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INTRODUCTION

The Kukutali Preserve, located within Skagit Bay in Skagit County, Washington, was purchased in 2010 and is co-owned and co-managed by the Washington State Parks and Recreation Commission (State Parks) and the Swinomish Indian Tribal Community (SITC). The preserve encompasses approximately 90 acres, including an island connected to Fidalgo Island (hereafter referred to as the mainland) via a natural tombolo, along with a natural coastal lagoon and associated upslope wetlands on the mainland (Figure 1). In addition, the preserve is surrounded by approximately 11 acres of Tribally owned tidelands. The acquisition of these unique habitat features presents the opportunity to identify potential restoration actions that would benefit juvenile Chinook and other salmon. This report outlines restoration opportunities in the areas surrounding the tombolo and the lagoon/wetland complex on the mainland portion of the Preserve. A range of alternatives, including no action, will be presented for both sites so that a full range of costs and benefits can be evaluated.

Figure 1. The Kukutali preserve is comprised of Kiket Island, Flagstaff Island, and the mainland of Fidalgo Island. The three sites are connected by tombolos.
BACKGROUND

Project Overview

Habitat restoration will enhance fish access and restore wetland processes within a 3.4 acre coastal lagoon and associated 7 acre wetland complex while preserving foot and maintenance vehicle access across the tombolo to Kiket Island for some alternatives and limited access as part of a larger restoration alternative. Currently, both sides of the narrow neck of the tombolo are armored with riprap, which is likely having an impact on sediment transport, and limits migration across the tombolo at high tides by juvenile salmonids. Riprap and fill along the southern side of the tombolo have isolated back beach zones from natural processes (SRSC and WDFW 2005), and the northern part of the lagoon has also been filled. The wetlands at the fringe of the lagoon and the adjacent uplands are generally well functioning but would benefit from actions to improve water quality and quantity. Removal of the shoreline armoring and of the additional artificial fill within the north side of the lagoon were identified as high-priority restoration actions in the Skagit Chinook Recovery Plan (SRSC and WDFW 2005). Kiket Lagoon provides important rearing and refuge habitat for juvenile salmonids migrating from the freshwater to the marine environment (Beamer et al 2003).

Goals and Objectives

This report addresses the feasibility of restoration actions to achieve the following primary objectives:

1. Sustainably restore natural processes, conditions, functions, and biological processes to a 3.4 acre long shore lagoon and 300 lineal foot tombolo along the northeastern shoreline of Skagit Bay
2. Restore critical estuarine rearing habitat for ESA-listed juvenile Chinook salmon during the early phases of their oceanward migration.
3. Restore estuarine habitat for other fish species, including other juvenile salmonids and forage fish, as well as for other wildlife (particularly marsh birds).
4. Conduct restoration actions in a manner consistent with the overall management goals of the Preserve.

In support of these objectives, the primary goals of this report are to

1. Evaluate alternatives for the removal of approximately 600 lineal feet of riprap and associated road fill to restore sediment transport processes, tidal hydrology, and possibly fish access across the neck of the tombolo joining Kiket Island to the mainland.
2. Evaluate alternatives for restoration of the partially filled 3.4 acre lagoon and its surrounding wetlands.
3. Consider the effect of restoration actions in both of these areas on foot and/or vehicle access to the Kiket Island portion of Kukutali Preserve.
4. Ensure that restoration activities are compatible with current and historic cultural uses of the site by members of the Swinomish Indian Tribal Community.
Site Description and History

Kukutali Preserve, designated as a unit of Deception Pass State Park after its purchase in 2010, totals approximately 90 acres and lies along the northeastern shoreline of Skagit Bay between Kiket and Similk Bays. The Preserve is comprised of two islands, Kiket Island (approximately 67 acres), a heavily forested island connected to the mainland by a narrow tombolo, and Flagstaff Island (approximately 2 acres), connected to Kiket Island by another tombolo, and a lagoon, wetlands, and small amount of upland located on both Kiket Island and the mainland portion of the Preserve (approximately 10 acres). The tombolo connecting Kiket Island to the mainland is approximately ½ mile long, running east-west, and is ¼ mile wide where it connects to the mainland (Figure 2). As the tombolo approaches Kiket Island, it narrows considerably. The lagoon lies just to the north of the tombolo along the mainland shoreline. An estuarine intertidal emergent wetland fringes the lagoon. This wetland is bordered on the upland side by palustrine scrub-shrub wetland. Total wetland area is approximately 7 acres. The Preserve is fringed by two miles of diverse shoreline that is used by a variety of marine, avian, and mammalian species including Chinook salmon and bald eagles (Houghton and Abercrombie 2008).

Figure 2. 2006 Washington Department of Ecology oblique photo, showing the tombolo connecting Kiket Island to Fidalgo Island. The longshore lagoon is shown at the center of the photo, bordered by estuarine intertidal emergent wetland. The estuarine wetland is bordered by freshwater scrub/shrub wetland that extends to Snee Oosh Road, shown at the top of the photo.
Land Use

Prior to the current co-ownership by State Parks and the SITC, the Preserve area was held in mostly private ownership. The Swinomish Reservation, which includes Kiket Island, was reserved by the Swinomish Indian Tribal Community under the Treaty of Point Elliot of 1855 and held in trust for the Tribe by the United States. Historic use of the area by the Tribe included shellfish gathering and beach seining for salmon. The traditional name of the area Kukutali means “place of cattail mat,” referring to the temporary shelters erected of cattail mats at the summer clam digging and beach seining sites. The Kiket Island area was allotted to a Tribal member following the Allotment Act in the 1880s which divided up the communal tribal holdings into individual trust allotments. The area was sold out of trust by the original allottee’s heirs in 1929 to a Seattle-based company who later sold the island to the City of Seattle. In the early 1970's, Seattle City Light considered using the property for potential development of a nuclear power plant site, prompting much environmental review. A laboratory and marine railway (to launch research vessels) was constructed along the western shore of Kiket Island during this time as part of the University of Washington studies of the environmental impacts of the proposed project. In 1982, after the nuclear project was abandoned due to widespread environmental concerns, the property was sold to private owners from the Seattle area. This family held the property for three decades prior to the acquisition by State Parks and SITC.

Figure 3. The Kukutali Preserve property and adjacent parcels. Property boundaries from 2013 Skagit County parcel layer.
The property is relatively undisturbed aside from a 1.6-acre residential area on Kiket Island and a 0.5-acre residential area on the mainland, although the lagoon and wetland on the mainland have been reduced in size by development pressures to the north and south. One access road exists, along the southern border of the property, along the top of the tombolo, and crossing the Kiket Island to the residential site on the west side of the Island. A few overgrown roads extend off the access road on the island, leading into the forest. The tombolo has been armored with rip-rap rock on both sides to prevent erosion of the roadway.

In 2010, the property was purchased for conservation purposes, and is co-managed by State Parks and the SITC (Figure 3). Access to the site is currently restricted to guided tours until site restoration and day-use amenities have been constructed (Washington State Parks and Recreation Commission 2012). Access is restricted to pedestrian use only.

Recreational facilities will be developed on the preserve as funding becomes available. A trail, possible shelter, and non-motorized boat access points on the island and parking area, kiosk, beach trail and wetland boardwalk on the mainland have been identified in the Kukutali Master Plan (Washington State Parks and Recreation Commission 2012). The residential area on the mainland currently serves as the caretaker's residence.

Site Conditions

Topography

During the summer of 2013, SRSC staff conducted a detailed topographic survey of the tombolo and the area surrounding the lagoon. A Leica Viva RTK-GPS rover was used to conduct the survey, and riprap, ditch lines, utility poles, road surfaces, and ground surfaces were recorded in sufficient detail to produce one foot contours for the site. All elevations were referenced to the NAVD88 datum. A current conditions topographic map is included as an appendix to this report.

Note that the survey was not conducted by a licensed surveyor and is therefore not intended to be an official record of property boundaries or site features. This survey was for the purpose of recording existing conditions for planning conceptual restoration design work. All features should be verified by a licensed surveyor or engineer prior to final design work.

Hydrology and Drainage

The eastern portion of the Kukutali preserve contains a unique and regionally decreasing wetland type (Pentec Environmental 2009). One wetland containing two wetlands types was identified in a survey completed by Pentec Environmental in 2009: estuarine intertidal emergent (coastal lagoon) covering 3.4 acres and a palustrine scrub/shrub wetland covering 7 acres (Figure 4). The two wetland types are contiguous which is fairly unique within the developed Puget Sound region (Pentec Environmental 2009). The coastal lagoon along the Fidalgo Island shoreline is bounded by a natural gravel berm containing a narrow outlet channel. The lagoon receives freshwater inputs from the adjacent sloped wetland to the east.
Figure 4. Wetlands that have been identified at the project site.

The property is relatively undisturbed in comparison to other Puget Sound coastal areas, but the lagoon and wetland have not escaped the impacts of area development (Figure 5). It is evident upon examining historic aerial photographs that both the lagoon and the wetland have been reduced in size. In the late 1930's/early 1940's an access road was built on the southern side of the property and along the southern edge of the lagoon, likely altering the size of the lagoon and wetlands, and a residence was built along that road by the mid 1950's. The inlet of Kiket Lagoon was altered in the late 1940's when the landowner put in a culvert and constructed a dike (360' long, 15' wide, 5' high) on the seaward side in order to create a saltwater lake for recreational purposes (Bureau of Land Management 2011). The dike was also used as a road and was partially washed out (Bureau of Land Management 2011). It appears that the wetland, which was partly forested in the early photographs, was cleared prior to the 1956 photograph. Sometime in the late 1950's or early 1960's, and then again in the late 1960's, the northern end of the lagoon experienced some fill as evidenced through historic aerial photography (Bureau of Land Management 2011). Measurement of the lagoon in a GIS indicates that this northernmost development likely reduced the lagoon footprint by approximately 0.6 acres.
While a field investigation would be required in order to precisely delineate the watershed boundary of the upslope area contributing to the wetland and lagoon because of the relatively uniform topography of the surrounding land, a rough delineation using contour data in GIS estimates the Kiket Lagoon watershed at approximately 219 acres (Figure 6). Most of this area is comprised of forested stands of mixed ages at the upper end of the watershed and a few residential units near the lower end. Snee Oosh Road bisects the watershed and until recently, water draining from the upper/east side of the road was diverted south and out of the water shed via a ditch running along the east edge of the road. Recently however, a ditch dam was installed and water collecting in the ditch is diverted beneath the road and down to the lagoon via a ditch running on the northern edge of Kiket Island Road. A ditch on the west side of Snee-Oosh Road collects water from Snee-Oosh Road and flows southward to the northeast corner of the Preserve, where the ditch ends. From there, stormwater flows overland through the Fidalgo portion of the Preserve. SITC has been working cooperatively with Skagit County Public Works to realign the stormwater system and direct the flow away from the Preserve.
Figure 6. Approximate watershed boundary for the Fidalgo Island portion of the project site.

Geology and Geomorphology

The rocky shoreline of Kiket Island contains vertical cliffs interspersed with beaches. The beach to the south of the tombolo is broadly sloping and has many accumulated drift logs in front of the riprap. The source of the logs is likely mainly marine drift (via the Skagit River), with additions from the adjacent riparian forest on the island. On the north side, the beach is steeper and coarser. The roadway is thinly rip-rapped on the north side and the access road has experienced some erosion (Houghton and Abercrombie 2008). The shoreline along Kukutali Preserve is a mix of accretion shoreforms (depositional zones), feeder bluffs, and bedrock (Figure 7). The tombolo is a depositional zone accumulating sediments from other sources to the south and north (MacLennan, Johannessen, and Williams 2010). The drift cell serving the northern side of the tombolo, which also maintains the lagoon, is relatively short and largely undisturbed by shoreline modification, while the southern drift cell is much longer and is impacted by a higher degree of modification, mostly in the form of bulkheads installed in the intertidal zone (MacLennan, Johannessen, and Williams 2010).
Figure 7. Shoretypes and historic feeder bluff restoration priorities, as mapped and designated by Maclennan, Johannessen, and Williams (2009).
Historic shoreline analyses by Collins and Sheikh (2005) indicate that approximately the northern ¼ of the historic lagoon has been filled (SRSC and WDFW 2005) (Figure 8). This fill lies on private property adjacent to the Kukutali preserve. A 2011 tidelands encroachment report, prepared by the Bureau of Land Management (BLM) for the purpose of describing alterations below the Mean High Tide line by landowners, notes that the fill was first apparent in 1965 aerial photographs and appears to have expanded in the 1971 photographs (BLM 2011).

Additionally, the report includes a letter dated 1/15/1980 which states that in 1948-1950 the lagoon was diked off on the seaward side, and a culvert was placed to allow drainage. A road was constructed along the top of the dike. At some subsequent point, the culvert washed out. This has not been repaired, and the concrete culvert is still present on the beach, partially buried by sediments (BLM 2011, Exhibit 6).

![Figure 8](image)

**Figure 8.** Current and historic habitat classification of the Kukutali Preserve Lagoon (map from SRSC and WDFW 2005).

Core samples collected within the road prism at the neck of the tombolo indicate that soils at the site consist mainly of native beach deposits, typically loose sand mixed with ¼ inch diameter or smaller gravel. Small sand sized shell fragments were interspersed amongst the sand and gravel. Approximately 100’ east of the edge of Kiket Island, bedrock was encountered at 23.5’ below the present road grade. The next adjacent core, located approximately 100’ east, reached bedrock at
35' below the road grade. The final sample, another 100’ east, was terminated without reaching bedrock at more than 50’ below road grade (MTC 2013).

**Sediments**

SITC mapped nearshore sediments along the inter-tidal and shallow sub-tidal zones within the Preserve during summer 2013 (Mitchell, 2014). Sediment character was visually assessed along transects perpendicular to the shoreline (ibid., Figure 9). To evaluate the quality of visual assessments, a subset of thirty transects was selected for detailed laboratory sediment analysis (ibid., Figure 10).

**Figure 9.** Map showing project area with transect lines oriented roughly perpendicular to the shoreline. Yellow dots indicate sampling stations location for a previous study. All stations used in this study are not displayed on this map, however the displayed stations provide a sense of the distribution and density of the sampling points. Figure and caption from Mitchell 2014.

Sediment analysis indicated typical seaward progression of grain sizes, from coarse sand/fine gravel in the back shore to a coarse gravel foreshore that rapidly grades to mud (Mitchell 2014). These results generally confirm observations made during bay-scale geomorphic mapping (MacLennan et al. 2010, McBride et al. 2006). SITC observed accretion limited to the south shoreline of the study site, mainly against the tombolos, with a dominant northwestward transport direction on this side of the site (Mitchell, 2014). Sediment on the northern shoreline of Kikiet Island generally moves in a west to east direction (ibid.), while sediment along the shoreline of Fidalgo Island to the north of the site moves southward, towards the lagoon and tombolo (ibid.).
**Biotic Resources**

**Overview**

The selection of Kiket Island as a potential location for a nuclear power plant has made its shorelines some of the most heavily studied in the state (Houghton and Abercrombie 2008). In studies conducted by the University of Washington, there were found to be 86 marine invertebrate species in the area (Strober 1973). Oysters, clams, seastars, river otters are abundant along the shoreline of Kiket Island, as well as diverse bird species including bald eagles (Houghton and Abercrombie 2008, Barber et al. 2012). Eelgrass is found along the north side of the island including along the tombolo (Washington State Parks 2009). Because of the location of Kiket Island in proximity to the Skagit River, the shorelines and waters of the island are heavily used by out-migrating juvenile salmonids (Beamer et al. 2005).

A low gradient saltmarsh bench surrounds the lagoon, and vegetation on the bench includes pickleweed, saltgrass, baldhip rose, and non-native cordgrass. Vegetation within the lagoon includes macrovegetation, eelgrass, and kelp, and invertebrates include crustaceans, snails, mussels, and clams. Juvenile salmon including Chinook, coho, chum, and pink, have been found within the lagoon, as well as bull trout, and many forage fish species (Washington State Parks 2009 and Houghton and Abercrombie 2008).
Salmon

Habitat use by juvenile Chinook salmon at Kukutali Preserve was monitored in 2009 (March-June), 2010 (February-June), and 2013 (January-June) (Beamer et al. 2014). Based upon other sampling efforts within the Whidbey Basin, juvenile salmon were not expected to be present at the site during other parts of the year (Beamer et al. 2006). Beach seine sets were made in both Kiket Lagoon and along the tombolo (Figure 11). The data were used to compare habitat use and fish size between years and months as well as between habitat types (lagoon or adjacent nearshore). Additionally, comparisons were made between Kiket Lagoon and other Skagit Bay pocket estuaries, as well as between the north and south sides of the tombolo (Beamer et al. 2014).

Data analysis showed that the timing of juvenile salmon use of the lagoon and adjacent nearshore (tombolo) was consistent with that observed at other locations (Beamer et al. 2014). Densities of juvenile Chinook salmon per unit area were 4.9 times higher inside Kiket Lagoon than in adjacent nearshore habitat (Figure 12, ibid.), and those caught within the lagoon were longer than those caught along the tombolo (ibid.). Within all Skagit Bay pocket estuaries, the mean density of juvenile Chinook has been observed to be 6.8 times higher in pocket estuaries than adjacent

Figure 11. Location of beach seine sites used for juvenile Chinook salmon analyses related to Kukutali Preserve and Kiket Lagoon. Figure and caption from Beamer et al. 2014.
nearshore. While the value for Kiket Lagoon is somewhat lower, the results are within the range of variability observed at other Skagit Bay sites (ibid.). Chinook densities did not vary significantly between the north and south sides of the tombolo (Figure 13, ibid.). This indicates that increasing connectivity between the north and south sides of the lagoon cannot be predicted to lead to a statistically significant increase in juvenile Chinook use of the lagoon (ibid.). However, Beamer et al. (2014) note that their conclusion of 'no effect' may be driven by a lack of data, and that there is no downside to increasing connectivity at the tombolo.

![Figure 12](image-url). Log transformed wild juvenile Chinook salmon density by year and strata (lagoon, adjacent nearshore) for Kiket Lagoon. Error bars are standard error. Figure and caption from Beamer et al. 2014.
Figure 13. Wild juvenile Chinook salmon density by month and strata (north side of the tombolo, south side of the tombolo) in 2013. Error bars are standard error. Fish density is fish per hectare of wetted area beach seined. Figure and caption from Beamer et al. 2014.

Forage Fish

From January through October 2013, Beamer et al. (2010) monitored surf smelt and sand lance egg presence, abundance, and condition at beaches along the north and the south sides of the tombolo connecting Kiket Island to the mainland (Figure 14). Sampling involved examining monthly sediment samples collected along both sides of the tombolo for presence of forage fish eggs. All samples were collected on or slightly below the beach wrack line. During the study period, only surf smelt eggs were observed in the samples collected from the beaches of Kukutali Preserve (Beamer et al. 2014). Pacific Herring typically spawn at lower beach elevations than those sampled during the study, so this may account for the absence of eggs observed for this species. However, sand lance and rock sole eggs could be predicted to be present within the sampled elevations (ibid.).

For surf smelt, eggs were only detected in samples collected during September 2013 on the south side of the tombolo (Beamer et al. 2014). Egg abundance within these samples was low (ibid.). Surf smelt eggs were detected during June through September along the tombolo connecting the west end of Kiket Island to Flagstaff Island, and spawner-sized smelt were captured during summer beach seine sets described in the previous section (ibid.). Few spawner-sized surf smelt were captured during winter months, providing little evidence of surf smelt spawning during this part of the year (ibid.). Similarly, WDFW smelt spawn data, though not extensive, also show greater
spawning activity in the summer months. This is consistent with observations from throughout the northern Whidbey Basin (Quinn et al. 2012).

![Figure 14](image)

**Figure 14.** Location of beaches sampled for forage fish eggs in 2013. Figure and caption from Beamer et al. 2014.

**Shellfish**

Barber et al. (2012) conducted clam surveys in 2010 along the tombolo linking Kiket Island to the Fidalgo Island “mainland.” Clams were systematically sampled within 0.18m² quadrats placed along random transects on beaches extending up to +1.5m above mean lower low water. Clam biomass data were used to interpolate clam biomass throughout the study area in a GIS.

Eight species of clams were recorded on beaches surrounding Kukutali Preserve (Barber et al. 2012). Butter clams (*Saxidomus gigantea*) and native littleneck (*Leukoma staminea*) within the site weighed more on average and had a broader range distribution than those found on other Skagit Bay beaches, likely due to lack of significant harvest for the past 20 years (ibid.). However, despite exhibiting greater weights, neither of the two species are particularly abundant at the site (ibid.). This is likely due to the presence of a heterogeneous substrate; butter clams, for example prefer mixed sand and gravel, and are more likely to be found in these areas (ibid.). Conversely, cockles (*Clinocarium nuttallii*) at Kukutali Preserve had a significantly lower weight per quadrat than did...
those at other Skagit Bay sites (ibid.) The area northeast of the (eastern) tombolo supports relatively dense populations of commercially important clams, while the southeast beach and the beach immediately north support populations of smaller less commercially important clams due to the silt-dominated substrate.

**Cultural Resources**

Until recently, the tidelands associated with Kukutali Preserve were inaccessible to Swinomish tribal members because of the private ownership. The tidelands at Kiket Island are now managed by the tribe and are not currently open for harvest except for a biennial elders harvest, which typically draws low numbers (Barber et al. 2012). There are two registered archeological sites in the Preserve. The presence of large quantities of shell midden along the tombolos indicates that these areas were historically and extensively used by tribal ancestors as a shellfish harvest site.
RESTORATION DESIGN ALTERNATIVES

We present restoration alternatives for the tombolo portion of the property separately from those for the lagoon/wetland, with discussion of opportunities, constraints, and drawbacks for each. Restoration actions at one location should be considered independent of those at the other site, although construction and ecological benefits would be maximized by completing restoration at both sites during the same period.

Tombolo Restoration Alternatives

Four tombolo restoration alternatives have been proposed for detailed engineering analysis with a “no action” option included to demonstrate how the proposed restoration actions would improve habitat conditions over the existing conditions. The four alternative concepts and the no-action options are described below and followed up with a simple preliminary ranking of the tombolo alternative concepts.

Figure 15. Riprap along the northern edge of the main Kukutali Preserve tombolo.
Alternative 1: No Action

Tombolo Alternative 1 involves allowing conditions along the armored neck of the tombolo to remain in their current form (see Conceptual Design Drawings, Sheets 1 and 2). Benefits to this approach are that the current levels of access to from the mainland to Kiket Island will be maintained, and upkeep of the roadway is likely to be necessary relatively infrequently and should involve known costs. Drawbacks to this approach include continued impact to sediment transport, as hard armoring along shorelines has been shown to reflect wave energy, depositing sediments offshore. Additionally, depending on the historic top elevation of the tombolo, which can be inferred to lie at approximately +11.0 feet NAVD88 based on the slopes of the beach faces below the riprap (Figure 15), the tombolo may have allowed occasional access for juvenile fish migrating along the shoreline. Mean Higher High Water (MHHW) for the site is +9.04 feet NAVD88, so this would have occurred only infrequently. However, transport of woody debris and other plant materials across the tombolo via wave action may have occurred more frequently. An additional drawback to Alternative 1 is limited resilience to sea level rise (SLR). While the road surface is currently elevated sufficiently to avoid overtopping by wave action, it may be insufficient in the future, given projections of up to 40cm of sea level rise by 2050 for the Puget Sound region (NCS 2012).

Alternative 2: Partial Road Removal

Tombolo Alternative 2 involves excavating a portion of the road prism down to the historic tombolo top elevation. Benefits to this approach include a reduction in the degree of shoreline armoring, resulting in more natural sediment transport conditions and high tide fish passage across the tombolo could potentially be achieved. Changes to the sediment transport regime that introduce coarser sediments to the beach north of the tombolo would have the potential to improve conditions for commercially important clams, which prefer a coarser (sandy/gravelly) substrate (J. Barber, personal communication). Bridge bottom elevation could be configured to allow passage of beach wrack and other materials during storm events, and sea level rise could be accommodated for. Drawbacks include relatively high cost and some continued habitat impacts. If a relatively small opening is selected, it has the potential to create a scour channel that could undermine bridge footings or further disrupt sediment transport.

The width of the excavated portion of the site would be determined by the budget available to construct a crossing feature, and the location of the crossing along the tombolo would be determined by the type of crossing selected. Options could include single-lane driveable bridge, a pedestrian bridge, or a driveable ford, depending on the access requirements. Costs associated with excavation would vary with the size opening selected.

A vehicle bridge is most expensive crossing option, and the most limiting in terms of location along the tombolo (see Conceptual Design Drawings, Sheets 2 and 3). Substantial engineering would likely be required. As noted in the geology discussion above, bedrock was encountered only towards the western end of the tombolo, near Kiket Island. Because the substrate of the tombolo is largely sand and gravel, bridge footings would likely need to extend down to the bedrock layer to provide sufficient stability. Shallow-footing options may be available, but these would involve large-footprint armored footings that would likely impact sediment transport along the tombolo. Regardless of footing style, fill would be required to build up the bridge approaches to allow for sufficient bottom-of-span clearance. Fill from the excavated road prism could likely be reused for this purpose, minimizing hauling costs. For bridges up to roughly 80’ in length, prefabricated single span bridges are available, with costs in the $200,000 to $500,000 range. Beyond this length, multiple spans set on piers would likely be required, increasing cost and complexity. Maintenance
costs would likely be periodic and typically low, though more expensive than the No Action approach.

If vehicle access to Kiket Island is not required, a smaller pedestrian bridge could be installed. Such a bridge would likely require much less substantial footings and would also be available as a prefabricated span. Costs for such bridges are much lower than bridges that can accommodate vehicle traffic. Similar requirements for bottom-of-span clearance and approach fill would apply. Maintenance costs would be lower than for a vehicle bridge.

A third crossing option that could be explored is a driveable ford (see Conceptual Design Drawings, Sheets 5 and 6). This type of crossing would involve embedding large rock armoring near the top elevation of the existing tombolo. Rock would be installed to have a relatively flat surface without large gaps, and smaller gaps would be filled with quarry spalls that are pounded in to “lock” them in place. This would create a driveable and walkable surface that would still be accessible throughout most tides. Cost for this option would be much lower than for bridge crossings and would require much less engineering. Riprap currently armoring the road prism could potentially be repurposed for the crossing. Drawbacks include the continued potential to influence sediment transport, because although the rocks would be embedded, the armored surface would still impact the sediment transport. However, those impacts will likely be less than those that exist currently since the tombolo profile will be returned to a more natural configuration. Additional concerns include potential for scour and movement among placed rocks. Public safety should be carefully considered with this option, as rocks installed near the MHHW mark would likely become slippery over time. At very high tides or during high wind/wave events, stranding on Kiket Island would become a concern.

**Alternative 3: Full Road Removal**

Full road removal would involve excavation of the entire road prism to a natural tombolo elevation from the point at which the tombolo meets Kiket Island to approximately 200’ east. The total excavated fill volume would be roughly 1800CY. Crossing options would be the same as those described for Alternative 2, though much larger, likely with multi-span bridges set on piers (see Conceptual Design Drawings, Sheets 7 and 8). As a result, costs associated with this alternative would be extremely high. A driveable ford could also potentially be used with this option (see Conceptual Design Drawings, Sheets 9 and 10) Benefits would include full restoration of the historic tombolo elevation, with improved sediment transport and greater potential for transfer of organisms and habitat-forming debris across the tombolo surface.

**Alternative 4: Full Tombolo Restoration**

Full tombolo restoration would be similar to Alternative 3 in that it would involve excavation of the entire road prism down to a natural tombolo elevation with no drivable ford or bridge constructed across the excavated area. The total excavated fill volume would be roughly 1800CY but would depend on the width of the excavated area. Benefits to this approach include removal of shoreline armoring, resulting in natural sediment transport conditions. High tide fish passage across the tombolo could potentially be achieved, the tombolo would allow passage of beach wrack and other materials during storm events, and sea level rise could be accommodated for. This option also allows for greater potential to install plantings to provide shade for forage fish spawning on the beaches at the tombolo, because vehicle clearance would no longer be a concern. Drawbacks include a reduction in accessibility for visitors to the preserve. Vehicles would no longer be able to
access the Kiket Island portion of the site, and foot traffic would only be able to do so at low tides, so high tide stranding is a possibility.

**Alternative 5: Sediment Source Restoration**

A final alternative to improve habitat conditions at the tombolo would be to complete work to restore the sediment sources that nourish the tombolo. As shown in Figure 7 above, drift cell mapping completed by Coastal Geologic Services showed that while the drift serving the northern side of the tombolo is largely unimpaired, the southern, and much longer, drift cell has undergone a great deal of modification. As a result of bulkheading and other activities, historic sediment feeder bluffs have become locked off, reducing the sediment inputs necessary to maintain the tombolo. Process-based restoration such as this would be extremely beneficial to shoreline habitats all along the drift cell, but the large number of residences along this reach makes implementation unlikely and costly both in terms of political and monetary capital.

**Tombolo Restoration Alternatives Decision Matrix**

A final decision about a preferred alternative will be decided by the Kukutali Preserve Management Board and will be informed by a detailed engineering analysis performed during a future phase of the project. However, as an aid for evaluating conceptual alternatives, we have compiled a simple ranking of tombolo restoration concepts based upon effectiveness in achieving project goals and objectives. Ranking criteria are grouped into three broad categories: Habitat Process, Biological, and Social & Economic (Error! Reference source not found.).

**Table 1. Draft Ranking of conceptual alternatives for tombolo restoration.**

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Name</th>
<th>Drift Cell Process</th>
<th>Connectivity Between Habitats</th>
<th>Sediment Quality</th>
<th>Habitat Process</th>
<th>Biological</th>
<th>Social &amp; Economic</th>
<th>Total</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No Change</td>
<td>4</td>
<td>3</td>
<td>3.75</td>
<td>5</td>
<td>5</td>
<td>4.5</td>
<td>6</td>
<td>3.75</td>
</tr>
<tr>
<td>2</td>
<td>Small Opening with Bridge</td>
<td>6.5</td>
<td>7.5</td>
<td>6.5</td>
<td>7</td>
<td>7.5</td>
<td>7.5</td>
<td>5</td>
<td>5.5</td>
</tr>
<tr>
<td>2a</td>
<td>Small Opening with Driveable Ford</td>
<td>6.25</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6.5</td>
<td>6</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Large Opening with Bridge</td>
<td>7.75</td>
<td>9</td>
<td>8.5</td>
<td>8.5</td>
<td>8.5</td>
<td>8.5</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>3a</td>
<td>Large Opening with Driveable Ford</td>
<td>7.5</td>
<td>7.5</td>
<td>9</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
<td>6</td>
<td>5.5</td>
</tr>
<tr>
<td>4</td>
<td>Full Tombolo Restoration</td>
<td>7.5</td>
<td>9.5</td>
<td>9.5</td>
<td>8.5</td>
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<td>9.5</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Sediment Source Restoration</td>
<td>8.5</td>
<td>3</td>
<td>8.5</td>
<td>6.5</td>
<td>8.5</td>
<td>7.5</td>
<td>5.5</td>
<td>7</td>
</tr>
</tbody>
</table>

Scores assume a baseline function as rated in ‘No Change’ alternative. Higher scores reflect improvement in this parameter; lower scores reflect degradation. Potential scores range from 0 (poor/no function/high cost) to 10 (excellent/high function/low cost).

Drift Cell Process: functioning of sediment transport processes and pathways within identified drift cells.

Connectivity Between Habitats: quality/function of physical connection between adjacent subtidal, intertidal, and supratidal habitats.

Sediment Quality: compatibility of grain size distribution with habitat function.
Lagoon Restoration Alternatives

The restoration alternatives around the Kiket Lagoon are included here for purposes of completeness in reviewing the restoration alternatives recommended in the Skagit Chinook Recovery Plan (2005). However, due to landowner issues with the lagoon, these alternatives will be addressed in potential future projects if and when the landownership issues are resolved. Thus, a decision matrix for the lagoon restoration alternatives was not developed.

Figure 16. 2006 Washington Department of Ecology oblique photo, showing the Kukutali Preserve lagoon and tombolo.

Alternative 1: No Action

Lagoon Alternative 1 involves maintaining lagoon conditions in their present form (Figure 16 and Conceptual Design Drawings, Sheet 13). Currently, the site can be accessed by juvenile salmonids. Costs associated with this alternative would be minimal if any, and access to the unfilled portion of the historic site by juvenile Chinook and other salmon would likely persist. Drawbacks to this approach include reduced habitat capacity compared to historic conditions and reduced tidal prism, which can lead to reduced nutrient delivery, increased water temperatures, and have other negative effects.

Alternative 2: Historic Fill Removal

Removal of fill placed in the historic lagoon at the northern edge of the property would add 0.33 acres to the lagoons current area, greatly increasing habitat availability for juvenile Chinook and
other salmon, as well as for other native plant and animal species (Figure 17 and Conceptual Design Drawings, Sheet 14). Increased tidal prism would better help to maintain the outlet channel for the lagoon, potentially increasing the period of time at which it is accessible to juvenile salmonids. Currently, the lagoon is largely cut off from the adjacent nearshore during very low tides. The estimated volume for fill removal is 2,100 CY, and could be removed using tracked excavators and dump trucks. Costs associated with this work would be moderate relative to the habitat gains. If access via private property to the north of the lagoon cannot be secured, costs may be somewhat higher because access from the Preserve property by large equipment is more difficult at this part of the site. Although this site was likely filled without a permit during the late 60’s and early 70’s, it may be challenging to implement restoration here, as it will require a willing landowner.

In addition to fill excavation within the lagoon footprint, it should be further investigated whether the top elevation of the berm forming the lagoon is typical of other longshore lagoons in the area. Exhibit 6 in the BLM encroachment report discussed above notes that the lagoon was once diked off, with a road constructed along the top of it (BLM 2011). Fill from this road/dike may be persisting and limiting the development of a natural back beach on its landward side. The top elevation of the berm is very similar to the elevation of the current road across the tombolo, indicating that it might be artificially high.

Figure 17. Fill placed in the historic lagoon footprint. The southern edge of the area in red approximately follows the property line of the Kukutali Preserve, so all work would occur on the private property to the north.
Alternative 3: New Excavation

As an alternative to excavation on the private property to the north a similar sized excavation could be created within the Kukutali preserve property utilizing existing low areas adjacent to the lagoon (Figure 18 and Conceptual Design Drawings, Sheet 15). More study may be required for this alternative, for while it is not difficult to excavate in this location, it is unknown whether an excavation in this location would sustain itself over time. It is far from the inlet channel for the lagoon, and is protected by the inlet berm, so current velocities in this location may be low, leading to it filling in over time. If such an excavation did persist over time, it would achieve similar results to that of Alternative 2, though at the cost of estuarine emergent wetland in the excavation zone. Excavation volumes and costs would be similar or slightly lower than those for Alternative 2, because access for earthmoving equipment would be simplified. Little or no maintenance would be associated with this alternative.

![Figure 18. Potential area for new excavation to restore historic tidal prism to the site.](image)

Alternative 4: Watershed Hydrology Restoration

Lagoon Alternative 4 is focused on improving water quality for freshwater entering the site from adjacent uplands on Fidalgo Island (Figure 19 and Conceptual Design Drawings, Sheet 16). As described in previous sections, stormwater is currently routed south along Snee Oosh road to a
culvert where it crosses beneath the road and enters the Kukutali Preserve property just north of Kiket Island Road. From there it flows steeply along a narrow ditch until it enters the lagoon at its southeast corner. The relatively steep narrow ditch probably contributes sediment to the lagoon, along with pollutants picked up from Snee Oosh road and other sources. Restoration actions to improve water quality would involve treatment via a vegetated swale to increase biofiltration prior to reaching the lagoon. Additionally, the ditchline along Kiket Island Road could be regraded into more of a stepped pool/drop configuration, allowing sediment and heavy contaminants to settle out prior to reaching the lagoon.

As noted in the wetlands report for the site, the single largest impact to the palustrine scrub-shrub wetland is the caretaker’s residence located on the southern margin of the wetland, just north of Kiket Island Road. The residence was built on fill placed in the wetland, reducing its size and habitat quality. Removal of the house and associated fill would restore wetland buffering capacity as well as native palustrine habitat.

Figure 19. Current stormwater routing (blue) and the location of the caretaker’s residence.
REFERENCES


