controls at the inlet of Skiyou should be considered for removal.

Populations Targeted
All.

Estimated Cost
A good candidate for Salmon Recovery Funding Board (SRFB) or NRCS funding. Could be possible to achieve results for less than $200,000

Timeframe
Would need to be sequenced after the Gilligan project. Assuming Gilligan can go forward within a near term time frame we could expect to submit this project for construction in 2008.

Contingencies
Landowner agreement might require additional acquisition. If active restoration cannot be implemented at the site, then natural forces will eventually provide the mechanism. However, this could be long term.

Expected Direct Results
Physical: This action would result in channel forming flows being able to help shape and maintain a more active and healthy rearing environment.
Biological: 8,549 parr migrants per year.

Effectiveness Monitoring
Will be developed as project is advanced

Backup Actions (if direct results are not achieved)
None identified at this time

10.4.5 Cockreham Island

Project Summary

Evaluate and implement habitat restoration for Etach Slough and Cockreham Island on the right bank of the Skagit River between just downstream from the town of Hamilton. Approximately 2,470 linear meters of bank armoring on the right bank limits connectivity between the river and floodplain on the north side. There are a number of houses in this area that are prone to flooding, and the large bank protection structures are routinely damaged or threatened by the river, so Skagit County is completing assessment work that may lead to relocating homes and infrastructure.

The floodplain between Lyman-Hamilton Highway and the river in this location is 540 hectares (1,334 ac) and there are over five kilometers of sloughs and channels that would benefit from increased connectivity with the river. Restoration actions could include removing or setting back bank protection structures, relocating homes, removing or relocating roads, and planting native vegetation in the floodplain. These may be expensive and difficult measures, but it makes sense to pursue ambitious restoration in this area because the habitat value is very high, flood risks and associated costs are high, and the overall density of houses and infrastructure is relatively low.

Populations Targeted

All

Estimated Cost

Exact costs have yet to be determined, but there may be funds available for buying property, relocating infrastructure, and restoring habitat from the Federal Emergency Management Agency (FEMA) due to past flood damage in this area. It is expected that full restoration of this floodplain reach would take 3-5 million dollars.

Timeframe

Currently Skagit County hired a consultant to complete assessment work to evaluate alternatives that might reduce the flooding risks in this area. At this point it is not clear what the specific alternatives will look like and how much habitat restoration will be considered. In any case, it will be several years before any kind of restoration work could be completed.

Contingencies

These will be worked out as part of the assessment, design, and permitting process.

Expected Direct Results

Physical: When implemented, this project is expected to restore connectivity between the Skagit River and its floodplain.
Biological: 10,702 parr migrants per year.

Effectiveness Monitoring

A monitoring plan needs to be developed once a specific restoration alternative has been selected and designed.

Backup Actions (if direct results are not achieved)

None identified at this time

10.4.6 Little Baker Channel

Project Summary
The purpose of this project is to increase freshwater rearing habitat by constructing a side channel on the right bank of the Baker River, connected to the Skagit River through the relic Little Baker channel. Approximately 600 meters of new channel will be constructed with an approximate width of six meters and 400 meters of existing channel will benefit from increased flow conditions. Preliminary investigations on this project have been completed by the Skagit Fisheries Enhancement Group and the U.S. Army Corps of Engineers. The project will likely receive water from a controlled surface connection with the Baker River or groundwater flow that will be enhanced with excavation work in the channel.

Populations Targeted
All

Estimated Cost
The cost will be approximately from $150,000 to $1,000,000 depending on the final design that is chosen. Funding will likely be available from the U.S. Army Corps of Engineers or through mitigation funds from Puget Sound Energy.

Timeframe
Planning and design work is still being completed and will likely take at least another year. After this is completed and funding is secured, the project could be completed in 2007 or 2008.

Contingencies
If the design work indicates that a constructed channel in the former Little Baker channel is not viable, then this project will not move forward.

Expected Direct Results
Physical: This project will not restore natural processes but will result in a discrete constructed channel that will provide rearing habitat for Chinook salmon.
Biological: 233 parr migrants per year. This is very low is fish spawn from within the habitat. It is expected that there will be an increase in fish use immediately after project completion as a result of new habitat being available.

Effectiveness Monitoring
Flow conditions and fish utilization will be monitored in the side channel after it is constructed.

Backup Actions (if Direct Results not achieved)
If flow conditions or fish use in the channel do not occur as expected, then further work will be conducted to evaluate how the project could be altered to improve flow conditions.

10.5. RESTORATION PROJECTS IN THE REARING RANGE OF UPPER SKAGIT SUMMERS AND UPPER CASCADE SPRINGS

10.5.1 Habitat Conditions

This rearing range has 2,473 hectares of floodplain with 48% isolated or impaired from roads, hydromodifications, or other floodplain structures (Figure 10.1). The mainstem channel length in this reach is 30.9 km, and the off-channel habitat length is 43.8 km, which is approximately 1.42 km of off-channel habitat length per km of mainstem length. The average floodplain width in this rearing range is relatively high at 877 m, but the effective width is only 453 m due to extensive floodplain impairment.

Figure 10.6 shows floodplain characteristics and habitat conditions. Floodplain boundaries are presented and areas that are isolated or shadowed by roads, hydromodifications, or other floodplain impairments are shown. Mainstem channels, backwaters, and off-channel habitats are all shown, along with the location of hydromodifications that may be impairing habitat conditions. Lastly, gaps in habitat availability are marked on the maps as likely areas to emphasize habitat restoration along with the location of specific projects described in this section. There are five gaps that were identified in this rearing range for a total of 15.7 km mainstem channel length

10.5.2 Restoration Strategy

This rearing range is characterized in the lower section by a relatively wide floodplain and a high level of floodplain disturbance, while in the upper section the floodplain is significantly narrower, but still has a high level of disturbance from hydromodifications and floodplain impacts, mostly associated with bridges, roads, and private property developments. For this reason, it is expected that significant gains can be made in off-channel habitat by removing hydromodifications and floodplain disturbances. The difficulty is that development and infrastructure is relatively high throughout this range, so projects of this nature may be expensive or complex to implement.

The overall length of off-channel habitat per mainstem channel length is moderately high, but this is mostly a result of substantial amounts of habitat in the very wide floodplain area at the lower end of the rearing range (Barnaby and Lucas Slough complexes and also near the mouth of Illabot Creek). However, the remainder of the range has a much lower quantity of off-channel habitat because of a large number of hydromodifications and floodplain impairments or possibly because of flow regulation from several major dams upstream which has reduced off-channel habitat formation. For these reasons, there were a number of gaps identified in this range despite the large quantity of habitat at the downstream end.

The strategy for this rearing range is to extend bridge crossings where they cross the floodplain, remove hydromodifications where they interfere with floodplain functions, and soften hydromodifications with the use of wood and complex structures where they are on the edge of the floodplain. There are also a number of roads that could be relocated outside or to the edge of the floodplain, although some of them are major highways so the expense may be high. Lastly, it is important to protect existing habitat by keeping roads, hydromodifications and developments out of the floodplain and avoiding timber harvest in the floodplain.

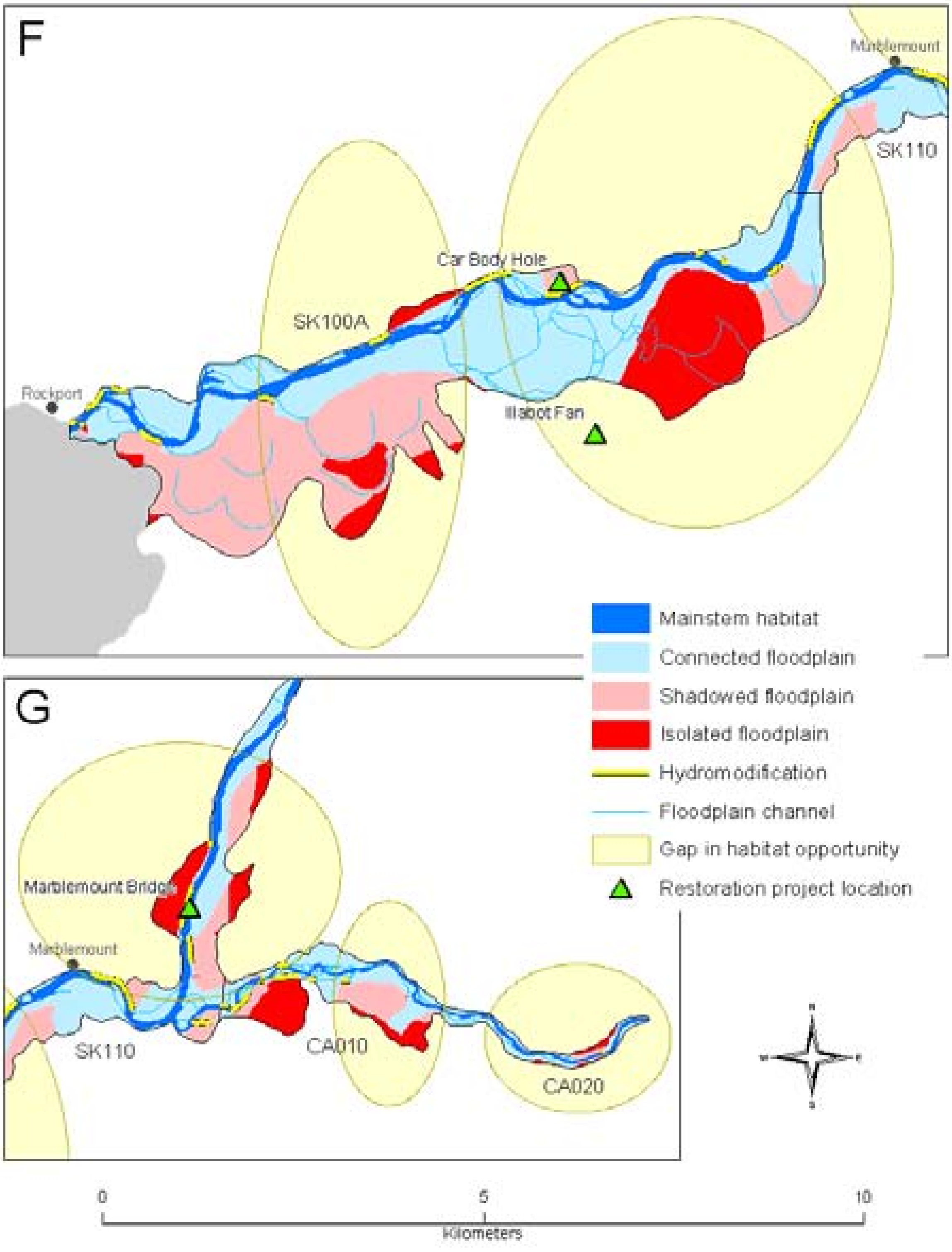

Figure 10.6. *Floodplain and habitat conditions for the upper Skagit River from Rockport to Diobsud Creek and the lower Cascade River*. (F) Rockport to Marblemount, (G) Marblemount to Diobsud Creek and the lower Cascade River.

10.5.3 Illabot Creek

Project Summary

Illabot Creek is a highly productive tributary that enters the left bank of the Skagit River shortly upstream from Rockport. The associated alluvial fan and floodplain area totals over 520 hectares (1300 acres). Over 400 meters of Illabot Creek have been straightened and armored with riprap to protect a bridge crossing and powerline corridor. As a result, a historic secondary channel was abandoned and current primary channel is steeper, shorter, and disconnected from the surrounding floodplain. Riprap bank armoring and channel straightening have decreased channel complexity and changed the channel type from a forced pool-riffle reach to a plane-bed reach, decreasing the available habitat. Adjacent riparian vegetation has also been removed, eliminating potential shade and a source of large woody debris.

A feasibility study to be completed by the end of 2005 will examine the effect of human modifications to the alluvial fan and floodplain of Illabot Creek. This study will identify multiple alternatives that will restore channel complexity to the compromised reach and select one based on potential costs and benefit to habitat. Restoration alternatives include: 1) relocating the road and bridge to the historic crossing further upstream on Illabot Creek and removing all riprap bank armoring in the floodplain reach, 2) constructing an additional bridge span at its present location to accommodate an historic secondary channel and removing most of the riprap upstream and downstream of the bridge, or 3) removing some of the excess riprap (270 m in length) downstream of the current bridge crossing.

Populations Targeted

Upper Skagit summers

Estimated Cost

Estimated project cost depends upon the chosen restoration alternative and will be finalized in the feasibility study. Alternative 1), replacing the road and bridge to its historic location will cost approximately $3.5 million. Alternative 2), adding an additional bridge span to the current crossing would cost between $500,000 and $1,000,000. Alternative 3), leaving the bridge in place and removing the excess riprap downstream (270 m in length), would cost $30,000 to $50,000. In all cases, the powerline structure must be protected for a cost of $40,000.

Timeframe

The Illabot Creek Feasibility Study will be completed by the end of 2005. At that time a preferred restoration alternative will be selected and project funding will be pursued. It will likely take several years to secure funding and implement a project.

Contingencies

Currently it seems very likely that it will be possible to implement at least one of the alternatives, however there is not a specific contingency plan. If it is not possible to remove riprap bank armoring, then the site will remain in its currently degraded state.

Expected Direct Results

Physical: Removing riprap and channel constrictions on Illabot Creek will increase channel edge complexity, decrease channel gradient and possibly convert it to a forced pool-riffle channel type,

and allow the development of new secondary channels. The amount of habitat restored will depend upon the chosen restoration alternative. Alternatives 1 and 2 will allow the most habitat to be restored, as all 440 m length of riprap will be removed and channel complexity and migration will be restored to the entire modified reach. An analysis of historical photos shows that the modified reach in Illabot Creek had *over three times* the channel area before it was channelized compared to current conditions. Alternative 3 will only restore channel complexity to approximately 270 m of channel and may only allow some additional secondary channels to develop.
Biological: 8,232 parr migrants per year.

<u>Effectiveness Monitoring</u>
A monitoring plan will be developed as part of the feasibility study.

<u>Backup Actions (if direct results are not achieved)</u>
None identified at this time

10.5.4 Car Body Hole

Project Summary

This project would be to remove approximately 550 linear meters of riprap bank armoring (and associated car bodies) at Car Body Hole, which is located on the right bank of the Skagit River across from Illabot Creek. This section of the Skagit River was identified in the floodplain analysis as having a gap in off-channel habitat and there are a number of historic channels on this parcel that would likely become wetted if the bank armoring were removed. Riparian and floodplain vegetation has been cleared on most of the parcel, so this project would also restore native vegetation to the site. The purpose of this project is to restore natural channel migration and the development of off-channel habitat and also to restore native vegetation on approximately 20 hectares (50 ac) in the floodplain of the Skagit River.

Populations Targeted

All

Estimated Cost

If the parcel is purchased in order to complete habitat restoration, then the cost of acquisition would be market value at time of purchase; removal of riprap is $200,000, and riparian and floodplain planting $75,000.

Timeframe

The landowner Ezra Buller has been approached a number of times by different agencies seeking to do habitat restoration on this parcel. He has expressed some interest in this idea, but a successful agreement has never been reached. Most recently, Mr. Buller has indicated that the agencies should work with his heirs to negotiate future restoration efforts. Since it is unknown when this parcel will change owners and whether future negotiations will be successful, there is no specific time frame for this project.

Contingencies

Currently there is no contingency plan. If it is not possible to remove riprap bank armoring or restore native vegetation, then the site will remain in its currently degraded state.

Expected Direct Results

Physical: In the main channel, habitat complexity would be increased and the process of lateral channel migration would be restored. It is expected that new off-channel habitat will be formed over time as the Skagit River migrates across its floodplain. Native vegetation will improve riparian and floodplain conditions by providing edge complexity and a source for future large woody debris.
Biological: 1,996 parr migrants per year.

Effectiveness Monitoring

Monitoring design will be developed in conjunction with feasibility and baseline analysis.

Backup Actions (if Direct Results not achieved)

This project would restore natural processes, so there is little risk that it will not succeed. However, we could choose to move to more active restoration actions if passive approach is under performing.

10.5.5 Marblemount Bridge

Project Summary

The habitat gap analysis indicated that there is very little natural off-channel or backwater habitat in the two kilometer reach of the Skagit River just upstream from the bridge in Marblemount, and that almost 81 hectares (200 ac) of the floodplain is isolated or shadowed by roads and riprap bank protection. No specific project has been identified for this area, but the analysis indicates that re-connecting channels or floodplain in this area to the river should be a high priority. This could be accomplished through acquisitions, setting back dikes, and relocating roads.

Populations Targeted

All

Estimated Cost

There is no cost estimate at this time.

Timeframe

Further field investigation is needed to identify projects and evaluate the feasibility of projects in this reach.

Contingencies

Currently there is no contingency plan. If no projects are possible, then this reach will remain in its currently degraded state.

Expected Direct Results

Physical: In the main channel, habitat complexity would be increased and the process of lateral channel migration would be restored. It is expected that new off-channel habitat will be formed over time as the Skagit River migrates across its floodplain.
Biological: 9,182 parr migrants per year.

Effectiveness Monitoring

Monitoring design will be developed in conjunction with feasibility and baseline analysis.

Backup Actions (if Direct Results not achieved)

There is not a specific project at this time, so no backup actions are indicated.

10.6. RESTORATION PROJECTS IN THE REARING RANGE FOR THE UPPER SKAGIT SUMMER STOCK ONLY

10.6.1 Habitat Conditions

This rearing range has 405 hectares of floodplain with 28% isolated or impaired from roads, hydromodifications, or other floodplain structures (Figure 10.1). The mainstem channel length in this reach is 16.3 km, and the off-channel habitat length is 10.6 km, which is approximately 0.65 km of off-channel habitat length per km of mainstem length. The average floodplain width in this rearing range is relatively narrow at 266 m, and the effective width is only 192 m due to moderate floodplain impairment.

Figure 10.7 shows floodplain characteristics and habitat conditions. Floodplain boundaries are presented and areas that are isolated or shadowed by roads, hydromodifications, or other floodplain impairments are shown. Mainstem channels, backwaters, and off-channel habitats are all shown, along with the location of hydromodifications that may be impairing habitat conditions. Lastly, gaps in habitat availability are marked on the maps as likely areas to emphasize habitat restoration along with the location of specific projects described in this section. There are five gaps that were identified in this rearing range for a total of 15.7 km mainstem channel length

10.6.2 Restoration Strategy

This rearing range is characterized by a relatively narrow floodplain and a moderately high level of disturbance. The length of off-channel habitat in this rearing range is the lowest of any of the rearing ranges, likely due to a relatively narrow floodplain, moderate floodplain impairment and possibly because flow regulation from several major dams upstream has reduced off-channel habitat formation.

Due to the narrow floodplain, there is limited opportunity to form off-channel habitat, so it is especially important in this reach to restore floodplain function where there are opportunities to do so. Restoring the alluvial fan at Bacon Creek and removing hydromodifications and floodplain impairments at the upstream end of the rearing range near Newhalem provide some of the only opportunities to accomplish this, so should be high priorities. For the remainder of the range, it is important to soften existing hydromodification with the use of wood and complex structures to benefit mainstem edge complexity. Lastly, it is important to protect existing habitat by keeping roads, hydromodifications and developments out of the floodplain and avoiding timber harvest in the floodplain.

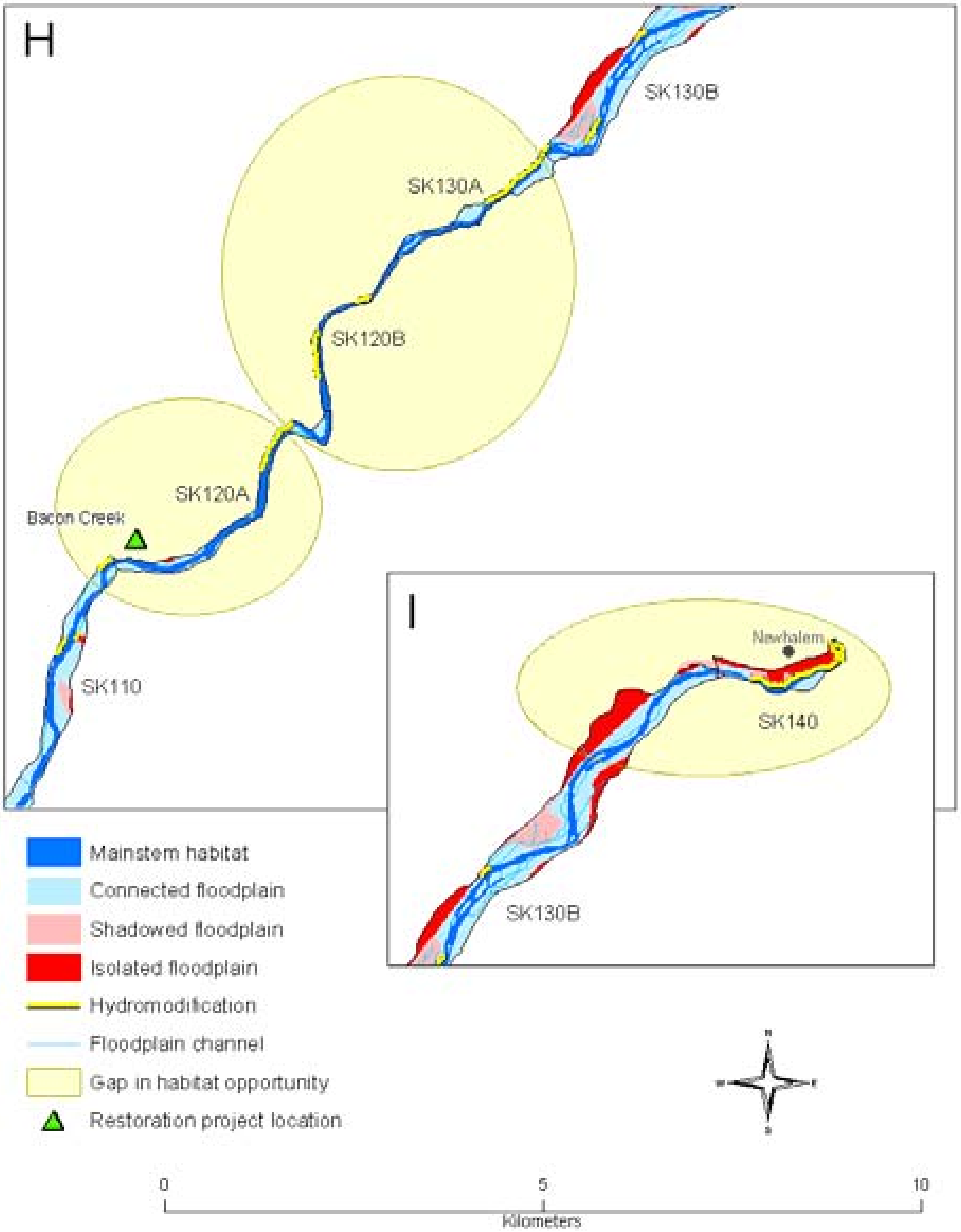

Figure 10.7. *Floodplain and habitat conditions for the Skagit River from Diobsud Creek to Newhalem.* (H) Diobsud Creek to Skagit/Whatcom county line, (I) Skagit/Whatcom county line to Newhalem.

10.6.3 Bacon Creek

Project Summary

The SR 20 road fill spans the alluvial fan and floodplain along the lower mile of Bacon Creek, which is a large tributary on the right bank of the Skagit River. The road fill crosses a small but productive groundwater tributary (Cub Creek) with a culvert that creates a barrier to juvenile fish during higher flows. In addition, the road fill reduces channel complexity in the main Bacon Creek channel and limits the development of off-channel habitat by constraining lateral channel migration. Constructing a full-spanning bridge at the Cub Creek crossing would restore fish passage and provide substantially more opportunity for channel migration and habitat development. A project was recently completed shortly upstream of SR 20 to restore lateral channel migration by relocating approximately one mile of a Forest Service road outside of the floodplain and alluvial fan of Bacon Creek, so improving the SR 20 road crossing would add value to this existing project by removing the largest remaining impact in this area. The purpose of this project is to restore complete fish passage to Cub Creek and restore the development of off-channel habitat on 11 hectares (27 ac) in the floodplain and alluvial fan of Bacon Creek.

Populations Targeted

All

Estimated Cost

Installing an additional bridge crossing structure at Bacon Creek would cost approximately one million dollars according to estimates from the Washington State Department of Transportation. This project may also require that a Seattle City Light utility tower located between SR 20 and the Skagit River be protected from erosion from Bacon Creek.

Timeframe

WSDOT has agreed to do this project if funding can be secured for the bridge, but there is currently no funding source. Once funding is secured, a project could be completed within two years.

Contingencies

Currently there is no contingency plan. If a new bridge is not constructed at the site, then the site will remain in its currently degraded state.

Expected Direct Results

Physical: In the main channel, habitat complexity would be increased and the process of lateral channel migration would be restored. It is expected that new off-channel habitat will be formed over time as Bacon Creek migrates across its floodplain and alluvial fan. Fish passage would be restored to Cub Creek.
Biological: 9,182 parr migrants per year

Effectiveness Monitoring:

Monitoring design will be developed in conjunction with feasibility and baseline analysis.

Backup Actions

Move from passive to active strategies. Identify additional bank armoring for removal

10.7. RESTORATION PROJECTS IN THE REARING RANGE OF UPPER CASCADE SPRINGS ONLY

10.7.1 Habitat Conditions

This rearing range has 330 hectares of floodplain with 4% isolated or impaired from roads, hydromodifications, or other floodplain structures (Figure 10.1). The mainstem channel length in this reach is 10.1 km, but the off-channel habitat length or other habitat parameters were not available. The average floodplain width in this rearing range is moderately wide at 453 m, and the effective width is 433 m with only minimal floodplain impairments.

Figure 10.8 shows floodplain characteristics and habitat conditions. Floodplain boundaries are presented and areas that are isolated or shadowed by roads, hydromodifications, or other floodplain impairments are shown. Mainstem channels, backwaters, and off-channel habitats are all shown, although the habitat inventory was not completed for this rearing reach. The location of hydromodifications that may be impairing habitat conditions is also shown. The habitat gap analysis was not completed for this rearing range due to insufficient data.

10.7.2 Restoration Strategy

A moderately wide floodplain and a minimal level of floodplain disturbance characterize this rearing range. Habitat data were not available, but field observations indicate that this rearing range has a large quantity of off-channel habitat.

The only habitat restoration project that would benefit this rearing range would be to remove or extend the bridge crossing for Forest Road 1570 to span the entire floodplain. This would increase mainstem edge complexity and restore processes that create of off-channel habitat. It is also especially important in this rearing range to protect existing habitat by keeping roads, hydromodifications and developments out of the floodplain and avoiding timber harvest in the floodplain.

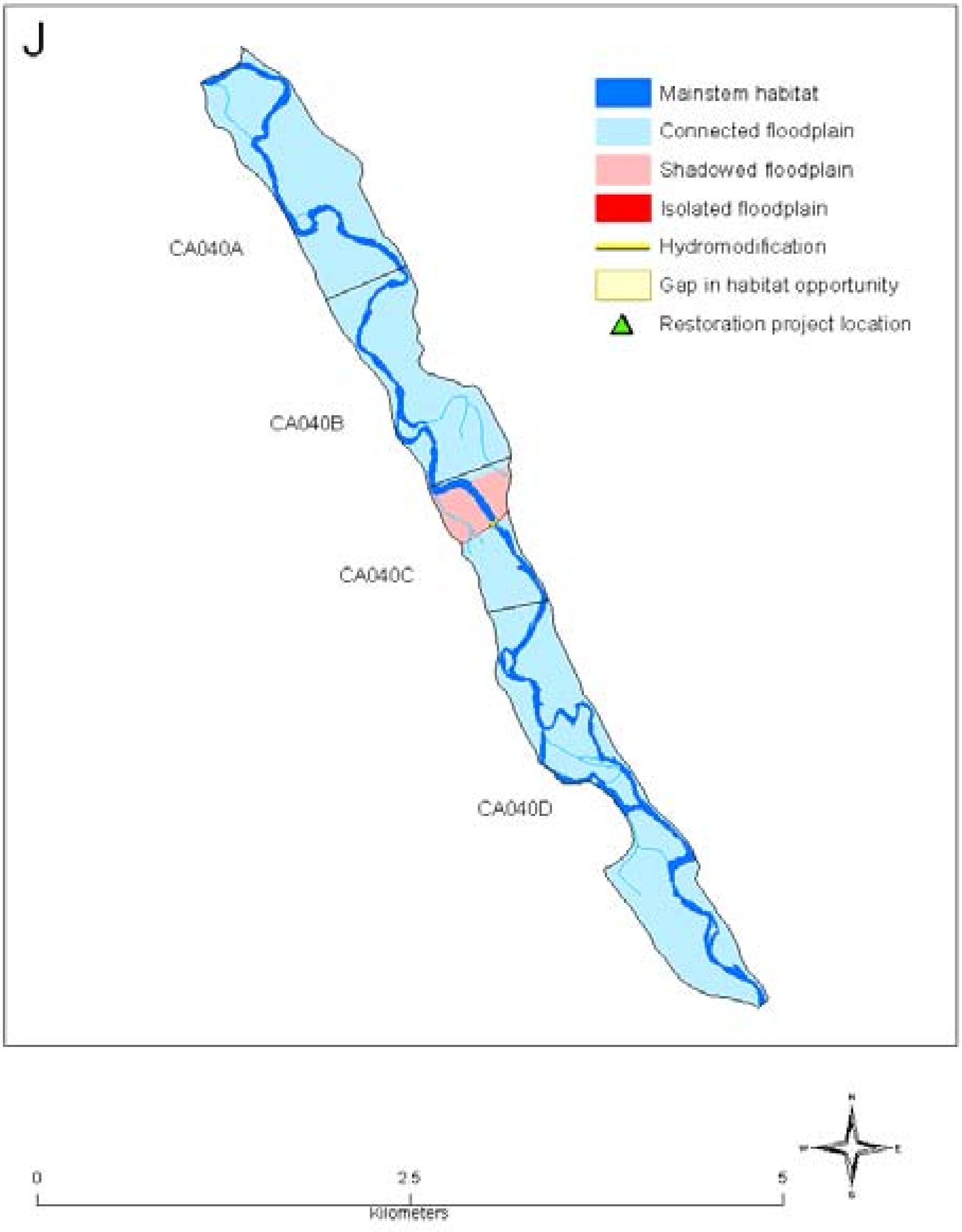

Figure 10.8. *Floodplain and habitat conditions for the upper Cascade River from Marble Creek to Kindy Creek.* (J) Marble Creek to Kindy Creek.

10.8. RESTORATION PROJECTS IN THE REARING RANGE OF ALL SAUK AND SUIATTLE STOCKS

10.8.1 Habitat Conditions

This rearing range has 1,657 hectares of floodplain with 27% isolated or impaired from roads, hydromodifications, or other floodplain structures (Figure 10.1). The mainstem channel length in this reach is 20.5 km, and the off-channel habitat length is 53.2 km, which is approximately 2.6 km of off-channel habitat length per km of mainstem length. The average floodplain width in this rearing range is relatively wide at 897 m, and the effective width is only 657 m due to moderate floodplain impairment.

Figure 10.9 shows floodplain characteristics and habitat conditions. Floodplain boundaries are presented and areas that are isolated or shadowed by roads, hydromodifications, or other floodplain impairments are shown. Mainstem channels, backwaters, and off-channel habitats are all shown, along with the location of hydromodifications that may be impairing habitat conditions. Lastly, gaps in habitat availability are marked on the maps as likely areas to emphasize habitat restoration along with the location of specific projects described in this section. There are three gaps that were identified in this rearing range for a total of 8.6 km mainstem channel length.

10.8.2 Restoration Strategy

This rearing range is characterized by alternating sections of wide and narrow floodplains and has a moderately high level of floodplain disturbance. As a whole, this rearing range has the largest length of off-channel habitat per mainstem length of any of the rearing ranges, primarily because of the very wide floodplain and large amount of habitat near the mouth of the river.

However, there are a number of hydromodifications and floodplain impacts, mostly associated with bridges, roads, and also some private property developments. The strategy for this rearing range is to extend bridge crossings where they cross the floodplain, remove hydromodifications where they interfere with floodplain functions, and soften hydromodifications with the use of wood and complex structures where they are on the edge of the floodplain. There are also a number of roads that could be relocated outside or to the edge of the floodplain, although some of them are major highways so the expense may be high. Lastly, it is important to protect existing habitat by keeping roads, hydromodifications and developments out of the floodplain and avoiding timber harvest in the floodplain.

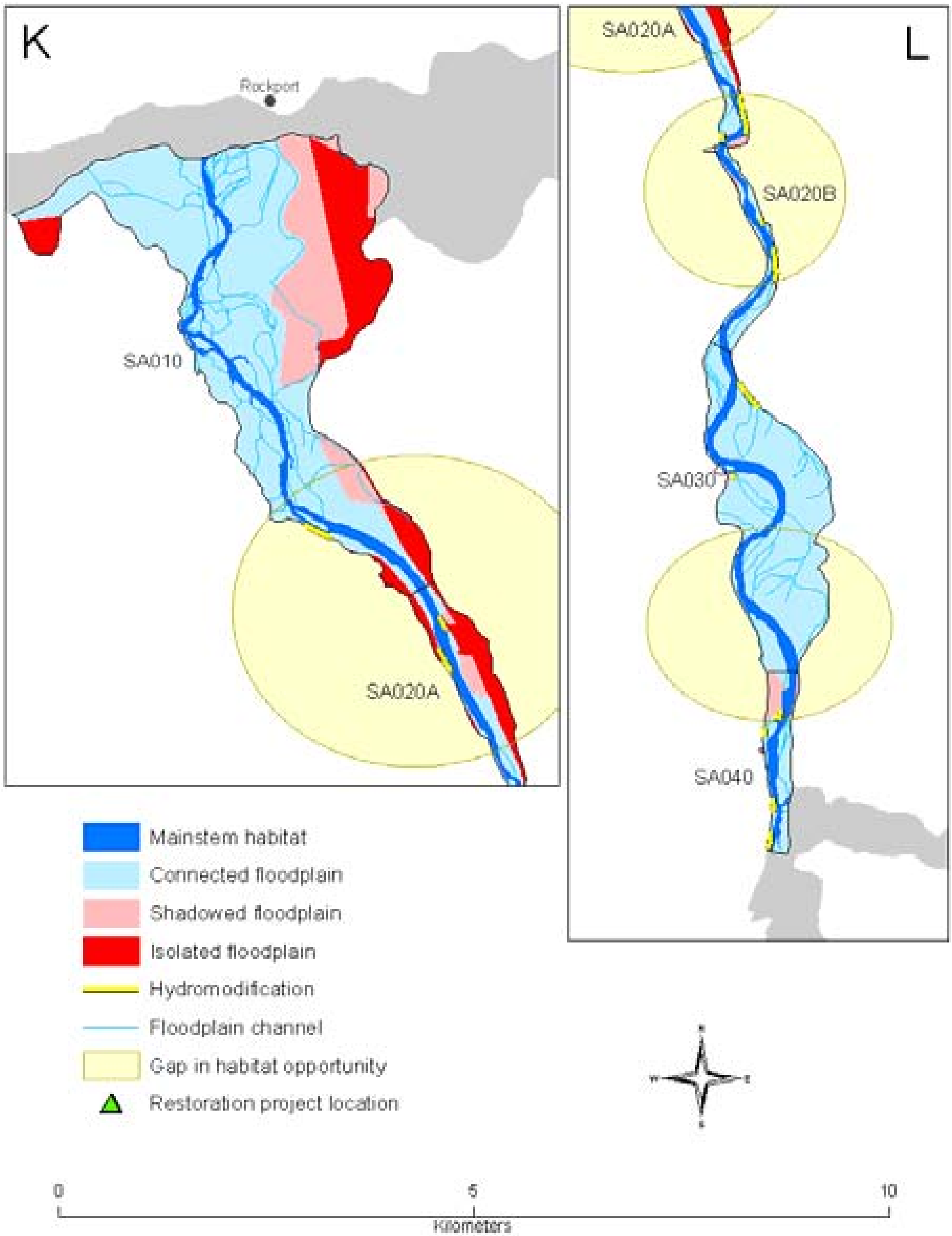

Figure 10.9. *Floodplain and habitat conditions for the Sauk River from the Skagit River to the Suiattle River.* (K) south of the Skagit, (L) north of the Suiattle.

10.8.3 Government Bridge

Project Summary

The habitat gap analysis showed that the Sauk River downstream from the Suiattle River between River KM 16.6-19.0 is lacking in off-channel and backwater habitat. The primary floodplain modification in this area is the Government Bridge and associated bank protection projects. The road fill associated with this bridge blocks connection to a historic floodplain channel and function for approximately 22 hectares (54 ac) of floodplain. A project in this location would involve constructing a bridge to span at least a portion of the floodplain, which extends approximately 215 meters on the left bank side of the Sauk River. The purpose of this project is to restore mainstem channel complexity and the development of off-channel habitat through the natural process of channel migration on the Sauk River.

Populations Targeted

All Sauk and Suiattle stocks

Estimated Cost

A larger bridge span would cost a minimum of $1,000,000.

Timeframe

There is no specific timeframe, but it makes sense to pursue habitat restoration in this reach as part of the Sauk River Reach Study, which is currently proposed and will hopefully be funded.

Contingencies

Currently there is no contingency plan. If it is not possible to expand the bridge span or remove riprap bank armoring, then this reach will remain in its currently degraded state.

Expected Direct Results

Physical: In the main channel, habitat complexity would be increased and the process of lateral channel migration would be restored. It is expected that new off-channel habitat will be formed over time as the Sauk River migrates across its floodplain.
Biological: 5,507 parr migrants per year.

Effectiveness Monitoring

Monitoring design will be developed in conjunction with feasibility and baseline analysis.

Backup Actions (if Direct Results not achieved)

This project would restore natural processes, so there is little risk that it will not succeed.

10.9. RESTORATION PROJECTS IN THE REARING RANGE OF LOWER AND UPPER SAUK STOCKS

10.9.1 Habitat Conditions

This rearing range has 1,392 hectares of floodplain with 16% isolated or impaired from roads, hydromodifications, or other floodplain structures (Figure 10.1). The mainstem channel length in this reach is 30.3 km, and the off-channel habitat length is 67.3 km, which is approximately 2.22 km of off-channel habitat length per km of mainstem length. The average floodplain width in this rearing range is moderately wide at 536 m, and the effective width is 451 m with only moderate floodplain impairment.

Figure 10.10 shows floodplain characteristics and habitat conditions. Floodplain boundaries are presented and areas that are isolated or shadowed by roads, hydromodifications, or other floodplain impairments are shown. Mainstem channels, backwaters, and off-channel habitats are all shown, along with the location of hydromodifications that may be impairing habitat conditions. Lastly, gaps in habitat availability are marked on the maps as likely areas to emphasize habitat restoration along with the location of specific projects described in this section. There was one gap that was identified in this rearing range for a total of 3.5 km mainstem channel length.

10.9.2 Restoration Strategy

This rearing range is characterized in the lower section (from Darrington downstream) by a relatively wide floodplain and a moderate level of floodplain disturbance, while in the upper section (upstream of Darrington) the floodplain is significantly narrower, and has a relatively low level of disturbance. The lower section has a much larger amount of off-channel habitat than the upper section, primarily because of the lower gradient and wider floodplain. The lower section has one of the largest lengths of off-channel habitat per unit mainstem length of any of the rearing ranges.

The lower section has a number of hydromodifications and floodplain disturbances that should be addressed, particularly in the area near the town of Darrington and several kilometers downstream. It is important for both sections in this range to protect the current conditions by keeping roads, hydromodifications and developments out of the floodplain and avoiding timber harvest in the floodplain.

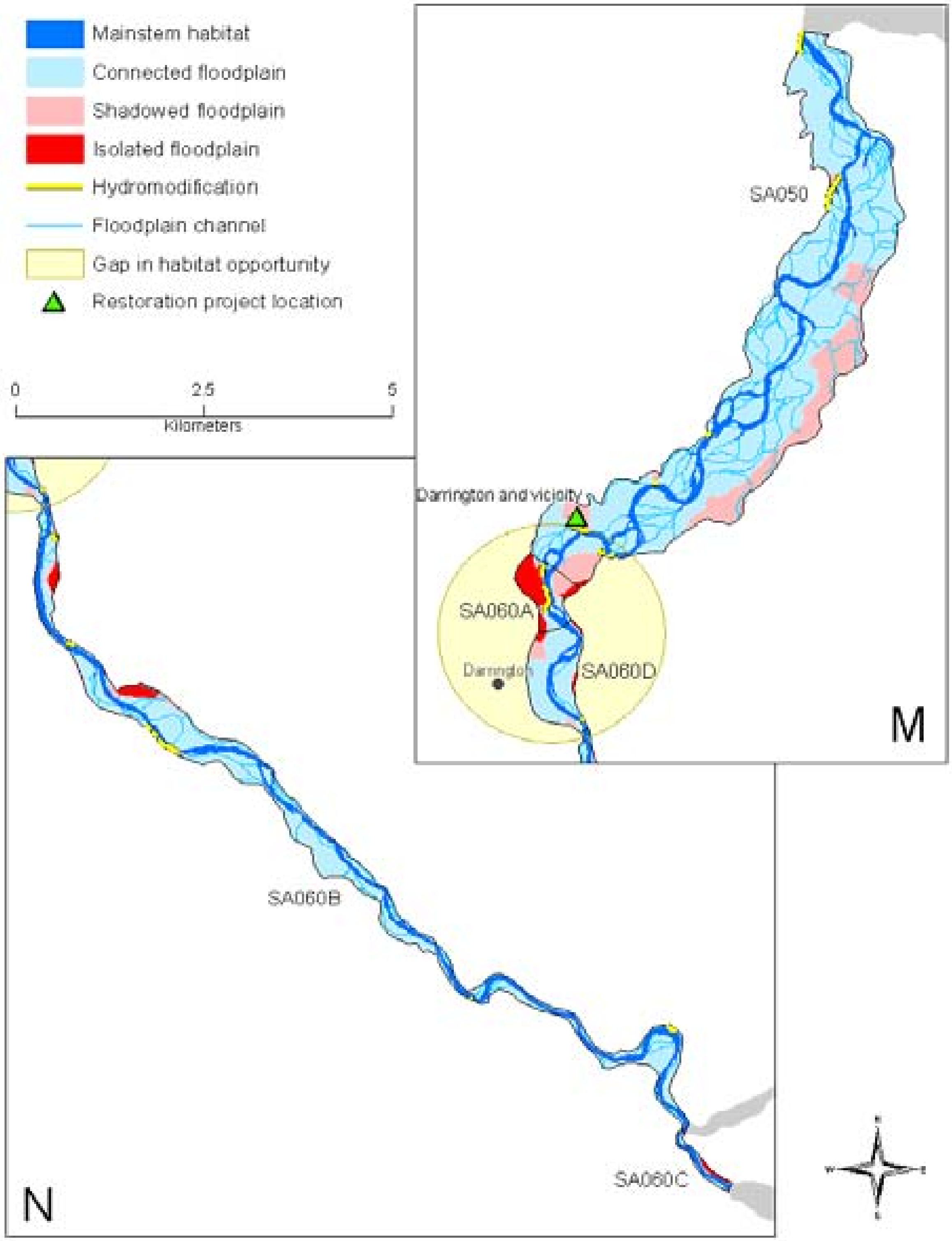

Figure 10.10. *Floodplain and habitat conditions for the Sauk River from the Suiattle River to the Whitechuck River.* (M) Suiattle River to Darrington, (N) Darrington to the Whitechuck River.

10.9.3 Darrington and Vicinity

Project Summary

The habitat gap analysis showed that the Sauk River between River KM 31.7-35.2 is lacking in off-channel and backwater habitat. This reach includes the town of Darrington, the Sauk Prairie Bridge, the Hampton timber mill, and private property owners. Significant portions of the floodplain are isolated or shadowed by roads or hydromodifications (approximately 67 ha or 164 ac), but restoration may not be costly or not possible due to the high value of some of the developments in this area. However, this reach should be evaluated in more detail, and some practical restoration actions might include increasing the span length for the bridge and removing hydromodifications on some of the properties downstream from the Hampton Mill. The purpose of this project is to restore mainstem channel complexity and the development of off-channel habitat through the process of natural channel migration on the Sauk River.

Populations Targeted

Lower Sauk summers and upper Sauk springs

Estimated Cost

No cost estimate at this time.

Timeframe

There is no specific timeframe, but it makes sense to pursue habitat restoration in this reach as part of the Sauk River Reach Study, which is currently proposed and will hopefully be funded.

Contingencies

Currently there is no contingency plan. If it is not possible to expand the bridge span or remove riprap bank armoring, then this reach will remain in its currently degraded state.

Expected Direct Results

Physical: In the main channel, habitat complexity would be increased and the process of lateral channel migration would be restored. It is expected that new off-channel habitat will be formed over time as the Sauk River migrates across its floodplain.
Biological: 9,394 parr migrants per year.

Effectiveness Monitoring

Monitoring design will be developed in conjunction with feasibility and baseline analysis.

Backup Actions (if Direct Results not achieved)

This project would restore natural processes, so there is little risk that it will not succeed.

10.10. RESTORATION PROJECTS IN THE REARING RANGE OF UPPER SAUK SPRINGS ONLY

10.10.1 Habitat Conditions

This rearing range has 475 hectares of floodplain with 6% isolated or impaired from roads, hydromodifications, or other floodplain structures (Figure 10.1). The mainstem channel length in this reach is 12.9 km, and the off-channel habitat length is 25.4 km, which is approximately 1.97 km of off-channel habitat length per km of mainstem length. The average floodplain width in this rearing range is moderately wide at 471 m, and the effective width is 444 m with only minimal floodplain impairment.

Figure 10.11 shows floodplain characteristics and habitat conditions. Floodplain boundaries are presented and areas that are isolated or shadowed by roads, hydromodifications, or other floodplain impairments are shown. Mainstem channels, backwaters, and off-channel habitats are all shown, along with the location of hydromodifications that may be impairing habitat conditions. Lastly, gaps in habitat availability are marked on the maps as likely areas to emphasize habitat restoration along with the location of specific projects described in this section. There were no gaps that were identified in this rearing range.

10.10.2 Restoration Strategy

This rearing range is characterized by a moderate width floodplain and a minimum of floodplain disturbance. For this reason, there is extensive off-channel habitat development and overall a high level of freshwater rearing habitat. There are a few hydromodifications that could be softened or removed, but the most important actions to take in this range is to protect the current conditions by keeping roads, hydromodifications and developments out of the floodplain and avoiding timber harvest in the floodplain.

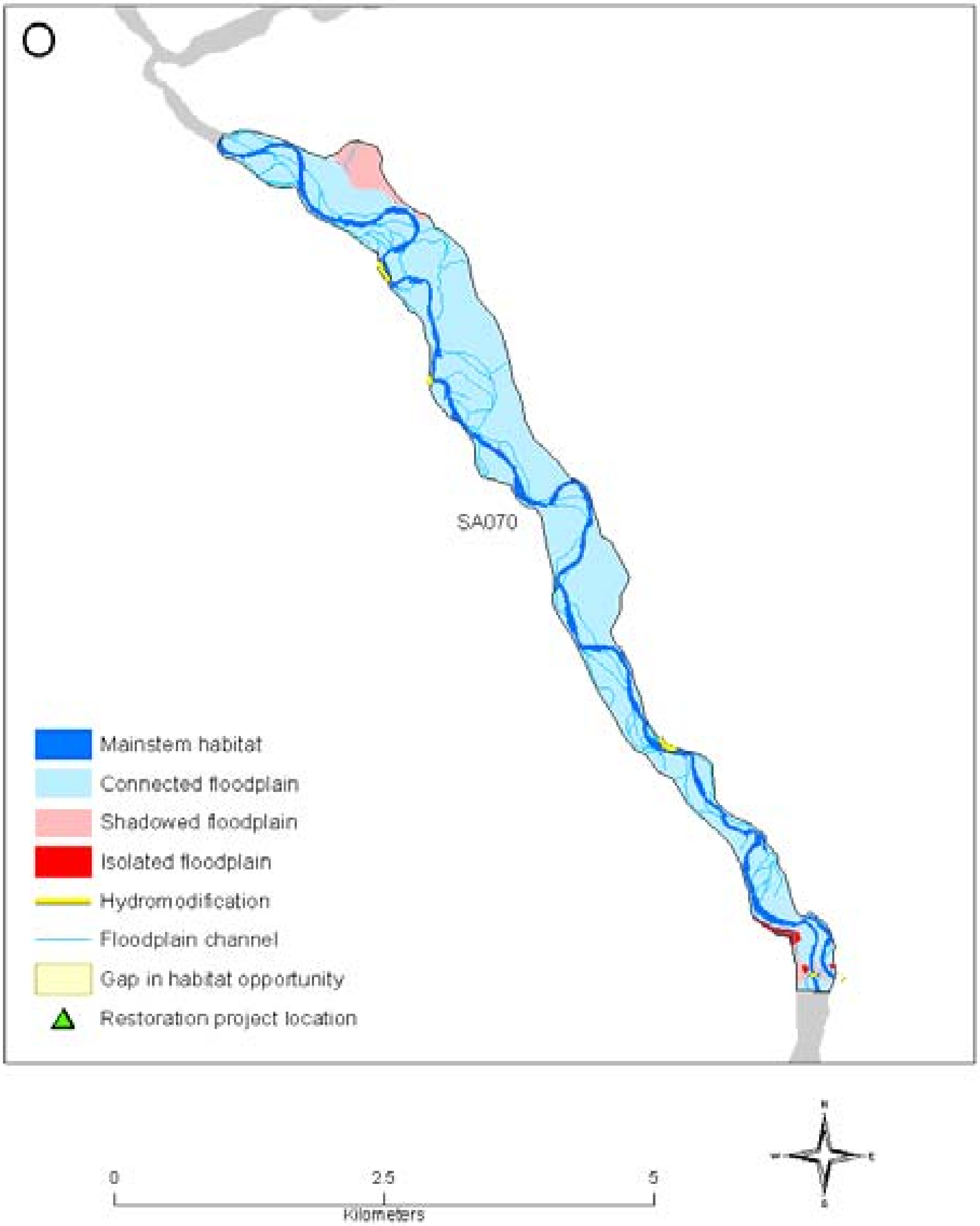

Figure 10.11. *Floodplain and habitat conditions for the Sauk River from the Whitechuck River to the Forks.* (O) Whitechuck River to the Forks.

10.11. RESTORATION PROJECTS IN THE REARING RANGE OF SUIATTLE SPRINGS ONLY

10.11.1 Habitat Conditions

This rearing range has 1,436 hectares of floodplain with 6% isolated or impaired from roads, hydromodifications, or other floodplain structures (Figure 10.1). The mainstem channel length in this reach is 40.6 km, and the off-channel habitat length is 52.3 km, which is approximately 1.29 km of off-channel habitat length per km of mainstem length. The average floodplain width in this rearing range is moderately wide at 420 m, and the effective width is 395 m with only minimal floodplain impairment.

Figure 10.12 shows floodplain characteristics and habitat conditions. Floodplain boundaries are presented and areas that are isolated or shadowed by roads, hydromodifications, or other floodplain impairments are shown. Mainstem channels, backwaters, and off-channel habitats are all shown, along with the location of hydromodifications that may be impairing habitat conditions. Lastly, gaps in habitat availability are marked on the maps as likely areas to emphasize habitat restoration along with the location of specific projects described in this section. There were two gaps that were identified in this rearing range for a total of 2.4 km mainstem channel length.

10.11.2 Restoration Strategy

This rearing range is characterized by a moderate floodplain width and a relatively low level of floodplain disturbance. However, the Suiattle has a lower off-channel habitat length per mainstem length than the upper Sauk River, which has a similar floodplain width. There were a few gaps in habitat that were identified in the analysis. There are several hydromodifications and floodplain roads that could be removed or upgraded to increase rearing habitat. However it is also important to protect the current conditions by keeping roads, hydromodifications and developments out of the floodplain and avoiding timber harvest in the floodplain.

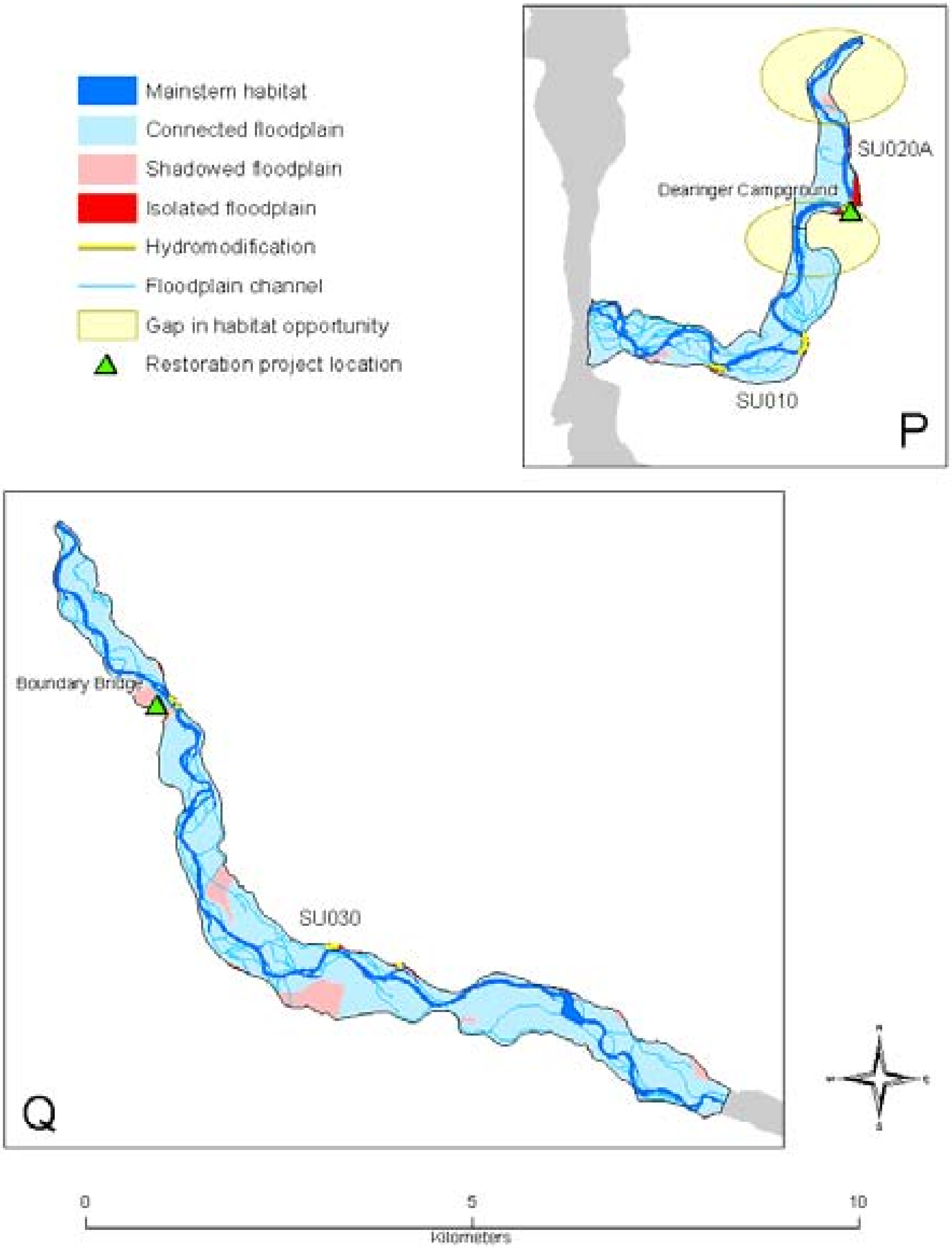

Figure 10.12. *Floodplain and habitat conditions for the Suiattle River.* (P) The mouth to the bottom of the canyon reach, (Q) the top of the canyon reach to Milk Creek.

10.11.3 Dearinger Campground Road

Project Summary

The habitat gap analysis showed that the Sauk River between River KM 5.2-6.2 is lacking in off-channel and backwater habitat. The primary floodplain modification in this area includes several riprap bank protection structures along a road that leads to Dearinger Campground. The one on the left bank of the Suiattle River at approximately River KM 6.8 was damaged during the flood of 2003 and is currently being considered for repairs. This is outside the identified reach, but the floodplain in this area is large enough that restoration at this site could benefit the identified reach. A project at this site would involve removing the riprap bank protection and relocating the road outside the floodplain. Although this project has not been scoped in detail, it would be relatively straightforward to relocate this road because it is not paved and the surrounding land use is entirely timber with no houses, structures, or other developments.

The purpose of this project is to restore mainstem channel complexity and the development of off-channel habitat through the process of natural channel migration on the Suiattle River.

Populations Targeted

All

Estimated Cost

Removal of riprap bank armoring and relocating the road would cost between $150,000 and $300,000. It is possible that some acquisition or easement exchanges would be necessary to construct a new road, which could cost up to $250,000.

Timeframe

This project has not been scoped in detail, but it would make sense to pursue this project in the context of repair work that is currently being planned for the road.

Contingencies

Currently there is no contingency plan. If it is not possible to remove riprap bank armoring, this reach will remain in its currently degraded state.

Expected Direct Results

Physical: In the main channel, habitat complexity would be increased and the process of lateral channel migration would be restored. It is expected that new off-channel habitat will be formed over time as the Suiattle River migrates across its floodplain.

Biological: No estimate at this time.

Effectiveness Monitoring

Monitoring design will be developed in conjunction with feasibility and baseline analysis.

Backup Actions (if Direct Results not achieved)

This project would restore natural processes, so there is little risk that it will not succeed.

10.11.4 Boundary Bridge

Project Summary

Restore floodplain connectivity by removing road and fill material associated with Boundary Bridge on the south side of the Suiattle River. Approximately 260 linear meters of road crosses the floodplain in this location. This road blocks several historic channels and isolates approximately 17 hectares (43 ac) of floodplain. The bridge currently does not provide access because the river eroded approximately 25 meters of the approach on the south side in October 2003. Habitat restoration options include removing the bridge and all of the associated roadfill in the floodplain or extending a new bridge span across a portion of the floodplain and replacing fill material with large culverts in historic channel crossings.

Populations Targeted

All

Estimated Cost

Exact costs have yet to be determined, but removing the road fill would cost approximately $300,000 plus the cost of removing the bridge. Adding a new bridge span and putting culverts in the existing road fill would cost between $1- $2.5 million. Some funds could come from emergency money provided to the Forest Service by the Federal Highways Administration, but habitat restoration elements may needed to be funded by another source.

Timeframe

Currently the federal agencies are completing environmental assessment work and will be making a decision on the preferred alternative sometime in 2005. This alternative may or may not include significant habitat restoration elements. Once that is completed, design, permitting, and implementation could take an additional two to three years.

Contingencies

These will be worked out as part of the assessment, design, and permitting process.

Expected Direct Results

Physical: If implemented, this project is expected to restore connectivity between the Suiattle River and its floodplain and increase the development of off-channel habitat in the floodplain as a result of channel migration after the road fill is removed.
Biological: 6,868 parr migrants per year.

Effectiveness Monitoring

Flow conditions, side channel formation, and fish utilization will be monitored in the floodplain habitats after the bridge is removed or improved.

Backup Actions (if Direct Results not achieved)

These will be worked out as part of the assessment, design, and permitting process.

10.11.5 Downey Creek Crossing

Project Summary
This project involves closing the Suiattle River Road at the Downey Creek Crossing, or expanding the bridge crossing over Downey Creek to a length that would minimize impacts to approximately 1.2 hectares (3 ac) of the alluvial fan associated with the Downey Creek near the confluence with the Suiattle River.

Populations Targeted
Suiattle springs

Estimated Cost
Road Closure would be the least costly since the crossing is currently washed out from the October 2003 flood event. Costs with this option could be as low as $200,000 for decommissioning and/or movement of the camping area and trail upgrades. The second option, which would restore vehicle passage to the Sulphur Creek Campground and Suiattle River trailheads could cost in excess of $1.5 million depending on crossing design and load rating.

Timeframe
Public pressure to re-open access to the Suiattle River trailheads is very high. USFS teams are currently reviewing options for re-development of this stream crossing. Preferred options will likely be identified (already identified) and implemented in 2006 (or maybe this summer)

Contingencies
Off-channel habitats associated with the Downey Creek alluvial fan will again be isolated and impaired if crossing is redeveloped to its original footprint. Road fill associated with the crossing could be retrofitted with a culvert if no other option is selected. However, this would likely lead to limited habitat value for Chinook.

Expected Direct Results
Physical: If natural processes are allowed to work over the entire available floodplain of this fan, then we would expect the development of one or more new channels through this transitional section of Downey Creek. Presently, sediments and hydrology are concentrated in the channel passing under the bridge, thereby limiting the suitability of habitat within this reach for Chinook due to swift flows and large substrates.
Biological: 4,897 parr migrants per year.

Effectiveness Monitoring
Monitoring design will be developed in conjunction with feasibility and baseline analysis.

Backup Actions (if Direct Results not achieved):
These will be worked out as part of the assessment, design, and permitting process.

11. RESTORATION ACTIONS IN TIDAL DELTA REARING HABITAT

The tidal delta is the lower portion of the Skagit geomorphic delta that is influenced by tidal hydraulics and saltwater mixing (Figure 8.1). Biological evidence indicates a significant need for improvements in both estuarine habitat capacity and connectivity in order to achieve recovery of wild Skagit Chinook salmon populations. Appendix D contains detailed information regarding studies that have been conducted within the Skagit Basin that led us to this conclusion. All six Skagit Chinook stocks benefit from restoration of tidally influenced delta habitat.

11.1. GENERAL TIDAL DELTA RESTORATION STRATEGY

Estuarine habitat can be divided into three major types based upon vegetation. The outer edge is emergent marsh habitat, characterized by sedges and grasses. Upstream of this zone is an area of transition habitat between the emergent vegetation and the upstream-forested zone. The vegetation in the transition area consists of scrub-shrub: small trees and bushes. The upper extent of estuarine habitat is the forested riverine tidal zone, which supports trees. The functions of each of these zones and how they relate to salmon rearing are not well understood. However, in the Skagit, Chinook juveniles grow fastest in the emergent marsh habitat with growth rates averaging 1.68 mm per day, compared to a rate of 0.53 mm per day in the transitional and forested zones (SSC and USGS 1999). Tidal marsh habitat produces an average annual standing crop of five tons of vegetation per hectare, supporting a vast array of insects and crustaceans that serve as prey for juvenile salmon (Kistritz 1996).

Under present day conditions, the contiguous habitat area of the Skagit delta that is exposed to tidal and river hydrology totals about 3,118 hectares (Figure 11.1). This is mostly the delta area in the vicinity of Fir Island, but it also includes a fringe of estuarine habitat extending from La Conner to the north end of Camano Island. Historically, the contiguous habitat area of the Skagit delta included the same area, but also included the Swinomish Channel corridor and extended to the southern end of Padilla Bay (Collins 2000). The historic area equaled 11,483 hectares. This results in a seventy-three percent (73%) loss of tidal delta footprint.

Based on the arrangement of existing delta habitat and the need for more of it, it is unlikely that we could achieve Skagit Chinook recovery without at least two delta restoration projects that strongly improve the pathways that juvenile Chinook salmon can find and occupy delta habitat. Therefore, we have included two connectivity projects, one for central Fir Island and another for Swinomish Channel. The Swinomish Channel project would to take advantage of the large restoration potential along Swinomish Channel and southern Padilla Bay as well as improve pathways to existing under utilized nearshore habitat within Padilla Bay. Potential delta restoration sites are shown in Figure 11.2.

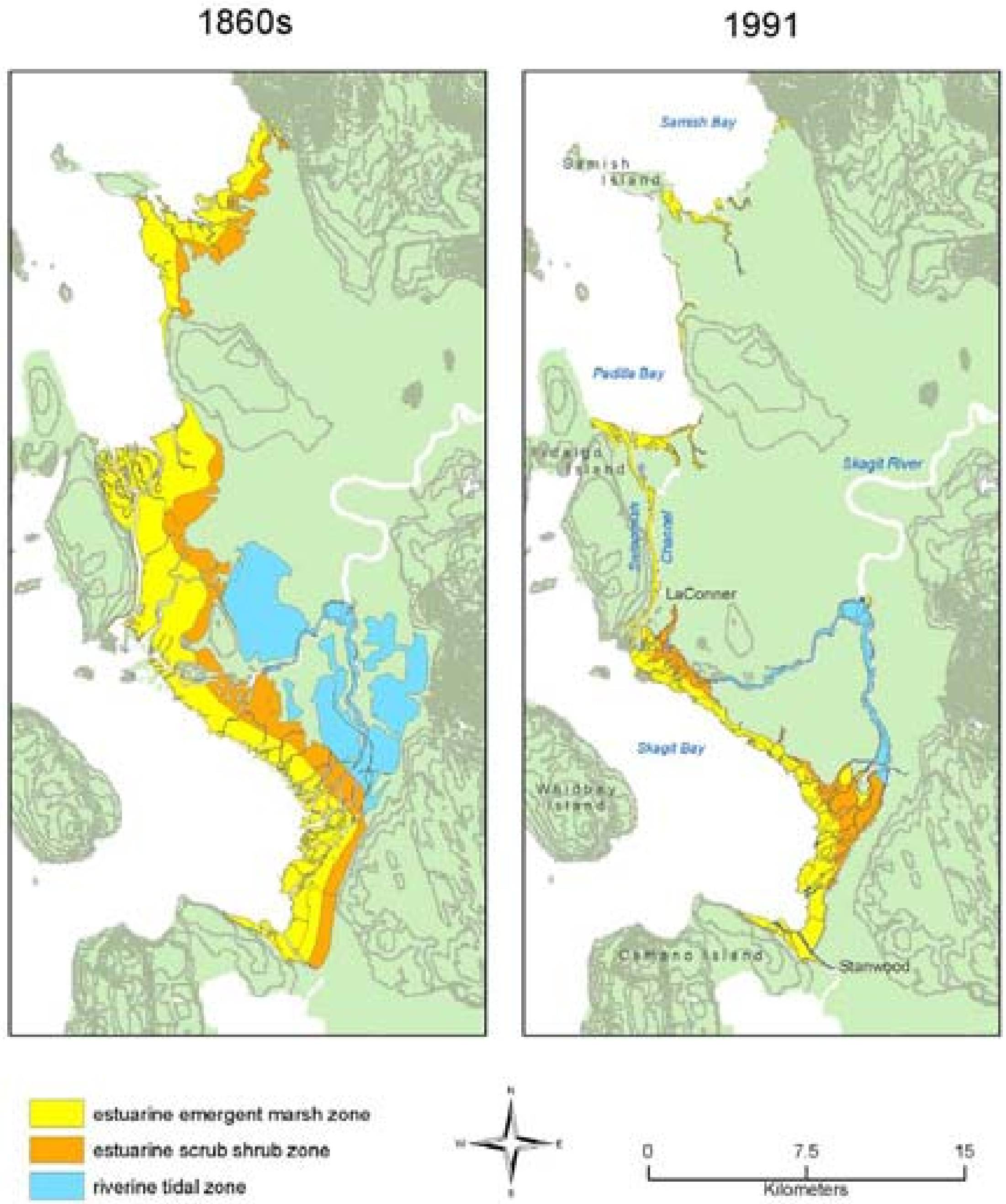

Figure 11.1. *Changes to the estuarine habitat zones within the geomorphic Skagit Delta.* Historic (circa. 1860s) conditions were reconstructed by Collins (2000) using archival maps and survey notes. Current habitat zones were mapped by Beamer et al. (2000b) using 1991 orthophotos.

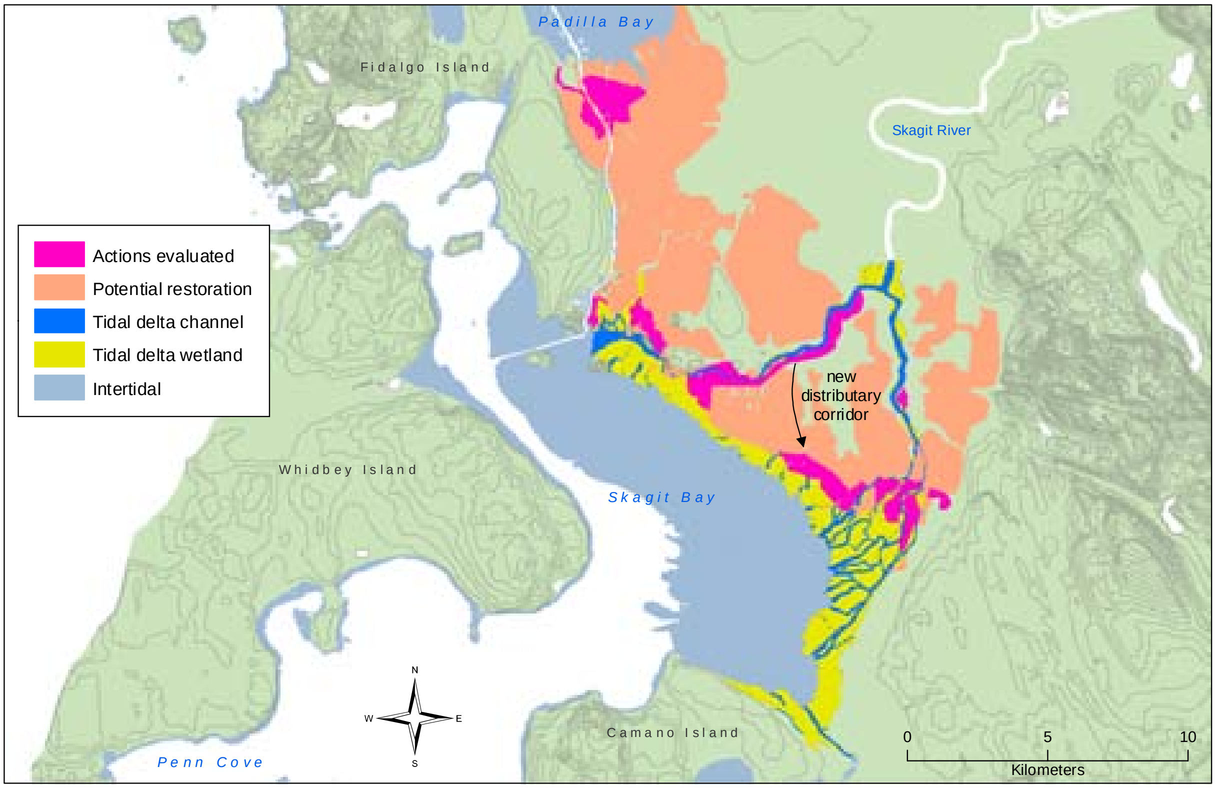

Figure 11.2. *Existing delta habitats and potential restoration.* Location of existing delta habitats that are easily accessible to delta rearing Chinook salmon (yellow and blue polygons) and the location of potential delta restoration (pink polygons).

11.2. IMPLEMENTATION

Recognizing the logistic complexities, scientific and engineering challenges, funding constraints and social barriers to implementing restoration actions we propose establishing specific implementation goals based on four five year incremental milestones. We have grouped our specific restoration recommendations into each of three milestone sequences: the years 2010, 2015 and 2020.

Projects listed under the long-term restoration horizon are generally less well developed and have a host of uncertainties or complexities that must be addressed before implementation could be expected to proceed. All of these projects are socially complex and resource intensive so will need to include some elements of mutually understood benefits for most, if not all, interest groups involved. For example, The North Fork levee setback project must have a demonstrable flood protection benefit to the residents of Fir Island before we would expect community acceptance of such a project. Furthermore, projects identified here would have very direct implications for particular landowners. For this reason alone many of these proposed projects will hinge on the success of projects implemented in the 5-10 year phases. The necessary incentive and institutional programs will need to be in place and working before landowner agreement can be reached. Projects identified in the 15 year implementation horizon will be informed by the relative success or failure of projects implemented in the first two phases of this plan. In this respect, the projects listed here are expected to be real time elements of our adaptive management strategy as they move toward further development and prospective implementation.

11.3. NEAR-TERM TIDAL DELTA RESTORATION PROJECTS

11.3.1 Wiley Slough

Project Summary

Set back dikes to the pre-1956 footprint of the levee system along Wiley Slough. The property is currently in public ownership. Details are available in a recently published design report (SRSC 2005) (Figure 11.3).

Purpose

Improve habitat connectivity and capacity.

Populations Targeted

All

Estimated Cost

Project design is currently underway having been funded by the Salmon Recovery Funding Board and matched with funds from Seattle City Light and in-kind contributions from WDFW and several other organizations. Design funding cost approximately $150,000. Preliminary cost estimates from the design phase place implementation costs near $2.5 Million.

Timeframe

High level of probability. Project design will be completed in early 2005. Assuming agency concurrence project funding and permitting can begin almost immediately. Successful funding can potentially lead to project implementation as early as 2006. However, 2007 implementation will likely be more realistic given the size of the funding need and the potential for delays from challenges by user groups.

Contingencies

Hunting groups are adamantly opposed to this project and will make every effort to prevent its implementation. Legal challenges are a possibility and could delay implementation for several years if the challenges are considered meritorious by the judicial system.

Expected Results

Physical: 65.0 ha of estuarine marsh area reconnected to tidal processes. Allometry predictions suggest this area can sustain 2.0 hectares of channel habitat with a connectivity rating of .040.
Biological: The resulting Chinook production is estimated to increase by approximately 38,492 smolts.

Effectiveness Monitoring

See Chapter 15 for details on estuarine monitoring strategy.

Backup Actions (if Direct Results not achieved)

Outmigrant rearing is strongly dependent on the development of channel area. However, a variety of factors could impede or retard channel development. Dense mats of established invasive vegetation is one such factor. If invasive species become a problem active management techniques will need to be employed to open channel corridors and control invasive spread.

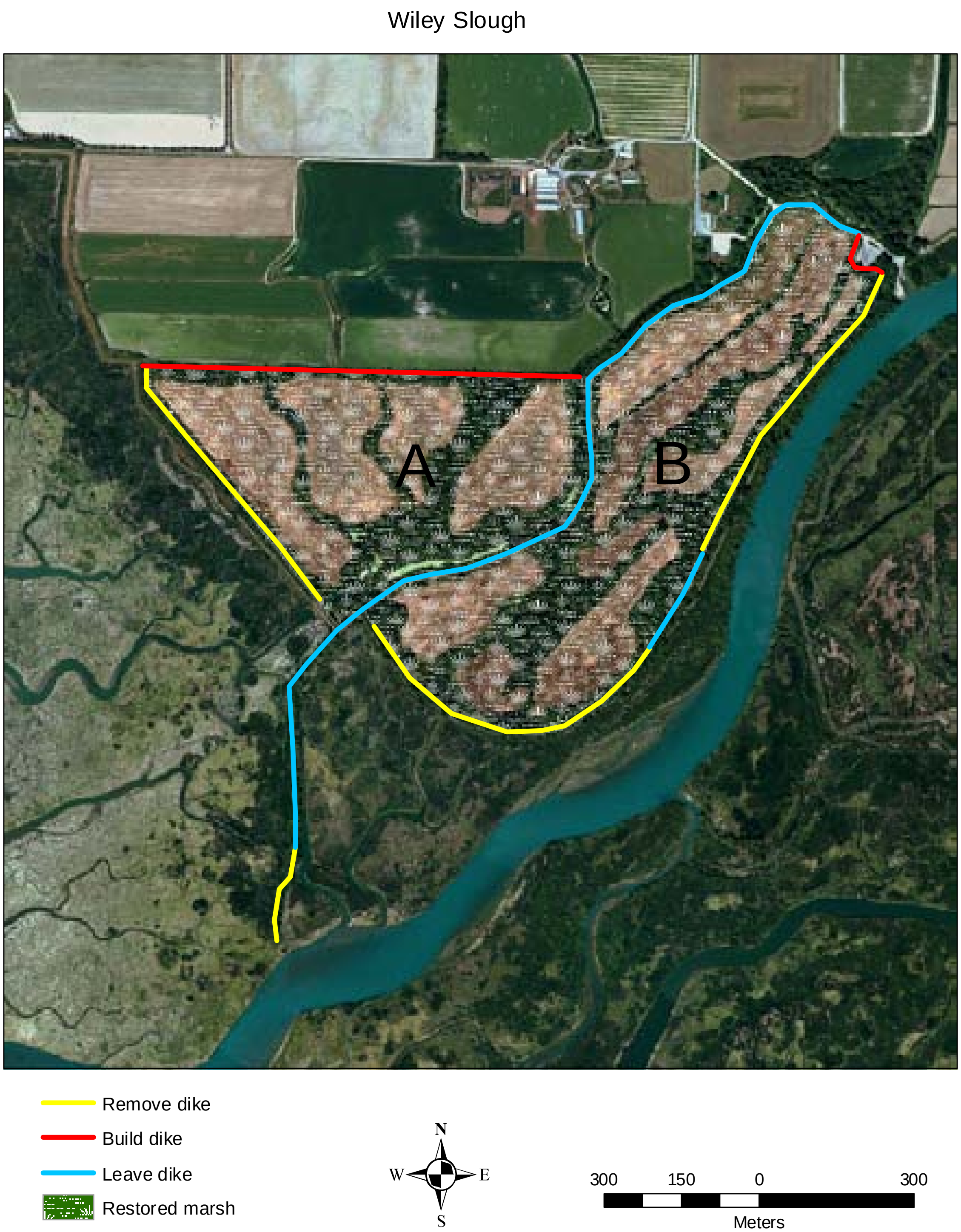

Figure 11.3. *Wiley Slough.* Wiley Slough site potential. Current on-site channels (red), including borrow ditches. Historical channels (black; observed from 1937 photos) often coincide with current channel remnants. The northeastern portion of the site was diked by 1889. The remainder was not diked until the early 1960s, so detailed reconstruction of historical channels on much of the site is possible through reference to historical (1937 and 1956) photos.

11.3.2 Milltown Island

Project Summary
Milltown Island (212 diked acres) was sold to WDFW after farming was deemed impractical in this area. The site has lain fallow and restoration efforts have been minimal, consisting of several *ad hoc* dike breaches in 2000. On-site tidal channel abundance is much less than in nearby reference areas. We propose to extensively breach dikes to restore tidal and riverine processes that will scour and maintain on-site tidal channels (Figure 11.4).

Purpose
To remove hydraulic controls on Milltown island that limit the development of channel networks and native vegetation.

Populations Targeted
All

Estimated Cost
$100,000 has been secured through Seattle City Light's ESA program. This money has been used as matching funds to secure a $350,000 commitment from the SRFB in 2004.

Timeframe
Planning and permitting work is now underway. These should be finished in 2005, allowing implementation work to proceed in 2006 and 2007.

Contingencies
Methods for project implementation are not settled. Explosives have been used in the past to breach the levees in selected locations. This method is also being considered again, however, ESA constraints could restrict the use of ordinances so other methods such as barging, hauling or spreading are being considered. Costs are expected to vary depending on methods approved.

Restoring shrub habitat to this site and eliminating or greatly reducing reed canary grass in the process will be difficult. While control of RCG is generally problematic, competition and shading by shrubs can be effective (Apfelbaum and Sams 1987). The topographic elevation in the Milltown area is appropriate to scrub-shrub growth (Hood 2004); a mowing and planting program is needed to bypass early life stage competition between shrubs and RCG.

Expected Direct Results
Physical: Tidal channel density relationships in undiked reference tidal marshes in the South Fork Skagit delta indicate that marsh area of 212 acres (the amount of area directly influenced by Milltown Island dikes) should support approximately 19 tidal channels amounting to a total of 14.8 acres and approximately 12.2 miles length (Hood, In Prep.). Instead, only five tidal channels amounting to 5.3 acres and 2.9 miles length are observed in the portion of Milltown Island behind dikes (Fig. 11.4), far less than predicted by the model. In comparison, the southern portion of Milltown Island, which was never farmed or diked and consists of 96 acres of tidal shrub wetlands, is predicted to support 11 tidal channels amounting 4.8 acres total. In fact, ten tidal channels totaling 3.9 acres are observed, which is in good agreement with model predictions. The contrast between predicted and observed tidal channel geometry for the diked versus undiked portions of

Milltown Island suggests that there is potential for significant restoration of tidal channels to the diked portion of Milltown Island. The limited amount of existing dike breaches probably constrains tidal channel development. More extensive dike removal may allow greater tidal channel development.
Biological: Juvenile salmon (40-110mm fork length) currently have access to the site. Restoration actions on this site could result in additional tidal channel habitat (following a period of channel network development) and higher quality tidal marsh vegetation. Restoration actions assume by this analysis include removal of at least 6,000 feet of dike. Under this scenario we expect the site to produce opportunity for an additional 57,179 smolts.

Effectiveness Monitoring
See Chapter 15 for details on estuarine monitoring strategy.

Backup Actions (if Direct Results not achieved)
Under the proposed restoration scenario not all remnant levee will be removed. Because of the extraordinary cost associated with levee removal at this remote location we have only targeted those levee sections have the greatest influence on hydraulic forces. If removal of these levee sections fails to produce desired results additional levee sections should be evaluated for removal.

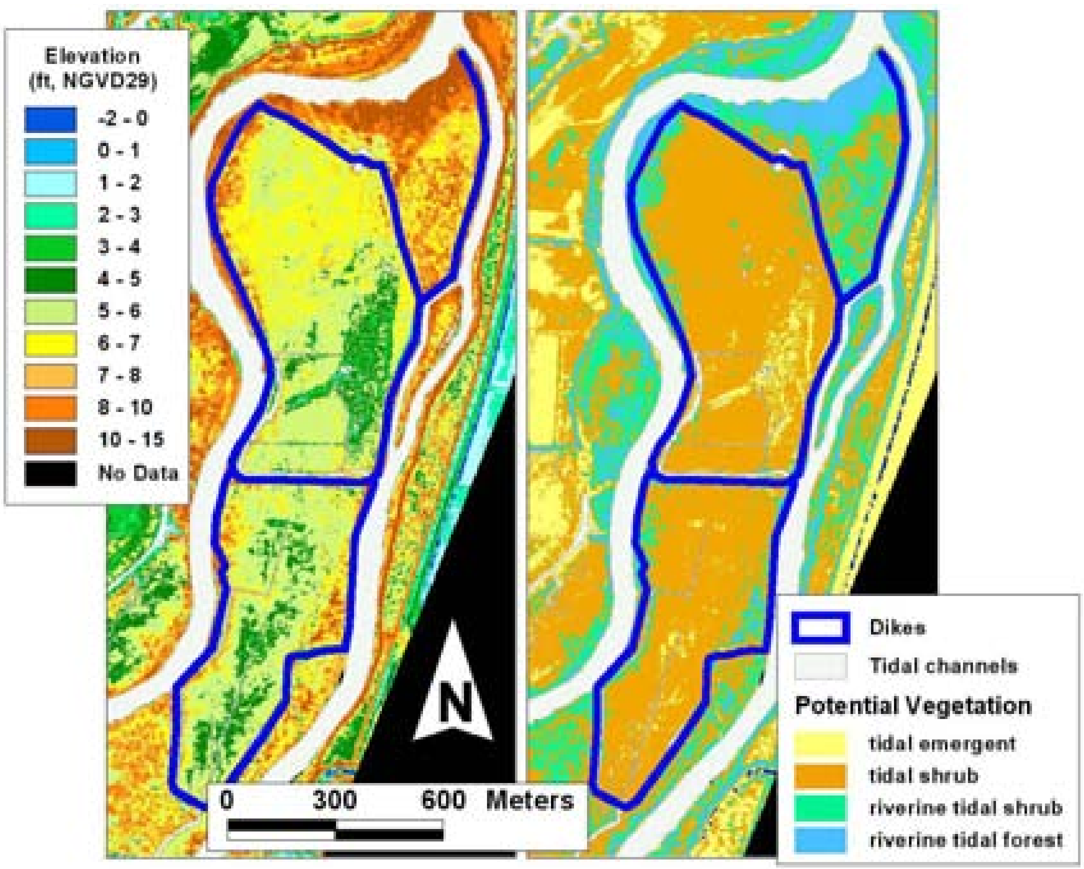

Figure 11.4 *Milltown Island.* Milltown Island site potential. Topography from LIDAR imagery (left). Potential vegetation, assuming elevation control (right).

11.3.3 Telegraph Slough-Phase 1

Project Summary
Dike setback project located at the north end of the Swinomish channel. This phase of the project would implement approximately 90 hectares of marsh restoration. The second phase would add an additional 100 hectares of marsh and a distributary connection following the historic Telegraph Slough (Figure 11.5).

Purpose
To expand estuarine emergent marsh rearing habitat in conjunction with improvements at McGlinn Island.

Populations Targeted
All

Estimated Cost
Funded in 2004 by the SRFB for $400,000 and matched by Ducks Unlimited (DU). Total project cost estimated at $750,000

Timeframe
This project has a moderate likelihood of implementation. Implementation is expected by 2007 is landowner agreement can be finalized.

Contingencies
A private citizen, who has expressed his desire to see the property restored under the guidance of DU, is acquiring Properties being restored. Written agreement has not been secured from the private party who acquired the property. Until such agreement is in place there is some possibility that the property can remain behind the levee system. Hunting organizations are likely to test the resolve of DU to opt, or advise for full restoration.

Expected Direct Results
Physical: Phase 1 would restore tidal influences to an estimated 90 hectares of potential habitat. This habitat could support just under seven hectares of channel with a connectivity index of .0087. If the causeway project is implemented the connectivity value goes to .016 and production estimates increase accordingly.
Biological: Phase 1 implementation yields a site potential capacity of just under 50,000 smolts when connectivity is improved at the Causeway. The productivity drops to about half this value without improved connectivity (see discussion in Appendix D).

Effectiveness Monitoring
This project would be monitored as described in estuary monitoring strategy outlined in Chapter 15.

Backup Actions
If invasive species become a problem active management techniques will need to be employed to open channel corridors and control invasive spread.

Figure 11.5 *Telegraph Slough – Phase 1*. Levee set back alignment shown in red with potential emergent marsh area highlighted.

11.3.4 McGlinn Island Causeway

Project Summary

Improve hydraulic connection between the North Fork of the Skagit and Swinomish Channel north of McGlinn Island. This action is expected to improve access by juveniles to estuarine rearing habitat in Padilla Bay. The current access, through a small opening in the rock jetty (known as the "Fish Hole") is limited because river flow is directed away from Swinomish Channel, and the opening is inaccessible at low tides (Figure 11.6).

Purpose

To improve hydraulic and fish passage connectivity between the Swinomish Channel and the North Fork of the Skagit River, thereby alleviating an identified barrier to Chinook migration.

Populations Targeted

All

Estimated Cost

Feasibility level investigations have been funded by the Salmon Recovery Funding Board for approximately $150,000 including match monies and services being supplied by the U. S. Geological Survey (USGS) who will take lead on hydraulic modeling tasks. Actual project implementation will depend on feasibility outcomes, but are expected to run in the $500,000-$700,000 range.

Timeframe

Feasibility work and preferred alternatives will completed by the end of 2006. Implementation can be as early as 2007 if funding is made readily available. However, a 2008 start date would be more likely given the complexities of the project.

Contingencies

Key questions regarding impacts on population distribution and effect on fisheries allocations remain. If this action causes an increase in Canadian interceptions or other negative management ramifications it will be reconsidered or dropped. The question of how this project could impact harvest management or be impacted by harvest not currently being realized by the stocks (i.e., Canadian fisheries) needs to be answered during the feasibility planning.

Expected Direct Results

Physical: Water will flow from the Skagit River into Swinomish Channel at a depth and velocity that allows fish migration. This will increase connectivity to existing habitat throughout the Swinomish channel and Padilla Bay. This will also increase the benefits of projects being considered at the North end of the Swinomish channel.

Biological: Significant restoration potential exists along the northern end of Swinomish Channel. Two projects are included in our five-year implementation schedule-smokehouse floodplain and Telegraph Slough. The smolt benefit for these projects is highly dependent on the Swinomish Channel Causeway project that improves connectivity between the North Fork and Swinomish Channel. Without the causeway project, the combined benefit for these two projects is 72,622 smolts annually. With the causeway project, the combined benefit for these two projects almost doubles to 133,616 smolts annually. The Swinomish Channel causeway project also improves the value of existing habitat along Swinomish Channel and in southern Padilla Bay. The increase in productivity to existing habitat is estimated to be 40,898 smolts annually. Another important part the causeway project is that it could improve migratory pathways to eelgrass habitat within Padilla Bay that is under-utilized. Because data on habitat values for eelgrass in Padilla were not readily available this habitat contribution was not modeled.

Effectiveness Monitoring

Monitoring will focus on evaluating the relationship between modeled flows and actual flows once project is implemented. Fish migration will need to be monitored as well to evaluate the effectiveness of predicted outcomes. A fyke net will be installed at the passage gate for limited periods of time, and will sample throughout the outmigration at different tidal stages and times of day, to estimate total fish use through the season. This number will be estimated for different smolt outmigration levels, and compared to rearing densities observed in different estuary habitat types.

Backup Actions (if Direct Results not achieved)

It's expected that feasibility investigations will address this issue in detail. It's likely that contingency alternatives will be included in final recommendations that will allow for some adaptive management once the project has been implemented.

Figure 11.6 *McGlinn Island.* Causeway conceptual design showing potential breech location. This action would likely be accompanied by work at the existing jetty fish way.

11.3.5 South Fork Dike Setback

Project Summary
2500' of existing levee will be removed and re-graded down to the existing "bank top level" at the top end and the lower end will be graded for off-channel connectivity. The main river levee will be relocated and constructed approximately 700' maximum from the riverbank at the mid-point of the project. 1800' of new levee will be built adjacent to the County road with the keyway located along the riverward toe slope of the levee.

Purpose
To restore riverine tidal habitats for Chinook rearing.

Populations Targeted
All

Estimated Cost
Approximately $1,000,000. This includes property acquisition. $850,000 has been funded by the SRFB. $160,000 was provided as matching funds from Dike District 3 tax revenues.

Timeframe
Project was implemented in 2004 under the direction of Skagit County.

Contingencies
The project has been funded and implemented. Some site alterations might still be needed depending on the results of site monitoring. For example: re-grading the "upper" end of the project reach to restore "flow through" hydrology will be included if the need is demonstrated. Additional conifer plantings could be included as time and maturity of the site warrants

Expected Direct Results
Physical: If implemented so that hydrology can naturally influence the project site (i.e., upstream floodplain connectivity is not altered by armoring or fill) the site has over 16 hectares of site potential area. This could yield .374 hectares of channel habitat with a .081 connectivity rating.
Biological: Modeling suggests the site has potential to increase Chinook production by ~14,588 smolts.

Effectiveness Monitoring
The project has been implemented by Skagit County, through the use of SRFB funds, in late 2004. It is not clear if a monitoring plan has been developed for the site. We are assuming the IMW monitoring plan will be applicable in the absence of anything more detailed. Chapter 15 has more detail on the Skagit IMW estuarine monitoring strategy.

Backup Actions
Channel development could be impeded by toe rock remaining in place after construction. Channel development could also be impeded by topography of upstream end of the site (floodplain fill was retained to protect newly constructed levee). If channel development is limited these features should be evaluated for removal.

11.3.6 Fisher Slough

Project Summary

This project acquires ~50-80 acres of farmland within the riverine tidal zone and restores agricultural land to channel, scrub-shrub, forested wetland, and tributary junction habitats. In addition, this project assesses ecosystem functions supplied by the Fisher Slough subbasin, including hydrology and geomorphology, and provides conceptual alternatives for addressing high priority problems (Figure 11.7).

Purpose

To restore riverine tidal wetland habitats for juvenile rearing

Populations Targeted

All

Estimated Cost

Initial project elements have been funded by SRFB. Feasibility costs are approximately $150,000. Acquisition costs are approximately $250,000. Project costs will vary, but estimates are between $1,000,000 and $1,500,000

Timeframe

The feasibility and acquisition phase of this project are now underway. Probability of project implementation is very high. Expect implementation in 2007.

Contingencies

The most significant constraint on the project is the Big Ditch siphon culvert underneath Fisher Slough. The degree of Chinook benefit achieved on these parcels will depend on the degree to which hydrological connectivity can be maximized. Alternatives for passing Big Ditch flows without impeding drainage on farmland will be a principle part of the assessment. Selection of an alternative will depend on the financial cost relative to the ecological benefit provided.

Expected Direct Results

Physical: Our estimate of restoration potential indicates and area of 27.5 hectares of habitat could be realized at this location. This subsequently would result in about .81 hectares of channel area with a connectivity rating of .042.

Biological: If implemented such that tidal wetland is allowed to redevelop over the area of what is now locally known as the Poor Farm, this project should improve Chinook production by an estimated 16,431 smolts within 2-3 years after implementation.

Effectiveness Monitoring

A monitoring plan is being developed as a part of the feasibility project. Expected study plan will be commensurate with estuary monitoring strategy outlined in Chapter 15.

Backup Actions

Evaluate additional actions related to the Carpenter Creek system. If invasive species become a problem active management techniques will need to be employed to open channel corridors and control invasive spread.

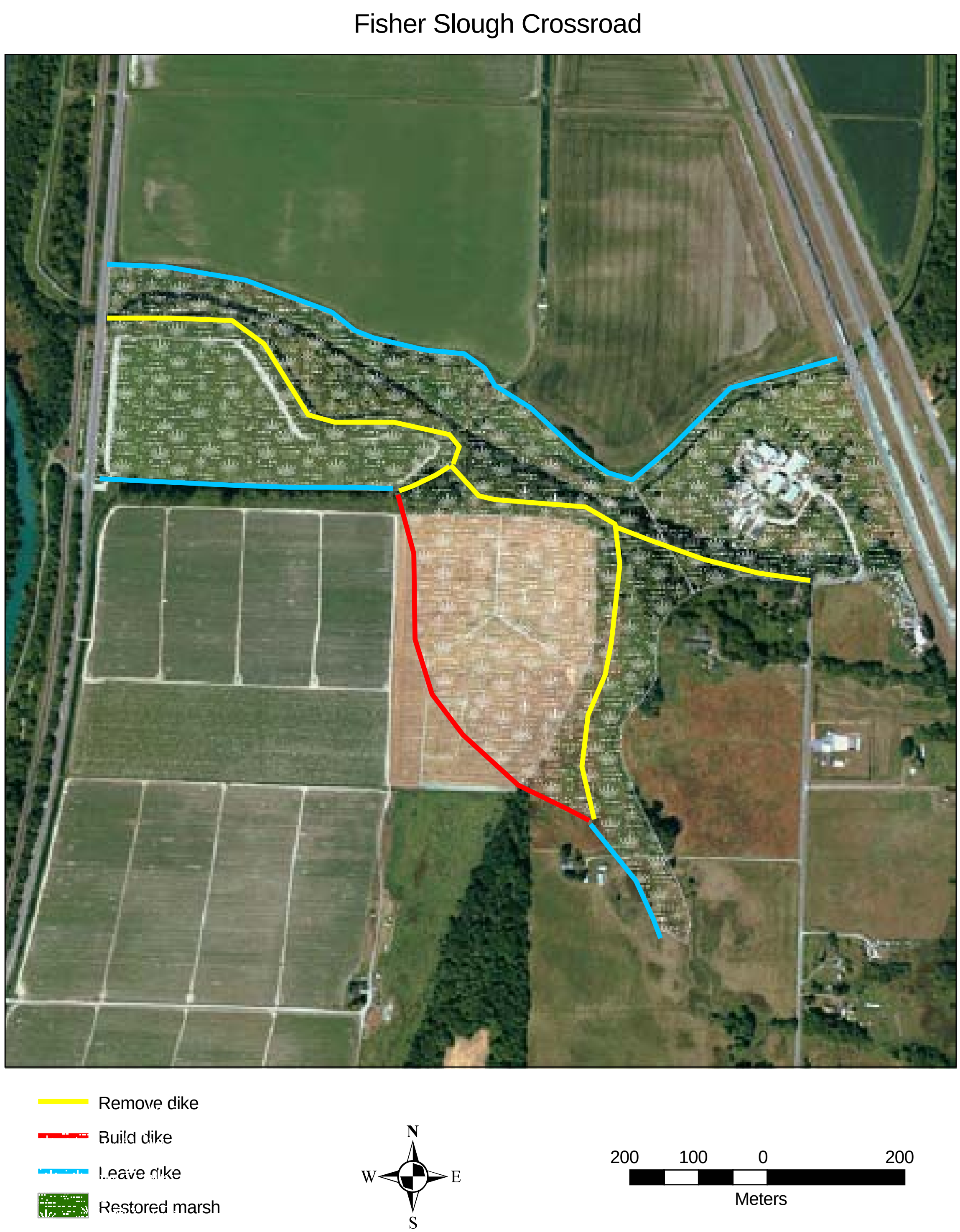

Figure 11.7. *Fisher Slough.* Fisher Slough conceptual restoration footprint.

11.3.7 Davis and Dry Slough

Project summary
Levee setback project in the vicinity of Claude Davis and Dry Slough. The project as described here proposes to involve approximately 90 acres of WDFW lands and 30 acres of private land in the first

Purpose
To restore estuarine emergent marsh habitats for improved juvenile Chinook rearing.

Populations Targeted
All

Estimated Cost
Funds for this project could be secured readily through established funding sources. Expected cost would run approximately $1.5 million

Timeframe
The site has been the subject of intense discussions between WDFW, private landowners, the Dike District and Tribes. If a reasonable settlement could be struck this project could move forward in less than five years.

Contingencies
The site is the subject of potential legal challenges regarding fish passage at tidegates. If this issue goes to court we cannot predict the outcome or timeline for a decision.

Expected Direct Results
Physical: The site potential is for 48.05 hectares of marsh habitat. This equates to 1.105 hectares of channel habitat under the current levels of connectivity, which is valued at .0221.
Biological: This project could yield 11,660 smolts per year.

Effectiveness Monitoring
This project would be monitored as described in estuary monitoring strategy outlined in Chapter 15.

Backup Actions (if Direct Results not achieved):
These will be worked out as part of the assessment, design, and permitting process.

11.3.8 Smokehouse Floodplain

Project Summary

The Fornsby Creek SRT project is a fish passage and habitat restoration project located along the Swinomish Channel of the Skagit River delta. The site was once an expansive estuarine emergent marsh over 900 acres in size (Collins and Sheik, 2002). Hydraulic modifications including installation of flap-style tide gates converted this emergent marsh to arable uplands. The modern site still contains a significant network of remnant slough channels, albeit simplified by decades of agriculture. These remnant channels are presently influenced by small freshwater tributary streams and seeps but isolated from tidal influence.

The project will replace existing impassible tide gates with self-regulating tidegates (SRTs). Tide gate replacement will restore tidal influence to the channels, enable fish passage, and increase the amount of available blind channel, distributary, and tributary habitat for all salmonid species. Allowing a wide range of tidal influence to interact with the remnant channels' freshwater flows on the floodplain will create estuary-type freshwater and salt water mixing zones. These mixing zones are critical rearing habitat for juvenile salmonids. The project will also implement habitat restoration actions on 1.3 miles of the re-opened channel habitat. In total, the project will re-open more than five miles of channel to fish and improve over 50 acres of aquatic habitat (Figure 11.8).

Purpose

To increase estuarine marsh habitats available to juvenile Chinook through improved passage at tide gates and riparian corridor development.

Populations Targeted

All

Estimated Cost

A total of $700,000 has been secured for this project.

Timeframe

Implementation will begin in 2005. Final project elements for the first phase will be in place in 2007.

Contingencies

This site will not be able to realize its full site potential until the McGlinn Island Causeway project is constructed. The salinity barrier present in the Swinomish Channel will continue to limit the utility of the area to migrating Chinook.

Also, The complexity of individual land allotments (or Individual Indian Trust Lands) currently constrains the project scope. These allotments are often owned jointly by dozens, and in some cases hundreds, of related individuals. Securing permission to conduct project work on these lands is extremely difficult and time consuming. Therefore this project does not propose work on these lands. Work on individual allotment lands will be pursued in later phases and as agreements can be secured.

Expected Direct Results

Physical: In total, the project will re-open more than five miles of channel to fish and improve over 25 hectares of aquatic habitat. We believe this will result in approximately 2.594 hectares of newly available channel.

Biological: Prior to the completion of the McGlinn Causeway project the connectivity rating will be significantly lower than afterwards. Pre McGlinn connectivity is estimated at .0091 and post connectivity .016.This will result in and 20,471 smolts respectively.

Effectiveness Monitoring

The goal of the Smokehouse monitoring plan is to determine: (1) the effectiveness of the new tide gates in controlling the quantity of the water passing into and out of the reopened channels; (2) the change, if any, in water quality within the reopened channels; (3) the effect, if any, of saltwater on nearby agricultural lands; and (4) the amount of fish use within the reopened channels. The monitoring goals will be accomplished by comparing the data gathered before, during, and after the new tide gate installation (Table 11.1). The effects of the tide gate installations will be evaluated against pre-installation baseline data and results from a control site. The south fork of Fornsby Creek will retain the old style flap tide gate and function as this control site. This site is situated on Individual Indian Trust land, with restoration constraints as noted above. Future restoration may include this area as permissions are gained.

Table 11.1. *Monitoring objectives and size allocation.*

	PROJECT AREA		**CONTROL AREA**		
	New Tidegate Sites	Re-opened Channel Sites	Tidegate Sites	Channel Sites	TOTAL
Surface Water Level	4	6	2	1	13
Flow Velocity	0	6	0	1	7
Water Quality	4*	6	2*	1	13
Monitoring Wells	0	12	0	2	14
Soil Salinity Transects	0	6	0	1	7

The water quality monitoring plan will consist of 13 monitoring sites within the project area (see vicinity map). Paired sites (salt water side and freshwater side) are located at each of three tide gates (one existing tide gate to be replaced with a SRT, one new SRT, and one existing tide gate not replaced in this project phase (control site)) for a total of six tide gate monitoring sites. An additional seven sites are located along the upstream channels re-opened as part of this project.

*Ambient water quality is currently monitored at these sites under a separate program. Data will be shared with this project, but funding is not sought to support current monitoring.

Several approaches will be taken to evaluate the effectiveness of the new tide gates in controlling the quantity of the water passing into and out of the reopened channels. The surface water level will be recorded with electronic dataloggers at 13 locations. Surface water level data will assess the functionality of the tide gates in preventing excess water from entering the system (flooding) or allowing de-watering. Flow velocity will be measured at seven locations using a standard flow meter at locations of measured channel profile. Flow velocity data will allow determination of water flow volume within the system as well as the magnitude of tidal flushing. This will allow project proponents to fine-tune tide gate function to optimize flushing within the re-opened channel habitat and optimize the fish passage window.

Surface water quality monitoring will be performed at 13 sites (three paired stations on either side of each tide gate and seven individual stations at upstream monitoring sites). Conventional water quality parameters will be recorded including pH, temperature, conductivity, salinity, dissolved oxygen, turbidity, and chloride. These sites will be monitored weekly to biweekly with a regular field probe (Hydrolab Surveyor/Sonde4). A second water quality probe, a continuously recording long-term deployment probe (Hydrolab Surveyor/Sonde4a), will be deployed at each station on a rotational basis. With this data, we will be able to monitor the affects of increased tidal influence on water quality and identified water quality problems, including high temperatures and low dissolved oxygen.

Water levels and water quality parameters including conductivity, salinity, and chloride will also be measured in 14 monitoring wells at seven upstream monitoring stations. Water levels will be continuously monitored, allowing evaluation of the effects of the SRTs on local water table elevations. Combined analysis of water quality data from the main channels and the wells will allow the evaluation of saltwater influence on the adjacent agricultural lands. The use of a soil moisture and salinity probe along transects perpendicular to the channels will provide an application-based assessment of any saltwater impact on the adjacent agricultural lands.

This project will assess juvenile salmon access to habitat upstream of standard tide gates and self-regulating tide gates using beach seining methodology. Monthly beach seine and habitat sampling will occur at sites at both high and low tidal stages from February through June. Conclusions about accessibility will be partially inferred by comparing catches immediately upstream and downstream of the tide gate structure. The probability of detecting salmon upstream of a tide gate structure by our sampling methods will be put in context by using an extensive database of beach seine results collected at Browns Slough and reported in Beamer and LaRock (1998). Catches will be analyzed for fish community composition and juvenile salmon size and abundance by species and age class.

A sample of juvenile Chinook will be collected and analyzed for diet composition three different times representing periods when Chinook (1) just arrive in estuarine habitat, (2) peak of estuarine rearing, and (3) decline in estuarine rearing. The study will put the biological results into an ecological context for salmon habitat quality by using bioenergetics modeling for juvenile Chinook. Comparison of results from tide gate sites to reference sites to will indicate the possible influence of differences in habitat quality at each site on corresponding fish catch results.

Backup Actions

Increase tidal connections or expand project to include levee setback.

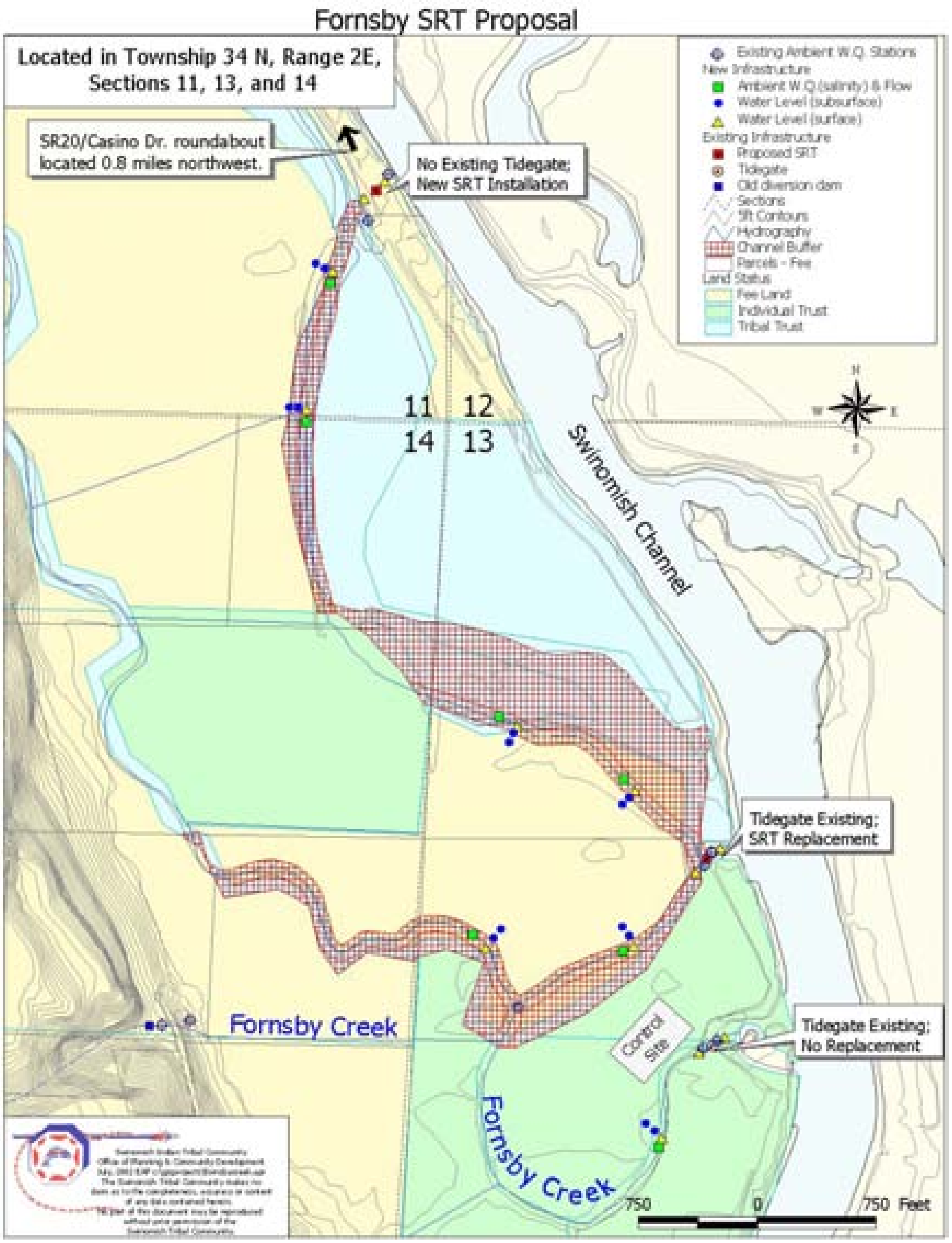

Figure 11.8 *Fornsby Creek and Smokehouse Floodplain – Phase 1.* Fornsby Creek and Smokehouse floodplain SRT replacement project - phase 1.

11.4. LONGER-RANGE DELTA RESTORATION PROJECTS

Projects in the mid term implementation horizon are those that have a significant degree of uncertainty that involve resolution by a new or established institutional mechanism. For example, the complexities involving the creation of a cross-island connector potentially involves many different individuals and a hand full of organizations. The incentive mechanisms for each of these parties differ. With these types of projects we are faced with identifying the incentive mechanisms that exist, or the mechanisms that could exist.

Therefore, this plan recognizes the need for an incentive framework that balances the needs of the individual with those of society. The mechanism by which such a balance is struck must rest with an institution that adequately represents the social and political will of local Skagit communities, relative to their responsibilities to the welfare of the region and State. Successful implementation of complex projects will require that first the appropriate institution is identified, and then the required ways and means are made available to such an institution. These requirements, by nature will require mandates by legislative bodies charged with meeting the will and the intent of public interest.

The following projects are likely candidates for the application of institutional ways and means.

11.4.1 Blake's Bottleneck

Project Summary

This project encompasses several alternative actions that can be implemented in the vicinity of the terminus of Rawlins Road and Blake's marina complex. Each action seeks to setback levees in such a way as to create additional emergent marsh and riverine wetlands. There is potential synergy between this project and the concept of a North Fork Levee setback. The projects footprint would vary substantially based on the willingness of private landowners to engage and the institutional incentives provided for their consideration. The alternatives evaluated include: Thein Farm (Figure 11.9), Rawlins Road Dike Setback (Figure 11.10), and Blake's Bottleneck.

Purpose

To restore riverine tidal habitats for Chinook rearing.

Populations Targeted

All

Estimated Cost

Feasibility studies have been funded through the SRFB in 2004. These studies will lead to more specific cost estimates and viable alternatives. Gross planning estimates place this project in the $3 million range including acquisition costs for full restoration for the Blake's Bottleneck and Rawlins Road Dike setbacks together. Add another $1 million for Thein farm project.

Timeframe

This project is being discussed with representatives from the Agricultural community and local landowners. The timeframe for implementation hinges on the ability of restoration planners and government officials to institutionalize long-term incentives that respect stewardship of the respective properties post project implementation.

Contingencies

As with all long-term project areas we expect numerous variables subject to resolution. This project can still take a variety of forms based on landowner willingness and institutional incentives.

Expected Direct Results

Physical: Thein Farm could yield 84.5 acres or 34.2 hectares of marsh area with a 1.039 connectivity rating. Channel allometry modeling indicates this could yield 1.04 hectares of channel area. Rawlins Dike Setback could yield 72 hectares of marsh area yielding 3.96 hectares of channel habitat. Blake's Bottleneck could yield 7.48 hectares of marsh and .067 hectares of channel habitat.
Biological: Thein Farm would be expected to yield 30,000 smolts per season. Rawlins setback 95,000, and Blake's Bottleneck 1,780.

Effectiveness Monitoring

This project would be monitored as described in estuary monitoring strategy outlined in Chapter 15.

Backup Actions

Riverine hydrology in the area could raise topography over time and limit the long term persistence of channels. Channel development must be closely monitored along with succession of vegetation. Invasive plants would need to monitored and controlled. If levee removal is not possible consider application of SRT technology.

Figure 11.9. *Thein Farm.* Conceptual restoration design for Thein farm project. Dike reinforcement is shown in red. Dike removal is shown in yellow.

Rawlins Road Levee Setback

Figure 11.10. *Rawlins Road.* Conceptual restoration footprint for the Rawlins Road levee setback project.

11.4.2 Telegraph-Phase 2

Project Summary

Following restoration actions described in Telegraph Phase 1 this project seeks to re-establish connectivity and estuarine marsh habitat through the historic footprint of the former Telegraph slough corridor. This project will necessitate concurrence from the WSDOT and local landowners. Isolation of this historic slough pathway was the direct result of State actions through the construction of the Highway 20 corridor. Therefore, restoration will require significant resources to address the barrier created by Highway 20 (Figure 11.11).

Purpose

To expand restoration of estuarine emergent marsh habitats in the Swinomish Channel corridor once Chinook passage is improved through the McGlinn Island project.

Populations Targeted

All

Estimated Cost

This project does require concurrence from local landowners. Key property owners are few, but will likely need to evaluate incentives and success of Telegraph-Phase 1 before committing to further restoration objectives. Initial estimates place this potential action at between $3-5 million.

Timeframe

Again this project hinges on the success and/or failure of the phase 1 project proposal. Assuming that the phase 1 project can be implemented on a schedule that results in tidal influences throughout the phase 1 site by 2007, then we might assume favorable reaction and potential implementation by 2011.

Contingencies

Passage through Highway 20 is a costly necessity for this project. If this cannot be accomplished the value of the additional action would be diminished. We strongly recommend WDOT review of the proposal and determination of preliminary feasibility. Expected results are based on Causeway project implementation. Agreement from the primary landowners - the Bell family - would also be required. Flood feasibility studies are evaluating the potential for developing a flood bypass through the vicinity. This may or may not affect the project and should be evaluated if the bypass option is pursued by USACE.

Expected Direct Results

Physical: Restored habitat connectivity (0.016 connectivity index) and 197 ha of restored estuarine habitat with 15 ha of channel and openwater habitat.
Biological: Increase habitat capacity by 113,145 smolts.

Effectiveness Monitoring

This project would be monitored as described in estuary monitoring strategy outlined in Chapter 15.

Backup Actions

Vegetation: Move from passive to active restoration strategies. Channels: Assess surface runoff and/or withdrawals. WQ: Monitor effluents for deleterious effects

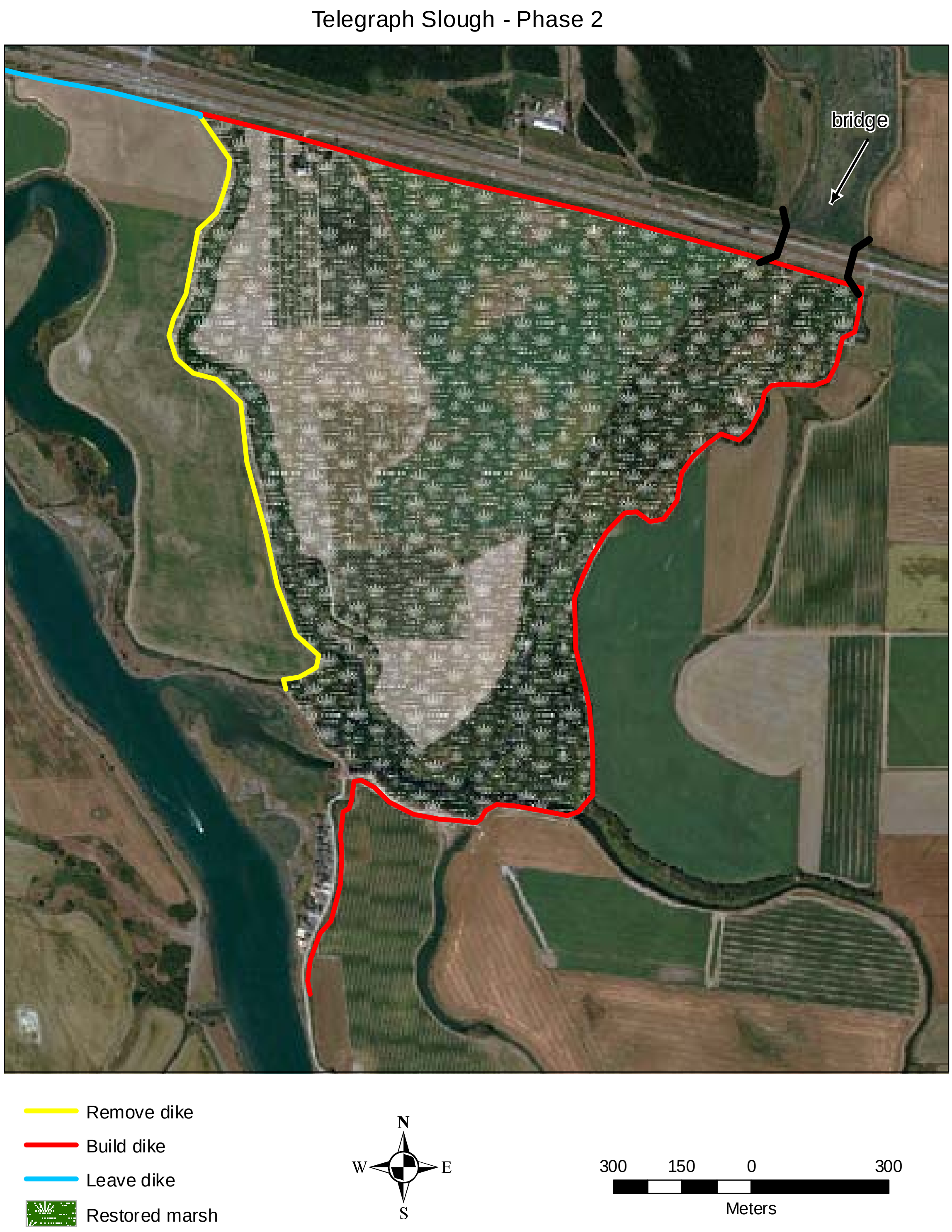

Figure 11.11. *Telegraph Slough - Phase 2.* Conceptual restoration design showing levee setback and additional marsh area that would complement the area created in phase 1.

11.4.3 Smokehouse-Phase 2

Project Summary:

The phase 1 project opens the Smokehouse floodplain to fish access. This project seeks to set back levees through key areas of the Smokehouse floodplain, allowing expression of larger emergent marsh communities and associated blind channel networks.

Purpose

Increase the availability of emergent marsh habitats in the Swinomish channel corridor once Chinook passage is improved through the McGlinn Island project.

Populations Targeted

All

Preliminary Cost Estimates

Costs again will depend on the actual alternatives proposed. Preliminary estimates predict dike setbacks of over 5500 lineal feet. Overall project cost is expected top be in the $2,000,000 to $3,000,000 range.

Timeframe

Assuming successful completion of elements of the first phase of estuarine projects we would expect this project to come on line in 2010.

Contingencies

Unsuccessful development of Phase 1 projects would lead to a break down of commitment from the Swinomish Indian Tribal Community. This would result in postponement until previous commitments have been delivered.

Expected Direct Results

Physical: This project would be expected to yield 37.46 hectares of additional marsh area, which would in turn provide 1.38 hectares of channel area at a .0166 connectivity rating.
Biological: The biological yield would be ~10,890 smolts per year or 56 adults per year with average survival on a low regime.

Effectiveness Monitoring

This project would be monitored as described in estuary monitoring strategy outlined in Chapter 15.

Backup Actions

Review functionality of causeway connections. Consider NF pathways. Examine the functionality of habitats between North and South ends of the channel. Pursue active vegetation restoration if needed to compete with invasive species.

11.4.4 Cross Island Connector

Project Summary:
This project looks to re-establish connectivity between the North Fork of the Skagit and the central bay front along Fir Island. This is most likely through the development of a connecting corridor that follows one of two historic pathways (Browns Slough and/or Dry Slough) or through low-lying farmlands.

Purpose
Restore historic distributary connections that will improve connectivity for fish, water and sediments to underutilized, and eroding, emergent marsh habitats in central delta.

Populations Targeted
All

Estimated Cost
Costs are difficult to ascertain given the complexities and wide array of engineering solutions that are part and parcel to this project proposal. Conservative estimates place this project in the $2-5 million range.

Timeframe
This element of the recovery plan is viewed as a critical element that serves to increase productivity within established emergent marshes. Central Fir Island marshes are currently under performing due to the loss of sediment and water pathways through the central core of the island. Therefore, this element has been targeted as a key element of the ten-year work plan. Its probability is considered moderate depending largely upon the culmination of political will, funding and landowner incentives.

Contingencies
A number of potential pathways exist and have been described in some detail in the Fir Island Feasibility Study completed for the Skagit Watershed Council in 2004 (SRSC and PWA 2004). Each of these pathways possesses its own merits and drawbacks. A number of technical issues must be addressed with local communities such as issues with flood protection and drainage infrastructure function. If solutions can be found and engineered this project could be implemented.

Expected Direct Results
Biological: Chinook model estimates place the value of this action at approximately 240,000 smolts, making it one of the most significant single measures that could be undertaken to recover Skagit Chinook populations.
Physical: Increased tidal influence and mixing and improved migration pathways in the delta.

Effectiveness Monitoring
This project would be monitored as described in estuary monitoring strategy outlined in Chapter 15.

Backup Actions
Backup actions will depend on approved design. We will assume that flood and tidal regulation will be a required feature by local landowners. Facilitating the development of drainage infrastructure will be required. In addition water management issues could be addressed. Monitoring of fisheries benefits will inform management plan.

11.4.5 Sullivan's Hacienda

Project Summary
This project proposes to setback levees to a pre 1956 footprint. Thereby, allowing for the re-establishment of emergent marsh and blind channel networks in the vicinity of Sullivan's Slough (Figure 11.12).

Purpose
Increase emergent marsh rearing habitat in tidal delta

Populations Targeted
All

Timeframe
If incentive programs can be established and drainage infrastructure needs addressed, this project could potentially be implemented within the 10-year time horizon if landowner agreement can be secured. This in part will be informed by the success or failure of efforts to establish institutional mechanisms for long term landowner incentive programs.

Estimated Cost
Allow $3 million for completion of this project.

Contingencies
Landowner agreement and drainage infrastructure. Significant drainage questions need to be addressed.

Expected Direct Results
Physical: Currently, 2.6 acres or 1.0 miles of ditches or vestigial tidal channels exist landward of dikes on the study site (Fig. 11.12). Restoration of tidal inundation could result in the redevelopment of 5.8 acres or 4.8 miles blind tidal channels. Seaward of the dikes there are currently 1.3 acres or 0.8 miles of blind tidal channel. Photos from 1937 show 3.4 acres or 0.7 miles of blind tidal channel seaward of the dikes. Modeling indicates the possibility of sustaining 1.9 acres, 1.6 miles of blind tidal channel. This amount is less than historical because the study site is half the size of the amount of marsh present in this area in 1937 (later diked by 1965).
Biological: The Chinook production benefit under this scenario is ~36,517 smolts annually.

Effectiveness Monitoring
This project would be monitored as described in estuary monitoring strategy outlined in Chapter 15.

Backup Actions
Vegetation: Move from passive to active restoration strategies
Channels: Assess surface runoff and/or withdrawals
WQ: Monitor effluents for deleterious effects

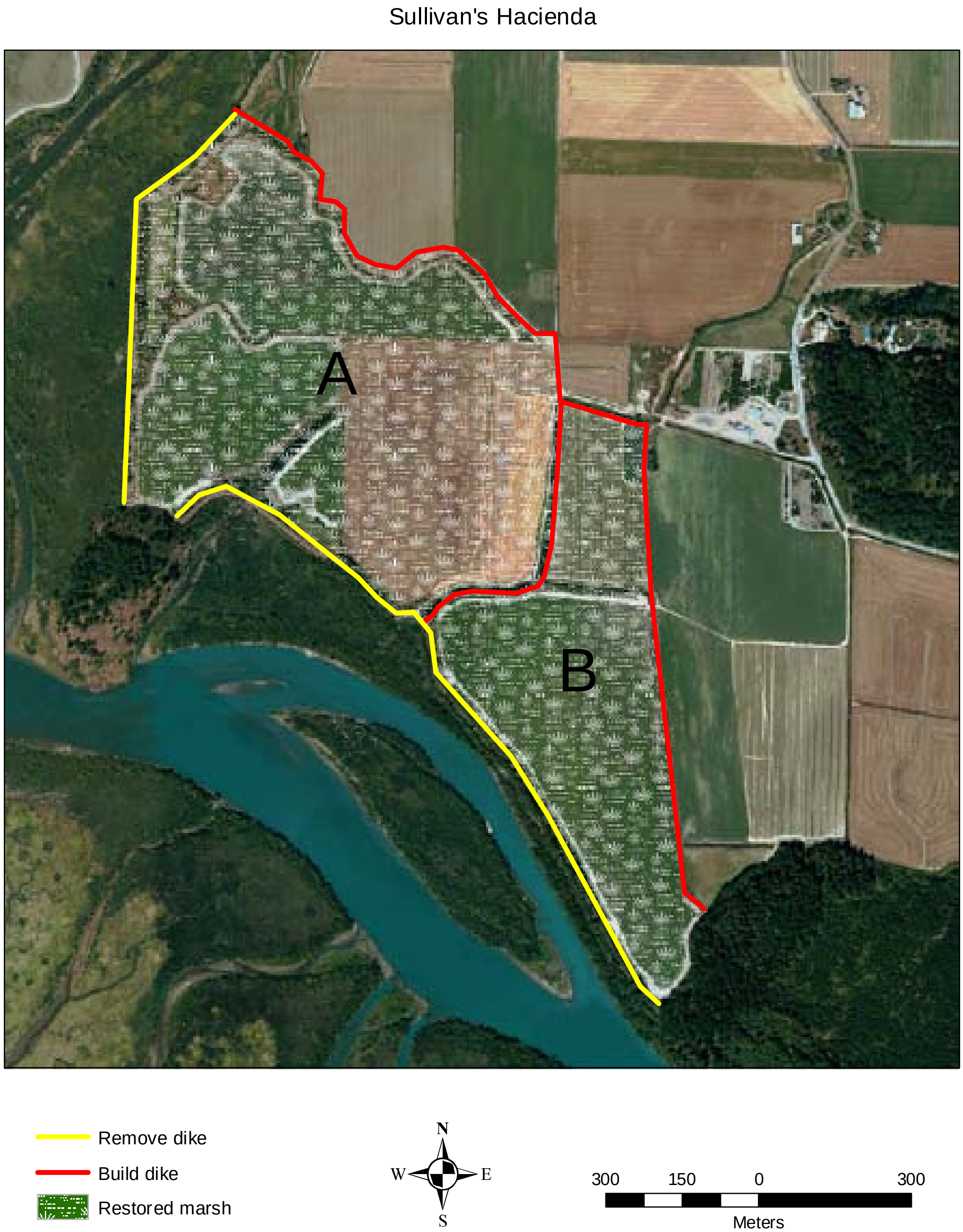

Figure 11.12. *Sullivan's Hacienda.* Channels interior (green) and exterior (dark blue [2000] and light blue [1937]) to the dikes. Light blue areas have filled in with sediments since 1937 and been transformed to marsh (outside the dikes) or agricultural land (inside the dikes). Note that the 1937 aerial photo was in black and white and had considerably lower resolution than the 2000 color aerial photo. Consequently, 1937 channel abundance is likely underestimated.

11.4.6 Deepwater Slough-Phase 2

Project Summary

If recovery goals are still not being achieved after the ten-year time horizon the WDFW will come under increasing pressure to restore the remaining habitat at the Deepwater Slough site. This would likely involve the complete removal of levees around each of the two lobes left after the first Deepwater project (Figure 11.13).

Purpose

Increase tidal delta rearing habitats in scrub-shrub zone

Populations Targeted

All

Estimated Cost

Estimate 2-3 million depending on the extent of levee removal.

Contingencies

Pressure from private landowners could press this project site into an earlier phase of restoration. Presently the site services a single user group. Making it a potential target by other user groups who would prefer to see restoration pressures realized by WDFW.

Expected Direct Results

Physical: Restored habitat connectivity (0.026 connectivity index) and 108.5 ha of restored estuarine habitat with 4.5 ha of channel and openwater habitat.
Biological: Increase habitat capacity by 95,5165 smolts.

Effectiveness Monitoring

This project would be monitored as described in estuary monitoring strategy outlined in Chapter 15.

Backup Actions

Vegetation: Move from passive to active restoration strategies
Hydrology: Disconnect or fill remnants of drainage network
Complexity: Add roughness to floodplain
Channels: Move from passive to active restoration strategies (e.g., identify site level opportunities for channel excavation)

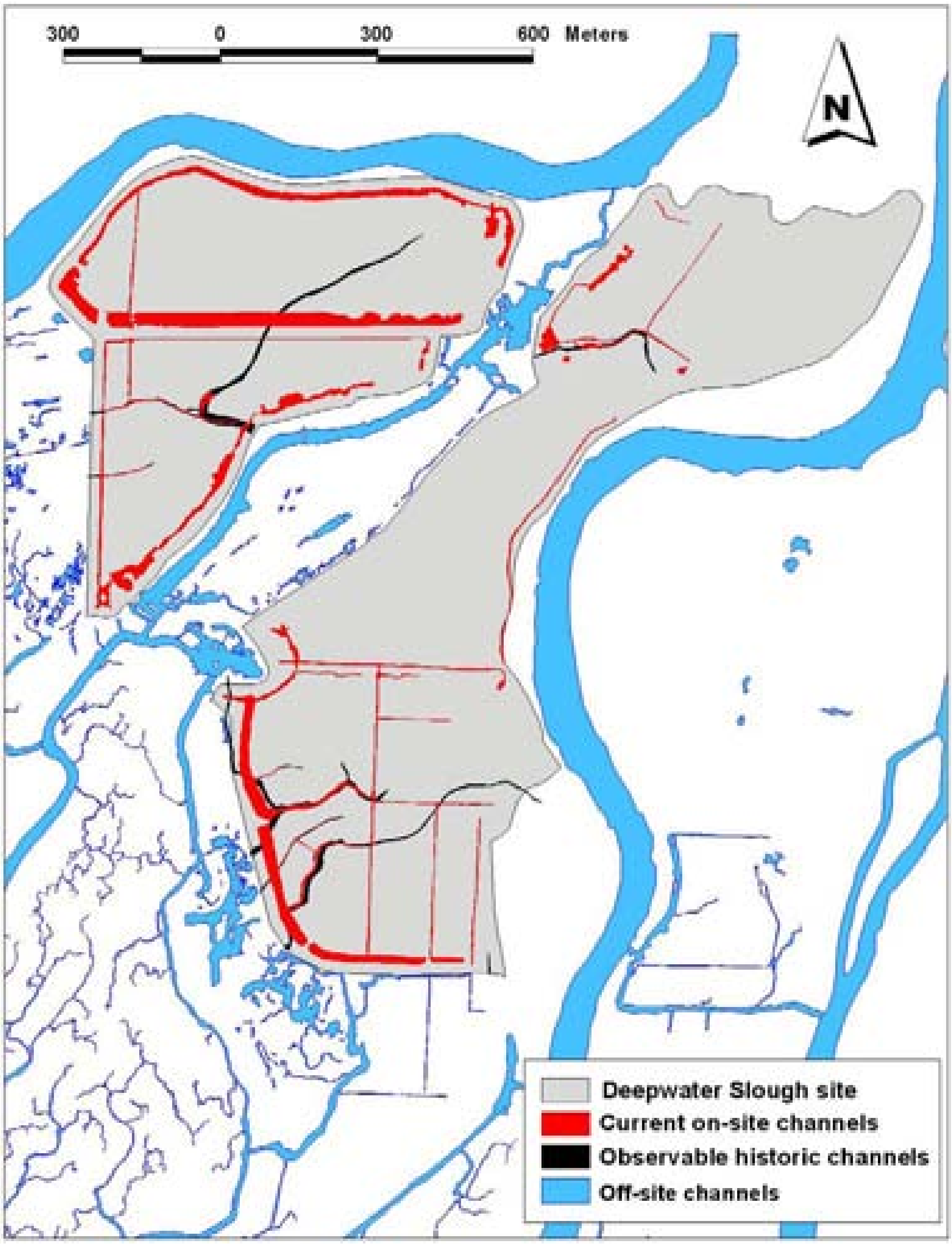

Figure 11.13. *Deepwater Slough - Phase 2*. Current on-site channels (red), including borrow ditches. Historical channels (black; observed from maps or historical photos) often coincide with current channel remnants or topographic swales visible in LIDAR imagery. Most of the site was already diked by 1889, so detailed reconstruction of historical channels is not possible.

11.4.7 North Fork Levee Setback

Project Summary
This project proposes to setback levees along the North Fork of the Skagit from the former inlet of Dry Slough to the Western terminus of the levee system near Rawlins Road. The proposed project could be phased in four distinct phases depending on its merit as a flood control project (Figure 11.14).

Purpose
Increase available floodplain for riverine tidal rearing habitats

Populations Targeted
All

Estimated Cost
This project could be over $15 million depending on choices made for phasing. The relationship to flood control for Fir Island is a keystone to this project, so USACE involvement is paramount.

Timeframe
If flood control benefits can be realized this project has a reasonable chance to be implemented. The timeframe for implementation would be long term given the planning complexities.

Contingencies
Its relationship to flood control, wide spread public support, and subsequent investment.

Expected Direct Results
Physical: If implemented in its entirety this project could yield 266.215 hectares of tidally influenced habitat. This habitat would have the added benefit of being a contiguous corridor cutting across several different habitat types. Channel potential is approximately 12.196 hectares with a high connectivity of .092.
Biological: Total smolt contribution could be 625,032.

Effectiveness Monitoring
This project would be monitored as described in estuary monitoring strategy outlined in Chapter 15.

Backup Actions
Vegetation: Move from passive to active restoration strategies
Hydrology: Lower floodplain topography.
Complexity: Add roughness to floodplain
Channels: Move from passive to active restoration strategies (e.g., identify site level opportunities for channel excavation)

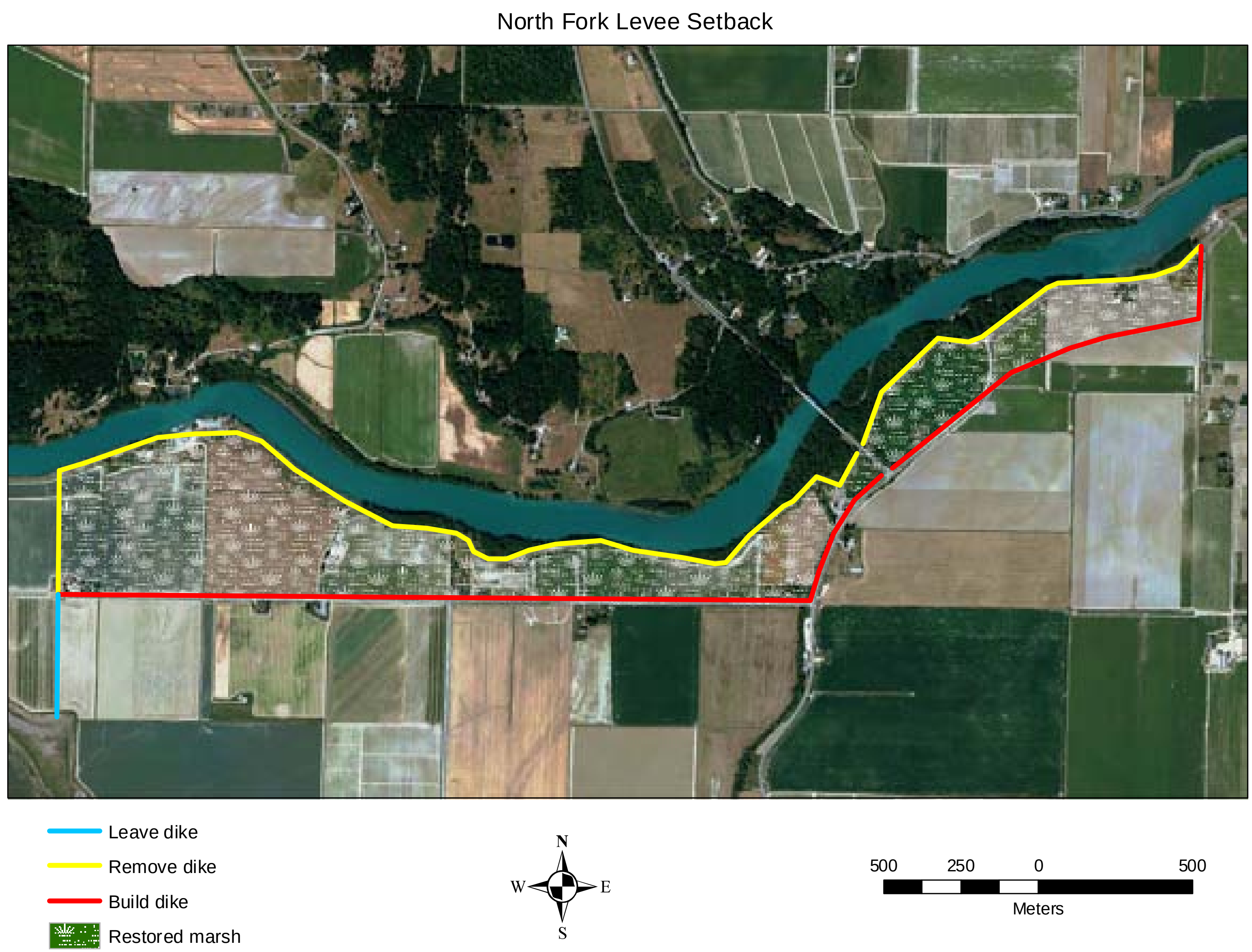

Figure 11.14. *North Fork Levee.* North Fork Levee setback showing extent of the first section of levee setback.

12. RESTORATION ACTIONS IN NEARSHORE REARING HABITAT

12.1. GENERAL NEARSHORE RESTORATION STRATEGY

Our nearshore restoration strategy focuses first on general precepts that can be applied throughout nearshore habitats in the Puget Basin that could be utilized by Skagit Chinook salmon as well as all Puget Sound and British Columbia stocks. Then, in more detail, we focus on restoration objectives in habitats specifically identified by our research in Skagit Bay: pocket estuaries utilized and preferred by Skagit-origin Chinook salmon.

Juvenile Chinook salmon utilize inland coastal waters such as the greater Puget Sound extensively, and survival during this residence period has been correlated with the overall success of their respective populations (Greene et al. 2005, Beamish et al. 2004). Chinook salmon using this area are exposed to different levels of survival risk due to differences in their migration timing, location, and duration of habitat use. Moreover, the greater Puget Sound environment is not homogeneous in habitat type or quality due to both natural and human causes. Thus Chinook salmon rearing potential varies across the landscape. A more specific understanding of the origins of juvenile Chinook salmon using this landscape will fill a glaring data gap needed for Puget Sound Chinook salmon population recovery by linking specific populations to specific areas within the greater Puget Sound and specific habitat types (see Chapter xx). The nearshore (intertidal and shallow subtidal) portions of the "salmonscape" can be influenced by human caused disturbances and thus can be improved by our management actions. A process-based restoration strategy is fundamental to long-term recovery because nearshore processes interacting with the landscape at a local scale determine and maintain the characteristics of habitats available to salmon and other species upon which salmon depend for their survival in the nearshore environment,

A Process based strategy requires that coastal and watershed processes influencing nearshore habitats remain or are restored to functional levels. These nearshore processes are both geomorphic and chemical. They include:

- Longshore sediment erosion, transport, and deposition within littoral cells;
- Tidal erosion;
- Tidal range, volume, and bathymetry;
- Fluvial deposition;
- Freshwater inflow and estuarine mixing; and
- Water and sediment quality.

12.1.1 Landscape Process Restoration

Restoration at the landscape process scale ensures the sustainability of existing habitats and facilitates the recreation of lost historic habitat. Specific objectives of our strategy include:

1. Protect existing and restore lost pocket estuary emergent marsh, channels and impoundments.
2. Protect existing and restore lost tidal connectivity and volume within pocket estuaries.

3. Preserve unarmored and restore armored sediment source beaches in littoral cells that create and maintain spits forming pocket estuaries.
4. Restore lost pocket estuary sites over a large spatial scale to protect and restore regional scale connectivity between pocket estuaries and between deltas and pocket estuaries.
5. Protect existing and restore lost or degraded freshwater inputs (quantity and quality) to pocket estuaries.
6. Restore pocket estuaries of various geomorphic types to maintain habitat diversity and functionality throughout variable long-term climatic and oceanographic conditions.
7. Protect existing and restore armored coastal landforms, like spits and cusps, which form pocket estuaries such that these landforms can change and function naturally to protect and maintain pocket estuary habitat.
8. Remove impediments to fluvial and coastal sediment transport processes.
9. Protect and restore known forage fish habitats, including intertidal and subtidal spawning habitats for smelt, sandlance and herring as well as larval rearing areas (known to include pocket estuaries at least for smelt) and eelgrass meadows;
10. Identify and implement protocols that protect juvenile salmon in boat harbors and other industrialized or modified shorelines. Boat harbors are a common habitat in the current nearshore landscape. They are relatively protected from the natural coastal energy regime and therefore do attract juvenile salmon and other estuarine fishes. However, they are not natural habitats so we can expect the fish community to be different, possibly with the introduction of more predators or a changed food chain. Also, fish within these areas are exposed to risks such as direct pollution spills not present in natural habitats.
11. Plan for predicted sea level rise in all nearshore restoration projects.

In addition to landscape process restoration, part of ensuring safer transition of Chinook salmon from natal rivers to the open ocean is protecting “choke points” within the Puget Sound ecosystem from catastrophic human disturbances such as oil and toxic spills. Choke points are those places where large proportions of salmon populations must travel through. For Puget Sound Chinook salmon this would include Admiralty Inlet. For Skagit Chinook salmon, it would include Deception Pass, Swinomish Channel, and Saratoga Passage. One catastrophic disturbance in a choke point could destroy a very high percentage of an individual salmon population.

12.1.2 Pocket Estuary Restoration

The biological evidence from our research near the Skagit River indicates that restoration of pocket estuaries within the Skagit’s nearshore environment will help improve the abundance and resilience of Skagit Chinook salmon populations. Our nearshore restoration strategy is three fold: 1) increase opportunity for juvenile Chinook salmon to utilize pocket estuary habitat close to their natal rivers so that outmigrants can make a safer transition from the river to the marine environment; 2) increase opportunity for juvenile Chinook salmon to utilize pocket estuaries throughout the Whidbey Basin for safe rearing and traveling through the nearshore; and 3) ensure healthy and functioning nearshore beaches connecting pocket estuaries for the benefit of forage fish and Chinook life history strategies that do not directly utilize pocket estuaries.

To maximize recovery benefits for Skagit Chinook salmon of any pocket estuary restoration, we first prioritize restoring and protecting pocket estuaries with a high degree of connectivity to the Skagit Delta. We have based our prioritization on existing fish migration pathways estimated from the drift buoy study (Appendix D.VI). We hypothesize that habitats “downstream” of tidal currents originating at river mouths are more important to fry migrant Chinook salmon populations than habitats “upstream” or distant from the same tidal currents. We base this hypothesis on our data suggesting pocket estuary habitats provide a rearing and refuge opportunity to fry migrants (Beamer et al. 2003) and on the idea that providing pocket estuary opportunity soon after fry leave delta or river habitats will reduce risk of mortality by reducing the time individual fish spend in the exposed nearshore or offshore environment at a small size.

12.2. IMPLEMENTATION

Potential pocket estuary restoration sites are shown in Figure 12.1. We have targeted as a priority the pocket estuaries in close proximity to the river. Each site listed in Figure12.1 has existing habitat, restoration potential, or both. Based on our understanding of fish migration pathways from the delta to nearshore areas within Skagit Bay, juvenile salmon could reach any of these pocket estuary sites quickly, often within five or six hours after leaving the delta. Because fish can find these sites within a day or less of when they leave the river, we believe they are a restoration priority for fry migrants that experience delta density dependence or are flushed out of the river during a high flow event.

In the following sections individual pocket estuary projects will be described in some detail, depending on the relative level of restoration project development. The follow descriptions provide details of specific pocket estuary projects that have been identified throughout Skagit Bay. While not exhaustive or inclusive, the identified projects would result in a total of 311.5 hectares (769.6 acres) of intertidal and subtidal pocket estuary habitat available to fry migrant Chinook salmon within a day’s migration from the Skagit River delta (Table 12.1). This prediction is based on the assumption that the collective pocket estuary footprint when restored will result in 31.1 hectares (76.8 acres) of additional channel habitat (e.g., tidal channels or impoundments, subtidal channels or open water). Therefore, this particular end state would yield a pocket estuary capacity for fry migrant Chinook salmon that would increase from 73,393 to 221,264 smolts annually.

Of these, Dugualla Bay potentially provides the single largest contribution. This is in part because of its high level of connectivity and size. This site is near the mouth of the North Fork Skagit River, the distributary pathway where density dependent migration of fry migrant Chinook salmon is highest within the Skagit Delta.

In the descriptions that follow we will be separating projects into five, ten and fifteen year time horizons based on their relative complexity and uncertainty. Those that are described in the five-year time horizon all relatively well underway in terms of planning and feasibility. Those further in the future, such as Dugualla Bay, depend on several unknown variables that are more difficult to predict. The first seven projects listed are in the 5-year Implementation Horizon. These projects are underway, have significant local support, or have been developed to a level of refinement that would allow for potential implementation within a five-year time horizon are described in the following sections. The following 12 projects have been identified through preliminary evaluations as potential projects with moderate likelihood of success, but have not been developed well enough to be implemented in the near term horizon. Dugualla Bay in particular has enough complexity to require at least several more years of planning and development before implementation can be pursued.

Figure 12.1. *Pocket estuary sites within one day's migration from the Skagit River delta by fry migrant Chinook salmon.*

Table 12.1. *Summary of potential habitat area, connectivity, and annual Chinook smolt benefit by pocket estuary sites after restoration.*

Project Area	**Potential estuarine area (ha)**	**Potential channel or openwater area (ha)**	**Connectivity index**	**Smolt capacity**
Ala Lagoon	10.012	1.789	0.017	14,122
Arrowhead Lagoon	4.773	0.691	0.011	3,671
Crescent Harbor	83.366	5.168	0.007	15,983
Dugualla Lagoon	156.939	9.730	0.020	93,758
Dugualla Bay Heights	2.550	2.398	0.023	26,025
English Boom Lagoon	9.551	0.563	0.013	3,418
Kiket Lagoon	1.416	0.900	0.014	6,219
Lone Tree Lagoon	2.590	1.318	0.017	11,038
Mariners Cove	8.007	5.394	0.011	27,448
Similk Beach	9.551	0.592	0.013	3,782
SneeOosh Lagoon	1.093	0.068	0.018	593
Turners Bay	21.610	2.469	0.013	15,203
Total	311.457	31.080		221,264

12.3. NEARSHORE RESTORATION PROJECTS

12.3.1 Lone Tree Lagoon

Project Summary
1) Pocket Estuary Restoration: Replace a 24-inch tidally inundated culvert with a 50-foot bridge to reconnect and restore tidal marsh. Remove road and campsite fill in the historic marsh above the culvert. Protect and restore sediment source beaches in adjacent drift cells that maintain the lagoon spit. 2) Stream Restoration: Restore in-stream habitat in the lower 700 feet of Lone Tree Creek, which flows into Lone Tree Lagoon. Replace four undersized culverts with channel spanning squashed culverts. Line all new culverts with streambed material. Eliminate one undersized culvert and restore channel in its location. Remove riprap and enhance buffer in lower riparian corridor. 3) Water Quality: Reduce water quality impacts by addressing key sediment and fecal contaminant sources in lower 700 feet of the creek. Restore watershed hydrology and in-stream flow (Figure 12.2).

Purpose
Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted
Restoration will benefit the fry migrant life history type from all six Skagit stocks. Chinook, coho, and steelhead juveniles will benefit directly due to their utilization of the lower creek corridor.

Cost
Characterization and Feasibility were funded through EPA PPG Section 319 for $90,476. Pre-project fish utilization monitoring was completed in 2004 through a Marine Resource Committee grant for $7,500. Marsh and stream restoration (Actions 1 and 3) are funded through the Swinomish Indian Tribal Community and NRCS Environmental Quality Incentives Program grant for $85,000. Post project monitoring is expected to cost approximately the same amount as pre-project monitoring and is anticipated through the same funding source. Costs for Actions 2, 4, and 5 have not been determined.

Probability and Timeframe
Site characterization and feasibility are complete for marsh and stream restoration. Project design is in progress for the bridge and culverts. Construction plans and permitting are targeted to be completed in time for construction in late summer 2005.

Contingencies
There are five alternative conceptual designs. If the preferred alternative is not implemented, one of the remaining four designs, or a combination of these will be implemented. The proposed actions are proven restoration measures for estuarine marsh. If water quality improvement measures don’t reduce sediment and fecal coliform input to the stream, additional measures may be implemented.

Expected Direct Results
Physical: This project will restore 0.22 ha of tidal marsh and 130 m^2 of in-stream habitat that has been eliminated by filling, ditching, rock armoring, and culverting. However, project components will protect the entire 2.59 ha pocket estuary from threats that risk the productivity of the entire

lagoon. Water quality improvement measures will reduce sediment and fecal coliform input to the stream.
Biological: Completed restoration will increase nearshore habitat fish capacity by an estimated 613 smolts annually. Protection components of this project should preserve the capacity of the entire lagoon (11,038 fish). Fish use is expected to increase in the restored area immediately after project completion. Increased utilization should occur as the disturbed project areas stabilize and in-stream habitat increases.

Effectiveness Monitoring
Post-project fish utilization will be monitored and compared with pre-project data. Habitat formation, culvert function, buffer re-establishment, bank stability, and water quality will also be monitored.

Backup Actions (if Direct Results not achieved):
These will be worked out as part of the assessment, design, and permitting process.

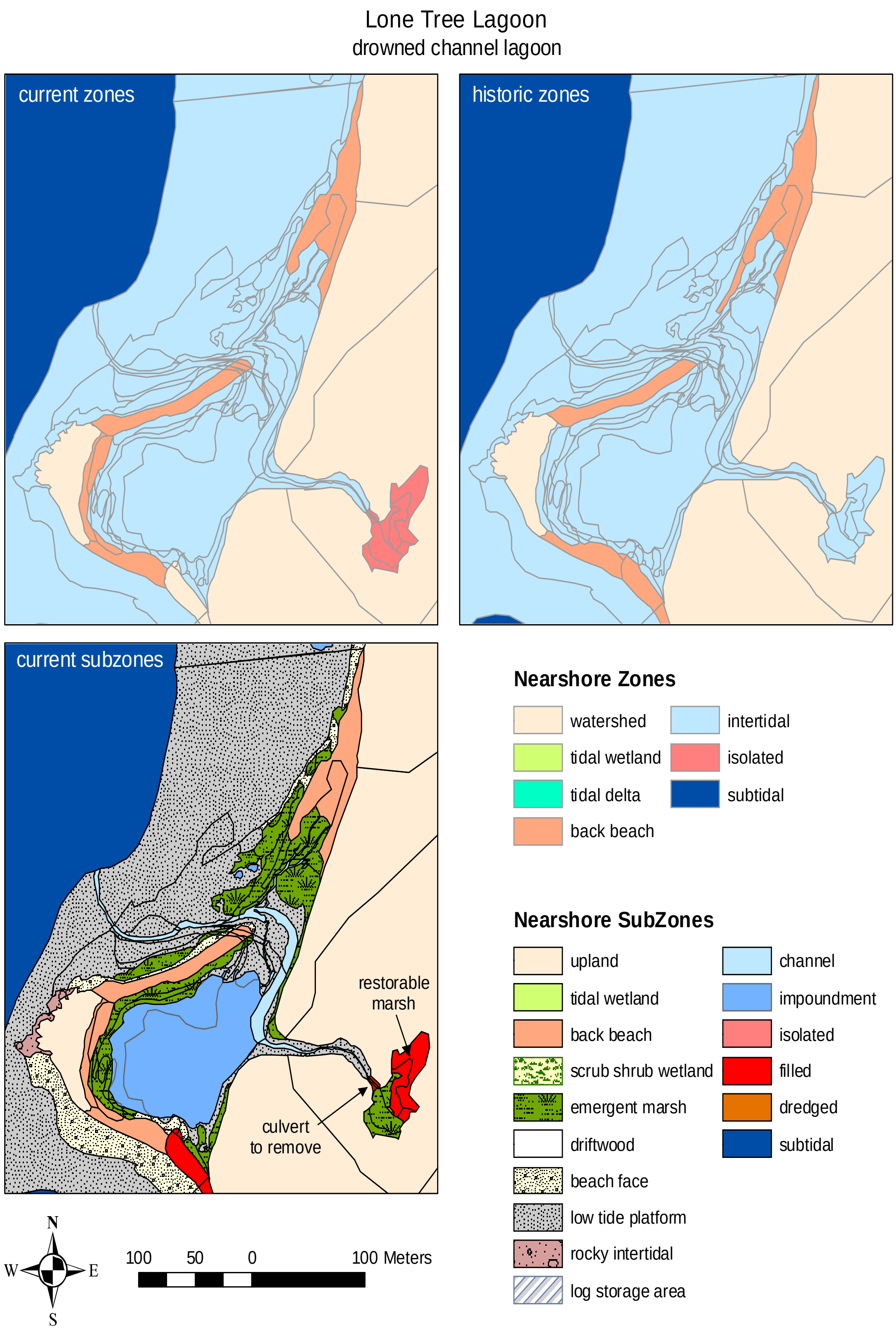

Figure 12.2. *Lone Tree Lagoon.* Lone Tree Lagoon is mostly intact. However, its watershed is severely impacted by paving and hydrologic modifications. This site is currently being studied for restoration. The culvert and tidal marsh to be restored are labeled.

12.3.2 Arrowhead Lagoon

Project Summary
1) Restore intertidal pocket estuary habitat by: a) Increasing the lagoon opening by approximately 60% by removing a hydraulic restriction caused by trail fill. b) Restoring natural tidal processes including tidal prism to the entire western portion of the lagoon by removing approximately two acres of fill, for a 30% to 40% increase in habitat capacity. 2) Protect and restore sediment source beaches in adjacent drift cells that maintain the lagoon spit. 3) Address water quality issues related to septic fields adjacent to the marsh (Figure 12.3).

Purpose
Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted
Restoration will benefit the fry migrant life history type from all six Skagit stocks.

Cost
The cost for marsh restoration (Action 1) will be approximately $260,000. Match funding has been approved through the SRFB. The BIA will provide the remaining funding. Costs of Actions 2 and 3 have not been evaluated.

Timeframe
Planning, design, and permitting work should take approximately one year. Construction is anticipated to begin summer 2006 due to seasonal work windows.

Contingencies
The project includes construction of a bridge to span the intertidal channel that is currently plugged by trail fill. This will require coordination with and approval from the property owners. Numerous bridge options will be explored. Fill removal may increase or decrease based on soil investigation findings within the fill areas. Additional fill removal from adjacent inner shoreline may be considered to offset a reduction in channel opening created by bridge limitations.

Expected Direct Results
Physical: This project will restore approximately 2.43 hectares of tidal marsh habitat that has been eliminated by filling and diking. Channel area will increase by approximately 0.7 hectares. Local connectivity for this pocket estuary should improve significantly due to increased channel entrance cross-section area and depth. Project components will protect the entire 4.78 ha pocket estuary from threats that risk the productivity of the entire lagoon.
Biological: Completed restoration will increase nearshore habitat fish capacity by and estimated 799 smolts annually. It is expected that there will be an immediate increase in fish use above the lagoon restriction following project completion. Protection components of this project should preserve the capacity of the entire lagoon (3,671 fish).

Effectiveness Monitoring
Habitat restoration, buffer re-establishment, fish utilization, lagoon outlet bank stability, and water quality will be monitored. Fish utilization will be monitored by SRSC and SRFB.

Backup Actions (if Direct Results not achieved):
These will be worked out as part of the assessment, design, and permitting process.

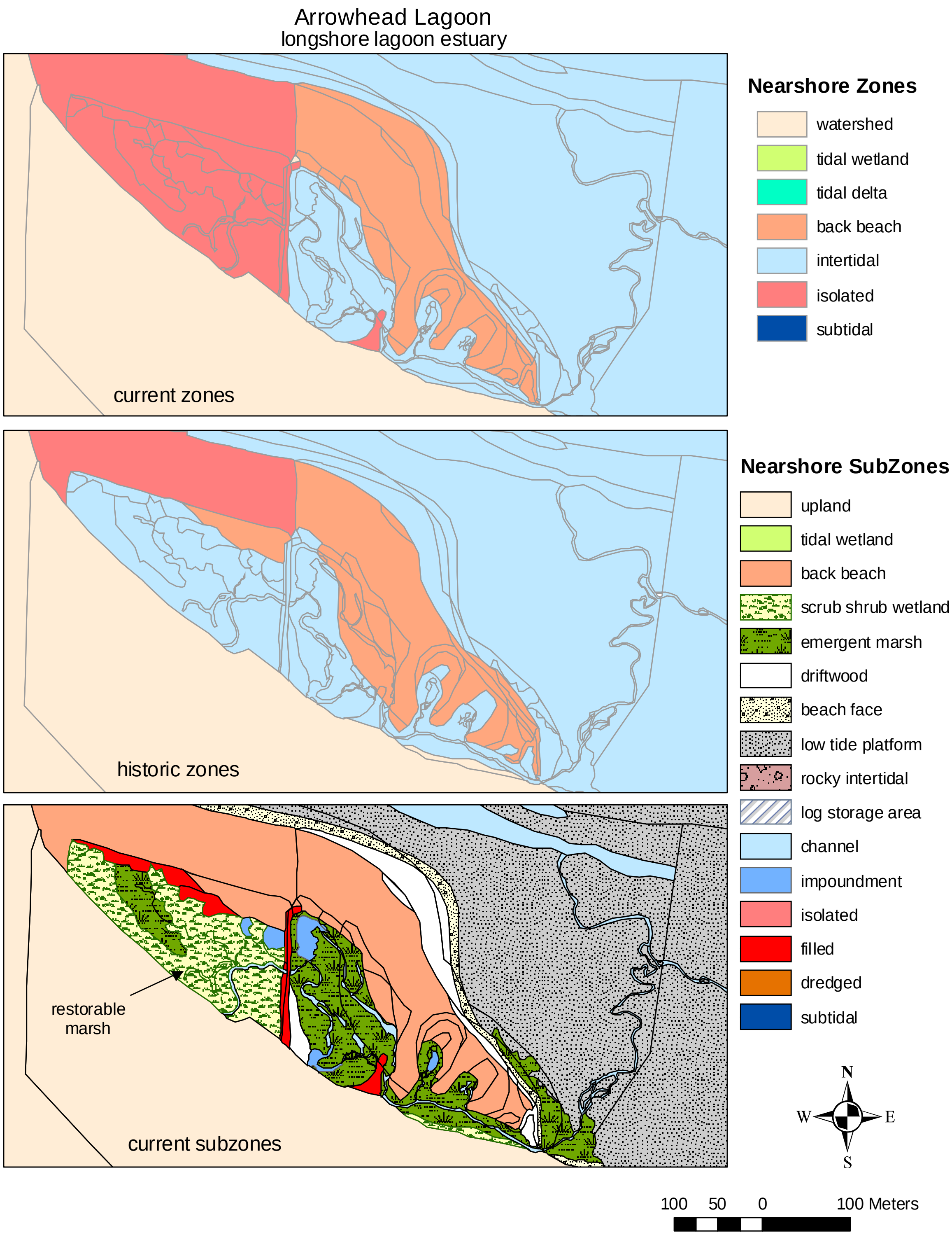

Figure 12.3. *Arrowhead Lagoon.* Arrowhead Lagoon has been diked and filled to isolate its western half. The outer beach of the spit is armored and the inner edge of the spit is partially armored and filled. This spit appears to have grown steadily to the east, with easterly curved fingers extending into the marsh as the spit has prograded. Maintaining sediment sources for this spit will be an important part of restoration and habitat protection.

12.3.3 Turners Bay Lagoon

Project Summary
1) Restore connectivity for the upper marsh area by removing road fill. 2) Address water quality and ditching in the headwater wetlands. 3)Protect existing sediment source beaches in adjacent the drift cell (Figure 12.4).

Purpose
Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted
Restoration will benefit the fry migrant life history type from all six Skagit stocks.

Cost
Proposed for feasibility work under EPA funding in 2005. Cost estimates are not available at this time

Probability and Timeframe
This project is in the early stages of investigation. The area is under tribal jurisdiction. Talks with adjacent landowners are now underway. There is mutual interest in completing a project at the site so probability is high

Contingencies
There are several businesses located along the stream and marsh feeding this lagoon. A composting business may need some evaluation in relation to its contributions to degraded water quality. Water quality monitoring will need to be stepped up to inform restoration alternatives and costs. In instances were violations are detected, enforcement actions will be pursued.

Expected Direct Results
Physical: Total estuarine habitat will increase by 3.52 hectares. Channel habitat will increase by 0.77 hectares. Project components will protect the entire 21.61 ha pocket estuary from threats that risk the productivity of the entire lagoon.
Biological: Completed restoration will increase nearshore habitat fish capacity by an estimated 4,735 smolts annually. It is expected that there will be notable increase in fish use within the lagoon immediately following project completion. Protection components of this project should preserve the capacity of the entire lagoon (15,203 fish).

Effectiveness Monitoring
SRSC will continue to monitor fish use at this site as part of ongoing research. The Swinomish Indian Tribal Community will continue to monitor water quality as part of ongoing baseline monitoring.

Backup Actions (if Direct Results not achieved):
These will be worked out as part of the assessment, design, and permitting process.

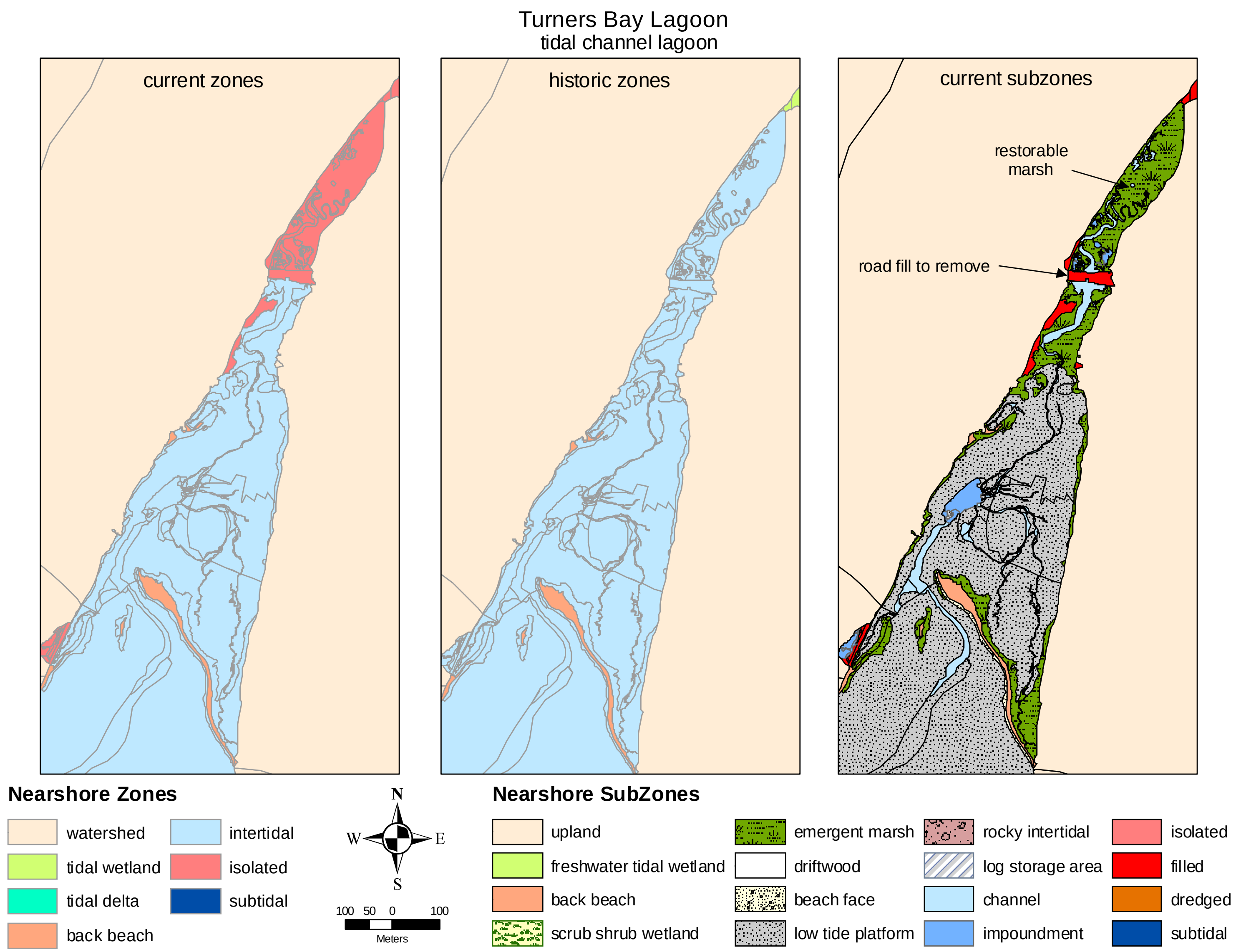

Figure 12.4. *Turners Bay Lagoon.* Turners Bay Lagoon is a tidal channel lagoon system with a small creek and wetland at its head. It is probable that the pocket estuary connected to Padilla Bay at some point during its evolution. A tide gate and road fill has isolated the upper wetland of Turners Bay Lagoon.

12.3.4 Crescent Harbor

Project Summary

Proposed restoration, developed by Island County, would include:

- Breaching the existing beach berm at the current culvert location
- Replacing the culvert with a spanning bridge
- Removing fill within the marsh at the south edge of the WWTP
- Filling existing dredged ditches and replacing them with excavated channels to mimic historic natural drainages
- Creating or improving connections between the three marsh segments (Figure 12.5)

Purpose

Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted

This project will benefit the fry migrant life history type from all six Skagit stocks.

Cost and Funding Sources

Feasibility work is complete. Island County Public Works received $406,424 from the SRFB in 2000 to develop the above described restoration plan. Complete project costs are not available at this time.

Probability and Timeframe

This project is in process. Whidbey Naval Air Station is the willing landowner. An exact timeline has not been developed. Completion is probable.

Contingencies

Water quality issues stemming from the WWTP may complicate this project.

Expected Direct Results

Physical: Total estuarine habitat will increase by 83.37 hectares. Channel habitat will increase by 5.17 hectares.

Biological: Completed restoration will increase nearshore habitat fish capacity by an estimated 15,938 smolts annually. It is expected that there will be juvenile salmon within the lagoon immediately following project completion.

Effectiveness Monitoring

It is expected that fish utilization would be monitored by SRSC and NOAA fisheries as part of the on-going research.

Backup Actions (if Direct Results not achieved):

These will be worked out as part of the assessment, design, and permitting process.

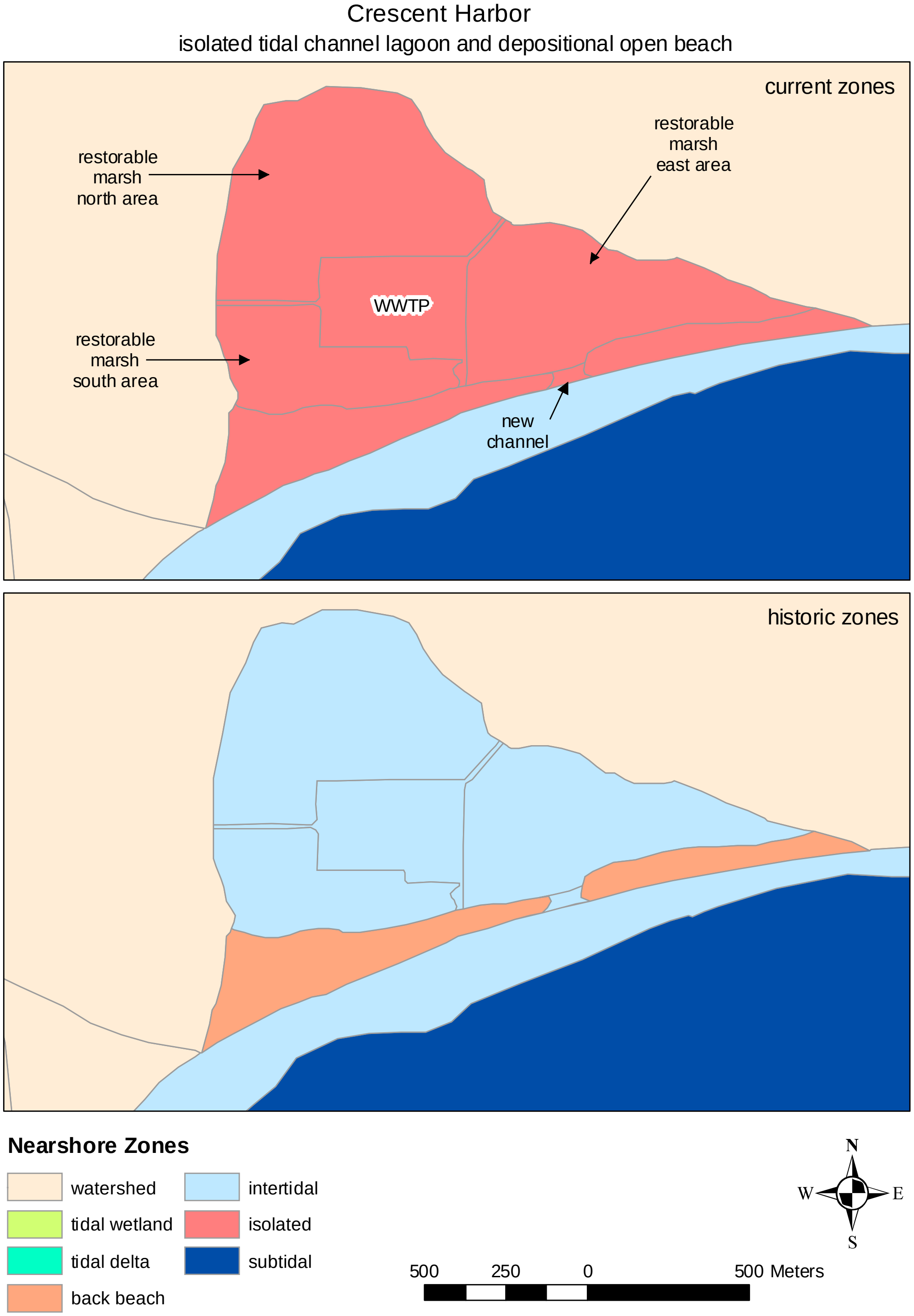

Figure 12.5. *Crescent Harbor.* Crescent Harbor pocket estuary has been completely cut off from tidal exchange except through ground water. The former spit is armored along its eastern half and filled with a road along the crest of the berm. The isolated marsh system, associated with a creek, is ditched and piped to the beach via a tide-gated culvert. Most of this system is restorable, minus a wastewater treatment pond (WWTP) and intake pipes in the middle of the marsh. The restorable marsh is in three separate segments, divided by the WWTP and intake pipes.

12.3.5 English Boom Lagoon

Project Summary

- Restore historic marsh and channels by removing dikes and fill from old log storage operation.
- Reroute the creek, which has been diverted away from the pocket estuary to flow into the pocket estuary (Figure 12.6).

Purpose

Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted

This project will benefit the fry migrant life history type from all six Skagit stocks.

Cost and Funding Sources

Likely SRFB proposal for 2005. Additional match monies are available through USFWS Coastal accounts, Ducks Unlimited, and WDFW. Complete project costs have not been evaluated.

Probability and Timeframe

This project is in the early stages of investigation. Preliminary correspondence has begun with Island County and WDFW. Prospects look favorable for implementation. We expect to submit a grant application to SRFB in 2005.

Contingencies

Unknown at this time.

Expected Direct Results

Total estuarine habitat will increase by 1.25 hectares. Channel habitat will increase by 0.08 hectares. Project components will protect the entire 9.55 ha pocket estuary from threats that risk the productivity of the entire lagoon. A significant part of this project is rerouting the creek back into the pocket estuary, which should help attract fish into it and increase local connectivity.

Expected Fish Use and Production Results, and Timeframe

Completed restoration will increase nearshore habitat fish capacity by an estimated 490 smolts annually. It is expected that there will be notable increase in fish use within the lagoon immediately following project completion. Protection components of this project should preserve the capacity of the entire lagoon (3,418 fish).

Monitoring of Fish Use and Production Results

It is expected that fish utilization would be monitored by SRSC as part of the on-going research into the role and function of pocket estuaries. See *Section 11: Monitoring Actions* for greater detail.

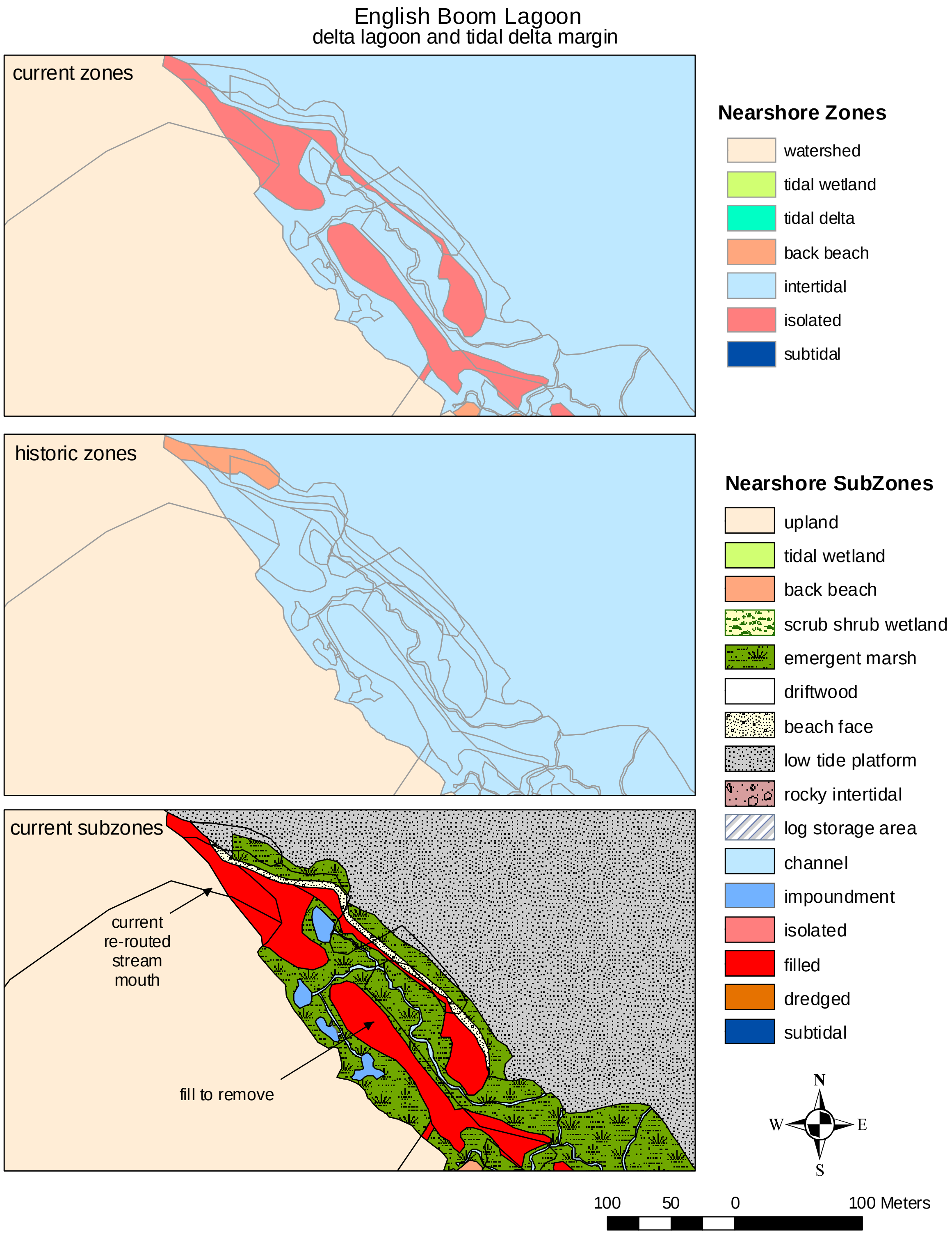

Figure 12.6. *English Boom Lagoon.* English Boom was originally a small spit formed along the margin of the tidal delta marsh of the Skagit and Stillaguamish deltas. The area has been filled and dredged for log storage historically. More recently those modifications have been left to coastal and delta processes and have evolved into a partially artificial channel and marsh complex.

12.3.6 SneeOosh Lagoon

Project Summary

- Restore intertidal pocket estuary habitat by removing fill and creating a new outlet channel.
- Protect and restore sediment source beaches in the adjacent drift cell that historically maintained the lagoon spit.
- Address water quality issues related to the sewer pump station in the isolated marsh (Figure 12.7).

Purpose

Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted

This project will benefit the fry migrant life history type from all six Skagit stocks.

Cost

Costs and funding sources have not been evaluated.

Probability and Timeframe

This project is in the early stages of investigation.

Contingencies

Landowner consent.

Expected Direct Results

Total estuarine habitat could increase by 1.09 hectares. Channel habitat will increase by 0.07 hectares.

Expected Fish Use and Production Results, and Timeframe

Completed restoration will increase nearshore habitat fish capacity by an estimated 593 smolts annually. It is expected that juvenile salmon will use the lagoon immediately following project completion.

Monitoring of Fish Use and Production Results

It is expected that fish utilization would be monitored by SRSC as part of the on-going research into the role and function of pocket estuaries. See Section 11: Monitoring for more detail.

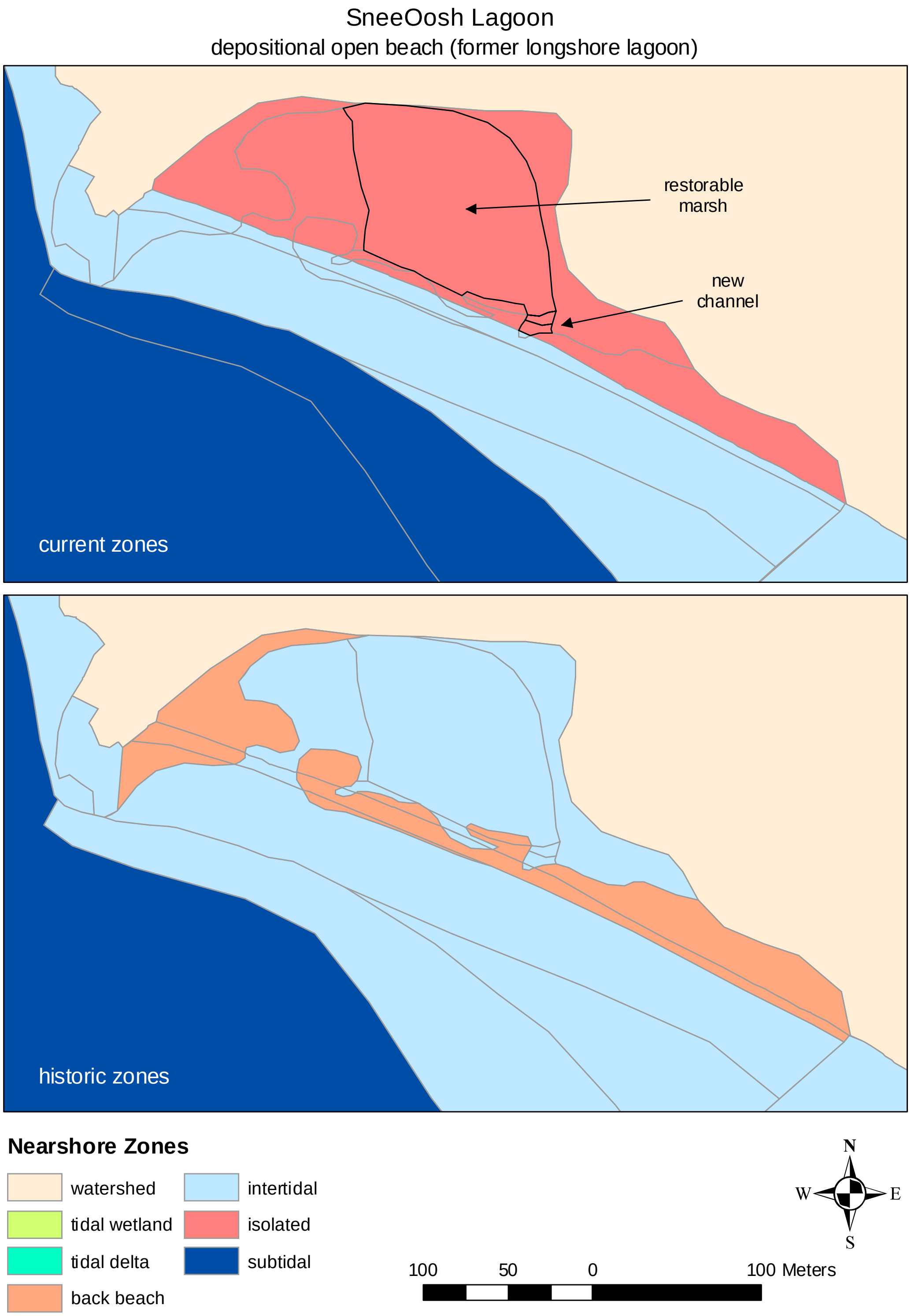

Figure 12.7. *SneeOosh Lagoon.* SneeOosh Lagoon has been isolated and partially filled. The isolated marsh is drained by a pumping station and pipe to the beach. The beach is armored. Restoration would involve reconnecting the isolated marsh via a new channel, as the original channel location is built upon.

12.3.7 Kiket Lagoon

Project Summary
- Restore intertidal pocket estuary habitat by removing fill and bank armoring.
- Protect and restore sediment source beaches in the adjacent drift cells that historically maintained the lagoon spit and tombolo (Figure 12.8).

Purpose
Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted
This project will benefit the fry migrant life history type from all six Skagit stocks.

Cost
Costs and funding sources have not been evaluated.

Probability and Timeframe
This project is in the early stages of investigation.

Contingencies
Landowner consent.

Expected Direct Results
Total estuarine habitat will increase by 1.25 hectares. Channel habitat will increase by 0.09 hectares. Project components will protect the entire 1.42 ha pocket estuary from threats that risk the productivity of the entire lagoon.

Expected Fish Use and Production Results, and Timeframe
Completed restoration will increase nearshore habitat fish capacity by an estimated 141 smolts annually. It is expected that juvenile salmon will use the newly restored parts of the lagoon immediately following project completion. Protection components of this project should preserve the capacity of the entire lagoon (6,219 fish).

Monitoring of Fish Use and Production Results
Monitoring has not been planned. Site access is limited due to landowner issues.

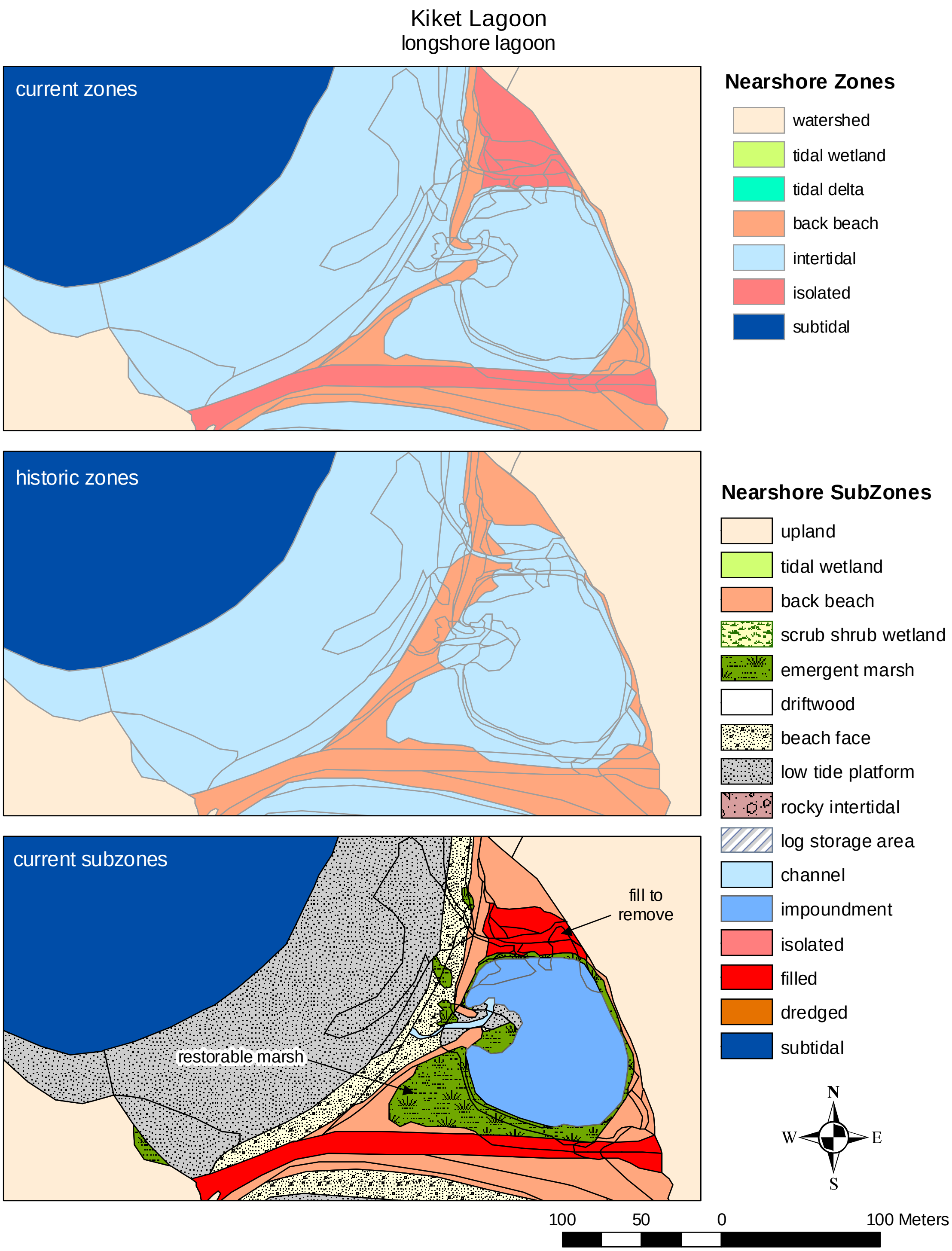

Figure 12.8. *Kiket Lagoon.* Kiket Lagoon is mostly intact, with only about ¼ of its historic footprint filled. However, the southern tombolo is completely armored, isolating the back beach from longshore drift and natural habitat development. Drift cell armoring at sediment source beaches in Kiket Bay may also be impacting this pocket estuary.

12.3.8 Mariners Cove

Project Summary

- Restore intertidal pocket estuary habitat by removing fill and bank armoring.
- Protect sediment source beaches in the adjacent drift cell that historically maintained the lagoon spit.
- Establish a protocol that any dredging of the boat basin will be utilized to nourish the beach immediately north of the basin opening, to maintain sediment transport processes in volume if not in mechanism.
- Establish a water quality protocol that prevents catastrophic kills of fish within the boat basin (Figure 12.9).

Purpose

Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted:

This project will benefit the fry migrant life history type from all six Skagit stocks.

Cost and Funding Sources

Costs and funding sources have not been evaluated.

Probability and Timeframe

This project is in the early stages of investigation.

Contingencies

Landowner consent.

Expected Direct Results

Total estuarine habitat could increase by 2.79 hectares. Channel habitat could increase by 0.17 hectares. Project components will protect the entire 1.42 ha pocket estuary from threats that risk the productivity of the entire lagoon.

Expected Fish Use and Production Results, and Timeframe

Completed restoration will increase nearshore habitat fish capacity by an estimated 881 smolts annually. It is expected that juvenile salmon will use the newly restored parts of the lagoon immediately following project completion. While the restoration component of this site is not large, the site itself has a large capacity already due to the artificial subtidal habitat of the boat basin. Any fish currently using the site are at risk from threats common in boat basins. Protection components of this project should preserve the capacity of the entire pocket estuary (27,448 fish).

Monitoring of Fish Use and Production Results

Monitoring has not been planned.

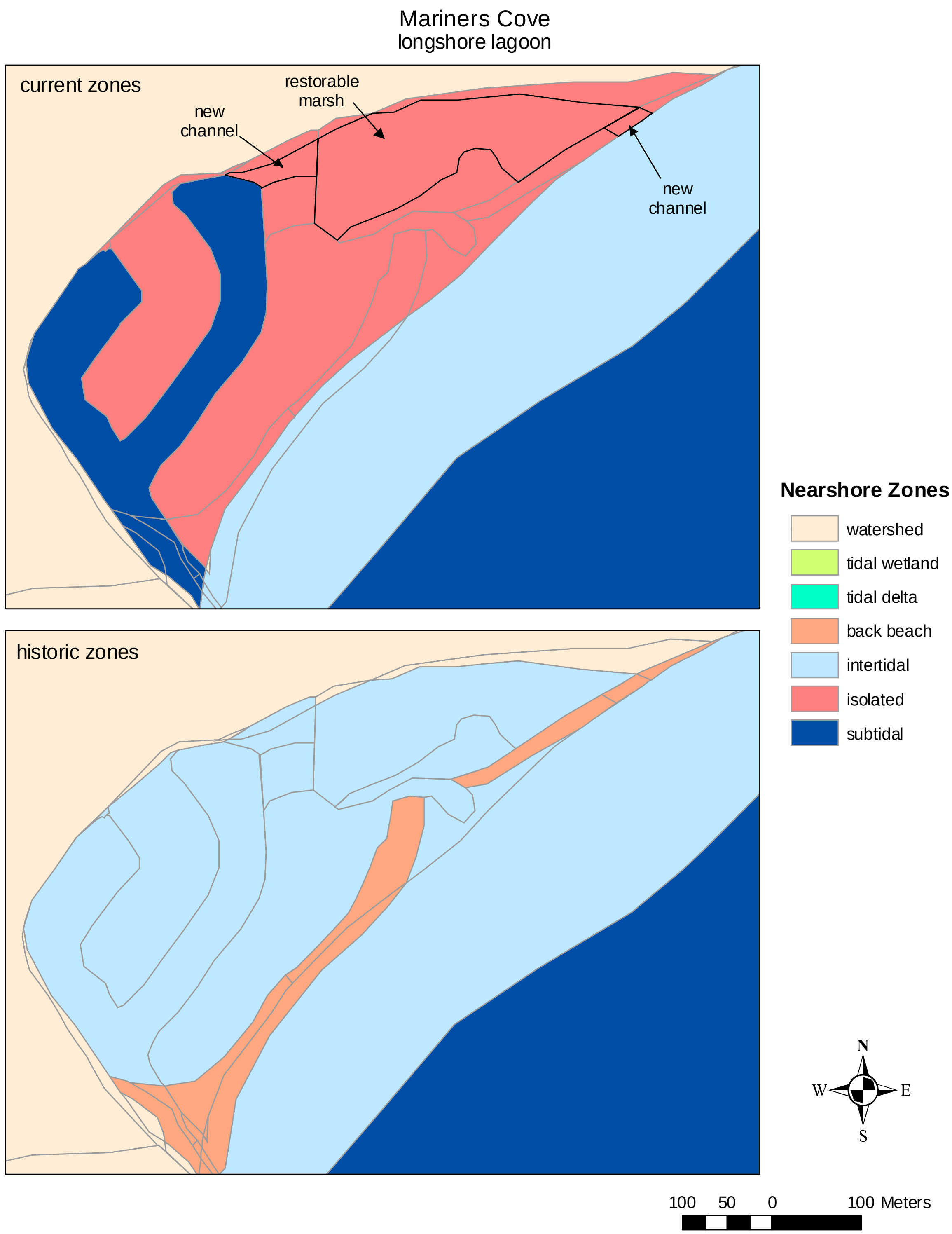

Figure 12.9. *Mariners Cove.* Mariners Cove has been completely altered from its original form into a dredged boat basin. Restoration is possible for a section of existing, isolated marsh along the northeast edge of the former pocket estuary. A new channel would need to be dredged to connect the marsh to tidal inundation. A second channel could connect the boat basin to the restorable marsh as well. Houses ring the boat basin.

12.3.9 Ala Lagoon

Project Summary

- Restore intertidal pocket estuary habitat by removing fill and opening up the outlet channel to the marsh by replacing the road fill with a bridge.
- Protect and restore sediment source beaches in the adjacent drift cell that historically maintained the lagoon spit (Figure 12.10).

Purpose

Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted

This project will benefit the fry migrant life history type from all six Skagit stocks.

Cost and Funding Sources

Costs and funding sources have not been evaluated.

Probability and Timeframe

This project is in the early stages of investigation.

Contingencies

Landowner consent.

Expected Direct Results

Total estuarine habitat could increase by 0.14 hectares. Channel habitat could increase by 0.01 ha. Project components will protect the entire 10.01 ha pocket estuary from threats that risk the productivity of the entire lagoon.

Expected Fish Use and Production Results, and Timeframe

Completed restoration will increase nearshore habitat fish capacity by an estimated 67 smolts annually. It is expected that juvenile salmon will use the newly restored parts of the lagoon immediately following project completion. While the restoration component of this site is not large, the site itself has a large capacity due to the protected habitat behind the large spit. Sediment processes supporting the maintenance of the spit have been disturbed. Therefore, the protection components of this project are the most important part of this project and they should preserve the capacity of the entire pocket estuary (14,122 fish).

Monitoring of Fish Use and Production Results

It is expected that fish utilization would be monitored by SRSC as part of the on-going research. See Section 11: Monitoring for more detail.

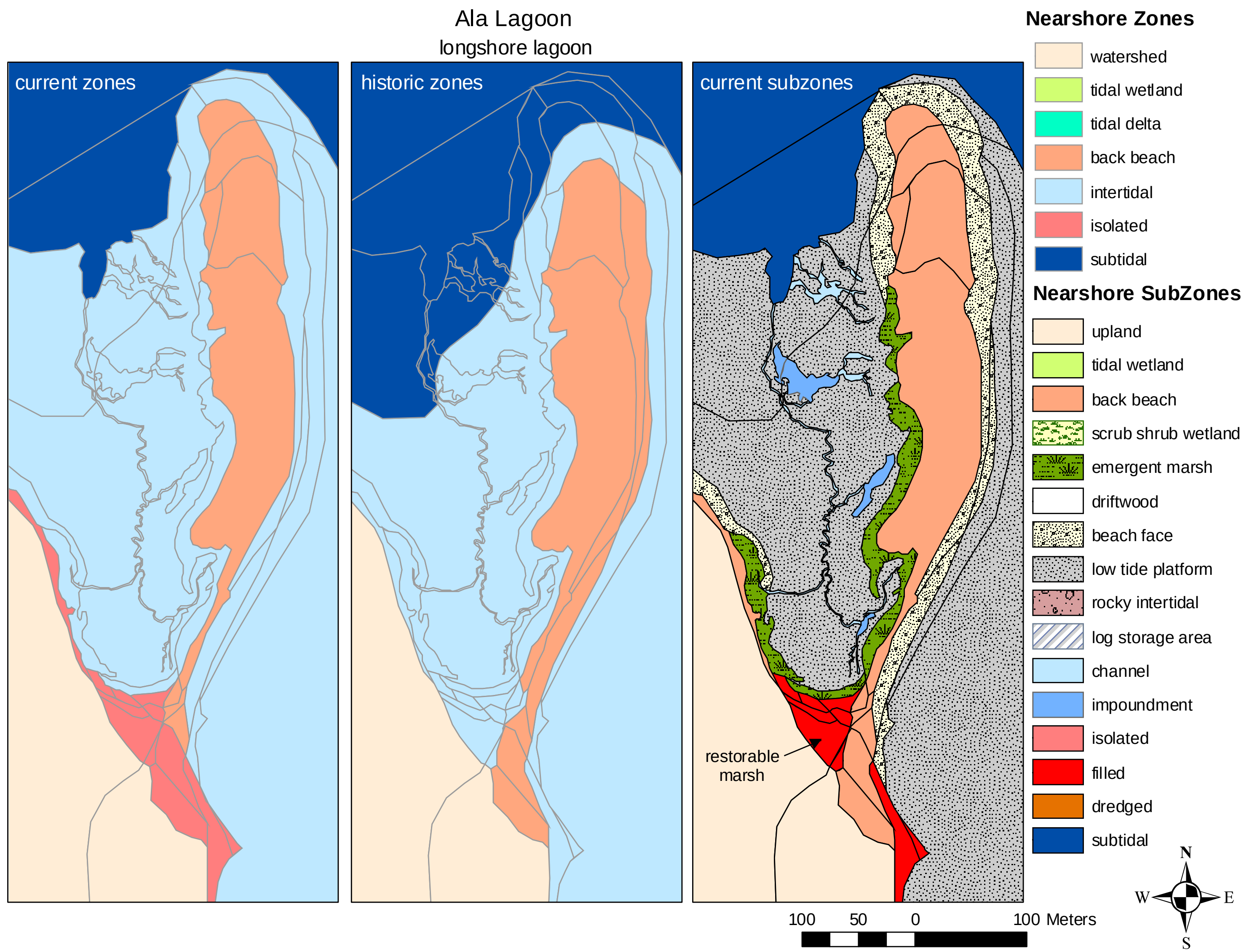

Figure 12.10. *Ala Lagoon.* Ala Lagoon has been modified by an access road that partially filled and cut off a small section of tidal marsh at the head of the lagoon. On the south edge of the spit, shoreline armoring and filling has cut off some sediment sources that contributed to the spit historically.

12.3.10 Dugualla Heights

Project Summary

- Restore intertidal pocket estuary habitat by removing fill or installing a tidegate to open the outlet channel to the existing artificial lake.
- Create tidal channels and marsh, where possible (Figure 12.11).

Purpose

Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted

This project will benefit the fry migrant life history type from all six Skagit stocks.

Cost and Funding Sources

Costs and funding sources have not been evaluated.

Probability and Timeframe

This project is in the early stages of investigation.

Contingencies

Landowner consent.

Expected Direct Results

Total estuarine habitat will increase by 2.55 hectares. Channel habitat could increase by 2.40 hectares.

Expected Fish Use and Production Results, and Timeframe

Completed restoration could increase nearshore habitat fish capacity by an estimated 26,025 smolts annually. It is expected that juvenile salmon would use the lagoon immediately following project completion. This site has the highest landscape scale connectivity of any pocket estuary with restoration potential.

Monitoring of Fish Use and Production Results

Monitoring has not been planned.

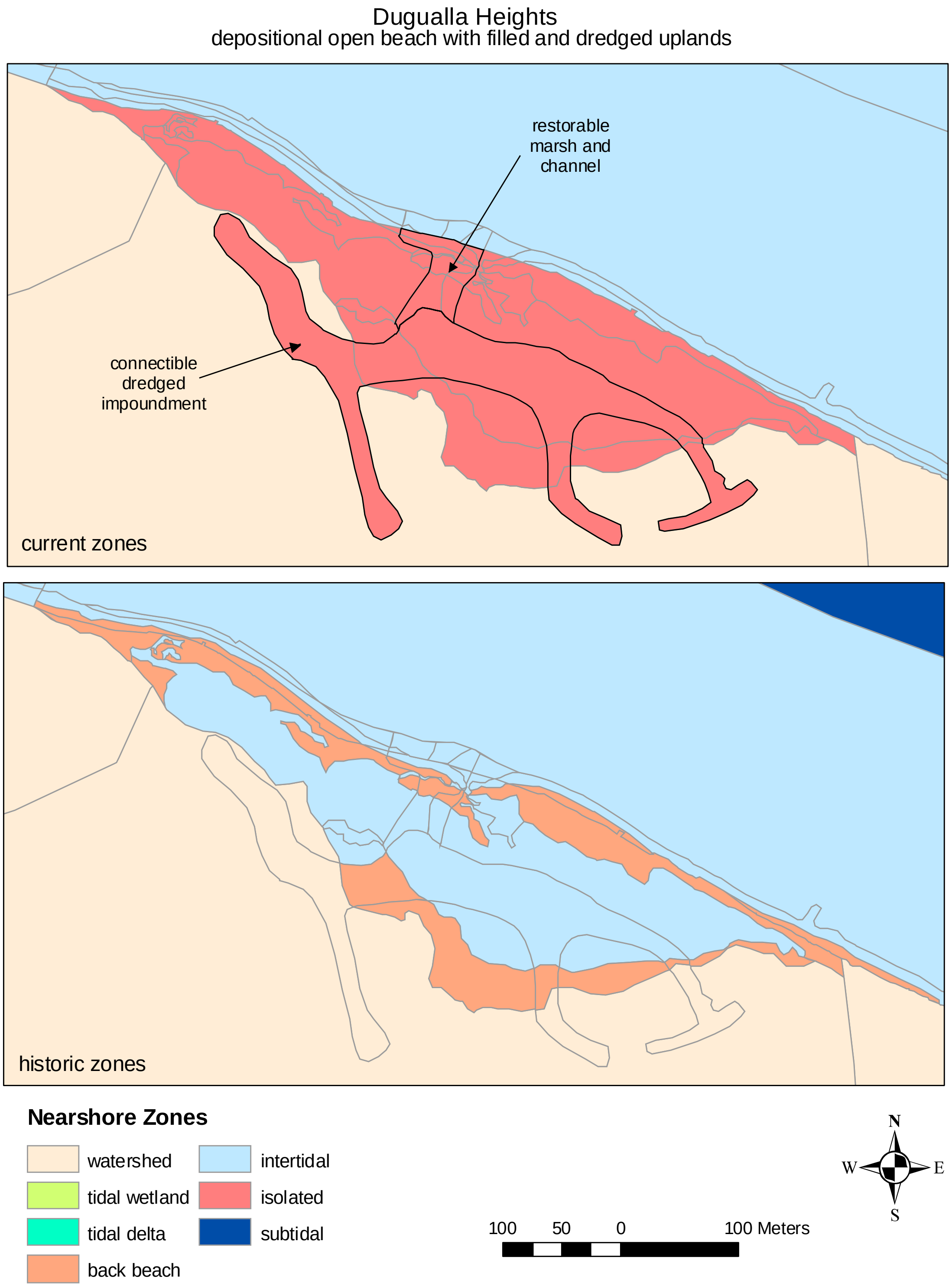

Figure 12.11. *Dugualla Heights*. Dugualla Heights was formerly a longshore lagoon. The historic impoundments have been cut off from tidal exchange, enlarged, dredged, and armored to create a lake. The former spit beach is also armored. Restoration could reconnect the artificial lake to tidal influence via a constructed channel through a narrow piece of existing marsh. The area is heavily built and armored, so restoring a more natural system is not feasible.

12.3.11 Similk Beach

Project Summary

- Characterize the restoration potential for this site.
- Restore intertidal pocket estuary habitat by removing fill to open up the outlet channel to the marsh, replacing the road fill with a bridge, and constructing channels in the existing golf course wet areas.
- Protect and restore sediment source beaches in the adjacent drift cell that historically maintained the lagoon spit (Figure 12.12).

Purpose

Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted

This project will benefit the fry migrant life history type from all six Skagit stocks.

Cost and Funding Sources

Costs and funding sources have not been evaluated.

Probability and Timeframe

This project is in the early stages of investigation.

Contingencies

Landowner consent.

Expected Direct Results

Total estuarine habitat will increase by 9.55 hectares. Channel habitat will increase by 0.59 hectares.

Expected Fish Use and Production Results, and Timeframe

Completed restoration will increase nearshore habitat fish capacity by an estimated 3,782 smolts annually. It is expected that juvenile salmon would use the lagoon immediately following project completion.

Monitoring of Fish Use and Production Results

Monitoring has not been planned.

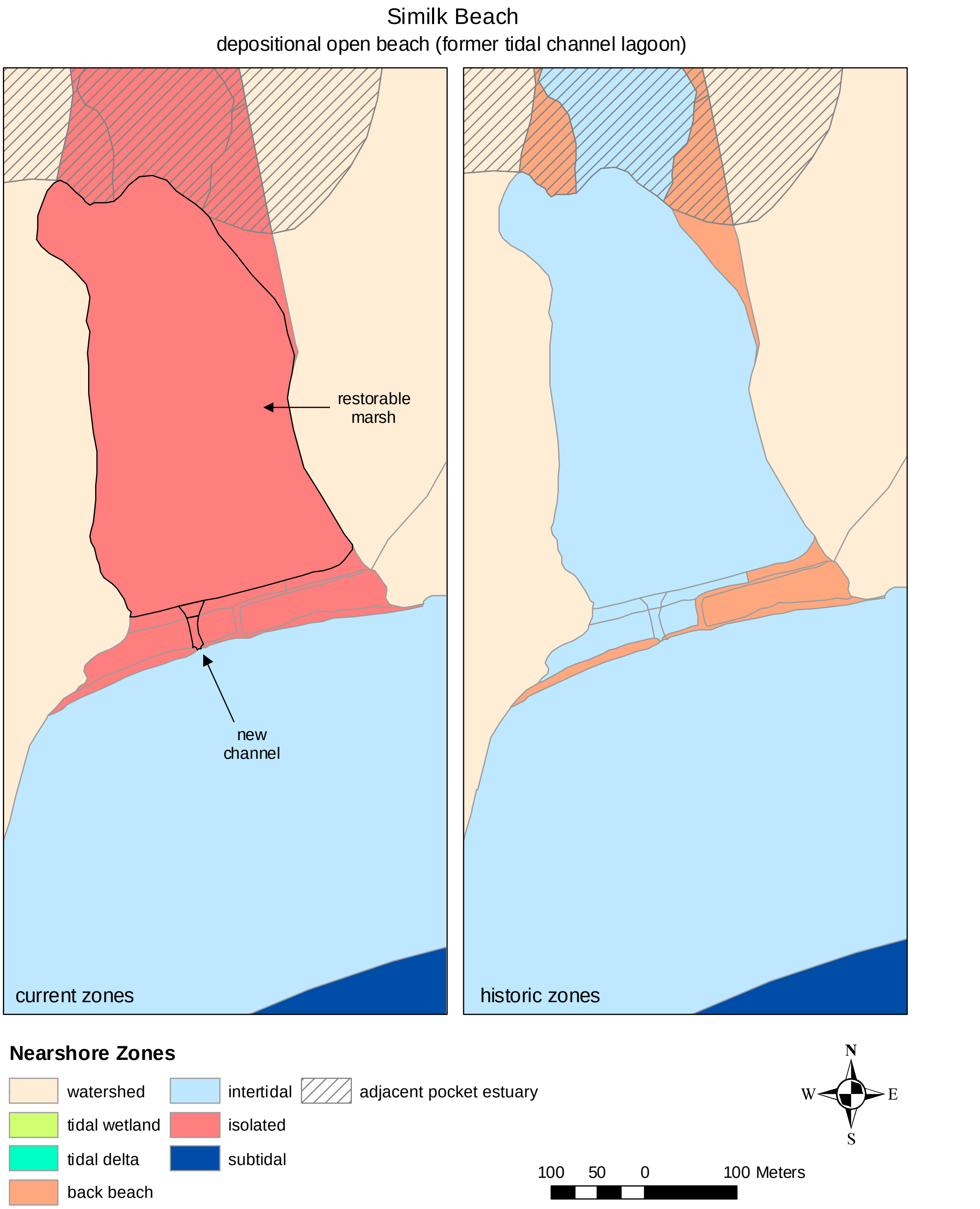

Figure 12.12. *Similk Beach.* Similk Beach is a former tidal channel that is now a golf course. This site floods every winter because of its low relief. The beach face is diked, with a pumping station and pipe to drain the golf course. Data for mapping historic conditions were of poor quality. Further investigation and site characterization would be necessary to determine appropriate restoration actions.

12.3.12 Dugualla Bay

Project Summary

- Characterize the restoration potential for this site.
- Restore intertidal pocket estuary habitat by removing fill to open up the outlet channel to the marsh.
- Protect and restore sediment source beaches in the adjacent drift cell that historically maintained the lagoon spit (Figure 12.13).

Purpose

Increase pocket estuary capacity near the Skagit delta and improve habitat quality.

Populations Targeted

This project will benefit the fry migrant life history type from all six Skagit stocks.

Cost and Funding Sources

Costs and funding sources have not been evaluated.

Probability and Timeframe

This project is in the early stages of investigation.

Contingencies

Landowner consent.

Expected Direct Results

Total estuarine habitat will increase by 156.94 hectares. Channel habitat will increase by 9.73 hectares. Local connectivity will improve significantly at this site depending on the restoration footprint size. Historically, this site had subtidal habitat (a connection to the source of fish 100% of the time) upstream of the spit enclosure. The site has the potential to have similar fish access conditions in a restored state.

Expected Fish Use and Production Results, and Timeframe

Completed restoration could increase nearshore habitat fish capacity by an estimated 93,758 smolts annually. It is expected that juvenile salmon will use the lagoon immediately following project completion. This site has the largest restoration potential and second highest landscape connectivity index.

Monitoring of Fish Use and Production Results

Monitoring has not been planned.

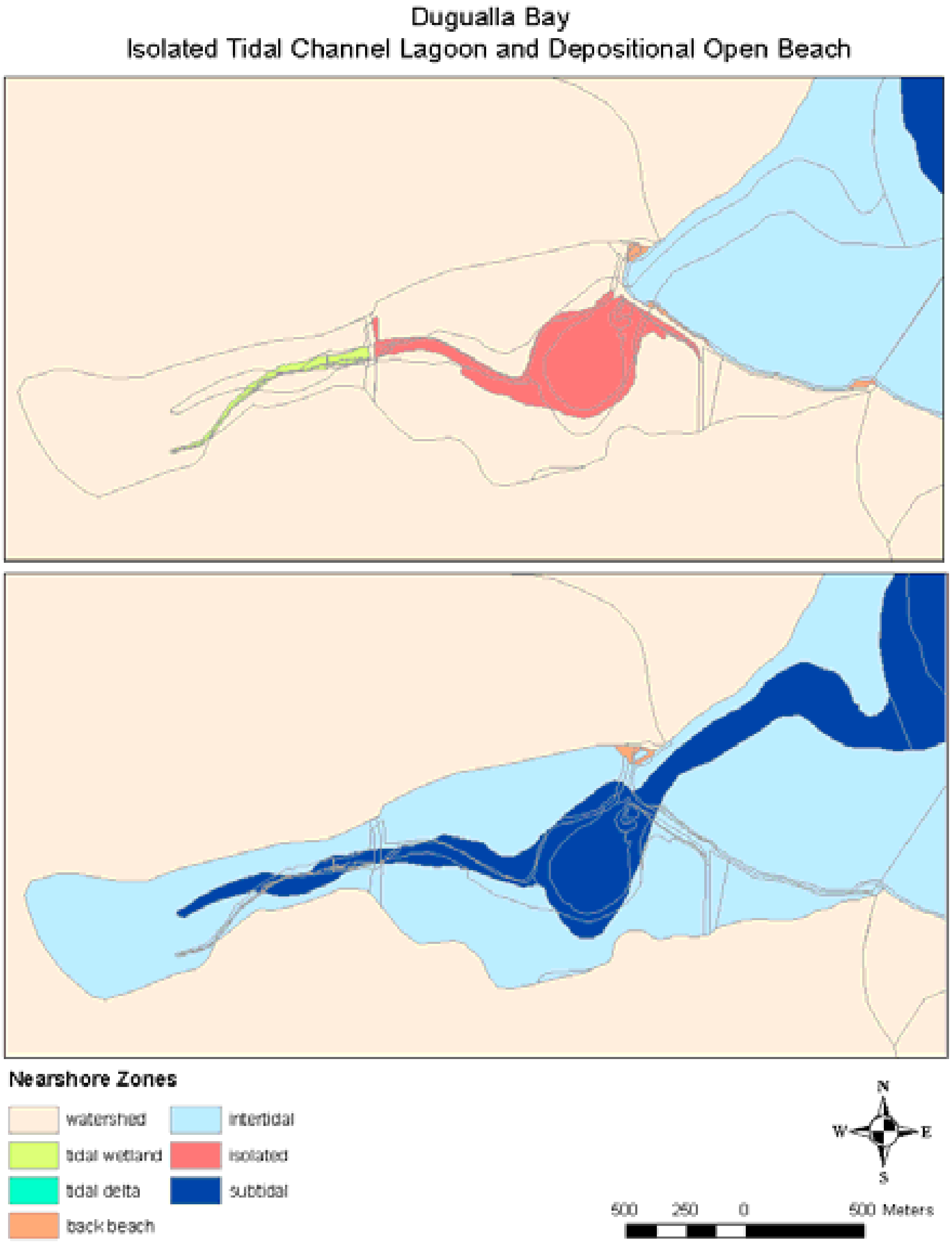

Figure 12.13. *Dugualla Bay*. Dugualla Bay has been completely cut off from its historic tidal channel and associated marsh and channel complex. The original pocket estuary probably included a spit that does not show on these maps because historic data in the central part of the bay were too coarse in resolution to identify any coastal landforms. Development of this site pre-dates 1941. This site is of particular importance due to close proximity to the Skagit Delta.