Whatcom County Nearshore Habitat Restoration Prioritization

Prepared for: Whatcom County Marine Resources Committee

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Coastal Geologic Services Inc.

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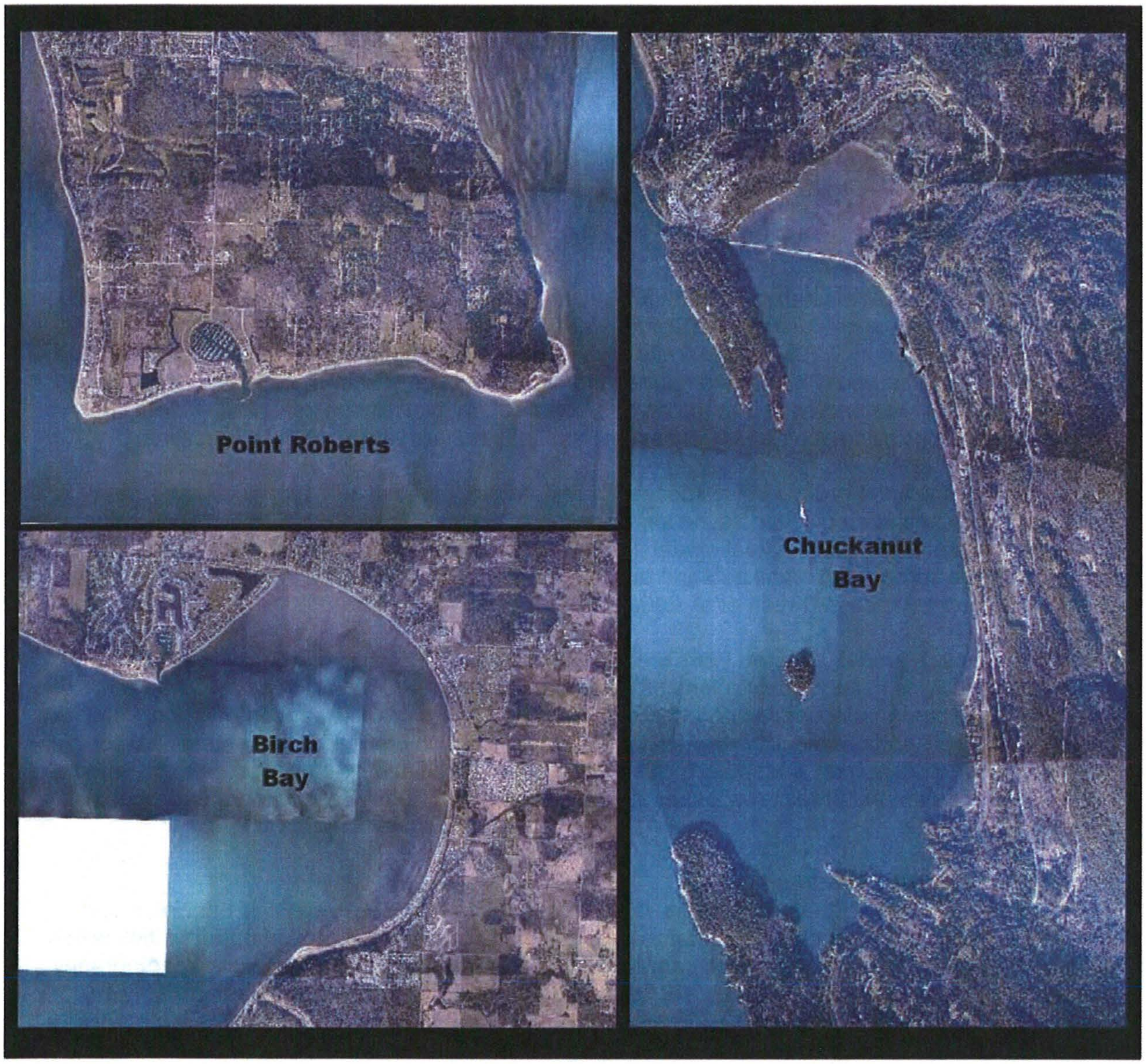

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Introduction

Coastal Geologic Services, Inc. (CGS) was contracted by the Whatcom County Marine Resource Committee (MRC) to augment and prioritize a list of nearshore restoration opportunities within three target regions of Whatcom County: Point Roberts, Birch Bay, and Chuckanut Bay. This restoration prioritization was intended to build on previous work completed for the County/MRC (Enhanced Nearshore Assessment, ESA Adolfson, Parametrix and CGS), and to employ similar methods developed for prioritizing nearshore restoration projects in nearby counties (Skagit Bays Blueprint, People for Puget Sound; Soft Shore Protection/Structure Removal Blueprint for San Juan County Forage Fish Beaches, CGS) but applied at a finer scale.

This project provides the MRC with a tool to help achieve the MRC mandate to identify and solve problems reagrding local marine resources such as intertidal and estuarine habitat, shellfish beds, and bottomfish. The objective of this study was to develop and apply a straightforward, user-friendly prioritization approach that integrates sustainability, risk, practicality and feasibility with each site's ability to support the following three key biological resources: forage fish spawning, juvenile salmonid rearing/migration, and aquatic vegetation.

Methods

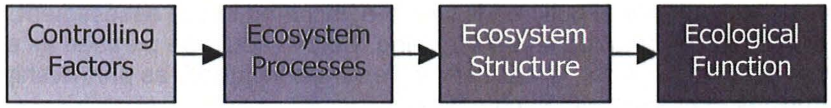
Restoration means the re-establishment of pre-disturbance aquatic functions and related physical, chemical and biological characteristics (Cairns 1998, Magnuson et al. 1980; and Lewis 1989 in National Research Council 1992). Restoration typically results in a net increase in the amount, size and/or functions of an ecosystem or components of an ecosystem (Thom et al. 2005). Inherent in current concepts in restoration is that restoration goals cannot typically be achieved without first addressing the controlling ecosystem processes, habitat structure and ecological functions.

In order to maximize the probability of successful restoration, one must develop a clear strategy. Fundamental to any strategic plan, is the identification of clear restoration goals and the development of a conceptual model. A conceptual model can help organize knowledge about how nearshore ecosystems are composed, organized and operate as well as how the system might respond to a particular restoration action (Fresh et al. 2004).

A basic conceptual model, adapted from Thom and Wellman (1996) and Diefenderfer et al. (2006), integrates conditions in the target regions of Whatcom County, MRC restoration objectives and a commonly accepted model used in nearshore restoration (Figure 1). This conceptual model can help guide restoration efforts to assure more sustainable, well functioning nearshore systems, rather than site-specific enhancement. Conceptual models have been developed by the Puget Sound Nearshore Partnership to guide and predict responses to restoration within Puget Sound nearshore systems (Figure 2).

Restoration List Augmentation

The first step in achieving the goals of this study was to refine the coarse-scale of the *Enhanced Nearshore Assessment* report, by supplementing the list of potential restoration opportunities within each of the targeted areas. The list was amended using the county's pictometry/aerial photography dataset (Pictometry International Corp 2004), combined with Washington State Department of Ecology's shoreline oblique air photos of Whatcom County (2001), and the Shorezone database shoreline (2001) in a GIS. Shores where anthropogenic alterations to the nearshore were degrading habitat processes, structure or function (stressors), were digitized and further assessed to determine if restoration was viable.



Controlling Factors	Ecosystem Processes	Ecosystem Structure	Ecological Function
Geology Climate Wave energy Tidal regime Geomorphic shoretype Drift cell context Water quality Anthropogenic stressors Sea level	Sediment input, transport Wave dissipation Hydrologic connectivity (tidal flushing) Nutrient exchange	Sediment composition Eelgrass beds LWD Landscape connectivity Shade Vegetation	Surf smelt spawning Sand lance spawning Herring spawning Eelgrass Shellfish production Juvenile salmonid rearing, migration

Figure 1. Basic conceptual model of nearshore systems in Whatcom County.

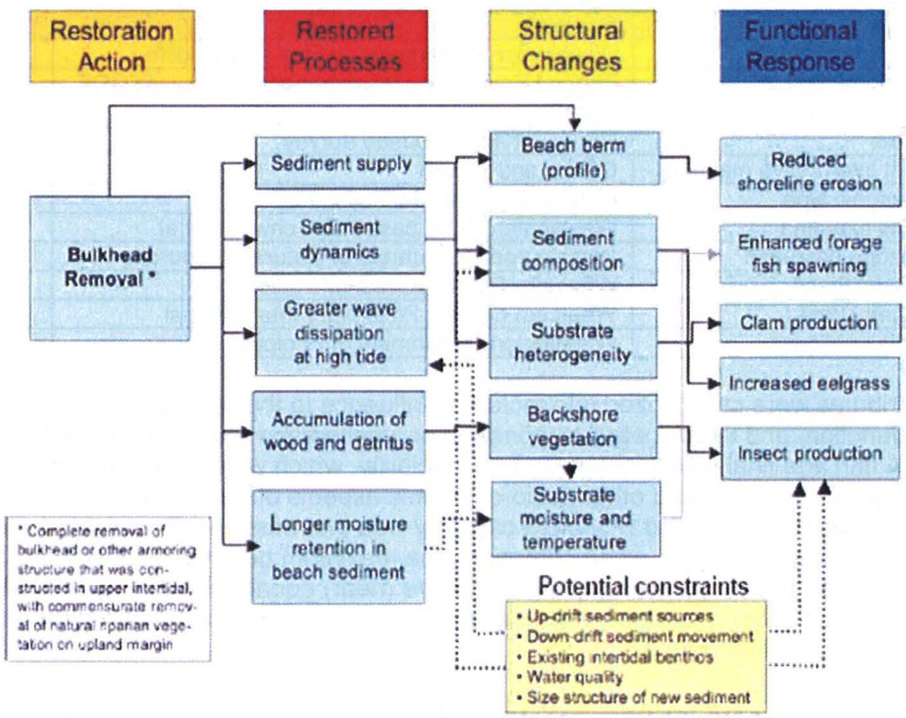


Figure 2. Demonstrates how conceptual models can be used to achieve restoration goals (Simenstad et al. 2006.)

In many locations it was challenging to determine the historic character of the shore and thus assess the degree of alteration from its original condition and the viability of restoration. For this purpose, the T-sheets (earliest accurate topographic maps, generally from the late 1800s) and interpretive T-sheet mapping by Collins and Sheikh (2005) were referenced. Historic air photos were also accessed via the WA DOE Digital Coastal Atlas to determine if structures were likely "grand-fathered" in prior to the Shoreline Management Act, and to observe how structures and shore alterations have changed coastal processes and habitat conditions. Where structures had been in place since the 1970s, and appeared still functioning, restoration was not recommended due to what seemed to be an obvious lack of willingness.

Public waterfront and community owned shores received full consideration in this assessment. Small, single family parcels with individual bulkheads were not included in this assessment, nor were the deconstruction of illegally constructed shore armoring, which should be pursued as a regulatory action. Restoration actions on larger, private properties were included, as partnership and/or mitigation opportunities may exist with such entities.

Once a potential project was appeared likely to be viable and restoration actions were identified, the new sites were digitized and the recommended restoration actions were recorded in the attribute table. Additional data was then compiled in preparation for scoring, which is discussed further below.

Prioritization Scoring

To achieve the objectives of this study and to fine-focus on restoration opportunities with the greatest feasibility, habitat value, and sustainability, CGS applied a three-tiered filter. This approach followed the same general model that was used by CGS in the San Juan County Soft Shore/Structure Removal Blueprint for San Juan County Forage Fish Beaches and entailed applying an initial filter using GIS data and proposed restoration actions, followed by field investigations and then the final ranking and mapping. Numerous data sets were used both in the ranking process and in determining restoration goals (Table 1).

Table 1. Data sources for restoration prioritization.

Name	Source	Year
Priority Species data	Washington Department of Fish and Wildlife	2006
FEMA flood data	Federal Emergency Management Agency via DOE	1998
LIDAR imagery	USGS	2007
T-sheets	US Coast and Geodetic Survey	1887-88
T-sheet interpretive mapping	Collins and Sheikh	2005
Geomorphic type	Coastal Geologic Services, Inc.	2005
Drift cell mapping	Washington DOE, based on Schwartz et al.	1991
Shorezone database	Washington Department of Natural Resources	2001
Parcel database	Whatcom County Assessor's office	2007
Pictometry data	Whatcom County, Pictometry International	2004
Shoreline obliques	Washington Department of Ecology	2001

Scoring attributes were categorized into factors of influence to the overall sustainability, risk, ecological function, and the targeted response(s) or amelioration resulting from the restoration action (Table 2). A fifth and final category focused on feasibility, which was designed to integrate property owner willingness, funding, and other socio-economic aspects of accomplishing a nearshore restoration project. The targeted response category was the most heavily weighted scoring category, followed by ecological function, when comparing the maximum potential scores in each category. Cumulatively, the remaining scoring categories were (near) equally weighted with ecological function. The ratio that each scoring category represents of the total restoration prioritization score is graphically displayed in Figure 3.

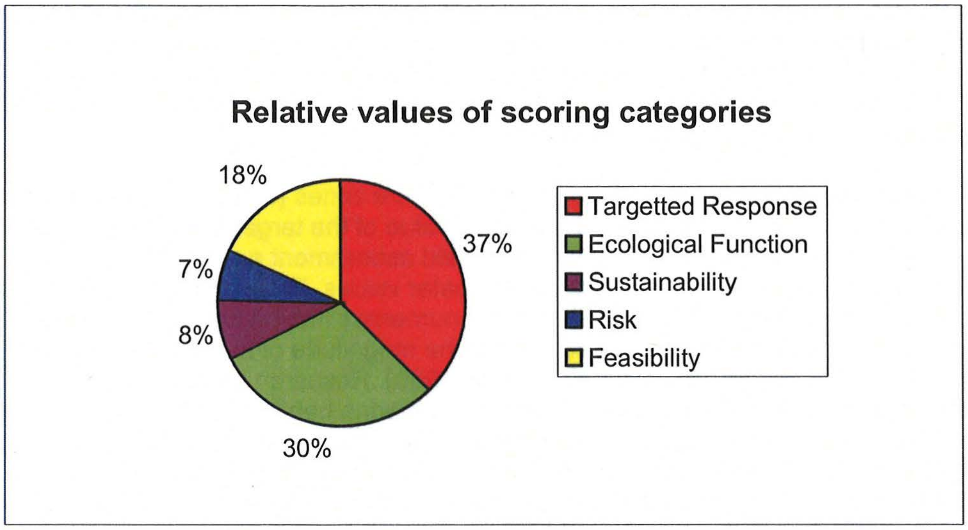


Figure 3. Relative value of each scoring category used in the prioritization model.

It must be noted that although a wide variety of regional assessments and research were reviewed to develop the prioritization scoring, this is far from an exact science and assumptions were made based on incomplete understanding of processes and function. Although certainly imperfect, this quantitative approach was chosen to allow for a systematic way to compare different potential restoration actions.

Targeted response score - Targeted response scores were comprised of 9 questions aimed at addressing the adverse impacts the restoration action is intended to ameliorate. The rationale for the scores assigned to each question was determined by reviewing best available science, including documents designed to guide restoration practitioners in the Puget Sound and Northern Straits.

Targeted response scores convey the relative influence the action will have on the nearshore system. The Puget Sound Nearshore Project has published several documents to aid in addressing Puget Sound restoration needs (pugetsoundnearshore.org). Their research emphasizes that the recovery of ecosystems can best be achieved by reestablishing or significantly improving ecosystem processes. Restoring processes is key to generating and maintaining ecosystem structures (habitats) and important functions (salmonid production, clean beaches and water) (Simenstad et al, 2006). These reasons comprise the general rationale for why restoration projects encompassing the restored ecosystem processes were awarded 5 points. Table 2 displays the rationale and related citation for each of the ranking criteria used in the targeted response category. Restoring ecosystem structure and function, would provide more site-specific benefits and were also included in the targeted response scoring protocol, however with fewer points awarded.

Applying a landscape perspective to restoration planning has received considerable emphasis in recent years. This new landscape view of salmon habitat proposes that the function of any unit of habitat depends upon both local attributes and the context of that habitat within the "bigger picture" of the surrounding habitat (Fresh et al 2004). Understanding transport, migratory pathways and associated barriers can enable restoration practitioners to clearly maintain connectivity across habitat types within nearshore systems. In this restoration prioritization connectivity is valued in three forms: alongshore-sediment, alongshore-salmon and cross-shore. Alongshore-sediment connectivity conveys the functionality of alongshore sediment transport pathways. An example of an impediment to alongshore transport would be a groin or jetty, up-drift of which sediment and driftwood often accumulate. Salmonid landscape connectivity is a measure of the transition and accessibility of habitat types at variable tidal elevations. For example contiguous shallow water habitat is known to reduce predation on juvenile salmonids (Simenstad et al. 1982). Groins and other infringing shore modifications decrease alongshore connectivity for juvenile salmonids migrating alongshore, as these shore modifications make for abrupt transitions from shallow to deeper water often increasing opportunities for predation. Another example of a feature that degrades salmonid landscape connectivity is a tide gate that controls access to potential rearing and foraging habitat at higher tides. Cross-shore connectivity is similar and encompasses the exchange of sediments, nutrients and large woody debris from terrestrial to marine ecosystems. A loss of cross-shore connectivity is commonly exemplified by bluff sediment impounded behind a bulkhead. Cross-shore connectivity typically entails process restoration but does not in every case.

The restoration area(s) within each of the three nearshore zones (estuarine, intertidal and backshore) were calculated and weighted to reflect the relative value of the target habitats being restored (Table 2). Areas were delineated using GPS points from field assessment and digitized in GIS. Restoration projects recovering larger areas were assigned greater values. Estuarine habitat restoration was awarded the greatest number of points, due to the numerous habitat functions provided to ESA listed salmonids during critical life stages and relative to the magnitude of habitat loss incurred in Puget Sound estuaries (Simenstad 1982, Bortelson et al. 1980). Research by Beamer (2005), in the Skagit River Delta, has found that the carrying capacity of estuarine habitats is often at or exceeding capacity. As a result, juvenile Chinook have been utilizing other nearshore habitats including pocket estuaries (Beamer at al. 2005). As a result restoration or recovery of additional estuarine area was awarded the highest points. Intertidal restoration was awarded slightly fewer points, but was also viewed as a priority due to the number of MRC priority species that rely on intertidal ecosystem structure and function. Backshore habitat restoration received fewer points for restoration as the functions provided by marine riparian areas may not be as critical to target species and require several years to achieve maturity following restoration.

Water quality improvements were identified as a requirement to increase capacity of nearshore environments to support more abundant out-migrant juvenile salmonids and generally increase marine productivity (SHARED STRATEGY 2005); as a result actions that will directly or indirectly improve water quality were also awarded points.

Table 2. Targeted response scores and rationale

Targeted response	Rationale	Citation	Points
Restore ecosystem process	Enhance system health	Simenstad et al. 2006, Fresh et al. 2004	5
Restore structure and/or function	Enhance habitat and/or conditions, thus productivity	Simenstad et al. 2006, Fresh et al. 2004.	2
Improve juvenile salmonid connectivity	Enhance alongshore salmonid migration corridors (shorescape connectivity)	Simenstad et al. 2006, Fresh et al. 2004, Pentec Environmental 2003	2
Restore alongshore connectivity	Remove impediment to alongshore sediment transport/habitat forming processes	Shared Strategy, 2005	3
Restore cross-shore connectivity	Remove impediment to cross-shore sediment/nutrient/water transport	Shared Strategy 2005, Fresh et al. 2004, Simenstad et al. 2006.	5
Backshore area	Calculated backshore area for marine riparian enhancement area (ft^2). <100 ft^2=1 pt, 101-500 ft^2=2, 501-1000 ft^2=3, 1001-3000 ft^2=4, >3000 ft^2 =5	Shared Strategy, 2005 Brennan and Culverwell 2004	1-5
Intertidal area	Calculated recoverable intertidal habitat (ft^2). <100 ft^2=4 pt, 101-500 ft^2=5, 501-1000 ft^2=6, 1001-3000 ft^2=7, >3000 ft^2 =8	Shared Strategy 2005, Beamer et al 2005	4-8
Estuarine area	Calculated recoverable estuarine habitat (ft^2). <100 ft^2=6 pt, 101-500 ft^2=7, 501-1000 ft^2=8, 1001-3000 ft^2=9, >3000 ft^2 =10	Shared Strategy 2005, Beamer et al 2005	6-10
Water quality	Improved water quality direct/indirect	Shared Strategy 2005	3

<u>Ecological function score</u> - The presence of specific habitats and shore characteristics in close proximity to the restoration action were used as a measure of the ecological function of the shore unit.

Each of the scored attributes contributed to the functionality of the nearshore system and directly related to habitat needs of the MRC target species (Table 3).

Table 3. Ecological function scores and rationale.

Ecological Function	Rationale	Citation	Points
Herring spawning	Salmonid forage food, MRC mandate	Diefenderfer et al. (2006)	2
Surf smelt spawning	Salmonid forage food, MRC mandate	Simenstad et al. 2006	2
Sand lance spawning	Salmonid forage food, MRC mandate	Simenstad et al. 2006	2
Eelgrass beds	Salmonid forage food, refuge from predation, MRC mandate, Shared Strategy 2005	Shared Strategy 2005	3
Marsh vegetation	Refuge and foraging habitat salmonids	Shared Strategy 2005, Fresh et al. 2004, Simenstad et al. 2006.	5
Marine Riparian vegetation	Shade; source of food, microclimate function, LWD recruitment.	Rice 2006, Brennan and Culverwell 2004	
Salmonid-bearing steam	Shorescape connectivity	Fresh et al. 2004, Beamer et al. 2005	
Freshwater	Juvenile salmonid osmoregulatory function	Fresh et al. 2004, Clark and Hirano 1995	
LWD recruitment/storage	Habitat structure, backshore ecosystems, detritivore habitat, nutrients	Brennan and Culverwell, 2004. Shared Strategy, 2005	3

Sustainability score - The sustainability of each restoration project was measured using two nested criteria, which included the condition of up-drift sediment sources and projected maintenance. The condition of up-drift sediment sources simply conveys how intact the sediment supply is relative to historic conditions at the site. An ample sediment supply enables shoreforms to be more resilient to changing conditions and naturally self-sustaining from a sediment perspective (Crooks 2004). Up-drift sediment sources were qualified as intact (n), impaired (i) or eliminated (e) (Table 4).

Required projected maintenance was determined by estimating the likelihood of required maintenance events, and projecting the approximate number of events required over a 50-year period. These scores were assigned based on the professional experience of Licensed Engineering Geologist, Jim Johannessen.

Table 4. Sustainability scores and rationale.

Sustainability	Rationale	Citation	Points
Intact Sediment Sources Up-drift?	Sediment impoundment has reduced self-sustaining capacity of many shoreforms but decreasing sediment volumes in nearshore systems. Intact=4, Impaired=2, Eliminated=0	Jacobsen and Schwartz 1981, Crooks 2004	4, 2, 0
Required Maintenance	Required maintenance per 50 year period Low=1 or fewer, Mod=2-4, High=4+	Johannessen, J., Professional judgment	2

Risk evaluation score -The level of risk associated with each restoration project was determined by assessing the erosion potential, measured setback and inundation hazard at each project location. Erosion potential had three nested criteria those being shoretype, exposure, shore orientation and intact up-drift sediment supply. Exposure, or maximum fetch (the unobstructed distance the wind can blow across water before hitting land), was measured using the ARC GIS measuring tool, and then qualified as low (< 5 mi), medium (5-15 mi), or high (>15 mi), respectively, as modified from Cox (1996). The shore orientation of each site was also recorded. Then the geomorphic shoretype was determined using a data set produced by CGS, which characterizes shores as one of the following shoretypes: Feeder Bluff Exceptional (FBE), Feeder Bluff (FB), Transport Zone, Accretion Shoreform or Modified. If the shore of interest was mapped as an Accretion Shoreform, then by definition it is a depositional landform and should not be erosional, assuming the sediment sources that historically supplied the shoreform with sediment are currently functioning and intact. If the shore of interest was not an Accretion Shoreform or is an Accretion Shoreform with impounded (impacted or eliminated) up-drift sediment sources, then erosion potential was exclusively determined by the shore orientation and exposure. If however, the shore of interest was an Accretion Shoreform with intact up-drift sediment sources, it was scored as having low erosion potential.

Regional predominant and prevailing winds are from the south, thus shores oriented to the south (SW, S, SE), typically receive the greatest wave energy and have higher erosion potential than other shore orientations. As a result, south-oriented shores that were also considered to have high exposure had high erosion potential. South-oriented shores with moderate exposure were considered to have mod-high erosion potential, while more sheltered shores (low exposure) had low erosion potential. Other shore orientations were exclusively west facing. Erosion potential along these shores was moderate-high along highly exposed shores, while those with moderate exposure had moderate erosion potential.

Setbacks were measured from the Shorezone shoreline to the nearest infrastructure. Setback distance and risk were inversely related. Inundation hazard potential was scored at each site, by viewing the FEMA flood hazard GIS data, which shows inundation hazard areas for a hypothetical 100-year flood. Anywhere restoration actions would likely enhance the threat of an existing inundation hazard was considered to enhance the risk associated with the project. Risk evaluation factors are summarized in Table 5.

Table 5. Risk evaluation scores and rationale

Risk Evaluation	Rationale	Citation	Points
Geomorphic type	If shore of interest is an AS, then it is a depositional landform, by definition not erosional, as long as sediment sources are intact	Johannessen and Chase 2005	*Nested in erosion potential*
Up-drift sediment source	Sediment supply and transport functioning and naturally supplying beaches with sediment	Cox 1996, Johannessen and MacLennan 2006a	*Nested in erosion potential*
Exposure	Maximum measured fetch, direct correlate with wave energy	Cox 1996, Johannessen and MacLennan 2006a	*Nested in erosion potential*
Orientation	Orientation relative to prevailing and predominant conditions	Downing 1983	*Nested in erosion potential*
Erosion potential	Salmonid forage food, MRC mandate	Simenstad et al. 2006	3
Setback distance	Distance from Shorezone shoreline to nearest infrastructure		3
Inundation hazard	Could restoration action result in heightened inundation hazard?		2

Results

Restoration List Augmentation

Twelve additional restoration projects were identified by CGS in the reconnaissance process. Five potential projects were identified in Birch Bay: 5 in Point Roberts, and 2 in Chuckanut Bay (Table 6). Prior to CGS fieldwork, Tim Wahl, with the City of Bellingham (COB) Parks Department, conceptualized an additional opportunity in the inner part of Chuckanut Bay (Chuckanut Bay – Wetland Reconnection and Backshore Restoration).

The original list of restoration opportunities provided to CGS by the County included 15 restoration projects. It was then augmented by CGS (and COB) resulting in a new total of 30 sites. Following field visits the list was reduced to 22 projects for scoring. A total of 7 restoration opportunities were eliminated by CGS from the list of restoration projects produced as part of the County's Shoreline Master Program update. Sites were removed from the list for a variety of reasons including: completion of the recommended restoration action (remove old telephone building at Lighthouse

Park, conserve/acquire Lily Point Feeder Bluff), actions that were largely outreach campaigns, such as improving water quality within the shores of the County's marinas, and due to a general lacking habitat benefits, such as the enhancement of marine riparian vegetation landward of several homes located at the base of the bluff along southern Point Roberts.

Table 6. Complete list of restoration opportunities in Whatcom County focus areas.

Shoreline Reach	Recommended Project	Source	Status	Scored?
Point Roberts	West Shore - Gulf Rd right-of-way remove 100+ pilings from intertidal	CGS		Yes
	West Shore - Remove infringing rockery from Breaker's property and enhance MRA	CGS		Yes
	Lighthouse Park - Remove old telephone building at point	SMP	Completed (County)	No
	Lighthouse Park - Remove shore defense and derelict structures	SMP	In process (BCTC)	Yes
	Pt Roberts Marina - Restore connectivity of wetlands, daylight culvert/tidegate	SMP		Yes
	Pt Roberts Marina - Improve marine water quality at marina	SMP	Outreach action	No
	Pt Roberts Marina – Lower elevation of intertidal rock sill	CGS		Yes
	South Shore - Restore marine riparian vegetation along south shore	SMP	No habitat benefit	No
	South Shore - Remove gabion baskets and groins	CGS		Yes
	Southeast Shore - Gabion baskets at base of FBE	CGS		Yes
	Lily Point - Remove derelict structures (pilings and slag)	SMP		Yes
	Lily Point - Acquire Lily Point Feeder Bluff property	SMP	In process (Land Trust)	No
	Lily Point - Conserve Feeder Bluffs	SMP	In process (Land Trust)	No
	Maple Beach - Investigate outfall at beach to determine treatment need	SMP	No Treatment/NA	No
	Maple Beach - Beach nourishment for habitat	CGS		Yes
	Maple Beach - Remove outfall and old pilings	SMP		Yes
Birch Bay	Birch Bay (Village) - Sunset Beach bulkhead removal	CGS		Yes
	Roger's Slough - Restore/enhance historic extent of intertidal marsh	SMP		Yes
	Birch Bay Dr. - Old boat ramp	CGS		Yes
	Birch Bay Dr - Remove groin field, nourish beach	SMP	County study	Yes
	Birch Bay Dr. - Bluefish restaurant -relict boat	CGS	County study	Yes
	Birch Bay Dr. - Bluefish restaurant - pier footings	CGS	County study	Yes
	Birch Bay - Lower Terrell Creek reconnection	CGS		Yes
	Birch Bay Dr - Create riparian buffer	SMP	County study	No
Chuckanut Bay	Inner Chuckanut Bay - Backshore & wetland restoration	SMP		Yes
	Inner Chuckanut Bay - Beach cleanup, remove piles, groins, etc	CGS		Yes
	Chuckanut Bay N - Remove rail causeway and restore tidal prism/flushing	CGS/COB		Yes
	Chuckanut Bay N - Teddy Bear Cove N nourishment	SMP		Yes
	South Chuckanut Bay - Remove old cannery footings	CGS		Yes

The restoration actions, attributes and associated scores for each potential project are found in Table 7, located in the Appendix. Table 8 displays a summary of the final scores for each scoring category as well as cost estimates, and can also be found in the Appendix. The location and restoration area for each scored restoration opportunity are shown in Figures 4-6 (also found in the Appendix).

Project scores ranged from 42-74 points (36-63%), with an average of 57 (49%). Scores within each target area spanned comparable ranges, with a slightly smaller range in Birch Bay. Pt Roberts had the highest average scoring restoration opportunities, and Chuckanut Bay had the highest scoring single restoration site.

The recommended restoration actions at each site could generally be classified as one of the four following restoration project types (followed by the number occurring in this prioritization): Pocket estuary restoration (PER) (4), remove shore armoring (RSA) (7), beach nourishment for habitat (BNFH) (2), and structure removal (SR) (9) (Table 9). Pocket estuary restoration projects scored the highest average in the targeted response and ecological function categories, followed by projects aimed at removing shore armoring, beach nourishment for habitat and structure removal.

Table 9. Summary of results of prioritization scores by the type of recommended restoration action. Scores were averaged by the type of restoration action.

Restoration type	Count	Total Average Score	Targeted Response	Sustainability	Risk	Ecosystem Function	Feasibility
PER	4	66.2	29.3	4.3	3.8	18.5	10.5
RSA	7	57.8	24.0	5.4	2.6	14.0	11.7
BNFH	2	54.5	18.0	5.5	3.0	16.0	12.0
SR	9	53.3	15.3	5.7	2.7	15.1	14.3

Highest Priority Sites

This section summarized scored attributes and restoration recommendations for each of the top 5 ranked restoration opportunities.

Site 1. Chuckanut Bay – Wetland Reconnection and Backshore Restoration - This project entails multiple restoration actions encompassing wetlands, and portions of the backshore and intertidal at the bayhead in northern Chuckanut Bay. The site is located at the end of Fairhaven Avenue where it reaches the beach. Restoration opportunities are located on both the southeast and northwest sides of the road end and landward of the small parking lot. Restoration actions at the site would ideally be comprised of enhancing the hydrologic connectivity and the tidal prism of the backshore wetland, recovering lost backshore habitat that is currently occupied by a parking lot and associated fill (Figure 7), and removing rock and derelict concrete structures from the upper intertidal/backshore (Figure 8). A 16-inch concrete culvert runs under the gravel road end with flow observed during all site visits. The road is only 12 ft wide in this area, with no shoulder and is in poor condition. Enlarging the tidal channel and installing a much larger culvert that extended lower and would enhance tidal flow in and out of the backshore wetland complex, which extends approximately 500 ft alongshore and 200 ft landward of the backshore berm (Figures 9 and 10). Decommissioning the last reach of road (90 ft long from end of pavement to the parking lot on the beach and backshore) and installing a simple footbridge would enhance the marine riparian and could also provide additional recreation area, in the area currently acting as a parking lot. This would likely require putting in some form of parking in the right-of-way for recreation access.

A detailed topographic survey of the wetland and surrounding area would need to be completed to determine the extent of saltwater inundation at several tidal levels and the exact estuarine area available for enhancement. The site would also need to be mapped for existing habitat types and drainage modifications.

These actions would potentially enhance this feature's ability to provide several pocket estuary functions such as rearing, foraging and osmoregulation for migrating juvenile salmonids from nearby Chuckanut Creek as well as potentially improving water quality (Shared Strategy 2005). Wetland ecosystems provide several ecosystem services including; water pollution abatement and flood mitigation, which would likely be additional indirect benefits of these restoration actions. Potential water quality impacts resulting from parking lot run-off could also improve as a result of these restoration actions.

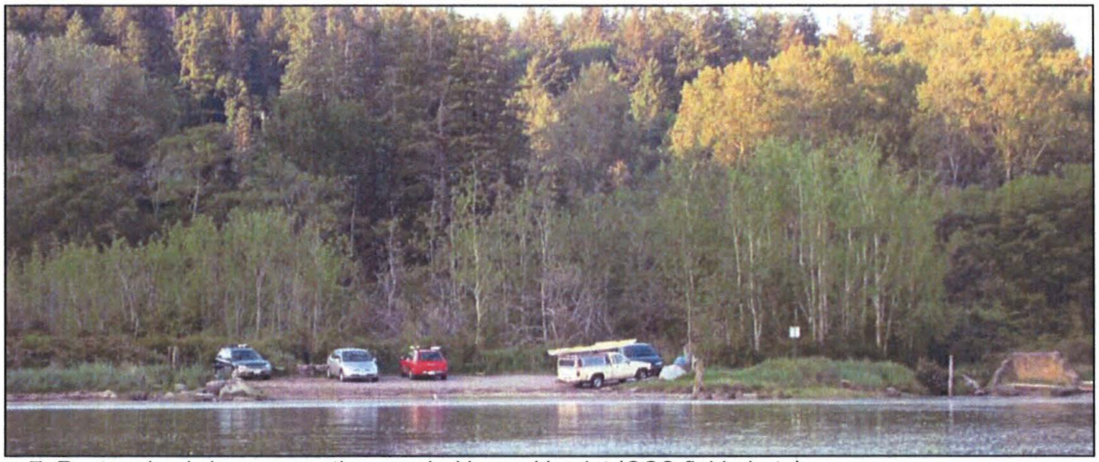


Figure 7. Restore backshore currently occupied by parking lot (CGS field photo).

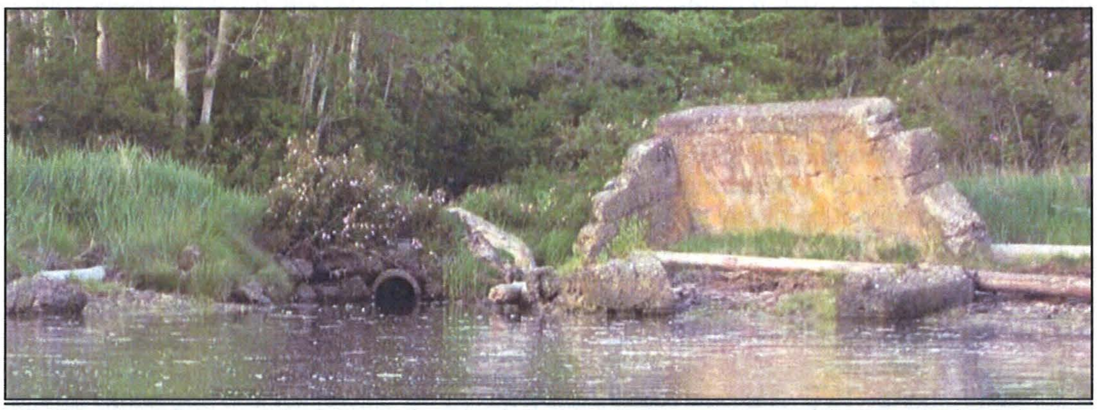


Figure 8. Remove relict concrete structure from backshore and enhance connectivity between backshore marsh/wetland and marine environment (CGS field photo).

Figure 9. Chuckanut Bay backshore wetland looking south (Pictometry International Corp 2004).

Figure 10. Chuckanut Bay backshore wetland looking north (Pictometry International Corp 2004).

This site was tied as the highest scoring restoration opportunity and received a total of 74 out of 117 points (Tables 7 and 8). It scored 30 targeted response points due to the number of ecosystem benefits that could result from the previously outlined restoration actions. Broadening and possibly day-lighting the stream channel flowing from the wetland to the beach would enhance hydrologic processes, nutrient exchange, ecosystem structure in the form of estuarine, tide channel and marine riparian habitats, as well as juvenile salmonid connectivity within Mud or North Chuckanut Bay.

The sustainability of this restoration site was rated as moderate, and should require a low level of maintenance (depending on tide channel configurations and how the channel would be opened up). Controlling factors within the bay have been heavily altered due to the Burlington Northern Santa Fe rail causeway, which has resulted in dampened wave energy within the Bay. Reduced wave energy at this site further decreases the level of risk and required maintenance. The risk level was qualified as low due to minimal erosion potential at the site and the generous setback distances for houses surrounding the site. The FEMA flood hazard zone shows this area as being located within the 100-year flood zone, however, as discussed above, the site is already connected to the marine system by a culvert and very low elevation backshore. The enlargement of the tidal channel would not constitute a substantial change to coastal flooding hazards as there is already a culvert in place and it appear that the parking lot is overtopped by waves at times. It also appears that surrounding houses were constructed high enough to be above the high hazard area for flooding.

Ecological function within the bay rated 17 out of a possible 35 points. The site scored for the presence of marsh vegetation, well establish riparian vegetation (across over half of the shore unit), patchy eelgrass (DNR 2001), a source of freshwater and its proximity to a salmonid bearing stream (Chuckanut Creek-only 1,000 ft distant). Additionally, the fine substrate in the bay likely contributes positively to invertebrate productivity.

The feasibility of this restoration opportunity scored 16 out of 21 points, and was one of the highest scoring in the feasibility category. The site is completely encompassed within public shores managed by the City of Bellingham Parks Department, which could potentially partner in the restoration. Several sources of funding exist for this type of restoration throughout the Puget Sound Region. Permitting should be not be overly burdensome, as all work would be conducted below the ordinary high water mark, and some actions may be waived from full permit requirements by the Corps due to the restorative nature of the action. The relative anticipated cost of this restoration opportunity were approximated as moderate ($40,000 - $80,000), relative to other nearshore restoration actions discussed or considered in this study.

<u>Site 2. Point Roberts - Hydrologically Reconnect Wetland</u> - A culvert system and outfall are located on the beach just east of the Point Roberts Marina jetties that drain a large (historic) wetland complex that used to occupy much of the southwest corner of the Point Roberts peninsula (Figure 11). The outfall is buried under a groin-like structure that crosses much of the intertidal beach width (Figure 12). The rock covering the outfall measured 24 ft across on average and extended approximately 135 ft across the shore. The concrete culvert measured 48-inches in diameter (Figure 13). The culvert discharges at approximately – 0.5 ft MLLW, and delivers considerable freshwater flow to the marine environment. The culvert extends approximately 700 ft from the lower intertidal, up the beach and beneath the backshore, under a cleared lot owned by Point Roberts Marina and Point Roberts Marina Resort (Whatcom County Assessor's Database 2007).

The property appeared to have been filled and the elevation increased, and at the time of the fieldwork, consisted of a flat area covered with driftwood, grasses and weeds (Figure 14). This area was historically encompassed within the historic salt marsh. Currently, part of this property is used for harvesting and hauling bypass sediment from the beach east of the marina jetties to the west side, by permit requirement dating back to the original marina permits (Johannessen 1998).

Freshwater flow out of the wetlands was controlled by a large tide gate, located the tide gate was located at the sharp turn in the road, adjacent to the new buildings at "Marina Mist" development, and just north of "Oceanside Estates" at 1728 Edwards Drive (Figure 15). The tide gate was located at the south end of an expansive pond (3150 ft^2)), which connects to other larger sloughs and channels of standing water and has a considerable drainage area to the north and east. A detailed topographic study would also be required for this area to determine the degree of potential hydrologic connectivity and that would occur and the degree of channel or wetland enhancement that would be possible with the proposed project. Feasibility research should also address whether flood hazards would be increased with the proposed project, but since the entire area appears to have been raised at the time of development, and the fact that the marina basin is located adjacent to the site, that would not appear to be a major issue.

Similar to Site 1, day-lighting the channel and restoring the connectivity between the fresh water and marine environment could enable this site to provide several pocket estuary functions such as rearing, foraging and osmoregulation for migrating juvenile salmonids from both the Fraser River Delta and other nearby salmonid bearing streams within Boundary Bay. Additional ecosystem services such as water pollution abatement and flood mitigation may also be an indirect result of this restoration action. Wetland ecosystems provide several ecosystem services including; water pollution abatement and flood mitigation, which would likely be additional indirect benefits of these restoration actions.

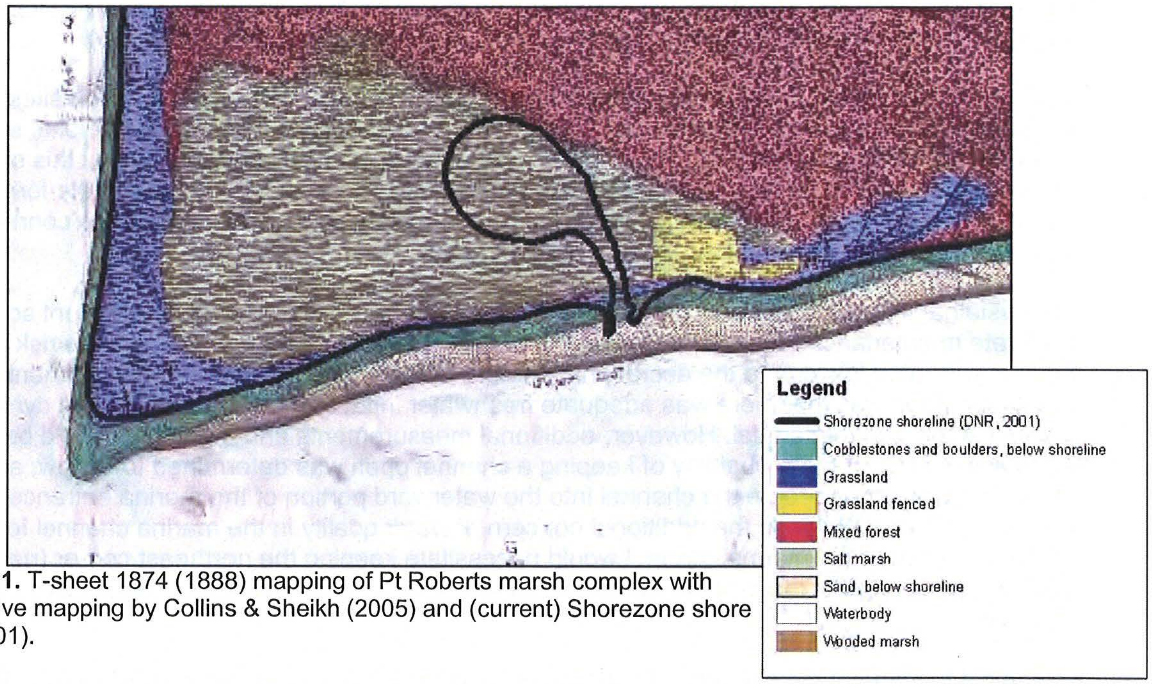


Figure 11. T-sheet 1874 (1888) mapping of Pt Roberts marsh complex with Interpretive mapping by Collins & Sheikh (2005) and (current) Shorezone shore -line (2001).

Figure 12. Looking east at armored culvert extending across shore (CGS field photo).

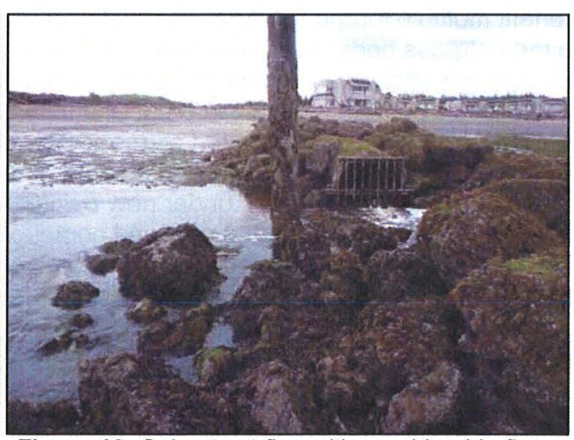


Figure 13. Culvert out-flow with considerable flow (CGS field photo).

Figure 14. Culvert/stream buried beneath backshore east of Pt Roberts marina (CGS field photo).

Figure 15. Tide gate and pond drained from Pt Roberts wetlands (CGS field photo).

Scoring 74 points total, this site was tied with Site 1 as the highest-ranking restoration sites in the study area. In the targeted response category, this site ranked higher than any other site, scoring 38 out of 45 points (Tables 7 and 8). The targeted response of the restoration actions at this site potentially encompasses restored tidal access and flushing, ecosystem structure in the form of estuarine, tide channel and intertidal habitats, enhanced alongshore and cross-shore connectivity, salmonid connectivity and indirect water quality benefits.

The sustainability of the site was rated as high due to the largely intact up-drift sediment sources and moderate maintenance required to sustain the restored site configuration. The relative risk rating at the site was rated low due to the accretionary nature of the site and intact up-drift sediment supply. The assumption was that there was adequate freshwater input to the site to maintain a dynamic tidal channel in the upper intertidal. However, additional measurements and modeling should be carried out to assess this. If the probability of keeping a channel open was determined to be low, an alternative would be to route the channel into the waterward portion of the marina entrance channel. This alternative would pose the additional concern of water quality in the marina channel for fish habitat. The use of the marina channel would necessitate keeping the northeast corner (near the road) and east edge of the property open for truck access to the beach for harvest of bypass sediment.

Ecological function at the site received 16 out of a total of 35 points. Enhancement of this site would benefit multiple forage fish spawning habitats including sand lance and surf smelt. Herring also spawn in the eelgrass beds found adjacent to the site (WDFW 2007). The presence of freshwater and LWD storage are additional contributors to the ecological function of this site. The feasibility rating of this restoration opportunity received 9 out of a total of 21 potential points. The opportunities to partner on this restoration project was rated as moderate, due to the tidelands being held in public ownership (WDNR). Restoration funding could also be funded as compensatory mitigation related to upcoming marina renovations, which is under new ownership. There are many potential funding sources for this type of restoration, though the cost and complexity would likely be relatively high (Table 8, $200,000-300,00). Permitting would encompass federal, state and local permits, and will likely require a biological assessment/evaluation and a wetland assessment.

<u>Site 3. Birch Bay (Village) – Sunset Beach Riprap Removal</u>

Located just west of the Birch Bay Village marina, this low-bank bulkheaded shore scored a total of 66 points, and is the third ranked restoration opportunity in the study area (Figures 16 and 17). This site was historically a pocket estuary of an unnamed creek. The basin includes two creeks, most of which drains Trillium property, and cumulatively measures approximately 1,167 acres (CH2MHill 2006. Figure 18 shows the historic T-sheet over Lidar imagery with the historic creek channel and confluence location (T-sheet no. 1873, 1888; Collins and Sheikh 2005). The creek has been channelized and culverted across Birch Bay Village residential areas, and its confluence relocated to within the northwest corner of Birch Bay Village Marina basin.

This site was originally identified and scored as a bulkhead removal site as the uplands do not have homes and/or other infrastructure. Although it appears quite challenging due to the dense development of the area, the feasibility of relocating the creek mouth to its original channel location was not fully explored in this prioritization and should be explored as part of a larger feasibility study. The site would have scored additional points if the restoration's targeted response had entailed restoring the historic pocket estuarine functions.

The rockery bulkhead extended well waterward of the adjacent bulkhead to the west and infringed on the upper intertidal beach (Figures 16 and 17). The site could be enhanced by removal of the rock and recreating a wider beach and backshore area. The site was filled to a higher elevation, likely during development of the marina, as shell fragments were observed in the eroding bank. An upper beach and backshore area would be created between retained (adjacent) bulkheads, resembling the upper part of a pocket beach. A small portion of the removed rock would likely be required for construction of return walls (running landward at the ends of adjacent bulkheads, designed to minimize end effects). These return walls would generally run landward along the property lines. The upper beach should also be nourished to aid in the reformation of lost forage fish spawning habitat area covered by riprap. Additional restoration recommendations for this site include enhancing the marine riparian area.

Removing the riprap and enhancing the marine riparian ecotone received 28 targeted response points, placing it in the top 5 scoring sites in that category. Restoring these features would potentially enhance ecosystem structure in the form of intertidal habitats and marine riparian habitats, ameliorate cross-shore, alongshore and salmonid connectivity, and provide indirect water quality improvements (in the form of marine riparian water pollution abatement). Despite the fact that this is a bulkhead/riprap removal project, it did not score for restoring ecosystem processes, as it was not a historic sediment source. However if restoration were to entail restoring the historic pocket estuary, it would score 5 additional points.

The sustainability of this restoration opportunity was ranked as high, as it will likely require minimal maintenance due to the number of intact up-drift sediment sources. The level of risk measured relatively low due to the lack of structures located in the uplands, the site occurring within a historic accretion shoreform and outside the 100-year flood hazard zone (FEMA/CZA 1998). Despite the fact that the fetch and exposure of this site measure relatively high, the presence of the marina jetties a short distance down-drift have resulted in the rapid accretion of the beach immediately east of the site in recent decades. Also, the historic creek delta on the lower intertidal, forces waves to break slightly farther from shore, somewhat decreasing the erosion potential of the site.

This opportunity scored 17 points in the ecological function category out of 35 possible points. Surf smelt spawning has been documented at this site and herring are known to spawn in the patchy eelgrass beds located waterward and adjacent to the site. This opportunity is also located within just 3-miles of salmonid-bearing Terrell Creek, which emphasized the function of this shore for juvenile salmonid migration.

The feasibility of these restoration actions received 11 out of 21 possible points. The site is encompassed within privately owned upland and tidelands, managed by the Birch Bay Village community. The opportunity to partner with the community seems apparent. Restoration could be integrated into compensatory mitigation if the opportunity were to arise. The potential funding sources appear slightly limited due to the private nature of the beach, however it is a "community" owned shore. The anticipated cost of the recommended restoration actions was estimated as moderate, in relative terms ($30,000 - $60,000, Table 8). Permitting the project would likely entail applying for state and county permits, which would require a moderate time commitment.

Figure 16. Air photo of Sunset Beach site, note toppled and infringing riprap at west end of site (Pictometry International Corp 2004)

Figure 17. Infringing riprap at Sunset Beach (CGS field photo).

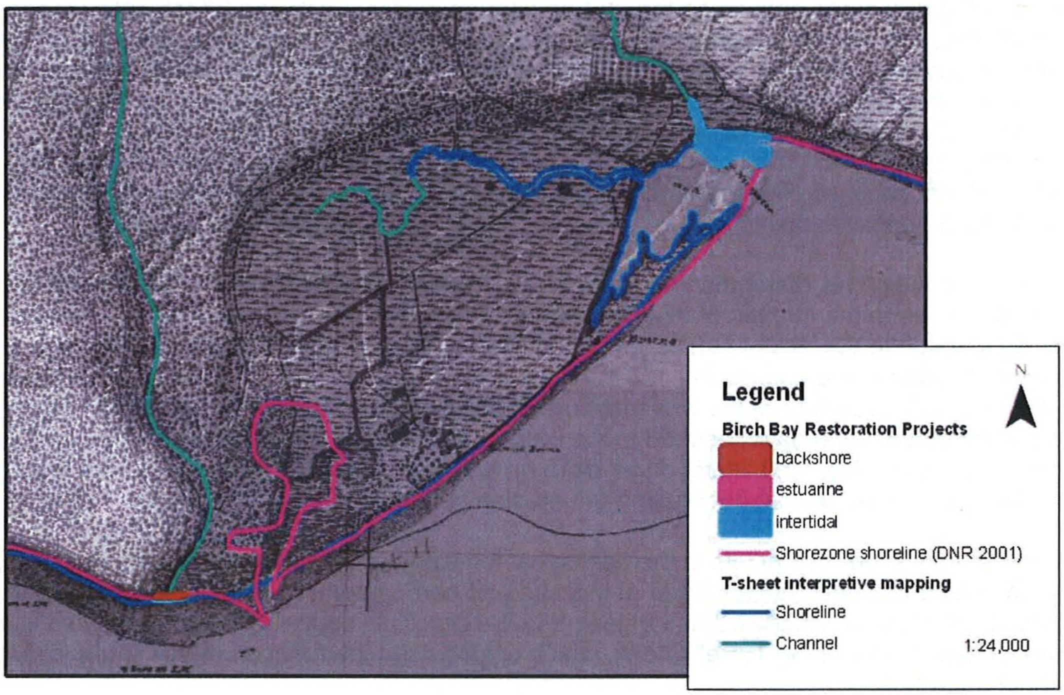


Figure 18. Historic T-sheet with interpretive mapping (Collins and Sheikh 2005) with Lidar imagery (USGS 2007), current shoreline (DNR 2001) and proposed restoration sites.

<u>Site 4. Chuckanut Bay – Open Burlington Northern Santa Fe (BNSF) Rail Causeway</u>

This forth-ranking restoration opportunity entails restoring the natural wave regime and tidal hydrodynamics within northern Chuckanut Bay (also called Mud Bay) by removing or modifying the BNSF rail causeway. A large-scale feasibility study should be performed to determine exactly how the restoration should be conducted, as described below. The BNSF rail causeway, constructed prior to the turn of the century, has largely closed off much of northern Chuckanut Bay to its natural wave regime (Figure 19), which appears to have caused a substantial increase in the sedimentation rates and a shift in the habitat types found in the Bay.

The causeway currently covers 153,040 sq ft of subtidal and intertidal area. The beach was historically composed of coarser material and apparently eelgrass beds were found throughout the inner shore of the Bay (Pers. Comm. T. Wahl 2007). Currently inner Chuckanut Bay beaches are comprised of relatively fine sediment (sands and silt) and patches of eelgrass are only found in the waterward end of the Bay. It is likely that if sedimentation rates continue at the current accelerated rate the Bay will experience further habitat degradation in the form of water quality issues, exceeded temperature thresholds for salmonids, and the progressive loss of intertidal area. It is likely that the tidal prism has already been substantially reduced in volume due to the accelerated sedimentation occurring within these shores. This process will likely be slowed by sea level rise, however, the native substrate of the beaches and the natural tidal hydrodynamics will not be recovered without restoration actions.

The causeway created additional shoreline along the revetment and the open shaded area beneath the causeway opening is the only access to the bay (Figure 20). The shading and additional riprap shoreline, provides an abrupt transition from shallow to deep water, likely increasing migrating juvenile salmonids' vulnerability to predation. The causeway opening was also constructed of heavily creosoted pilings, which likely adversely impacts water quality.

This site scored a total of 65 points, and 29 points in the targeted response category. Targeted response scores were higher than any other site except Site 1. The targeted response of the proposed restoration actions at this site encompasses restored hydrodynamic processes and wave regime within the bay, ecosystem structure in the form of intertidal habitats lost beneath the large causeway footing, enhanced alongshore, cross-shore and salmonid connectivity and indirect water quality benefits resulting from enhanced tidal flushing and creosote removal.

The sustainability of this restoration was rated very high, as the restored condition is likely more sustainable than the currently altered condition. Additionally little maintenance would be required under natural conditions. The level of risk of this restoration opportunity was also relatively low, though risk ratings may change depending on how restoration is approached and if the causeway will be entirely removed or just altered to allow for more flushing.

Ecosystem function within northern Chuckanut Bay received 10 of 21 points and was one of the lowest scoring sites within the study area. This shore scored for having or providing the following ecosystem functions: eelgrass beds (patchy), freshwater, and being in close proximity to a salmonid bearing stream.

This restoration opportunity scored 15 of 21 points in the feasibility category. The tidelands and intertidal zone within which the BNSF rail causeway is located, are publicly owned and managed by the City of Bellingham (Whatcom County Assessor's Database, 2007). The potential to partner in moving forward with this restoration opportunity was deemed high, and there are likely many available funding opportunities. Additionally restoration and/or enhancement could be encompassed within compensatory mitigation if it were required for BNSF. The projected cost of performing the restoration would be relatively high ($800,000-$2,500,000, Table 8) and permitting would require federal approval, thus the time required to gain permits would be high.

Specific restoration actions for restoring natural processes at Northern Chuckanut Bay was outside the scope of this restoration prioritization, and needs further examination. Quantifying physical parameters and further understanding trends within the Bay, such as sediment character, altered sedimentation rates, and the degree of tidal prism reduction would be a first step in this process. Sediment coring and associated dating could be carried out to determine sedimentation rates across different time periods (over the course of the last 150 years). Topography and bathymetry of the bay and comparison with early data sets would also be useful for determining the degree of change. Historic eelgrass mapping could be conducted by compiling oral histories, historic photos, and maps, followed by comparison with more current eelgrass mapping. Sedimentation, erosion, and hydrodynamic flushing could be modeled under different causeway bridging/removal scenarios, once data collection was completed. This larger scale feasibility study would require additional involvement relative to the other proposed projects and would need considerable funding, however the benefit to the larger estuarine/nearshore system may reach beyond the metrics applied in this prioritization.

Figure 19. Aerial view of Chuckanut Bay causeway (Pictometry International Corp 2004).

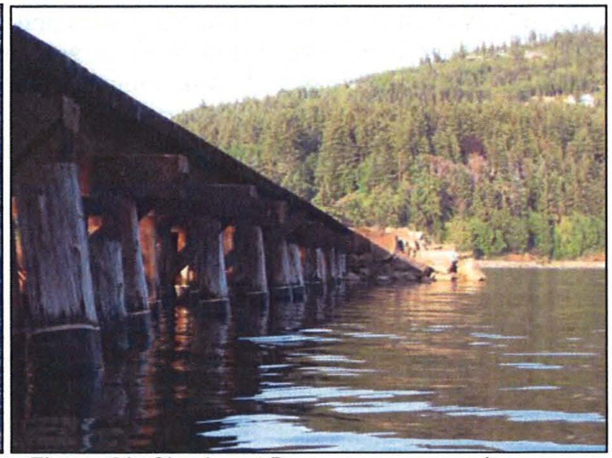


Figure 20. Chuckanut Bay causeway opening, creosote pilings (CGS field photo).

Site 5. Point Roberts – Lily Point Slag, Piles and Car Parts Removal - The fifth-ranked restoration opportunity is comprised of recovering lost intertidal habitat by removing relict piles, slag (metallic waste piles from canning operations) deposits and abandoned car parts along Lily Point, located at southeast Point Roberts. This site scored a total of 65 points. The proposed project is a straightforward debris removal project on the shore of the large Accretion Shoreform waterward of the high bluff. The piles and pile remnants extend across the width of the sloping beachface (Figure 21) with large slag piles covering portions of the mid-intertidal beach (Figure 22), all of which should be removed. Additional debris should be removed from the backshore from the same general area.

Removal of these relict items would restore intertidal habitat structure and ameliorate adverse impacts to water quality caused from the further decay and erosion of the slag and car parts. The field of over 100 relict piles would recover lost intertidal substrate, and enhance alongshore sediment transport that appears diminished due to wave attenuation caused by the piles and slag deposit. Juvenile salmonid migration pathways would likely also be enhanced as a result of the restoration. The cumulative targeted response of these actions was awarded 18 out of 45 points for these reasons.

The sustainability of these restoration actions was the highest rated site within this prioritization, due to the accretionary nature of the site, intact up-drift sediment sources, and the lack of required maintenance. The relative risk of this opportunity was also ranked lower than any other opportunity due to the absence of erosion risk and upland improvements, and since the proposed removal project would not alter the inundation threat during coastal flooding events.

The ecosystem function of the Lily Point site scored 11 out of 35 possible points. Herring spawn in the continuous eelgrass beds waterward of the site, which functions as a migratory pathway for juvenile salmonids from the Fraser River estuary and nearby salmonid-bearing streams in Boundary Bay. Large woody debris is also stored along the upper beach at this site, which likely contributes to the ecological function of this site.

This site was the highest rated restoration opportunity in the feasibility category, scoring 19 of 21 possible points. The shore was scored as being encompassed within public shores as it is in the process (acquiring funding) of being acquired and protected by the Whatcom County Land Trust. As a result, partnership opportunities with other agencies seemed highly probable. Many possible funding opportunities likely exist to conduct this type of restoration. The cost of completing this restoration would be relatively low ($30,000-$60,000, Table 8). Permitting efforts would likely require minimal time, as exemptions are potentially available for restoration comprised exclusively of removing exotic material to eliminate adverse impacts to nearshore habitats such as these.

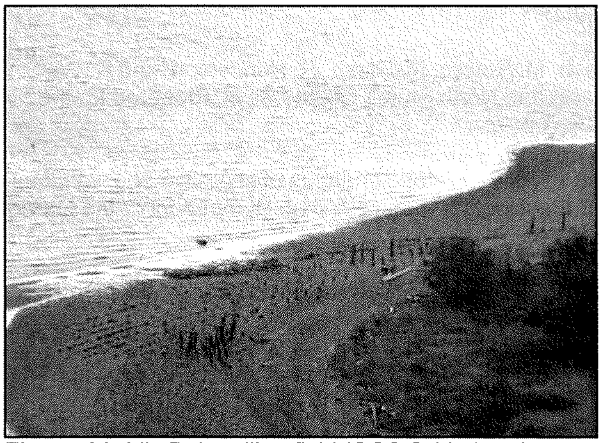


Figure 21. Lily Point piling field (CGS field photo).

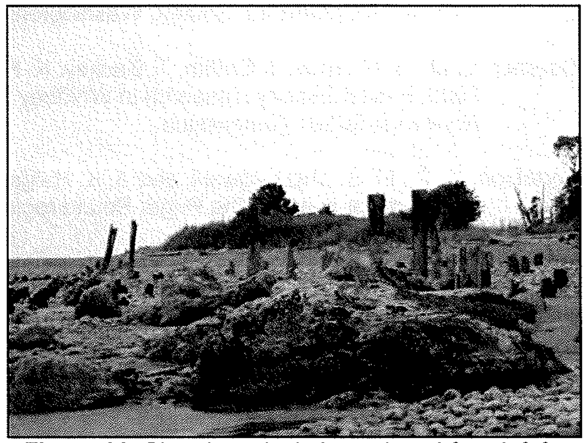


Figure 22. Slag deposits in lower beachface left from old cannery (CGS field photo).

Conclusions

This targeted restoration prioritization was designed be a relatively user-friendly, straightforward approach that integrates the goals of the Whatcom County Marine Resource Committee. Project sustainability, risk, feasibility and the MRC's stated restoration objective (of the site's ability to support forage fish spawning, juvenile salmonids rearing and migration and aquatic vegetation) were built into the in the prioritization to rank sites with the greatest likelihood of achieving successful restoration. In total over 262,596 ft^2 of recoverable intertidal habitat, 15,150 ft^2 of estuarine habitat and 25,241 ft^2 of marine riparian habitat were assessed and prioritized for restoration throughout the Point Roberts, Birch Bay and Chuckanut Bay target areas. It is likely that the site dimensions used in these calculations were under-estimated, and additional nearshore area can be recovered as part of these restoration projects.

The results of this restoration prioritization can be used both with and without feasibility considerations. Without consideration for feasibility, two different sites would have been in the top 5 ranking sites. These opportunities entail removing infringing riprap and enhancing the marine riparian ecotone along a forage fish spawning beach on the west shore of Point Roberts (Pt Roberts – The Breakers riprap removal) and enhancing the intertidal and tide channel habitat within Roger's Slough (Figure 18), located in northeast Birch Bay. However, these potential projects would be both quite expensive and would involve additional challenges due to private ownership (which is why they fell below the top 5 with feasibility considered). Other high scoring restoration opportunities can be reviewed in Appendix 2.

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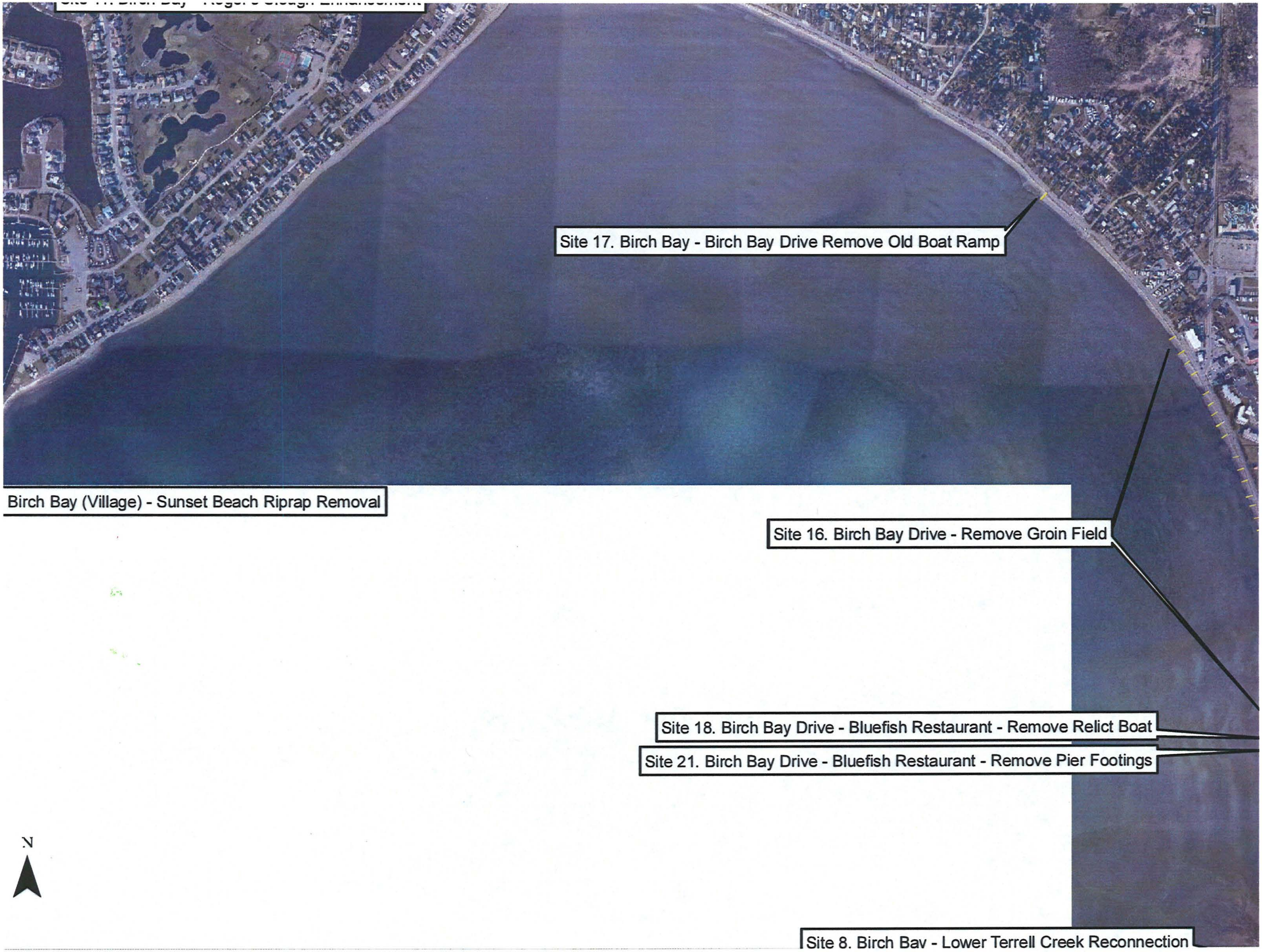
Appendix 1

estoration Action	Restores ecosystem process(es)?	Restores ecosystem structure? function?	Enhances juv. Salmonid connectivity?	Enhances alongshore connectivity?	Enhanced cross-shore connectivity?	Recoverable backshore area?	Recoverable estuarine area?	Recoverable intertidal area?	Direct or indirect water quality improvements?	Sustainability	Intact sediment source up-drift? l=impaired, n=intact, e=eliminated	Required maintenance?	Risk level	Inundation hazard?	Setback distance? (ft)	Erosion potential	Exposure?	Shore orientation?	Geomorphic shoretype?	Herring spawning?	Surf smelt spawning?	Sand lance spawning?	Eelgrass? (patchy/continuous)	Marsh vegetation?	Riparian vegetation (%)	Distance to Salmonid-bearing stream? (miles)	Source of freshwater?	LWD recruitement or storage?	Ownership (pvt/pb)	Parcel density (<3, 3-8, >8)	Partnerships (low-med-high)	Mitigation?
estoration Action	**Restoration Target**									**Sustainability**			**Risk Level**							**Target habitat characteristics**									**Final Feasibility and**			
emove 105 piles (low beach), nourish upper beach	n	y	n	n	n	0	0	3350	y	v.high	l	none	mod	n	10	mod-high	high	W	AS	y	y	n	p	n	0	8.5	y	s	pvt&pub	2	mod	n
emove revetment and edge of parking lot, minor ourishment, restore marine riparian	n	y	y	y	y	1775	0	5106	y	high	l	low	high	y	20	mod-high	high	W	AS	y	y	n	p	n	0	8.5	y	n	pvt	2	mod	y
emove riprap and old piles, nourish upper beach	n	y	y	y	n	4175	0	1854	n	mod	l	mod	mod	y	140	high	high	SW	AS	y	y	n	n	n	0	9.0	n	s	pub	2	mod	y
aylight channel and reconnect tidal hydrologic connectivity th wetland/ponds	y	y	y	y	y	0	10455	2168	y	high	n	mod	low	y	90	low	high	S	AS	y	y	n	n	n	0	9.5	y	s	pvt	1	med	y
ower crest elevation of intertidal rock sill	n	y	y	n	n	0	0	3530	n	v.high	n	low	low	n	101	high	high	S	AS	y	y	y	n	n	0	9.5	y	n	pub	1	med	y
emove gabion baskets and groins, (unpermitted?)	y	y	y	y	y	132	0	1105	n	high	n	mod	mod-high	y	85	high	high	S	FB	y	n	n	p	n	70	10.0	n	r	pub	1	med	n
emove gabion baskets, likely unpermitted	y	y	n	n	y	859	0	0	n	high	n	mod	high	y	45	high	high	SW	FBE	y	n	n	n	n	100	10.0	n	r	pvt	2	med	n
emove piles, slag deposits left from old cannery and car arts farther west	n	y	y	y	n	0	0	1279	y	v.high	n	none	low	n	250	low	high	S	AS	y	n	n	c	n	0	11.0	n	s	pub	1	high	n
ourish for forage fish habitat; recreate beach profile	n	y	y	n	n	9674		60721	n	high	n	mod	mod	n	0	mod-high	mod	SE	AS	y	y	y	p	n	0	8.0	y	n	pub	1	high	n
emove piles and relict outfall pipe from upper beach	n	y	y	y	n	0	0	88	y	v.high	n	low	high	y	0	mod-high	mod	SE	AS	y	y	n	n	n	0	8.0	y	s	pub	1	high	y
emove riprap, nourish beach, restore/enhance marine parian	n	y	y	y	y	2854	0	3346	y	high	n	mod	low	n	101	mod-high	mod	SW	MOD	y	y	n	p	n	0	3.0	n	n	pvt	1	high	y
rch bay drive - remove old boat ramp just north of ottonwood Drive	y	y	y	y	y	0	0	822	n	high	l	low	high	y	15	high	high	SW	AS	n	n	n	c	n	0	1.2	n	n	pvt	1	high	n
hance tidal flushing and enlarge culverts	y	y	y	n	y	0	2458	0	n	low	l	mod	low	y	101	mod	high	SW	AS	y	n	n	c	y	0	2.0	y	s	pvt	2	high	y
emove groins and nourish upper beach	y	y	y	y	n	0	0	4554	n	mod	l	mod	mod-high	n	10	high	high	SW	AS	y	n	n	c	n	0	1.0	y	n	pvt	12	high	n
emove concrete boat	n	y	y	y	n	0	0	176	y	mod	l	mod	high	y	0	high	high	SW	AS	y	n	n	c	n	0	1.0	y	n	pvt	1	high	y
emove old dock footings	n	y	y	y	n	0	0	204	n	low	l	mod	high	y	0	high	high	SW	AS	y	n	n	c	n	0	1.0	y	n	pvt	1	high	y
emove tide gate, replace erosion control flood structure	y	y	y	n	y	0	886	0	y	mod	l	mod	mod-high	y	10	mod	high	SW	AS	y	n	n	c	y	0	0.0	y	n	pvt&pub	3	high	n
emove pilings, concrete debris, and failing groin from tertidal and backshore	n	y	y	y	n	0	0	1296	n	v.high	l	none	low	y	>100	low	low	SW	AS	n	n	n	p	y	0	0.0	y	n	pub	1	high	n
nlarge culvert and restore hydrology of backshr wetland, store backshore, relocate parking lot off beach	y	y	y	n	y	501	1351	0	y	high	l	low	low	y	>100	low	low	SW	AS	n	n	n	p	y	60	0.0	y	s	pub	1	high	n
nlarge or open additional portion of causeway, restore tidal ushing, reverse adverse sedimentation	y	y	y	y	y	0	0	153040	y	v.high	l	none	low	y	n/a	mod	mod	S	MOD	n	n	n	p	n	5	0.0	y	n	pub	1	high	y
emove boulder lag, create 900 ft pocket beach north of eddy Bear Cove	n	y	y	n	n	4983	0	19954	n	high	l	low	mod	n	8	mod-high	mod	SW	MOD	n	n	n	c	n	5	0.1	n	n	pvt&pub	2	high	y
emove relict steel structure and foundation	n	y	y	y	n	289	0	0	y	mod	l	mod	mod-high	y	15	mod	mod	W	MOD	n	n	n	p	n	30	2.0	y	r	pvt	1	high	y
estoration Action	**Restortation Target**									**Sustainability**			**Risk Level**							**Target habitat characteristics**									**Final Feasibility and**			
emove 105 piles (low beach), nourish upper beach	0	3	0	0	0	0.0	0.0	8.0	3	7	2	5	3	2	0	1	no scores. nested in erosion potential.			5	5	0	3	0	0	2	3	1	2	2	1	0
emove revetment and edge of parking lot, minor ourishment, restore marine riparian	0	3	2	3	5	4.0	0.0	8.0	3	5	2	3	1	0	0	1				5	5	0	3	0	0	2	3	0	0	2	1	2
emove riprap and old piles, nourish upper beach	0	3	2	3	0	5.0	0.0	7.0	0	4	2	2	3	0	3	0				5	5	0	0	0	0	2	0	1	4	2	1	2
aylight channel and reconnect tidal hydrologic connectivity th wetland/ponds	5	3	2	3	5	0.0	10.0	7.0	3	6	4	2	5	0	2	3				5	5	0	0	0	0	2	3	1	0	3	0	2
ower crest elevation of intertidal rock sill	0	3	2	0	0	0.0	0.0	8.0	0	7	4	3	5	2	3	0				5	5	5	0	0	0	2	3	0	4	3	0	2
emove gabion baskets and groins, (unpermitted?)	5	3	2	3	5	2.0	0.0	7.0	0	6	4	2	2	0	2	0				5	0	0	3	0	3	0	0	2	4	3	0	0
emove gabion baskets, likely unpermitted	5	3	0	0	5	3.0	0.0	0.0	0	6	4	2	1	0	1	0				5	0	0	0	0	3	0	0	2	0	2	0	0
emove piles and slag deposit left from old cannery	0	3	2	3	0	0.0	0.0	7.0	3	9	4	5	8	2	3	3				5	0	0	5	0	0	0	0	1	4	3	2	0
ourish for forage fish habitat; recreate beach profile	0	3	2	0	0	5.0	0.0	8.0	0	6	4	2	3	2	0	1				5	5	5	3	0	0	2	3	0	4	3	2	0
emove piles and relict outfall pipe from upper beach	0	3	2	3	0	0.0	0.0	3.0	3	7	4	3	1	0	0	1				5	5	0	0	0	0	2	3	1	4	3	2	2
emove riprap, nourish beach, restore/enhance marine parian	0	3	2	3	5	4.0	0.0	8.0	3	6	4	2	6	2	3	1				5	5	0	3	0	0	4	0	0	0	3	2	2
rch bay drive - remove old boat ramp just north of ottonwood Drive	5	3	2	3	5	0.0	0.0	6.0	0	5	2	3	0	0	0	0				0	0	0	5	0	0	4	0	0	0	3	2	0
hance tidal flushing and enlarge culverts	5	3	2	0	5	0.0	9.0	0.0	0	2	2	0	5	0	3	2				5	0	0	5	3	0	4	3	1	0	2	2	2
emove groins and nourish upper beach	5	3	2	3	0	0.0	0.0	8.0	0	4	2	2	2	2	0	0				5	0	0	5	0	0	4	3	0	0	0	2	0
emove concrete boat	0	3	2	3	0	0.0	0.0	4.0	3	4	2	2	0	0	0	0				5	0	0	5	0	0	4	3	0	0	3	2	2
emove old dock footings	0	3	2	3	0	0.0	0.0	4.0	0	2	2	0	0	0	0	0				5	0	0	5	0	0	4	3	0	0	3	2	2
emove tide gate, replace erosion control flood structure	5	3	2	0	5	0.0	7.0	0.0	3	4	2	2	2	0	0	2				5	0	0	5	3	0	4	3	0	2	2	2	0
emove pilings, concrete debris, and failing groin from tertidal and backshore	0	3	2	3	0	0.0	0.0	7.0	0	7	2	5	6	0	3	3				0	0	0	3	3	0	4	3	0	4	3	2	0
nlarge culvert and restore hydrology of backshr wetland, store backshore, relocate parking lot off beach	5	3	2	0	5	3.0	9.0	0.0	3	5	2	3	6	0	3	3				0	0	0	3	3	3	4	3	1	4	3	2	0
nlarge or open additional portion of causeway, restore tidal ushing, reverse adverse sedimentation	5	3	2	3	5	0.0	0.0	8.0	3	7	2	5	5	0	3	2				0	0	0	3	0	0	4	3	0	4	3	2	2
emove boulder lag, create 900 ft pocket beach north of eddy Bear Cove	0	3	2	0	0	5.0	0.0	8.0	0	5	2	3	3	2	0	1				0	0	0	5	0	0	4	0	0	2	2	2	2
emove relict steel structure and foundation	0	3	2	3	0	2.0	0.0	0.0	3	4	2	2	2	0	0	2				0	0	0	3	0	2	4	3	2	0	3	2	2
	5	3	2	3	5	5	10	8	3	9	4	5	8	**	**	**				5	5	5	5	3	3	4	3	2	4	3	2	2
	4%	3%	2%	3%	4%	4%	9%	7%	3%	8%			7%							4%	4%	4%	4%	3%	3%	3%	3%	2%	3%	3%	2%	2%

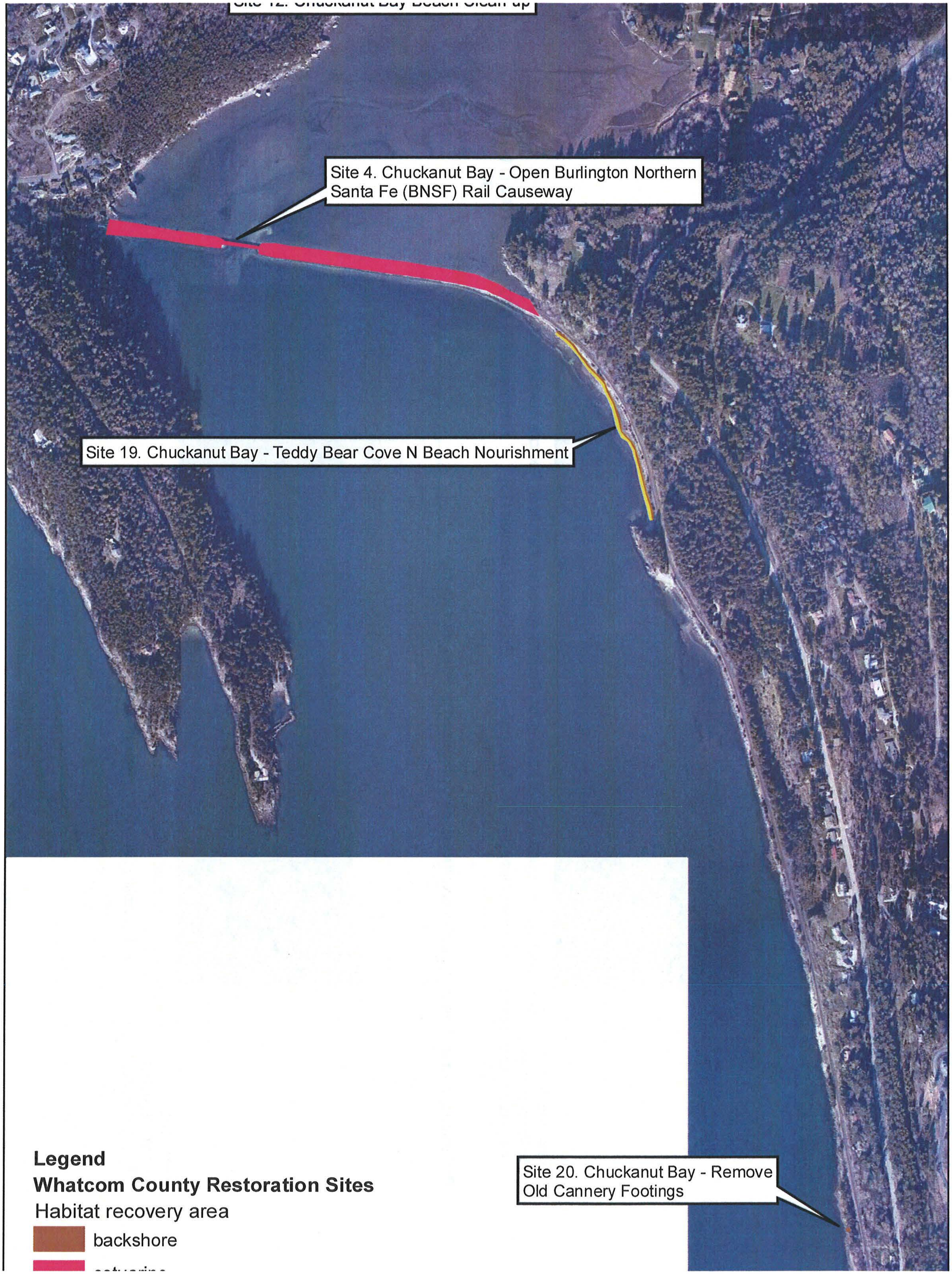
***nested level

Table 8. Summary of the final scores for each scoring category as well as cost estimates

	Name	Target area	Cost ($1000)	Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
1	Chuckanut Bay - Backshore wetland restoration	Chuckanut	40-80	38	6	5	16	9	74
2	Pt Roberts - Hydrologicaly reconnected wetlands	Pt Roberts	200-300	30	5	6	17	16	74
3	Birch Bay (Village) - Sunset Beach riprap removal	Birch Bay	30-60	28	6	6	17	11	68
4	Chuckanut Bay - Open BNSF causeway	Chuckanut	800-2500	29	7	5	10	15	66
5	Pt Roberts - Lily Pt Remove slag & piles	Pt Roberts	30-60	18	9	8	11	19	65
6	Pt Roberts - Maple Beach nourishment	Pt Roberts	100-150	18	6	3	23	13	63
7	Pt Roberts - Gabion baskets & groin removal	Pt Roberts	25-35	27	6	2	13	14	62
8	Birch Bay - Lower Terrell Ck reconnection	Birch Bay	100-400	25	4	2	20	10	61
9	Pt Roberts - The Breakers riprap removal	Pt Roberts	60-120	28	5	1	18	8	60
10	Pt Roberts - Pt Roberts marina sill	Pt Roberts	15-25	13	7	5	20	15	60
11	Birch Bay Dr. - Roger's Slough ehancement	Birch Bay	100-500	24	2	5	21	7	59
12	Chuckanut Bay - North beach cleanup	Chuckanut	20-40	15	7	6	13	16	57
13	Pt Roberts - Lighthouse Park remove riprap & nourish	Pt Roberts	70-110	20	4	3	13	16	56
14	Pt Roberts - W. Gulf Rd right-of-way piling removal	Pt Roberts	40-80	14	7	3	19	12	55
15	Pt Roberts - Maple Beach outfall pipe and pilings removal	Pt Roberts	20-35	14	7	1	16	16	54
16	Birch Bay Dr. - Groin field removal	Birch Bay	80-150	21	4	2	17	9	53
17	Birch Bay Dr. - Old boat ramp removal	Birch Bay	20-35	24	5	0	9	12	50
18	Birch Bay Dr. - Bluefish restaurant -relict boat	Birch Bay	10-20	15	4	0	17	13	49
19	Chuckanut Bay - Teddy Bear Cove N nourishment	Chuckanut	60-90	18	5	3	9	11	46
20	Chuckanut Bay - Old cannery footing removal	Chuckanut	15-25	13	4	2	14	13	46
21	Birch Bay Dr. - Bluefish restaurant - remove pier footings	Birch Bay	10-20	12	2	0	17	13	44
22	Pt Roberts - Gabion baskets removal at base of FBE	Pt Roberts	20-35	16	6	1	10	9	42


Site 17. Birch Bay - Birch Bay Drive Remove Old Boat Ramp
Birch Bay (Village) - Sunset Beach Riprap Removal
Site 16. Birch Bay Drive - Remove Groin Field
Site 18. Birch Bay Drive - Bluefish Restaurant - Remove Relict Boat
Site 21. Birch Bay Drive - Bluefish Restaurant - Remove Pier Footings
N
Site 8. Birch Bay - Lower Terrell Creek Reconnection

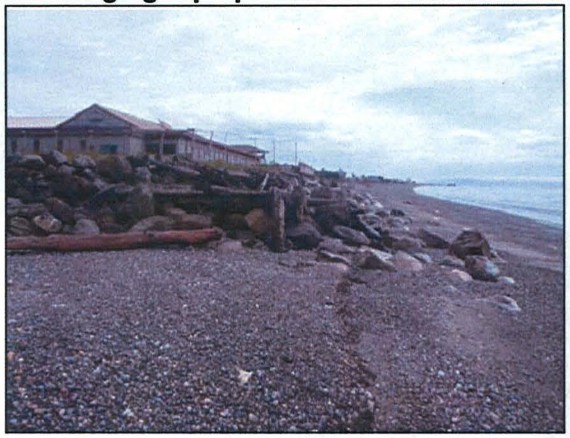

Site 15. Pt Roberts - Remove Old Outfall Pipe and Pilings
Site 6. Pt Roberts
Roberts - W. Gulf Rd Right-of-Way Creosote Pile Removal
t Roberts - Removing Infringing Riprap at The Breaker's
Site 5. Pt Roberts - Remove Slag Deposit, Pilings and Car Parts From Lily Point
Site 7. Pt Roberts - Remove Gabion Baskets and Groins
Roberts - Reconstruct Pt
arina Sill at Lower Elevation
Site 2. Pt Roberts - Hydrologically Reconnect Wetland
Site 22. Pt Roberts - Gabion baskets at base of Feeder Bluff Exceptional

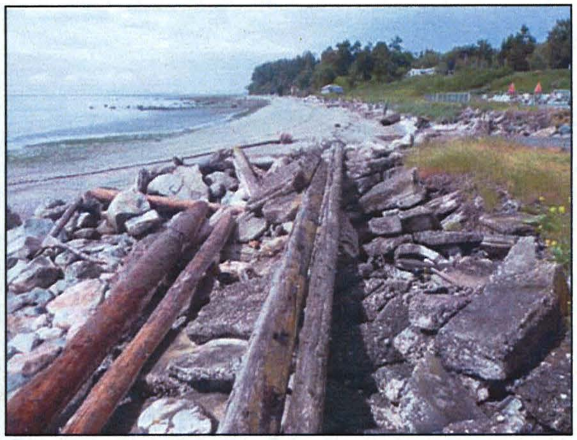

Site 4. Chuckanut Bay - Open Burlington Northern Santa Fe (BNSF) Rail Causeway
Site 19. Chuckanut Bay - Teddy Bear Cove N Beach Nourishment
Site 20. Chuckanut Bay - Remove Old Cannery Footings
Legend
Whatcom County Restoration Sites
Habitat recovery area
backshore

Whatcom County Nearshore Habitat Restoration Prioritization

Appendix 2: Recommendations for sites scoring below the top five, sorted geographically from north to south.

Pt Roberts, The Breakers Infringing Riprap





Restoration Recommendation: Remove revetment and edge of parking lot. Perform minor nourishment. Restore marine riparian.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
28	5	1	18	8	60

Pt Roberts, Lighthouse Park Shore Modifications Comprised of Piles and Riprap

Restoration Recommendation: Remove riprap and old piles. Perform upper beach nourishment.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
20	4	3	13	16	56

South Pt Roberts, Groins and Gabion Baskets


Restoration Recommendation: Remove gabion baskets and groins.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
27	6	2	13	14	62

South Pt Roberts, Gabions at Base of Feeder Bluff Exceptional


Restoration Recommendation: Remove gabion baskets.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
16	6	1	10	9	42

Pt Roberts, Maple Beach Nourishment

Restoration Recommendation: Perform nourishment to enhance eroded forage fish spawning habitat. Recreate beach profile.

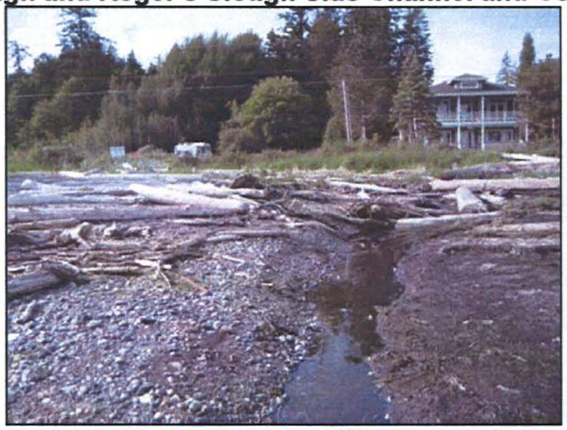
Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
18	6	3	23	13	63

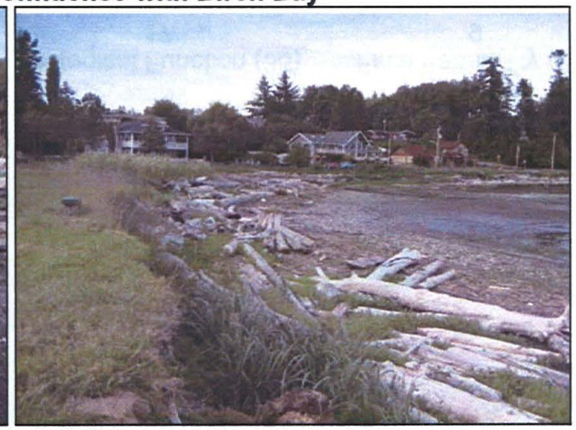
Pt Roberts, Maple Beach Old Outfall and Piles

Restoration Recommendation: Remove relic outfall pipe and old piles from upper beach.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
14	7	1	16	16	54

Birch Bay, Roger's Slough and Roger's Slough Side Channel and Confluence with Birch Bay

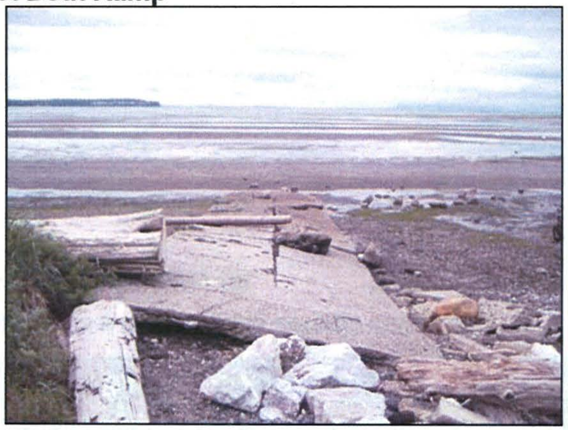




Restoration Recommendation: Enhance tidal flushing and enlarge culverts.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
24	2	5	21	7	59

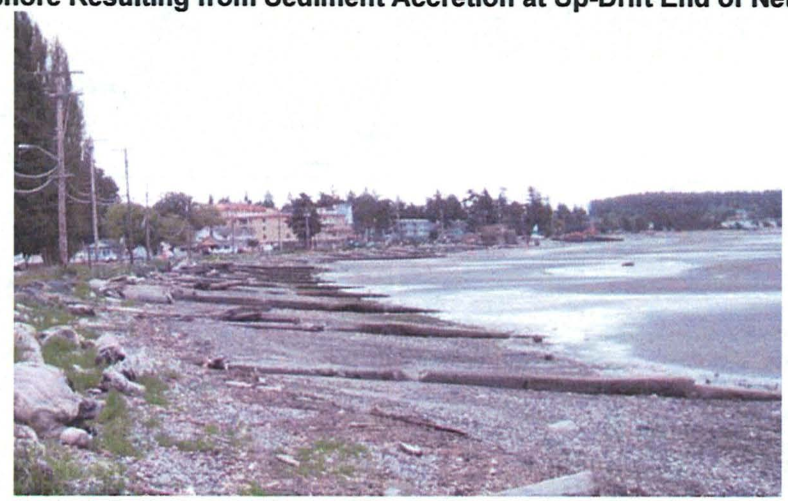
North Birch Bay, Derelict Boat Ramp



Restoration Recommendation: Remove old boat ramp just north of Cottonwood Drive.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
24	5	0	9	12	50

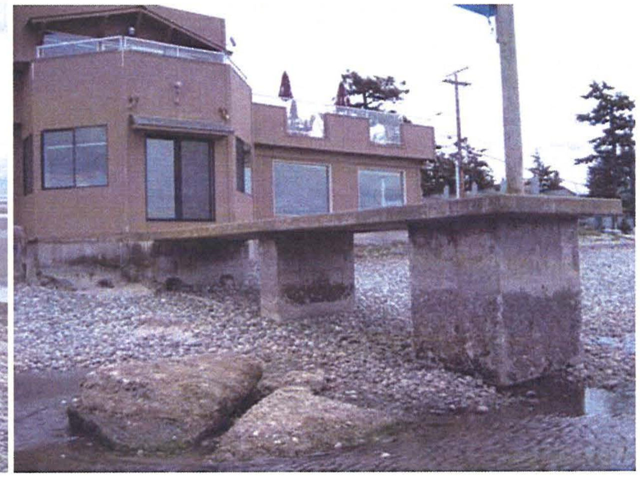
Birch Bay, Groins and Scalloped Foreshore Resulting from Sediment Accretion at Up-Drift End of Net Shore-Drift Impediments



Restoration Recommendation: Remove groins. Perform upper beach nourishment.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
21	4	2	17	9	53

Birch Bay, Bluefish Restaurant



Restoration Recommendation: Remove concrete boat.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
15	4	0	17	13	49

Restoration Recommendation: Remove old dock footings.

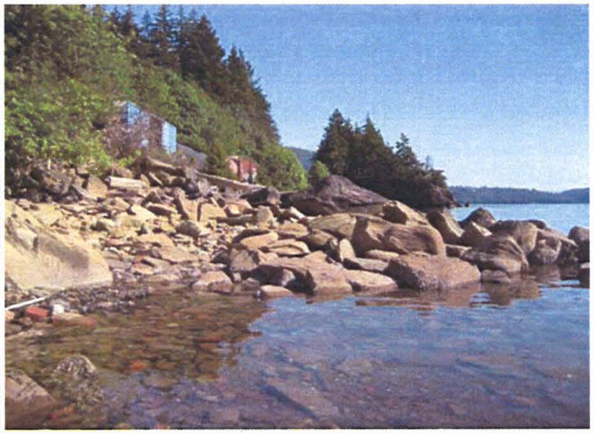
Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
12	2	0	17	13	44

Birch Bay, Lower Terrell Creek Reconnection

Restoration Recommendation: Remove tide gate. Replace erosion control flood structure.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
25	4	2	20	10	61

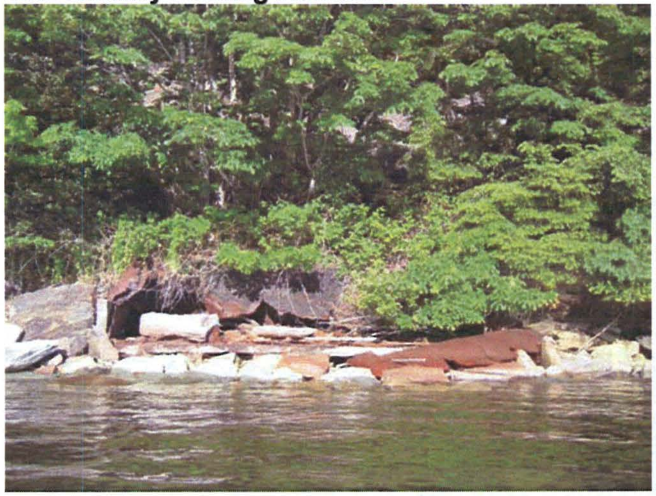
Chuckanut Bay, North Teddy Bear Cove Nourishment

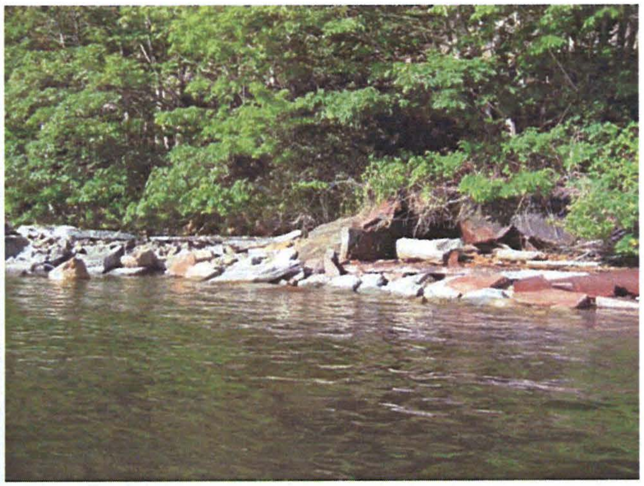


Restoration Recommendation: Remove boulder lag. Create a 900-foot pocket beach north of Teddy Bear Cove.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
18	5	3	9	11	46

Chuckanut Bay – Old Cannery Footing Removal





Restoration Recommendation: Remove relic steel structure and foundation.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
13	4	2	14	13	46

Chuckanut Bay, North Beach Cleanup

Restoration Recommendation: Remove pilings, concrete debris, and failing groin from intertidal and backshore.

Targeted Response (45)	Sustainability (9)	Risk (8)	Ecological Function (35)	Final Feasibility (21)	Total (117)
15	7	6	13	16	57