Year 1 (2002) Monitoring Report for Commencement Bay Habitat Restoration Sites

Prepared for the

Commencement Bay
Natural Resource Damage Assessment
and Restoration Trustees

YEAR 1 (2002) MONITORING REPORT
FOR COMMENCEMENT BAY HABITAT RESTORATION SITES

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Commencement Bay
Natural Resource Damage Assessment and Restoration Trustees

Prepared by

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and
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LIST OF ACRONYMS AND ABBREVIATIONS

BSC	biological success criterion
CHB	Citizens for a Healthy Bay
MHHW	mean higher high water
MHW	mean high water
MLLW	mean lower low water
MLW	mean low water
msl	mean sea level
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PSC	physical success criterion
sp.	species
USGS	U.S. Geological Survey

EXECUTIVE SUMMARY

Under the direction of the National Oceanic and Atmospheric Administration (NOAA), Ridolfi Inc. conducted year 1 (2002) monitoring activities at several habitat restoration sites on Commencement Bay, in Tacoma, Washington. NOAA is the lead agency of the Commencement Bay Natural Resources Trustees (Trustees) and is responsible for managing the restoration projects the Commencement Bay Natural Resource Damage Assessment and Restoration program.

The Trustees prepared a Restoration Monitoring Plan for Commencement Bay, in which they identified several objectives:

- To measure the success of the restoration efforts;
- To identify adaptive management efforts if projects are unsuccessful;
- To address monitoring requirements specified by permitting agencies; and
- To serve as an outreach tool to disseminate project information to interested parties.

The year 1 (2002) monitoring effort took place at eight restoration sites around Commencement Bay: Mowitch, Squally Beach, Skookum Wulge, and Yowkwala along the Hylebos Waterway and the eastern edge of Commencement Bay; Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), and Olympic View along the Middle Waterway; and Tahoma Salt Marsh, along the western edge of Commencement Bay.

Four physical success criteria and nine biological success criteria were monitored in various combinations at the different sites to evaluate:

- Physical stability – Intertidal areal coverage, intertidal stability, tidal circulation, and elevation and channel morphology;
- Marsh development – Areal coverage, species composition, plant vigor, and herbivory avoidance;
- Riparian vegetation – Survival and areal coverage;
- Fish access and presence;
- Invertebrate prey resource production; and

- Bird use.

The monitoring program was most comprehensive at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites, and included only a reduced number of parameters at the other sites. Fish access and presence was monitored at all sites by the National Marine Fisheries Service.

Overall results indicate that the restoration efforts are on a positive trajectory. Riparian and marsh plant communities are developing at sites where the plants were installed. The sites are relatively stable, suggesting that appropriate hydrological conditions, as controlled by the tides, should continue into the future. Possible actions suggested for adaptive management include:

- Mowitch: In-fill planting in the marsh areas.

- Squally Beach: Placing a small quantity of cobbles to fill a small erosion rill; re-directing the water across the marsh bench to the west of the eastern rock box to create a longer, slower flow path; placement of cobbles in the space that has developed on the landward side of several toe logs; and maintaining or supplementing the purple martin boxes located on pilings adjacent to the site.

- Middle Waterway (Simpson/Trustees): Evaluate control options for erosion on the northeastern portion of site that may be associated with re-directed wave energy from logs placed to protect nearby marsh vegetation; in-fill planting in the marsh areas; testing the soils to evaluate the need for soil amendments; and installation of additional goose exclusion devices for any new planting.

- Yowkwala and Skookum Wulge: Protect these sites and other similar areas to provide suitable habitat.

- General: Routine maintenance of the herbivory/goose exclusion devices; surveying of such devices; control of weedy species; routine maintenance and inspection of irrigation systems.

1.0 INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) issued Task Order No. 56ABNF-2-00028 under Contract 50ABNF-2-00013 to Ridolfi Inc. (Ridolfi) to conduct year 1 monitoring activities at several habitat restoration sites on Commencement Bay, in Tacoma, Washington (Figure 1-1). NOAA is the lead agency of the Commencement Bay Natural Resources Trustees[1] (Trustees) and is responsible for managing the restoration projects of the Commencement Bay Natural Resource Damage Assessment and Restoration program.

The Trustees prepared a Restoration Monitoring Plan for Commencement Bay (Trustees, 2000). The Trustees' planning document identified several objectives of the monitoring program.

- To measure the success of the restoration efforts;
- To identify adaptive management efforts if projects are unsuccessful;
- To address monitoring requirements specified by permitting agencies; and
- To serve as an outreach tool to disseminate project information to interested parties.

This report describes the monitoring activities, presents the results of the field work and identifies lessons learned from the monitoring work. Ridolfi personnel, with support from Adolfson Associates, Inc. (Adolfson) and volunteers from Citizens for a Healthy Bay (CHB), collected most of the monitoring data. National Marine Fisheries Service (NMFS) staff monitored fish at sites in Commencement Bay, assisted by Ridolfi, Adolfson and CHB personnel during some of the events. Ridolfi and Adolfson prepared a work plan to guide the physical and biological monitoring activities (Ridolfi and Adolfson, 2001). NMFS prepared a work plan for the fish-monitoring task (Rice et al., 2002).

[1] Commencement Bay Natural Resource Trustees consist of the following entities: National Oceanic and Atmospheric Administration; U.S. Fish and Wildlife Service; Washington State Department of Ecology; Washington State Department of Fish and Wildlife; Washington State Department of Natural Resources; Puyallup Tribe of Indians and Muckleshoot Indian Tribe.

1.1 Site Descriptions

The restoration sites discussed in this report are briefly described below.

1.1.1 Mowitch

The Mowitch site, previously known as the Wasser/Winter site or Hylebos Estuary site, is located on land owned by the Port of Tacoma at the junction of Hylebos Creek and the southeast end of the highly industrialized Hylebos Waterway (Figure 1-2). The site covers approximately 2.3 acres and includes Hylebos Creek and an adjacent strip approximately 100 feet (30 m) wide and 1,000 feet (300 m) in length immediately northwest of the creek. The site is bounded on the south by the centerline of the Hylebos Creek; on the west by a railroad right-of-way adjacent to Marine View Drive; on the north by an 8-foot-high cedar fence; and on the west by the pier headline at the southeast end of the Upper Hylebos Waterway turning basin.

The elevation of the upland portion of the site is approximately 6 to 12 feet above mean sea level (msl) or 12 to 18 feet above mean lower low water (MLLW). The site includes the north half of Hylebos Creek, which prior to restoration passed through the site in a straight, deep, steep-banked channel. The site sloped slightly toward the creek and the Hylebos Waterway, and included a log ramp at the northwest end of the site. From June through October of 2000, a restoration effort was conducted under the direction of NOAA for the Trustees.

Three backwater pools with base elevations near mean low water (MLW) were sculpted from the existing upland buffer area. A secondary stream mouth was added in the area of the site that was an historical log ramp. The backwater areas are flooded twice each day. The pools and adjacent terraces include horizontal logs as habitat features. In addition, the area between the pools was regraded to an elevation between mean high water (MHW) and mean higher high water (MHHW) (10.96 to 11.84 on a MLLW datum). A buffer of 25 feet next to the fence remained vegetated. Large woody debris was placed, and the upland areas of the site (elevation above 14 feet MLLW) were hydroseeded with a mix of native grasses and forbs.

Native plants, shrubs, and trees were planted by volunteers in the fall of 2000 and spring of 2001. Table 1-1 lists the species that were planted at the Mowitch site.

1.1.2 Squally Beach

The Squally Beach site, previously known as the Puyallup Tribal Nursery site or the Puyallup Tribal Conservancy and the Inner Hylebos site, is located along the northern shoreline of the Hylebos Waterway, south of Marine View Drive and immediately west of East 11th Street (Figure 1-2). The project site consists of approximately 0.66 acres of uplands bordering an extensive area of intertidal mudflats immediately west of the site. The Squally Beach site is situated adjacent to the largest area of original mudflats in Commencement Bay. The site contains salt marshes and low-gradient mudflats that provide habitat for benthic organisms important to the food chain. These organisms are of particular importance to shorebirds and juvenile salmon.

Prior to restoration, the Squally Beach site contained some hardwood trees, blackberry bushes, and a strip of intertidal marsh vegetation approximately 3 to 4 feet wide growing at approximately MHHW elevation. The upland portion of the site was covered with blackberry bushes and other invasive plants and was used as a dump site. The site contained several pilings, logs, and downed wood, indicative of previous log storage activities in the vicinity. The design was consistent with the overall objective for the Hylebos Waterway of increasing the sinuosity of the shoreline and increasing the area and quality of the intertidal habitat. The design phase was completed in late 1999, construction was completed in fall of 2000, and vegetation planting of the upland site took place in fall 2000 and spring 2001.

The project involved excavating about 2,000 cubic yards of material, grading an area north of the existing vegetation line, and planting intertidal vegetation. Runoff from the hillside on the north side of Marine View Drive, which forms the eastern project boundary, was intercepted and routed through the project site in a dendritic channel pattern. Freshwater inputs were used to lower salinity and encourage growth of saltwater marsh species that tolerate brackish

conditions. The site was hydroseeded with a mix of native species, and native plants, shrubs, and trees were hand-planted by volunteers (Table 1-1).

1.1.3 Middle Waterway (Simpson/Trustees)

The Middle Waterway (Simpson/Trustees) site is a 3.3-acre nearshore area, on property owned by Simpson Tacoma Land Company (Simpson) and situated in a highly industrialized area in Commencement Bay, at the southeast end of the Middle Waterway (Figure 1-2). The project is located in proximity, and functionally related to, the intertidal habitat constructed in 1988 as part of the St. Paul Waterway Area Remedial Action and Habitat Restoration Project conducted by Simpson and Champion at the north end of the Tacoma Kraft mill, as well as other intertidal and subtidal areas near the Puyallup River delta. Under the St. Paul Waterway Natural Resource Damage settlement agreement, Simpson and Champion International Corporation (Champion) (now International Paper Company) funded the completion of the Middle Waterway Shore Restoration Project. The Project was selected and proposed by a project planning group consisting of Simpson, Champion, the Trustees , and other cooperating federal and state agencies.

The primary objective of the project was to provide estuarine habitat, in perpetuity, that is adjacent to one of the largest remaining areas of original Commencement Bay intertidal mudflat. Under the original settlement agreement, monitoring at the site was initiated in 1994, prior to site construction, and continued through the summer of 2000. Site construction was initiated in early 1995 and planting was undertaken between October 1995 and May 1996. In the summer of 1999, the Trustees assumed management responsibilities for the site and, in the fall, conducted additional adaptive management activities to promote the establishment of intertidal vegetation by regarding a portion of the site and by organic soil amendment, followed by supplemental planting in the spring of 2000.

Lower elevations at the site are functioning as mudflat habitats with patchy but extensive cover of microalgae, macroalgae, and a few species of vascular plants. These species generate primary production and organic matter (detritus) that are consumed by bacteria and primary

consumers (herbivores and detritivores) which, in turn, provide food for secondary consumers such as benthic invertebrates, juvenile salmon, flatfish, and shorebirds. Buffer and riparian vegetation planted at the site is surviving but physical and biological stresses including high salinity, sandy soils, wave action, and herbivory by geese have hampered the establishment of mid- and upper-intertidal vegetation. Adaptive management measures have been undertaken by the Trustees to ameliorate some of these stresses.

1.1.4 Middle Waterway (City of Tacoma)

As part of the settlement with the City of Tacoma, the City developed an estuarine shoreline wetland restoration project on the Middle Waterway within the City of Tacoma and Commencement Bay. Excavation and re-grading of the 1.85-acre vacant upland property, located adjacent to and within the southwest shore of the Waterway, created an intertidal marsh and riparian buffer bordering one of the few remaining original mudflats within Commencement Bay. The project objectives were to create new habitat, enhance existing habitat, provide buffers for both the new and existing habitat, and provide public access for education and passive recreation. The project goal is to establish estuarine marsh habitat for an assemblage of wetland dependent marine, bird and plant species. The project is across the head of Middle Waterway from and complements the Middle Waterway (Simpson/Trustees) site.

The site is composed of three adjacent parcels, designated as the City parcel, the DNR parcel, and the 11th Street right-of-way.

1.1.5 Skookum Wulge

The Skookum Wulge site, formerly known as the Meeker site, is located on a parcel owned by the Puyallup Tribe just outside of the mouth of the Hylebos Waterway (Figure 1-2). The site covers less than one acre and is bounded by Marine View Drive to the northeast, and residential properties to the southeast and northwest. Across Marine View Drive is a steep undeveloped wooded slope rising to approximately 400 feet above msl. The site was reportedly occupied by a residential structure until the mid-1930s. At that time, a landslide from the steep hillside

adjacent to Marine View Drive swept the structure into Commencement Bay and the site has been undeveloped since that time.

The site slopes gently from Marine View Drive towards Commencement Bay. A low, steep erosional bluff, approximately 2 to 4 feet (0.6 to 1.2 m) high, separates the upland portion of the site from the beach below. The upland area is semi-circular in shape and protrudes approximately 100 feet (30 m) towards the southwest into Commencement Bay. The landform is apparently the remnant of the landslide. The steep face at the edge of the upland area seemingly indicates that wave action is eroding the face and cutting back towards Marine View Drive.

The beach below the upland bluff is composed of gravel and cobble-sized materials that are similar to materials present in the exposed bluff. The beach grades uniformly towards the benthic environment in a radial pattern that is consistent with erosion from a relatively recent landslide. The beach slopes at approximately 10 to 12 percent away from the bluff.

In 1999, the Trustees evaluated restoration alternatives for the Skookum Wulge site and decided that site conditions made the "no-action" alternative preferable.

1.1.6 Yowkwala

The Yowkwala site, approximately 15 acres in size, is located between the Tyee Marina and Browns Point (Figure 1-2). A beach cleanup was conducted in March 2000.

The beach cleanup restoration involved demolishing and disposing of two derelict wooden barges stranded on the shoreline of the property, and removing from the site the debris from one former drydock and a sunken concrete float. The barges were demolished on site using minimal construction equipment, then hauled away using an existing access road. The majority of the wood debris was chipped and recycled rather than transported to a landfill. The demolition of the barges occurred at low tide to minimize any risks or impacts to the marine environment.

1.1.7 Olympic View

The Olympic View project included the acquisition by the City of Tacoma of 0.7 acres of upland and intertidal property bordering the 11.7 acres of state-owned adjacent aquatic lands lease site (Figure 1-2). The lease precludes use of the eelgrass areas by incompatible commercial or industrial activities. A portion of one of the buildings owned by the defunct Puget Sound Plywood Company, extending over private and state-owned intertidal lands, was removed to allow the re-establishment of a productive community of tidal species. In June through September 2002, concrete and wood pilings were removed, and contaminated sediments were excavated before backfilling with clean materials. The project goal is to protect and enhance nearshore eelgrass and intertidal habitat for an assemblage of aquatic species, in a manner consistent with low-impact public use and enjoyment of a shoreline and water areas.

Through the remedial process, the U.S. Environmental Protection Agency managed the in-water work, which included the removal of dioxin-contaminated sediments and backfilling with clean sediments. The pilings were removed and the site prepared for the implementation of restoration activities, including softening the shoreline to enhance the intertidal habitat and to create a riparian buffer.

1.1.8 Tahoma Salt Marsh

The City plans to conduct a salt marsh wetland restoration project at the Tahoma Salt Marsh site on the Ruston Way shoreline within the City of Tacoma and Commencement Bay (Figure 1-2). The project will include excavation or regrading of 1.95 acres and the planting of native marsh and riparian vegetation. A tidal channel will be excavated to connect the newly created marsh and the restored beach to permit tidal inundation of the marsh. The project goal is to establish salt marsh and mudflat habitat to provide nesting, refuge, and feeding opportunities for a variety of fish and waterfowl species. Construction of this project is scheduled for 2003. Cement slabs along the shoreline are slated for replacement with smaller "fish friendly fix mix" substrate, a smaller size cobble rock. The dirt and gravel parking lot will become a salt marsh.

2.0 DESCRIPTION OF FIELD ACTIVITIES

This section describes the procedures used to evaluate the restoration sites. The fieldwork was performed according to the schedule outlined in the Work Plan for the project (Ridolfi and Adolfson, 2001). Table 2-1 summarizes the monitoring that was conducted at each site during year 1. The remainder of this section describes the field work that was conducted for each monitoring task.

2.1 Physical Success Criterion 1 – Intertidal Areal Coverage

INTERTIDAL AREAL COVERAGE. *The total restored area between an elevation of +12 ft. NOS MLLW and –2 ft. MLLW will be at least 90% of the target intertidal elevation.*

Intertidal area is an important measure of available habitat at restoration sites. In many of the sites in Commencement Bay, one of the project goals is to increase the intertidal area. As used in this report, intertidal area is defined as the area between the –2 feet and +12 feet contours, measured in acres or other appropriate units. The vertical datum for the project is MLLW as reported by the U.S. Army Corps of Engineers. Ridolfi used a Nikon DTM-521 total station instrument to measure the coordinates of the upper and lower edges of the intertidal zone at each site. The general procedure was to establish survey control at a site and shoot along each contour at approximately 20-foot intervals.

Because the lower edge of the intertidal zone did not exist or was inaccessible at most sites, an arbitrary lower contour was selected at the edge of the restored area. Similarly, lateral boundaries were often undefined, so the field crew selected and noted an endpoint for the contours. At the Skookum Wulge site, none of the endpoints were obvious or particularly relevant. Additionally, the site was not actively restored because of its small size. For these

reasons, surveying at Skookum Wulge was limited to surveying the upper and lower edges of the actively eroding bluff.

The total station has a horizontal and vertical accuracy of approximately one centimeter (cm) at the scale of the work described in this report. Coordinates were measured along contours at approximately 20-foot intervals. The total intertidal acreage area between –2 ft. MLLW and +12 ft. MLLW was calculated using the survey information, with Autodesk's AutoCAD Land Development Desktop software.

2.2 Physical Success Criterion 2 – Intertidal Stability

INTERTIDAL STABILITY. *The as-designed contour elevations, especially for intertidal plant introductions, will be +/- 0.5 ft. of the elevations specified in the construction plan. 75% of the target elevations will be maintained through Year 5.*

This criterion focuses on potential changes at sites in the elevation band where most marsh vegetation grows. This band is in the upper tidal ranges near and above the MHW line. The MHW line and other important tidal datums in Commencement Bay are shown in Table 2-2. To evaluate physical success criterion 2, the location of contours at specified elevations were measured at each site. The total station instrument was used to obtain horizontal coordinates of the +8, +10, +12, and +13.5 ft. MLLW contours at approximately at 20-foot intervals. In addition, the total station was used to measure coordinates along the transects employed for the Biological Monitoring Criteria 2 and 5.

2.3 Physical Success Criterion 3 – Tidal Circulation

TIDAL CIRCULATION. *The tidal amplitude, as determined by both timing and elevation of high and low tide events, is equivalent inside and outside of the project area.*

This task is intended to evaluate whether tidal circulation is similar inside and outside the project area. Tidal circulation differences could arise if debris or slumping soil had blocked a channel. Given the relatively small size of each site and the lack of potential flow restrictions, this task did not require separate monitoring efforts. Instead, visual observation of flow restrictions, if any, were noted during other monitoring tasks.

2.4 Physical Success Criterion 4 – Elevation and Channel Morphology

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ELEVATION AND CHANNEL MORPHOLOGY. *No evidence of erosion that threatens restoration project goals, property, infrastructure, or is otherwise unacceptable is observed after a period of initial site stabilization.*

In this task, visual observations and cross-sectional surveys were used to evaluate channel elevations and morphology. Surveys were conducted along permanent cross-sections using the total station. In areas between cross-sections, observations regarding erosion or other morphological changes were made. Approximately eight cross-sections were surveyed per site. To identify cross-sections during subsequent years, reinforcing steel bars ("rebar"), capped with protective plastic covers, were driven at the ends of the cross-sections. The total station unit was used to obtain horizontal and vertical coordinates along the selected cross-sections

2.5 Biological Success Criterion 1 – Marsh Development / Areal Coverage

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MARSH VEGETATION AND AREAL COVERAGE. *The areal extent (percent cover) of vegetation should be stable or increasing within portions of the project within elevations suitable to marsh establishment.*

In this task, Adolfson staff mapped the percent cover of marsh vegetation in mid-summer. Stake-wire flags were placed around areas of dominant marsh vegetation (i.e., areas in which the percent cover of marsh vegetation was at least 25 percent). Mapped areas (or polygons) indicate the extent of marsh vegetation and were given a unique label (e.g., RA, RB). For each mapped area, the overall percent cover of the vegetation and the dominant species were estimated visually and recorded. The total station instrument was subsequently used to obtain coordinates for the flags. In the label identifiers, the first letter "R" or "M" stands for riparian or marsh; the second letter was assigned sequentially, beginning with "A", as polygons were mapped.

Marsh areal coverage monitoring was conducted at Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. The Middle Waterway (City) site was monitored by the City of Tacoma.

2.6 Biological Success Criterion 2 – Marsh Development / Species Composition

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MARSH VEGETATION / SPECIES COMPOSITION. *Species composition of native wetland/emergent plant species should be comparable to that of appropriate reference or comparison sites. If planted, survival should reach or show a trend toward 50% by Year 3. The project should not contain more than 5% cover by area of non-native or invasive plant species. invasive plant species of special concern include, but are not limited to, Spartina spp. (cordgrass), Lythrum salicaria (purple loosestrife), Phalaris arundinacea (reed canarygrass), and Phragmities communis (common reed).*

In this task, the plant species composition was evaluated in mid-summer within the marsh area along transects, using randomly placed quadrats. Transects were positioned along contours to achieve a stratified random approach. Samplers recorded the presence and percent cover of marsh species within each quadrat. These data were then tabulated and compared with planting plans and general restoration goals to approach 50 percent cover with target vegetation. In addition, data results identified whether non-native and invasive plant species comprise more than five percent of the vegetation cover.

Permanent transects were established generally along contours at each site monitored. The number and location of quadrats were determined based on an approach identified in the work plan. A pilot sampling was conducted to determine the sample size at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. Sampling methods presented in Appendix D of the Long-term Monitoring Work Plan, which are based on methods in Elzinga et al. (1998), were used. For the pilot sampling at each site, 20 quadrats were placed along the transect line in the marsh and 20 were placed in the riparian habitat along the transect line. The sampling locations were based on random numbers taken from a random numbers table in Elzinga et al. (1998). The number of plant species occurring in each quadrat along the transects were recorded, and the standard deviation calculated. The standard normal coefficient (which corresponds to the acceptable level of error) and precision level for 90 percent confidence level were used (Table D-1 in the Long-term Monitoring Work Plan). The results of this calculation provide the uncorrected sample size. Table D-2 in the Long-term Monitoring Work Plan provided the corrected or adjusted sample size.

Based on this analysis, the corrected sample size for Mowitch was 46 for the marsh habitat and 45 for the riparian habitat. For Squally Beach, the corrected sample size was 26 for the marsh habitat and 25 for the riparian habitat. For Middle Waterway (Simpson/Trustees), the corrected sample size was 23 for the marsh habitat and 15 for the riparian habitat.

The transects were positioned to capture the areal extent of marsh vegetation as well as characterize the plant community. Rebar was used to permanently mark the transect locations and orange plastic caps were placed on the rebar to indicate the transect number.

A random number table was used to determine the sampling locations for the first sampling event. The total number of sampling points was based on the number and length of each transect. At each sampling location, a 0.5 by 0.5 m quadrat was placed on the ground. At each location, the percent cover of each plant species present within each quadrat was visually estimated (viewed from the vertical). To ensure consistency of observations between monitoring events, data forms were used. Individual species' cover values were summed to determine the total areal coverage in each quadrat. Daubenmire cover classes (0 to 5%, 5 to 25%, 25 to 50%, 50 to 75%, 75 to 95%, and 95 to 100%) and cover class midpoint values (2.5%, 15%, 37.5%, 62.5%, 85%, and 97.5%) for each species also were recorded. A determination of whether the plant was non-native or invasive was also made. Analyses for plant species occurring in all the quadrats were based on the estimated cover and cover class midpoint values.

Marsh species composition monitoring was conducted at Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. The Middle Waterway (City) site were monitored by the City of Tacoma.

2.7 Biological Success Criterion 3 – Marsh Development / Plant Vigor

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MARSH DEVELOPMENT / PLANT VIGOR. *As measured by stem height and shoot density, should be comparable (greater than 80% by Year 3) to that of appropriate reference sites and/or improving over time.*

For this task, plant vigor was evaluated in mid-summer, along the transects and within the quadrats described in BSC 2. Stem height and shoot density of all species occurring in the quadrat

were measured. Using the standardized form for BSC 2, the stem height (in inches) and shoot density were recorded. Data were analyzed for each quadrat sampled. In addition, the data were tabulated in order to serve as a basis of comparisons between sampling events.

Marsh development monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. As with BSC 2, the naturally vegetated portion of the Squally Beach site was used as a reference location. The Middle Waterway (City) site was monitored by the City of Tacoma.

2.8 Biological Success Criterion 4 – Marsh Vegetation Herbivory Avoidance

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MARSH VEGETATION HERBIVORY AVOIDANCE. *Confirm the success of stopping physical herbivory by Canada geese using physical barriers of wire, rope, rebar, posts, string, or netting.*

In this task, herbivory exclusion devices were inspected and plant health was noted to evaluate the effectiveness of the devices. A standardized form was prepared to serve as a permanent record of the condition of the device and the extent to which these devices were functioning to exclude geese. In addition, photographs of each device were collected each time the site was sampled. The photographs record the success (or failure) of each device.

Herbivory exclusion monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. Monitoring for this task was conducted concurrently with monitoring for BSC 1, 2, 3, 8, and 9. Additional monitoring of the devices, conducted by CHB volunteers, supplements observations made by staff biologists.

2.9 Biological Success Criterion 5 – Riparian Vegetation Survival

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RIPARIAN VEGETATION SURVIVAL. *Riparian vegetation plantings should maintain not less than 75% survival over the first three years following initial planting.*

In this task, riparian vegetation was inspected in mid-summer to evaluate plant survival. This was evaluated in quadrats along contours through the riparian areas. Samplers used the "as planted" surveys as the basis for data collection.

Permanent transects were established generally along contours at each site monitored. The number and location of transects were determined and identified prior to the first scheduled monitoring site visit. The transects were placed to assess adequately the percent survival and areal coverage of the riparian vegetation, as well as to characterize the plant community. Rebar was used to permanently mark the transect locations and the transect number was permanently marked on plastic caps (placed on top of the rebar).

Sampling locations along the transect were determined using a random number table. These locations were used during all subsequent sampling events. The total number of sampling points was based on the number and length of each transect. At each sampling location, a 1.0 m by 3.0 m rectangular quadrat was placed on the ground. At each location, the percent survival of each plant species present within each quadrat was visually estimated (viewed from the vertical). To ensure consistency of observations between monitoring events, standardized data forms were used.

Riparian vegetation survival monitoring was conducted at the Mowitch, Middle Waterway/Trustee, and Squally Beach sites. Monitoring for this task was conducted concurrently with monitoring for BSC 1, 2, and 3. The City of Tacoma monitored the Middle Waterway (City) site.

2.10 Biological Success Criterion 6 – Riparian Vegetation / Areal Coverage

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RIPARIAN VEGETATION AREAL COVERAGE. *Areal extent of native trees, shrubs, herbs, and other riparian vegetation should be stable or increasing over time, and cover not less than 90% of the upland vegetated area of a project after 10 years. Invasive plant coverage should be minimal; species of special concern include Rubus procerus (Himalayan blackberry), Cytisus scoparius (Scot's broom), and Polygonum cuspidatum (Japanese knotweed). By Year 3, minimum percent coverage of vegetation layers should be: >70% (herbs); >30% (shrubs); > 25% (trees); and <2% (non-native invasive vegetation).*

In this task, riparian vegetation was mapped in mid-summer. This was accomplished using the transects and quadrats established for BSC 5. A form was used to record all vegetation data collected from the riparian plant habitats. Percent cover in the riparian area was estimated in a 1.0 meter by 3.0 meter quadrat located along transects. Transects were located to obtain representative results within the riparian zone. Quadrats were randomly selected on the transects during the initial monitoring events. The coordinates of the center of each quadrat were measured using the total station instrument. Adolfson also determined the extent of the riparian vegetation and noted approximate percent cover of vegetation while on the site. Stake-wire flags were placed around areas of dominant riparian vegetation (i.e., areas in which the percent cover of riparian vegetation was 25 percent or greater). Ridolfi then surveyed these areas.

Riparian coverage monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. The City of Tacoma monitored the Middle Waterway (City) site.

2.11 Biological Success Criterion 7 – Fish Access / Presence

FISH ACCESS / PRESENCE. *Estuarine fish will access the project, with increasing utilization and colonization by resident species. Juvenile salmonid presence within the project should be comparable to that of appropriate reference sites at the end of 10 years.*

One of the main goals of the Commencement Bay restoration program is to provide habitat for juvenile salmon. NMFS personnel used nets to collect, identify, and measure the fork length of salmonids. If possible, hatchery fish were identified by presence of clipped fins or wire coding. A fraction of the fish was retained for further analyses of stomach content and chemistry and other fish were released.

At the Mowitch site block nets were set across the mouth of each pool at high tide to trap fish that were using the pools. As the tide receded fish were collected from the nets, identified by species and counted. At other sites, a small motor boat was used to set beach seines. At these sites, a sampler would stand on the beach holding one end of the net. The boat would motor away from shore about 50 feet, turn parallel to the shore, travel about 100 feet, and turn again bringing the other end of the net to shore. Next, samplers would slowly pull the ends of the net onto the beach, trapping the fish in the central portion of the net. Captured fish were then identified and counted as described previously.

Fish sampling was conducted three times per month in April; twice per month in May and June; and once per month in July, August, September, and October for eleven sampling events. Monitoring was conducted at the Mowitch, Squally Beach, Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), Skookum Wulge, Yowkwala, Olympic View, and Tahoma Salt Marsh sites.

2.12 Biological Success Criterion 8 – Invertebrate Prey Resource Production

INVERTEBRATE PREY RESOURCE PRODUCTION. *Production of invertebrate prey taxa known to be important to juvenile salmonids should be comparable to that of appropriate reference or comparison sites at the end of 10 years.*

In this task, core samples to a depth of 10 cm were collected and invertebrate prey resources were enumerated. Six replicate samples were collected from each site. A stratified random approach were used to select the sampling locations. Invertebrate samples were collected along the lower fringe of marsh vegetation areas at approximately +10 feet MLLW. Within this strata, sample locations were established along a contour by measuring from one end of the site. For example, for the Mowitch site, which is approximately 1,000 feet (300 m) long, six random numbers, between 0 and 1,000, were used to establish sampling locations.

In addition, six replicate fallout samples were established and data collected. Fallout traps were divided between marsh areas and the lower fringe of the riparian zone. Similar protocols were used to select random locations within these areas. Insects were collected using fallout traps following similar procedures to those described by Cordell et al. (1999). A rectangular plastic tray approximately 62 cm x 43 cm were placed in marsh areas, tethered between four vertical PVC pipes, wooden stakes and/or rebar. Sampling locations were established based on the "as planted" surveys and will be permanent. They were located to collect invertebrates from planted vegetation. The floating traps rose and fell with the tide and collected insects that fell into the traps from vegetation or the air. Approximately four centimeters of a soapy water solution was placed in the traps to collect the insects (Toft, 2000). The trays were deployed for 24 hours after which the water was sieved and the insects were preserved in alcohol. The invertebrates were identified and recorded on a standard form. The total number of each invertebrate was also recorded. Insects were identified to the lowest practical taxonomic level with light microscopy. Data collection identified invertebrates to order for those species important to salmonids. Results were normalized to square meter (number/m^2). Data were analyzed to determine the invertebrates at the site, by type of sample (fallout or benthic), sample location, and total number of each invertebrate identified.

A 1-3/4 inch (45 mm) diameter sediment sampler was used to collect samples from the mud or sand flat and in the marsh. Samples were placed in a plastic container and alcohol was added to preserve the samples. The sampling locations were identified in the field during the first field visit. They were located based on channel morphology and, to the extent possible, near BSC 7 sampling stations. In addition, the sampling locations were placed near the fallout trap locations. The site name, sample location, sample number, and date were recorded on the sample containers. Invertebrates identified in the sample were recorded on standardized forms. The total number of each invertebrate was also recorded. Samples were identified in the field by site name, sample location, sample number, and date.

Invertebrate monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites.

2.13 Biological Success Criterion 9 – Bird Use

BIRD USE. *Use of project sites including an area beyond 50 meters of the site boundaries by indigenous/native bird species should be comparable to reference/comparison sites.*

In this task, bird use was observed and recorded for 0.5 to 1 hour per visit in early mornings. Observers recorded bird species observed on the site and within approximately 50 meters of the site boundary on a standardized form. At the beginning of the first visit, the monitoring team evaluated the site to identify a means of approaching the site to minimize disturbance. Observations were made from a relatively inconspicuous location where the site could be observed unnoticed. In subsequent events, monitors will approach the site from the same direction. This technique is intended to reduce observer influences on monitoring results and to increase reproducibility of bird counts. The type of observation was recorded (seen, heard,

tracks, flyover) as well as other climatic and tidal factors that may influence bird use of the site. Observations were made between May and November.

Bird monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites.

3.0 MONITORING RESULTS

This section describes monitoring results for each site. The level of detail depends on the extent of monitoring activities performed at the sites. The information is provided in the same order outlined in Section 2. Maps were created using AutoCAD software and cross-sections were prepared in Delta Graph. Biological observations were recorded on data forms in the field and then entered into an Access database that was developed for the project. CHB volunteers and Ridolfi staff entered data into the database and entries were spot checked to ensure quality control of the data entry process. The database was queried to generate the site-specific summary tables that are presented in this section. Fish monitoring data, collected and summarized by NMFS staff, were subsequently imported into the database for archival purposes.

3.1 Mowitch

Data collected at the Mowitch site included physical, vegetation (marsh and riparian), fish, invertebrate, and avian. Ridolfi performed topographic surveying, NMFS personnel collected fish data, and Adolfson performed the vegetation, invertebrate, and avian monitoring with assistance from CHB staff and volunteers. The following presents the results for each of the success criteria for the Mowitch site.

3.1.1 PSC 1 – Intertidal Areal Coverage

Topographic surveying was conducted at Mowitch to determine the intertidal area, defined as the area between –2 feet MLLW and +12 feet MLLW. This proved to be an extensive effort because of the size and long, narrow configuration of the site. Five monuments with known coordinates were used to establish survey control. The total station instrument was positioned in central locations and the rod technician moved along contour lines. Site elevations do not drop to the lower reference elevation of –2 feet MLLW at the site, particularly on the Hylebos Creek side where the lowest elevations are in the centerline or thalwag of the creek. The toe of

the slope, which is the edge of the area where restoration earthwork was performed, was used as a surrogate for this measurement. Figure 3-1 shows the contours defining the intertidal area for Mowitch, which is 1.74 acres or 7,040 square meters (m^2). Although this was the first year of monitoring and the edge of the restoration area was not previously surveyed, it appears that this criterion is being met.

3.1.2 PSC 2 – Intertidal Stability

Intertidal stability at Mowitch was evaluated by surveying the +8, +10, and +13.5 MLLW contours. These contours are shown on Figure 3-1 along with similar contours from the 2000 as-built survey. Differences between the 2000 and 2002 contours reflect a combination of topographic changes at Mowitch and differences in surveying technique. The primary difference in technique is that the as-built contours were interpolated from spot elevations, while in 2002 the surveying was done along contours. Based on visual comparison between the two sets of contours, there do not seem to be any significant changes and stability appears good. A possible exception is near the fence line in the vicinity of survey monument Mon-1 where there is evidence of some localized slumping on the steep slope. Overall, this criterion is being met at the Mowitch site.

3.1.3 PSC 3 – Tidal Circulation

No tidal circulation problems or blockage problems were observed at the Mowitch site, indicating that this criterion is being met. Tidewater was free to flow through each of the three openings between the tidal pools and Hylebos Creek, and between the northernmost tidal pool and the Hylebos Waterway. A number of logs had floated onto flat areas (benches) between the tidal pools at an elevation near MHW. There had also been occasions (prior to the formal monitoring activities described in this report) when significant quantities of bark debris had been observed at the site (Adams, 2002). Both types of events, which are likely to be associated with commercial log handling activities in the Hylebos Waterway, can have negative impacts on growth of marsh vegetation although tidal circulation, per se, is not restricted.

3.1.4 PSC 4 – Elevation and Channel Morphology

Elevation and channel morphology at Mowitch was evaluated by surveying ten cross-sections approximately perpendicular to the long axis of the site. The cross-sections are shown on Figures 3-2 through 3-5. Each cross-section also shows the as-built survey data that were collected in 2000. It should be noted that the as-built survey was not performed using the same cross-section alignments. In other words, the points on each cross-section were interpolated from a contour map of the as-built survey. Consequently, differences shown on the cross-sections reflect both real differences associated with topographic changes between the two surveys and artificial differences associated with the interpolation process.

Generally, the 2002 elevation agrees with the 2000 elevations within six inches or less. At a few locations, 55 feet along cross-section A-A, there is a difference approaching two feet. This criterion is being met at Mowitch.

3.1.5 BSC 1 – Marsh Development / Areal Coverage

The areal extent of marsh vegetation is shown on Figure 3-6. The percent cover of vegetation and the dominant species present in each polygon are also included in Table 3-1. Forty-six quadrats were sampled along a transect running through the marsh area at or near elevation +12 feet MLLW (Figure 3-6). The location of each quadrat along the transect is shown in Table 3-2. The percent cover of vegetation in each quadrat by species are shown in Table 3-3. Dominant vegetation on the site included seaside arrow-grass (*Triglochin maritima*), fat-hen saltbush (*Atriplex patula*), brass buttons (*Cotula coronopifolia*), and monotypic patches of spikerush (*Eleocharis sp.*). Other species such as seaside plantain (*Plantago maritima*), tufted hairgrass (*Deschampsia cespitosa*), and Lyngby's sedge (*Carex lyngbyei*) were also present on the site. In general, vegetated areas within the herbivory avoidance devices provided the greatest areal coverage, with the exception of the *Eleocharis* species. This plant typically occurred outside of the herbivory exclusion devices, but was diminutive in size, growing low to the ground. Marsh development in areas that have not been planted is limited. At this time, it is

unclear whether this criterion will be met in the next few years without installing additional plants.

3.1.6 BSC 2 – Marsh Development / Species Composition

Plant species identified in each quadrat along the marsh transect (Figure 3-6) are presented in Table 3-3. Information from Table 3-3 was used to determine the frequency of occurrence for each species identified along the transect. This table also indicates whether the plant is native or non-native. Of the 46 marsh quadrats sampled, 26 contained vegetation. The species that occurred most frequently along the marsh transect were fat-hen saltbush and brass buttons. Of the 16 species observed along the transect, 10 species are native and 4 are non-native. The remaining two species (unknown grass and unknown herbs) could not be accurately identified at the time of the site visit, but are assumed to be non-native.

Percent cover in the quadrats ranged from 0 percent (unvegetated) to over 75 percent cover. Variation could be attributed to grazing, micro-site conditions, and the time of year in which the survey was conducted. The five species which had relatively high percent cover within individual quadrats (greater than 20 percent) included:

- seaside arrow-grass, which ranged from one to 75 percent;
- brass buttons, which ranged from 0.5 to 45 percent;
- seaside plantain, which ranged from five to 30 percent;
- fat-hen saltbush, which ranged from 0.5 to 25 percent; and
- seashore saltgrass (*Distichlis spicata*) which ranged from one to 20 percent.

Plant cover was also analyzed using the Daubenmire cover class and midpoint method as described in Appendix B (Table 3-4). This table shows that fat-hen saltbush, a native plant species, had the greatest canopy cover, percent cover, and frequency in the marsh area. Both seaside arrow-grass and brass buttons are commonly occurring species, with a canopy cover of 80 and 70, respectively, and a percent cover of 1.74 and 1.52, respectively. However, the frequency in which brass buttons occurred (19.6) was much higher than that of seaside arrow-

grass (6.5). Seaside arrow-grass is a native species, while brass buttons is a non-native species. As with BSC 1, it may be necessary to install additional marsh plants to achieve this criterion in the long term.

3.1.7 BSC 3 – Marsh Development / Plant Vigor

Stem height and shoot density, used to assess plant vigor, are shown in Tables 3-5 and 3-6, respectively. This information will be used in future comparisons of vegetation occurring on site. In general, vegetation appeared more vigorous within the herbivory avoidance devices. Both average stem height and average shoot density were higher within the devices. Stem lengths varied between one and 12 inches for fat-hen saltbush and between 0.5 and nine inches for brass buttons. Shoot density varied between one and 13 shoots per quadrat for fat-hen saltbush and between one and 66 shoots per quadrat for brass buttons. The performance criterion is based on a comparison to a reference site which has not been selected. Therefore, this will be re-evaluated in Year 2 to evaluate change over time.

3.1.8 BSC 4 – Marsh Vegetation Herbivory Avoidance

Five herbivory avoidance devices have been installed on the site. The devices consisted of four-foot-high chicken wire with string crisscrossing over the top. Most of the devices were intact and were grazed primarily along the edges. However, materials from some of these devices have become detached, primarily in the central portion of the marsh area. Within these areas, vegetation had been grazed throughout. At the time of the field study, Canada geese (*Branta canadensis*) were observed grazing within herbivory devices in the central and eastern portion of the site. This criterion is being met where the structures are intact. Minor repairs are appropriate in a few locations.

3.1.9 BSC 5 – Riparian Vegetation Survival

The location of the riparian vegetation transect is shown on Figure 3-6. The location of each quadrat along the transect is shown in Table 3-2. Plant species identified in 45 quadrats along

the riparian transect are presented in Table 3-7. The majority of planted species within the quadrats are surviving. Of the 546 plants recorded as occurring in the quadrats, 19 were dead. This included six young western hemlock trees (*Tsuga heterophylla*), five oceanspray shrubs (*Holodiscus discolor*), and two young Douglas fir trees *(Pseudotsuga menziesii*), all of which had been planted. The remaining plants occurring in the quadrats that had not survived were from species that had become established on the site. They included two grasses (*Bromus sp.*), two yarrow plants (*Achillea millefolium*), one red alder (*Alnus rubra*), and one lupine (*Lupinus sp.*). Many of the salal plants had survived, but did not appear healthy. Shrubs are generally achieving the performance criterion but trees are not. Survival problems are believed to be related to soil compaction. Soil amendments, de-compaction, and infill planting is recommended. Shrubs are generally achieving the performance criterion, but trees are not. Survival problems are believed to be related to soil compaction. Soil amendments, de-compaction, and infill planting are recommended.

3.1.10 BSC 6 – Riparian Vegetation / Areal Coverage

Vegetative cover varied within each quadrat; overall cover ranged from 15 percent to 65 percent (Table 3-7). The five species which had relatively high coverage within individual quadrats (greater than 20 percent) included:

- lupine, which ranged from trace to 30 percent;
- perennial ryegrass (*Lolium perenne*), which ranged from 2 to 35;
- birdsfoot-trefoil (*Lotus corniculatus*), which ranged from trace to 25 percent;
- Douglas fir, which ranged from 11 to 25 percent; and
- rose (*Rosa sp.*), which ranged from 1 to 25 percent.

In addition, the riparian vegetation on the site has been mapped, and is shown on Figure 3-6. The percent cover of vegetation and the dominant species present in each polygon are included in Table 3-1. The percent cover of vegetation in each quadrat and the dominant species present are shown in Table 3-7. The majority of the species on the site are early seral species such as

lupine, perennial ryegrass, birdsfoot-trefoil, clover (*Trifolium* species), and white sweet-clover (*Melilotus alba*). Planted species were present on the site, but generally occurred as small plants interspersed on the site, and thus provided limited coverage.

Data were also analyzed using the Daubenmire cover class and midpoint method, described in Appendix B (Table 3-8). This table shows that herbaceous vegetation, much of which is non-native or invasive, comprises much of the vegetative cover in the riparian area. The species with the greatest canopy cover and percent cover is perennial ryegrass. Other herbaceous species with relatively high total canopy cover includes white sweet-clover (192.5), lupine (187.5), birds-foot trefoil (150), and yarrow (110). Lupine and yarrow were seeded at the time of restoration, while the other two are non-native or invasive. Rose had the greatest canopy cover (215) and percent cover (4.78) in the shrub layer. In the tree layer, Douglas fir and western hemlock have the greatest cover, with a canopy cover of 92.5 and 77.5, respectively, and a percent cover of 2.06 and 1.72, respectively. This criterion may not be met without soil amendments and additional planting.

3.1.11 BSC 7 – Fish Access / Presence

The Mowitch site was sampled for fish assemblage composition, salmonid diets, chemical contamination of sediments, and chemical contamination of fish tissue from selected species. Fish sampling occurred on an approximately biweekly basis through June, and continued monthly into September. The results of the diet, sediment chemistry, fish chemistry, and stomach content analysis were not available for this report.

The customized fishing gear built for the project functioned as intended, with a few small modifications. Over the seven-month sampling period, 36 individual net sets were completed at the Mowitch site. The basic block net design deployed at the site consist of four 37-m x 13.5-m nets made of 1-cm mesh.

Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The number of species (species richness or SR) per sampling event ranged

from two (April) to 13 (August); a total of 19 different species (total species richness) were caught at the site during various sampling events. Four salmonid species (chinook, coho, chum, and cutthroat trout) were observed at Mowitch. These species are listed in Table 3-9, and the complete results of the study are found in Appendix C. This criterion at Mowitch is being met based on the presence of salmonid and non-salmonid fish.

3.1.12 BSC 8 – Invertebrate Prey Resource Production

Invertebrate samples for the Mowitch site were collected on July 10, 2002 and August 8, 2002. Sampling locations are shown on Figure 3-6.

Fallout Traps

The results of the fallout trap sampling are shown in Table 3-10. During the July sampling, seven different Orders of invertebrates were observed within the traps. Flies (*Diptera*) were found in all six traps and included seven identified families. True bugs (*Hemiptera*) were found in four traps and included two identified families. The dominant family was the leaf miners (*Diptera Agromyzidae*).

Results for order were normalized to number of individuals per square meter (m^2):

- *Amphipoda* had 15 individuals/m^2;
- *Coleoptera* had 50 individuals/m^2;
- *Diptera* had 200 individuals/m^2;
- *Hemiptera* had 27 individuals/m^2;
- *Homoptera* had four individuals/m^2;
- *Hymenoptera* had 35 individuals/m^2;
- *Orthoptera* had four individuals/m^2; and
- *Trichoptera* had 12 individuals/m^2.

During the August sampling, seven different orders were observed within the traps. Flies (*Diptera*) were found in five traps and included three identified families. Beetles (*Coleoptera*) were found in four traps and included two known families. The dominant families included shore bugs (*Hemiptera Saldidae*) and leaf miners (*Diptera Agromyzidae*).

Results for order were normalized to number of individuals per m^2:

- *Amphipoda* had 46 individuals/m^2;
- *Coleoptera* had 31 individuals/m^2;
- *Diptera* had 131 individuals/m^2;
- *Hemiptera* had 50 individuals/m^2;
- *Homoptera* had 8 individuals/m^2;
- *Hymenoptera* had 4 individuals/m^2; and
- *Trichoptera* had 4 individuals/m^2.

Substrate Sample

Samples were difficult to collect due to gravelly soils and netting placed over the soils for erosion control. No invertebrate species were observed within either the July or August substrate samples. BSC 8 is being met based on samples collected in the fallout traps. The substrate sampling protocol will be modified in subsequent years to collect samples from lower (more frequently wetted) locations.

3.1.13 BSC 9 – Bird Use

The number of species observed on the Mowitch site between May and November ranged from 10 to 18, as shown in Table 3-11. The greatest number of bird species was observed in August (18) followed by May (16). However, bird use of the site habitats varied considerably by season, as shown in Table 3-12; use of riparian habitat (12 species) and marsh (12 species) was heavy in May, while riparian and intertidal habitat each had seven species in August. The European

starling (*Sturnus vulgaris*) was observed in the highest numbers, with up to 190 individuals observed (Table 3-11).

Species present during all of the seven site visits include: killdeer (*Charadrius vociferus*), belted kingfisher (*Ceryle alcyon*), and glaucus-winged gull (*Laurus glaucescens*), with Canada goose and European starling present on six visits. European starling was present in August, September, and November visits in high numbers – between 40 and 100 individuals present at any one time.

Waterfowl species observed at Mowitch include: Canada goose, mallard (*Anas platyrhynchos*), American widgeon (*Anas americana*), and double-crested cormorant *(Phalacrocorax penicillatus*). Shorebird species include killdeer, spotted sandpiper (*Actitis macularia*), western sandpiper (*Calidris mauri*), and semipalmated sandpiper (*Calidris pusilla*).

Obvious breeding / territorial behavior (singing, fighting or pursuit, "broken-wing" distraction technique, gathering nesting material, presence of young) was observed in the following species:

- Canada goose,
- killdeer,
- cliff swallow (*Petrochelidon pyrrhonota*),
- mourning dove (*Zenaida macroura*),
- spotted sandpiper,
- song sparrow (*Melospiza melodia*),
- barn swallow (*Hirundo rustica*), and
- violet-green swallow (*Tachycineta thalassina*).

The swallow species are not likely to be nesting on the Mowitch site, although the barn swallows appeared to be nesting under the adjacent bridge.

Species observed only in the spring include cliff swallow, mourning dove, Caspian tern *(Sterna caspia*), and violet-green swallow. Fall migrants include: American pipit (*Anthus rubescens*),

American widgeon, double-crested cormorant, and savannah sparrow *(Passerculus sandwichensis*).

Tide did not appear to significantly influence the number of species using the site. BSC 9 is being met at the site based on the presence of numerous birds and a variety of species. However, there is no reference site against which to make a numerical comparison**.**

3.2 Squally Beach

Data collected at the Squally Beach site included physical, vegetation (marsh and riparian), fish, invertebrate, and avian. Ridolfi performed topographic surveying, fish data were collected by the NMFS, and the vegetation, invertebrate, and avian data were collected by Adolfson with assistance from CHB staff and volunteers. The following presents the results for each of the success criteria for the Squally Beach site.

3.2.1 PSC 1 – Intertidal Areal Coverage

Topographic surveying was conducted at Squally Beach to determine the intertidal area, defined as the area between –2 feet MLLW and +12 feet MLLW. This required a moderate field effort because the site is relatively compact. Three monuments with known coordinates were used to establish survey control. The total station instrument was positioned in central locations and the rod technician moved along contour lines. Site elevations do not drop to the lower reference elevation of –2 feet MLLW at the site; instead the site grades into mudflats below an elevation of +8 feet MLLW. The +8 foot contour, which is the approximate edge of the area where restoration earthwork was performed, was used as a lower boundary measurement. Figure 3-7 shows the contours defining the intertidal area for Squally Beach, which is 0.54 acres or 2,190 square meters (m^2). It appears that this criterion is being met at Squally Beach.

3.2.2 PSC 2 – Intertidal Stability

Intertidal stability at Squally Beach was evaluated by surveying the +10 and +13.5 contours. These contours are shown on Figure 3-7 along with similar contours from the 2000 as-built survey. Differences between the 2000 and 2002 contours reflect a combination of topographic changes at Squally Beach and differences in surveying technique. The primary difference in technique is that the as-built contours were interpolated form spot elevations while in 2002 the surveying was done along contour. Based on visual comparison between the two sets of contours, there do not seem to be any significant changes and stability appears good. A possible exception is the eastern channel directly south of the rockbox outlet. A channel approximately one foot deep has eroded at that location. This criterion is being met at Squally Beach, except in the limited area mentioned above.

3.2.3 PSC 3 – Tidal Circulation

No tidal circulation problems were observed at the Squally Beach site, so this criterion is being met. Tide water was freely flowing through each of the three openings between the portion of the marsh protected by berms and the mudflats. A number of logs had floated onto flat areas of the site near the MHW elevation. This type of event, which is likely to be associated with commercial log handling activities in the Hylebos Waterway, can have negative impacts on growth of marsh vegetation although tidal circulation, per se, is not restricted.

3.2.4 PSC 4 – Elevation and Channel Morphology

Elevation and channel morphology at Squally Beach was evaluated by surveying six cross-sections approximately perpendicular to the long axis of the site. The cross-sections are shown on Figures 3-8 and 3-9. Each cross-section also shows the as-built survey data that were collected in 2000. It should be noted that the as-built survey was not performed using the same cross-section alignments. In other words, the points on each cross-section were interpolated from a contour map of the as-built survey. Consequently, differences shown on the cross-sections reflect both real differences associated with topographic changes between the two

surveys, and artificial differences associated with the interpolation process. This criterion is being met at Squally Beach.

3.2.5 BSC 1 – Marsh Development / Areal Coverage

The areal extent of marsh vegetation is shown on Figure 3-10. The percent cover of vegetation in each polygon and the dominant species present are also included in Table 3-13. On this site, the topographically low areas generally have little to no vegetation (i.e., less than 25 percent cover). This may be due to tidal action, in that, these low areas are inundated on a daily basis and have the greatest potential for surface scouring as water flows in and out of the site (as evidence of drainage patterns). Therefore, marsh vegetation on this site generally occurs at slightly higher elevations. Dominant vegetation on the site included fat-hen saltbush, brass buttons, fleshy jaumea (*Jaumea carnosa*), and Lyngby's sedge. Other species such as American bulrush (*Scirpus americanus)*, seashore saltgrass, and American glasswort or pickleweed (*Salicornia virginica*), were also present on the site. This criterion is being met at Squally Beach in areas where marsh vegetation have been planted. Non-quantitative observations suggest that the areal coverage is expanding.

3.2.6 BSC 2 – Marsh Development / Species Composition

The locations of the two marsh transects are shown on Figure 3-10. The location of each quadrat along the transect is shown in Table 3-14. Plant species identified in the quadrats along each transect are presented in Table 3-15. Information from Table 3-15 was used to determine the frequency of occurrence for each species identified along the transect. Table 3-15 also indicates if the plant is native or non-native. Of the 26 marsh quadrats sampled, 20 contained vegetation. The species that occurred most frequently along the marsh transects were fat-hen saltbush, seashore saltgrass, and fleshy jaumea, all of which are native. Of the 22 species observed along the transects, 13 species are native and eight are non-native. The remaining species (unknown sedge) could not be accurately identified at the time of the site visit.

Percent cover for each of the species occurring in the quadrats ranged from zero percent (unvegetated) to 98 percent. Variation may be attributed to grazing, elevation and tides (duration of inundation and surface scouring), and the patchiness of some species. The three species with relatively high percent cover within individual quadrats (greater than 70 percent) included Lyngby's sedge which ranged from 10 to 98 percent, fleshy jaumea which ranged from trace to 95 percent, and American bulrush which ranged from five to 70 percent.

Plant cover was also analyzed using the Daubenmire cover class and midpoint method as described in Appendix B (Table 3-16). This data shows that along Transect 1-1, fleshy jaumea had the greatest canopy cover. This table also shows that the Lyngby's sedge, which provides high canopy cover, occurred in a relatively low frequency in few quadrats. Feshy jaumea and fat-hen saltbush, however, both occurred in 30 percent or more of the quadrats to achieve high canopy covers. This table also shows that along Transect 1-1, percent cover of native plant species (27.12) is considerably higher than the non-native or invasive species (0.48).

Along Transect 1-2, those species with the greatest canopy cover, are American bulrush, Lynbgy's sedge, and fat-hen saltbush. All of these are native. Of these three, however, only fat-hen had a frequency greater than 30 percent. Of the non-native plant species, birds-foot trefoil, a non-native species, had the highest canopy cover. Although the percent cover of native species (33.67) along Transect 1-2 was greater than that of non-natives or invasives (10.50), the non-natives comprised a greater coverage and frequency along Transect 1-2 than that of Transect 1-1. Planted marsh species are surviving at Squally Beach, indicating that this criterion is being met.

3.2.7 BSC 3 – Marsh Development / Plant Vigor

Stem height and shoot density were used to assess plant vigor. Data collected for stem height and shoot density are presented in Tables 3-17 and 3-18, respectively. This information will be used in future comparisons of vegetation occurring on the site. In general, the most vigorous plants were those occurring in areas of existing vegetation such as the Lynbgy's sedge in the southeastern portion of the site and the fleshy jaumea at the western edge of the site.

Plant vigor was evaluated for the three most frequently identified species (see above BSC 2 discussion). Stem lengths varied between two and seven inches for fat-hen saltbush, between one and 13 inches for seashore saltgrass, and between 0.5 and 7.5 inches for fleshy jaumea. Shoot density varied between one and 76 shoots per quadrat for fat-hen saltbush, between two and 50 shoots per quadrat for seashore saltgrass, and between one and 822 shoots per quadrat for fleshy jaumea. There is no reference site for this criterion which makes it difficult to reach a definite conclusion regarding success.

3.2.8 BSC 4 – Marsh Vegetation Herbivory Avoidance

Herbivory exclusion devices on the site were made from rebar and rope, with rope criss-crossing over the top. Most of the devices were generally intact. However, two devices had sufficient damage to allow easy access to geese for grazing. One of these devices is located in the central portion of the site and the other in the western portion of the site. For both, the ropes along the northern side were missing. Based on observations made during the field study, it appears that geese had been able to infiltrate the herbivory exclusion devices; geese had not been prevented from access the vegetated areas with the devices. Criterion BSC 4 has not been met at Squally Beach and the exclusion devices should be repaired.

3.2.9 BSC 5 – Riparian Vegetation Survival

The location of the riparian vegetation transect is shown on Figure 3-10. The location of each quadrat along the transect is shown in Table 3-14. Plant species identified in quadrats along the riparian transect are presented in Table 3-19. The majority of planted species within the quadrats are surviving. Of the 316 plants recorded as occurring in the 25 quadrats (most of which are weedy species), three were dead. Of this, two of the dead plants were red alder and one was a velvet grass (*Holcus lanatus*) that had become established on the site.

While most of the native species in the quadrats were alive, some were stressed. Red alder occurring in the western portion of the site had leafed out, but then started to die back, possibly

due to lack of water. Some small shrubs were out-competed by taller weedy species such as white sweet-clover.

Data were also analyzed using the Daubenmire cover class and midpoint method (Table 3-20). These data indicate that the herbaceous layer comprises the majority of canopy cover, the greatest percent cover, and the majority of the species composition. In the herbaceous layer, white sweet-clover and perennial ryegrass provided the highest canopy cover (570 and 497.5, respectively) and percent cover (22.80 and 19.90, respectively). White sweet-clover is non-native, while perennial ryegrass is a seeded species. Within the shrub layer, rose had the greatest canopy cover (72.5) and percent cover (2.9), while Scouler's willow (*Salix scouleriana*) had the highest canopy cover (232.5) and percent cover (9.30) in the tree layer. Both of these species are native. It is not clear whether this criterion will be met because of the abundant white sweet-clover. It is recommended that adaptive management actions be taken to control or remove the clover and infill with native shrubs as appropriate.

3.2.10 BSC 6 – Riparian Vegetation / Areal Coverage

Vegetative cover varied within each quadrat; however, overall cover ranged from trace to 70 percent (Table 3-19). The five species which had relatively high coverage within individual quadrats (greater than 50 percent) included:

- white sweet-clover which ranged from two to 70 percent;
- lupine which ranged from trace to 55 percent;
- hedge mustard (*Sisymbrium officinale*) which ranged from 5 to 50 percent;
- Scouler's willow which ranged from 10 to 50 percent; and
- common horsetail (*Equisetum arvense*) which ranged from two to 50 percent.

Of these five species, one (Scouler's willow) is native, and one (lupine) was seeded.

In addition, the riparian vegetation on the site has been mapped, and is shown on Figure 3-10. The percent cover of vegetation and the dominant species present in each polygon are included

in Table 3-13. The percent cover of vegetation in each quadrat and the dominant species present are shown in Table 3-20. Much of the riparian area is vegetated with white sweet-clover, lupine, red alder, willow (*Salix* spp.), rose, Himalayan blackberry (*Rubus discolor*), and common herbaceous weeds such as perennial ryegrass, birdsfoot-trefoil, and clover. Planted species were present on the site, but many of the plants had been covered by tall weedy species such as the white sweet-clover. In general, the planted species were small and provided limited areal coverage. This criterion may not be achieved without adaptive management as indicated in BSC 5.

3.2.11 BSC 7 – Fish Access / Presence

The Squally Beach site was successfully sampled for fish assemblage composition four times between June and October. One sampling event per month in June, July, September, and October were completed at the Squally Beach site.

The customized fishing gear built for the project functioned as intended, with a few small modifications. The basic block net design deployed at the site consist of four 9.7-m x 1.8-m nets made of 0.5-cm mesh in various configurations (additional wings, etc.). Squally Beach proved to be difficult to sample because of its high elevation. Tidal water only inundates the site for about one hour per day.

Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The number of species (species richness or SR) per sampling event ranged from two (August, September and October) to three (June); a total of three different species (total species richness) were caught at the site during various sampling events. These species are listed in Table 3-21. Squally Beach was the only site where salmonids were not observed. However, the first sampling event did not take place until after the peak migration period (early June) had occurred at other sites. This criterion is minimally being met based on the presence of non-salmonid fish.

3.2.12 BSC 8 – Invertebrate Prey Resource Production

Invertebrate samplings for the Squally Beach site were collected on June 26, 2002 and August 8, 2002. Sampling locations are shown on Figure 3-10.

Fallout Traps

The results of the fallout trap sampling are shown in Table 3-22. During the June sampling, eight different orders of invertebrates were observed within the traps. *Diptera* (flies) were found in all six traps and included seven identified families. *Coleoptera* (beetles) were found in four traps and included four identified families. *Hemiptera* (true bugs) were found in all six traps and included one identified family and one unknown. *Amphipoda* (amphipods) were also found in all six traps. The most frequently-occurring families in the traps were amphipods (*Amphipoda*), long-legged flies (*Dolichopodidae),* and shore bugs *(Saldidae)*. Results for order were normalized to number of individuals per m^2:

- *Amphipoda* had 266 individuals/m^2;
- *Coleoptera* had 50 individuals/m^2;
- *Diptera* had 200 individuals/m^2;
- *Hemiptera* had 27 individuals/m^2;
- *Homoptera* had 4 individuals/m^2;
- *Hymenoptera* had 35 individuals/m^2; and
- *Trichoptera* had 12 individuals/m^2.

During the August sampling, six different orders were observed within the traps. *Diptera* (flies) were found in all six traps and included six identified families. *Hymenoptera* (bees, ants and wasps) were found in five traps and included two identified families and one unknown. *Coleoptera* (beetles) were found in five traps and included one identified family and one unknown. The most frequently occurring family was amphipod (*Amphipoda*). Results for order were normalized to number of individuals per m^2:

- *Amphipoda* had 462 individuals/m^2;
- *Coleoptera* had 77 individuals/m^2;
- *Diptera* had 277 individuals/m^2;
- *Hemiptera* had 100 individuals/m^2;
- *Homoptera* had 23 individuals/m^2; and
- *Hymenoptera* had 31 individuals/m^2.

Substrate Sample

No invertebrate species were observed within either the June or August substrate samples. Samples were difficult to collect due to gravelly soils and netting placed over the soils for erosion control.

BSC 8 is being met based on samples collected in the fallout traps. The substrate sampling protocol will be modified in subsequent years to collect samples from lower (more frequently wetted) locations.

3.2.13 BSC 9 – Bird Use

The number of species observed on the Squally Beach site between May and November ranged from 8 to 16 (Tables 3-23 and 3-24). The greatest number of bird species were observed on late June 25 (16); 11 species were observed during site visits in August and November. The lowest number of species was observed on September 30, although 150 individuals of one species (American widgeon) were observed on that day. Use of riparian habitat was highest on June 25, with seven species observed. Avian use of the marsh and intertidal habitats varied from zero to three species per visit, while open water habitat was used by zero to four species per visit (Table 3-24). Species observed in the greatest numbers during the 2002 field surveys were waterfowl – American widgeon and mallard with up to 233 and 65 individuals, respectively (Table 3-23).

Species present during all of the seven site visits include: glaucous-winged gull, and song sparrow, with mallard present on six of seven field days. Purple martin, a Washington State

priority species, was recorded on all visit from May through August. This species was using nest boxes placed upon pilings off-shore of the Squally Beach site, and a number of juveniles were observed.

Waterfowl species observed at Squally Beach include: mallard, Canada goose, American widgeon, and double-crested cormorant. Shorebird species include killdeer, spotted sandpiper, and semipalmated sandpiper. Great blue herons (*Ardea herodias*) were observed on five field visits. One osprey was observed foraging in open water habitat off of Squally Beach in late June.

Obvious breeding / territorial behavior (singing, fighting or pursuit, "broken-wing" distraction technique, gathering nesting material, presence of young) was observed in the following species:

- Canada Goose,
- killdeer,
- purple martin,
- song sparrow, and
- white-crowned sparrow (*Zonotrichia leucophrys*).

Species only observed in spring and early summer include Caspian tern, American goldfinch (*Carduelis tristis*), and purple martin. Fall migrants included American widgeon in large numbers.

Tide did not appear to significantly influence the number of species using the site.

BSC 9 is being met at the site based on the presence of numerous birds and a variety of species. However, there is no reference site against which to make a definitive comparison.

3.3 Middle Waterway (Simpson/Trustees)

Data collected at the Middle Waterway (Simpson/Trustees) site included physical, vegetation (marsh and riparian), fish, invertebrate, and avian. Ridolfi performed topographic surveying, fish data were collected by the NMFS, and the vegetation, invertebrate, and avian data were collected by Adolfson with assistance from CHB staff and volunteers. The following presents the results for each of the success criteria for the Middle Waterway (Simpson/Trustees) site.

3.3.1 PSC 1 – Intertidal Areal Coverage

Topographic surveying was conducted at the Middle Waterway (Simpson/Trustees) site to determine the intertidal area, defined as the area between –2 feet MLLW and +12 feet MLLW. This required a significant effort because the site is large and survey control was relatively inconvenient. Three monuments with known coordinates were used to establish survey control. The total station instrument was positioned in central locations and the rod technician moved along contour lines. Site elevations do not drop to the lower reference elevation of –2 feet MLLW at the site; instead, the site grades into mudflats below an elevation of +8 feet MLLW. The +8 foot contour, which is the approximate edge of the area where restoration earthwork was performed, was used as a lower boundary measurement. Figure 3-11 shows the contours defining the intertidal area for Middle Waterway (Simpson/Trustees) site, which is 2.52 acres or 10,200 m^2. This criterion is being met.

3.3.2 PSC 2 – Intertidal Stability

Intertidal stability at the Middle Waterway (Simpson/Trustees) site was evaluated by surveying the +10 and +13.5 contours. These contours are shown on Figure 3-11 along with contours from a survey performed by Parametrix in 2001. Differences between the 2001 and 2002 contours reflect a combination of topographic changes at the Middle Waterway (Simpson/Trustees) site and differences in surveying technique. The surveying technique for the 2001 survey was not specified in the associated report (Parametrix, 2002) but was likely to have involved interpolation between spot elevations points as opposed to the along contour method used in

the 2002 survey. In spite of the differing techniques, there is little evidence of significant change in site elevations. This criterion is being met.

3.3.3 PSC 4 – Elevation and Channel Morphology

Elevation and channel morphology at the Middle Waterway (Simpson/Trustees) site was evaluated by surveying eight cross-sections approximately perpendicular to the long axis of the site. The cross-sections are shown on Figures 3-12 and 3-13. Cross-sections were measured previously at the site (Parametrix, 2002) but these data were not readily available for use in this report and consequently comparisons were not made. Although a direct comparison between years was not made, it would appear that this criterion is being met.

3.3.4 BSC 1 – Marsh Development / Areal Coverage

The areal extent of marsh vegetation at the Middle Waterway (Simpson/Trustees) site is shown on Figure 3-14. The percent cover of vegetation in each polygon and the dominant species present are included in Table 3-25. Commonly occurring vegetation in the marsh habitat included fat-hen saltbush, seashore saltgrass, American glasswort, Canadian sand-spurry, and tufted hairgrass. Other species such as seaside plantain and seaside arrow-grass were present on the site. In general, vegetated areas within the herbivory avoidance devices provided the greatest areal coverage. This criterion is being met in areas where planting has occurred and avoidance devices are in place.

3.3.5 BSC 2 – Marsh Development / Species Composition

The location of the marsh transect at the Middle Waterway (Simpson/Trustees) site is shown on Figure 3-14. The location of each quadrat along the transect is shown in Table 3-26. Plant species identified in each of the 23 quadrats along this transect are presented in Table 3-27. Information from Table 3-27 was used to determine the frequency of occurrence for each species identified along the transect. Of the 23 marsh quadrats sampled, 13 contained vegetation. The

species that occurred most frequently along the marsh transect were fat-hen saltbush and Canadian sand-spurry. All five species observed along the transect are native.

Percent cover for each species in the quadrats ranged from zero percent (unvegetated) to 55 percent cover. The two species which had relatively high percent cover within individual quadrats (greater than 40 percent) included seashore saltgrass, which ranged from 15 to 55 percent, and Canadian sand-spurry, which ranged from trace to 40 percent.

Plant cover was also analyzed using the Daubenmire cover class and midpoint method (Table 3-28). Although fat-hen saltbush and Canadian sand-spurry have relatively high canopy cover (95 and 150, respectively) and percent cover (4.13 and 6.52, respectively), the frequency in which they occurred was also high. Seashore saltgrass comprises the highest canopy cover and percent cover in the marsh area, but it occurred in the quadrats at a much lower frequency than the two previously mentioned species. All of the marsh plant species found on this site are native, herbaceous species. This criterion is being met in portions of the site where planting has occurred and the plants are protected from geese.

3.3.6 BSC 3 – Marsh Development / Plant Vigor

Stem height and shoot density were used to assess plant vigor at the Middle Waterway (Simpson/Trustees) site. Data collected for stem height and shoot density are presented in Tables 3-29 and 3-30. This information will be used in future comparisons of vegetation occurring on the site. In general, vegetation appeared more vigorous within the herbivory avoidance devices (Quadrats 11-17). However, a patch of Canadian sand-spurry, located outside of a herbivory exclusion device, showed relatively high plant vigor (Quadrats 4-6).

Plant vigor for the two most frequently occurring species (see above BSC 2 discussion) indicates that stem lengths varied between four and six inches for seashore saltgrass and between two and eight inches for Canadian sand-spurry. Shoot density varied between 58 and 327 shoots per quadrat for seashore saltgrass and between one and 85 shoots per quadrat for Canadian sand-spurry.

3.3.7 BSC 4 – Marsh Vegetation Herbivory Avoidance

Herbivory exclusion devices at the Middle Waterway (Simpson/Trustees) site consisted of wood or rebar posts with chicken wire on the sides and cross-strings across the top. Approximately half of the devices on the site were intact. For the remaining devices, the posts were intact, but portions of the chicken wire or string had either come loose or were missing. The devices appeared to remain effective, as little to no evidence of grazing was present at the time of the field study. This criterion is generally being met judging by the superior plant growth within projected areas.

3.3.8 BSC 5 – Riparian Vegetation Survival

The location of the riparian vegetation transect at the Middle Waterway (Simpson/Trustees) site is shown on Figure 3-14. The location of each quadrat along the transect is shown in Table 3-26. Plant species identified in quadrats along the riparian transect are presented in Table 3-31. The majority of planted species within the quadrats are surviving. Of the 108 plants recorded as occurring in the quadrats, 11 were dead. None of the planted individuals had died; all of the plants that had died were non-native or invasive species.

Data were also analyzed using the Daubenmire cover class and midpoint method (Table 3-32). This table shows that herbaceous vegetation layer comprises the highest canopy cover, percent cover, and species composition. Brome had the greatest canopy cover (300) and percent cover (20.00). This species also had a high frequency (73.3). Strawberry (*Fragaria* sp.) and colonial bentgrass (*Agrostis tenuis*) had relatively high canopy covers (160 and 197.5, respectively) and percent covers (10.67 and 13.17, respectively), although the frequency in which colonial bentgrass (46.7) occurred was lower than that of strawberry (73.3) and brome (73.3). In the shrub layer, kinnikinnick (*Arctostaphylos uva-ursi*) had the greatest canopy cover (202.5) and percent cover (13.50), while in the tree layer, black cottonwood (*Populus balsamifera*) had the greatest canopy cover and percent cover. This criterion is being met.

3.3.9 BSC 6 – Riparian Vegetation / Areal Coverage

Vegetative cover for each species in the quadrats at the Middle Waterway (Simpson/Trustees) site ranged from trace to 75 percent (Table 3-31). The five species having relatively high coverage within individual quadrats (greater than 60 percent) included Scouler's willow with a cover of 75 percent (in the one quadrat in which it occurred), colonial bentgrass which ranged from one to 75 percent, kinnikinnick which ranged from 20 to 70 percent, and rose which ranged from two to 65 percent.

In addition, the riparian vegetation on the site has been mapped, and is shown on Figure 3-14. The percent cover of vegetation in each polygon and the dominant species present are included in Table 3-25. A mix of native and non-native plant species occur in the riparian habit on the site. Native trees such as black cottonwood, Douglas fir, and western hemlock occur on the site, but are most prevalent in the northern portion of the site. Other species common to the riparian habitat include rose, lupine, kinnikinnick, butterfly bush (*Buddleja davidii*), and sapling madrona (*Arbutus menziesii*), as well as weedy herbaceous species such as St. John's-wort (*Hypericum perforatum*) and perennial ryegrass. This criterion is being met.

3.3.10 BSC 7 – Fish Access / Presence

The Middle Waterway (Simpson/Trustees) site was successfully sampled for fish assemblage composition, salmonid diets, chemical contamination of sediments, and chemical contamination of fish tissue from selected species. Fish sampling occurred on an approximately monthly basis from June through October. The results of the diet, sediment chemistry, fish chemistry, and stomach content analysis were not available for this report.

The customized fishing gear built for the project functioned as intended, with a few small modifications. Over the seven-month sampling period, 19 individual net sets were completed at the Middle Waterway (Simpson/Trustees) site. Beach seine samples were conducted with a 37-m floating "Puget Sound" beach seine.

Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The number of species (species richness or SR) per sampling event ranged from four (October) to seven (July and August); 14 different species (total species richness) were caught at the site during various sampling events, including four salmon species and two unidentified species of sculpin. The most abundant salmon species were chum and chinook, which had peak abundances in late April and late June, respectively. These species are listed in Table 3-33. This criterion is being met at the Middle Waterway (Simpson/Trustees) site.

3.3.11 BSC 8 – Invertebrate Prey Resource Production

Invertebrate samplings for the Middle Waterway (Simpson/Trustees) site were collected on July 24, 2002 and August 8, 2002. Sampling locations are shown on Figure 3-14.

Fallout Traps

The results of the fallout trap sampling at the Middle Waterway (Simpson/Trustees) site are shown in Table 3-34. During the July sampling, nine different Orders of invertebrates were observed within the traps. *Diptera* (flies) were found in five traps and included seven identified families and one unknown. *Hymenoptera* (bees, ants and wasps) were found in five traps and included two identified families and one unknown. The most frequently-occurring family was the leaf miner (*Agromyzidae*). Results for order were normalized to number of individuals per m^2:

- *Amphipoda* had 23 individuals/m^2;
- *Araneae* had eight individuals/m^2;
- *Coleoptera* had 19 individuals/m^2;
- *Diptera* had 547 individuals/m^2;
- *Hemiptera* had 23 individuals/m^2;
- *Hymenoptera* had 27 individuals/m^2;
- *Orthoptera* had four individuals/m^2; and
- *Trichoptera* had eight individuals/m^2.

During the August sampling, four different orders were observed within the traps. *Diptera* (flies) were found in all six traps and included six identified families. The dominant families included the leaf miner (*Agromyzidae*) and long-legged flies (*Dolichopodidae*). Results for order were normalized to number of individuals per m^2:

- *Coleoptera* had four individuals/m^2;
- *Diptera* had 670 individuals/m^2;
- *Hemiptera* had eight individuals/m^2; and
- *Trichoptera* had four individuals/m^2.

Substrate Sample

No invertebrate species were observed within either the July or August substrate samples.

BSC 8 is being met based on samples collected in the fallout traps. The substrate sampling protocol will be modified in subsequent years to collect samples from lower (more frequently wetted) locations.

3.3.12 BSC 9 – Bird Use

The number of species observed at the Middle Waterway (Simpson/Trustees) site between May and November ranged from seven to 14 (Tables 3-35 and 3-36). The greatest number of bird species were observed in late June (14); 13 species were observed during site visits in May. The lowest number of species was observed in November (seven). Use of riparian habitat was high during field visits in May (five species) and June (seven species on June 21st, and four on June 25th). Avian use of the marsh and intertidal habitats varied from one to six species per visit, while open water habitat was used by one to three species per visit, and seven species total throughout the field season (Table 3-36). Glaucous-winged gull was observed in the highest numbers, with up to 30 individuals observed (Table 3-35).

Species present during all of the seven site visits include house finch (*Carpodacus mexicanus*) and glaucous-winged gull; song sparrow and American crow (*Corvus brachyrhynchos*) were each observed on four field visits.

Waterfowl species observed at Middle Waterway (Simpson/Trustees) include: Canada goose, American widgeon, double-crested cormorant, and mallard. Shorebird species include: killdeer, American golden plover (*Pluvialis dominica*), spotted sandpiper, western sandpiper, and semipalmated sandpiper.

Obvious breeding / territorial behavior (singing, fighting or pursuit, "broken-wing" distraction technique, gathering nesting material, presence of young) was observed in the following species:

- killdeer,
- house finch,
- barn swallow,
- cliff swallow, and
- white-crowned sparrow.

Species only observed in spring and early summer include: American widgeon, Caspian tern, and American goldfinch. Fall migrants included American golden plover, and semipalmated, spotted, and western sandpipers.

Highest number of species were observed during field visits at low tide.

BSC 9 is being met at the site based on the presence of numerous birds and a variety of species. However, there is no reference site against which to make a definitive comparison**.**

3.4 Middle Waterway (City of Tacoma)

This site was evaluated by the City of Tacoma, except for PSC 1, PSC 3, and PSC 4 surveyed by Ridolfi, and BSC 7 fish data which were obtained by NMFS.

3.4.1 PSC 1 – Intertidal Areal Coverage

Topographic surveying was conducted at the Middle Waterway (City of Tacoma) site to determine the intertidal area, defined as the area between –2 feet MLLW and +12 feet MLLW. This required a moderate field effort because the site is relatively compact. Three monuments with known coordinates were used to establish survey control. The total station instrument was positioned in central locations and the rod technician moved along contour lines. Site elevations do not drop to the lower reference elevation of –2 feet MLLW at the site; instead the site grades into mudflats below an elevation of +8 feet MLLW. The +8 foot contour, which is the approximate edge of the area where restoration earthwork was performed, was used as a lower boundary measurement. Figure 3-7 shows the contours defining the intertidal area for Squally Beach, which is 0.99 acres or 4,020 square meters (m^2). Although this was the first year of monitoring and the edge of the restoration area was not previously surveyed, it appears that this criterion is being met.

3.4.2 PSC 2 – Intertidal Stability

Intertidal stability at the Middle Waterway (City of Tacoma) site was evaluated by surveying the +10 and +13.5 contours. These contours are shown on Figure 3-15 along with contours from the 2000 design drawings. Differences between the 2000 and 2002 contours are suspected to reflect differences between the design and constructed elevations. This is most likely in the upper reaches of the channels which were probably not as smoothly contoured as had been designed. It would appear that this criterion is being met.

3.4.3 PSC 4 – Elevation and Channel Morphology

Elevation and channel morphology at the Middle Waterway (City of Tacoma) site were evaluated by surveying six cross-sections. The cross-sections are shown on Figures 3-16 and 3-17. There are no "as-built" contours against which the 2002 results can be compared. Survey data collected in later 2003 will provide the first opportunity for comparison. It would appear that this criterion is being met.

3.4.4 BSC 7 – Fish Access / Presence

The Middle Waterway (City of Tacoma) site was successfully sampled for fish assemblage composition, salmonid diets, chemical contamination of sediments, and chemical contamination of fish tissue from selected species. Fish sampling occurred on an approximately monthly basis from April through October. The results of the diet, sediment chemistry, fish chemistry, and stomach content analysis were not available for this report.

The customized fishing gear built for the project functioned as intended, with a few small modifications. Over the seven-month sampling period, eight individual net sets were completed at the Middle Waterway (City of Tacoma) site. The basic block net design deployed at the site consist of one 9.7-m x 1.8-m net made of 0.5-cm mesh.

Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The number of species (species richness or SR) per sampling event ranged from two (August) to five (May); a total of nine different species (total species richness) were caught at the site during various sampling events, including chinook, chum, and pink salmon. As with the other Middle Waterway site, the peak chum abundance occurred in late March. These species are listed in Table 3-37. This criterion is being met.

3.5 Skookum Wulge

Based on the current long-term monitoring work plan, only two criteria, PSC 1 and BSC 7 are being monitored at Skookum Wulge.

3.5.1 PSC 1 – Intertidal Areal Coverage

Topographic surveying intended to determine the intertidal area for the Skookum Wulge site was planned but the plans were modified after inspecting site conditions. In 1999, the Trustees evaluated restoration alternatives for the Skookum Wulge site and decided that site conditions made the “no-action” alternative preferable. This approach was selected because the portion of the site amenable to restoration was a small knob of land that is exposed to significant erosive

force from wave action during storms. The beach side of the upland area is a ledge of sandy gravel about three feet tall that erodes during major storms. Because of these conditions, changes to site topography will focus on the ledge area. Consequently, the most effective way to measure the changes to the site is to survey the top and bottom edges of ledge. Figure 3-18 shows the results of this survey effort. Although this was the first year of monitoring, it appears that this criterion is being met.

3.5.2 BSC 7 – Fish Access / Presence

The Skookum Wulge site was successfully sampled for fish assemblage composition, salmonid diets, chemical contamination of sediments, and chemical contamination of fish tissue from selected species. Fish sampling occurred on an approximately biweekly basis through June, and continued monthly into October. The sediment sampling occurred in late June.

The customized fishing gear built for the project functioned as intended, with a few small modifications. Over the seven-month sampling period, 21 individual net sets were completed at the Skookum Wulge site. Beach seine samples were conducted with a 37-m floating "Puget Sound" beach seine.

Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The number of species (species richness or SR) per sampling event ranged from three (September) to 10 (June); a total of 19 different species (total species richness) were caught at the site during various sampling events, including chinook, coho, chum, pink, and cutthroat salmonids. Chum were most abundant with a peak in early May. These species are listed in Table 3-38. This criterion is being met at Skookum Wulge.

3.6 Yowkwala

Data to be collected at the Yowkwala site included marsh development/areal coverage (BSC 1), marsh development/species composition (BSC 2), and fish access/presence (BSC 7). Adolfson was to collect information for BSC 1 and BSC 2, while the NMFS was to obtain BSC 7 data.

3.6.1 BSC 1 and BSC 2 – Marsh Development / Areal Coverage

Marsh vegetation does not occur on the Yowkwala site, which is a gravel and cobble beach. Previously, old barges were present on the site. At that time, an approximately 10-foot by 15-foot (3 m by 4.6 m) patch of marsh vegetation was present in an area that appeared to be protected by the barges (J. Lantor, pers. comm., 2002). Once the barges were removed from the beach, cobbles filled in and covered the vegetated area. As a result, the small patch of marsh vegetation is no longer present on the site. This criterion is not being met. It is unlikely that a marsh will develop at Yowkwala unless significant site grading is undertaken. However, the site is currently functional as a gravelly beach and marsh creation is not recommended. There is reportedly a small area of dunes with some vegetation at the Yowkwala site. This area will be monitored in 2003.

3.6.2 BSC 7 – Fish Access / Presence

The Yowkwala site was successfully sampled for fish assemblage composition, salmonid diets, chemical contamination of sediments, and chemical contamination of fish tissue from selected species. Fish sampling occurred on an approximately biweekly basis through June, and continued monthly into October. The sediment sampling occurred in late June.

The customized fishing gear built for the project functioned as intended, with a few small modifications. Over the seven-month sampling period, 33 individual net sets were completed at the Yowkwala site. Beach seine samples were conducted with a 37-m floating "Puget Sound" beach seine.

Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The number of species (species richness or SR) per sampling event ranged from three (May) to 15 (June); a total of 26 different species (total species richness) were caught at the site during various sampling events, including chinook, coho, chum, pink, and cutthroat salmonids. Coho were the most abundant, peaking in mid-May; chinook were the next most

abundant with a peak in mid-June. These species are listed in Table 3-39. This criterion is being met at Yowkwala.

3.7 Olympic View

Based on the current long-term monitoring work plan, fish monitoring conducted by NMFS personnel in year 1 is the only monitoring activity planned for the Olympic View site.

3.7.1 BSC 7 – Fish Access / Presence

The Olympic View site was successfully sampled for fish assemblage composition, salmonid diets, chemical contamination of sediments, and chemical contamination of fish tissue from selected species. Fish sampling occurred on an approximately biweekly basis through June, and continued monthly into October. The sediment sampling occurred in late May and late June.

The customized fishing gear built for the project functioned as intended, with a few small modifications. Over the seven-month sampling period, 18 individual net sets were completed at the Olympic View site. Beach seine samples were conducted with a 37-m floating "Puget Sound" beach seine.

Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The number of species (species richness or SR) per sampling event ranged from five (mid-April) to 21 (late June); a total of 30 different species (total species richness) were caught at the site during various sampling events, including low numbers of chinook, chum, and pink salmon. Chinook were the most abundant with a peak in late May. These species are listed in Table 3-40. This criterion is being met at the Olympic View site.

3.8 Tahoma Salt Marsh

Based on the current long-term monitoring work plan, fish monitoring conducted by NMFS personnel in year 1 is the only monitoring activity planned for the Tahoma Salt Marsh site.

3.8.1 BSC 7 – Fish Access / Presence

The Tahoma Salt Marsh site was successfully sampled for fish assemblage composition, salmonid diets, chemical contamination of sediments, and chemical contamination of fish tissue from selected species. Fish sampling occurred on an approximately monthly basis from May through August and October. The sediment sampling occurred in late June.

The customized fishing gear built for the project functioned as intended, with a few small modifications. Over the sampling period, seven individual net sets were completed at the Tahoma Salt Marsh site. Beach seine samples were conducted with a 37-m floating "Puget Sound" beach seine.

Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The number of species (species richness or SR) per sampling event ranged from four (October) to 10 (July); a total of 20 different species (total species richness) were caught at the site during various sampling events, including chinook, coho, chum, and pink salmon. Pink were most abundant in a peak in late May. These species are listed in Table 3-41. This criterion is being met at the Tahoma Salt Marsh site.

4.0 SUMMARY AND RECOMMENDATIONS

4.1 Monitoring Summary and Other Observations for Selected Sites

Table 4-1 summarizes the performance criteria for the monitoring at each site during Year 1.

4.1.1 Mowitch

The Mowitch site was physically stable based on the survey work done in 2002, with the possible exception of localized slumping in the transition between the riparian habitat and the off-channel pool closest to the Hylebos Waterway. Installed riparian vegetation is beginning to take hold but is suffering from competition from white clover and dry hard soil conditions as observed in June 2002. The sprinkler system was subsequently activated, which improved conditions by the end of the summer 2002, although monitoring data were not collected at that time to quantify improvements. Furthermore, a re-planting event was initiated in November 2002 when several hundred individual potted plants were installed (Table 4-2). Organic-rich topsoil was placed around each of the new plants to improve the chances of success.

Marsh vegetation is doing reasonably well at Mowitch where plants were installed and where goose exclusion devices are in place to protect the plants. There has been some colonization by volunteer species but this has not resulted in significant vegetative cover to date. Presumably, colonization will occur in coming years but in-fill planting in the marsh area is worth consideration.

Invertebrates are using the site and usage should increase (both in numbers and species diversity) as the plant community expands in the future, creating additional habitat. Fish are using the site, including several juvenile salmonid species. It is not clear whether the salmonids are originating in the Hylebos Creek or from another watershed such as the Puyallup River. Bird use of the site is significant, including a variety of terrestrial and shore birds.

4.1.2 Squally Beach

Squally Beach is physically stable based on the 2002 survey work. There are three erosional features that were visually noted but were too small to pick up in the survey. Surface runoff from Marine View Drive flowing around the east end of the riparian berm has caused some localized rill erosion. This could be reduced by placing a small quantity (less than one cubic yard) of cobbles (2″ to 4″ diameter) in the rill. Secondly, the surface water flowing from the eastern rock box has created a distinct channel between the rock box and the mud flats. This could be alleviated by redirecting the water across the marsh bench to the west, creating a longer, slower flow path. Finally, there is erosion on the landward side of several toe logs. This seems to be caused by water flowing under the logs after waves overtop them. Judicious placement of cobbles in the space that has developed should control this problem.

Riparian vegetation at Squally Beach was dominated by sweet clover. The CHB volunteers arranged at least one weed-pulling event (after the monitoring) to manage this species. This was followed by in-fill planting in November 2002, which should improve coverage in the riparian area after the new plants become established.

Marsh vegetation is doing well at the site. Informal site observations in late summer and fall 2002 indicate that the coverage significantly increased later in the growing season. The coverage of brass buttons continues to expand, which may be problematic although some reference sources do consider it to be a beneficial species.

As with Mowitch, invertebrates are using the Squally Beach site and usage should increase (both in numbers and species diversity) as the plant community expands in the future. Fish use of the site is quite limited, probably because of the broad shallow mudflats separating Squally Beach from the Hylebos Waterway. No juvenile salmonid species were collected at the site. Bird use of the site is significant, including a variety of terrestrial species and shore birds. The purple martin boxes located on pilings adjacent to the site are an excellent feature that should be maintained or supplemented if possible.

4.1.3 Middle Waterway (Simpson/Trustees)

Although a direct comparison with historical survey data was not possible, there are no signs of major physical instability based on the 2002 survey work. There is some erosion occurring on the northeastern portion of site that may be associated with re-directed wave energy since logs have been placed to protect nearby marsh vegetation. It is appropriate to consider remedies for this problem.

The riparian vegetation community seems to be developing well, which is consistent with the fact that it was planted several years ago. As such, this vegetation has had considerable time to become established.

The marsh vegetation, particularly tufted hairgrass, is doing well in isolated areas that are protected by goose exclusion devices. Soil characteristics at the site may be a limiting factor. The substrate is a mineral soil (sand and silt) that lacks organic matter and perhaps other nutrients. Consideration should be given to testing the soils to evaluate the need for soil amendments, particularly if in-fill planting is contemplated. Goose exclusion devices should also be installed as a part of any planting effort.

Invertebrate use of the site is similar to that found at the other sites. Fish usage is somewhat limited by the elevation of the site. A wide variety of birds are using the site.

4.1.4 Yowkwala and Skookum Wulge

These rocky beach sites are adjacent to a significant corridor for out-migrating salmonid and were also heavily used by many other fish species. With the exception of debris removal from Yowkwala, neither site was actively restored. The fish usage results indicate the importance of protecting these sites and other similar areas to provide suitable habitat.

4.2 Monitoring Recommendations

Based on the field study and results of the Year 1 monitoring of sites near Commencement Bay, we have the following suggestions:

- The plastic mesh embedded in the erosion control matting at the Squally Beach and Mowitch sites does not appear to be decomposing. During the field survey, the plastic had come loose in places and was tangled around debris that had been carried in by the tide or was "balled up" on the ground. It is our recommendation that loose netting be removed from these sites as the opportunity arises.

- Routine maintenance of the herbivory exclusion devices is needed to keep the devices functional. In addition, those made entirely of rebar and rope would likely benefit from having chicken wire added to the sides of the devices.

- For future monitoring of the sites, we recommend that the herbivory avoidance devices be surveyed so that the location of the devices can be shown on site drawing. Overlaying the herbivory exclusion devices with the transect line will clearly show on a figure which quadrat data was taken from within a device.

- Control of weedy species, especially in the Squally Beach riparian area, would reduce the potential for small planted vegetation to be shaded-out or otherwise stressed by more aggressive non-natives.

- Some native plants had showed evidence that they had started to leaf out, but had died or nearly perished. In some cases, this may have been due to lack of water. Ensuring that the irrigation system is working properly will increase the potential for survival.

- Benthic invertebrate sampling locations should be moved to lower elevations to increase the probability of encountering target species.

- Capturing fish, particularly salmonids, at Squally Beach is likely to be very challenging because the site is at a high elevation with relatively flat slopes. These conditions leave a very short window to collect fish and appropriately high tides occur in the evening during the spring and summer months.

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FIGURES

TABLES

APPENDIX A

Photos

APPENDIX B

Daubenmire Method

APPENDIX C

2002 Fish Monitoring Report

Figure 1-1. Vicinity Map

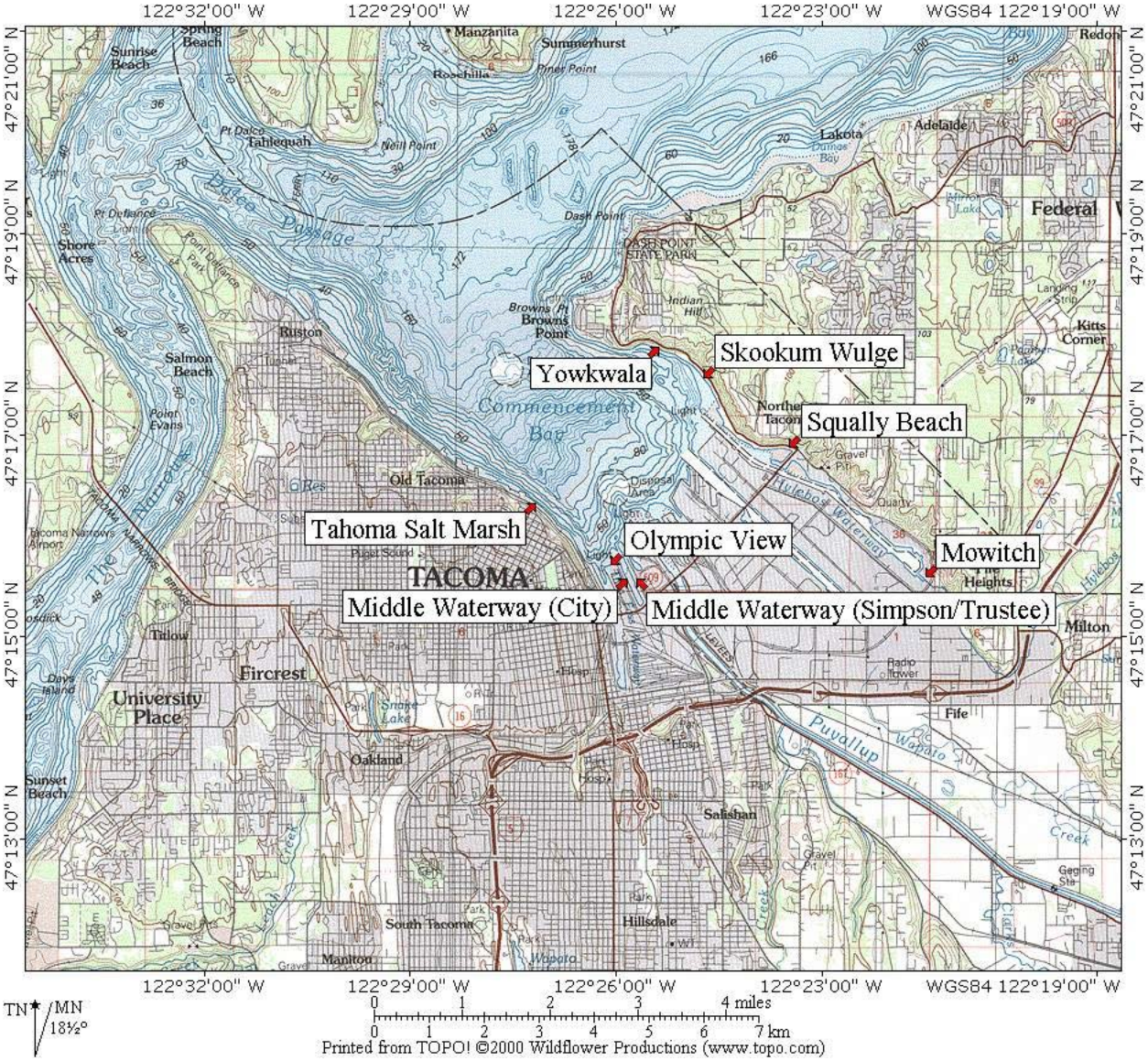
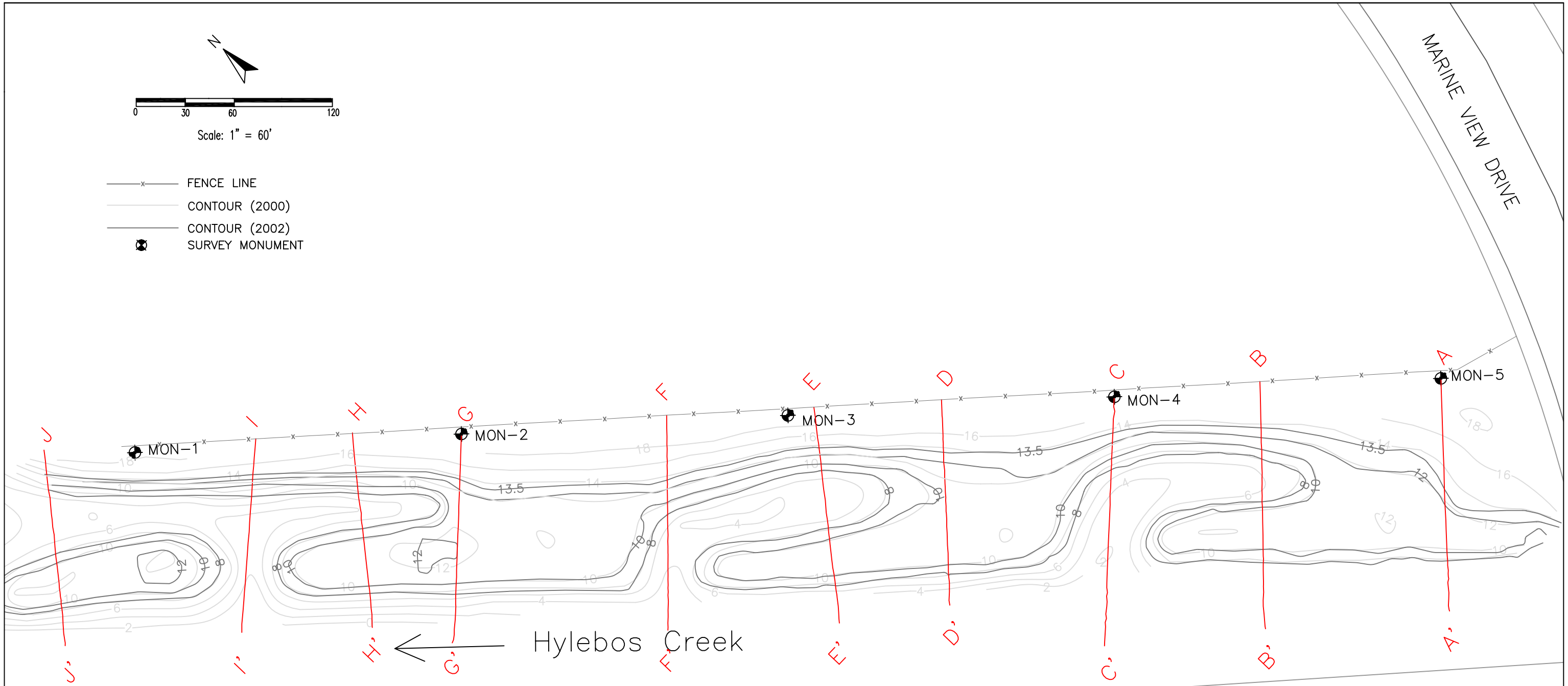


Figure 1-2. Location of Habitat Restoration Sites



Monument	Easting	Northing	Elev.
MON-1	1,178,660.61	708,407.48	16.93
MON-2	1,178,806.51	708,270.52	18.86
MON-3	1,178,952.25	708,133.62	19.37
MON-4	1,179,098.07	707,996.78	17.64
MON-5	1,179,243.96	707,859.95	18.02

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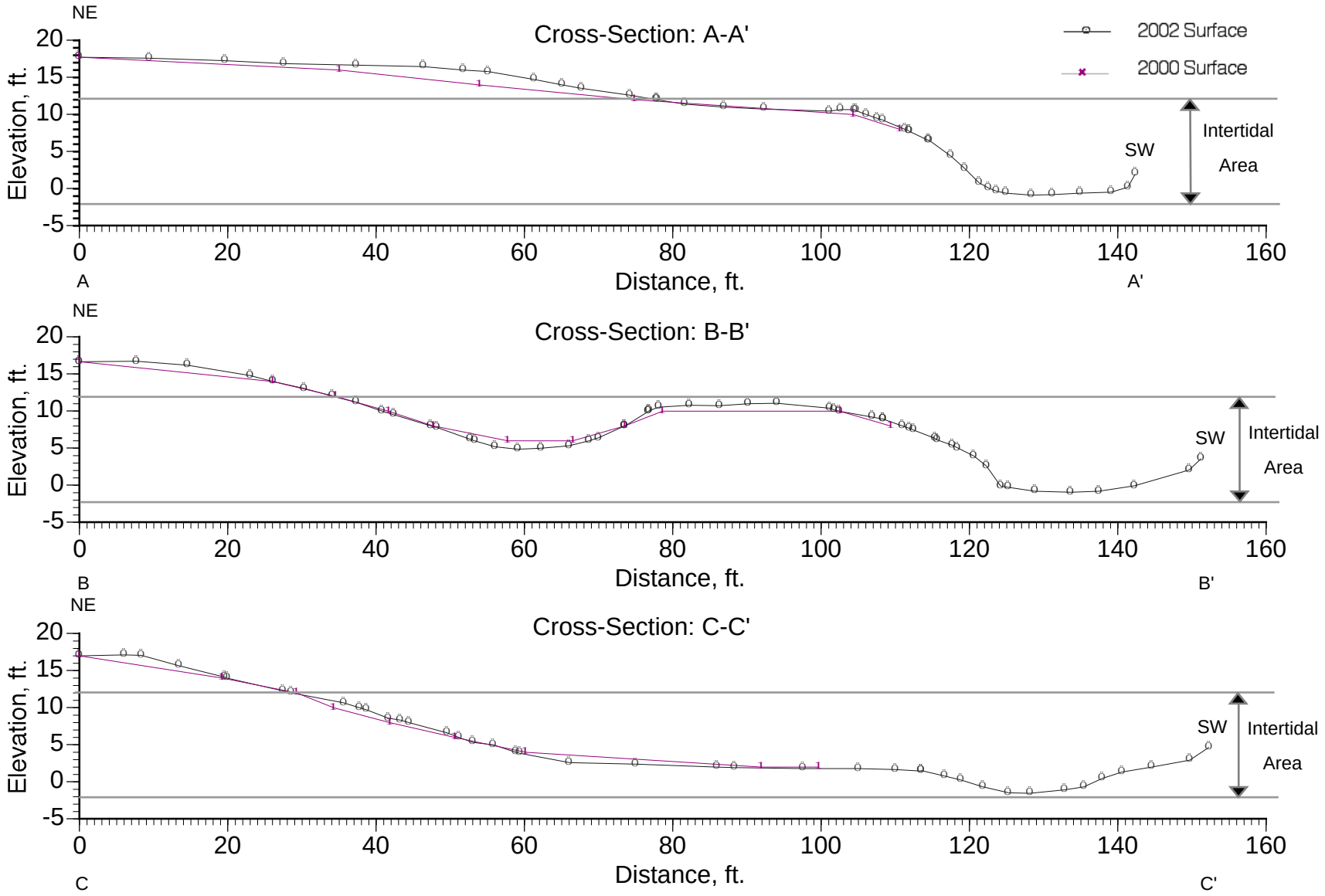
COMMENCEMENT BAY RESTORATION
YEAR 1 (2002) MONITORING REPORT

Mowitch Site Plan

Drawing No. 3-1

Project No. 460B3

Mowitch_Veg.dwg



NOTE: Elevations are in feet above mean lower low water.

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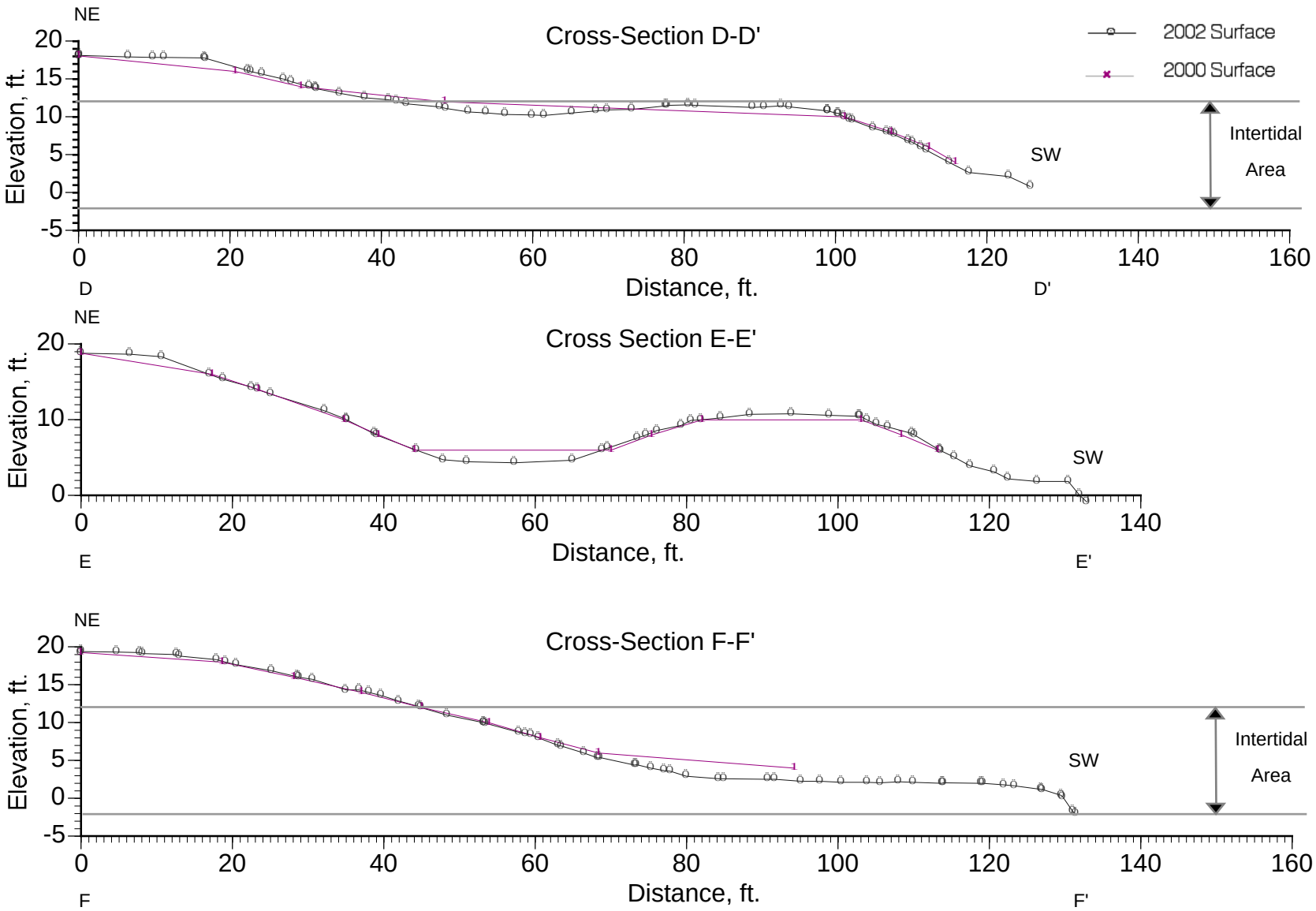
Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay

Figure 3-2

Mowitch Cross-Sections A-A' through C-C'



NOTE: Elevations are in feet above mean lower low water.

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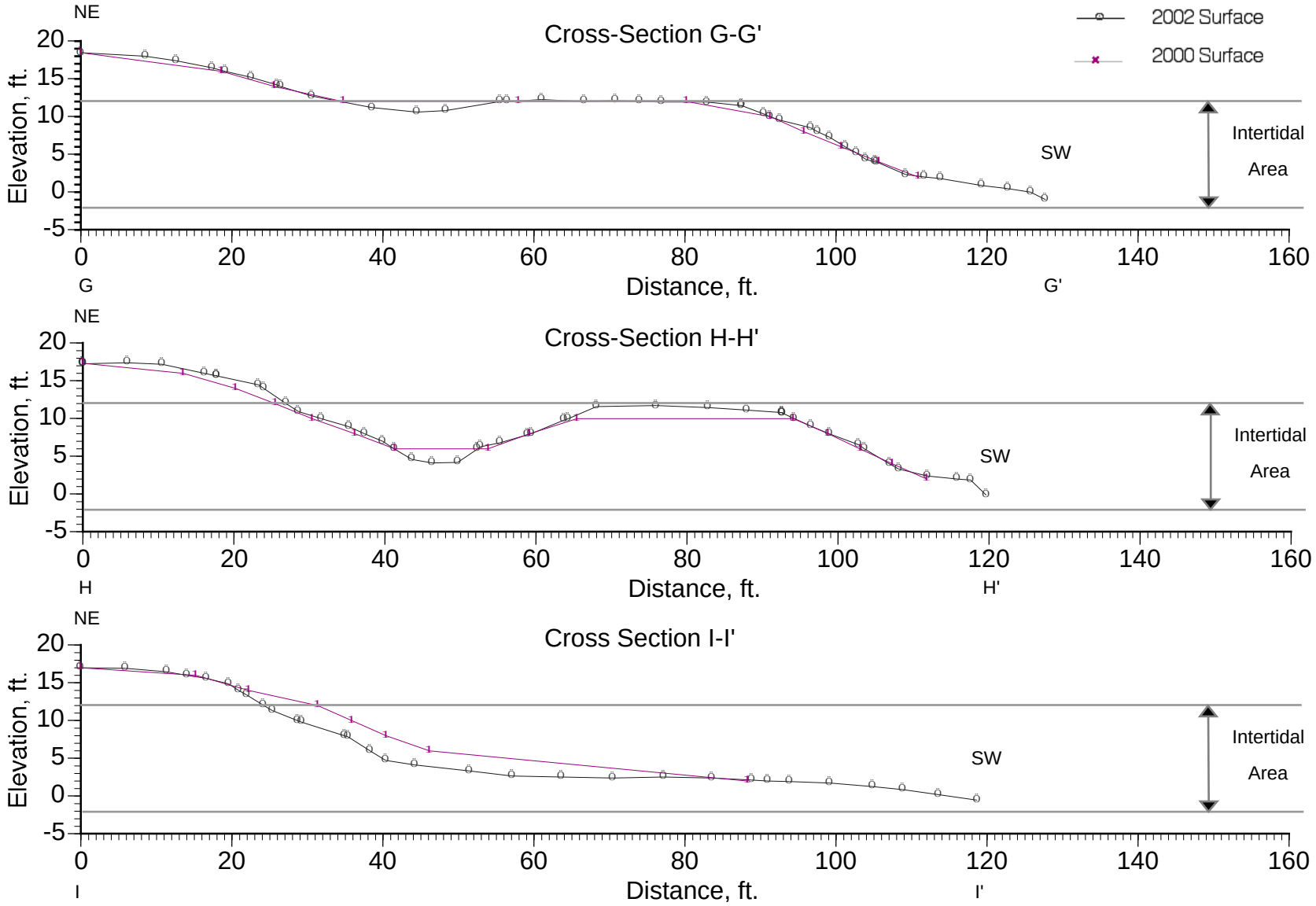
Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay

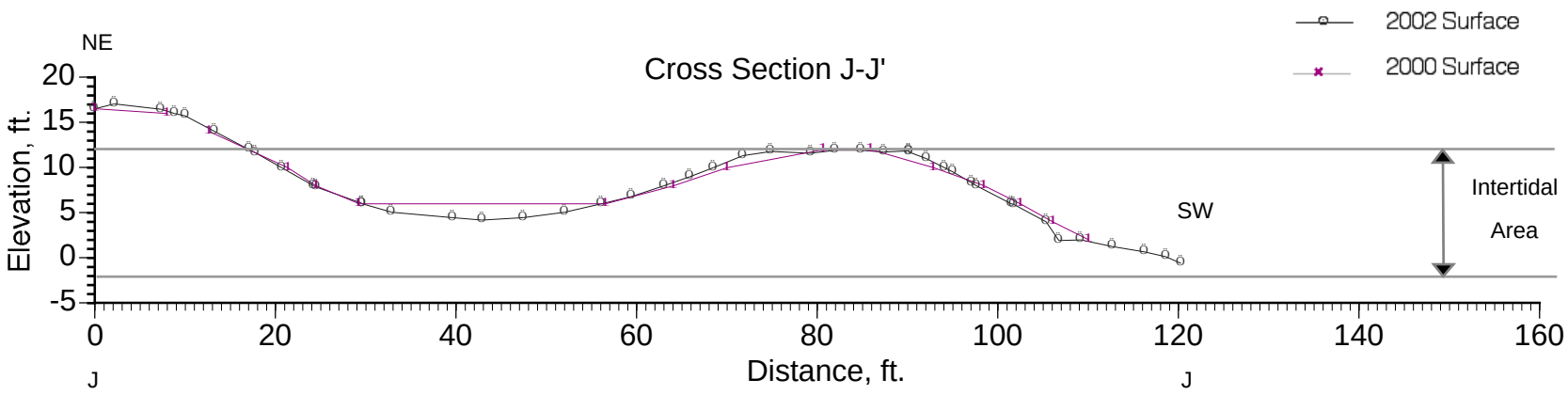
Figure 3-3

Mowitch Cross-Sections D-D' through F-F'



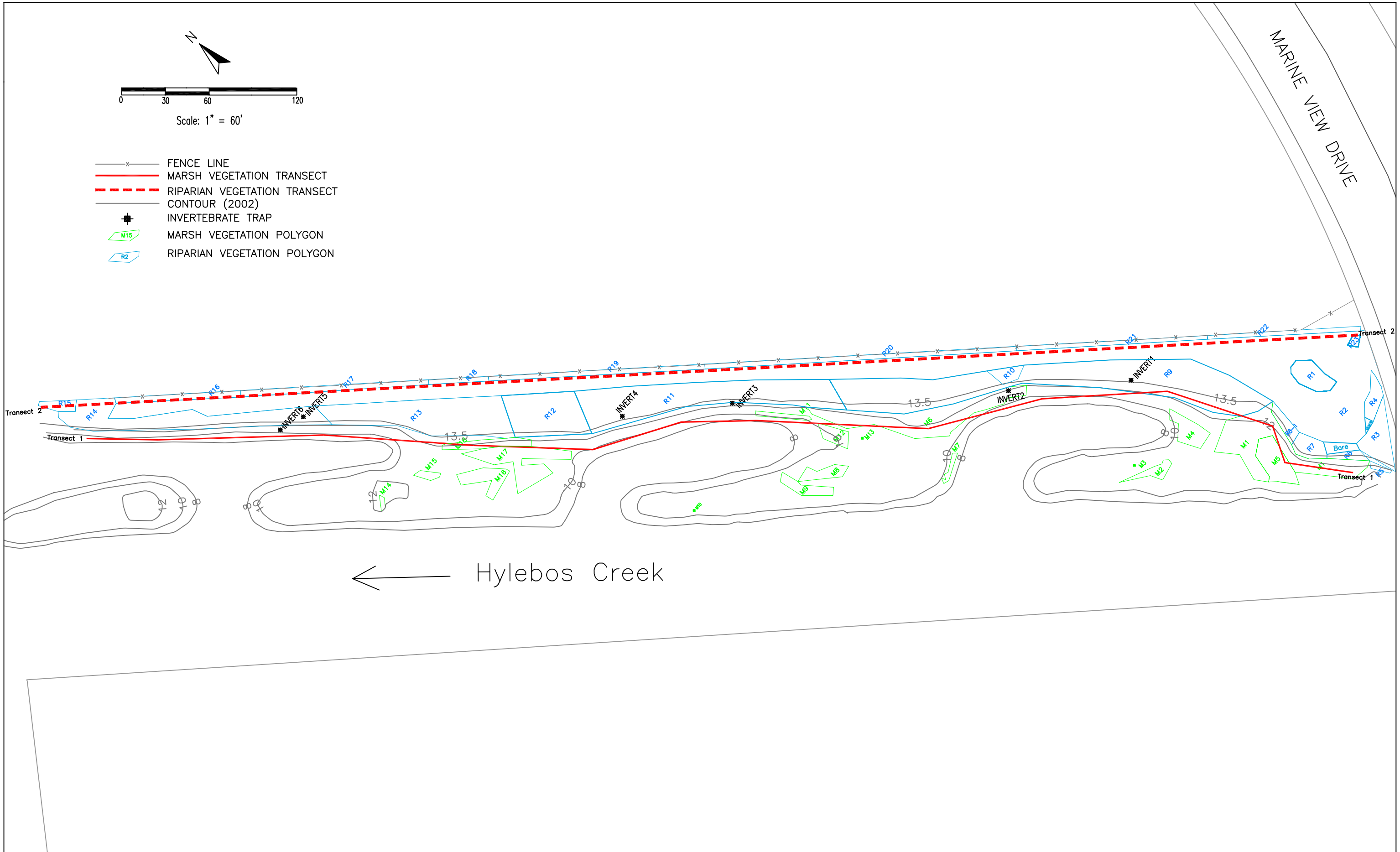
NOTE: Elevations are in feet above mean lower low water.

RIDOLFI Inc.	Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay	Figure 3-4
		Mowitch Cross-Sections G-G' through I-I'



NOTE: Elevations are in feet above mean lower low water.

RIDOLFI Inc.	Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay	Figure 3-5 Mowitch Cross-Section J-J'



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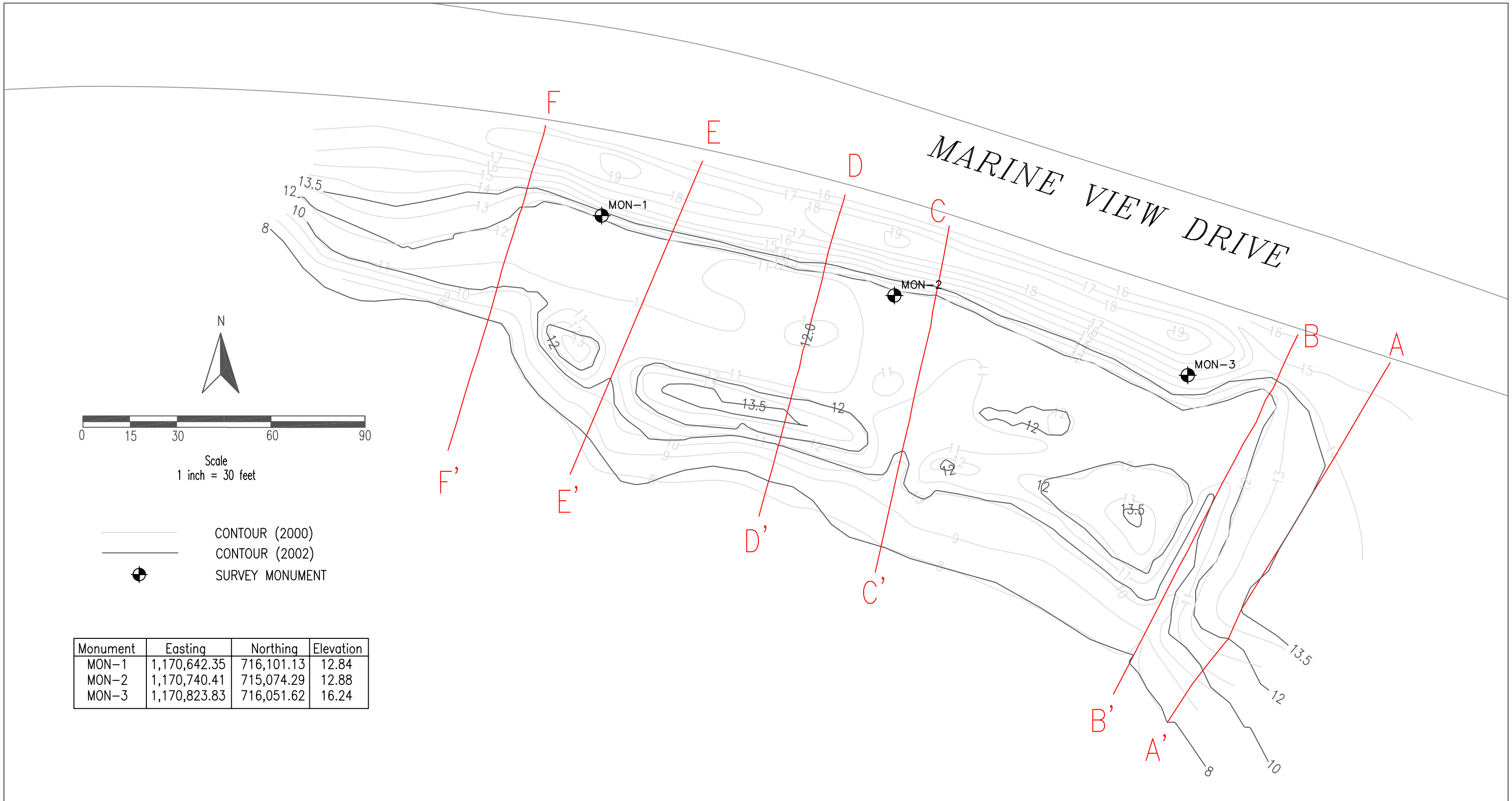
COMMENCEMENT BAY RESTORATION
YEAR 1 (2002) MONITORING REPORT

Mowitch Marsh and Riparian Vegetation Coverage

Drawing No. 3–6

Project No. 460B3

Mowitch_Veg.dwg



Monument	Easting	Northing	Elevation
MON-1	1,170,642.35	716,101.13	12.84
MON-2	1,170,740.41	715,074.29	12.88
MON-3	1,170,823.83	716,051.62	16.24

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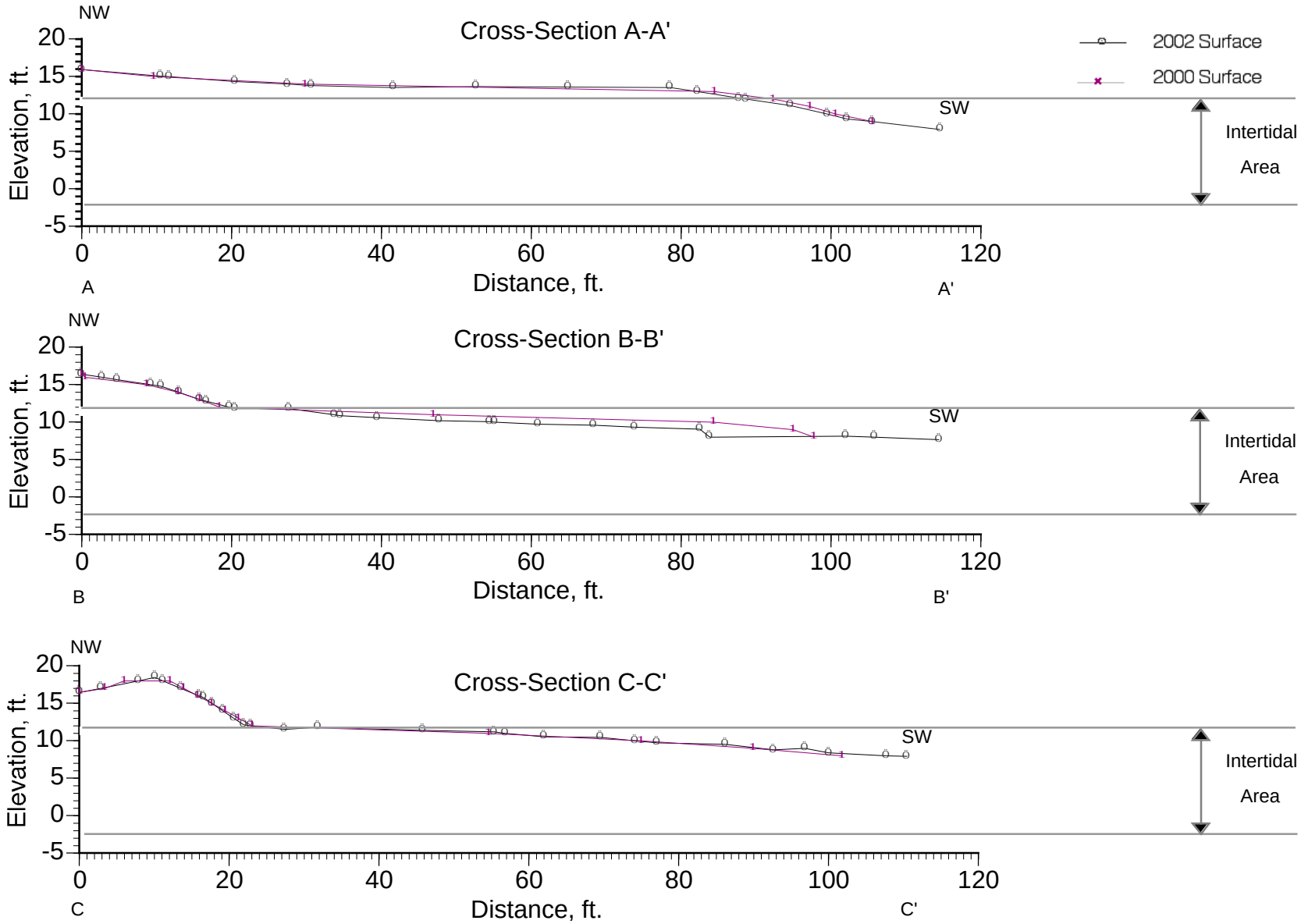
COMMENCEMENT BAY RESTORATION
YEAR 1 (2002) MONITORING REPORT

Squally Beach Site Plan

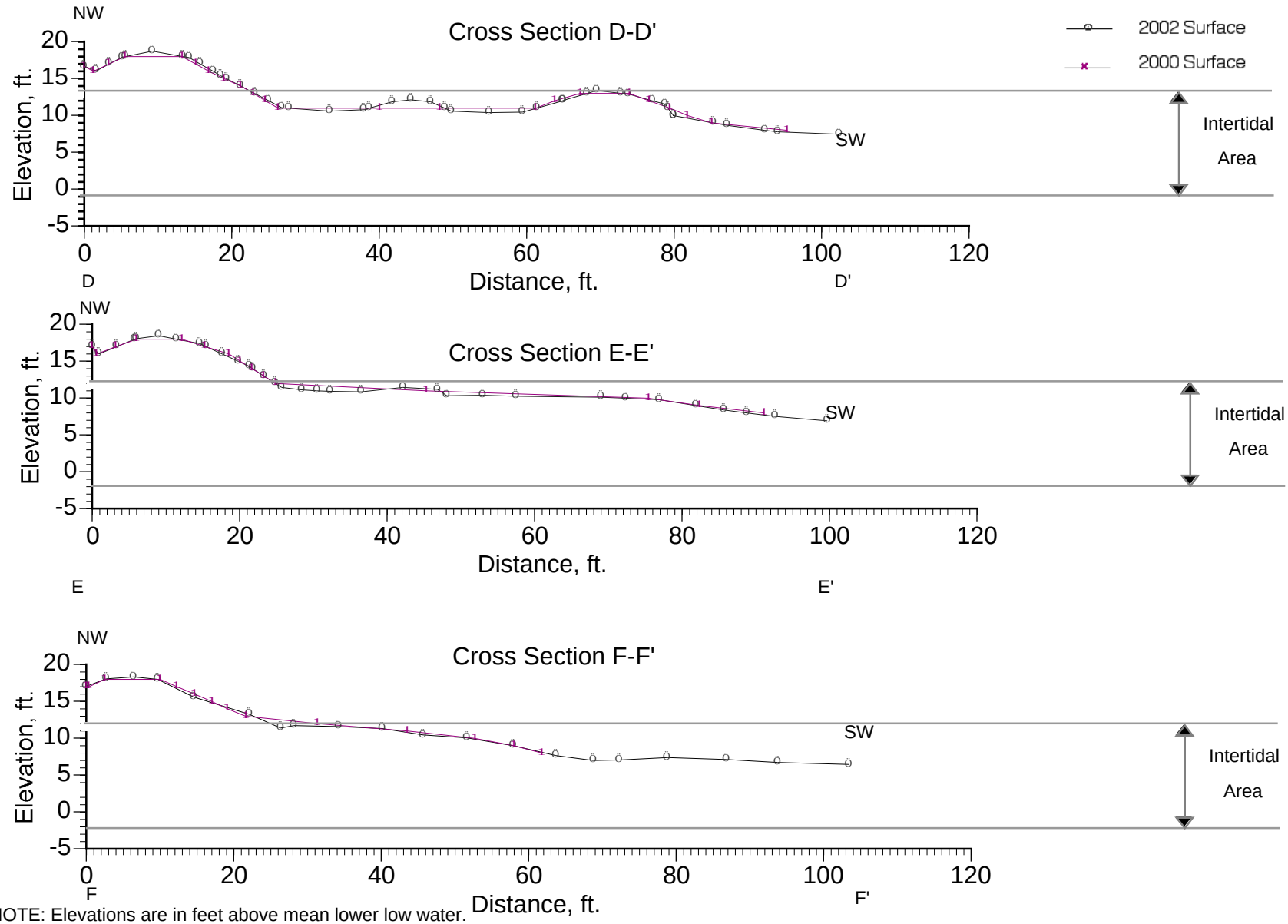
Drawing No. 3-7

Project No. 460B3



NOTE: Elevations are in feet above mean lower low water.

RIDOLFI Inc.	Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay	Figure 3-8 Squally Beach Cross-Sections A-A' through C-C'



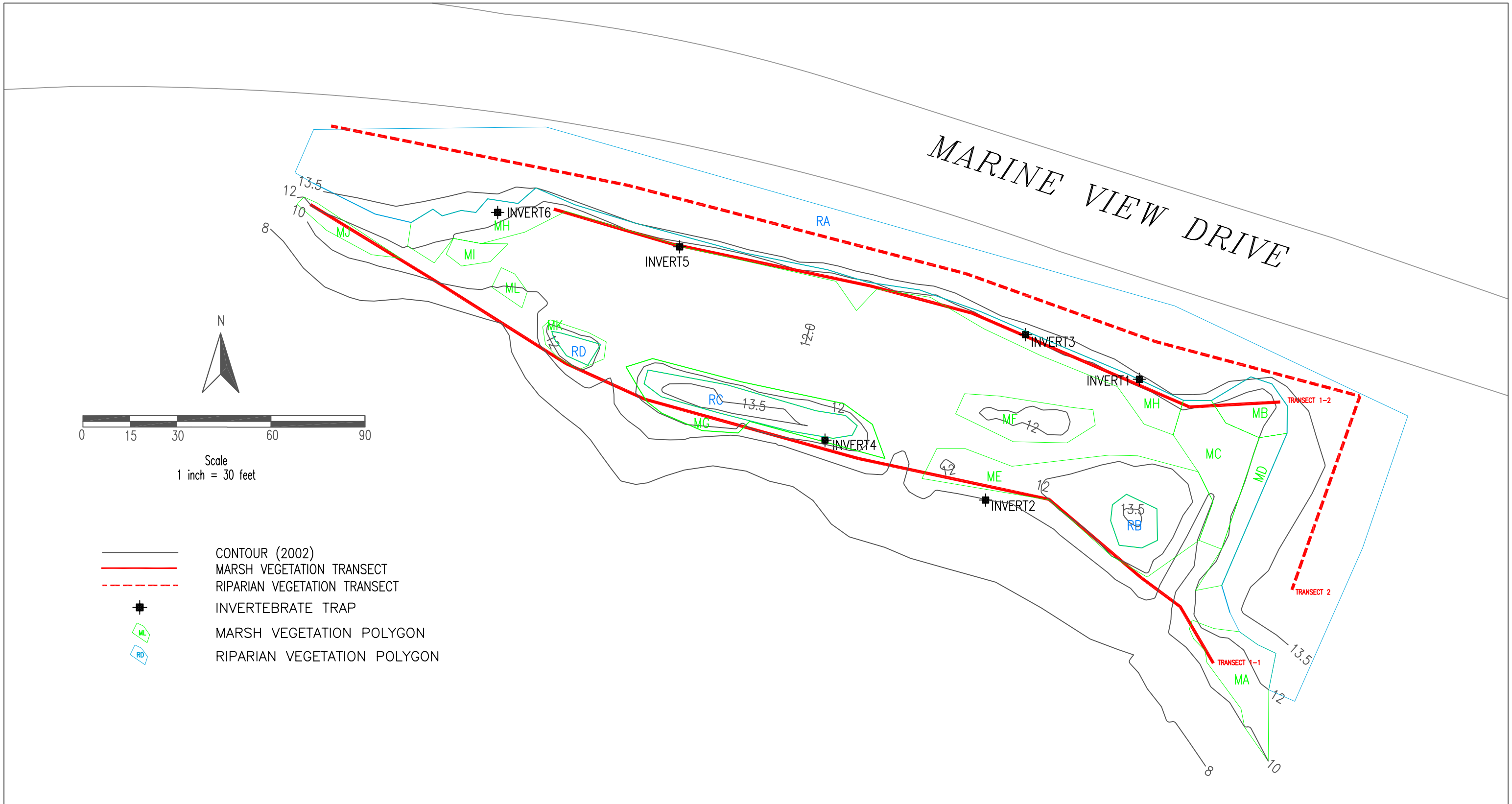
NOTE: Elevations are in feet above mean lower low water.

RIDOLFI Inc.

Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay

Figure 3-9

Squally Beach
Cross-Sections D-D' through F-F"



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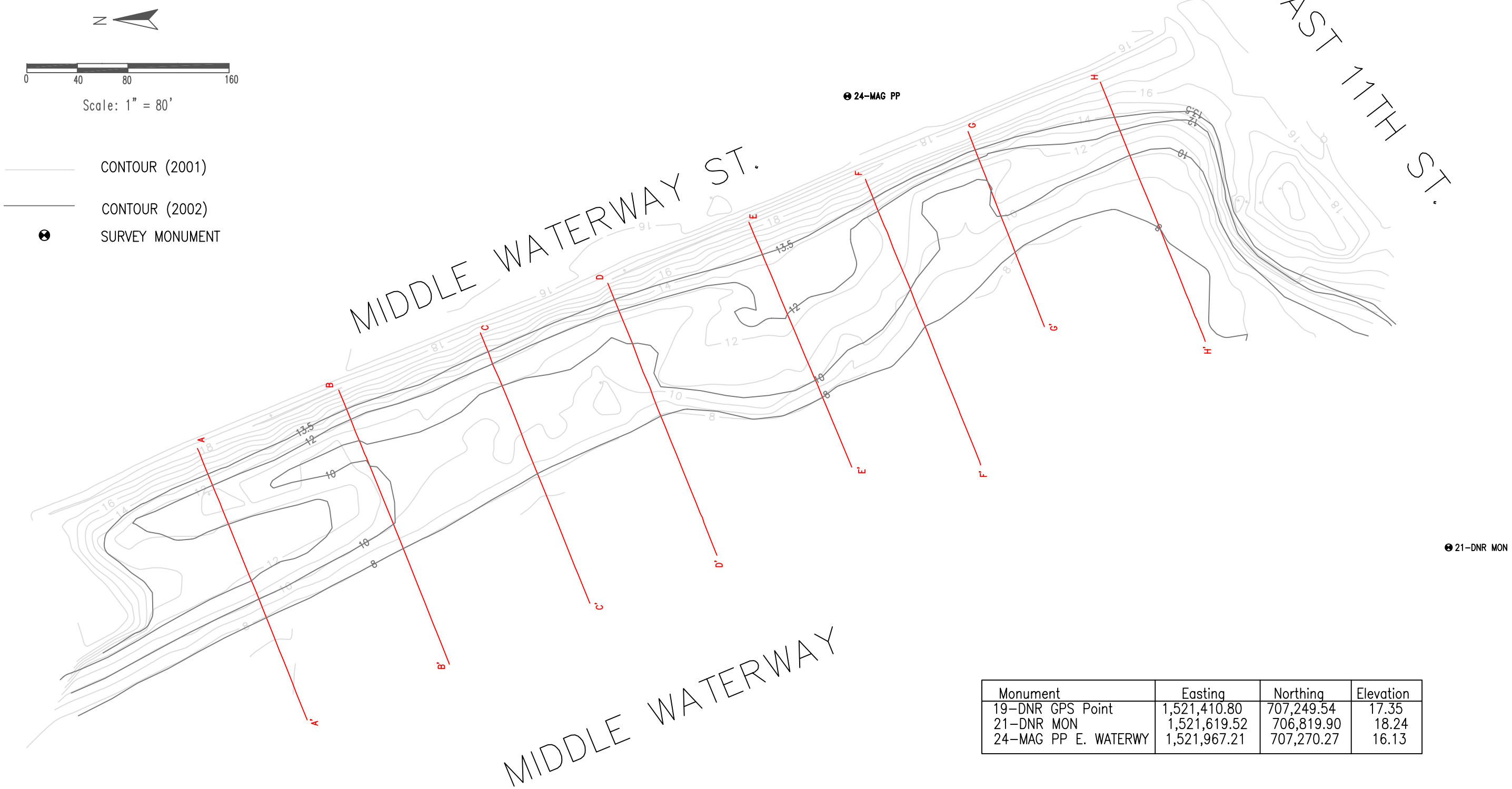
COMMENCEMENT BAY RESTORATION
YEAR 1 (2002) MONITORING REPORT

Squally Beach Marsh and Riparian Vegetation Coverage

Drawing No. 3-10

Project No. 460B3



Monument	Easting	Northing	Elevation
19-DNR GPS Point	1,521,410.80	707,249.54	17.35
21-DNR MON	1,521,619.52	706,819.90	18.24
24-MAG PP E. WATERWY	1,521,967.21	707,270.27	16.13

REV.	DATE	DESCRIPTION	DWN BY	DES BY	CHK BY	APP BY

RIDOLFI Inc.

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APPROVED BY	BAR

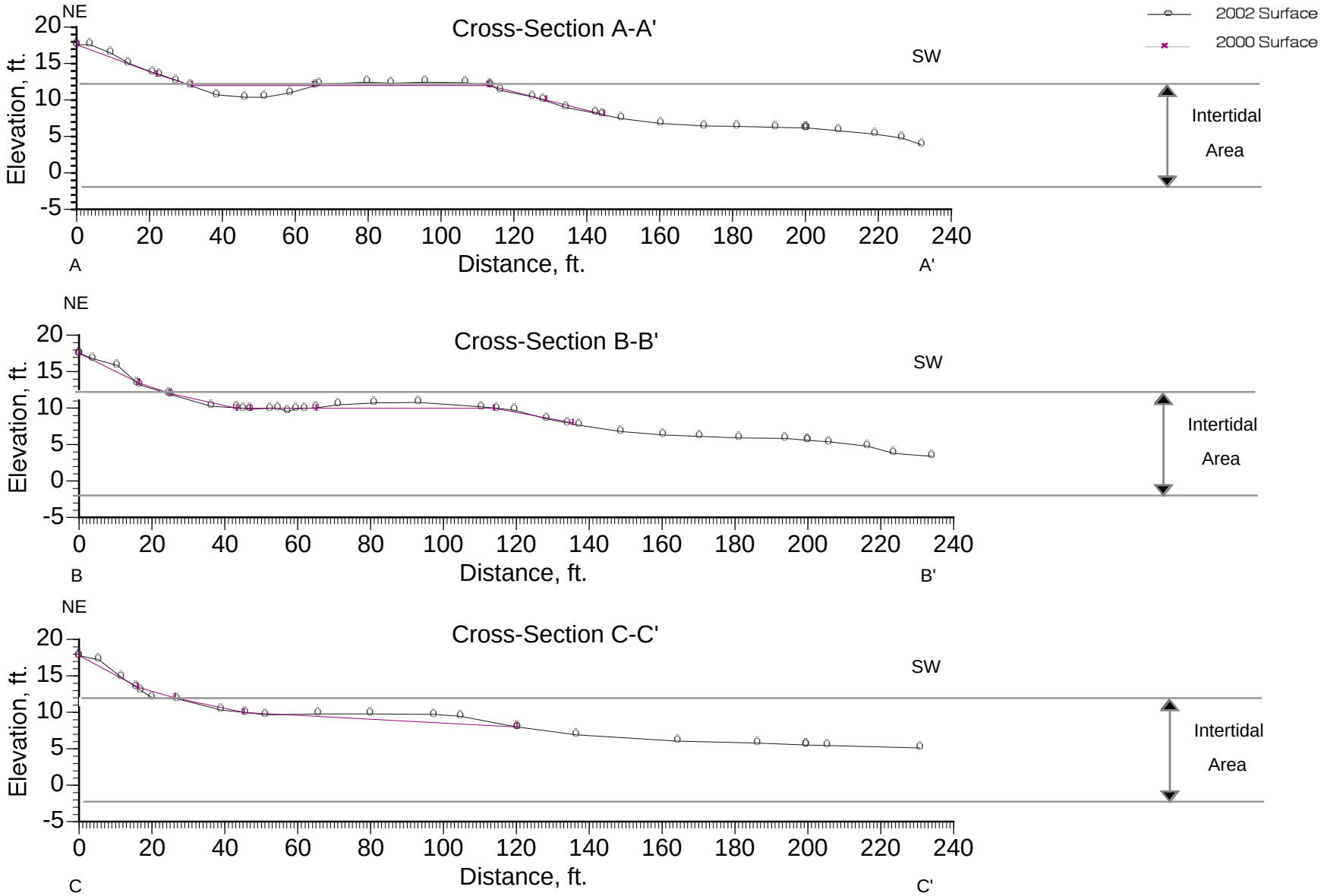
COMMENCEMENT BAY RESTORATION
YEAR 1 (2002) MONITORING REPORT

Middle Waterway (Simpson/Trustee)
Site Plan

Drawing No.
3-11

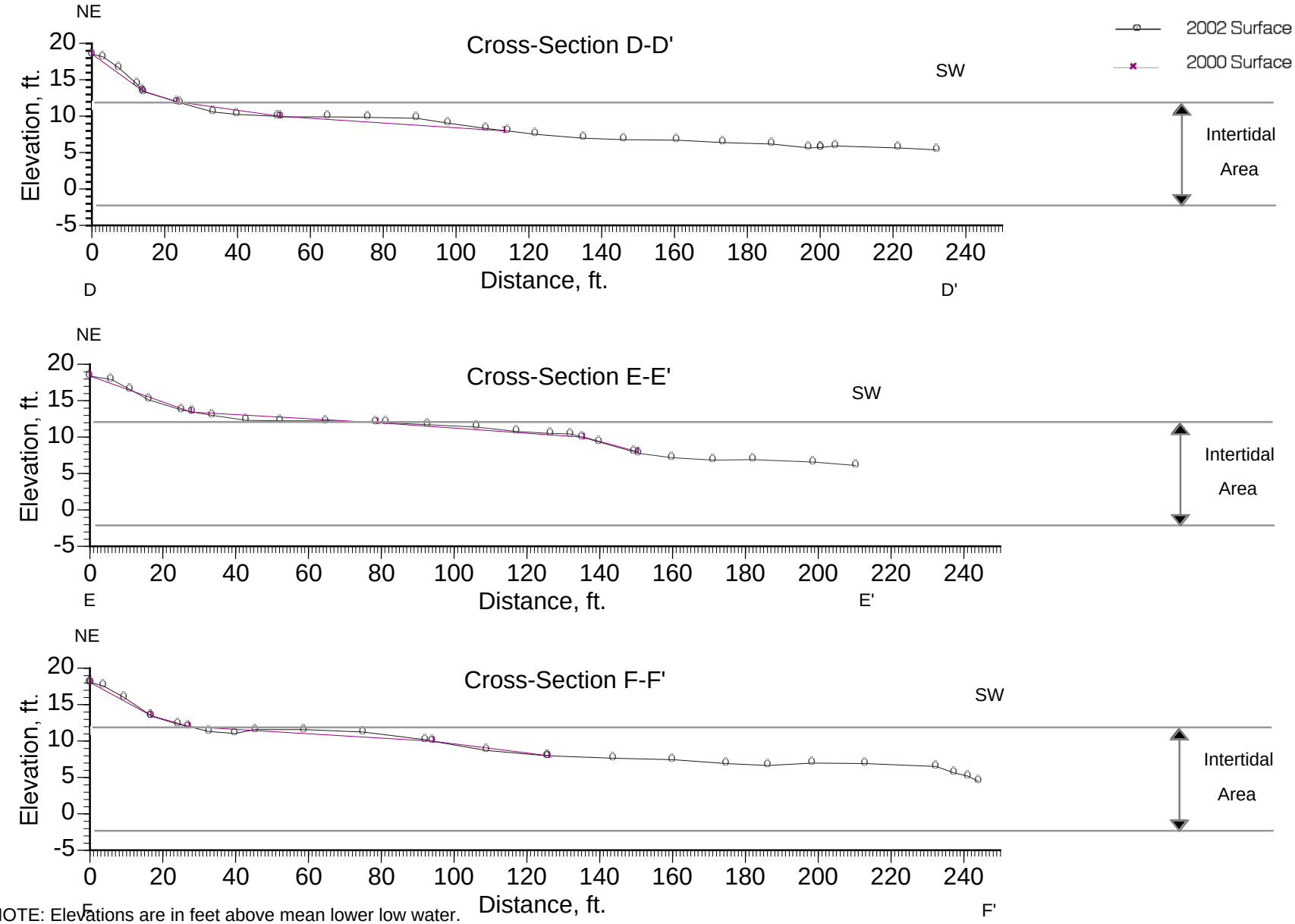
Project No.
460B3

Sf42mpsn1.dwg



NOTE: Elevations are in feet above mean lower low water.

RIDOLFI Inc.	Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay	Figure 3-12 Middle Waterway (Simpson/Trustee) Cross-Sections A-A' throug C-C'



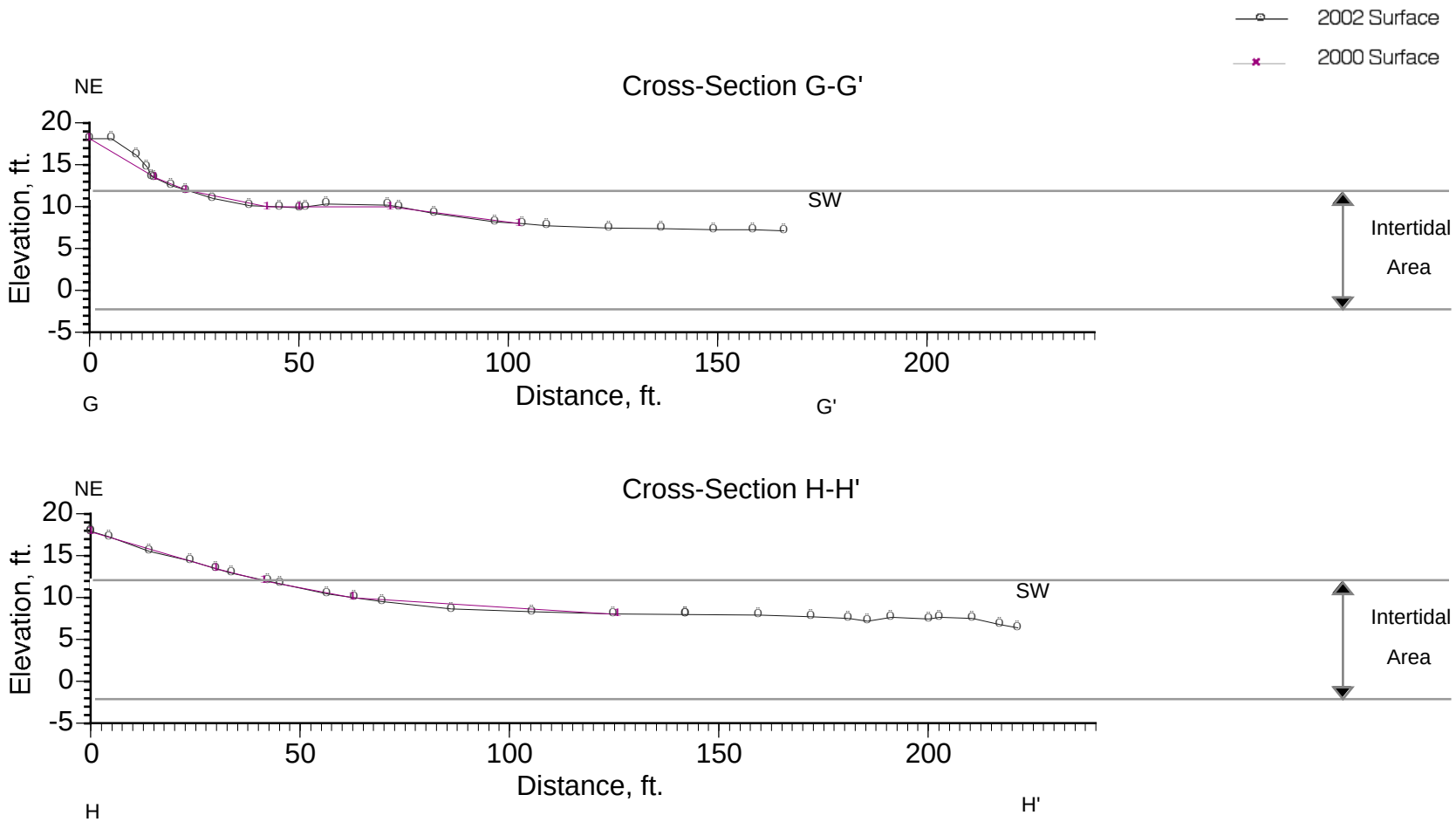
NOTE: Elevations are in feet above mean lower low water.

RIDOLFI Inc.

Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay

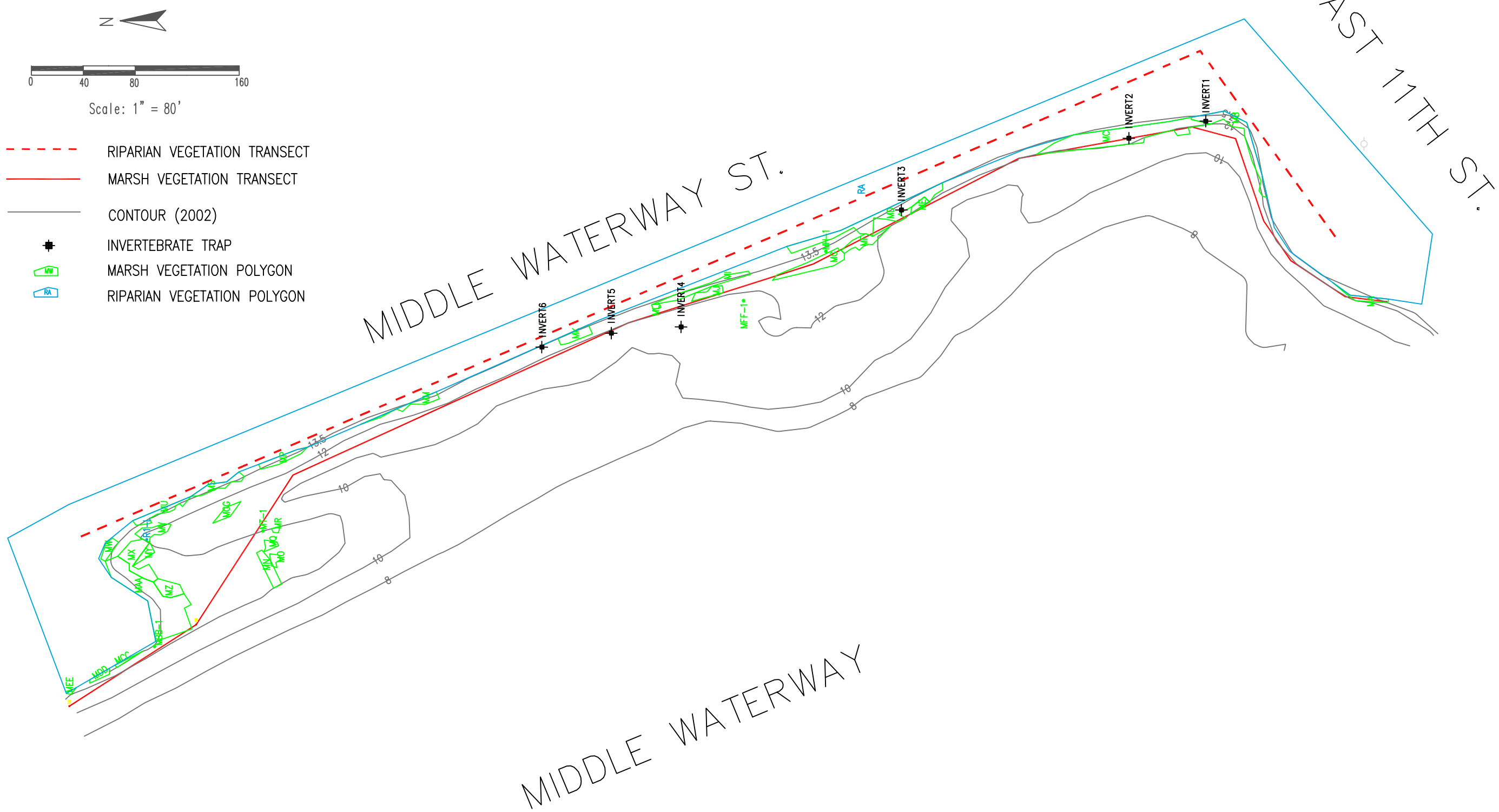
Figure 3-13

Middle Waterway (Simpson/Trustee) Cross-Section D-D' through F-F'



NOTE: Elevations are in feet above mean lower low water.

RIDOLFI Inc.	Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay	Figure 3-14 Middle Waterway (Simpson/Trustee) Cross-Sections G-G' through H-H'



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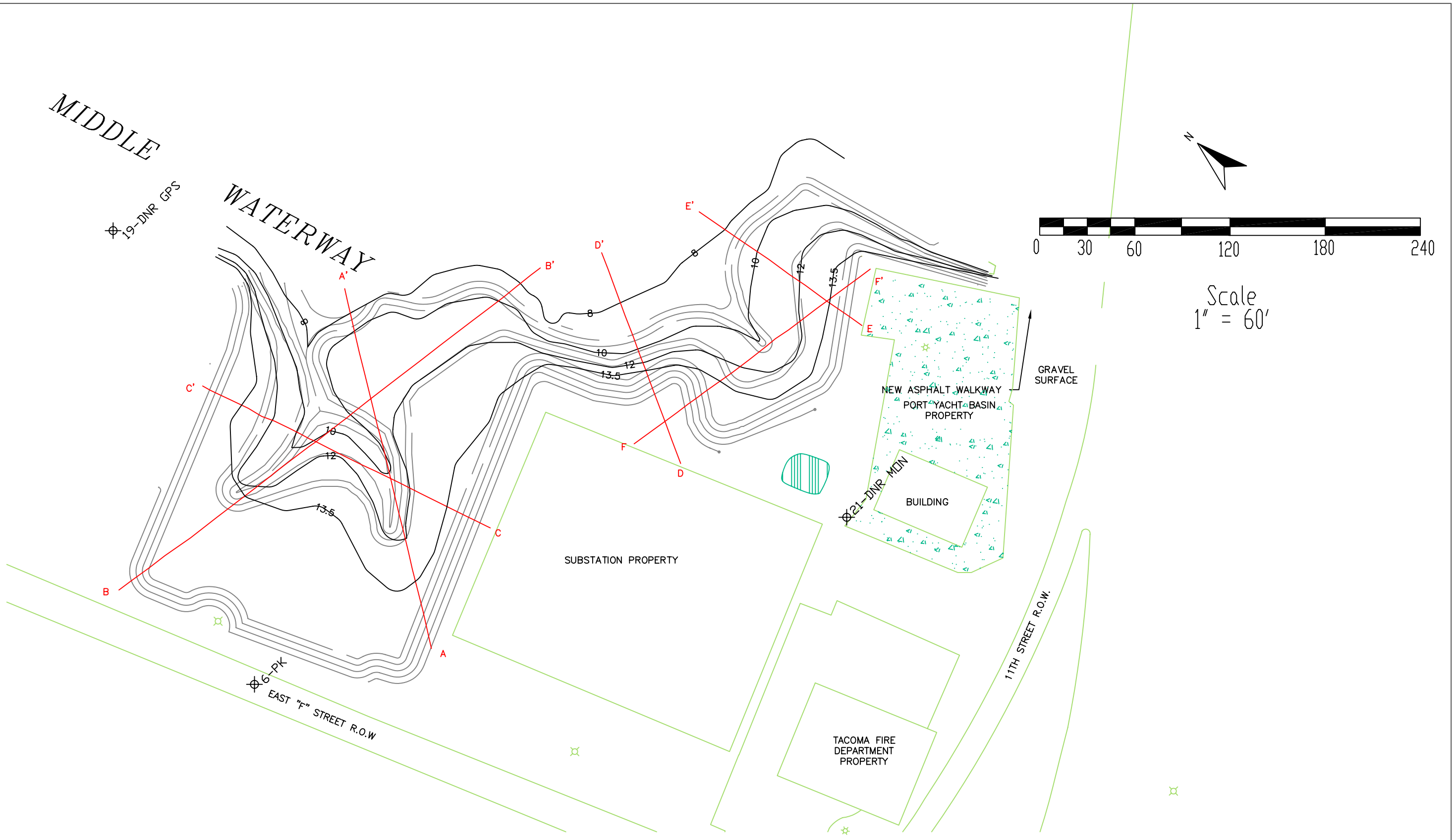
COMMENCEMENT BAY RESTORATION
YEAR 1 (2002) MONITORING REPORT

Middle Waterway (Simpson/Trustee)
Marsh and Riparian Vegetation
Coverage

Drawing No.
3-14B

Project No.
460B3

Si42mpsn1.dwg



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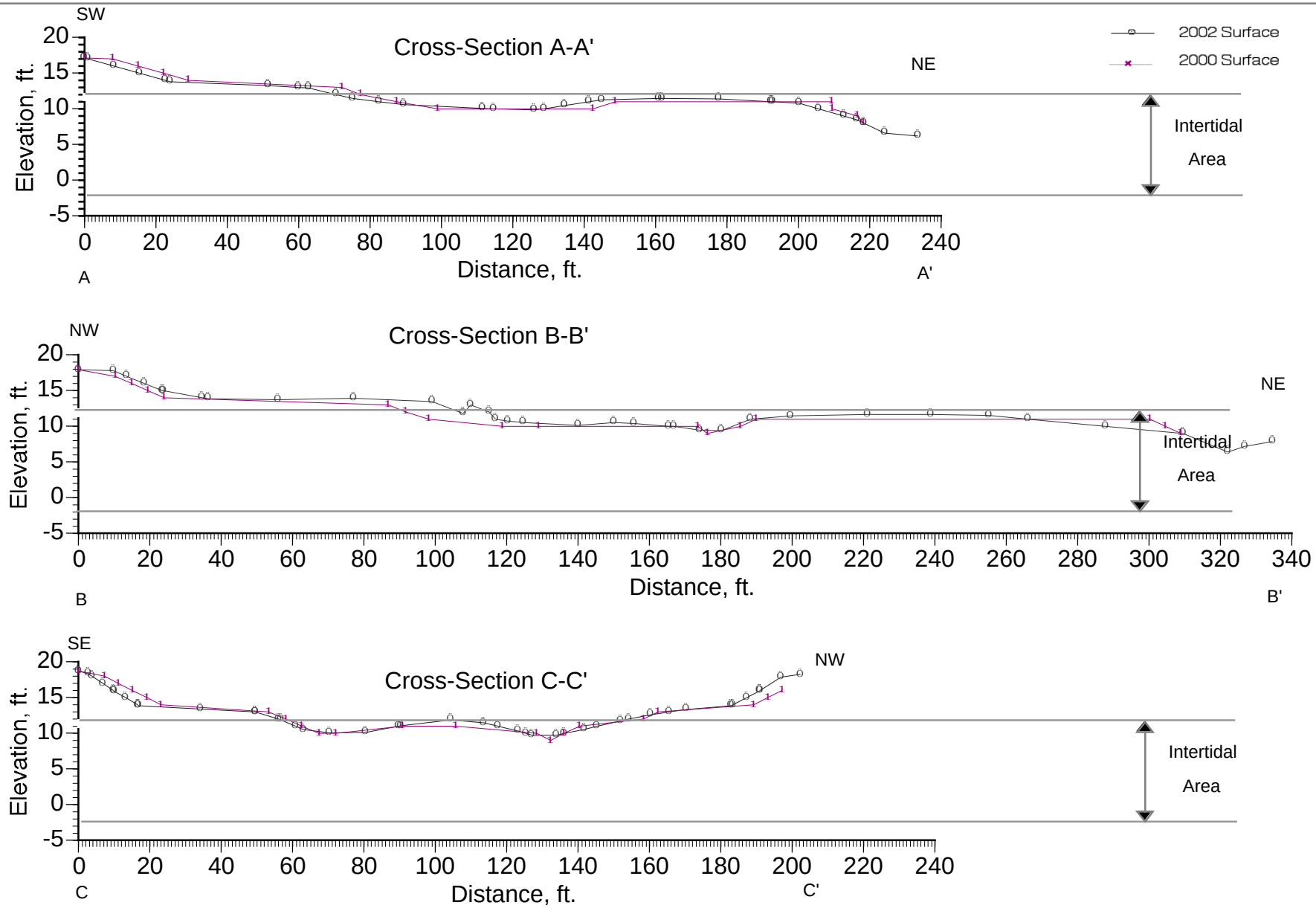
COMMENCEMENT BAY RESTORATION
YEAR 1 (2002) MONITORING REPORT

Middle Waterway (City of Tacoma)

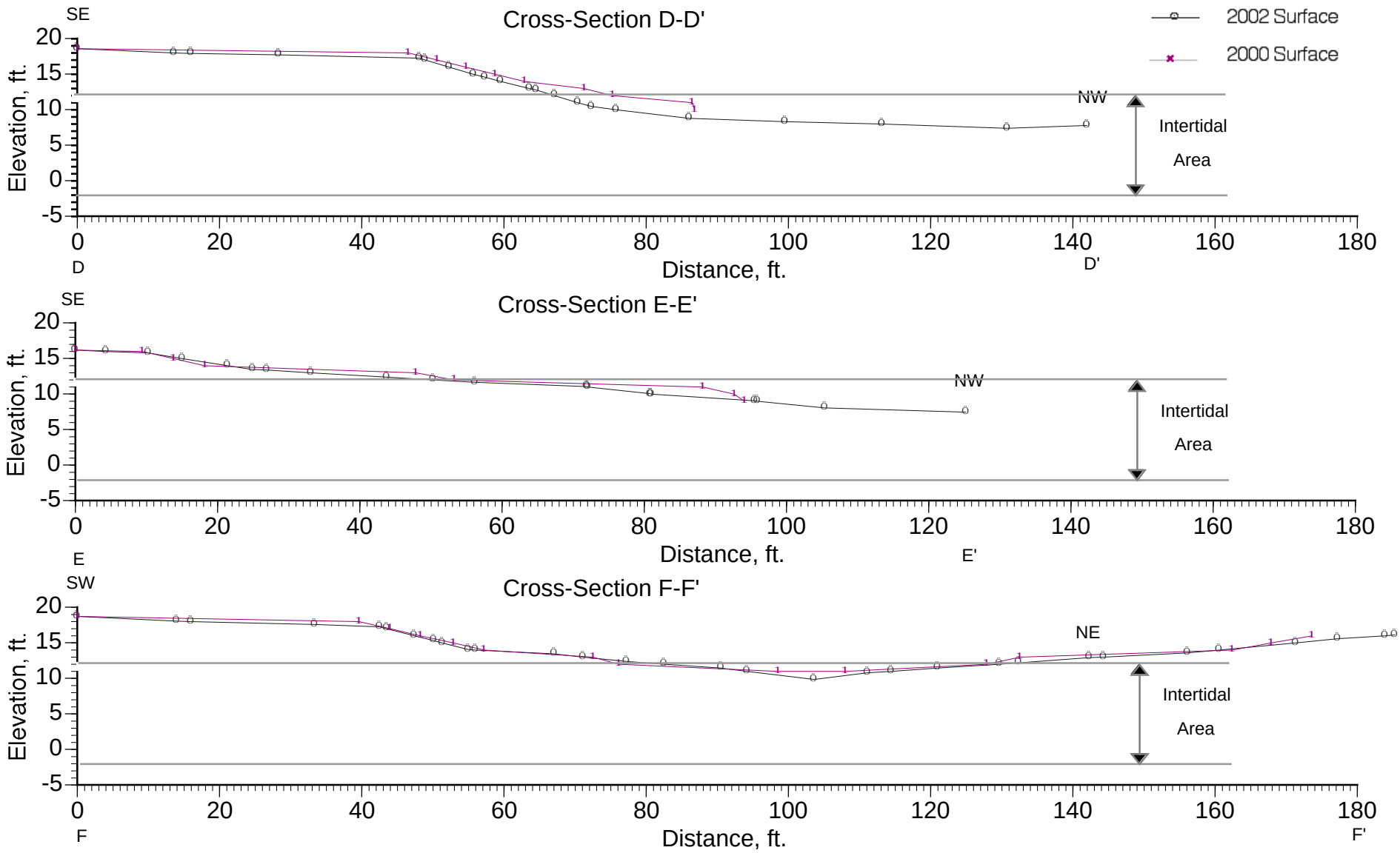
Drawing No. 3-15

Project No. 460 B3



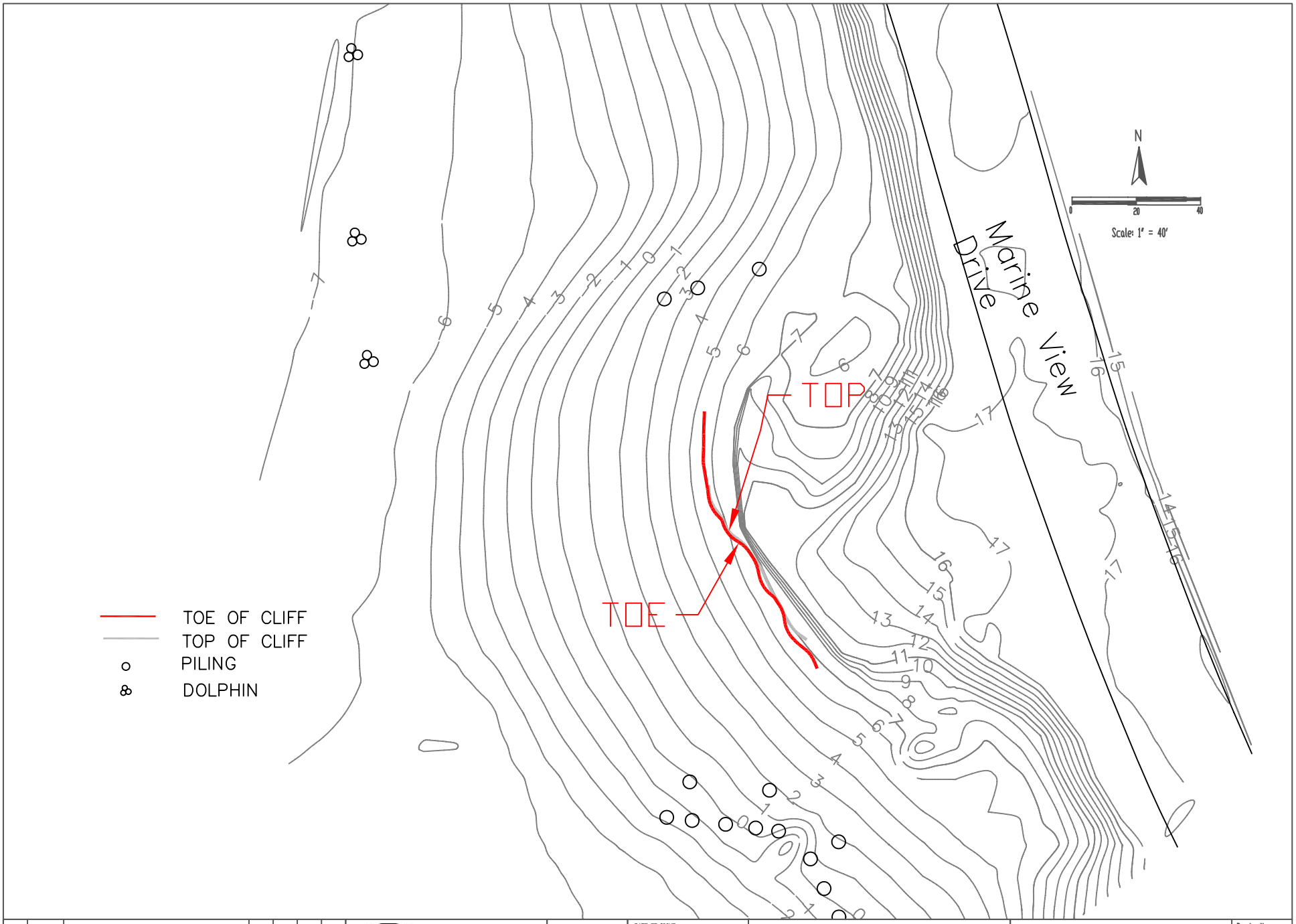
NOTE: Elevations are in feet above mean lower low water.

RIDOLFI Inc.	Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay	Figure 3-16 Middle Waterway (City of Tacoma) Cross-Section A-A' through C-C'



NOTE: Elevations are in feet above mean lower low water.

RIDOLFI Inc.	Year 1 (2002) Monitoring for Habitat Restoration Sites in Commencement Bay	Figure 3-17 Middle Waterway (City of Tacoma) Cross-Section D-D' through F-F'



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COMMENCEMENT BAY RESTORATION
YEAR 1 (2002) MONITORING REPORT

Skookum Wulge Site Plan

Drawing No.
3-18

Project No.
460 B3

Table 1-1. Plants Installed at Mowtich and Squally Beach

Scientific Name	**Common Name**	Mowitch	Squally Beach
Trees			
Pseudotsuga menziesii	Douglas Fir	Yes	Yes
Tsuga heterophylla	Western Hemlock	Yes	Yes
Acer macrophyllum	Big Leaf Maple	Yes	Yes
Alnus rubra	Red Alder	Yes	Yes
Shrubs			
Cornus sericea	Red-Osier Dogwood	Yes	Yes
Mahonia nervosa	Oregon Grape	Yes	Yes
Holodiscus discolor	Oceanspray	Yes	Yes
Rosa nutkana	Nootka Rose	Yes	Yes
Salix hookeriana	Hooker's Willow	Yes	Yes
Gaultheria shallon	Salal	Yes	Yes
Symphoricarpos albus	Common Snowberry	Yes	Yes
Corylus cornuta	Hazelnut	Yes	Yes
Sambucus racemosa	Red Elderberry	Yes	Yes
Ribes sanguineum	Red-Flowering Currant	Yes	Yes
Hydroseeded Grasses and Forbs			
Festuca rubra	Red fescue	Yes	Yes
Lolium perenne var	Barclay Perennial Rye	Yes	Yes
Lupinus albicaulis	Sickle-Keeled Lupine	Yes	Yes
Anaphalis margaritacea	Pearly Everlasting	Yes	Yes
Emergents			
Carex lyngbyei	Lyngby's Sedge	Yes	Yes
Distichlis spicata	Salt Grass	Yes	Yes
Jaumea carnosa	Fleshy Jaumea	Yes	Yes
Salicornia virginia	Pickleweed	No	Yes
Scirpus Americanus	American 3-Square Rush	No	Yes
Triglochim martimum	Seaside Arrowgrass	No	Yes
Deschampsia caespitosa	Tufted Hairgrass	Yes	Yes
Scirpus maritimus	Seacoast Bullrush	No	Yes

Table 2-1. Monitoring Conducted in Year 1 (2002) by Site and Parameter

	Physical Success Criteria				**Biological Success Criteria**								
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Site Name	Intertidal Areal Coverage	Intertidal Stability	Tidal Circulation	Elevation and Channel Morphology	Marsh Development/Areal Coverage	Marsh Development/Species Composition	Marsh Development/ Plant Vigor	Marsh Development/ Herbivory Avoidance	Riparian Vegetation Survival	Riparian Vegetation/Areal Coverage	Fish Access / Presence	Invertebrate Prey Resource Production	Bird Use
Mowitch	X	X	X	X	X	X	X	X	X	X	X	X	X
Squally Beach	X	X	X	X	X	X	X	X	X	X	X	X	X
Middle Waterway (Trustee/Simpson)	X	X		X	X	X	X	X	X	X	X	X	X
Middle Waterway (City of Tacoma)	X	X		X							X		
Yowkwala					X						X		
Skookum Wulge	X										X		
Olympic View											X		
Tahoma Salt Marsh											X		

Table 2-2. Relationship Between Vertical Datums in Commencement Bay

Datum Plane	**MLLW (feet)**	**NGVD 29 (feet)**
Highest Estimated Tide	15.50 +/- 0.5	9.18 +/- 0.5
Mean Higher High Water	11.84	5.52
Mean High Water	10.96	4.64
Mean (Half) Tide Level	6.91	0.59
NGVD	6.32	0
Mean Low Water	2.86	-3.46
Mean Lower Low Water	0	-6.32
Lowest Estimated Tide	-4.50 +/- 0.5	-10.82 +/- 0.5

MLLW: mean lower low water
NGVD 29: National Geodetic Vertical Datum of 1929
Source: U.S. Army Corps of Engineers webpage:
www.nws.usace.mil/hh/tides/sp/spgo.htm

Table 3-1. Marsh and Riparian Areal Cover by Polygon at Mowitch

Vegetation Polygon	Percent Cover	Dominant Species
M1	30	*Triglochin maritimum, Atriplex patula*
M2	50	*Eleocharis* sp.
M3	60	*Eleocharis* sp.
M4	40	*Eleocharis* sp.
M5	70	*Eleocharis* sp.
M6	60	*Atriplex patula, Carex lyngbyei, Cotula coronopifolia*
M7	35	*Eleocharis* sp.
M8	45	*Cotula coronopifolia*
M9	35	*Eleocharis* sp.
M10	40	*Eleocharis* sp.
M11	35	*Eleocharis* sp.
M12	50	*Eleocharis* sp.
M13	45	*Eleocharis* sp.
M14	35	*Triglochin maritimum*
M15	35	*Triglochin maritimum*
M16	40	*Triglochin maritimum, Cotula coronopifolia*
M17	50	*Eleocharis* sp.
M18	50	*Triglochin maritimum, Cotula coronopifolia, Atriplex patula*
R1	75	*Lupinus* sp., *Lolium perenne*
R2	25	grass spp.
R3	90	*Lupinus* sp.
R4	70	*Lolium perenne*
R5	40	*Epilobium* sp.
R6	75	*Lotus corniculatus, Trifolium pratense*
R7	60	*Lotus corniculatus, Melilotus alba*
R8	60	*Trifolium* sp., *Lupinus* sp., *Lotus corniculatus, Melilotus alba*
R9	60	*Lotus corniculatus, Melilotus alba*
R10	85	*Lupinus* sp.
R11	55	*Lupinus s* p., *Melilotus alba*
R12	50	*Lotus corniculatus*
R13	75	*Lupinus* sp.
R14	60	*Lupinus* sp., *Melilotus alba*
R15	100	*Melilotus alba, Rubus discolor, Cirsium arvense,* unknown mustard
R16	70	*Cirsium* sp., *Lupinus* sp., *Lotus corniculatus, Melilotus alba*
R17	60	*Cirsium arvense, C. vulgare*
R18	50	*Festuca* sp., *Agrostis* sp., *Lotus corniculatus*
R19	80	*Cirsium arvense, C. vulgare*
R20	80	*Festuca* spp., *Lotus corniculatus, Lupinus* sp.
R21	45	*Lotus corniculatus, Lupinus* sp.
R22	90	*Cirsium arvense, Lupinus* sp., *Festuca* sp.
R23	45	*Chrysanthemum leucanthemum, Festuca arundinacea, Plantago lanceolata*

Note: In Vegetation Polygon column, M=Marsh polygon; R=Riparian polygon

Table 3-2. Quadrat Locations Along Marsh and Riparian Transects at Mowitch

Marsh Transect 1		Riparian Transect 2	
Quadrat	**Distance Along Transect (ft)**	**Quadrat**	**Distance Along Transect (ft)**
1	37	1	37
2	39	2	41
3	80	3	80
4	86	4	86
5	137	5	136
6	142	6	142
7	158	7	158
8	165	8	165
9	171	9	171
10	206	10	206
11	243	11	243
12	245	12	247
13	272	13	272
14	274	14	276
15	315	15	315
16	354	16	354
17	366	17	366
18	370	18	370
19	375	19	375
20	440	20	440
21	444	21	444
22	446	22	448
23	472	23	472
24	474	24	476
25	481	25	481
26	483	26	485
27	519	27	519
28	536	28	536
29	552	29	552
30	573	30	573
31	588	31	588
32	640	32	640
33	656	33	656
34	669	34	669
35	674	35	674
36	690	36	690
37	695	37	695
38	718	38	718
39	734	39	734
40	748	40	748
41	758	41	758
42	770	42	770
43	803	43	803
44	859	44	859
45	861	45	863
46	898		

Table 3-3. Marsh Development at Mowitch - Percent Cover

Common Name	Scientific Name	Average % Cover	Quadrat 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
American glasswort, pickleweed	***Salicornia virginica***	Trace																T																															
colonial bentgrass	*Agrostis tenuis*	3.0																																	3													
fireweed	*Epilobium angustifolium*	1.0					T																											1		2												
Lyngby's sedge	***Carex lyngbyei***	7.0													15			10	2	1																												
orache, fat-hen saltbush	***Atriplex patula***	8.5	15	20		1	10	5	2			5			10	2	5	20	15	15	25													5	5	T		2							T	10	10	5
seaside arrow-grass	***Triglochin maritimum***	28.7		1																														10	75													
seaside plantain	***Plantago maritima***	8.8		5	T	30												T																															
seashore saltgrass	***Distichlis spicata***	10.5															20																		1													
spike-rush	*Eleocharis sp.*	Trace			T																																											
tufted hairgrass	***Deschampsia cespitosa***	1.3	1	2																																												
Non-Native or Invasive[1]																																																
brass buttons	*Cotula coronopifolia*	9.2		1	1										45	25																	2	2	5	2									T		
English plantain	*Plantago lanceolata*	15.0																																		15												
hairy catsear	*Hypochaeris radicata*	2.0																																2														
white sweet-clover	*Melilotus alba*	1.0					1																																									
unclassified-grass	unknown	0.6				T										T					1											T		2														
unclassified-herb	unknown	1.4		1	1	T										2		2		1																T									5				

Notes:
1: Unknown species are assumed to be weeds or invasives.
Blank indicates no vegetation was observed in the quadrat
Bold indicates planted native species, underline indicates volunteer native species
"T" = Trace

Table 3-4. Marsh Development at Mowitch - Cover (Daubenmire Method)

Common Name	Scientific Name	Total Canopy	Canopy Cover (%)	Frequency (%)	Species Composition
American glasswort, pickleweed	***Salicornia virginica***	2.5	0.05	2.2	0.01%
colonial bentgrass	*Agrostis tenuis*	2.5	0.05	2.2	0.01%
fireweed	*Epilobium angustifolium*	7.5	0.16	6.5	0.03%
Lyngby's sedge	***Carex lyngbyei***	35	0.76	8.7	0.15%
orache, fat-hen saltbush	***Atriplex patula***	180	3.91	47.8	0.77%
seaside arrow-grass	***Triglochin maritimum***	80	1.74	6.5	0.34%
seaside plantain	***Plantago maritima***	45	0.98	8.7	0.19%
seashore saltgrass	***Distichlis spicata***	17.5	0.38	4.3	0.07%
spike-rush	*Eleocharis sp.*	2.5	0.05	2.2	0.01%
tufted hairgrass	***Deschampsia cespitosa***	5	0.11	4.3	0.02%
Subtotal		*377.5*	*8.21*		*1.61%*
Non-Native or Invasive[1]					
brass buttons	*Cotula coronopifolia*	70	1.52	19.6	0.30%
English plantain	*Plantago lanceolata*	15	0.33	2.2	0.06%
hairy catsear	*Hypochaeris radicata*	2.5	0.05	2.2	0.01%
white sweet-clover	*Melilotus alba*	10	0.22	8.7	0.04%
unclassified-grass	unknown	32.5	0.71	17.4	0.14%
unclassified-herb	unknown	2.5	0.05	2.2	0.01%
Subtotal		*132.5*	*2.88*		*0.56%*
TOTAL		**510**	**11.09**		

Notes:
1: Unknown species are assumed to be weeds or invasives.
Bold indicates planted native species, underline indicates volunteer native species

Total canopy: Obtained by counting the number of quadrats in each of six cover class (by species), multiplying this value times the midpoint of the appropriate cover class, and totalling the products for all cover classes by species.

Canopy cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

Frequency: Obtained by dividing the number of occurrences of a plant species (the number of quadrats in which a plant species was observed) by the total number of quadrats sampled along the transect.

Species composition: Obtained by dividing the percent canopy cover of each plant species by the total canopy cover of all plant species.

See Appendix B for a complete description of the Daubenmire method.

Table 3-5. Marsh Development at Mowitch - Stem Height

Common Name	Scientific Name	Average Stem Height (in.)	Quadrat																																															
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**
American glasswort, pickleweed	***Salicornia virginica***	2.0																2																																
colonial bentgrass	*Agrostis tenuis*	18.0																																	18													
fireweed	*Epilobium angustifolium*	3.8																																3		5												
Lyngby's sedge	***Carex lyngbyei***	9.0													18			8	4	6																													
orache, fat-hen saltbush	***Atriplex patula***	4.5	6	8		2	5	2	3			2			6	2	5	4	12	10	10													4	4	1		3						1	5	3	3
seaside arrow-grass	***Triglochin maritimum***	8.7		2																														9	15													
seaside plantain	***Plantago maritima***	1.0		1	1	1												1																															
seashore saltgrass	***Distichlis spicata***	4.8															5																		5													
spike-rush	*Eleocharis sp.*	0.3			0																																												
tufted hairgrass	***Deschampsia cespitosa***	4.0	6	2																																													
Non-Native or Invasive[1]																																																	
brass buttons	*Cotula coronopifolia*	2.8		1	3										9	4																	2	2	3	1										2		
English plantain	*Plantago lanceolata*	4.5																																		5												
hairy catsear	*Hypochaeris radicata*	2.5																																3														
white sweet-clover	*Melilotus alba*	1.9				2										2					3											1		3														
unclassified-grass	unknown	1.5		2	1	1										2		3		1																1									1				
unclassified-herb	unknown	1.5					2																																										

Notes:
Stem height in inches
1: Unknown species are assumed to be weeds or invasives.
Bold indicates planted native species, underline indicates volunteer native species
Blank indicates no vegetation was observed in the quadrat

Table 3-6. Marsh Development at Mowitch - Shoot Density

Common Name	Scientific Name	Average Shoot Density	Quadrat																																															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
American glasswort, pickleweed	***Salicornia virginica***	1.0																1																																
colonial bentgrass	*Agrostis tenuis*	7.0																																	7													
fireweed	*Epilobium angustifolium*	1.0					1																											1		1												
Lyngby's sedge	***Carex lyngbyei***	6.5													23			1	1	1																													
orache, fat-hen saltbush	***Atriplex patula***	4.7	9	6		1	6	2	4			3			1	2	4	10	13	11	5													8	1	1		2							1	3	8	2
seaside arrow-grass	***Triglochin maritimum***	28.0		7																														24	53													
seaside plantain	***Plantago maritima***	5.3		2	1	17												1																															
seashore saltgrass	***Distichlis spicata***	41.0															76																		6													
spike-rush	*Eleocharis sp.*	1.0			1																																												
tufted hairgrass	***Deschampsia cespitosa***	7.5	1	14																																													
Non-Native or Invasive[1]																																																	
brass buttons	*Cotula coronopifolia*	16.8		2	2										64	66																	2	3	4	7										1		
English plantain	*Plantago lanceolata*	1.0																																		1												
hairy catsear	*Hypochaeris radicata*	1.0																																1														
white sweet-clover	*Melilotus alba*	7.2				4										2					12											3		15															
unclassified-grass	unknown	6.7		1	8	10										2		2		1																1									34				
unclassified-herb	unknown	1.0					1																																										

Notes:

Shoot density in shoots per quadrat. Quadrats are 0.25 m^2 in area.

1: Unknown species are assumed to be weeds or invasives.

Bold indicates planted native species, <u>underline</u> indicates volunteer native species

Blank indicates no vegetation was observed in the quadrat

Table 3-7. Riparian Coverage at Mowitch - Percent Cover

Common Name	Scientific Name	No. of Quadrats Found 1	Percent Cover (range)	Percent Cover (mean)
Herbs, Forbes and Grasses				
bentgrass	*Agrostis sp.*	1	1%	1.0
birds-foot trefoil	*Lotus corniculatus*	40	Trace to 25%	6.5
black medick	*Medicago lupulina*	19	Trace to 2%	0.5
bluegrass	*Poa sp.*	2	Trace	0.1
brome	*Bromus sp.*	10	Trace to 2%	0.6
bull thistle	*Cirsium vulgare*	2	1 to 3%	2.0
Canada thistle	*Cirsium arvense*	5	Trace to 5%	1.4
cheatgrass	*Bromus tectorum*	1	Trace	0.1
colonial bentgrass	*Agrostis tenuis*	2	2%	2.0
common dandelion	*Taraxacum officinale*	5	Trace to 1%	0.2
common plantain	*Plantago major*	3	Trace to 3%	1.0
common stork's-bill	*Erodium cicutarium*	1	1%	1.0
common velvet-grass	*Holcus lanatus*	16	Trace to 2%	1.0
creeping bentgrass	*Agrostis alba*	2	3 to 5%	4.0
creeping buttercup	*Ranunculus repens*	6	Trace to 1%	0.2
curly dock	*Rumex crispus*	1	2%	2.0
hairy catsear	*Hypochaeris radicata*	17	Trace to 1%	0.3
knotweed	*Polygonum sp.*	3	Trace to 1%	0.7
lupine	***Lupinus sp.***	26	Trace to 30%	7.2
oxeye daisy	*Chrysanthemum leucanthemum*	1	1%	1.0
perennial ryegrass	***Lolium perenne***	43	2 to 35%	12.8
pineapple weed	*Matricaria discoidea*	4	Trace to 3%	0.8
purple-leaved willowherb	*Epilobium ciliatum*	20	Trace to 15%	2.9
quackgrass	*Agropyron repens*	1	2%	2.0
rabbitfoot clover	*Trifolium arvense*	3	Trace to 2%	1.0
red clover	*Trifolium pratense*	9	Trace to 2%	0.6
English plantain	*Plantago lanceolata*	20	Trace to 5%	1.6
Siberian bitter-cress	*Cardamine oligosperma*	2	1%	1.0
speedwell	*Veronica sp.*	3	1 to 3%	2.0
thistle	*Cirsium sp.*	14	1 to 5%	2.4
toad rush	*Juncus bufonius*	5	Trace to 5%	1.2
western dock	*Rumex occidentalis*	1	Trace	0.1
white clover	*Trifolium repens*	9	Trace to 1%	0.2
white sweet-clover	*Melilotus alba*	42	1 to 17%	3.9
willowherb	*Epilobium sp.*	29	Trace to 7%	2.8
yarrow	***Achillea millefolium***	44	Trace to 3%	0.8
yellow parentucellia	*Parentucellia viscosa*	2	Trace	0.1
unclassified-composite	unclassified-composite	6	Trace to 3%	1.5
unclassified-grass	unclassified-grass	4	Trace to 2%	0.8
unclassified-herb	unclassified-herb	28	Trace to 3%	0.5
Shrubs				
beaked hazelnut	***Corylus cornuta***	4	5 to 15%	8.5
common snowberry	***Symphoricarpos albus***	15	3 to 15%	6.3

Table 3-7. Riparian Coverage at Mowitch - Percent Cover

Common Name	Scientific Name	No. of Quadrats Found 1	Percent Cover (range)	Percent Cover (mean)
dull Oregon-grape	***Mahonia nervosa***	1	3%	3.0
Himalayan blackberry	*Rubus discolor*	1	Trace	0.1
oceanspray	***Holodiscus discolor***	6	2 to 10%	5.7
red-flowering current	***Ribes sanguineum***	2	3 to 5%	4.0
red-osier dogwood	***Cornus stolonifera***	3	10%	10.0
rose	***Rosa sp.***	21	1 to 25%	8.0
salal	***Gaultheria shallon***	9	3 to 15%	7.0
Scot's broom	*Cytisus scoparius*	4	1%	1.0
Trees				
bigleaf maple	***Acer macrophyllum***	1	2%	2.0
Douglas-fir	***Pseudotsuga menziesii***	7	1 to 25%	18.0
red alder	***Alnus rubra***	3	3 to 10%	6.0
western hemlock	***Tsuga heterophylla***	6	5 to 15%	10.8

Notes: There were a total of 45 quadrats

1: No. of Quadrats Found = Number of quadrats in which the species was observed

Bold are planted native species, underline indicates volunteer native species. (All other entries are non-native or invasive.)

Mean percent cover is calculated for the number of quadrats where the plant was observed.

Table 3-8. Riparian Coverage at Mowitch - Cover (Daubenmire Method)

Common Name	Scientific Name	Total Canopy	Canopy Cover (%)	Frequency (%)	Species Composition
Herbs, Forbes and Grasses					
bentgrass	*Agrostis sp.*	2.5	0.06	2.2%	0.00%
birds-foot trefoil	*Lotus corniculatus*	150	3.33	88.9%	0.13%
black medick	*Medicago lupulina*	47.5	1.06	42.2%	0.04%
bluegrass	*Poa sp.*	5	0.11	4.4%	0.00%
brome	*Bromus sp.*	25	0.56	22.2%	0.02%
bull thistle	*Cirsium vulgare*	5	0.11	4.4%	0.00%
Canada thistle	*Cirsium arvense*	12.5	0.28	11.1%	0.01%
cheatgrass	*Bromus tectorum*	2.5	0.06	2.2%	0.00%
colonial bentgrass	*Agrostis tenuis*	5	0.11	4.4%	0.00%
common dandelion	*Taraxacum officinale*	12.5	0.28	11.1%	0.01%
common plantain	*Plantago major*	7.5	0.17	6.7%	0.01%
common stork's-bill	*Erodium cicutarium*	2.5	0.06	2.2%	0.00%
common velvet-grass	*Holcus lanatus*	40	0.89	35.6%	0.03%
creeping bentgrass	*Agrostis alba*	5	0.11	4.4%	0.00%
creeping buttercup	*Ranunculus repens*	15	0.33	13.3%	0.01%
curly dock	*Rumex crispus*	2.5	0.06	2.2%	0.00%
hairy catsear	*Hypochaeris radicata*	42.5	0.94	37.8%	0.04%
knotweed	*Polygonum sp.*	7.5	0.17	6.7%	0.01%
lupine	***Lupinus sp.***	187.5	4.17	57.8%	0.16%
oxeye daisy	*Chrysanthemum leucanthemum*	2.5	0.06	2.2%	0.00%
perennial ryegrass	***Lolium perenne***	555	12.33	95.6%	0.47%
pineapple weed	*Matricaria discoidea*	10	0.22	8.9%	0.01%
purple-leaved willowherb	*Epilobium ciliatum*	87.5	1.94	44.4%	0.07%
quackgrass	*Agropyron repens*	2.5	0.06	2.2%	0.00%
rabbitfoot clover	*Trifolium arvense*	7.5	0.17	6.7%	0.01%
red clover	*Trifolium pratense*	22.5	0.50	20.0%	0.02%
English plantain	*Plantago lanceolata*	50	1.11	44.4%	0.04%
Siberian bitter-cress	*Cardamine oligosperma*	5	0.11	4.4%	0.00%
speedwell	*Veronica sp.*	7.5	0.17	6.7%	0.01%
thistle	*Cirsium sp.*	35	0.78	31.1%	0.03%
toad rush	*Juncus bufonius*	12.5	0.28	11.1%	0.01%
western dock	*Rumex occidentalis*	2.5	0.06	2.2%	0.00%
white clover	*Trifolium repens*	22.5	0.50	20.0%	0.02%
white sweet-clover	*Melilotus alba*	192.5	4.28	93.3%	0.16%
willowherb	*Epilobium sp.*	97.5	2.17	64.4%	0.08%
yarrow	***Achillea millefolium***	110	2.44	97.8%	0.09%
yellow parentucellia	*Parentucellia viscosa*	5	0.11	4.4%	0.00%
unclassified-composite	unclassified-composite	15	0.33	13.3%	0.01%
unclassified-grass	unclassified-grass	10	0.22	8.9%	0.01%
unclassified-herb	unclassified-herb	70	1.56	62.2%	0.06%
	Subtotal	*1900*	*42.22*		*1.60%*
Shrubs					
beaked hazelnut	***Corylus cornuta***	47.5	1.06	8.9%	0.04%

Table 3-8. Riparian Coverage at Mowitch - Cover (Daubenmire Method)

Common Name	Scientific Name	Total Canopy	Canopy Cover (%)	Frequency (%)	Species Composition
common snowberry	***Symphoricarpos albus***	100	2.22	33.3%	0.08%
dull Oregon-grape	***Mahonia nervosa***	2.5	0.06	2.2%	0.00%
Himalayan blackberry	*Rubus discolor*	2.5	0.06	2.2%	0.00%
oceanspray	***Holodiscus discolor***	52.5	1.17	13.3%	0.04%
red-flowering current	***Ribes sanguineum***	5	0.11	4.4%	0.00%
red-osier dogwood	***Cornus stolonifera***	45	1.00	6.7%	0.04%
rose	***Rosa sp.***	215	4.78	46.7%	0.18%
salal	***Gaultheria shallon***	72.5	1.61	20.0%	0.06%
Scot's broom	*Cytisus scoparius*	10	0.22	8.9%	0.01%
	Subtotal	*552.5*	*12.28*		*0.46%*
Trees					
bigleaf maple	***Acer macrophyllum***	2.5	0.06	2.2%	0.00%
Douglas-fir	***Pseudotsuga menziesii***	92.5	2.06	15.6%	0.08%
red alder	***Alnus rubra***	20	0.44	6.7%	0.02%
western hemlock	***Tsuga heterophylla***	77.5	1.72	13.3%	0.07%
	Subtotal	*192.5*	*4.28*		*0.16%*
	TOTAL	**2645**	**58.8**		

Notes:

Bold are planted native species, underline indicates volunteer native species. All other entries are non-native or invasive.

Total canopy: Obtained by counting the number of quadrats in each of six cover class (by species), multiplying this value times the midpoint of the appropriate cover class, and totalling the products for all cover classes by species.

Canopy cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

Frequency: Obtained by dividing the number of occurrences of a plant species (the number of quadrats in which a plant species was observed) by the total number of quadrats sampled along the transect.

Species composition: Obtained by dividing the percent canopy cover of each plant species by the total canopy cover of all plant species.

See Appendix B for a complete description of the Daubenmire method.

Table 3-9. Fish Species Richness at Mowitch

Common Name	Scientific Name	Number Caught
Chinook salmon	*Oncorhynchus tshawytscha*	41
Coho salmon	*Oncorhynchus kisutch*	2
Chum salmon	*Oncorhynchus keta*	28
Cutthroat trout	*Oncorhynchus clarkii*	1
Starry flounder	*Platichthys stellatus*	264
Staghorn sculpin	*Leptocottus armatus*	2,700
Sculpin	unidentified; 2 species	315
Surf smelt	*Hypomesus pretiosus*	3
Shiner perch	*Cymatogaster aggregata*	8,047
Striped perch	*Embiotoca lateralis*	4
Pile perch	*Damalichthys vacca*	1
Penpoint gunnel	*Apodichthys flavidus*	2
Crescent gunnel	*Pholis laeta*	27
Saddleback gunnel	*Pholis ornate*	42
Threespine stickleback	*Gasterosteus aculeatus*	313
Snake prickleback	*Lumpenus sagitta*	114
Pacific herring	*Clupea pallasii*	4
Sandlance	*Ammodytes hexapterus*	1
Shad	*Alosa sapidissima*	4

Table 3-10. Invertebrates in Fallout Traps at Mowitch

Order	Family	July 10	August 8	Total
Amphipoda	Unknown	4	12	16
Coleoptera	Curculionidae	8	1	9
Coleoptera	Staphylinidae	5	6	11
Coleoptera	Unknown		1	1
Diptera	Agromyzidae	35	13	48
Diptera	Blephariceridae	1		1
Diptera	Ceratopogonidae	1		1
Diptera	Chironomidae	1		1
Diptera	Dolichopodidae	10	11	21
Diptera	Tabanidae	1		1
Diptera	Tipulidae	1	9	10
Diptera	Unknown	2	1	3
Hemiptera	Notonectidae	1		1
Hemiptera	Saldidae	5	13	18
Hemiptera	Unknown	1		1
Homoptera	Aphididae	1		1
Homoptera	Cicadellidae		2	2
Hymenoptera	Apoidea	1	1	2
Hymenoptera	Ichneumunidae	5		5
Hymenoptera	Unknown	3		3
Trichoptera	Helicopsychidae	1		1
Trichoptera	Unknown	2	1	3
TOTAL:		**89**	**71**	**160**

Notes:
Blank indicates no specimen was caught in the sampling for the month

Table 3-11. Seasonal Bird Counts at Mowitch

Common Name	Scientific Name	Total Count	Spring	Summer	Fall
Cormorants					
double-crested cormorant	*Phalacrocorax auritus*	3			3
Bitterns and Herons					
great blue heron	*Ardea herodias*	3		1	2
Waterfowl					
American wigeon	*Anas americana*	11		1	10
Canada goose	*Branta canadensis*	33	9	23	1
mallard	*Anas platyrhynchos*	46	2	15	29
Hawks and Falcons					
Cooper's hawk	*Accipter cooperii*	1			1
Plovers					
killdeer	*Charadrius vociferus*	30	2	17	11
Sandpipers					
semipalmated sandpiper	*Calidris pusilla*	16		16	
spotted sandpiper	*Actitis macularia*	15	4	10	1
western sandpiper	*Calidris mauri*	2			2
Gulls and Terns					
Caspian tern	*Sterna caspia*	2		2	
glaucous-winged gull	*Larus glaucescens*	16	1	11	4
Doves					
mourning dove	*Zenaida macroura*	7	4	3	
Kingfishers					
belted kingfisher	*Ceryle alcyon*	3		2	1
kingfisher	*Ceryle sp.*	5			5
Swallows					
barn swallow	*Hirundo rustica*	7		7	
cliff swallow	*Petrochelidon pyrrhonota*	22	16	6	
violet-green swallow	*Tachycineta thalassina*	8	1	7	
Crows					
American crow	*Corvus brachyrhynchos*	15		2	13
Northwestern crow	*Corvus caurinus*	3		2	1
Thrushes					
American robin	*Turdus migratorius*	3	1	2	
Pipits					
American pipit	*Anthus rubescens*	21			21
Starlings					
European starling	*Sturnus vulgaris*	297	4	103	190
Warblers					
common yellowthroat	*Geothylpis trichas*	1			1
Old World Sparrows					
house sparrow	*Passer domesticus*	2	2		
Finches and Sparrows					
American goldfinch	*Carduelis tristis*	10		10	
house finch	*Carpodacus mexicanus*	48	2	20	26
Oregon junco	*Junco hyemalis*	9	5		4
savannah sparrow	*Passerculus sandwichensis*	18			18
song sparrow	*Melospiza melodia*	12	2	1	9
white-crowned sparrow	*Zonotrichia leucophrys*	4	2	2	
	Total Number of Species:	**31**	**15**	**22**	**21**
	Total Number of Birds:	**673**	**57**	**263**	**353**

Notes:
Blank indicates no bird was observed.

Spring = March to May
Summer = June to August
Fall = September to November

Table 3-12. Bird Use at Mowitch

Date	Common Name	Scientific Name	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier Pilings	Riparian	Marsh	Intertidal	Mud Flats	Open Water	Comments
5/31/02	American robin	*Turdus migratorius*	M	1	L	X					X					Immature
5/31/02	barn swallow	*Hirundo rustica*	M		L	X			X		X	X				
5/31/02	Canada goose	*Branta canadensis*		9	L	X		X			X	X			X	5 adults, 4 young; droppings; evidence of grazing
5/31/02	cliff swallow	*Petrochelidon pyrrhonota*	M	8	L	X			X		X	X				
5/31/02	cliff swallow	*Petrochelidon pyrrhonota*	F	8	L	X	X		X		X	X				Gathering mud - nesting material
5/31/02	European starling	*Sturnus vulgaris*		4	L	X	X		X			X				both male and female
5/31/02	glaucous-winged gull	*Larus glaucescens*		1	L	X				X		X				Feeding
5/31/02	house finch	*Carpodacus mexicanus*	M	1	L	X	X				X					
5/31/02	house finch	*Carpodacus mexicanus*	F	1	L	X					X					
5/31/02	house sparrow	*Passer domesticus*	M	2	L	X					X					
5/31/02	killdeer	*Charadrius vociferus*		2	L	X					X	X				2 pairs breeding; both male and female
5/31/02	mallard	*Anas platyrhynchos*		2	L	X						X			X	1 pair; both male and female
5/31/02	mourning dove	*Zenaida macroura*	M	1	L	X			X		X					
5/31/02	mourning dove	*Zenaida macroura*		3	L	X			X		X	X	X			1 pair plus 1; both male and female
5/31/02	Oregon junco	*Junco hyemalis*	F	2	L	X	X				X	X				Foraging
5/31/02	Oregon junco	*Junco hyemalis*	M	3	L	X	X				X	X	X			Foraging
5/31/02	song sparrow	*Melospiza melodia*	M	2	L	X	X				X	X				Singing; 2 pairs?
5/31/02	spotted sandpiper	*Actitis macularia*	U	4	L	X	X					X	X			2 pairs; breeding?
5/31/02	violet-green swallow	*Tachycineta thalassina*		1	L	X			X		X	X				
5/31/02	white-crowned sparrow	*Zonotrichia leucophrys*	M	1	L	X	X				X					
5/31/02	white-crowned sparrow	*Zonotrichia leucophrys*	F	1	L	X	X				X					
6/21/02	American goldfinch	*Carduelis tristis*		3	L	X			X							
6/21/02	barn swallow	*Hirundo rustica*	M	1	L	X			X					X		Collecting mud, foraging
6/21/02	barn swallow	*Hirundo rustica*	F	1	L	X			X					X		Collecting mud, foraging
6/21/02	Canada goose	*Branta canadensis*		2	L	X				X						
6/21/02	Caspian tern	*Sterna caspia*		2	L	X			X						X	
6/21/02	cliff swallow	*Petrochelidon pyrrhonota*		2	L	X										
6/21/02	European starling	*Sturnus vulgaris*		3	L	X					X					Juvenile
6/21/02	house finch	*Carpodacus mexicanus*		2	L	X			X				X			
6/21/02	killdeer	*Charadrius vociferus*		5	L	X	X						X	X		3 pairs; one nearest to road displayed "broken wing"
6/21/02	mallard	*Anas platyrhynchos*		6	L	X			X						X	
6/21/02	mourning dove	*Zenaida macroura*		2	L	X										
6/21/02	spotted sandpiper	*Actitis macularia*		4	L	X	X				X	X	X	X		Nesting in riparian area near west end
6/21/02	violet-green swallow	*Tachycineta thalassina*		4	L	X										number recorded as 4+
6/25/02	American goldfinch	*Carduelis tristis*		4	H	X	X		X							2 marked as seen
6/25/02	American robin	*Turdus migratorius*	M	1	H	X					X					
6/25/02	barn swallow	*Hirundo rustica*		3	H	X			X							Foraging; landed on mud; 1 male, 2 female
6/25/02	belted kingfisher	*Ceryle alcyon*			H	X	X		X		X		X			
6/25/02	Canada goose	*Branta canadensis*		20	H	X						X	X			1 adult and 4 young in enclosure; 15 adults in 2nd group

Table 3-12. Bird Use at Mowitch

Date	Common Name	Scientific Name	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier Pilings	Riparian	Marsh	Intertidal	Mud Flats	Open Water	Comments
6/25/02	cliff swallow	*Petrochelidon pyrrhonota*		2	H	X			X							Foraging; both male and female
6/25/02	glaucous-winged gull	*Larus glaucescens*		5	H	X				X			X		X	
6/25/02	killdeer	*Charadrius vociferus*		6	H	X	X				X		X			3 (or 4?) pairs, territorial
6/25/02	mallard	*Anas platyrhynchos*		5	H	X								X	X	both male and female
6/25/02	mourning dove	*Zenaida macroura*		1	H	X					X					
6/25/02	Northwestern crow	*Corvus caurinus*		2	H	X	X		X		X					
6/25/02	spotted sandpiper	*Actitis macularia*		4	H	X	X				X		X			2 pairs, territorial
6/25/02	violet-green swallow	*Tachycineta thalassina*		3	H	X			X							Foraging
8/22/02	American crow	*Corvus brachyrhynchos*		2	M	X			X				X			
8/22/02	American goldfinch	*Carduelis tristis*	F	3	M	X					X					Foraging
8/22/02	American robin	*Turdus migratorius*		1	M	X					X					
8/22/02	American wigeon	*Anas americana*		1	M	X									X	
8/22/02	barn swallow	*Hirundo rustica*		2	M	X			X							
8/22/02	belted kingfisher	*Ceryle alcyon*		2	M	X	X		X		X					So. Side of waterway; 1 on a sprinkler
8/22/02	Canada goose	*Branta canadensis*		1	M	X							X			Appears to have broken wing
8/22/02	cliff swallow	*Petrochelidon pyrrhonota*	F	2	M	X			X						X	
8/22/02	European starling	*Sturnus vulgaris*		100	M	X	X				X		X			Foraging
8/22/02	glaucous-winged gull	*Larus glaucescens*		6	M	X						X	X		X	Bathing; foraging; resting
8/22/02	great blue heron	*Ardea herodias*	M	1	M	X				X						Resting
8/22/02	house finch	*Carpodacus mexicanus*		18	M	X					X	X				Foraging, male and female
8/22/02	killdeer	*Charadrius vociferus*		6	M	X	X						X			
8/22/02	mallard	*Anas platyrhynchos*	F	4	M	X						X				Foraging in pools
8/22/02	semipalmated sandpiper	*Calidris pusilla*		16	M	X							X	X		Several small flocks; mixed plumage - dark legs
8/22/02	song sparrow	*Melospiza melodia*		1	M	X	X				X					
8/22/02	spotted sandpiper	*Actitis macularia*		2	M	X	X		X				X			
8/22/02	white-crowned sparrow	*Zonotrichia leucophrys*		2	M	X					X					Juveniles, on fence
9/27/02	American pipit	*Anthus rubescens*		20	H	X	X				X	X	X			Foraging with savannahs
9/27/02	Canada goose	*Branta canadensis*		1	H	X							X			Preening
9/27/02	European starling	*Sturnus vulgaris*		60	H	X	X		X		X	X				
9/27/02	house finch	*Carpodacus mexicanus*		4	H				X							
9/27/02	house finch	*Carpodacus mexicanus*	M	2	H	X	X				X					Foraging
9/27/02	house finch	*Carpodacus mexicanus*	F	3	H	X	X					X				
9/27/02	killdeer	*Charadrius vociferus*		3	H	X	X									
9/27/02	kingfisher	*Ceryle sp.*		3	H	X	X		X							
9/27/02	mallard	*Anas platyrhynchos*		14	H	X			X						X	
9/27/02	Oregon junco	*Junco hyemalis*		4	H	X										
9/27/02	savannah sparrow	*Passerculus sandwichensis*		6	H	X					X					Yellow lures
9/27/02	song sparrow	*Melospiza melodia*		3	H	X	X				X					
9/30/02	American crow	*Corvus brachyrhynchos*		1	L	X	X		X							

Table 3-12. Bird Use at Mowitch

Date	Common Name	Scientific Name	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier Pilings	Riparian	Marsh	Intertidal	Mud Flats	Open Water	Comments
9/30/02	American pipit	*Anthus rubescens*		1	L	X	X									With Savannah sparrows
9/30/02	American wigeon	*Anas americana*	F	4	L	X									X	
9/30/02	common yellowthroat	*Geothylpis trichas*	M	1	L	X					X					
9/30/02	double-crested cormorant	*Phalacrocorax auritus*		1	L				X							
9/30/02	European starling	*Sturnus vulgaris*		90	L	X	X				X	X	X			Foraging, bathing; number is approximate
9/30/02	great blue heron	*Ardea herodias*		1	L					X						
9/30/02	house finch	*Carpodacus mexicanus*		15	L	X	X				X	X				Both male and female; number is approximate; Mostly non-male (females and immatures)
9/30/02	killdeer	*Charadrius vociferus*		5	L	X	X						X			
9/30/02	kingfisher	*Ceryle sp.*		2	L	X	X		X	X						Both male and female
9/30/02	mallard	*Anas platyrhynchos*		10	L	X									X	Both male and female
9/30/02	savannah sparrow	*Passerculus sandwichensis*		12	L	X										Number is approximate
9/30/02	song sparrow	*Melospiza melodia*		6	L	X					X	X				
9/30/02	spotted sandpiper	*Actitis macularia*		1	L	X	X									
11/5/02	American crow	*Corvus brachyrhynchos*		12	H				X		X					2 in riparian
11/5/02	American wigeon	*Anas americana*		6	H										X	
11/5/02	belted kingfisher	*Ceryle alcyon*		1	H				X		X					
11/5/02	Canada goose	*Branta canadensis*			H							X				Preening
11/5/02	Cooper's hawk	*Accipter cooperii*	F	1	H						X					Perched in tree, riparian so. side
11/5/02	double-crested cormorant	*Phalacrocorax auritus*		2	H										X	
11/5/02	European starling	*Sturnus vulgaris*		40	H				X							number is approximate
11/5/02	glaucous-winged gull	*Larus glaucescens*		4	H				X							
11/5/02	great blue heron	*Ardea herodias*		1	H					X						
11/5/02	house finch	*Carpodacus mexicanus*		2	H						X					
11/5/02	killdeer	*Charadrius vociferus*		3	H							X				Resting
11/5/02	mallard	*Anas platyrhynchos*		5	H				X						X	Resting
11/5/02	Northwestern crow	*Corvus caurinus*		1	H							X				
11/5/02	western sandpiper	*Calidris mauri*		2	H							X				Foraging in shallow water

Notes:
Gender: "F" = female, "M" = male, "U" = unknown
Tide: "L" = low, "M" = medium, "H" = high

Table 3-13. Marsh and Riparian Areal Cover by Polygon at Squally Beach

Vegetation Polygon	Percent Cover	Dominant Species
MA	95	*Carex lyngbyei*
MB	70	*Scirpus americanus, Atiplex patula,Cotula coronopifolia*
MC	65	*Cotula coronopifolia, Carex* sp.
MD	65	*Glyceria* sp., *Lolium* sp., *Lotus corniculatus, Atriplex patula*
ME	25	*Atriplex patula*
MF	20	*Atriplex patula*
MG	40	*Atriplex patula*
MH	30	*Scirpus americanus, Atiplex patula,Cotula coronopifolia*
MI	45	*Carex lyngbyei*
MJ	90	*Jaumea carnosa*
MK	50	*Jaumea carnosa, Distichlis spicata, Salicornia virginica, Atriplex patula*
ML	34	*Atriplex patula*
RA	80	*Melilotus alba, Salix* spp., *Alnus rubra, Lupinus* sp., *Rosa* spp., *Rubus discolor*
RB	90	*Melilotus alba*
RC	95	*Melilotus alba*
RD	80	*Melilotus alba*

Note: In Vegetation Polygon column, M=Marsh polygon; R=Riparian polygon

Table 3-14. Quadrat Locations Along Marsh and Riparian Transects at Squally Beach

Marsh Transect 1-1		Marsh Transect 1-2		Riparian Transect 2	
Quadrat	**Distance Along Transect (ft)**	**Quadrat**	**Distance Along Transect (ft)**	**Quadrat**	**Distance Along Transect (ft)**
1	2	1	3	1	20
2	4	2	86	2	72
3	36	3	111	3	80
4	38	4	116	4	86
5	57	5	137	5	118
6	86	6	142	6	134
7	94	7	173	7	141
8	101	8	177	8	151
9	116	9	315	9	209
10	137	10	317	10	223
11	142	11	361	11	230
12	151	12	135	12	245
13	158	13	166	13	306
14	173	14	259	14	317
15	177	15	344	15	353
16	206			16	346
17	245			17	353
18	272			18	365
19	274			19	376
20	315			20	392
21	317			21	401
22	135			22	309
23	166			23	37
24	243			24	276
25	259			25	272
26	344				

Table 3-15. Marsh Development at Squally Beach - Percent Cover

Common Name	Scientific Name	Average % Cover	Quadrats, Transect 1-1																									
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
American glasswort, pickleweed	***Salicornia virginica***	6.3			T												10		5			15	5			3		
entire-leaved gumweed	*Grindelia integrifolia*	5.0																										5
fleshy jaumea	***Jaumea carnosa***	36.3			T	10												5	5			85	95			10		80
Lyngby's sedge	***Carex lyngbyei***	60.0	85	85		10																						
orache, fat-hen salt bush	***Atriplex patula***	9.9		T	35	20		5	5		5			5		5	5	30	5							3		5
seaside plantain	***Plantago maritima***	2.5				T																	5					
seashore saltgrass	***Distichlis spicata***	8.0		3	T	10											30	5								3		5
Non-Native or Invasive																												
broadleaved pepperweed	*Lepidium latifolium*	4.3															5	5										3
bull thistle	*Cirsium vulgare*	5.0																5										
white sweet-clover	*Melilotus alba*	5.0																5										

Common Name	Scientific Name	Average % Cover	Quadrats, Transect 1-2														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
American bulrush	***Scirpus americanus***	38.3		70							40	5					
American glasswort, pickleweed	***Salicornia virginica*** [1]	15.0												15			
creeping spike-rush	***Eleocharis palustris***	5.0										5					
fleshy jaumea	***Jaumea carnosa*** [1]	15.0												15			
Lyngby's sedge	***Carex lyngbyei*** [1]	56.5				15											98
orache, fat-hen salt bush	***Atriplex patula***	15.9	1	T	45	15	25	15	5	10		5		25	20	25	
perennial ryegrass	***Lolium perenne***	Trace		T												T	
red alder	***Alnus rubra***	5.0			5												
Scouler's willow	*Salix scouleriana*	30.0													30		
seashore saltgrass	***Distichlis spicata***	6.0			10												2
soft-stemmed bulrush	*Scirpus validus*	10.0									5	15					
tufted hairgrass	***Deschampsia cespitosa***	25.0													25		
unclassified-sedge	*unclassified-sedge*	10.0							10								
Non-Native or Invasive																	
birds-foot trefoil	*Lotus corniculatus*	42.5			65										20		
creeping buttercup	*Ranunculus repens*	10.0								10							
lambsquarters	*Chenopodium sp.*	25.0								25							
white clover	*Trifolium repens*	5.0			5												
white sweet-clover	*Melilotus alba*	18.4								50					T	5	

Notes:
Blank indicates no vegetation was observed in the quadrat
Bold indicates planted native species, underline indicates volunteer native species
"T" = Trace
[1] Salicornia virginica, Jaumea carnosa, and Carex lyngbyei were present on the site prior to restoration. Supplement planting of these three species was also conducted.

Table 3-16. Marsh Development at Squally Beach - Cover (Daubenmire Method)

Common Name	Scientific Name	Total Canopy	Canopy Cover (%)	Frequency (%)	Species Composition
Transect 1-1					
American glasswort, pickleweed	***Salicornia virginica***	40	1.54	23.1%	0.21%
entire-leaved gumweed	*Grindelia integrifolia*	2.5	0.10	3.8%	0.01%
fleshy jaumea	***Jaumea carnosa***	292.5	11.25	30.8%	1.57%
Lyngby's sedge	***Carex lyngbyei***	185	7.12	11.5%	0.99%
orache, fat-hen salt bush	***Atriplex patula***	115	4.42	50.0%	0.62%
seaside plantain	***Plantago maritima***	5	0.19	7.7%	0.03%
seashore saltgrass	***Distichlis spicata***	65	2.50	26.9%	0.35%
	Subtotal:	*705*	*27.12*		*3.78%*
Non-Native or Invasive					
broadleaved pepperweed	*Lepidium latifolium*	7.5	0.29	11.5%	0.04%
bull thistle	*Cirsium vulgare*	2.5	0.10	3.8%	0.01%
white sweet-clover	*Melilotus alba*	2.5	0.10	3.8%	0.01%
	Subtotal:	*12.5*	*0.48*		*0.07%*
	TOTAL:	**717.5**	**27.60**		
Transect 1-2					
American bulrush	***Scirpus americanus***	102.5	6.83	20.0%	1.03%
American glasswort, pickleweed	***Salicornia virginica***	15	1.00	6.7%	0.15%
creeping spike-rush	***Eleocharis palustris***	2.5	0.17	6.7%	0.03%
fleshy jaumea	***Jaumea carnosa***	15	1.00	6.7%	0.15%
Lyngby's sedge	***Carex lyngbyei***	112.5	7.50	13.3%	1.13%
orache, fat-hen salt bush	***Atriplex patula***	152.5	10.17	80.0%	1.53%
perennial ryegrass	***Lolium perenne***	5	0.33	13.3%	0.05%
red alder	***Alnus rubra***	2.5	0.17	6.7%	0.03%
Scouler's willow	*Salix scouleriana*	37.5	2.50	6.7%	0.38%
seashore saltgrass	***Distichlis spicata***	17.5	1.17	13.3%	0.18%
soft-stemmed bulrush	*Scirpus validus*	17.5	1.17	13.3%	0.18%
tufted hairgrass	***Deschampsia cespitosa***	15	1.00	6.7%	0.15%
unclassified-sedge	*unclassified-sedge*	15	1.00	6.7%	0.15%
	Subtotal:	*510*	*34.00*		*5.13%*
Non-Native or Invasive					
birds-foot trefoil	*Lotus corniculatus*	77.5	5.17	13.3%	0.78%
creeping buttercup	*Ranunculus repens*	15	1.00	6.7%	0.15%
lambsquarters	*Chenopodium sp.*	15	1.00	6.7%	0.15%
white clover	*Trifolium repens*	2.5	0.17	6.7%	0.03%
white sweet-clover	*Melilotus alba*	42.5	2.83	20.0%	0.43%
	Subtotal:	*152.5*	*10.17*		*1.53%*
	TOTAL:	**662.5**	**44.17**		

Notes:

Bold indicates planted native species, underline indicates volunteer native species

Total canopy: Obtained by counting the number of quadrats in each of six cover class (by species), multiplying this value times the midpoint of the appropriate cover class, and totalling the products for all cover classes by species.

Canopy cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

Frequency: Obtained by dividing the number of occurrences of a plant species (the number of quadrats in which a plant species was observed) by the total number of quadrats sampled along the transect.

Species composition: Obtained by dividing the percent canopy cover of each plant species by the total canopy cover of all plant species.

See Appendix B for a complete description of the Daubenmire method.

Table 3-17. Marsh Development at Squally Beach - Stem Height

Common Name	Scientific Name	Average Stem Height (in.)	Quadrats, Transect 1-1																									
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
American glasswort, pickleweed	***Salicornia virginica***	5.4			1												4		7			4	4			13		
entire-leaved gumweed	*Grindelia integrifolia*	2.0																										2
fleshy jaumea	***Jaumea carnosa***	4.1			1	1												2	7			8	3			7		5
Lyngby's sedge	***Carex lyngbyei***	13.3	14	24		2																						
orache, fat-hen salt bush	***Atriplex patula***	3.7		6	5	3		2	2		6			3		6	5	4	2							3		2
seaside plantain	***Plantago maritima***	2.5				2																	3					
seashore saltgrass	***Distichlis spicata***	5.5		13	1	2											10	1								9		3
Non-Native or Invasive																												
broadleaved pepperweed	*Lepidium latifolium*	4.8															5	4										6
bull thistle	*Cirsium vulgare*	0.5																1										
white sweet-clover	*Melilotus alba*	2.5																3										

Common Name	Scientific Name	Average Stem Height	Quadrats, Transect 1-2														
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
American bulrush	***Scirpus americanus***	21.0									18	24					
American glasswort, pickleweed	***Salicornia virginica***	9.0												9			
creeping spike-rush	***Eleocharis palustris***	12.0										12					
fleshy jaumea	***Jaumea carnosa***	0.5												1			
Lyngby's sedge	***Carex lyngbyei***	19.0				13											25
orache, fat-hen salt bush	***Atriplex patula***	3.7	2	7	6	4	4	2	6	3		4		2	2	4	
perennial ryegrass	***Lolium perenne***	10.5		15												6	
red alder	***Alnus rubra***	18.0			18												
Scouler's willow	*Salix scouleriana*	36.0													36		
seashore saltgrass	***Distichlis spicata***	4.5			5												4
soft-stemmed bulrush	*Scirpus validus*	42.0									48	36					
tufted hairgrass	***Deschampsia cespitosa***	24.0													24		
unclassified-sedge	*unclassified-sedge*	9.0							9								
Non-Native or Invasive																	
birds-foot trefoil	*Lotus corniculatus*	19.0			36										2		
creeping buttercup	*Ranunculus repens*	3.0								3							
lambsquarters	*Chenopodium sp.*									N							
white clover	*Trifolium repens*	1.0			1												
white sweet-clover	*Melilotus alba*	65.3								66					70	60	

Notes:
Stem height in inches
1: Unknown species are assumed to be weeds or invasives.
Blank indicates no vegetation was observed in the quadrat
Bold indicates planted native species, underline indicates volunteer native species
"N" = Not measured

Table 3-18. Marsh Development at Squally Beach - Shoot Density

Common Name	Scientific Name	Average Shoot Density	Quadrats, Transect 1-1																									
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
Native																												
American glasswort, pickleweed	***Salicornia virginica***	13.8			1												6		3			48	20			5		
entire-leaved gumweed	*Grindelia integrifolia*	1.0																										1
fleshy jaumea	***Jaumea carnosa***	265.4			1	22												1	11			752	822			24		490
Lyngby's sedge	***Carex lyngbyei***	123.0	298	41		30																						
orache, fat-hen salt bush	***Atriplex patula***	13.7		1	33	42		3	4		2			2		1	2	76	1							3		8
seaside plantain	***Plantago maritima***	1.0				1																	1					
seashore saltgrass	***Distichlis spicata***	15.3		2	3	40											28	4								5		25
Non-Native or Invasive																												
broadleaved pepperweed	*Lepidium latifolium*	1.0															1	1										1
bull thistle	*Cirsium vulgare*	1.0																1										
white sweet-clover	*Melilotus alba*	6.0																6										

Common Name	Scientific Name	Average Shoot Density	Quadrats, Transect 1-2														
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Native																	
American bulrush	***Scirpus americanus***	77.3		120							100	12					
American glasswort, pickleweed	***Salicornia virginica***	8.0												8			
creeping spike-rush	***Eleocharis palustris***	20.0										20					
fleshy jaumea	***Jaumea carnosa***	6.0												6			
Lyngby's sedge	***Carex lyngbyei***	90.0				38											142
orache, fat-hen salt bush	***Atriplex patula***	20.3	3	1	26	24	17	17	4	21		5		40	65	20	
perennial ryegrass	***Lolium perenne***	1.0		1												1	
red alder	***Alnus rubra***	1.0			1												
Scouler's willow	*Salix scouleriana*	7.0													7		
seashore saltgrass	***Distichlis spicata***	31.5			50												13
soft-stemmed bulrush	*Scirpus validus*	24.0									7	41					
tufted hairgrass	***Deschampsia cespitosa***	8.0													8		
unclassified-sedge	*unclassified-sedge*	7.0							7								
Non-Native or Invasive																	
birds-foot trefoil	*Lotus corniculatus*	15.0			22										8		
creeping buttercup	*Ranunculus repens*	5.0								5							
lambsquarters	*Chenopodium sp.*	8.0								8							
white clover	*Trifolium repens*	25.0			25												
white sweet-clover	*Melilotus alba*	2.7								5					1	2	

Notes:

Shoot density in shoots per quadrat. Quadrats are 0.25 m^2 in area.

1: Unknown species are assumed to be weeds or invasives.

Bold indicates planted native species, underline indicates volunteer native species

Table 3-19. Riparian Coverage at Squally Beach - Percent Cover

Common Name	Scientific Name	No. of Quadrats Found 1	Percent Cover (range)	Percent Cover (mean)
Herbs, Forbes and Grasses				
birds-foot trefoil	*Lotus corniculatus*	20	2 to 35%	12.9
black medick	*Medicago lupulina*	12	Trace to 5%	3.3
bluegrass	*Poa sp.*	3	5 to 10%	8.3
brome	*Bromus sp.*	2	2 to 3%	2.5
bull thistle	*Cirsium vulgare*	2	3 to 20%	11.5
Canada thistle	*Cirsium arvense*	3	5 to 15%	11.7
cheatgrass	*Bromus tectorum*	5	1 to 5%	3.6
colonial bentgrass	*Agrostis tenuis*	14	Trace to 10%	3.4
common dandelion	*Taraxacum officinale*	1	3%	3.0
common horsetail	*Equisetum arvense*	11	2 to 50%	20.6
common rush	*Juncus effusus*	2	Trace to 3%	1.5
common St. John's-wort	*Hypericum perforatum*	1	3%	3.0
common stork's-bill	*Erodium cicutarium*	2	Trace	0.1
common velvet-grass	*Holcus lanatus*	15	Trace to 10%	3.5
creeping buttercup	*Ranunculus repens*	2	1%	1.0
hairy catsear	*Hypochaeris radicata*	1	Trace	0.1
hedge mustard	*Sisymbrium officinale*	3	5 to 50%	21.7
Japanese knotweed	*Polygonum cuspidatum*	2	Trace	0.1
lettuce	*Lactuca sp.*	1	2%	2.0
lupine	***Lupinus sp.***	14	Trace to 55%	11.2
oxeye daisy	*Chrysanthemum leucanthemum*	2	2 to 5%	3.5
pea	*Lathyrus sp.*	1	Trace	0.1
perennial ryegrass	***Lolium perenne***	24	3 to 45%	20.2
purple-leaved willowherb	*Epilobium ciliatum*	2	Trace to 3%	1.5
quackgrass	*Agropyron repens*	1	5%	5.0
rabbitfoot clover	*Trifolium arvense*	3	2 to 5%	3.0
red clover	*Trifolium pratense*	11	1 to 10%	3.9
red fescue	***Festuca rubra***	8	3 to 15%	5.8
English plantain	*Plantago lanceolata*	7	Trace to 3%	1.9
toad rush	*Juncus bufonius*	1	Trace	0.1
white clover	*Trifolium repens*	7	Trace to 5%	2.6
white sweet-clover	*Melilotus alba*	23	2 to 70%	28.6
willowherb	*Epilobium sp.*	13	Trace to 15%	3.1
yarrow	***Achillea millefolium***	3	Trace to 2%	0.7
yellow salsify	*Tragopogon dubius*	1	3%	3.0
unclassified-composite	*unclassified-composite*	6	Trace to 3%	1.8
unclassified-grass	*unclassified-grass*	10	1 to 15%	4.8
unclassified-herb	*unclassified-herb*	3	Trace	0.1
unclassified-wheat	*unclassified-wheat*	2	Trace	0.1
Shrubs				
beaked hazelnut	***Corylus cornuta***	1	3%	3.0
common snowberry	***Symphoricarpos albus***	2	5%	5.0
dull Oregon-grape	***Mahonia nervosa***	3	1 to 5%	3.0
Himalayan blackberry	*Rubus discolor*	11	Trace to 25%	3.7
nootka rose	***Rosa nutkana***	1	15%	15.0

Table 3-19. Riparian Coverage at Squally Beach - Percent Cover

Common Name	Scientific Name	No. of Quadrats Found 1	Percent Cover (range)	Percent Cover (mean)
oceanspray	***Holodiscus discolor***	4	3 to 10%	5.8
red-flowering current	***Ribes sanguineum***	1	3%	3.0
red-osier dogwood	***Cornus stolonifera***	3	5 to 15%	11.7
rose	***Rosa sp.***	10	1 to 10%	6.3
Scot's broom	*Cytisus scoparius*	4	2%	2.0
trailing blackberry	*Rubus ursinus*	1	Trace	0.1
Trees				
Douglas-fir	***Pseudotsuga menziesii***	5	2 to 15%	8.4
red alder	***Alnus rubra***	15	1 to 15%	6.5
Scouler's willow	*Salix scouleriana*	11	10 to 50%	22.3

Notes: There were a total of 26 quadrats

1: No. of Quadrats Found = Number of quadrats in which the species was observed

Bold are planted native species, underline indicates volunteer native species. (All other entries are non-native or invasive.) Unknown species are assumed to be weeds or invasives. Mean percent cover is calculated for the number of quadrats where the plant was observed.

Table 3-20. Riparian Coverage at Squally Beach - Cover (Daubenmire Method)

Common Name	Scientific Name	Total Canopy	Canopy Cover (%)	Frequency (%)	Species Composition
Herbs, Forbes and Grasses					
birds-foot trefoil	*Lotus corniculatus*	267.5	10.70	80.0%	0.36%
black medick	*Medicago lupulina*	27.5	1.10	48.0%	0.04%
bluegrass	*Poa sp.*	32.5	1.30	12.0%	0.04%
brome	*Bromus sp.*	5	0.20	8.0%	0.01%
bull thistle	*Cirsium vulgare*	17.5	0.70	8.0%	0.02%
Canada thistle	*Cirsium arvense*	17.5	0.70	12.0%	0.02%
cheatgrass	*Bromus tectorum*	12.5	0.50	20.0%	0.02%
colonial bentgrass	*Agrostis tenuis*	45	1.80	56.0%	0.06%
common dandelion	*Taraxacum officinale*	2.5	0.10	4.0%	0.00%
common horsetail	*Equisetum arvense*	217.5	8.70	44.0%	0.30%
common rush	*Juncus effusus*	5	0.20	8.0%	0.01%
common St. John's-wort	*Hypericum perforatum*	2.5	0.10	4.0%	0.00%
common stork's-bill	*Erodium cicutarium*	5	0.20	8.0%	0.01%
common velvet-grass	*Holcus lanatus*	62.5	2.50	60.0%	0.09%
creeping buttercup	*Ranunculus repens*	5	0.20	8.0%	0.01%
hairy catsear	*Hypochaeris radicata*	2.5	0.10	4.0%	0.00%
hedge mustard	*Sisymbrium officinale*	55	2.20	12.0%	0.07%
Japanese knotweed	*Polygonum cuspidatum*	5	0.20	8.0%	0.01%
lettuce	*Lactuca sp.*	2.5	0.10	4.0%	0.00%
lupine	***Lupinus sp.***	180	7.20	52.0%	0.24%
oxeye daisy	*Chrysanthemum leucanthemum*	5	0.20	8.0%	0.01%
pea	*Lathyrus sp.*	2.5	0.10	4.0%	0.00%
perennial ryegrass	***Lolium perenne***	497.5	19.90	96.0%	0.68%
purple-leaved willowherb	*Epilobium ciliatum*	5	0.20	8.0%	0.01%
quackgrass	*Agropyron repens*	2.5	0.10	4.0%	0.00%
rabbitfoot clover	*Trifolium arvense*	7.5	0.30	12.0%	0.01%
red clover	*Trifolium pratense*	50	2.00	44.0%	0.07%
red fescue	***Festuca rubra***	32.5	1.30	32.0%	0.04%
English plantain	*Plantago lanceolata*	17.5	0.70	28.0%	0.02%
toad rush	*Juncus bufonius*	2.5	0.10	4.0%	0.00%
white clover	*Trifolium repens*	17.5	0.70	28.0%	0.02%
white sweet-clover	*Melilotus alba*	570	22.80	92.0%	0.78%
willowherb	*Epilobium sp.*	42.5	1.70	52.0%	0.06%
yarrow	***Achillea millefolium***	5	0.20	12.0%	0.01%
yellow salsify	*Tragopogon dubius*	2.5	0.10	4.0%	0.00%
unclassified-composite	*unclassified-composite*	15	0.60	24.0%	0.02%
unclassified-grass	*unclassified-grass*	50	2.00	40.0%	0.07%
unclassified-herb	*unclassified-herb*	5	0.20	12.0%	0.01%
unclassified-wheat	*unclassified-wheat*	5	0.20	8.0%	0.01%
	Subtotal:	*2305*	*92.20*		*3.14%*
Shrubs					
beaked hazelnut	***Corylus cornuta***	2.5	0.10	4.0%	0.00%
common snowberry	***Symphoricarpos albus***	5	0.20	8.0%	0.01%

Table 3-20. Riparian Coverage at Squally Beach - Cover (Daubenmire Method)

Common Name	Scientific Name	Total Canopy	Canopy Cover (%)	Frequency (%)	Species Composition
dull Oregon-grape	***Mahonia nervosa***	7.5	0.30	12.0%	0.01%
Himalayan blackberry	*Rubus discolor*	37.5	1.50	44.0%	0.05%
nootka rose	***Rosa nutkana***	5	0.20	4.0%	0.01%
oceanspray	***Holodiscus discolor***	22.5	0.90	16.0%	0.03%
red-flowering current	***Ribes sanguineum***	2.5	0.10	4.0%	0.00%
red-osier dogwood	***Cornus stolonifera***	32.5	1.30	12.0%	0.04%
rose	***Rosa sp.***	72.5	2.90	40.0%	0.10%
Scot's broom	*Cytisus scoparius*	7.5	0.30	16.0%	0.01%
trailing blackberry	*Rubus ursinus*	2.5	0.10	4.0%	0.00%
	Subtotal:	*197.5*	*7.90*		*0.27%*
Trees					
Douglas-fir	***Pseudotsuga menziesii***	105	4.20	20.0%	0.14%
red alder	***Alnus rubra***	100	4.00	60.0%	0.14%
Scouler's willow	*Salix scouleriana*	232.5	9.30	44.0%	0.32%
	Subtotal:	*437.5*	*17.50*		*0.60%*
	TOTAL:	**2940**	**117.60**		

Notes:

Bold are planted native species, underline indicates volunteer native species. All other entries are non-native or invasive.

Total canopy: Obtained by counting the number of quadrats in each of six cover class (by species), multiplying this value times the midpoint of the appropriate cover class, and totalling the products for all cover classes by species.

Canopy cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

Frequency: Obtained by dividing the number of occurrences of a plant species (the number of quadrats in which a plant species was observed) by the total number of quadrats sampled along the transect.

Species composition: Obtained by dividing the percent canopy cover of each plant species by the total canopy cover of all plant species.

See Appendix B for a complete description of the Daubenmire method.

Table 3-21. Fish Species Richness at Squally Beach

Common Name	Scientific Name	Number Caught
Staghorn sculpin	*Leptocottus armatus*	235
Shiner Perch	*Cymatogaster aggregata*	2,427
Threespine stickleback	*Gasterosteus aculeatus*	3

Table 3-22. Invertebrates in Fallout Traps at Squally Beach

Order	Family	June 26	August 8	Total
Amphipoda	unknown	69	128	197
Coleoptera	Cantharidae	1		1
Coleoptera	Curculionidae	4	16	20
Coleoptera	Elmidae	2		2
Coleoptera	Sphaeriidae	1		1
Coleoptera	unknown	3	4	7
Diptera	Agromyzidae	1	6	7
Diptera	Blephariceridae	1		1
Diptera	Calliphoridae	1		1
Diptera	Chironomidae	2	12	14
Diptera	Culicidae	7		7
Diptera	Dolichopodidae	63	20	83
Diptera	Syrphidae		1	1
Diptera	Tabanidae		5	5
Diptera	Tipulidae	11	12	23
Diptera	unknown	9	3	12
Hemiptera	Saldidae	61	24	85
Hemiptera	unknown		2	2
Homoptera	Aphididae	6		6
Homoptera	Cicadellidae	2	6	8
Hymenoptera	Apoidea		7	7
Hymenoptera	Ichneumunidae	3	12	15
Hymenoptera	unknown	1	8	9
Lepidoptera	unknown	2		2
Orthoptera	unknown	1		1

Notes:
Blank indicates no specimen was caught in the sampling for the month

Table 3-23. Seasonal Bird Counts at Squally Beach

Common Name	Scientific Name	Total Count	Spring	Summer	Fall
Cormorants					
double-crested cormorant	*Phalacrocorax auritus*	6		5	1
Bitterns and Herons					
great blue heron	*Ardea herodias*	10	1	5	4
Waterfowl					
American wigeon	*Anas americana*	237		4	233
Canada goose	*Branta canadensis*	33	9	24	
green-winged teal	*Anas crecca*	11			11
mallard	*Anas platyrhynchos*	96	1	30	65
Ospreys					
osprey	*Pandion haliaetus*	1		1	
Plovers					
killdeer	*Charadrius vociferus*	8		4	4
Sandpipers					
semipalmated sandpiper	*Calidris pusilla*	15		15	
spotted sandpiper	*Actitis macularia*	2		1	1
Gulls and Terns					
Caspian tern	*Sterna caspia*	7	4	3	
glaucous gull	*Larus hyperboreus*	1			1
glaucous-winged gull	*Larus glaucescens*	20		9	11
immature gull	*Larus sp.*	3		2	1
Kingfishers					
kingfisher	*Ceryle sp.*	1	1		
Woodpeckers					
red-shafted flicker	*Colaptes auratus cafer*	1			1
Swallows					
purple martin	*Progne subis*	26	2	24	
violet-green swallow	*Tachycineta thalassina*	2		2	
Chickadees					
black-capped chickadee	*Poecile atricapilla*	1		1	
Crows					
American crow	*Corvus brachyrhynchos*	7		3	4
Northwestern crow	*Corvus caurinus*	17	8	2	7
Thrushes					
American robin	*Turdus migratorius*	1			1
Starlings					
European starling	*Sturnus vulgaris*	6		6	
Finches and Sparrows					
American goldfinch	*Carduelis tristis*	6	1	5	
house finch	*Carpodacus mexicanus*	4		2	2
song sparrow	*Melospiza melodia*	19	2	7	10
white-crowned sparrow	*Zonotrichia leucophrys*	3		3	
	Total Number of Species:	**27**	**9**	**22**	**16**
	Total Number of Birds:	**544**	**29**	**158**	**357**

Notes:
Blank indicates no bird was observed.

Spring = March to May
Summer = June to August
Fall = September to November

Table 3-24. Bird Use at Squally Beach

Date	Common Name	Scientific Name	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier Pilings	Riparian	Marsh	Intertidal	Mud Flats	Open Water	Comments
5/31/02	American goldfinch	*Carduelis tristis*		1	M		X		X		X					
5/31/02	Canada goose	*Branta canadensis*		9	M	X									X	both males and females, 1 pr. With 7 goslings
5/31/02	Caspian tern	*Sterna caspia*		4	M	X	X								X	feeding
5/31/02	great blue heron	*Ardea herodias*	M	1	M	X			X	X						on piling
5/31/02	house finch	*Carpodacus mexicanus*	U		M		X				X					
5/31/02	kingfisher	*Ceryle sp.*	U	1	M	X	X		X							
5/31/02	mallard	*Anas platyrhynchos*	F	1	M	X									X	
5/31/02	Northwestern crow	*Corvus caurinus*		8	M				X							fly over
5/31/02	purple martin	*Progne subis*		2	M	X				X						male and female; 1 box active
5/31/02	song sparrow	*Melospiza melodia*		2	M	X	X				X					2 - off nests
6/21/02	American goldfinch	*Carduelis tristis*		3	L	X	X		X		X					number recorded as 3+; number heard recorded as 2+
6/21/02	European starling	*Sturnus vulgaris*		3	L											1 juvenile; at least 2 adults
6/21/02	glaucous-winged gull	*Larus glaucescens*		4	L											using trees north side of road
6/21/02	immature gull	*Larus sp.*		2	L	X							X	X		
6/21/02	killdeer	*Charadrius vociferus*		2	L	X	X						X	X		foraging
6/21/02	Northwestern crow	*Corvus caurinus*		2	L											foraging
6/21/02	purple martin	*Progne subis*		15	L	X	X		X	X						boxes seem occupied; young flying
6/21/02	song sparrow	*Melospiza melodia*	M	1	L		X				X					territorial male
6/21/02	song sparrow	*Melospiza melodia*		2	L	X						X				male and female; 2 seen while another sang in riparian
6/21/02	violet-green swallow	*Tachycineta thalassina*		2	L											
6/21/02	white-crowned sparrow	*Zonotrichia leucophrys*	M	1	L		X				X					singing in riparian
6/25/02	American goldfinch	*Carduelis tristis*		2	M	X	X		X		X					
6/25/02	American wigeon	*Anas americana*		3	M										X	
6/25/02	black-capped chickadee	*Poecile atricapilla*		1	M		X				X					number recorded as 1+
6/25/02	Canada goose	*Branta canadensis*		24	M	X					X	X			X	7 goslings
6/25/02	Caspian tern	*Sterna caspia*		3	M	X	X								X	
6/25/02	double-crested cormorant	*Phalacrocorax auritus*		4	M				X	X						yellow faces
6/25/02	European starling	*Sturnus vulgaris*		3	M	X			X		X	X				young around (fledglings)
6/25/02	glaucous-winged gull	*Larus glaucescens*		4	M											
6/25/02	great blue heron	*Ardea herodias*	M	4	M	X				X						3 landed in trees across the street
6/25/02	house finch	*Carpodacus mexicanus*		2	M		X				X					saw 2 twice; same birds?
6/25/02	killdeer	*Charadrius vociferus*		2	M								X			not territorial
6/25/02	mallard	*Anas platyrhynchos*		19	M											while another on south shore
6/25/02	osprey	*Pandion haliaetus*		1	M										X	immature; unsuccessful foraging
6/25/02	purple martin	*Progne subis*		8	M				X	X	X					5 boxes used; using trees north side of road
6/25/02	song sparrow	*Melospiza melodia*	M	3	M	X	X				X					2 males singing
6/25/02	white-crowned sparrow	*Zonotrichia leucophrys*		2	M	X										male and female; 1 pair
8/22/02	American crow	*Corvus brachyrhynchos*		3	M	X	X		X		X					
8/22/02	American wigeon	*Anas americana*		1	M	X									X	
8/22/02	double-crested cormorant	*Phalacrocorax auritus*		1	M	X			X							
8/22/02	glaucous-winged gull	*Larus glaucescens*		1	M				X							
8/22/02	great blue heron	*Ardea herodias*		1	M	X				X						resting
8/22/02	kingfisher	*Ceryle sp.*			M		X								X	heard only
8/22/02	mallard	*Anas platyrhynchos*		11	M	X									X	male and female
8/22/02	purple martin	*Progne subis*		1	M		X			X						number recorded as 1-2; heard only
8/22/02	semipalmated sandpiper	*Calidris pusilla*		15	M	X	X						X			foraging; faded plumage
8/22/02	song sparrow	*Melospiza melodia*		1	M	X					X					
8/22/02	spotted sandpiper	*Actitis macularia*		1	M	X	X						X			foraging
9/27/02	American crow	*Corvus brachyrhynchos*		4	M		X		X							
9/27/02	American wigeon	*Anas americana*		60	M	X	X			X						males and females; 60 recorded as +/-60; +/-20 recorded under pier/pilings; some resting on logs
9/27/02	black-capped chickadee	*Poecile atricapilla*			M											
9/27/02	double-crested cormorant	*Phalacrocorax auritus*		1	M	X									X	
9/27/02	great blue heron	*Ardea herodias*		1	M				X							
9/27/02	immature gull	*Larus sp.*		1	M				X							
9/27/02	mallard	*Anas platyrhynchos*	F	9	M					X						+/-5 recorded for pier/pilings
9/27/02	mallard	*Anas platyrhynchos*	M	10	M					X						+/-5 recorded for pier/pilings; some resting on logs (floating)
9/27/02	song sparrow	*Melospiza melodia*		2	M	X			X							male and female
9/27/02	song sparrow	*Melospiza melodia*	M		M		X				X					singing
9/30/02	American wigeon	*Anas americana*		150	L	X	X								X	150 recorded as +/-150
9/30/02	glaucous-winged gull	*Larus glaucescens*		2	L	X							X			
9/30/02	great blue heron	*Ardea herodias*		3	L	X								X	X	
9/30/02	house finch	*Carpodacus mexicanus*		2	L		X				X					
9/30/02	killdeer	*Charadrius vociferus*		1	L	X								X		
9/30/02	mallard	*Anas platyrhynchos*		20	L	X									X	20 recorded as +/-20
9/30/02	red-shafted flicker	*Colaptes auratus cafer*		1	L		X				X					red shafted, across street
9/30/02	song sparrow	*Melospiza melodia*		3	L	X	X				X					
11/5/02	American crow	*Corvus brachyrhynchos*			M	X	X									
11/5/02	American robin	*Turdus migratorius*		1	M				X							
11/5/02	American wigeon	*Anas americana*		23	M	X									X	Drinking, foraging, resting
11/5/02	glaucous gull	*Larus hyperboreus*		1	M										X	
11/5/02	glaucous-winged gull	*Larus glaucescens*		9	M	X			X					X		Resting, foraging
11/5/02	green-winged teal	*Anas crecca*		11	M	X									X	Resting, foraging
11/5/02	killdeer	*Charadrius vociferus*		3	M	X	X						X			Resting
11/5/02	mallard	*Anas platyrhynchos*		26	M	X				X					X	Resting, foraging
11/5/02	Northwestern crow	*Corvus caurinus*		7	M		X		X	X			X			
11/5/02	song sparrow	*Melospiza melodia*		5	M	X					X					Foraging
11/5/02	spotted sandpiper	*Actitis macularia*		1	M								X			Foraging in shallow water

Notes:
Gender: "F" = female, "M" = male, "U" = unknown
Tide: "L" = low, "M" = medium, "H" = high

Table 3-25. Marsh and Riparian Areal Cover at Middle Waterway (Simpson/Trustees) by Polygon

Vegetation Polygon	Percent Cover	Dominant Species
MA	30	*Atriplex patula, Salicornia virginica*
MB	85	*Deschampsia cespitosa, Salicornica virginica*
MC	80	*Spergularia canadensis*
MD	35	*Scirpus americanus, Salicornia virginica, Distichlis spicata, Deschampsia cespitosa*
ME	80	*Distichlis spicata, Spergularia canadensis*
MF	95	*Spergularia canadensis*
MG	80	*Atriplex patula, Spergularia canadensis*
MH	25	*Gnaphlium palustre*
MI	20	*Deschampsia cespitosa*
MJ	60	*Distichlis spicata*
MK	30	*Deschampsia cespitosa*
ML	25	*Scirpus americanus*
MM	50	*Deschampsia cespitosa, Distichlis spicata*
MN	60	*Triglochin maritimus*
MO	85	*Atriplex patula*
MP	35	*Deschampsia cespitosa*
MQ	85	*Atriplex patula*
MR	35	*Plantago maritima*
MS	30	*Deschampsia cespitosa*
MT	100	*Salicornia virginica*
MU	25	*Distichlis spicata, Deschampsia cespitosa*
MV	90	*Atriplex patula, Salicornia virginica, Spergularia canadensis*
MW	90	*Deschampsia caespitosa*
MX	80	*Spergularia canadensis, Plantago maritima, Salicornia virginica, Gnaphlium palustre*
MY	25	*Salicornia virginica, Spergularia canadensis*
MZ	50	*Triglochin maritimus*
MAA	60	*Distichlis spicata*
MBB	95	*Deschampsia cespitosa*
MCC	95	*Deschampsia cespitosa, Distichlis spicata*
MDD	95	*Distichlis spicata*
MEE	85	*Distichlis spicata*
MFF	40	*Eleocharis* sp.
MGG	30	*Eleocharis* sp.
RA	75	*Populus balsamifera, Pseudotsuga menziesii, Thuja plicata, Rosa* spp., *Lupinus* sp., *Arctostaphylos uva-ursi, Hypochaeris radicata, Hypericum perforatum,* grass spp.

Note: In Vegetation Polygon column, M=Marsh polygon; R=Riparian polygon

Table 3-26. Quadrat Locations Along Marsh and Riparian Transects at Middle Waterway (Simpson/Trustees)

Marsh Transect 1		Riparian Transect 2	
Quadrat	**Distance Along Transect (ft)**	**Quadrat**	**Distance Along Transect (ft)**
1	115	1	115
2	117	2	122
3	177	3	177
4	271	4	271
5	273	5	342
6	327	6	370
7	342	7	378
8	370	8	378
9	378	9	447
10	428	10	473
11	444	11	637
12	447	12	690
13	453	13	744
14	473	14	748
15	600	15	986
16	603		
17	637		
18	690		
19	702		
20	715		
21	744		
22	748		
23	986		

Table 3-27. Marsh Development at Middle Waterway (Simpson/Trustees) - Percent Cover

Common Name	Scientific Name	Average % Cover	Quadrat 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
American bulrush	***Scirpus americanus***	3.0															3								
American glasswort, pickleweed	*Salicornia virginica*	14.0												3		25									
Canadian sand-spurry	*Spergularia canadensis*	16.3				40	30	35					T	10	10	5	T								
orache, fat-hen saltbush	*Atriplex patula*	8.4	30			5	5	5	20			3		5	3		5					3			
seashore saltgrass	***Distichlis spicata***	41.0											45	50	40	55			15						

Notes:
Blank indicates no vegetation was observed in the quadrat
Bold indicates native planted species, underline indicates volunteer native species.
"T" = Trace

Table 3-28. Marsh Development at Middle Waterway (Simpson/Trustees) - Cover (Daubenmire Method)

Common Name	Scientific Name	Total Canopy	Canopy Cover (%)	Frequency (%)	Species Composition
American bulrush	***Scirpus americanus***	2.5	0.11	4.35	0.02%
American glasswort, pickleweed	***Salicornia virginica***	17.5	0.76	8.7	0.17%
Canadian sand-spurry	*Spergularia canadensis*	150	6.52	43.5	1.43%
orache, fat-hen saltbush	***Atriplex patula***	95	4.13	43.5	0.91%
seashore saltgrass	***Distichlis spicata***	190	8.26	21.7	1.82%
	TOTAL	**455**	**19.78**		

Notes:
Bold indicates planted native species, underline indicates volunteer native species
Total canopy: Obtained by counting the number of quadrats in each of six cover class (by species), multiplying this value times the midpoint of the appropriate cover class, and totalling the products for all cover classes by species.

Canopy cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

Frequency: Obtained by dividing the number of occurrences of a plant species (the number of quadrats in which a plant species was observed) by the total number of quadrats sampled along the transect.

Species composition: Obtained by dividing the percent canopy cover of each plant species by the total canopy cover of all plant species.

See Appendix B for a complete description of the Daubenmire method.

Table 3-29. Marsh Development at Middle Waterway (Simpson/Trustees) - Stem Height

Common Name	Scientific Name	Average Stem Height (in.)	Quadrat																						
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
American bulrush	***Scirpus americanus***	2.5															3								
American glasswort, pickleweed	***Salicornia virginica***	7.0												8		6									
Canadian sand-spurry	*Spergularia canadensis*	4.7				3	2	4					3	7	8	4	8								
orache, fat-hen saltbush	***Atriplex patula***	3.6	5			3	1	3	4			1		4	6		3					7			
seashore saltgrass	***Distichlis spicata***	5.1											4	5	6	6			4						

Notes:
Stem height in inches
Blank indicates no vegetation was observed in the quadrat
Bold indicates native planted species, underline indicates volunteer native species.

Table 3-30. Marsh Development at Middle Waterway (Simpson/Trustees) - Shoot Density

Common Name	Scientific Name	Average Shoot Density	Quadrat																						
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
American bulrush	***Scirpus americanus***	5.0															5								
American glasswort, pickleweed	***Salicornia virginica***	45.5												3		88									
Canadian sand-spurry	*Spergularia canadensis*	31.6				85	70	73					2	4	8	10	1								
orache, fat-hen saltbush	***Atriplex patula***	7.8	25			12	8	7	12			2		2	2		6					2			
seashore saltgrass	***Distichlis spicata***	229.6											185	270	327	308			58						

Notes:

Shoot density in shoots per quadrat. Quadrats are 0.25 m^2 in area.
Blank indicates no vegetation was observed in the quadrat
Bold indicates native planted species, underline indicates volunteer native species.

Table 3-31. Riparian Coverage at Middle Waterway (Simpson/Trustees) - Percent Cover

Common Name	Scientific Name	No. of Quadrats Found	Percent Cover (range)	Percent Cover (mean)
Herbs, Forbes and Grasses				
brome	*Bromus sp.*	11	15 to 45%	28.6
colonial bentgrass	*Agrostis tenuis*	7	1 to 75%	30.0
common St. John's-wort	*Hypericum perforatum*	7	1 to 30%	8.9
common velvet-grass	*Holcus lanatus*	3	Trace to 3%	1.7
hairy catsear	*Hypochaeris radicata*	6	Trace to 3%	1.5
lupine	*Lupinus sp.*	5	Trace to 15%	4.2
orchard grass	*Dactylis glomerata*	2	1 to 5%	3.0
pea	*Lathyrus sp.*	3	Trace to 10%	3.4
red clover	*Trifolium pratense*	1	3%	3.0
English plantain	*Plantago lanceolata*	4	2 to 10%	4.3
sheep sorrel	*Rumex acetosella*	2	Trace to 7%	3.5
silver hairgrass	*Aira caryophyllea*	3	5 to 15%	8.3
strawberry	***Fragaria chiloensis***	11	2 to 35%	15.5
unclassified-herb	unclassified-herb	3	Trace to 1%	0.4
Shrubs				
common snowberry	***Symphoricarpos albus***	3	5 to 30%	14.0
Himalayan blackberry	*Rubus discolor*	4	3 to 45%	18.3
kinnikinnick	***Arctostaphylos uva-ursi***	4	20 to 70%	51.3
nootka rose	***Rosa nutkana***	1	20%	20.0
oceanspray	***Holodiscus discolor***	1	10%	10.0
butterfly bush	*Buddleja davidii*	1	5 to 5%	5.0
rose	***Rosa sp.***	6	2 to 65%	23.5
trailing blackberry	*Rubus ursinus*	1	3%	3.0
vine maple	***Acer circinatum***	1	5%	5.0
Trees				
bigleaf maple	***Acer macrophyllum***	1	5%	5.0
black cottonwood	*Populus balsamifera*	6	5 to 45%	25.0
Douglas-fir	***Pseudotsuga menziesii***	1	15%	15.0
madrone	*Arbutus menziesii*	3	1 to 5%	2.3
Scouler's willow	*Salix scouleriana*	1	75%	75.0
Shore pine	***Pinus contorta***	1	5%	5.0
western redcedar	***Thuja plicata*** [(1)]	3	5 to 35%	18.3
Unknown				
unknown	unknown	2	2 to 3%	2.5

Notes: There were a total of 23 quadrats

Bold are planted native species, underline indicates volunteer native species. (All other entries are non-native or invasive.)

Mean percent cover is calculated for the number of quadrats where the plant was observed.

(1) Thuja plicata was planted and there are volunteers.

Table 3-32. Riparian Coverage at Middle Waterway (Simpson/Trustees) - Cover (Daubenmire Method)

Common Name	Scientific Name	Total Canopy	Canopy Cover (%)	Frequency (%)	Species Composition
Herbs, Forbes and Grasses					
brome	*Bromus sp.*	300	20.00	73.3%	1.41%
colonial bentgrass	*Agrostis tenuis*	197.5	13.17	46.7%	0.93%
common St. John's-wort	*Hypericum perforatum*	65	4.33	46.7%	0.30%
common velvet-grass	*Holcus lanatus*	7.5	0.50	20.0%	0.04%
hairy catsear	*Hypochaeris radicata*	15	1.00	40.0%	0.07%
lupine	*Lupinus sp.*	25	1.67	33.3%	0.12%
orchard grass	*Dactylis glomerata*	5	0.33	13.3%	0.02%
pea	*Lathyrus sp.*	20	1.33	20.0%	0.09%
red clover	*Trifolium pratense*	2.5	0.17	6.7%	0.01%
English plantain	*Plantago lanceolata*	22.5	1.50	26.7%	0.11%
sheep sorrel	*Rumex acetosella*	17.5	1.17	13.3%	0.08%
silver hairgrass	*Aira caryophyllea*	20	1.33	20.0%	0.09%
strawberry	*Fragaria sp.*	160	10.67	73.3%	0.75%
unclassified-herb	unclassified-herb	7.5	0.50	20.0%	0.04%
	Subtotal:	*565*	*37.67*		*2.65%*
Shrubs					
common snowberry	***Symphoricarpos albus***	55	3.67	20.0%	0.26%
Himalayan blackberry	*Rubus discolor*	70	4.67	26.7%	0.33%
kinnikinnick	*Arctostaphylos uva-ursi*	202.5	13.50	26.7%	0.95%
nootka rose	***Rosa nutkana***	15	1.00	6.7%	0.07%
oceanspray	***Holodiscus discolor***	15	1.00	6.7%	0.07%
orange eye	***Buddleja davidii***	2.5	0.17	6.7%	0.01%
rose	***Rosa sp.***	135	9.00	40.0%	0.63%
trailing blackberry	*Rubus ursinus*	2.5	0.17	6.7%	0.01%
vine maple	***Acer circinatum***	2.5	0.17	6.7%	0.01%
	Subtotal:	*500*	*33.33*		*2.34%*
Trees					
bigleaf maple	***Acer macrophyllum***	2.5	0.17	6.7%	0.01%
black cottonwood	*Populus balsamifera*	207.5	13.83	40.0%	0.97%
Douglas-fir	***Pseudotsuga menziesii***	15	1.00	6.7%	0.07%
madrone	*Arbutus menziesii*	7.5	0.50	20.0%	0.04%
Scouler's willow	*Salix scouleriana*	62.5	4.17	6.7%	0.29%
lodgepole	*Pinus contorta*	2.5	0.17	6.7%	0.01%
western redcedar	*Thuja plicata*	55	3.67	20.0%	0.26%
	Subtotal:	*352.5*	*23.50*		*1.65%*
Unknown					
unknown	unknown	5	0.33	13.3%	0.02%
	Subtotal:	*5*	*0.33*		*0.02%*
	TOTAL:	**1422.5**	**94.83**		

Notes:
Bold are planted native species, underline indicates volunteer native species. All other entries are non-native or invasive.

Total canopy: Obtained by counting the number of quadrats in each of six cover class (by species), multiplying this value times the midpoint of the appropriate cover class, and totalling the products for all cover classes by species.

Canopy cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

Frequency: Obtained by dividing the number of occurrences of a plant species (the number of quadrats in which a plant species was observed) by the total number of quadrats sampled along the transect.

Species composition: Obtained by dividing the percent canopy cover of each plant species by the total canopy cover of all plant species.

See Appendix B for a description of the Daubenmire method.

Table 3-33. Fish Species Richness at Middle Waterway (Simpson/Trustees)

Common Name	Scientific Name	Number Caught
Chinook salmon	*Oncorhynchus tshawytscha*	32
Coho salmon	*Oncorhynchus kisutch*	2
Chum salmon	*Oncorhynchus keta*	281
Pink	*Oncorhynchus gorbuscha*	21
Starry flounder	*Platichthys stellatus*	15
Staghorn sculpin	*Leptocottus armatus*	193
Sculpin	unknown species	5
Surf smelt	*Hypomesus pretiosus*	651
Shiner perch	*Cymatogaster aggregata*	6,003
Pile perch	*Damalichthys vacca*	4
Threespine stickleback	*Gasterosteus aculeatus*	1
Snake prickleback	*Lumpenus sagitta*	27
Pacific herring	*Clupea pallasii*	1

Table 3-34. Invertebrates in Fallout Traps at Middle Waterway (Simpson/Trustees)

Order	Family	July 24	August 8	Total
Amphipoda	Unknown	6		6
Araneae	Unknown	2		2
Coleoptera	*Cicindelidae*	1		1
Coleoptera	*Curculionidae*	2		2
Coleoptera	*Staphylinidae*	2		2
Coleoptera	Unknown		1	1
Diptera	*Agromyzidae*	67	98	165
Diptera	*Chironomidae*	39	2	41
Diptera	*Culicidae*	1		1
Diptera	*Dolichopodidae*	30	65	95
Diptera	*Sciomyzidae*		4	4
Diptera	*Tabanidae*		3	3
Diptera	*Tipulidae*	1	1	2
Diptera	Unknown	4	1	5
Hemiptera	*Saldidae*	6	2	8
Hymenoptera	*Formicidae*	2		2
Hymenoptera	*Ichneumunidae*	4		4
Hymenoptera	Unknown	1		1
Orthoptera	Unknown	1		1
Trichoptera	Unknown	2	1	3
Unknown	Unknown	3		3
TOTAL:		**174**	**178**	**352**

Notes:
Blank indicates no specimen was caught in the sampling for the month

Table 3-35. Seasonal Bird Counts at Middle Waterway (Simpson/Trustees)

Common Name	Scientific Name	Total Count	Spring	Summer	Fall
Cormorants					
double-crested cormorant	*Phalacrocorax auritus*	5			5
Bitterns and Herons					
great blue heron	*Ardea herodias*	2		1	1
Waterfowl					
American wigeon	*Anas americana*	6	6		
Canada goose	*Branta canadensis*	9	4		5
mallard	*Anas platyrhynchos*	6		6	
Plovers					
American golden plover	*Pluvialis dominica*	1			1
killdeer	*Charadrius vociferus*	11	2	7	2
Sandpipers					
semipalmated sandpiper	*Calidris pusilla*	8		8	
spotted sandpiper	*Actitis macularia*	2		2	
western sandpiper	*Calidris mauri*	5			5
Gulls and Terns					
Caspian tern	*Sterna caspia*	4	3	1	
glaucous-winged gull	*Larus glaucescens*	73	14	30	29
Heermann's gull	*Larus heermanni*	1			1
Doves					
rock dove	*Columba livia*	6		4	2
Kingfishers					
kingfisher	*Ceryle sp.*	1			1
Woodpeckers					
red-shafted flicker	*Colaptes auratus cafer*	1			1
Swallows					
barn swallow	*Hirundo rustica*	3		3	
cliff swallow	*Petrochelidon pyrrhonota*	1		1	
swallow		2	2		
violet-green swallow	*Tachycineta thalassina*	6		6	
Crows					
American crow	*Corvus brachyrhynchos*	19	3	3	13
Northwestern crow	*Corvus caurinus*	15	4	6	5
Bushtits					
bushtit	*Psaltriparus minimus*	2		2	
Thrushes					
American robin	*Turdus migratorius*	3	1	2	
Starlings					
European starling	*Sturnus vulgaris*	24	5	18	1
Finches and Sparrows					
American goldfinch	*Carduelis tristis*	1	1		
house finch	*Carpodacus mexicanus*	23	5	10	8
song sparrow	*Melospiza melodia*	11		4	7
white-crowned sparrow	*Zonotrichia leucophrys*	7	2	5	
Blackbirds and Orioles					
cowbird	*Molothrus sp.*	2		2	
	Total Number of Species:	**30**	**13**	**20**	**16**
	Total Number of Birds:	**260**	**52**	**121**	**87**

Notes:
Blank indicates no bird was observed.

Spring = March to May
Summer = June to August
Fall = September to November

Table 3-36. Bird Use at Middle Waterway (Simpson/Trustees)

Date	Common Name	Scientific Name	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier Pilings	Riparian	Marsh	Intertidal	Mud Flats	Open Water	Comments
5/31/02	American crow	*Corvus brachyrhynchos*		3	L	X	X				X					on wires just outside site
5/31/02	American goldfinch	*Carduelis tristis*		1	L		X				X					2 flyovers
5/31/02	American robin	*Turdus migratorius*	M	1	L		X				X					
5/31/02	American wigeon	*Anas americana*		6	L										X	
5/31/02	Canada goose	*Branta canadensis*		4	L										X	
5/31/02	Caspian tern	*Sterna caspia*		3	L	X	X		X					X	X	diving; foraging.
5/31/02	European starling	*Sturnus vulgaris*		5	L	X			X							
5/31/02	glaucous-winged gull	*Larus glaucescens*		14	L									X		
5/31/02	house finch	*Carpodacus mexicanus*		5	L	X	X		X		X		X			singing in riparian; foraging in intertidal inside exclusions
5/31/02	killdeer	*Charadrius vociferus*		2	L	X	X						X	X		pair
5/31/02	Northwestern crow	*Corvus caurinus*		4	L	X				X		X	X			foraging in intertidal
5/31/02	swallow			2	L				X							too far away to tell species
5/31/02	white-crowned sparrow	*Zonotrichia leucophrys*	M	2	L	X	X				X					2 singing males; 2 pairs?
6/21/02	American robin	*Turdus migratorius*	M	1	L	X			X		X					
6/21/02	American robin	*Turdus migratorius*	F	1	L	X			X		X					
6/21/02	barn swallow	*Hirundo rustica*	F	1	L				X				X	X	X	
6/21/02	barn swallow	*Hirundo rustica*	M	1	L	X			X				X			flyovers; one collecting nesting material.
6/21/02	bushtit	*Psaltriparus minimus*		2	L		X				X					number recorded as 2+
6/21/02	cliff swallow	*Petrochelidon pyrrhonota*	M	1	L	X	X		X					X		
6/21/02	cowbird	*Molothrus sp.*	F	1	L	X					X					
6/21/02	cowbird	*Molothrus sp.*	M	1	L	X					X					
6/21/02	European starling	*Sturnus vulgaris*		3	L	X					X					both male and female.
6/21/02	glaucous-winged gull	*Larus glaucescens*		13	L	X								X		
6/21/02	house finch	*Carpodacus mexicanus*		1	L	X	X				X					
6/21/02	killdeer	*Charadrius vociferus*		5	L	X							X	X		both male and female; 4 together; family?; 1 alone.
6/21/02	Northwestern crow	*Corvus caurinus*		3	L	X								X		
6/21/02	song sparrow	*Melospiza melodia*		2	L	X					X					
6/21/02	spotted sandpiper	*Actitis macularia*		2	L	X	X									both male and female.
6/21/02	violet-green swallow	*Tachycineta thalassina*		3	L	X			X							chasing cliff swallow.
6/21/02	white-crowned sparrow	*Zonotrichia leucophrys*	M	3	L	X	X				X					3 singing males.
6/21/02	white-crowned sparrow	*Zonotrichia leucophrys*	F	1	L	X					X					
6/25/02	barn swallow	*Hirundo rustica*	F	1	H	X			X							number recorded as 1-2; foraging.
6/25/02	Caspian tern	*Sterna caspia*		1	H	X	X		X							
6/25/02	European starling	*Sturnus vulgaris*		5	H	X										
6/25/02	glaucous-winged gull	*Larus glaucescens*		5	H	X				X					X	sitting on pilings; 1 foraging in open water.
6/25/02	house finch	*Carpodacus mexicanus*	M	1	H	X	X				X		X			foraging in intertidal.
6/25/02	house finch	*Carpodacus mexicanus*	F	2	H	X	X				X		X			foraging in intertidal.
6/25/02	killdeer	*Charadrius vociferus*		2	H	X	X				X		X			pair; nesting behavior; nest - riparian.
6/25/02	Northwestern crow	*Corvus caurinus*		3	H	X	X		X		X					
6/25/02	rock dove	*Columba livia*		1	H											
6/25/02	spotted sandpiper	*Actitis macularia*			H		X						X			likely on south side of waterway.
6/25/02	violet-green swallow	*Tachycineta thalassina*		3	H	X			X							
6/25/02	white-crowned sparrow	*Zonotrichia leucophrys*	M	1	H	X					X					
8/22/02	American crow	*Corvus brachyrhynchos*		3	M								X			foraging
8/22/02	European starling	*Sturnus vulgaris*		10	M	X										number recorded as +/-10; flock; foraging.
8/22/02	glaucous-winged gull	*Larus glaucescens*		12	M	X			X				X			3 flyover; 5 intertidal; 2 open water. Two juveniles "begging" for food
8/22/02	great blue heron	*Ardea herodias*		1	M				X			X				took off from marsh.
8/22/02	house finch	*Carpodacus mexicanus*		6	M		X				X					foraging
8/22/02	mallard	*Anas platyrhynchos*		6	M								X		X	1 intertidal; 5 open water; 4 females; 2 males
8/22/02	rock dove	*Columba livia*		3	M	X			X				X			1 intertidal; 2 flyover.
8/22/02	semipalmated sandpiper	*Calidris pusilla*		8	M	X							X	X		males and females; mixed; worn plumage.
8/22/02	song sparrow	*Melospiza melodia*		2	M		X									number recorded as 2?; no clearly seen.
9/27/02	American crow	*Corvus brachyrhynchos*			H											
9/27/02	American crow	*Corvus brachyrhynchos*		2	H				X							on wires
9/27/02	American Golden-Plover	*Pluvialis dominica*		1	H								X			non-breeding plumage; resting at edge of water.
9/27/02	double-crested cormorant	*Phalacrocorax auritus*		1	H				X						X	
9/27/02	glaucous-winged gull	*Larus glaucescens*		3	H				X							
9/27/02	great blue heron	*Ardea herodias*			H				X	X						
9/27/02	house finch	*Carpodacus mexicanus*		2	H		X				X					
9/27/02	killdeer	*Charadrius vociferus*		2	H	X			X	X						
9/27/02	red-shafted flicker	*Colaptes auratus cafer*		1	H		X				X					
9/27/02	song sparrow	*Melospiza melodia*		2	H	X	X									one bird seen, one bird heard.
9/30/02	Canada goose	*Branta canadensis*		5	L				X							
9/30/02	double-crested cormorant	*Phalacrocorax auritus*		3	L				X							
9/30/02	European starling	*Sturnus vulgaris*		1	L				X				X			
9/30/02	glaucous-winged gull	*Larus glaucescens*		6	L									X	X	
9/30/02	great blue heron	*Ardea herodias*	M	1	L									X		
9/30/02	Heermann's gull	*Larus heermanni*		1	L				X							
9/30/02	house finch	*Carpodacus mexicanus*		4	L	X	X									number recorded as 4+
9/30/02	kingfisher	*Ceryle sp.*		1	L					X					X	
9/30/02	Northwestern crow	*Corvus caurinus*		5	L	X			X	X	X		X	X		crow eating rosehip.
9/30/02	rock dove	*Columba livia*		2	L	X							X	X		
11/5/02	American crow	*Corvus brachyrhynchos*		11	L	X			X				X			
11/5/02	double-crested cormorant	*Phalacrocorax auritus*		1	L										X	
11/5/02	glaucous-winged gull	*Larus glaucescens*		20	L	X								X	X	Foraging
11/5/02	great blue heron	*Ardea herodias*			L				X							
11/5/02	house finch	*Carpodacus mexicanus*		2	L		X				X					
11/5/02	song sparrow	*Melospiza melodia*		5	L						X	X				
11/5/02	western sandpiper	*Calidris mauri*		5	L								X	X		

Notes:
Gender: "F" = female, "M" = male, "U" = unknown
Tide: "L" = low, "M" = medium, "H" = high

Table 3-37. Fish Species Richness at Middle Waterway (City of Tacoma)

Common Name	Scientific Name	Number Caught
Chinook salmon	*Oncorhynchus tshawytscha*	4
Chum salmon	*Oncorhynchus keta*	160
Pink	*Oncorhynchus gorbuscha*	6
Starry flounder	*Platichthys stellatus*	2
Speckled sandab	*Citharichthys stigmaeus*	1
Staghorn sculpin	*Leptocottus armatus*	92
Sculpin	unidentified species	1
Shiner perch	*Cymatogaster aggregata*	3,678

Table 3-38. Fish Species Richness at Skookum Wulge

Common Name	Scientific Name	Number Caught
Chinook salmon	*Oncorhynchus tshawytscha*	67
Coho salmon	*Oncorhynchus kisutch*	27
Chum salmon	*Oncorhynchus keta*	522
Pink	*Oncorhynchus gorbuscha*	117
Cutthroat trout	*Oncorhynchus clarkii*	9
Salmon	unidentified species	2
Starry flounder	*Platichthys stellatus*	7
Flatfish	unidentified species	1
Staghorn sculpin	*Leptocottus armatus*	58
Sculpin	unidentified species	1
Surf smelt	*Hypomesus pretiosus*	522
Shiner perch	*Cymatogaster aggregata*	703
Tubesnout	*Aulorhynchus flavidus*	18
Pipefish	*Syngnathus leptorhynchus*	1
Threespine stickleback	*Gasterosteus aculeatus*	5
Pacific herring	*Clupea pallasii*	27
Sandlance	*Ammodytes hexapterus*	1
Northern anchovy	*Engraulis mordax*	1

Table 3-39. Fish Species Richness at Yowkwala

Common Name	Scientific Name	Number Caught
Chinook salmon	*Oncorhynchus tshawytscha*	324
Coho salmon	*Oncorhynchus kisutch*	2,404
Chum salmon	*Oncorhynchus keta*	258
Pink	*Oncorhynchus gorbuscha*	202
Cutthroat trout	*Oncorhynchus clarkii*	3
Starry flounder	*Platichthys stellatus*	1
Staghorn sculpin	*Leptocottus armatus*	7
Silverspot sculpin	*Blepsias cirrhosus*	2
Great sculpin	*Myoxocephalus polyacanthocephalus*	1
Buffalo sculpin	*Enophrys bison*	5
Sculpin	unidentified; 2 species	36
Surf smelt	*Hypomesus pretiosus*	208
Shiner perch	*Cymatogaster aggregata*	870
Striped perch	*Embiotoca lateralis*	1
Pile perch	*Damalichthys vacca*	11
Penpoint gunnel	*Apodichthys flavidus*	2
Crescent gunnel	*Pholis laeta*	1
Saddleback gunnel	*Pholis ornata*	5
Tubesnout	*Aulorhynchus flavidus*	11
Threespine stickleback	*Gasterosteus aculeatus*	42
Pacific herring	*Clupea pallasii*	121
Sandlance	*Ammodytes hexapterus*	14
Shad	*Alosa sapidissima*	1
Whitespot greenling	*Hexagrammos stelleri*	1
Ratfish	*Hydrolagus colliei*	1

Table 3-40. Fish Species Richness at Olympic View

Common Name	Scientific Name	Number Caught
Chinook salmon	*Oncorhynchus tshawytscha*	20
Chum salmon	*Oncorhynchus keta*	8
Pink	*Oncorhynchus gorbuscha*	12
English sole	*Parophrys vetulus*	23
Starry flounder	*Platichthys stellatus*	27
Flatfish	unidentified species	1
Rock sole	*Lepidopsetta bilineata*	2
Speckled sandab	*Citharichthys stigmaeus*	17
Staghorn sculpin	*Leptocottus armatus*	106
Silverspot sculpin	*Blepsias cirrhosus*	8
Buffalo sculpin	*Enophrys bison*	2
Sculpin	unidentified species	277
Tidepool sculpin	*Oligocottus maculosus*	2
Sailfin sculpin	*Nautichthys oculofasciatus*	2
Surf smelt	*Hypomesus pretiosus*	65
Shiner perch	*Cymatogaster aggregata*	3,484
Striped perch	*Embiotoca lateralis*	32
Pile perch	*Damalichthys vacca*	40
Penpoint gunnel	*Apodichthys flavidus*	99
Crescent gunnel	*Pholis laeta*	35
Saddleback gunnel	*Pholis ornata*	167
Tubesnout	*Aulorhynchus flavidus*	14
Pipefish	*Syngnathus leptorhynchus*	38
Threespine stickleback	*Gasterosteus aculeatus*	3
Snake prickleback	*Lumpenus sagitta*	14
Pacific herring	*Clupea pallasii*	6
Sandlance	*Ammodytes hexapterus*	1
Whitespot greenling	*Hexagrammos stelleri*	1
Sturgeon poacher	*Agonus acipenserinus*	1
Sebastes	unidentified species	1

Table 3-41. Fish Species Richness at Tahoma Salt Marsh

Common Name	Scientific Name	Number Caught
Chinook salmon	*Oncorhynchus tshawytscha*	110
Coho salmon	*Oncorhynchus kisutch*	7
Chum salmon	*Oncorhynchus keta*	207
Pink	*Oncorhynchus gorbuscha*	766
Salmon	unidentified species	1
Staghorn sculpin	*Leptocottus armatus*	3
Buffalo sculpin	*Enophrys bison*	3
Sculpin	unidentified; 2 species	25
Tidepool sculpin	*Oligocottus maculosus*	9
Shiner perch	*Cymatogaster aggregata*	30
Striped perch	*Embiotoca lateralis*	2
Pile perch	*Damalichthys vacca*	3
Penpoint gunnel	*Apodichthys flavidus*	8
Saddleback gunnel	*Pholis ornata*	1
Pipefish	*Syngnathus leptorhynchus*	3
Pacific herring	*Clupea pallasii*	88
Sandlance	*Ammodytes hexapterus*	1

Table 4-1. Monitoring Performance Summary for Year 1

	Physical Success Criteria				**Biological Success Criteria**								
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Site Name	Intertidal Areal Coverage	Intertidal Stability	Tidal Circulation	Elevation and Channel Morphology	Marsh Development/Areal Coverage	Marsh Development/Species Composition	Marsh Development/ Plant Vigor	Marsh Vegetation / Herbivory Avoidance	Riparian Vegetation Survival	Riparian Vegetation/Areal Coverage	Fish Access / Presence	Invertebrate Prey Resource Production	Bird Use
Mowitch	Yes	Yes	Yes	Yes	No	No	?	Yes	?	No	Yes	Yes	Yes
Squally Beach	Yes	Yes	Yes	Yes	Yes	Yes	?	No	No	No	Yes	Yes	Yes
Middle Waterway (Trustee/Simpson)	Yes	Yes		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Middle Waterway (City of Tacoma)	Yes	Yes		Yes							Yes		
Skookum Wulge	Yes										Yes		
Yowkwala					No						Yes		
Olympic View											Yes		
Tahoma Salt Marsh											Yes		

Notes:
Yes means that the criteria is being met or is likely to be met.
No means that the criteria is not being met.
Blank cells indicate that the criteria was not evaluated at the listed site.
? Means that it is unclear whether this criteria is being or will be met.

Common Name	Scientific Name	Squally Beach	Mowitch	Total
Shore Pine	*Pinus contorta*	10	20	30
Indian Plum	*Oemleria cerasiformis*	8	10	18
Red Osier Dogwood	*Cornus stolonifera*	10	40	50+
Black Twinberry	*Lonicera involucvata*	10	20	30
Ninebark	Physocarpus capitatus	13	5	18
Snowberry	*Symphoricarpos albus*	15	15	30
Elderberry	*Sambucus racemosa*	7	0	7
Nootka Rose	*Rosa nutkana*	13	22	35
Stink Currant	*Ribes bracteosum*	5	5	10+
Willow (Sitka / Hooker)	*Salix sitchensis/hookeriana*	50	100	150
Vine Maple	*Acer circinatum*	10	5	15
Hawthorne	*Crateagus douglasii*	4	3	7+
Gooseberry	*Ribes acustre*	10	5	15
Pacific Crab-apple	*Malus fusca*	4	6	10
Cascara	*Rhamnus purshiana*	2	5	7
Bigleaf Maple	*Acer macrophyllum*	3	3	6+
Cottonwood	*Populus balsamifera*	5	3	8+
Salmonberry	*Rubus Spectabilis*	5	0	5+
	TOTALS:	184	267	451+

Figure A-1. Mowitch, from railroad bridge looking north, 6/13/02

RIDOLFI Inc.	Year 1 (2002) Monitoring Report Commencement Bay Prepared for the Commencement Bay NRDA Trustees	January 29, 2002	Figures A-1 and A-2.

Figure A-3. Squally Beach, looking east, 6/12/02

Figure A-4. Squally Beach, looking northwest, 6/12/02

RIDOLFI Inc.	Year 1 (2002) Monitoring Report Commencement Bay Prepared for the Commencement Bay NRDA Trustees	January 29, 2002	Figures A-3 and A-4.

Figure A-5. Skookum Wulge, looking south, 6/18/02

Figure A-6. Skookum Wulge, looking south 6/18/02

RIDOLFI Inc.	Year 1 (2002) Monitoring Report Commencement Bay Prepared for the Commencement Bay NRDA Trustees	January 29, 2002	Figures A-5 and A-6.

Figure A-7. Middle Waterway (Simpson/Trustees) looking north, 10/10/02

RIDOLFI Inc.	Year 1 (2002) Monitoring Report Commencement Bay Prepared for the Commencement Bay NRDA Trustees	January 29, 2002	Figures A-7 and A-8.

DAUBENMIRE METHOD

1. General Description The Daubenmire method consists of systematically placing a 20- x 50-cm quadrat frame along a tape on permanently located transects. The following vegetation attributes are monitored using the Daubenmire method·

A. Canopy cover
B. Frequency
C. Composition by canopy cover

It is important to establish a photo plot and take both close-up and general view photographs. This allows the portrayal of resource values and conditions and furnishes visual evidence of vegetation and soil changes over time.

2. Areas of Use This method is applicable to a wide variety of vegetation types as long as the plants do not exceed waist height. It tends to be inexpensive. Estimates can be made very quickly. It is necessary for the plants' canopies to be distinct.

3 . Advantages and Limitations This method is relatively simple and rapid to use. A limitation is that there can be large changes in canopy cover of herbaceous species between years because of climatic conditions, with no relationship to the effects of management. In general, quadrats are not recommended for estimating cover. This method cannot be used to calculate rooted frequency.

This method can be moderately accurate. Where greater accuracy is required, Line Intercept or Point Intercept techniques can be used.

4. Equipment The following equipment is needed.

A. Study Location and Documentation Data form
B. Daubenmire forms (Daubenmire form and Daubenmire Summary form).
C. Hammer
D. Permanent yellow or orange spray paint
E. Two stakes: 3/4 - or 1 -inch angle iron not less than 16 inches long
F. Tape: 100- or 200-foot, delineated in tenths and hundreds, or a metric tape of the desired length.
G. Steel pins (reinforcement bar) for marking zero, mid, and end points of the transect
H. Frame to delineate the 20- x 50-cm quadrats
I. Compass
J. Steel post and driver

5. Training The accuracy of data depends on the training and ability of the examiners. Error arises simple from inadequate training, but can be minimized by making quantitative measurements of cover using other techniques (e.g., line intercept). Examiners must be able to identify the plant species. They must receive adequate and consistent training in laying out transects and making canopy coverage estimates using the frame.

6. Establishing Studies Careful establishment of studies is a critical element in obtaining meaningful data.

A. **Site Selection** The most important factor in obtaining usable data is selecting representative areas (critical or key areas) in which to run the study. Study sites should be located within a single plant community within a single ecological site. Transects and sampling points need to be randomly located within the critical or key areas (see Section III).

B. **Pilot Studies** Collect data on several pilot studies to determine the number of samples (transects or observation points) and the number and size of quadrats needed to collect a statistically valid sample.

C. **Number of Studies** Establish a minimum of one study on each study site; establish more if needed (see Section II.D and III.B).

D. **Study Layout** Data can be collected using the baseline, macroplot, or linear study designs. The linear technique is the one most often used.

(1) Align a tape (100-, or 200-foot, or metric equivalent) in a straight line by stretching it between the transect location and

the transect bearing stakes. Do not allow vegetation to deflect the alignment of the tape. A spring and pulley may be useful to maintain a straight line. The tape should be aligned as close to the ground as possible.

(2) Drive steel pins almost to the ground surface at the zero point on the tape and at the end of the transect. A pin may also be driven into the ground at the midpoint of the transect.

E. **Reference Post or Point** Permanently mark the location of each study with a reference post and a study location stake.

F. **Study Identification** Number studies for proper identification to ensure that the data collected can be positively associated with specific sites on the ground.

G. **Study Documentation** Document pertinent information concerning the study on the Study Location and Documentation Data form.

7. Taking Photographs Establish photo plots.

8. Sampling Process In addition to collecting the specific studies data, general observations should be made of the study sites.

A. **Cover Classes** This method uses six separate cover classes. The cover classes are:

Cover Class	Range of Coverage	Midpoint of Range
1	- 5%	2.5%
2	5- 25%	15.0%
3	25 - 50%	37.5%
4	50 - 75%	62.5%
5	75 - 95%	85.0%
6	95 - 100%	97.5%

B. **Ten Cover Classes** Where narrower and more numerous classes are preferred, a ten-cover class system can be used.

C. **Collecting Cover Data** As the quadrat frame is placed along the tape at the specified intervals, estimate the canopy coverage of each plant species. Record the data by quadrat, by species, and by cover class on the Daubenmire form. Canopy coverage estimates can be made for both perennial and annual plant species.

(1) Observe the quadrat frame from directly above and estimate the cover class for all individuals of a plant species in the quadrat as a unit. All other kinds of plants are ignored as each plant species is considered separately.

(2) Imagine a line drawn about the leaf tips of the undisturbed canopies (ignoring inflorescence) and project these polygonal images onto the ground. This projection is considered "canopy coverage." Decide which of the classes the canopy coverage of the species falls into and record on the form.

(3) Canopies extending over the quadrat are estimated even if the plants are not rooted in the quadrat.

(4) Collect the data at a time of maximum growth of the key species.

(5) For tiny annuals, it is helpful to estimate the number of individuals that would be required to fill 5% of the frame (the 71 - x 71 -mm area). A quick estimate of the numbers of individuals in each frame will then provide an estimate as to whether the aggregate coverage falls in Class I or 2, etc.

(6) Overlapping canopy cover is included in the cover estimates byspecies; therefore, total cover may exceed 100 percent. Total cover may not reflect actual ground cover.

9. **Calculations** Make the calculations and record the results in the appropriate columns on the Daubenmire and Daubenmire Summary forms.

A. **Canopy Cover** Calculate the percent canopy cover by species as follows:

(1) On the Daubenmire form count the number of quadrats in each of the six cover class (by species) and record in the Number column on the Daubenmire Summary form.

(2) Multiply this value times the midpoint of the appropriate cover class.

(3) Total the products for all cover classes by species.

(4) Divide the sum by the total number of quadrats sampled on the transect.

(5) Record the percent cover by species on the form.

B. **Frequency** Calculate the percent frequency for each plant species by dividing the number of occurrences of a plant species (the number of quadrats in which a plant species was observed) by the total number of quadrats sampled along the transect. Multiply the resulting value by 100. Record the percent frequency on the form.

C. **Species Composition** With this method, species composition is based on canopy cover of the various species. It is determined by dividing the percent canopy cover of each plant species by the total canopy cover of all plant species. Record the percent composition on the form.

10. Data Analysis Tests should be directed at detecting changes in cover of the species and/or in major ground cover classes. Tests for changes in minor species will have low power to detect change. If quadrats are spaced far enough apart on each transect so as to be considered independent, the quadrat can be analyzed as the sampling unit. Otherwise, the transects should be considered the sampling units. If the transects are treated as the sampling unit, and given that the transects are permanent, either the paired t-test or the nonparametric Wilcoxon signed rank test should be used to test for change between two years. Repeated measures ANOVA can be used to test for differences between 3 or more years. If the quadrats are treated as the sampling units, care must be taken to ensure they are positioned the same along each transect in each year of measurement. A paired t-test, Wilcoxon signed rank test, or ANOVA is then used as described above for transects.

11. Cost About 5-25 min/10 quadrats.

Daubenmire

Page ___ of ___

Study Number	Date	Examiner	Allotment Name & Number	Pasture

Transect Number and Location	Number of Quadrats

Plant Species	Quadrat																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25

Plant Species	Quadrat																								
	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50

Daubenmire Summary

Page ____ of ____

Study Number	Date	Examiner	Allotment Name & Number	Pasture
Study Location			Number of Quadrats	

Cover Class	Mid-Point	Species		Species		Species		Species		Species		Species		Species		Species		Species		Species		Species	
		Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product	Number	Product
1 1-5%	2.5																						
2 5-25%	15																						
3 26-50%	37.5																						
4 51-75%	62.5																						
5 76-95%	85																						
6 96-100%	97.5																						
Total canopy																							
Number of Samples																							
% canopy cover																							
Species composition																							
Frequency																							

COMMENCEMENT BAY RESTORATION FISH MONITORING —
2002 FIELD SAMPLING AND DATA SUMMARY.
December, 2002.

Casey Rice, Dan Lomax, Cathy Laetz, Wynnae Osenga, and Tracy Collier

From April through October, 2002, members of the Environmental Conservation Division (ECD) of the Northwest Fisheries Science Center (NWFSC) conducted field sampling for the fish component of the Commencement Bay community-based restoration site monitoring. This document summarizes sampling effort, data and samples collected, and also presents selected catch and length results for 2002.

Six established sites and one yet to be constructed site (Figure 1) were successfully sampled for fish assemblage composition, salmonid diets, chemical contamination of sediments (where possible) and chemical contamination of fish tissue from selected species. Fish sampling occurred on an approximately biweekly basis through June, and continued monthly into October. The majority of sediment sampling occurred in late June, with an extra collection at Olympic View in May, before extensive substrate manipulation activities occurred at the site.

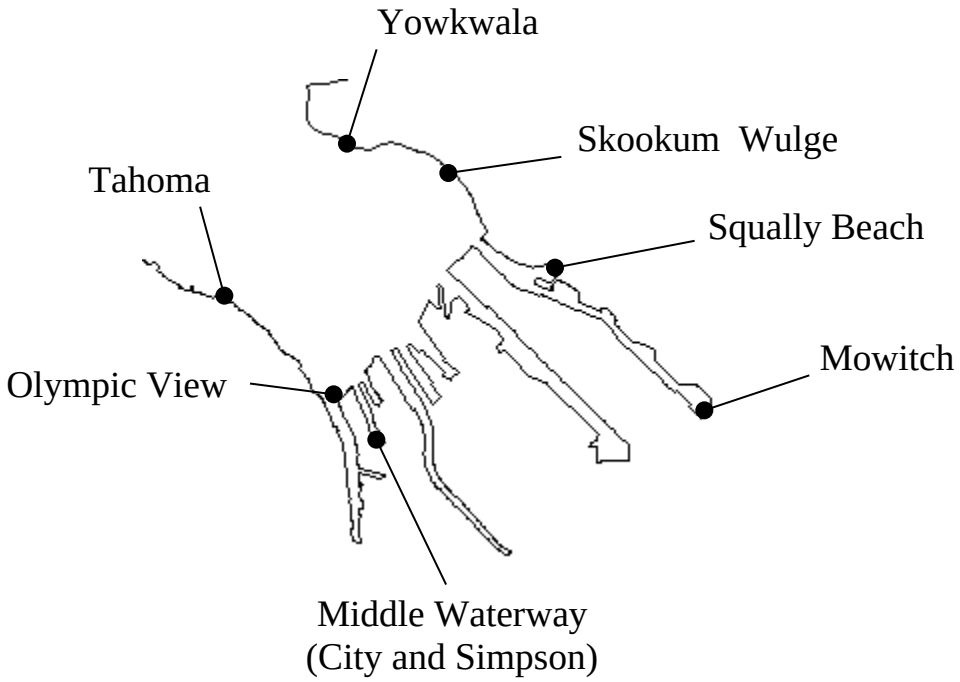

Figure 1. Commencement Bay restoration sites to be sampled during 2002 field season. Note: two adjacent sites (City and Simpson) are located at the head of Middle Waterway; Tahoma Salt Marsh is not yet constructed.

Fishing Effort

Due to the variety of site characteristics (topography, elevation, currents, etc.), distance between sites, and the timing of appropriate tides, sampling logistics were challenging. However, the customized fishing gear built for the project functioned as intended, with a few small modifications. Over the seven-month sampling period, 158 individual net sets were completed (Table 1). Beach seine samples were conducted with a 37-m floating "Puget Sound" beach seine. Two basic block net designs were deployed: four, 37-m x 13.5-m nets made of 1-cm mesh were used at Mowitch, and 9.7-m x 1.8-m nets made of 0.5-cm mesh in various configurations (additional wings, etc.) were used at Middle Waterway City (one net), and Squally Beach (four nets). It is important to note that caution must be exercised when comparing catch results from the various sites because of differences in habitat, gear selectivity, and areas sampled.

Fish Catch

Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The total number of species (species richness, SR) peaked in late spring/early summer (Figure 2), and ranged from three at Squally Beach, to 30 at Olympic View (Table 2, figure 3), with different patterns among sites (Figure 4). Juvenile salmonids were encountered at all sites except Squally Beach (Figures 6, 7, 8, and 11). The seasonal pattern of salmonid species abundance was as expected with peak abundances occurring in late spring/early summer (Figures 5, 9, 10, and 11), and chinook having the latest peak and broadest temporal distribution. Catches of chinook and coho salmon were dominated by hatchery fish (Figures 8 and 9). Mean lengths of coho (Figure 12A) were fairly similar over time (except for occasional catches of adults in beach seines at Yowkwala), indicative of fairly transitory and uniform population. In contrast, chinook lengths over the year (Figure 12B) show evidence of multiple life history types migrating through, and possibly rearing in, the system. Increasing size of pink and chum over the season (Figure 12C-D) also suggest rearing by these species.

Abundances of English sole (one of the primary target species) were quite low, resulting in a lack of samples for certain analyses.

DRAFT

Site	Gear Type	April 1-3	April 18	April 29-May 1	May 13-14	May 28-29	June 11-13	June 24-28	July 22-26	August 12-20	September 5-10	October 3-9	Total
Yowkwala	Beach seine	3	3	3	3	3	3	3	3	3	3	3	**33**
Skookum Wulge	Beach seine	1	1	3	1	2	2	2	3	2	2	2	**21**
Squally Beach	Block net	0	0	0	0	0	0	4	4	0	4	4	**16**
Mowitch	Block net	4	4	4	0	4	4	4	4	4	4	0	**36**
Middle Waterway (Simpson)	Beach seine	3	0	2	0	3	0	2	3	0	3	3	**19**
Middle Waterway (City)	Block net	1	0	1	0	1	0	1	1	1	1	1	**8**
Olympic View	Beach seine	3	1	1	2	2	2	2	2	1	1	1	**18**
Tahoma	Beach seine	0	0	0	0	1	2	1	1	1	0	1	**7**
Total		**15**	**9**	**14**	**6**	**16**	**13**	**19**	**21**	**12**	**18**	**15**	**158**

Table 1. Summary of fishing effort (net sets per sampling period) by site and sampling period for 2002.

Table 2. All fish species captured during 2002 by site. (Several sculpin and salmon samples await confirmation of species identification via preserved voucher specimens.)

Site	Species Captured
Middle Waterway (City, block net)	Chinook salmon *(Oncorhynchus tshawytscha)* Chum salmon *(Oncorhynchus keta)* Pink salmon *(Oncorhynchus gorbuscha)* Starry flounder *(Platichthys stellatus)* Speckled sanddab *(Citharichthys stigmaeus)* Staghorn sculpin *(Leptocottus armatus)* Sculpin – (unidentified; 2 spp.) Shiner perch *(Cymatogaster aggregata)*
Middle Waterway (Simpson, beach seine)	Chinook salmon *(Oncorhynchus tshawytscha)* Coho salmon *(Oncorhynchus kisutch)* Chum salmon *(Oncorhynchus keta)* Pink salmon *(Oncorhynchus gorbuscha)* Starry flounder *(Platichthys stellatus)* Staghorn sculpin *(Leptocottus armatus)* Sculpin – (unidentified; 2 spp.) Surf smelt (*Hypomesus pretiosus)* Shiner perch *(Cymatogaster aggregata)* Pile perch Threespine stickleback (*Gasterosteus aculeatus)* Snake prickleback *(Lumpenus sagitta)* Pacific herring *(Clupea pallasii)*
Mowitch	Chinook salmon *(Oncorhynchus tshawytscha)* Coho salmon *(Oncorhynchus kisutch)* Chum salmon *(Oncorhynchus keta)* Cutthroat trout *(Oncorhynchus clarkii)* Starry flounder *(Platichthys stellatus)* Staghorn sculpin *(Leptocottus armatus)* Sculpin – (unidentified; 2spp.) Surf smelt (*Hypomesus pretiosus)* Shiner perch *(Cymatogaster aggregata)* Striped perch *(Embiotoca lateralis)* Pile perch *(Damalichthys vacca)* Penpoint gunnel *(Apodichthys flavidus)* Crescent gunnel *(Pholis laeta)* Saddleback gunnel *(Pholis ornate)* Threespine stickleback (*Gasterosteus aculeatus)* Snake prickleback *(Lumpenus sagitta)* Pacific herring *(Clupea pallasii)* Sandlance (*Ammodytes hexapterus)* Shad *(Alosa sapidissima)*
Olympic View	Chinook salmon *(Oncorhynchus tshawytscha)* Chum salmon *(Oncorhynchus keta)* Pink salmon *(Oncorhynchus gorbuscha)* English Sole *(Parophrys vetulus)*

Site	Species Captured
	Starry flounder *(Platichthys stellatus)* Rock Sole *(Lepidopsetta bilineata)* Speckled Sandab *(Citharichthys stigmaeus)* Staghorn sculpin *(Leptocottus armatus)* Silverspot sculpin *(Blepsias cirrhosus)* Buffalo sculpin *(Enophrys bison)* Tidepool sculpin *(Oligocottus maculosus)* Sailfin sculpin *(Nautichthys oculofasciatus)* Sculpin (unidentified; 2 spp.) Surf smelt *(Hypomesus pretiosus)* Shiner perch *(Cymatogaster aggregata)* Stripped perch *(Embiotoca lateralis)* Pile perch *(Damalichthys vacca)* Penpoint gunnel *(Apodichthys flavidus)* Crescent gunnel *(Pholis laeta)* Saddleback gunnel *(Pholis ornate)* Tubesnout *(Aulorhynchus flavidus)* Pipefish *(Syngnathus leptorhynchus)* Threespine stickleback *(Gasterosteus aculeatus)* Snake prickleback *(Lumpenus sagitta)* Pacific herring *(Clupea pallasii)* Sandlance (*Ammodytes hexapterus)* White Spot Greenling *(Hexagrammos stelleri)* Sturgeon Poacher *(Agonus acipenserinus)* Sebastes – unidentified *(Sebastes sp.)*
Skookum Wulge	Chinook salmon *(Oncorhynchus tshawytscha)* Coho salmon *(Oncorhynchus kisutch)* Chum salmon *(Oncorhynchus keta)* Pink salmon *(Oncorhynchus gorbuscha)* Salmon (unidentified) Cutthroat trout *(Oncorhynchus clarkii)* Starry flounder *(Platichthys stellatus)* Flatfish – unidentified Staghorn sculpin *(Leptocottus armatus)* Sculpin – (unidentified; 2spp.) Surf smelt *(Hypomesus pretiosus)* Shiner perch *(Cymatogaster aggregata)* Pipefish *(Syngnathus leptorhynchus)* Tubesnout *(Aulorhynchus flavidus)* Threespine stickleback *(Gasterosteus aculeatus)* Sandlance (*Ammodytes hexapterus)* Pacific herring *(Clupea pallasii)* Northern Anchovy *(Engraulis mordax)*
Squally Beach	Staghorn sculpin *(Leptocottus armatus)* Shiner perch *(Cymatogaster aggregata)* Threespine stickleback *(Gasterosteus aculeatus)*
Tahoma	Chinook salmon – wild *(Oncorhynchus tshawytscha)*

Site	Species Captured
	Chinook salmon – hatchery *(Oncorhynchus tshawytscha)* Coho salmon – wild *(Oncorhynchus kisutch)* Coho salmon – hatchery *(Oncorhynchus kisutch)* Chum salmon *(Oncorhynchus keta)* Pink salmon *(Oncorhynchus gorbuscha)* Salmon – unidentified Staghorn sculpin *(Leptocottus armatus)* Buffalo sculpin *(Enophrys bison)* Tidepool sculpin *(Oligocottus maculosus)* Sculpin (unidentified; 2 spp.) Shiner perch *(Cymatogaster aggregata)* Striped perch *(Embiotoca lateralis)* Pile perch *(Damalichthys vacca)* Penpoint gunnel *(Apodichthys flavidus)* Saddleback gunnel *(Pholis ornata)* Pipefish *(Syngnathus leptorhynchus)* Pacific herring *(Clupea pallasii)* Sandlance (*Ammodytes hexapterus)*
Yowkwala	Chinook salmon *(Oncorhynchus tshawytscha)* Coho salmon *(Oncorhynchus kisutch)* Chum salmon *(Oncorhynchus keta)* Pink salmon *(Oncorhynchus gorbuscha)* Cutthroat trout *(Oncorhynchus clarkii)* Starry flounder *(Platichthys stellatus)* Staghorn sculpin *(Leptocottus armatus)* Silverspot sculpin *(Blepsias cirrhosus)* Great sculpin *(Myoxocephalus polyacanthocephalus)* Buffalo sculpin *(Enophrys bison)* Sculpin (unidentified; 2 spp.) Surf smelt *(Hypomesus pretiosus)* Shiner perch *(Cymatogaster aggregata)* Striped perch *(Embiotoca lateralis)* Pile perch *(Damalichthys vacca)* Penpoint gunnel *(Apodichthys flavidus)* Crescent gunnel *(Pholis laeta)* Saddleback gunnel *(Pholis ornata)* Threespine stickleback *(Gasterosteus aculeatus)* Tubesnout *(Aulorhynchus flavidus)* Pacific herring *(Clupea pallasii)* Sandlance *(Ammodytes hexapterus)* Shad *(Alosa sapidissima)* Rat fish *(Hydrolagus colliei)* Whitespot greenling *(Hexagrammos stelleri)*

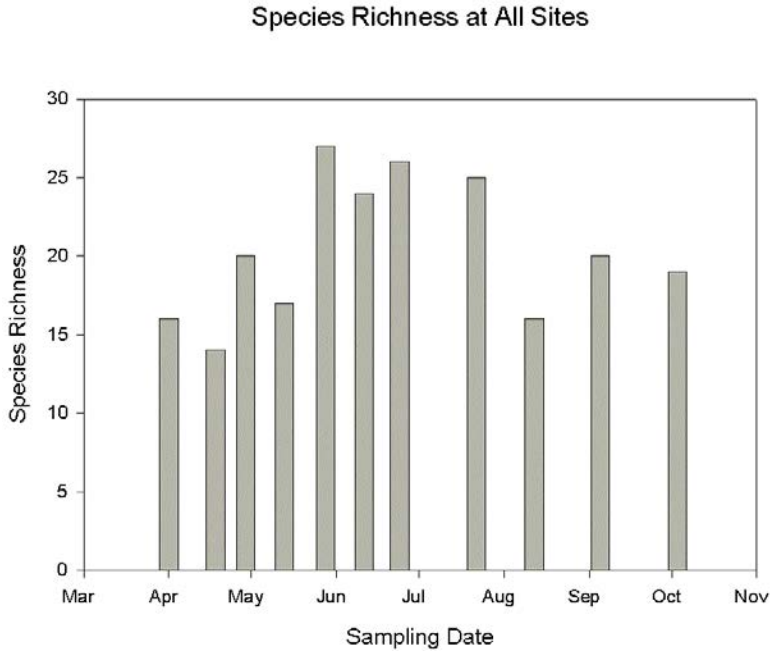

Figure 2. Total number of spcecies captured over time in 2002, all sites combined (not adjusted for fishing effort.

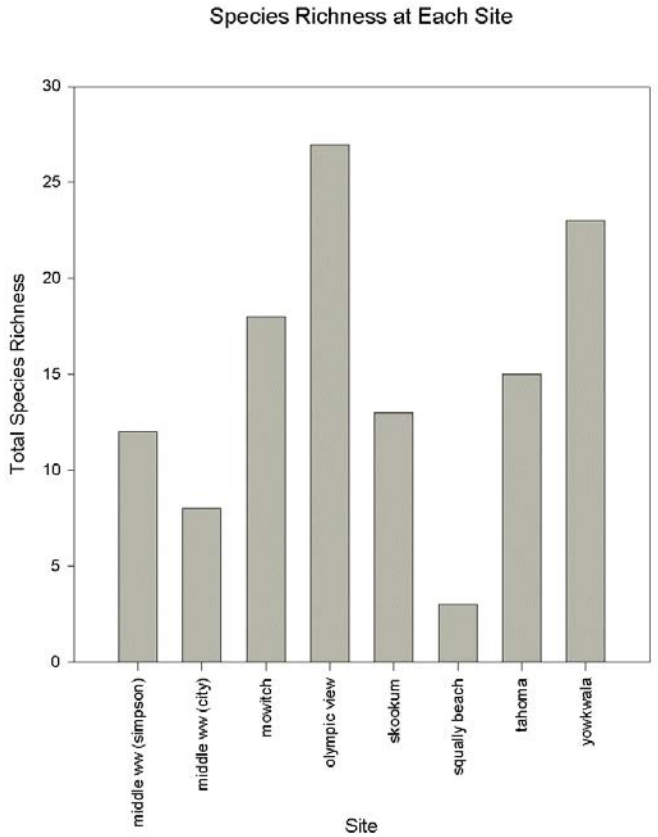

Figure 3. Total number of spcecies captured by site in 2002 (not adjusted for fishing effort; unidentified taxa not yet included in plot).

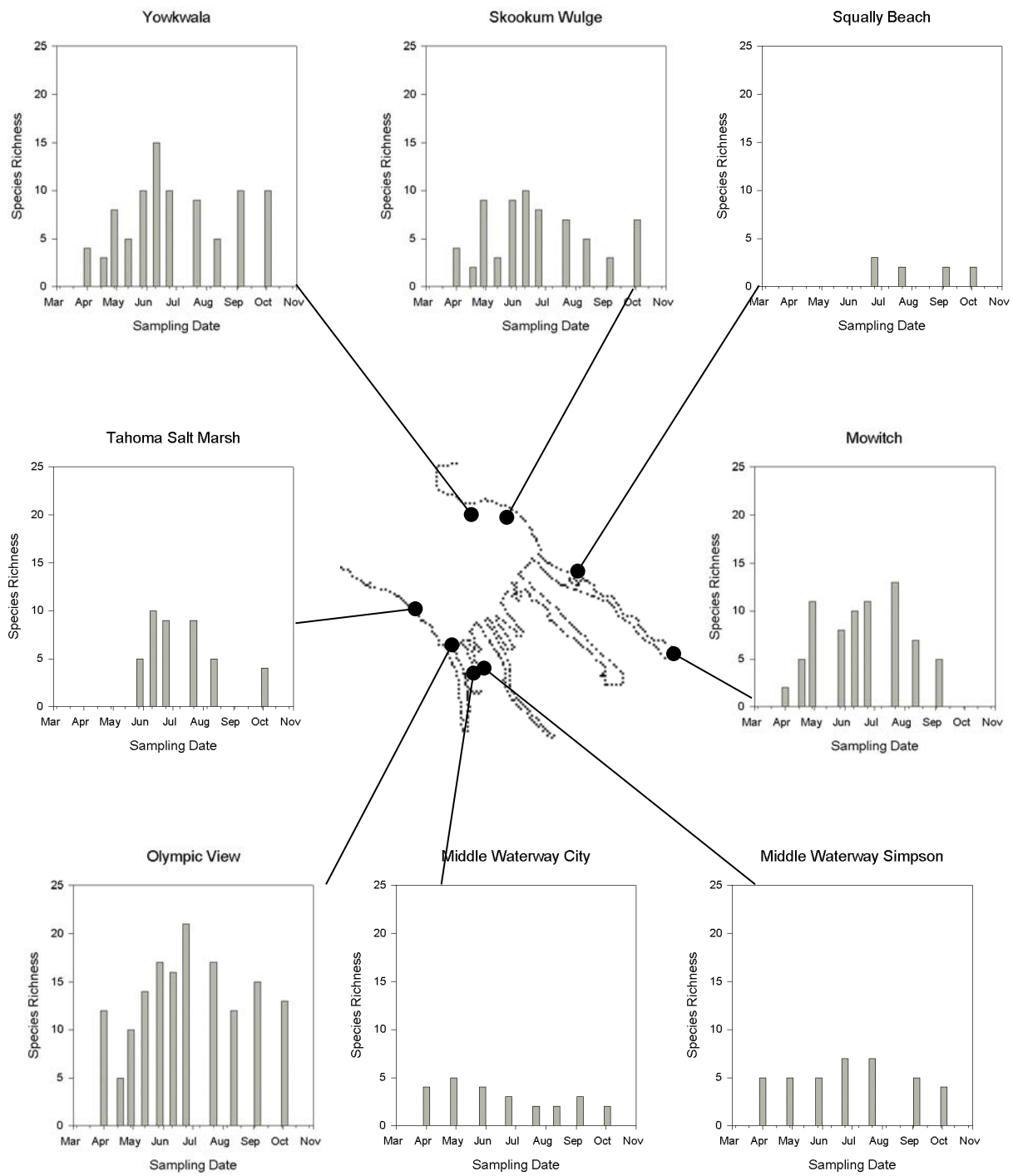

Figure 4. Total number of species captured over time at each site in 2002 (not adjusted for fishing effort).

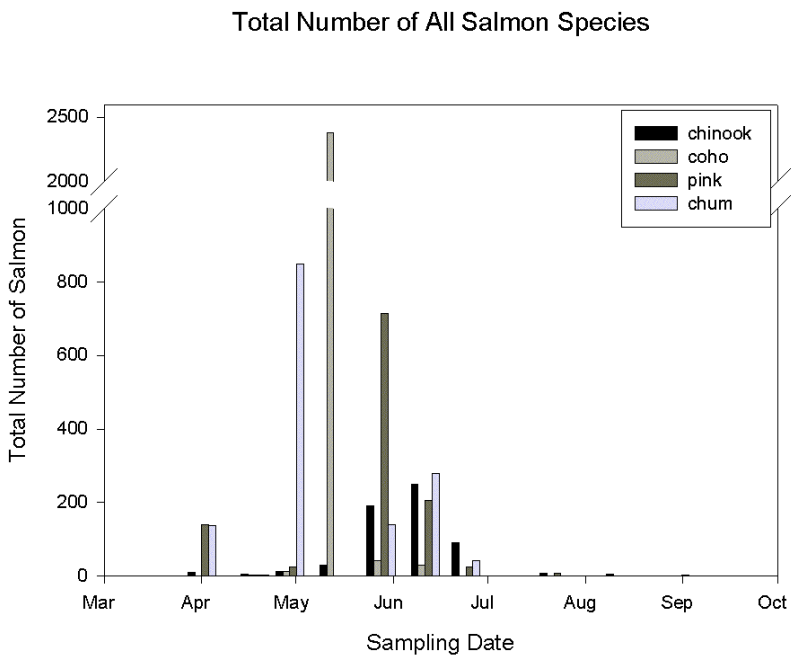

Figure 5. Total catch of all salmonids by month in 2002 (not adjusted for fishing effort).

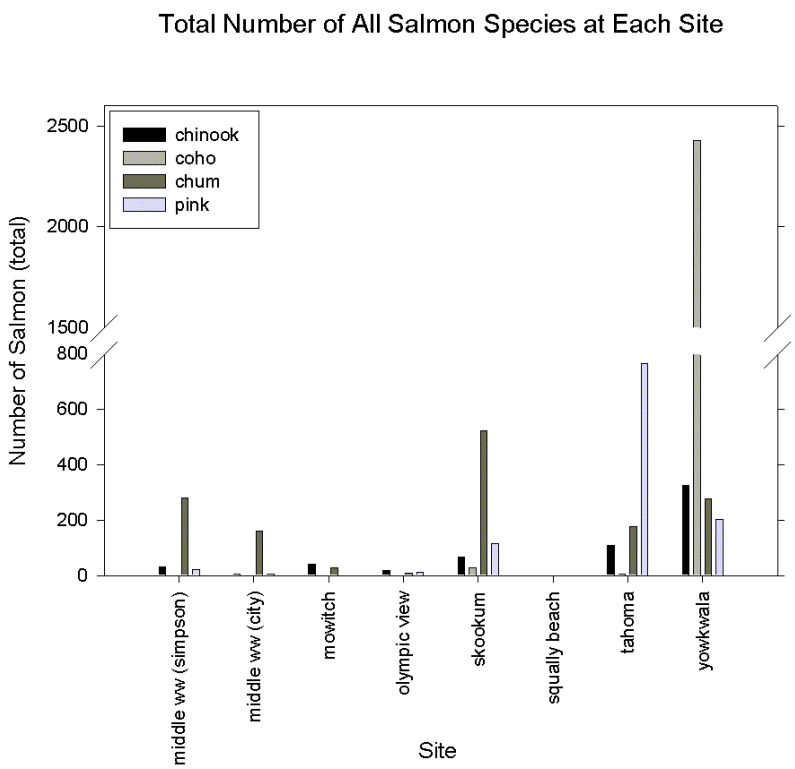

Figure 6. Total catch of all salmonids by site in 2002 (not adjusted for fishing effort).

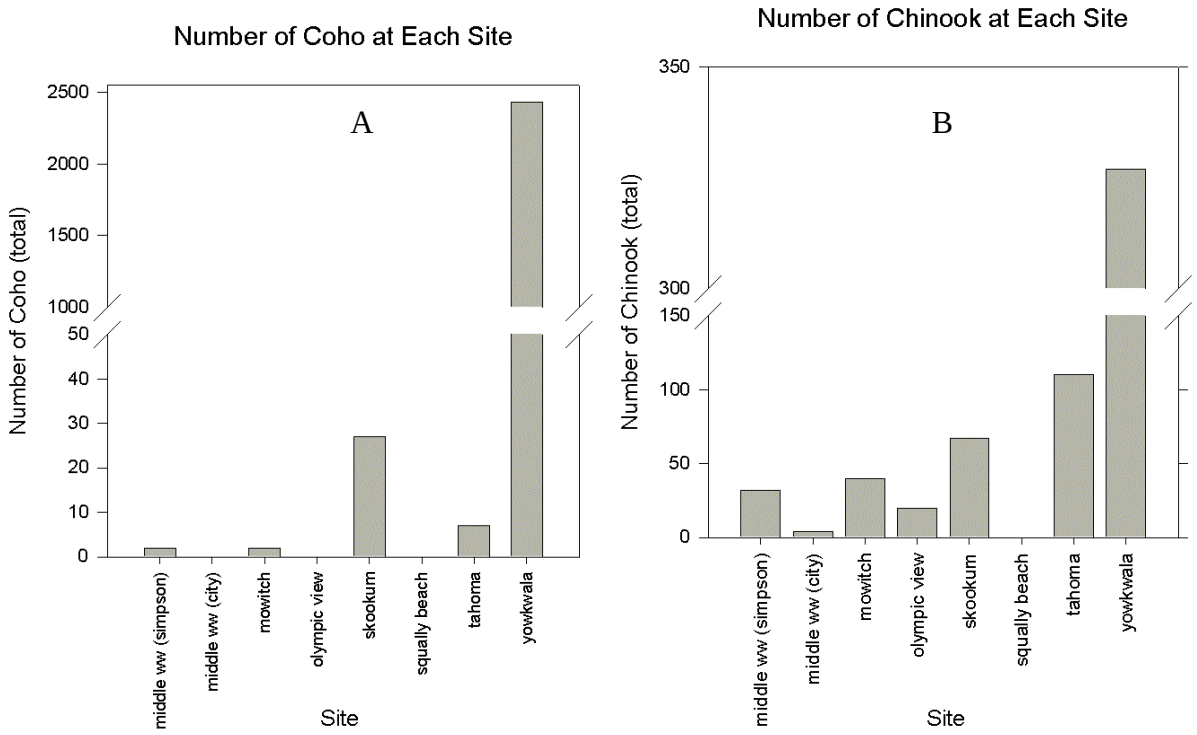

Figure 7. Total catch of all coho (A) and Chinook (B) by site in 2002.

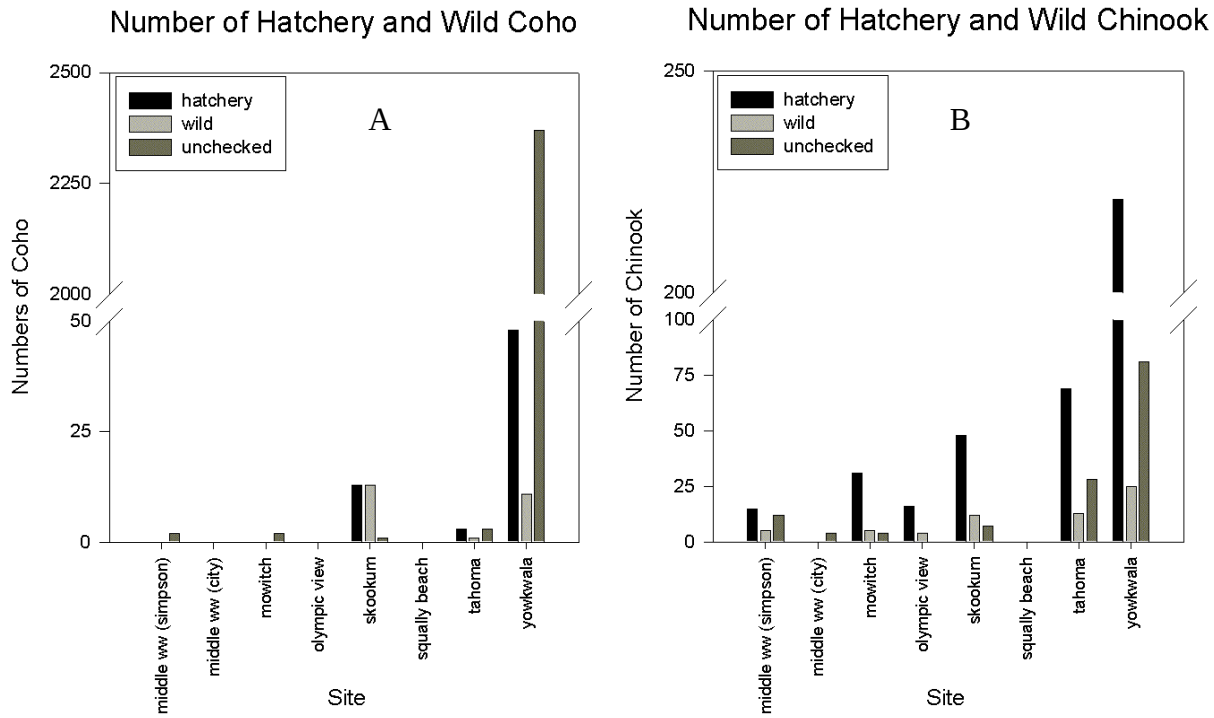

Figure 8. Total catch of marked, unmarked, and unchecked coho (A) and Chinook (B) by site in 2002.

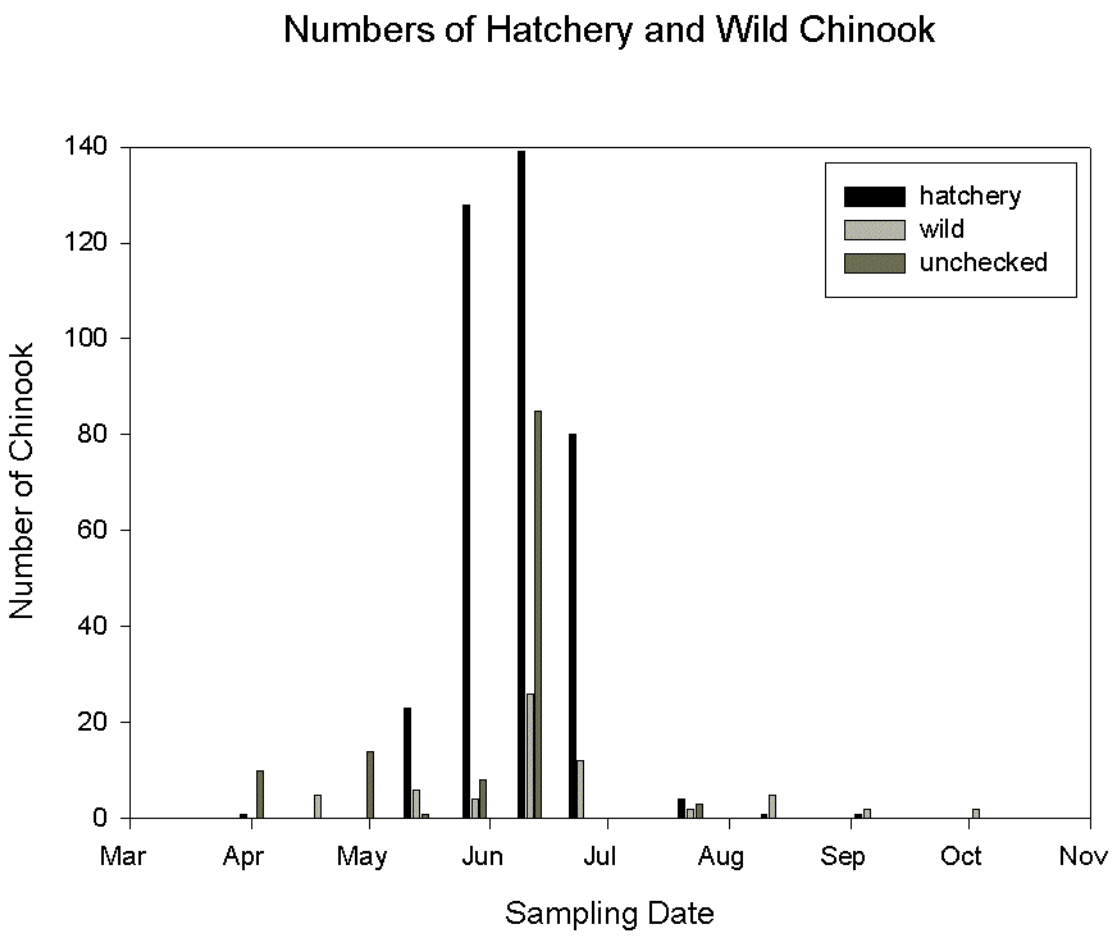

Figure 9. Total catch of hatchery (unmarked), wild (unmarked), and unchecked chinook salmon in 2002, all sites combined.

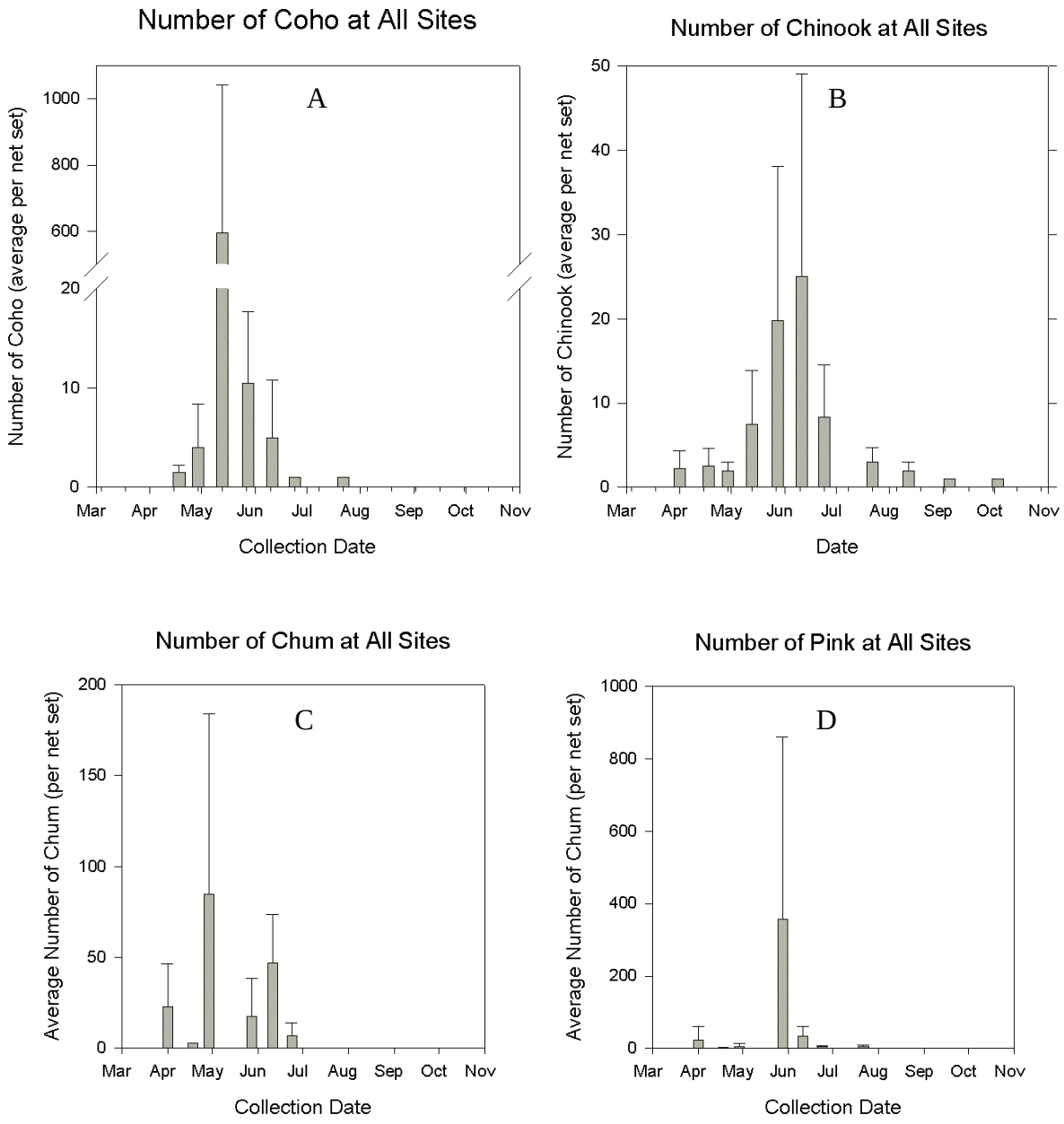

Figure 10. Total catch over time of coho (A) and Chinook (B), chum (C), and pink (D) salmon in 2002, all sites combined.

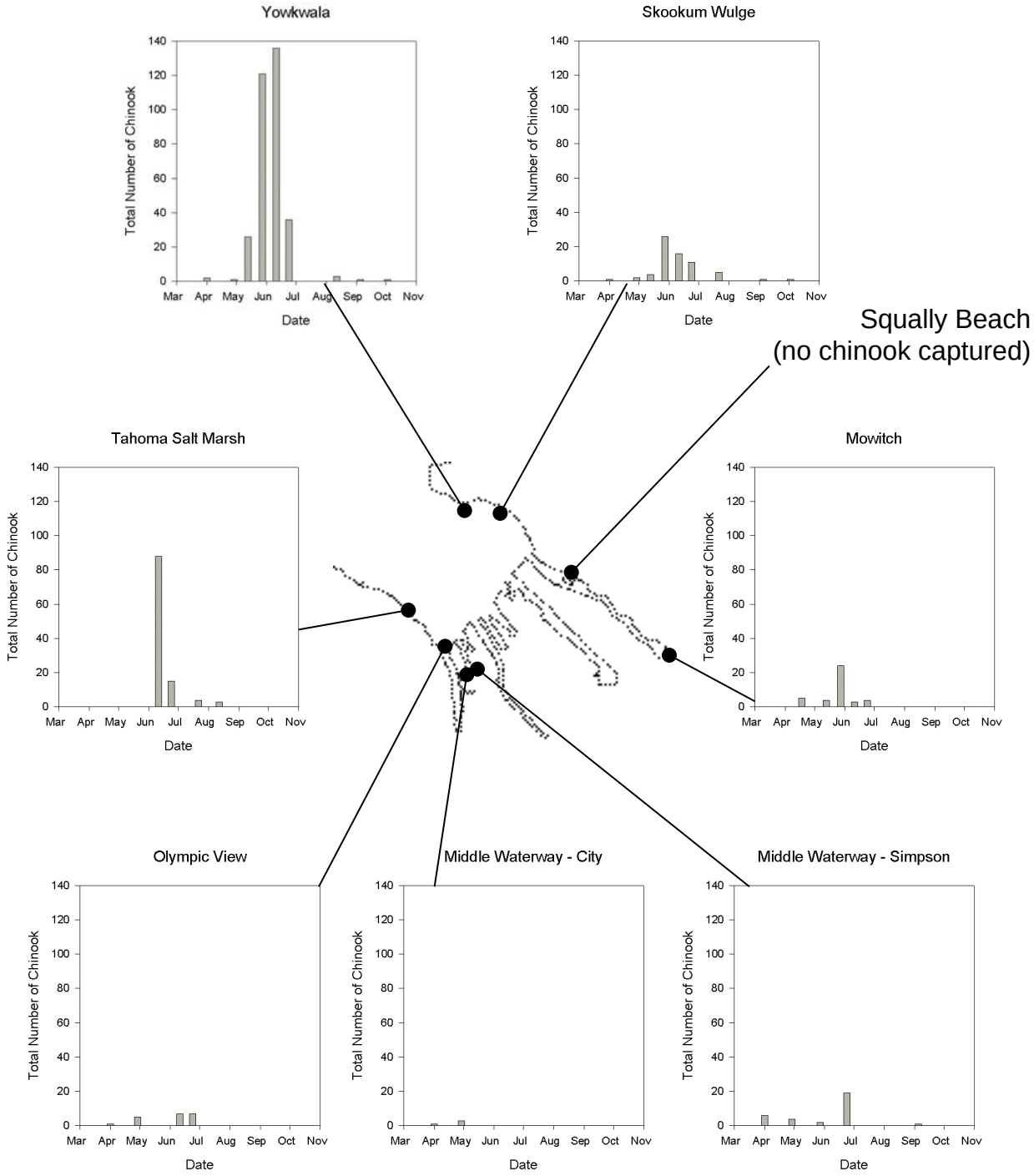

Figure 11. Total number of chinook captured over time at each site in 2002.

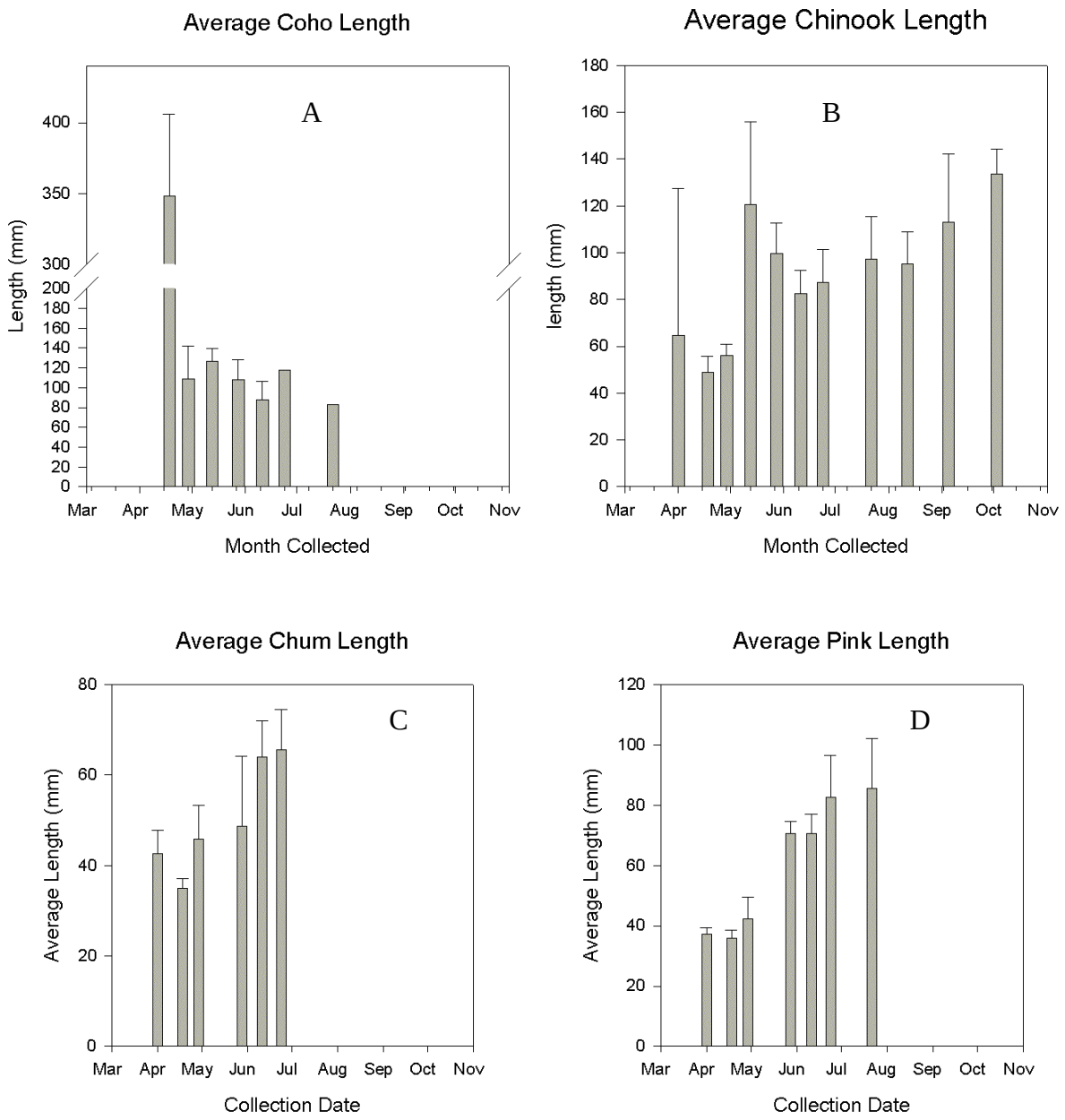

Figure 12. Average coho (A), chinook (B), chum (C), and pink (D) salmon lengths by month, all sites combined.

Diet and Chemistry

Stomach Taxonomy and tissue chemistry samples where taken for all salmonid species (except for wild chinook where only taken as a result of incidental catch mortality) at nearly all time points and sites when available. Total samples collected by species are listed in Table 3. Sediment samples are listed in Table 4. Taxonomic and chemistry analyses are presently being conducted by contractors.

Table 3. Number of diet and chemistry samples collected by species and sampling date.

	Diet				Chemistry			
Date	Chinook	Coho	Chum	Pink	Chinook	Coho	Chum	Pink
4/1/2002	0	0	20	10	0	0	18	27
4/18/2002	3	0	3	3	0	0	0	0
4/29/2002	1	1	50	17	1	0	38	7
5/13/2002	16	0	0	0	0	20	0	0
5/28/2002	33	13	42	13	14	0	22	5
6/11/2002	41	20	21	21	11	0	10	10
6/24/2002	48	1	28	23	19	0	9	3
7/22/2002	7	1	0	1	0	0	0	0
8/12/2002	1	0	0	0	0	0	0	0
9/5/2002	1	0	0	0	0	0	0	0
10/3/2002	0	0	0	0	0	0	0	0
Total	151	36	164	88	45	20	97	52

Table 4. Sites, dates, positions, and substrates for sediment chemistry samples collected during 2002.

Site name	Date	Latitude	Longitude	Substrate Type
Olympic View	5/31/02	47 15.81ºN	122 26.06 ºW	Sand/mud
Olympic View	5/31/02	47 15.78 ºN	122 26.11 ºW	Mud in eelgrass
Olympic View	5/31/02	47 15.76 ºN	122 26.16 ºW	
Olympic View	6/24/02	47 15.716 ºN	122 26.169 ºW	Sand/mud
Olympic View	6/24/02	47 15.724 ºN	122 26.165 ºW	Sand/mud
Olympic View	6/24/02	47 15.738 ºN	122 26.155 ºW	Sand/mud
Skookum Wulge	6/24/02	47 17.35 ºN	122 24.55 ºW	Mud/sand
Skookum Wulge	6/24/02	47 17.36 ºN	122 24.58 ºW	Mud/sand
Skookum Wulge	6/24/02	47 17.39 ºN	122 24.57 ºW	Sand
Middle Waterway- Simpson	6/24/02	47 15.37 ºN	122 25.71 ºW	Mud
Middle Waterway- Simpson	6/24/02	47 15.356 ºN	122 25.713 ºW	Sand/mud
Middle Waterway- Simpson	6/24/02	47 15.36 ºN	122 25.68 ºW	Fine mud/sand
Middle Waterway- Simpson	6/24/02	47 15.34 ºN	122 25.67 ºW	Fine mud
Middle Waterway- City	6/24/02	47 15.45 ºN	122 25.67 ºW	Fine mud
Middle Waterway- City	6/24/02	47 15.41 ºN	122 25.63 ºW	Mud
Middle Waterway- City	6/24/02	47 15.40 ºN	122 25.64 ºW	Mud
Squally Beach	6/26/02	47 16.877 ºN	122 23.527 ºW	Mud over sand/gravel
Squally Beach	6/26/02	47 16.885 ºN	122 23.559 ºW	Mud over sand/gravel
Squally Beach	6/26/02	47 16.889 ºN	122 23.564 ºW	Mud over sand/gravel
Squally Beach	6/26/02	47 16.888 ºN	122 23.574 ºW	Fine mud
Squally Beach	6/26/02	47 16.875 ºN	122 23.56 ºW	Fine mud
Squally Beach	6/26/02	47 16.874 ºN	122 23.54 ºW	Fine mud
Mowitch	6/26/02	47 15.582 ºN	122 21.495 ºW	Fine mud
Mowitch	6/26/02	47 15.573 ºN	122 21.478 ºW	Mud/gravel
Mowitch	6/26/02	47 15.607 ºN	122 21.538 ºW	Fine mud
Mowitch	6/26/02	47 15.599 ºN	122 21.51 ºW	Mud/gravel
Mowitch	6/26/02	47 15.637 ºN	122 21.588 ºW	Mud/gravel
Mowitch	6/26/02	47 15.625 ºN	122 21.557 ºW	Mud/gravel
Mowitch	6/26/02	47 15.663 ºN	122 21.608 ºW	Mud/gravel
Mowitch	6/26/02	47 15.649 ºN	122 21.588 ºW	Mud/gravel