Coastal Biota Survey of the Swinomish Tribal Community

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Abstract
The Coastal Biota Survey Project (CBS) consisted of a four-part project implemented in 1999 by the Swinomish Indian Tribal Community (SITC) and the United States Environmental Protection Agency (EPA) through the Tribal Environmental Assistance pilot project. CBS is an example of extensive and achievable research on a tribal reservation. Main objectives of the project were to map eelgrass beds, survey the intertidal biota, and establish tools for accurate tide level readings. The tidelands are a culturally important resource for the Swinomish people and require environmental management. The four components of CBS were: the eelgrass survey, the shellfish population survey, NASA over flight, and the tidal standards survey.

The eelgrass survey involved a reconnaissance-mapping project, a dive team survey of the mapped areas, and a density survey of eelgrass beds. The shellfish population survey consisted of sampling randomly selected species on commonly harvested Swinomish Indian Reservation (SIR) tidelands. The NASA over flight mapped vegetation using remote sensing and color infrared photos. Through the tidal standards survey permanent benchmarks were established on the Reservation tidelands.

The eelgrass survey mapping was successful and provided baseline population/density amounts used for processing the remote sensing maps. The shellfish survey provided valuable population parameters. The NASA over flight has produced infrared photos, but remote sensing results remain unprocessed. Tidal elevation standards have been established as a result of successful permanent bench marker placing.

Introduction
The Swinomish Indian Tribal Community (SITC), a Federally Recognized Tribe, is located near LaConner, WA (Figure 1). A project was initiated between SITC and the U.S. Environmental Protection Agency (EPA) in 1999 when three project opportunities were identified that coincided with the Swinomish Tribe's goals and with the EPA's ability to provide assistance under the Tribal Environmental Assistance (TEA) pilot project. The projects identified were: modeling marine water circulation; mapping eelgrass and kelp beds; and surveying intertidal biota including aquatic vegetation, shellfish, and other macroinvertebrates. Also, a funding contract was set up to establish tidal elevations around the Reservation as part of this project. The following four projects dealing with Eelgrass Surveying, Shellfish Surveying, a NASA overflight for map and vegetation zoning production, and elevation establishment were the resulting projects from the original identified opportunities.

1. Eelgrass Survey
Eelgrass (*Zostera marina*) is an important constituent of intertidal and subtidal marine waters where its primary roles are: stabilizing bottom sediments; providing substrate and cover for bottom organisms; providing a surface for forage fish eggs; and as a food source for many animals ranging from detritivores to waterfowl. Surveying eelgrass was chosen as the TEA project to implement in 1999. Duane Karna was assigned project lead at EPA and responsible for coordinating the actual eelgrass survey. Discussions between Swinomish Indian Tribal Community (SITC) staff and Karna established a project outline that included assessing the size and location of eelgrass and kelp beds. The Eelgrass was to be accomplished by: reconnaissance land mapping; dive team surveys; density field surveys; and remote sensing which would utilize aerial photographs flown at an extreme low water tide.

The first phase of the Eelgrass was reconnaissance land mapping. This mapping was completed on the Reservation's western intertidal area by Aundrea Noffke and Duane Karna in July 1999. The approximate overall length of the Reservation's western shore is nearly six miles. The west shore was defined as three units: the north beach (from Turners Bay south to Kiket Island), the middle beach (from Kiket Island south to Snee-oosh Point), and the west beach (a large triangular-shaped area from south of Snee-oosh Point to the south entrance of the Swinomish Channel). The eastern shore along the Swinomish Channel from Padilla Bay to Skagit Bay was called the eastern beach. This mapping provided a base map of areas that would later be surveyed by the dive team and density field crew (Figure 2).

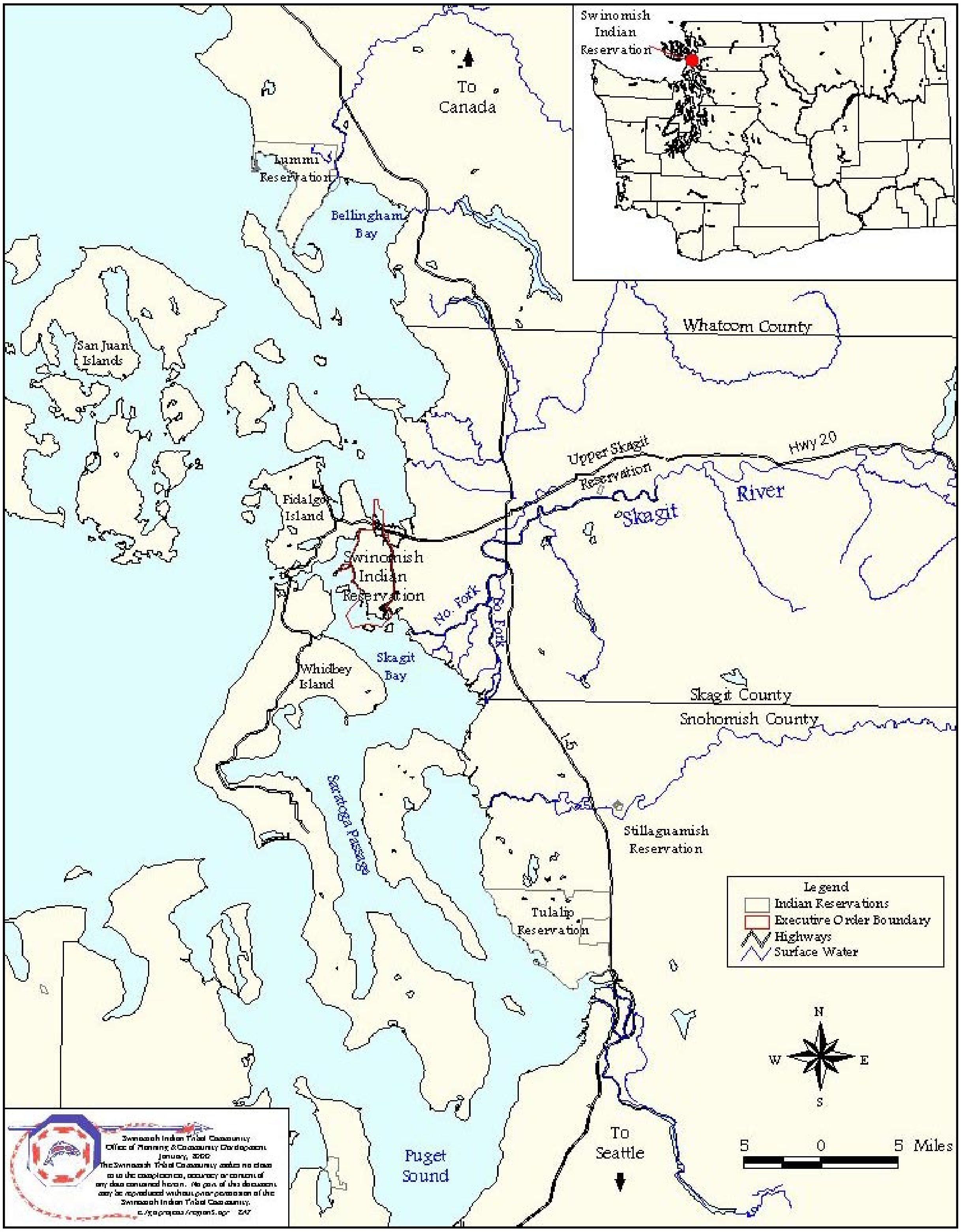

Figure 1. Regional location map.

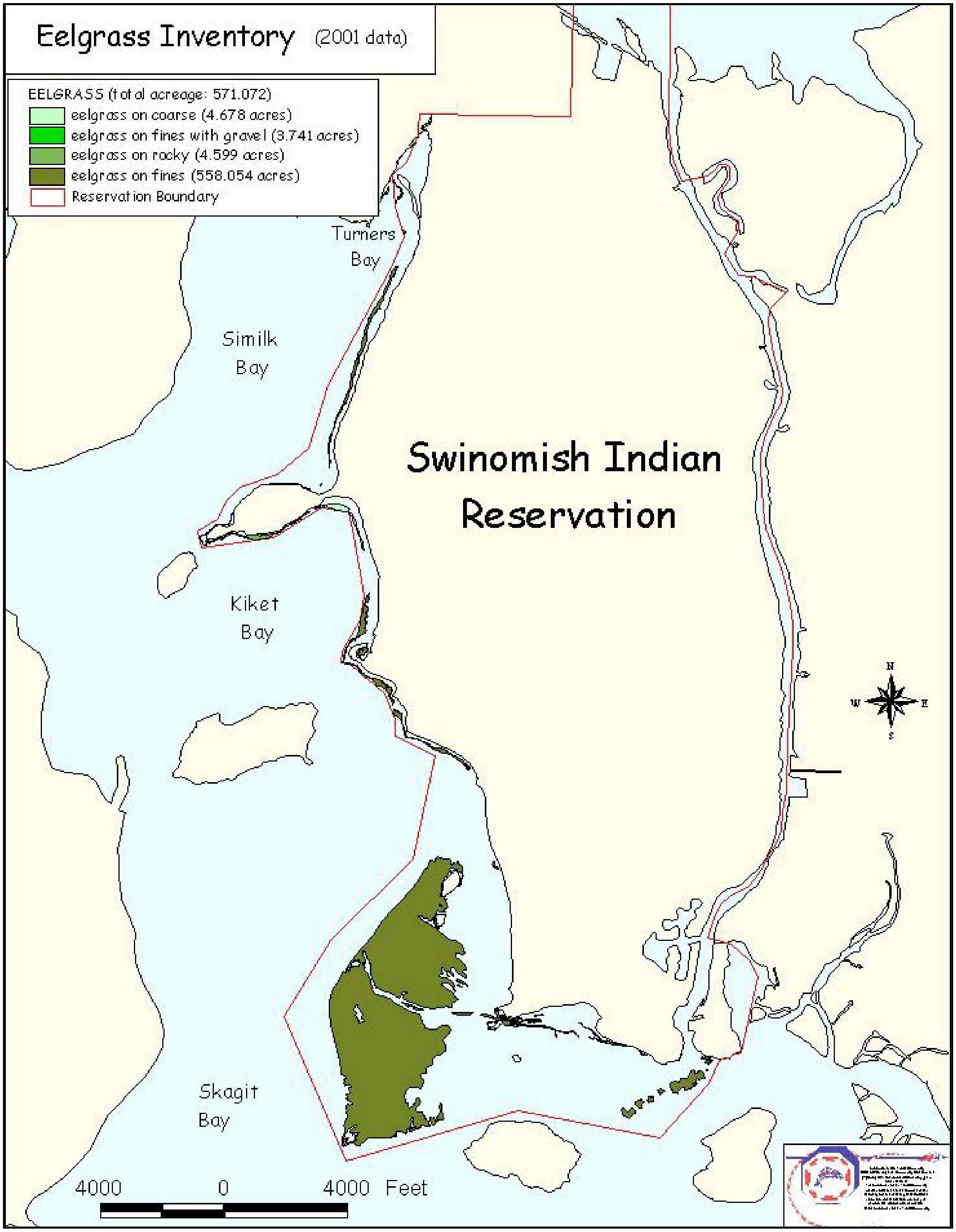

Figure 2. Eelgrass Inventory Map.

The second phase of the Eelgrass Project was a dive-team survey. Karna was able to arrange two days of dive-team time in June 2000. However, their work was unsuccessful because the equipment they were using was not suitable for the environment. In lieu of mapping sub-tidal and intertidal beds with dive teams, it was decided that aerial photos would provide ample data for the project. No further dive-team surveys were planned since it was thought that the aerial photo would work well for mapping the sub-tidal beds as well and intertidal beds.

The third phase of the Eelgrass Project was a density field survey. The purpose of the survey was to determine baseline conditions for any future monitoring of eelgrass beds and establish ground truth sites for the later remote sensing map. The methods used in the survey were based on those outlined in Eelgrass Surveys in Eagle Harbor (Duncan and Karna 1996). In July 2000, four crews of at least two people per crew surveyed each beach (north, middle, west, and east) with one separate crewmember occupying a GPS base station for the duration of the survey day. Each survey crew used a GPS unit to map the position of each density survey and a 0.25m^2 grid (50x50cm square gridded in 10cm intervals) was used to estimate density. The density estimation included the percentage of eelgrass, other vegetation, and/or bare patches measured in the quadrant as well as a total visual estimation. A basic sketch map of each survey location was produced. The results are listed in Table 1. This and future eelgrass surveys can be used to document any changes in mean eelgrass density in the eelgrass beds.

Table 1. Swinomish Eelgrass Density Survey, % coverage in 0.25m^{2}quads.

Station	Eelgrass Est.	Eelgrass Meas.	Other Vegetation Measured	Bare Areas Measured
N1	97	92	4	4
N2	65	68	0	32
N3	92	88	12	0
N4	60	56	0	44
N5	75	80	0	20
N6	80	60	0	40
N7	60	60	28	12
M1	60	60	0	40
M2	70	76	0	30
M3	45	45	0	52
M4	20	24	60	16
M5	15	28	72	0
W1	70	68	0	32
W2	95	96	4	0
W3	75	76	0	24
W4	55	52	0	48
E1	75	68	0	32
E2	65	72	8	20
E3	80	84	0	16
E6	90	88	0	12
E7	40	60	20	20

The fourth phase of the Eelgrass Project is remote sensing and mapping of eelgrass using aerial photographs. This part of the project is being carried out by NASA Dryden using the NASA overflight scan (TM-MSS) and incorporating the density survey girds. The post-processing method on the overflight scan data will produce geographic information system (GIS) shape files for all types of vegetation reservation wide including: eelgrass and other vegetation in the tidelands; and vegetation in the uplands needed for our groundwater modeling project. Final work on field verification and ground truthing of classification types will be completed this summer. Please see *Section 3* for information on the NASA overflight.

2. Shellfish Surveys

The shellfish survey of the Swinomish beaches is used to determine baseline conditions of shellfish populations. Using a systematic approach to sample and collect data, the survey will accurately predict the size and status of the shellfish population on a particular beach. The resulting data can be used to determine mean clam density, productive beach area, relative dispersion, and size distribution of shellfish. Several methods can then be applied to predict a sustainable harvest for each beach. Then, taking into account the predictable sustainable harvest and potential harvest effort by tribal members, resource management can be applied. The shellfish survey was conducted in June 2000 by planning staff and contracted field technicians. The methods used were based on those of Fyfe (1996) using 1-square-foot test holes on a 50-foot grid. Turners Bay and Lone Tree Point were the shellfish areas surveyed. Eleven and 12 transects were plotted in Turners Bay and Lone Tree Point, respectively, with 6 to 8 sampling/digging sites per transect. More than 1100 clams were collected and placed in cold storage. Contract technicians recorded clam weight and length in July 2000. A data quality assessment of the recorded data was initiated in December 2000. However, some sample bags were not intact, some were missing, and the cold storage had experienced a major power outage. Although not accurate in assigning values for density per beach and therefore making specific beach clam trends invalid, the clam weight and length data was still useful. Analysis of the recorded data resulted in the creation of a shellfish survey trend line of clam length versus weight chart for each species of clam. This established a method by which only the length of clam needed to be measured in future surveys.

The Shellfish Survey Project was conducted again in the summer of 2002 (May- July). Two hundred one dig sites were dug at Lone Tree Point and 93 sites at Turners Bay with a total of 1244 clams collected. Clam length was recorded by contracted technicians and, together with the shellfish survey trend line and GPS data, clam density (g/acre) was determined for each beach for each species (Table 2).

Table 2. Clam Density Data.

Lone Tree Point	Butter Clams	Native Little Neck Clams
total weight (g)	41554.6	1679.5
average weight (g)	101.35	27.5
total number clams	410	61
total area (acres)	11.45	11.45
density (g/acre^2)	3629.2	146.7

Turners Bay	Butter Clams	Native Little Neck Clams
total weight (g)	10635.7	15394.9
average weight (g)	158.7	48
total number clams	67	321
total area (acres)	4.8	4.8
density (g/acre^2)	2215.7	3207.3

3. NASA Overflight—Aerial Photos

As part of the Eelgrass Survey Project, aerial photography remote sensing (digital) techniques will be used to map vegetation. The project selected the following required products: aerial infrared photographs flown during a very low tide, an orthorectified image of the photographs (orthophoto), a digital elevation map (DEM), and a vegetation map.

Early in the project, EPA identified aerial photography assistance from NASA for remote sensing imagery. SITC pursued this lead for obtaining for the aerial imagery necessary for the project. Initially, NASA determined they could provide color infrared photographs, multispectral scanner (MSS) digital data [which simulates Thematic Mapper (T M) MSS of Landsat satellites] with 5-meter resolution, and digital processing, which included orthorectification of the photos with 6-inch to 1-foot resolution. Later on, however, NASA was not able to provide post-processing, and the TM-MSS data of the flight has not been released yet to SITC. As of April 2003, NASA has once again agreed to process the data. This project is being undertaken at NASA Dryden.

NASA's first availability for the aerial flight was the summer of 2000. A low tide series of –3.4' to –3.5' MLLW from July 1-3 was chosen as the primary date, with a back-up flight for the next low tide series of –2.9' MLLW on July 29-30. The flight was flown on July 30 due to cloudy skies during the primary date. In preparation of the aerial flight, a ground crew installed control points on the ground and located the points with mapping-grade GPS units (GeoExplorer) from EPA. Since NASA was using high accuracy positional equipment on the airplane, only 2 points per flight line were needed. The control points were large Xs painted on the ground, one on each end of the flight lines. Given 4 primary flight lines, a total of 8 points were located on the eservation. The 4 flight lines were flown north/south at 6000' altitude to cover the entire eservation. Additional passes were made NE/SW at 6000' and N/S at 3000'. Diapositives of the photographs and flight navigational information of the flight were provided to SITC from NASA as a final product.

The next step in processing the aerial photographs was orthorectification. Triathlon Inc. was chosen as the contractor. Procedures that comprise the orthorectification process include digital elevation map (DEM) processing and rectification. DEM processing includes the collection of elevation data using stereo photography. This elevation data is compared to control points measured during the flight. The rectification process calculates the true geographic position of each pixel within the scanned image (photograph). Correcting for the flight characteristics (altitude, pitch, yaw, roll) of the airplane and camera characteristics, the unrectified image is registered to the surface of the earth using a series of orientations. The digital orthophoto is created by combining the orientation data and DEM for each photograph. The complete series of photographs are mosaicked to produce one large seamless image that is then cut into tiles. So far, the digital orthophoto and DEM have been received and heavily used.

The final product for the project will be the creation of a vegetation map. A process using the Thematic Mapper Multispectral Scan (TM-MSS) data will be able to interpret the vegetation present in the tidelands and uplands. A contact at EPA is waiting for approval/funding in order to carry out this portion of the mapping. Currently, NASA Dryden is processing the file and establishing vegetation categories for use in upland vegetation characterization.

4. Tidal Project—Tidal Bench Marks, Tide Gauges and Tide Staffs

This part of the Eelgrass Survey provided accurate vertical elevations in the vicinity of surveyed tidelands. The first phase was the installation of permanent benchmarks with their vertical elevation given in the two standard vertical datums [North American Vertical Datum of 1988 (NAVD88) and Mean Lower Low Water (MLLW)] where possible. [Note: NAVD88 is a North American wide fixed datum, whereas MLLW is a local datum that varies from locale to locale.] The second phase used tide gauges to determine the relationship of NAV88 and MLLW at the new SITC benchmarks that are too remote from previously established benchmarks to determine the datum relationship. The third phase will establish permanent tide staffs in the vicinity of the new benchmarks to provide surveyors an accurate visual determination of the current tidal level. The first phase of the Tidal Project was completed in 1999. The contractor, Reid Middleton, Inc, placed four permanent benchmarks on the . The benchmarks are brass caps embedded in concrete, strategically located under the direction of Aundrea Noffke. The benchmarks are now known as: "Longhouse" near the planning office (Figure 3); "Train Bridge" near the Casino; "Lone Tree" at Lone Tree Point; and "Turner Spit" in Turners Bay. North American Vertical Datum of 1988 (NAVD88) and Mean Lower Low Water (MLLW) elevations were determined for "Longhouse" and "Train Bridge" by differential leveling from nearby benchmarks. NAVD88 elevations were determined for "LoneTree" and "Turner Spit" using a network of GPS stations either occupying known benchmarks or differentially leveled to nearby locations of known benchmarks. MLLW was not determined for "LoneTree" or "Turner Spit" given their remote locations from known benchmarks. All four benchmarks are certified within accuracy of +-0.1 feet (Table 3).

Table 3. SITC Benchmarks.

Benchmark Stamping	Elevation (Ft) (NAVD88)	Elevation (Ft) (MLLW)
SITC LONGHOUSE	14.2	15.9*
SITC TRAINBRIDGE	12.3	13.1*
SITC LONE TREE	20.3	*22.4***
SITC TURNER SPIT	11.1	*12.8***
	**R. Middleton*	*** NOS*

Figure 3. Longhouse benchmark.

The second phase of the Tidal Project was completed in 2000. Under contract with the US Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Center for Operational Oceanographic Products and Services (USDOC, NOAA, NOS, CO-OPS), NOS installed two real-time tide level gauges in the vicinities of the SITC Lone Tree and Turner Spit benchmarks in order to determine the MLLW elevation of these benchmarks. To insure the accuracy and stability of the gauge over the course of monitoring, four new benchmarks were installed by NOS in the vicinity of each tide gauge (8 new benchmarks in all).

The NAVD88 elevations of the NOS benchmarks were determined by using the nearby SITC benchmark as the initial reference. These NOS benchmarks were used as reference points to insure the tide gauge remained perfectly stationary during the 90-day monitoring period. The eight NOS benchmarks were installed in early May 2000. The tide gauges were installed at the Turners Bay entrance on the Culbertson's , and at Snee-oosh Point under the deck of the Hope Island Inn. The tide gauges collected data from June 1 to August 29, 2000 and recorded 174 high tides and 173 lows at Turners Bay and 172 highs and 171 lows at Snee-oosh Point. A final report was issued for each location by NOS / CO-OPS and includes the benchmark elevation in Mean Lower Low Water (MLLW) (Table 4). At the new SITC benchmarks, MLLW is below the NAVD88 zero elevation ranging from -0.8' to –2.1' NAVD88. Since the establishment of these original benchmarks, 4 new benchmarks have been established by SITC at commonly used beaches in order to aid in further nearshore study (Table 5).

Table 4. SITC & NOS Benchmarks.

Benchmark Designation	Elevation (m) (NAVD88)	Elevation (m) (MLLW)
SITC NAVD88 TURNERSPIT	3.383 (11.1 ft)	3.888 (12.8 ft)
8657 A 2000		4.329
8657 B 2000		4.679
8657 C 2000		5.614
8657 D 2000		6.303
SITC NAVD88 LONETREE	6.187 (20.3 ft)	6.837 (22.4 ft)
8576 A 2000		3.304
8576 A 2000		3.092
8576 A 2000		3.127
8576 A 2000		4.038

The third phase of the Tidal Project has been deemed unnecessary. Four (4) permanent tide staffs were originally planned to be installed in the vicinities of the new benchmarks to be used as reference points. The tide staffs are 7" wide and 5' long with numbered increments of 1' and 0.1" tick marks. Each staff is 4 sections long and range from –4' to +15' with 0' aligned with 0' NAVD88. Elissa Fjellman, Todd Mitchell, and Sue Moreno surveyed and installed the 2 lower sections of a tide staff on the pier by the planning office that is visible from the office's windows. 0' for this tide staff was aligned with 0' MLLW since MLLW is the standard tidal datum used on tidal charts and will facilitate easier planning of the Water Program's marine activities. The tide staffs were deemed unnecessary after the addition of a transept and stadiarod to the programs equipment and will not be installed at the other planned locations.

Table 5. SITC Additional Benchmarks.

Benchmark Designation	Elevation (Ft) Above (NAVD88)	Elevation (M) above (NAVD88)
SKA2-001	12.66	3.858
SKA2-002	12.15	3.703
LTP-001	10.35	3.154
SB.S-1	12.70	3.870

Works Cited

Duncan, B. and Karna, D., 1996, Eelgrass Surveys in Eagle Harbor, WA, following capping of adjacent contaminated sediments, US EPA, Region 10, Seattle, WA.

Fyfe, D, 1996, Surveying Intertidal Clam Populations and Assigning an Annual Harvestable Biomass, Northwest Indian Fisheries Commission.