YEAR 3 (2004) MONITORING REPORT FOR

COMMENCEMENT BAY HABITAT RESTORATION SITES

PREPARED FOR THE

COMMENCEMENT BAY
NATURAL RESOURCE DAMAGE ASSESSMENT
AND RESTORATION TRUSTEES

YEAR 3 (2004) MONITORING REPORT

FOR COMMENCEMENT BAY HABITAT RESTORATION SITES

Prepared for the

Commencement Bay
Natural Resource Damage Assessment and Restoration Trustees

Prepared by

RIDOLFI Inc.

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EXECUTIVE SUMMARY

The National Oceanic and Atmospheric Administration (NOAA) is the lead agency of the Commencement Bay Natural Resource Trustees (Trustees) and is responsible for managing restoration projects under the Commencement Bay Natural Resource Damage Assessment and Restoration program. In 2000, the Trustees prepared a Restoration Monitoring Plan for Commencement Bay in order to measure the success of restoration efforts, identify adaptive management approaches if projects are not achieving goals, address monitoring requirements specified by permitting agencies, and serve as an outreach tool to disseminate project information to interested parties.

Under the direction of NOAA, Ridolfi Inc. conducted Year 3 (2004) monitoring at seven habitat restoration sites around Commencement Bay in Tacoma, Washington. The seven sites are Mowitch, Squally Beach, Skookum Wulge, and Yowkwala along the Hylebos Waterway and the eastern edge of Commencement Bay and Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), and Olympic View along the Middle Waterway.

Nine biological success criteria were monitored in various combinations at the different sites to evaluate marsh development, riparian vegetation, fish access and presence, invertebrate prey resource production, and bird use. Not all criteria were required to be monitored at all sites in Year 3.

The data collected were analyzed to evaluate whether the sites were meeting performance objectives. Table ES-1 summarizes the performance at each site to date.

Table ES-1. Performance summary for Year 3 (2004) monitoring.

Site Name	Biological Success Criteria								
	1	2	3	4	5[a]	6	7[a]	8[a]	9[a]
	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	Y	+[b]	N	Y	Y	+[b]	Y	N	Y
Squally Beach	Y	+[b]	+	Y	Y	+[b]		N	Y
Middle Waterway (Simpson/Trustees)	Y	Y[b]	n/a	Y	N	+[b]	Y	Y	Y
Middle Waterway (City of Tacoma)							Y		
Yowkwala	Y						Y		
Skookum Wulge							Y		
Olympic View							Y		

Notes:
Y = Criterion met.
+ = Criterion partially met or improving.
N = Criterion not met, no trend assessed.
n/a = Criterion could not be assessed.
[a] = Reference not available for criterion quantitative comparison; evaluation based on site observations or trends over time.
[b] = Results of statistical analysis using the unbiased average percent cover indicate that the average percent cover meets the biological success criterion. However, variability remains high within the 90 percent confidence intervals, and the lower bound of the confidence interval may not necessarily meet the criterion.

Overall results indicate that the restoration efforts are on a positive trajectory. Riparian and marsh plant communities are developing at the sites where plants were installed. Some key actions suggested for adaptive management and improved monitoring include:

- Reinstall reinforcing steel bars (rebar) as needed along the transects in Year 5. Protect rebar/stakes marking transect and quadrat locations.

- Survey site boundaries and install permanent, easily identifiable markers so that the extent of polygon mapping of marsh and riparian areas can more accurately be compared over time.

- Evaluate means of controlling brass buttons on the sites.

- Conduct riparian plant survival (BSC 5) determinations earlier in the year (July to August).

- Conduct additional invertebrate monitoring (BSC 8) earlier in the year: twice a month during the spring months of April and May and the summer months of July and August. This would increase the chances of documenting emerging aquatic invertebrates on the sites.

- Provide greater control of non-native and invasive species, especially in the riparian area of the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites.

- Reevaluate the vegetation monitoring protocols relative to the level of effort required, especially with regard to polygon mapping. As vegetation cover has increased, the field effort required to monitor vegetation has also increased substantially.

- Conduct future fish monitoring events weekly from early March through June (rather than mid-April to late June as in Year 3). This would increase the chances of documenting the onset and peak of salmonid migration.

- Conduct fish monitoring in Year 4, in addition to the next scheduled monitoring season (Year 5). This would allow better assessment of long-term trends in fish use of the restoration sites.

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LIST OF UNITS

cm	centimeter
ft	foot/feet
ha	hectare
in.	inch
m	meter
mm	millimeter

LIST OF ABBREVIATIONS AND ACRONYMS

Adolfson	Adolfson Associates, Inc.
BSC	biological success criterion
Champion	Champion International Corporation
90CI	90 percent confidence interval
CPUE	catch per unit effort
CWT	coded wire tag
DNR	Washington State Department of Natural Resources
EPA	U.S. Environmental Protection Agency
FL	fork length
GPS	global positioning system
MHHW	mean higher high water
MHW	mean high water
MLLW	mean lower low water
MLW	mean low water
msl	mean sea level
NNI	non-native or invasive species
NOAA	National Oceanic and Atmospheric Administration
rebar	reinforcing steel bar
SCT	salinity-conductivity-temperature
Simpson	Simpson Tacoma Land Company
sp.	species
SR	species richness
Trustees	Commencement Bay Natural Resource Trustees
WDFW	Washington Department of Fish and Wildlife

1.0 INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) issued Task Order No. T0013 under Contract50ABNF-2-00013 to Ridolfi Inc. (Ridolfi) to conduct Year 3 (2004) monitoring activities at seven habitat restoration sites on Commencement Bay in Tacoma, Washington (Figure 1-1). NOAA is the lead agency of the Commencement Bay Natural Resource Trustees[1] (Trustees) and is responsible for managing restoration projects under 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 purposes of the monitoring program:

- To measure the success of the restoration efforts;
- To identify adaptive management approaches if projects are not achieving goals;
- 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 Year 3 monitoring activities, presents the results of the field work, assesses progress toward meeting the success criteria identified for the project, and recommends adjustments (adaptive management) for future monitoring years. Ridolfi personnel, with support from Adolfson Associates, Inc. (Adolfson), collected the monitoring data.

Appendices contain detailed tables presenting the Year 3 monitoring data (Appendix A), a photographic record of some fish monitoring activities (Appendix B), and the statistical analysis methods used to generate the data (Appendix C).

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

Figure 1-1. Vicinity map and location of habitat restoration sites.

[Placeholder. Color portrait figure, 8.5″ x 11″.]

The seven restoration sites at which monitoring occurred in Year 3 (2004) are briefly described below. The vertical datum for the project is mean lower low water (MLLW) as reported by the U.S. Army Corps of Engineers.

1.1 Mowitch

The Mowitch site, previously known as the Wasser/Winter site or Hylebos Estuary site, is at the junction of Hylebos Creek and the southeast end of the highly industrialized Hylebos Waterway on land owned by the Port of Tacoma (Figure 1-1). The site is approximately 2.3 acres (0.9 hectare [ha]) in area and includes Hylebos Creek and an adjacent strip immediately northwest of the creek that is approximately 100 feet (ft) (30 meters [m]) in width and 1,000 ft (300 m) in length. The site is bounded on the south by the centerline of Hylebos Creek; on the west by a railroad right-of-way adjacent to Marine View Drive; on the north by an 8-ft (2.4-m) 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 ft (1.8 to 3.7 m) above mean sea level (msl) or 12 to 18 ft (3.7 to 5.5 m) above 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 formerly sloped slightly toward the creek and the Hylebos Waterway and included a log ramp at its northwest end.

From June through October 2000, a restoration effort was conducted on behalf of the Trustees under the direction of NOAA. Three backwater pools with base elevations near mean low water (MLW) were sculpted from the existing upland buffer. The backwater areas are flooded twice each day. A secondary stream mouth was added at the location of the historical log ramp. 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 ft [3.34 to 3.61 m] on an MLLW datum). A buffer of 25 ft (7.6 m) next to the fence remained vegetated. Large woody debris was placed, and the upland areas of the site (elevation above 14 ft [4.3 m] MLLW) were hydroseeded with a mix of

native grasses and forbs. Volunteers planted native plants, shrubs, and trees in the fall of 2000 and spring of 2001.

Following initial monitoring, several hundred individual potted plants were installed in a replanting event initiated in November 2002. Organic-rich topsoil was placed around each of the new plants to improve the chances of successful plant establishment. Another round of supplemental plantings took place in February 2004; over 700 specimens were planted, comprising the following species: Lyngby's sedge, tufted hairgrass, seashore saltgrass, and seaside arrow-grass in marsh areas; twinberry honeysuckle, Pacific ninebark, Sitka spruce, shore pine, Douglas fir, Scouler's willow, and red elderberry in riparian areas.

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 1-1). The site consists of approximately 0.66 acre (0.27 ha) of uplands bordering an extensive area of intertidal mudflats immediately west. The Squally Beach site is adjacent to the largest expanse 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 ft (0.9 to 1.2 m) in width 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. The site contained several pilings, logs, and downed wood, indicative of previous log storage in the vicinity.

The restoration 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 the fall of 2000, and vegetation planting of the upland took place in the fall of 2000 and spring of 2001.

The restoration 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. Initial monitoring indicated that riparian vegetation at Squally Beach was dominated by sweet clover. Volunteers arranged a weed-pulling event to manage this species, followed by in-fill planting in November 2002.

1.3 Middle Waterway (Simpson/Trustees)

The Middle Waterway (Simpson/Trustees) site is a 3.3-acre (1.3-ha) nearshore area. The site is on property owned by Simpson Tacoma Land Company (Simpson) in a highly industrialized area at the southeast end of the Middle Waterway (Figure 1-1). The site is in proximity to 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 International Corporation (Champion) (now International Paper Company) at the north end of the Tacoma Kraft mill, as well as to other intertidal and subtidal areas near the Puyallup River delta.

Under the St. Paul Waterway Natural Resource Damage settlement agreement, Simpson and Champion funded the Middle Waterway Shore Restoration Project, which 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 adjacent to one of the largest remaining areas of original Commencement Bay intertidal mudflats. Under the settlement agreement, monitoring was initiated at the site in 1994, prior to construction, and continued through the summer of 2000. 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 responsibility for the site. In the fall of 1999, the Trustees put into practice adaptive management techniques to

promote the establishment of intertidal vegetation by regrading a portion of the site and by adding organic soil amendments, 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). The primary consumers 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.

1.4 Middle Waterway (City of Tacoma)

As part of the City of Tacoma's settlement agreement, the City developed an estuarine shoreline wetland restoration project on the Middle Waterway within the City of Tacoma and Commencement Bay. The project is across the head of Middle Waterway from and complements the Middle Waterway (Simpson/Trustees) site. The site is composed of three contiguous parcels, designated as the City parcel, the Washington State Department of Natural Resources (DNR) parcel, and the 11th Street right-of-way, which collectively make up the Middle Waterway (City of Tacoma) site (Figure 1-1).

Excavation and regrading of the 1.85-acre (0.75-ha) vacant upland property, which is 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 are to create new habitat, enhance existing habitat, provide buffers for both 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.

1.5 Yowkwala

The Yowkwala site, which is approximately 15 acres (6 ha) in size, is between the Tyee Marina and Browns Point (Figure 1-1). Restoration at this site consisted of a beach cleanup conducted in March 2000.

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

1.6 Skookum Wulge

The Skookum Wulge site, formerly known as the Meeker site, is on a parcel just outside of the mouth of the Hylebos Waterway that is owned by the Puyallup Tribe (Figure 1-1). The site, which covers less than 1 acre (under 0.4 ha), is bounded by Marine View Drive to the northeast and residential properties to the southeast and northwest. The site was reportedly occupied by a residential structure until the mid-1930s, when a landslide from the steep, undeveloped, wooded hillside adjacent to Marine View Drive, which rises to approximately 400 ft (120 m) above msl, swept the structure into Commencement Bay. The site has been undeveloped since that time.

The site slopes gently from Marine View Drive toward Commencement Bay. A low, steep, erosional bluff, approximately 2 to 4 ft (0.6 to 1.2 m) in height, separates the upland portion of the site from the beach below. The upland area is semicircular and protrudes approximately 100 ft (30 m) toward the southwest into Commencement Bay. This 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 toward Marine View Drive.

The beach below the upland bluff is composed of gravel and cobble-sized materials similar to materials present in the exposed bluff. The beach grades uniformly toward 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.

1.7 Olympic View

The Olympic View project included the City of Tacoma's acquisition of 0.7 acre (0.3 ha) of upland and intertidal property bordering the 11.7-acre (4.7-ha) lease site of state-owned aquatic lands (Figure 1-1). The lease precludes use of the eelgrass areas for incompatible commercial or industrial purposes. A building owned by the now-defunct Puget Sound Plywood Company and extending over private and state-owned intertidal lands was partially removed to allow the re-establishment of a productive community of tidal species. In June through September 2002, the U.S. Environmental Protection Agency (EPA) managed in-water work through the remedial process that included removing dioxin-contaminated sediments and backfilling the excavation with clean sediments. The pilings were removed and the site was prepared for restoration, including softening the shoreline to enhance the intertidal habitat and create a riparian buffer.

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 shoreline and water areas.

2.0 DESCRIPTION OF METHODS

This section describes the procedures used to evaluate the restoration sites. The field work was performed according to the schedule outlined in the project work plan (Ridolfi and Adolfson, 2001). Table 2-1 summarizes by site the biological success criteria (BSCs) evaluated during the Year 3 monitoring. In accordance with the work plan, physical success criteria were not monitored in Year 3.

Table 2-1. Monitoring conducted in Year 3 (2004) by site and parameter.

	Biological Success Criteria								
	1	2	3	4	5	6	7	8	9
Site Name	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	X	X	X	X	X	X	X	X	X
Squally Beach	X	X	X	X	X	X	[a]	X	X
Middle Waterway (Simpson/Trustees)	X	X	[b]	X	X	X	X	X	X
Middle Waterway (City of Tacoma)	[c]	[c]	[c]	[c]	[c]	[c]	X		
Yowkwala	X	[d]					X		
Skookum Wulge							X		
Olympic View							X		

Notes:

[a] Deleted after Year 1 monitoring indicated the site geometry was unsuitable.

[b] Lyngby's sedge was not present within any of the quadrats; therefore, BSC 3 could not be assessed.

[c] Monitoring to be performed by the City of Tacoma.

[d] Insufficient vegetation to evaluate criterion.

The monitoring tasks performed to assess progress toward the BSC goals are described below. Statistical analyses were incorporated into the Year 3 monitoring study for BSC 1, BSC 2, BSC 3,

and BSC 6. For each of these four BSCs, the monitoring and program objectives were refined by the project statistician to more clearly determine whether the monitoring objectives are being met (Shelly, 2004a).

2.1 Biological Success Criterion 1 – Marsh Development/Areal Coverage

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MARSH DEVELOPMENT/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.* (Ridolfi and Adolfson, 2001)

MONITORING OBJECTIVES:
Determine whether the areal extent of vegetation is stable, increasing, or decreasing across each of the monitored sites. (Shelly, 2004a)

2.1.1 BSC 1 Field Work

Adolfson staff mapped the extent of marsh vegetation in late summer 2004. Stake-wire flags were placed around areas of dominant (i.e., percent cover 25 percent or greater) marsh vegetation (Photo 5, Appendix B). Ridolfi personnel subsequently used a global positioning system (GPS) instrument to obtain coordinates for the flags. Mapped areas represented on the vegetation figures are at least 4 ft^2 (0.4 m^2) in size.

Mapped areas were given unique labels (e.g., MA, MB). The first letter, either "R" or "M," denotes either riparian or marsh; the second letter was assigned sequentially beginning with "A" as vegetated areas were mapped. For each mapped area, which may be either a point or a polygon, the overall percent cover of the vegetation and the dominant species were estimated visually and recorded by Adolfson staff biologists.

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

2.1.2 BSC 1 Data Analysis

To determine the total vegetated marsh area on each site, Ridolfi calculated the area of each polygon mapped by Adolfson biologists. Using percent cover as a weighted average, the vegetated area of each polygon was determined. The sum of these calculations represents the total marsh area vegetated for each site. Polygon calculations, along with the dominant species in each polygon, are presented for each site monitored. The results of the Year 3 analysis were compared with the results from Year 1.

To assess the extent of marsh vegetation cover along the transects, the total average percent cover of marsh vegetation along the transects was evaluated. This average was based on data collected along transects and derived from statistical analyses described for BSC 2. The Year 3 results were compared to the Year 1 results to determine whether marsh vegetation cover increased along the transects. Note that this result does not address areal extent for the whole site, but only for total vegetative cover for the area immediately surrounding each transect.

2.2 Biological Success Criterion 2 – Marsh Development/Species Composition

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MARSH DEVELOPMENT/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 percent by Year 3. The project should not contain more than 5 percent 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* Phragmites communis *(common reed).* (Ridolfi and Adolfson, 2001)

MONITORING OBJECTIVES:

(1) Determine the percent cover of non-native or invasive (NNI) species along each marsh transect with acceptable precision. (2) Determine if the percent cover of NNI species is increasing, decreasing, or remaining stable through time. (3) Determine if individual native marsh species are increasing, decreasing, or remaining stable through time. (Shelly, 2004a)

2.2.1 BSC 2 Field Work

In late summer, plant species composition was evaluated within the marsh area along transects using randomly placed quadrats ("quadrats" are plots, usually rectangular, used for ecological or population studies). Adolfson staff biologists recorded the presence and percent cover of marsh species within each quadrat.

Permanent transects were established generally along contours at each site monitored. Most of the transects had been installed for the Year 1 (2002) monitoring and were positioned to capture the development of marsh habitat along the transects and to characterize the plant species composition at certain elevations. In Year 2 (2003), a new transect was added on the Squally Beach site to capture the lower marsh vegetation establishment, and a new transect was added on the Mowitch site to characterize marsh vegetation establishment on three lobes of intertidal habitat. Reinforcing steel bars (rebar) were used to permanently mark the transect locations. Some of the rebar was missing in Year 3, presumably washed away by tides or removed to reconstruct herbivory fencing. In Year 3, Transect 1-2 was added at the Middle Waterway (Simpson/Trustees) site to capture marsh vegetation colonization on a lobe in the northern portion of the site, and three quadrat sampling locations were added to Transect 1-1 to obtain cover data that more closely reflects conditions along that transect. Also in Year 3, the portion of Squally Beach Transect 1-1 located within an existing patch of Lyngby's sedge (*Carex lyngbyei*) was removed. In doing this, the total length of Transect 1-1 was reduced by 7 feet.

Based on recommendations made at the end of Year 2 monitoring, the original sampling locations from Year 1 (or Year 2 for Transects 1-2 at Mowitch and 1-3 at Squally Beach) were used to allow for paired comparisons (Shelly, 2004a). Random sampling locations for the new marsh transect (Transect 1-2) at the Middle Waterway (Simpson/Trustees) site were determined by the project statistician (Shelly, 2004b).

At each sampling location, a 1.6-ft x 1.6-ft (0.5-m x 0.5-m) quadrat was placed on the ground. The percent cover of each plant species present within each quadrat was visually estimated (viewed from the vertical). A determination was also made as to whether a given plant species was non-native or invasive (NNI). To ensure consistency between monitoring events, observations were recorded on standardized data forms. The percent of a quadrat that occurred within the herbivory avoidance fencing was also recorded. Photographs were taken of each quadrat sampled.

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

2.2.2 BSC 2 Data Analysis

Cover values for individual species were summarized using an unbiased average percent coverage estimate for each transect. Plant species analysis was based on the estimated cover values. Percent cover is discussed in this report in terms of the unbiased average quadrat canopy percentage. The term "unbiased" is used to signify that the estimate is different from the arithmetic mean of the quadrat cover values, which would be a biased estimate for the average or expected value for these data. The unbiased estimate is calculated in a way that compensates for the patchy distribution of plant species among quadrats.

As with most scientific sampling, these averages for canopy cover contain some uncertainty. This is because only a portion of the entire population of plants along the transect (those within the sampling quadrats) has been measured. Therefore, it is possible that the average canopy percentage for the entire population of plants along the transect is actually somewhat higher or

lower than the average based on the quadrat sampling data. To describe this uncertainty, the upper and lower bounds of the 90 percent confidence interval (90CI) are provided, i.e., there is 90 percent probability that the average canopy percentage for the entire population of plants along the transect falls somewhere between the upper and lower bounds. In addition to the analyses described below, the statistical results served as a basis for between-site comparisons.

The recorded information about the percent of the quadrat that occurred within herbivory avoidance fencing was analyzed to determine whether the fencing influenced species composition in the marsh habitats.

Based on the recommendations produced at the end of Year 2 monitoring, a statistical analysis was performed to compare the Year 3 percent cover data to those from the year of origin (Year 1 or Year 2, depending on transect).

2.2.2.1 Statistical Estimate of Percent Cover by Species

The objective of this analysis was to provide an unbiased estimate and confidence interval for individual species and total percentage of NNI species by transect. The percent cover for individual species and total native and NNI cover by quadrat was assumed to have zero-modified log-normal distribution. In other words, the distribution is log-normal with a positive probability of zero cover (i.e., log-normal with a spike at zero).

This estimate of mean cover for a given transect is:

$$\hat{C}_{NNI} = (1-\hat{p}) * \exp(\bar{y} + \frac{s_y^2}{2})$$

where :

$\hat{p} = r / n$,

r = the number of zero quadrats,

n = the number of sampled quadrats, $i = 1,\ldots, n$,

$\bar{y} = \sum_{i=1}^{n-r} y_i /(n-r)$,

$$y_i = \ln(\sum_{j=1}^{m} c_{ij}),$$

m = the number of observed NNI species, $j = 1,\ldots, m$,

c_{ij} = the observed percent cover of species j in quadrat i, and

$$s_y^2 = \frac{\sum_{i=1}^{n-r}(y_i - \bar{y})^2}{(n-r-1)}.$$

Note that $\bar{y}$ and s_y^2 are the sample mean and variance of the non-zero quadrat cover estimates.

An approximate 90CI is given by:

$$\hat{C}_{NNI} \pm t_{.10(2),(n-2)} * \sqrt{\left(\frac{N-n}{N}\right)\left(\hat{\text{var}}(\hat{C}_{NNI})\right)},$$

where:

N = the total number of quadrats that could fit on the transect, and

$\hat{\text{var}}(\hat{C}_{NNI}) = \frac{1}{n}\exp(2\bar{y} + s_y^2)\cdot(1-p)\left[p + \frac{2s_y^2 + s_y^4}{2}\right]$, the asymptotic variance estimate (Owen and DeRouen, 1980).

The results of this analysis indicate the unbiased average percent cover of plant species in the marsh as well as the upper and lower bounds of the 90CI. The results also indicate the frequency with which each species was found along the transect. A determination as to whether the monitoring objectives for this BSC were met is based on these statistical analyses.

2.2.2.2 Statistical Comparison Between Years

To show trends over time, the results of the statistical analyses were compared with the year of origin data (Year 1 or Year 2, depending on the transect). To make the trends analysis comparable, year of origin data were also analyzed using methods described in this section.

The objective of this comparison was to provide a confidence interval on the mean of paired differences for the NNI category and for individual species observed in both the year of origin and Year 3.

The log-transformed data for individual species are skewed with negative numbers and a large number of zeros, and transformations could not be found to approximate normality. It is possible that suitable transformations can be found to approximate normality for some species or groups of species (e.g., total NNI species). However, to retain consistency and simplicity of analysis, the non-parametric sign test was used to test for increased or decreased percent cover. The more powerful non-parametric Wilcoxon or Mann-Whitney signed rank tests were not used because the difference distributions are not generally symmetric. The sign test tests the hypothesis that the population median difference is zero. The two-tailed alternative hypothesis is that the median difference is greater than or less than zero.

2.3 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 percent by Year 3) to that of appropriate reference sites and/or improving over time.* (Ridolfi and Adolfson, 2001)

MONITORING OBJECTIVES:
(1) Compare stem height and shoot density of Carex lyngbyei *to the Squally Beach Reference site. (2) Determine whether stem height and shoot density of sedges and bulrushes are stable, increasing, or decreasing through time for each transect.* (Shelly, 2004a)

2.3.1 BSC 3 Field Work

Plant vigor was evaluated in late summer 2004 along the transects and within the quadrats described above for BSC 2. Using the standardized form for BSC 2, the stem height (in inches) and

shoot density of Lyngby's sedge were recorded. To collect stem height data, the quadrat was divided into a 3 x 3 grid. Stem height was recorded from one randomly selected plant from each of the nine grids where the plant occurred. A minimum of four samples were collected from each quadrat unless fewer than four shoots occurred in the quadrat.

In Year 3, a new transect was added through an existing patch of Lyngby's sedge on Squally Beach. This reference transect (designated C-1) was used to compare patches of Lyngby's sedge within the restoration areas and to determine whether the monitoring objectives for this BSC were being met.

Marsh development monitoring was conducted at the Mowitch and Squally Beach sites. Lyngby's sedge was not present within any of the quadrats on the Middle Waterway (Simpson/Trustees) site; therefore, no assessment of BSC 3 was conducted at this site. The City of Tacoma monitored the Middle Waterway (City of Tacoma) site.

2.3.2 BSC 3 Data Analysis

Data were analyzed for each quadrat in which Lyngby's sedge occurred. Based on the recommendations produced at the end of Year 2 monitoring, a statistical analysis was performed to compare the Year 3 stem height and shoot density data to those from the year of origin and from the new Squally Beach reference transect. The results of the analysis were used to determine if the monitoring objectives are being met.

2.3.2.1 Statistical Comparison with Reference Transect

The objective of this analysis was to compare Lyngby's sedge shoot density and stem height in plants occurring along the transect in the restoration area with shoot density and stem height in Lyngby's sedge along the reference transect. The plant must be present in at least three quadrats to run the statistical analyses. Therefore, comparisons were made for those transects in which more than two quadrats contained the sedge, using shoot density and stem height (t-test or non-parametric t-test).

Squally Beach Transect 1-2 was the only transect with a sufficient number of quadrats for statistical testing. Shoot density was approximately log-normally distributed among quadrats (Shapiro-Wilks p-value of 0.64), so the data were transformed prior to the t-test comparison. Stem height was approximately normally distributed (Shapiro-Wilks p-value of 0.53), so a t-test was performed on untransformed data.

2.3.2.2 Statistical Comparison Between Years

The objective of this analysis was to compare shoot density from Year 3 to that of the year of origin. A comparison of stem height could not be performed this year because of insufficient data (i.e., the plant does not occur within a sufficient number of quadrats along each transect for the results to be analyzed statistically).

With regard to the percent cover comparison between years, the paired quadrat data could not be transformed to approximate normality, and the signed ranks test was used to compare the median shoot density for year of origin to Year 3.

2.4 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.* (Ridolfi and Adolfson, 2001)

2.4.1 BSC 4 Field Work

Herbivory avoidance fencing was inspected and, to evaluate the effectiveness of the devices, plant health was noted (Photo 5, Appendix B). A standardized form was used to create a permanent record of the condition of the devices and the extent to which they were functioning to exclude geese. In addition, each device was photographed to document its success or failure.

Monitoring of herbivory avoidance fencing was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites concurrently with monitoring for BSCs 1, 2, and 3. The City of Tacoma monitored the Middle Waterway (City of Tacoma) site. At the Mowitch and Squally Beach sites, herbivory avoidance fencing had been reinforced and expanded since the Year 1 and Year 2 monitoring. At the Squally Beach site, a portion of this fencing was being dismantled by the site steward in Year 3.

2.4.2 BSC 4 Data Analysis

The results of the field study for this BSC were described in terms of the condition of the fences (materials used to construct the fence, structural integrity of the fence, and ability of the fence to discourage grazing by geese) and the general condition of the vegetation (grazed or ungrazed) within the fencing.

2.5 Biological Success Criterion 5 – Riparian Vegetation Survival

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RIPARIAN VEGETATION SURVIVAL. *Riparian vegetation plantings should maintain not less than 75 percent survival over the first three years following initial planting.* (Ridolfi and Adolfson, 2001)

2.5.1 BSC 5 Field Work

No baseline information is available to adequately determine whether the monitoring objectives have been met, because some of the plants originally planted on the restoration sites died and the sites were replanted. Because no as-built drawings were maintained, it was determined that, beginning in Year 3, riparian survival assessments would be made qualitatively. While in the field, Adolfson biologists made observations within the riparian areas to qualitatively assess the survival of the planted vegetation. The information recorded includes the relative abundance of tree and shrub species on the site, the general health of the species observed, and a rough approximation of plant species mortality.

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

2.5.2 BSC 5 Data Analysis

On the basis of field observations, the results were qualitatively described for each site monitored. Results were presented in terms of tree and shrub species that appear to be most successful at each site, that appear to be least successful at each site, and that are most abundant at each site. Riparian survival was also compared among the three sites monitored.

2.6 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 percent 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 percent (herbs); >30 percent (shrubs); > 25 percent (trees); and <2 percent (non-native invasive vegetation).* (Ridolfi and Adolfson, 2001)

MONITORING OBJECTIVES:
(1) Determine whether the areal extent of riparian vegetation is stable, increasing, or decreasing over time. (2) Determine the percent cover of herbs, shrubs, trees, NNI, and individual species in riparian areas with acceptable precision. (Shelly, 2004a)

2.6.1 BSC 6 Field Work

The extent of riparian vegetation was mapped in late summer 2004. Site boundaries have not been marked in the field, and the extent of riparian vegetation was mapped based on observations of approximate site boundaries made during the field study. Stake-wire flags were placed around areas of dominant (i.e., percent cover 25 percent or greater) riparian vegetation (Photo 5, Appendix B). Dominant plant species were determined based on a visual estimate of area within the polygon and recorded for each identified polygon by Adolfson staff biologists. Ridolfi personnel used the GPS instrument to obtain flagging coordinates. Each mapped polygon has a unique identifier, consisting of two characters. Within the riparian habitats, the first letter is "R" and the second letter was assigned sequentially beginning with "A."

Percent cover in the riparian area was estimated in a 3.3-ft x 9.8-ft (1.0-m x 3.0-m) quadrat located along transects that generally follow contours. The number and location of transects were established prior to Year 1 monitoring, and the locations were marked with rebar. The transects were placed to adequately assess the areal coverage of the riparian vegetation. In Year 2, the riparian transect at the Mowitch site was extended to include a vegetated area in the southeast portion of the site.

The locations of quadrats were selected on the transects for Year 1 monitoring using random numbers from Elzinga et al. (1998). To ensure consistency between monitoring events, observations were recorded on standardized data forms. The percent cover of each species within the quadrat was estimated (viewed from the vertical) and recorded on the form. Based on recommendations provided by the project statistician, the number of quadrats sampled at each site was different in Year 3 than in Year 1 (Shelly, 2004b). At Mowitch, the number of quadrats sampled in Year 3 was reduced from 46 to 21; at Squally Beach, quadrat sampling was reduced from 25 to 10. At Middle Waterway (Simpson/Trustees), the number of quadrats sampled increased in Year 3 from 15 to 16. The project statistician assisted in determining the sampling locations in Year 3.

In Year 3, all non-native and invasive herbaceous plant species were grouped into one general category called "non-natives/invasives" (NNI) on the data form, except for those species of most

concern. These included Japanese knotweed (*Polygonum cuspidatum*), giant knotweed (*P. sachalinense*), yellow sweetclover (*Melilotus officinalis*), white sweetclover (*M. alba*), reed canarygrass (*Phalaris arundinacea*), pepperweed (*Lepidium* spp.), and bindweed (*Convolvulus* spp.).

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

2.6.2 BSC 6 Data Analysis

To determine the total vegetated riparian area on each site, Ridolfi calculated the area of each polygon mapped by Adolfson biologists. Using percent cover as a weighted average, the vegetated area of each polygon was determined. The sum of these calculations represents the total riparian area vegetated for each site. Polygon calculations, along with the dominant species in each polygon, are presented for each site monitored. The results of the Year 3 analysis were compared with those from Year 1.

A statistical analysis was performed on the riparian vegetation cover data. The objective of this analysis was to estimate percent cover by herbs, shrubs, trees, and NNI, as well as individual species, with associated confidence intervals.

The distributions of individual species cover by quadrat and total native, NNI, herb, shrub, and tree cover by quadrat were assumed to be zero-modified log-normal distributions. The unbiased average percent cover for each individual species and species groupings was estimated in the same manner as described for marsh species in Section 2.3.2.

2.7 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. (Ridolfi and Adolfson, 2001)

2.7.1 BSC 7 Field Work

One of the principal goals of the Commencement Bay restoration program is to provide habitat for juvenile salmon. To monitor progress toward this goal, Ridolfi personnel formed four-person crews that used block nets and beach seine nets to sample fish at six sites. The crew collected, identified, and measured the fork length (FL) of salmonids to the nearest millimeter (mm). If possible, hatchery fish were identified by the presence of clipped fins or coded wire tags (CWTs). The fish were released after examination.

Monitoring was conducted at the Mowitch site using block nets and at the Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), Yowkwala, Skookum Wulge, and Olympic View sites using beach seine nets. Fish sampling was conducted from April through October 2004. Sampling was conducted on a weekly schedule from mid-April through June, and on an approximately bimonthly schedule from July through October, for a total of 32 sampling events comprising 232 sets. The Mowitch site was sampled only once in September and was not sampled in October because of poor tides. The Middle Waterway (City of Tacoma) site was not sampled after early July because of a dredging project that began in mid-July at the head of the waterway. The Trustees have not identified any reference or comparison sites at this point.

2.7.1.1 Block Nets

At the Mowitch site, a 16-ft (5-m) outboard skiff was used to set four 120-ft x 44-ft (37-m x 13.5-m) block nets made of 0.4 inch (in.) (1 centimeter [cm]) mesh (Photo 1, Appendix B). The catch from all four nets was counted as one set for the sampling event. Each block net was attached to a length of rebar driven into the shore on either side of the mouth of each pool to ensure full blockage of the outlet. Each block net was equipped with a weighted lead line attached to the bottom of the net, which created a seal along the substrate of the mouth of the pool. A cork line

kept the top of the net from sinking below the water surface, thus creating fish blockage. The nets were set during tide cycles that included an 8 ft (2.4 m) or greater high tide and a 0 ft (0 m) or lower low tide. The nets were allowed to "soak" as the tide receded, until the pools were emptied of water; this took approximately three to four hours. Sampling personnel monitored the nets as low tide approached to ensure the catch was not left without water.

As the tide receded, all fish were collected from the nets, identified by genus and species, counted, examined for external anomalies, and released. Additionally, up to 30 specimens from each species of sculpin, flat fish, forage fish, and salmonids were measured before being released. Salmonid fork lengths were measured to the nearest mm (from nose to mid-fork of tail); all other species were measured full length to the nearest mm (from nose to end of tail).

Salmonids were also checked for hatchery marks. These data were used to estimate the proportion of wild to hatchery fish, as well as the hatchery origin of marked fish. Possible hatchery marks include adipose fin clips, right ventral fin clips, left ventral fin clips, and CWTs (Table 2-2). Sampling personnel examined salmonids for fin clips while the fish were being measured and identified. Tags were detected using a handheld CWT wand detector. Hatchery fish examined were assumed to originate from the Washington State and tribal hatcheries located in the Puyallup River basin.

Table 2-2. Possible marks for Commencement Bay hatchery fish.

Species	Source	Mark
Chinook	White River	Right ventral fin removed
Chinook	White River	CWT – no marks
Chinook	Puyallup	Adipose fin removed/CWT
Chinook	Puyallup	Adipose fin removed
Chinook	White River	Pit tag
Coho	Puyallup	Adipose fin removed/CWT
Coho	Puyallup	CWT – no marks
Steelhead	Puyallup	Adipose fin removed
Chinook	Puyallup	Left ventral fin removed

The Puyallup River basin supports wild and hatchery chinook, coho, chum, and pink salmon, as well as steelhead, sea-run cutthroat, and bull trout/Dolly Varden. The Puyallup Tribe, Muckleshoot Tribe, and Washington Department of Fish and Wildlife (WDFW) have hatcheries in the basin that produce spring/fall chinook, coho, and steelhead. Outmigration occurs from March through July, with peak use of the nearshore tidal areas occurring May through June.

For all sampling events, the following data were collected at each site: location, date, time, tide stage (time and height), and weather conditions, including an approximation of air temperature, wind direction, precipitation, and cloud cover. The time at which each set was deployed was also recorded.

Environmental measurements taken at each site included water quality parameters such as temperature and salinity. A YSI 30 salinity-conductivity-temperature (SCT) meter was used to collect water quality data (Photo 2, Appendix B). Any uncommon events or changes in the sites were noted.

2.7.1.2 Beach Seine Nets

At the Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), Skookum Wulge, Yowkwala, and Olympic View sites, the skiff was used to deploy a 120-ft x 8-ft (37-m x 2.4-m) floating "Puget Sound" beach seine net of 0.4 in. (1 cm) mesh (Figure 2-1). The main part of the beach seine, known as the "wings," is constructed with 1 in. (2.5 cm) mesh. In between both wings is a "bag" made of 0.25-inch (0.6-cm) mesh and 6 ft (1.8 m) in depth. The bag creates a deep pocket, increasing the chance that fish will be trapped as the net is dragged through the water. Seine nets are equipped with a weighted lead line attached to the bottom of the mesh that creates a seal along the topography of the substrate as the net is being pulled to shore. A cork line attached to the top of the net keeps the net from sinking below the water surface. Attached to each end of the beach seine at the cork line is approximately 50 ft (15 m) of polypropylene line (poly-line), which is used to pull the net to shore.

To conduct the sampling, a sampler stood on the beach and held one end of the net. Two people stayed in the boat to deploy the net. The driver motored backward away from shore

approximately 50 ft (15 m), then turned parallel to the shore. The net person began releasing the net as the boat continued to travel backward about 100 ft (30 m) until the net was fully deployed and taut; the driver then turned the boat and motored forward, bringing the full length of the poly-line (boat end of net) to shore. The deployer handed off the poly-line to the second sampler. Next, the samplers slowly pulled the full length of the net toward the beach; as the samplers came together on the beach, the net formed a V shape, allowing trapped fish to slide down the wings into the bag (Photo 3, Appendix B). Nets were set in the direction the tide was moving at the time.

Captured fish were identified, measured, and counted (Photo 4, Appendix B) as described for the block net sampling method. Water quality parameters were measured once per sampling event at beach seine sites, roughly in the center of each site, approximately 50 ft (15 m) from shore.

Replicate sets were made at each site if space, time, and tide stage permitted. Care was taken to ensure that the area covered by one set was not duplicated in the replicate sets. This was achieved by moving approximately 10 to 20 ft (3 to 6 m) away from the previous set's endpoint. Generally, three sets were deployed at each site with the exception of the Middle Waterway (City of Tacoma) and the Skookum Wulge sites. The configuration of these two sites is not conducive to more than one set. Time between sets varied between five and 30 minutes, a reflection of the time needed to process fish caught in a set. Beach seining was conducted during high to mid-tide, generally on an outgoing tide. At times, environmental factors, such as tides that were too high or too low or mass accumulations of seaweed in the net, prevented the samplers from completing the prescribed number of sets at some sites.

Figure 2-1. Puget Sound 37 m (120 ft) beach seine net.

[Placeholder. B&W landscape figure, 8.5" x 11".]

2.7.2 BSC 7 Data Analysis

All data were entered into an Excel spreadsheet by Ridolfi personnel. Salmon numbers were adjusted by catch per unit effort (CPUE), and salmon mean average lengths were used in the data analysis. The data were analyzed using Delta Graph 5 software.

2.8 Biological Success Criterion 8 – Invertebrate Prey Resource Production

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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.* (Ridolfi and Adolfson, 2001)

2.8.1 BSC 8 Field Work

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

2.8.1.1 Substrate Sampling

In this task, core samples were collected to a depth of 4 in. (10 cm) and invertebrate prey resources were enumerated. Six replicate samples were collected from each site. A stratified random approach was used to select the sampling locations along the lower fringe of marsh vegetation areas in Year 1. In Year 3, invertebrate samples were collected at the same distance along the transect, but at a lower elevation than in Year 1 monitoring (i.e., below +10 feet [+3 m] MLLW).

A 1.75-inch (4.5-cm)-diameter sediment sampler was used to collect samples from the mudflats or sandflats and in the marsh. Samples were placed in plastic containers and alcohol was added to preserve the samples. 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.

2.8.1.2 Fallout Sampling

Six replicate fallout samples were established. Fallout traps were divided between marsh areas and the lower fringe of the riparian zone. Random sampling locations identified for Year 1 sampling were used for Year 3 sampling. Insects were collected using fallout traps following similar procedures to those described by Cordell et al. (1999). A rectangular plastic tray approximately 24 in. x 17 in. (61 cm x 43 cm) was placed in the marsh area, tethered between four vertical polyvinyl chloride pipes, wooden stakes, and/or rebar. Sampling locations, which were established based on the "as planted" surveys and will be permanent, were located to collect invertebrates from planted vegetation. The floating traps rose and fell with the tide, collecting insects that fell into the traps from vegetation or the air. Approximately 1.5 in. (4 cm) of a soapy water solution was placed in the traps to collect the insects (Sutherland et al., 1996). 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 using light microscopy. Invertebrate species important to salmonids were identified to order.

2.8.2 BSC 8 Data Analysis

Invertebrates collected in the fallout traps and sediment cores were identified to order, some of which could be accurately identified to family. Invertebrates were identified using a dissecting microscope and a compound light microscope. The total number of individuals for each order (or family) was tallied by site. Results were normalized to square meter (number/m^2). The data for each site were analyzed to identify the invertebrates by sample type (fallout or substrate) and sample location, as well as to determine the total number of each invertebrate identified.

2.9 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.* (Ridolfi and Adolfson, 2001)

2.9.1 BSC 9 Field Work

Prior to the first visit in Year 1, the monitoring team identified a manner of approaching each site that would minimize disturbance, making observations from relatively inconspicuous locations. In Year 3, monitors approached the sites in the same manner and from the same directions. This technique is intended to reduce observer influences on monitoring results and to increase the reproducibility of bird counts.

Between January and November 2004, bird use was observed and recorded during early mornings over periods of half an hour to an hour. Using a standardized form, observers recorded the bird species observed on site and within approximately 150 ft (50 m) of the site boundary, as well as the type of observation (i.e., seen, heard, tracks, flyover) and climatic and tidal factors that could influence bird use of the site.

Bird monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. The Trustees have not identified any reference or comparison sites at this time.

2.9.2 BSC 9 Data Analysis

Data collected in the field were entered into a database by Ridolfi staff. Bird use was recorded for each site, and numbers of species observed per season were recorded by site. Bird species counts were totaled for each site, and numbers of species using different habitat segments were recorded. The results were compared to previous monitoring years by total number of species and groups of species (e.g., waterfowl, gulls, raptors).

3.0 MONITORING RESULTS

This section describes monitoring results by site and BSC. Maps presented in this section were created using AutoCAD software, and cross sections were prepared in DeltaGraph. Biological observations were recorded on data forms in the field and then entered into an Access database developed for the project. Ridolfi personnel performed the data entry; entries were spot-checked for quality control. The database was queried to generate the site-specific summary tables discussed in this section; the tables appear in Appendix A. Fish monitoring data, which were collected and summarized by Ridolfi personnel, were subsequently imported into the database for archival purposes.

3.1 Mowitch

Information collected at the Mowitch site included vegetation (marsh and riparian), fish, invertebrate, and avian data. Ridolfi performed the surveying and fish monitoring; Adolfson collected vegetation, invertebrate, and avian data. The data are discussed below in terms of the success criteria applicable to the Mowitch site for Year 3 monitoring.

3.1.1 Biological Success Criterion 1 – Marsh Development/Areal Coverage

Introduction. Figure 3-1 shows the vegetation polygons mapped in the marsh area at Mowitch during Year 3. The areal extent and percent cover of marsh vegetation were compared between Years 1 and 3. Tables A-1a through A-1e provide the overall marsh area and vegetation cover of polygons at Mowitch in Year 3, as compared to the total marsh area vegetated in Year 1.

Sixty-nine quadrats were sampled along two marsh transects at Mowitch, designated as Transects 1-1 and 1-2 (Figure 3-1). The location of each quadrat along each transect is shown in Table A-2. The native and non-native marsh species found along the marsh transect at Mowitch and their percent cover are shown in Table A-3a (Transect 1-1) for Year 1, Table A-3b (Transect 1-2) for Year 2, and Table A-5a (Transect 1-1) and Table A-5b (Transect 1-2) for Year 3. Tables A-4a and A-4b show the percent cover data collected during Year 3.

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Figure 3-1. Mowitch marsh and riparian vegetation coverage.

[Placeholder. Color landscape figure, 11" x 17".]

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The percent cover data for Year 3 and previous monitoring years were compared to assess changes in the median coverage of marsh vegetation over time. Percent cover is discussed here in terms of the unbiased average quadrat canopy cover and the 90CI around this estimate (see Section 2.2.2 for discussion of these terms).

Marsh Vegetation Mapping. Based on polygon mapping, the vegetated marsh area at Mowitch during Year 1 was approximately 0.08 acre, compared to a vegetated marsh area of approximately 0.37 acre during Year 3 (Table A-1 series). This is an increase of 0.29 acre, or approximately 375 percent, in the areal extent of marsh vegetation over the timeframe. Marsh vegetation cover has increased such that there is now a nearly continuous patch of marsh vegetation immediately downslope from the riparian habitat. Vegetation has increased along all four lobes within the marsh area. It appears that both new patches of marsh vegetation have become established and that existing patches have increased in areal extent.

Percent Cover Along Transects (Comparison Between Years). During Year 1, the unbiased average percent cover along Mowitch Transect 1-1 was 13.7 percent (90CI of 5.0 to 22.3 percent) (Table A-3a). During Year 3, the unbiased average percent cover along this transect increased to 72.3 percent (90CI of 40.0 to 104.5 percent) (Table A-5a). As shown in Table A-6, the median percent cover has significantly increased.

Transect 1-2 was first established at the Mowitch site during Year 2. Therefore, cover data from Year 2 are compared to Year 3 data for this transect. During Year 2, the unbiased average percent cover along Mowitch Transect 1-2 was 67.3 percent (90CI of 0.0 to 165.2 percent) (Table A-3b). During Year 3, the unbiased average percent cover along this transect increased to 87.9 percent (90CI of 11.7 to 164.1 percent) (Table A-5b). As shown in Table A-6, the median percent cover has significantly increased.

Success Criterion Evaluation. BSC 1 requires a stable or increasing areal extent of marsh vegetation. Based on polygon mapping, the area of marsh vegetation has increased between Years 1 and 3 at the Mowitch site. In addition, the percent cover of marsh vegetation showed a statistically significant increase along Transect 1-1 between Years 1 and 3 and at Transect 1-2 between Years 2 and 3. Therefore, BSC 1 has been met at Mowitch during Year 3.

3.1.2 Biological Success Criterion 2 – Marsh Development/Species Composition

3.1.2.1 Transect 1-1

Descriptive Analysis. Of the 46 marsh quadrats sampled along Transect 1-1, 45 contained vegetation in Year 3. Thirteen species were observed in quadrats along this transect. Of these, 10 species were native and two were non-native. The remaining unclassified herb could not be accurately identified at the time of the site visit, but was assumed to be non-native. The most prevalent native species observed along this transect was spike-rush (*Eleocharis* sp.), which occurred within 27 of 46 quadrats. The most prevalent non-native species observed was brass buttons (*Cotula coronopifolia*), which was observed within 36 of 46 quadrats (Table A-5a).

The average percent canopy covers for the 13 species identified along this transect are presented in Table A-5a. The unbiased average for canopy cover was used to represent canopy coverage for each species along the entire transect. The two species with the highest unbiased average percent canopy coverage were brass buttons (11.0 percent with a 90CI of 6.1 to 15.9 percent), a non-native species, and spike-rush (10.8 percent with a 90CI of 1.3 to 20.2 percent), a native species.

The unbiased average percent cover for native species is 74.0 percent (90CI of 12.8 to 135.2 percent), as shown in Table A-5a and on Figure 3-2. The average percent cover for native species was considerably higher than that for non-native species, which have an unbiased average percent cover of 16.8 percent (90CI of 9.2 to 24.4 percent).

The average percent cover values for individual species, based only on the quadrats where the species were found, are presented in Table A-5a. Based on these data, the species with the highest percent cover included fleshy jaumea (*Jaumea carnosa*) (34.3 percent), seashore saltgrass (*Distichlis spicata*) (26.6 percent), Lyngby's sedge (*Carex lyngbyei*) (22.5 percent), and seaside plantain (*Plantago maritima*) (20.9 percent).

Figure 3-2. Confidence intervals for Mowitch marsh vegetation cover, by transect.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Of the 46 quadrats along Transect 1-1, 13 were entirely within herbivory avoidance fencing, one was partially within the avoidance fencing, and 32 were entirely outside of the fencing. Table A-4a shows that the quadrats falling within the fenced areas generally had the greatest plant species diversity and greatest overall percent cover of native plant species. In general, areal coverage along this transect was greatest within the areas protected with herbivory avoidance fencing. Native species such as fleshy jaumea, Lyngby's sedge, seashore saltgrass, pickleweed (*Salicornia virginica*), seaside plantain, and seaside arrowgrass (*Triglochin maritimum*) showed higher percent cover in fully fenced areas. In general, native spike-rush and non-native species such as brass buttons and saltmarsh sandspurry (*Spergularia marina*) showed similar percent cover both inside and outside of the herbivory avoidance devices. Brass buttons and saltmarsh sandspurry demonstrated particularly high percent cover for quadrats 5 through 12, which were outside of herbivory avoidance fencing.

Comparison Between Years. A total of eight native plant species were observed along Transect 1-1 during Year 1, with a total unbiased average cover of 10.5 percent (Table A-3a). During Year 3, 10 native species were observed, with a total unbiased average cover of approximately 74.0 percent. The results for the non-parametric sign test (Table A-6) indicate that total native species have significantly increased along the transect. Therefore, both the diversity of native plant species and the average percent cover of native species have increased along Transect 1-1 from Year 1 to Year 3.

During Year 1, six non-native plant species and two unknown species (assumed to be non-native) were observed, with a total unbiased average cover of 2.7 percent (with a 90 percent confidence interval of 0.4 to 5 percent). During Year 3, two non-native species and one unknown (assumed to be non-native) species were observed, with a total unbiased average cover of approximately 16.8 percent. In addition, the proportion of NNI cover to native cover has increased from 19.7 percent in Year 1 to 23.2 percent in Year 3. The statistical results show a significant increase in the median of total non-native cover (Table A-6). Based on the Year 3 monitoring data, the number of non-native species has decreased along Transect 1-1 and the total unbiased average percent cover has increased.

3.1.2.2 Transect 1-2

Descriptive Analysis. Of the 23 marsh quadrats sampled along Transect 1-2 at the Mowitch site, all contained vegetation during Year 3 (Table A-4a). Of the nine species observed in quadrats along this transect, seven species are native and two are non-native. The most prevalent native species observed along this transect was spike-rush, which occurred within 15 of 23 quadrats. The most prevalent non-native species observed was brass buttons, which was observed within 18 of 23 quadrats (Table A-5b).

The average percent covers for the nine species within all quadrats identified along this transect are presented in Table A-5b. The two species with the highest unbiased average percent cover were spike-rush (34.8 percent with a 90CI of 0.7 to 68.9 percent), a native species, and brass buttons (19.4 percent with a 90CI of 2.8 to 36.0 percent), a non-native species.

The unbiased average percent cover for native species is 49.9 percent (90CI of 3.6 to 96.1 percent), as shown in Table A-5b and on Figure 3-2. The percent cover for native species was higher than that for non-native species, which have an unbiased average percent cover of 23.9 percent (90CI of 8.2 to 39.6 percent).

The arithmetic average percent covers, based only on the quadrats where the species were found, are presented in Table A-5b. Based on these data, the species with the highest percent cover are seashore saltgrass (40 percent) and spike-rush (33.7 percent), two native species.

Of the 23 quadrats along Transect 1-2, 14 were entirely within herbivory avoidance fencing and nine were entirely outside of the fencing. Table A-4b shows that the quadrats falling within the fenced areas generally had the greatest plant species diversity and greatest overall percent cover of native plants. Native plant species such as spike-rush, seashore saltgrass, and seaside arrow-grass showed higher percent cover in fenced areas. Non-native plants also have higher percent cover in fenced areas on Transect 1-2.

Comparison Between Years. Seven native plant species were observed along Transect 1-2 during the Year 2 monitoring, with a total unbiased average cover of 20.3 percent. During Year 3, seven native species were observed, with a total average cover of 49.9 percent. The increase in

median total cover by native species is statistically significant (Table A-6). Therefore, although the number of native species stayed the same, the average percent cover of native species along Transect 1-2 increased.

During Year 2, two non-native plant species and one unknown (assumed to be non-native) species were observed, with a total unbiased average cover of 24.5 percent. During Year 3, two non-native species were observed, with a total average cover of approximately 23.9 percent. The proportion of NNI plant cover to native cover has decreased from 36.4 percent in Year 1 to 27.2 percent in Year 3. There is no statistically significant change in total non-native cover along the transect (Table A-6). Both the total number of non-native species observed on the site and the average percent cover of non-native species along Transect 1-2 have slightly decreased, but the difference is not significant.

3.1.2.3 Discussion

Comparison of Transects. Both Mowitch marsh transects show an increase in native vegetation. However, both of the Mowitch transects have greater than 15 percent cover of NNI species.

Success Criterion Evaluation. BSC 2 for marsh development and plant species composition at the Mowitch site is measured by percent cover of native marsh plant species that remains stable or increases over time and percent cover of NNI species that is limited to less than 5 percent. Based on the data collected during the Year 3 monitoring, percent cover of native species has increased along both Transect 1-1 and Transect 1-2, meeting the success criterion for percent cover of native species.

Non-native cover for both Transects 1-1 and Transect 1-2 was greater than 5 percent and, therefore, does not meet BSC 2 for non-native cover.

3.1.3 Biological Success Criterion 3 – Marsh Development/Plant Vigor

Introduction. To assess plant vigor in marsh areas, the stem height and shoot density of Lyngby's sedge were measured in quadrats along Transects 1-1 and 1-2 at the Mowitch site during Year 3 (transect locations are shown on Figure 3-1). These measurements were

compared to similar measurements taken along a reference transect (Transect C-1, shown on Figure 3-7) at Squally Beach during Year 3. Where possible, the data were also compared between years. Stem heights of Lyngby's sedge could not be compared between years because of the difference in sampling techniques used during different years (see Section 2.3.2). Shoot densities of Lyngby's sedge in quadrats along Transects 1-1 and 1-2 were compared to densities measured during a previous monitoring year. Stem height and shoot density data for Year 3 at Mowitch are shown in Tables A-7a and A-7b; data for Year 1 are provided in Tables 3-5 and 3-6 of the Year 1 (2002) monitoring report (Ridolfi and Adolfson, 2003a). Data for the Squally Beach Transect C-1 are provided in Tables A-23a and A-23b. Tables A-8a and A-8b show the results of statistical analysis of these data for Mowitch.

Year 3 Quadrat Sampling Results. Of the 46 quadrats sampled along Mowitch Transect 1-1 during Year 3, only two quadrats contained Lyngby's sedge. The stem height of Lyngby's sedge within these two quadrats ranged from 10.0 to 28.0 in. (Table A-7a), with an average of 16.5 in. (Table A-8a). The shoot densities of Lyngby's sedge within these two quadrats were 16 and 79 per quadrat (Table A-7b), with an average of 47.5 stems per quadrat (Table A-8a).

Of the 23 quadrats sampled along Mowitch Transect 1-2 during Year 3, one quadrat contained Lyngby's sedge. The stem heights of Lyngby's sedge within this quadrat ranged from 9.0 to 11.0 in. (Table A-7a), with an average of 9.5 in. (Table A-8a). The shoot density of Lyngby's sedge within this quadrat was 22 (Table A-7b).

Comparison with Reference Transect. The stem height and shoot density of Lyngby's sedge along the transects at the Mowitch site could not be statistically compared to the reference transect at Squally Beach during Year 3 because of small sample size (i.e., there were not enough quadrats containing Lyngby's sedge along the Mowitch transects to allow for statistical comparison to the reference area) (Table A-8a).

Comparison Between Years. Lyngby's sedge was not present in most of the quadrats sampled along Mowitch Transect 1-1, and therefore the shoot density was zero in these quadrats during both years. As a result, most of the 46 quadrats (89 percent) sampled along Transect 1-1 showed no change in the shoot density of Lyngby's sedge between Year 1 and Year 3 (Table A-8b).

Lyngby's sedge was found in four quadrats along Mowitch Transect 1-1 during Year 1 (Table 3-6, Ridolfi and Adolfson, 2003a) and in two quadrats during Year 3 (Tables A-7a and A-7b). Three quadrats of the 46 sampled (7 percent) contained a trace of Lyngby's sedge during Year 1 and decreased to a shoot density of zero during Year 3. Two quadrats of the 46 sampled (4 percent) increased markedly in shoot density over this timeframe (from 23 to 79 shoots in one of the two quadrats and from zero to 16 shoots in the other from Year 1 to Year 3) (Table A-8b). Although there were large increases in these two quadrats, the median shoot density along the transect showed no significant change from Year 1 to Year 3 (Table A-8b).

Transect 1-2 was first established at the Mowitch site during Year 2. Therefore, data from Year 2 are compared to Year 3 data for this transect. Lyngby's sedge was not found in any quadrats (i.e., the shoot density was zero) along Transect 1-2 during Year 2 and was found in only one quadrat during Year 3 (Tables A-7a and A-7b). As a result, almost all of the 23 quadrats (96 percent) sampled along Transect 1-2 showed no change in the shoot density of Lyngby's sedge between Year 2 and Year 3 (Table A-8b). Only one of the 23 quadrats sampled (4 percent) showed an increase in shoot density (from zero to 22 shoots) by Year 3. The change in Lyngby's sedge shoot density between Years 2 and 3 along Transect 1-2 could not be statistically evaluated because there were not enough quadrats containing Lyngby's sedge to allow for statistical testing (Table A-8b).

Success Criterion Evaluation. As discussed, the stem height and shoot density of Lyngby's sedge along the Mowitch transects could not be statistically compared to the reference transect at Squally Beach because of small sample size. Therefore, it is not possible to determine based on statistical analysis whether BSC 3 has been met during Year 3. Mowitch Transect 1-1 did not exhibit a statistically significant change in shoot density between Years 1 and 3. Therefore, the criterion of having increasing shoot density over time has not been met during Year 3 for Transect 1-1. Shoot densities along Transect 1-2 during Years 2 and 3 could not be statistically compared, and so it is not possible to determine whether BSC 3 has been met during Year 3 for Transect 1-2. Overall, given the lack of Lyngby's sedge in most quadrats sampled along Transects 1-1 and 1-2, Year 3 data suggests that BSC 3 has not been met for the Mowitch site.

3.1.4 Biological Success Criterion 4 – Marsh Vegetation Herbivory Avoidance

Introduction. Prior to the Year 3 monitoring, new herbivory avoidance fences were installed near previously existing areas (Figure 3-3). The seven previously existing areas are HFA, HFH, HFI, HFQ, HFP, HFR, and HFV. For Year 3 monitoring, 18 new fenced areas were present on these lobes: HFB through HFG were added to the south lobe; HFJ through HFO were added to the center lobe; and HFS, HFT, HFU, HFW, HFX, and HFY were added to the north lobe.

The previously existing avoidance areas were constructed using metal stakes, rebar, chicken wire, string, and chain link fencing. The new areas were all constructed using metal stakes with 4-foot (1.2-m)-tall chicken wire and, in some cases, with criss-crossed string.

Descriptive Analysis. Most of the herbivory avoidance fencing was intact at the time of inspection, with the exception of some broken strings in fenced areas HFB and HFH. In addition, HFH was missing a portion of fencing around the perimeter near HFI. All of the structures appeared to be functioning, as there were no signs of grazing or of geese having accessed the areas. In general, vegetation in the fenced areas appeared to be healthy.

Success Criterion Evaluation. Some of the strings were broken on a number of the structures, yet vegetation appeared ungrazed and healthy. Fencing on this site appears to be a barrier to grazing. Therefore, the Mowitch site has met the requirements for BSC 4.

3.1.5 Biological Success Criterion 5 – Riparian Vegetation Survival

Introduction. Riparian plant survival results presented in this section are qualitative and are based on observations made at the Mowitch site during Year 3 monitoring. As described in Section 1.1.1, a substantial planting effort was conducted at the beginning of Year 4, which included trees and shrubs in the riparian zone.

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Figure 3-3. Mowitch herbivory avoidance fencing.

[Placeholder. Color landscape figure, 11" x 17".]

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<u>Descriptive Analysis</u>. During Year 3, the majority of the installed riparian plants observed at Mowitch appeared to be alive and healthy. Willow (*Salix* sp.) and red alder (*Alnus rubra*) were common species on this site during Year 3. All of the willow and red alder plants observed were alive and appeared healthy. Black cottonwood (*Populus balsamifera*) and Oregon ash (*Fraxinus latifolia*) also occur on this site, but less frequently. All black cottonwood trees observed were surviving; however, two young Oregon ash trees were dead. Of the conifers observed on the site, most of the Douglas fir (*Pseudotsuga menziesii*) and Sitka spruce (*Picea sitchensis*) were alive and appeared healthy. Approximately 25 percent of the shore pines (*Pinus contorta*) observed were dead. Western red cedar (*Thuja plicata*) suffered the greatest mortality, with approximately 50 percent of the observed specimens dead. Ten other dead young deciduous trees were observed at Mowitch, but lacked identifiable characteristics; most of these trees were likely sapling alder or willow.

Within the shrub layer, rose (*Rosa* sp.) was the most abundant and robust of the planted species during Year 3, although hazelnut (*Corylus cornuta*), snowberry (*Symphoricarpos albus*), red-osier dogwood (*Cornus stolonifera*), and currant (*Ribes* sp.) were common and appeared to be healthy. Most of the shrubs observed were alive and appeared healthy. The shrubs that appeared to be the most stressed at the time the site was monitored were snowberry, vine maple (*Acer circinatum*), and black twinberry (*Lonicera involucrata*).

Most of the native riparian vegetation planted at the Mowitch site generally appeared healthy. The plants that did appear to be stressed might have been responding to seasonality, lack of water during the growing season, or shading by NNI species (for example, birds-foot trefoil [*Lotus corniculatus*] was prevalent and robust at this site).

<u>Success Criterion Evaluation</u>. Baseline information is not available to allow an accurate determination of survival rate of the initial plantings; therefore, it cannot be quantitatively determined whether the goal of 75 percent survival is being met. However, based on qualitative observations, it appears that at least 75 percent of the native trees and shrubs observed at the Mowitch site were alive during Year 3.

3.1.6 Biological Success Criterion 6 – Riparian Vegetation/Areal Coverage

Introduction. Figure 3-1 shows the vegetation polygons mapped in the riparian area at Mowitch during Year 3. The areal extent and percent cover of riparian vegetation mapped in polygons at the Mowitch site were compared between Years 1 and 3. Table A-1f provides the overall riparian area and vegetation cover at Mowitch in Year 3, as well as the total riparian area vegetated in Year 1.

Data on the percent cover of herb, tree, and shrub layers and of NNI vegetation were collected from quadrats located along a transect through on-site riparian habitat at the Mowitch site (transect location is shown on Figure 3-1). Table A-10 shows the percent cover data collected from the 23 riparian quadrats sampled during Year 3, as well as the corresponding quadrat numbers from Year 1; two new quadrats were added to the transect during Year 2 and were subsequently sampled during Year 3.

The herb, shrub, tree, and NNI species found along the riparian transect at Mowitch and their respective percent cover are shown in Table A-9 (Year 1) and Table A-11 (Year 3). Percent cover data for Year 3 were compared to the minimum cover criterion for each vegetation layer under BSC 6 (70 percent for herbs, 30 percent for shrubs, 25 percent for trees, and less than 2 percent for NNI species). Percent cover is discussed here in terms of the unbiased average quadrat canopy cover and the corresponding 90CI (see Section 2.2.2). The unbiased average percent cover for riparian vegetation and the 90CIs are shown on Figure 3-4.

Comparison of Areal Extent Between Years. Based on polygon mapping, riparian vegetation at the Mowitch site covered approximately 0.38 acre during Year 1. Riparian vegetation covered approximately 0.64 acre during Year 3 (Table A-1f). This is an increase of 0.26 acre, or approximately 68 percent, of riparian vegetation over this timeframe.

Figure 3-4. Confidence intervals for Mowitch riparian vegetation cover, by cover type

[Placeholder. B&W landscape figure, 8.5″ x 11″.]

Quadrat Vegetation Cover. During Year 1, species planted at the Mowitch site were still small and provided limited coverage. All three of the vegetation layers increased in cover by Year 3, with the growth of both planted species and NNI species over this timeframe. Additional trees and shrubs were planted at this site in November 2002 and February 2004, which contributed to the increased percent cover. The percent cover of all vegetation layers in the riparian quadrats at the Mowitch site increased substantially between Year 1 and Year 3 (Tables A-9 and A-11). The herb layer increased from an unbiased average of 16.9 percent in Year 1 (90CI of 11.6 to 22.2 percent) to an unbiased average of 120.4 percent in Year 3 (90CI of 104.5 to 136.3 percent). The shrub layer increased from an unbiased average of 5.0 percent in Year 1 (90CI of 3.3 to 6.7 percent) to an unbiased average of 20.5 percent in Year 3 (90CI of 10.7 to 30.3 percent).

The tree layer increased from an unbiased average of 1.5 percent in Year 1 (90CI of 0.1 to 2.9 percent) to an unbiased average of 26.1 percent in Year 3 (90CI of 11.7 to 40.5 percent). The percent cover of all native riparian vegetation (herbs, shrubs, and trees combined) in the quadrats at Mowitch increased from an unbiased average of 10.7 percent in Year 1 (90CI of 7.5 to 13.8 percent) to an unbiased average of 76.5 percent in Year 3 (90CI of 55.6 to 97.4 percent). Native riparian species that contributed to much of the increase in native cover along the transect by Year 3 included yarrow (*Achillea millefolium*), rose, red-osier dogwood, red alder, and willow (Tables A-9 and A-11).

The percent cover of all NNI species in the quadrats at Mowitch increased from an unbiased average of 12.5 percent in Year 1 (90CI of 8.6 to 16.5 percent) to an unbiased average of 89.4 percent in Year 3 (90CI of 79.8 to 99.0 percent). The growth in cover of NNI herbaceous species contributed much of the increase along the transect between these two years; Himalayan blackberry (*Rubus discolor*) also increased in frequency and cover along the transect between Years 1 and 3 (Tables A-9 and A-11).

Success Criterion Evaluation. The area of riparian vegetation within mapped polygons at Mowitch increased by approximately 0.26 acre between Years 1 and 3. Therefore, the extent of riparian vegetation is increasing over time, although a portion of this coverage is being contributed by NNI species.

During Year 3, the unbiased average cover of the herb layer along the riparian transect at Mowitch substantially exceeded the coverage criterion of 70 percent (unbiased average herb coverage was 120.4 percent, with a 90CI of 104.5 to 136.3 percent). The unbiased average cover of the shrub layer along the transect was 20.5 percent with a 90CI of 10.7 to 30.3 percent, which is below the criterion of 30 percent cover. The tree layer had an unbiased average cover along the transect of 26.1 percent with a 90CI of 11.7 to 40.5 percent, slightly exceeding the 25 percent cover criterion. Based on the unbiased average percent cover, the herb and tree layers met BSC 6 during Year 3 but the shrub layer did not. Note that there is wide variability in the cover data, as indicated by the 90CIs.

The riparian transect did not meet the criterion of having less than 2 percent cover of NNI species during Year 3 (unbiased average cover of non-natives was 89.4 percent with a 90CI of 79.8 to 99.0 percent).

3.1.7 Biological Success Criterion 7 – Fish Access/Presence

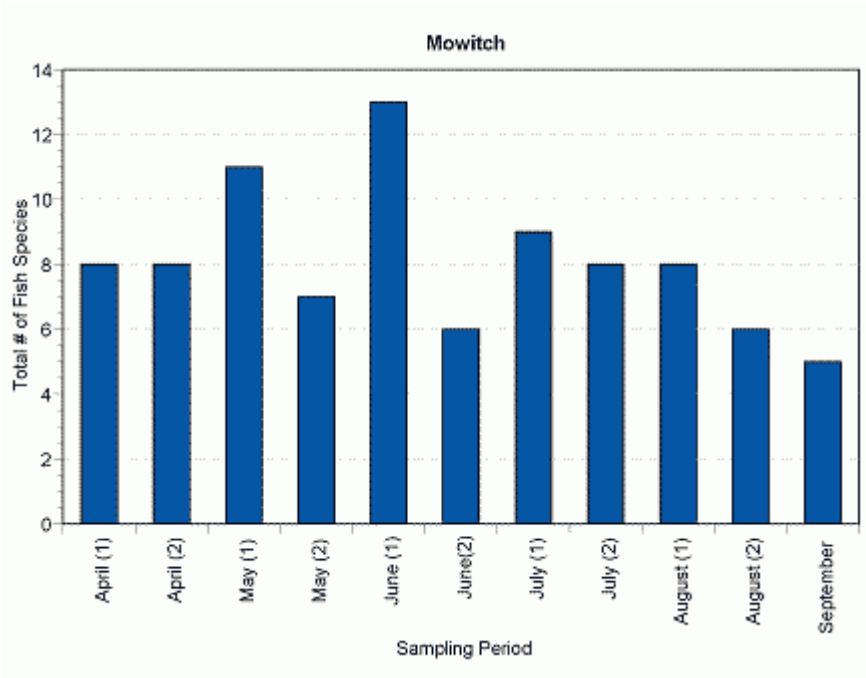
Introduction. The Mowitch site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Table A-12. Fish sampling occurred on 11 occasions between early April and early September on an approximately biweekly basis, with only one event in September, which was the final event of the season, because of tides that were not conducive to sampling during daylight hours.

The customized fishing gear built for the project functioned as intended. In mid-May, a log boom was tied off at the opening of the pool adjacent to the Hylebos Waterway; as a result, the pool could not be accessed to set a net. From June through August, three nets were set instead of four. Over the six-month sampling period, 37 individual block net sets were completed at the Mowitch site during 11 sampling events, for a total of 11 sets. The block net design is described in Section 2.7.1.1.

Descriptive Analysis. Complete catch records were kept for all sampling events, and lengths were recorded for selected species as described in Section 2.7. The number of species (species

richness, or SR) per sampling event ranged from two to 11. In total, 18 different species (total SR) were caught at the site during various sampling events. The greatest number of species was caught in June (Figure 3-5). To facilitate comparisons over time, the results for each month in Figure 3-5 have been aggregated for the first and second half of the month, e.g., the catch results for the two sampling events in the first half of April are aggregated as April (1), and the two sampling events in the second half are aggregated as April (2).

Figure 3-5. Total number of fish species caught at Mowitch per sampling event in 2004.



The Mowitch site had the fourth-highest SR of any of the sites (Figure 4-1). Four salmonid species, including cutthroat trout, were present during the sampling season. Shiner perch and Pacific staghorn sculpin were the most abundant species observed over the sampling period, with shiner perch the dominant species. Forage fish such as herring were also observed. Complete catch results for the Mowitch site are listed in Table A-13.

The peak catch for salmon occurred in early June. Salmon were not seen at the Mowitch site after mid-June. The peak catch for chinook and coho was observed in early June (Figure 3-6). The most abundant salmonid species observed at the Mowitch site was coho (Table A-13). One

cutthroat trout was sampled in May. Table 3-1 summarizes the total catch and average per set (i.e., CPUE) for juvenile salmon caught at the Mowitch site. Again, sampling results are aggregated for the first and second half of each month.

Figure 3-6. Average chinook caught per set at Mowitch in 2004.

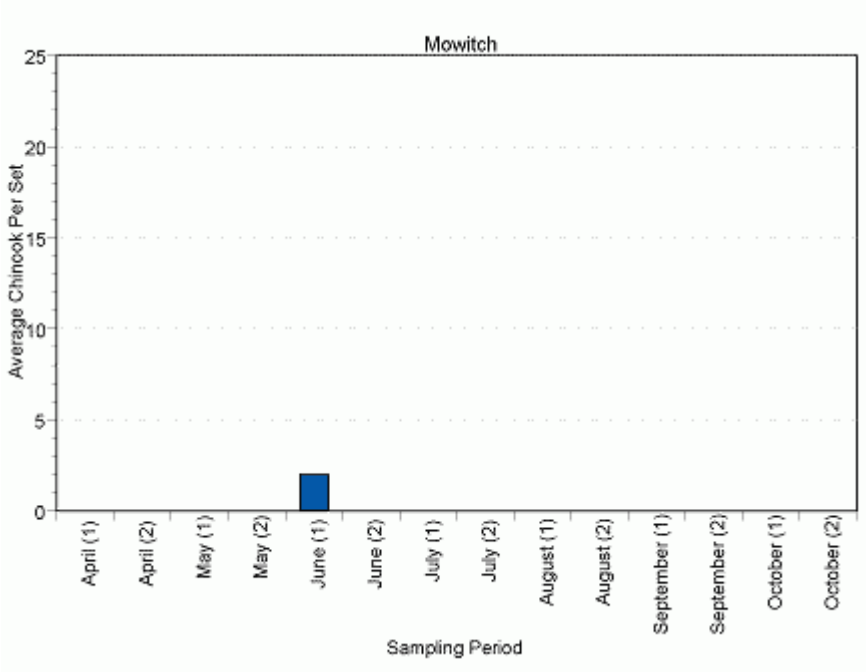


Table 3-1. Summary of total juvenile salmon caught and average numbers of salmon per set observed at the Mowitch site for Year 3 (2004).

Species	Number of Salmon Caught	Average per Set/Catch per Unit Effort
Chinook	2	0.18
Coho	17	1.55
Chum	3	0.27
Total Salmon	22	2.00

Success Criterion Evaluation. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Mowitch site.

3.1.8 Biological Success Criterion 8 – Invertebrate Prey Resource Production

Introduction. Invertebrate samples for the Mowitch site were collected on September 23, 2004. Samples were collected from fallout traps and substrate cores.

Fallout Samples. The results of the fallout trap sampling are shown in Table A-14a. During the September sampling, six different orders of invertebrates were observed within the traps. Flies (Diptera) were found in five of the six traps and included three identified families. The dominant family was the shorefly (Diptera Ephydridae). Coleoptera (beetles), Hemiptera (true bugs), Homoptera (leaf hopper), and Trichoptera (caddisfly) were also identified, along with an unknown order.

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

- Coleoptera: four individuals/m2;
- Diptera: 137 individuals/m2;
- Hemiptera: four individuals/m2;
- Homoptera: four individuals/m2;
- Trichoptera: four individuals/m2; and
- Unknown: four individuals/m2.

Samples collected for Year 1 (2002) and Year 3 (2004) occurred in different numbers and were collected at different times of the year. The Year 3 samples were collected in September (one visit), while samples for Year 1 were collected in July (one visit) and August (one visit). Six invertebrate orders were identified in fallout traps during Year 3 monitoring, compared to seven orders observed during each of the July and August site visits in Year 1. Eight invertebrate families were identified in fallout traps during Year 3 monitoring, while 20 families were observed during the July site visit and 12 families were observed during the August site visit in Year 1.

Substrate Samples. The results of the substrate sampling are shown in Table A-14b. Although substrate samples were collected at a lower elevation during this monitoring year relative to

Year 1 sampling locations, the presence of gravel in the substrate made data collection difficult. During the September sampling, one order (Amphipoda) was observed. Amphipoda were found in two of the six samples.

In Year 1, Amphipoda were observed within fallout traps, but not in the sediment samples. During Year 3, Amphipoda were observed in sediment samples, but not in the fallout traps.

Taxa Analysis. It is likely that juvenile salmonids will feed on whatever invertebrates are found within the water column. Of the six orders observed at the Mowitch site during Year 3, the two most likely to be consumed by juvenile salmonids are Amphipoda and Trichoptera. In addition, the family Saldidae in the order Hemiptera may also be consumed. Each of these invertebrates can be found in the water column at some point in their lives. The other orders observed at the site spend most of their lives on land, although they may be consumed if they happen to fall into the water.

Comparison Between Years. Invertebrate samples collected in September of Year 3 were compared to invertebrate samples collected in August of Year 1, since these dates were closest to each other. During Year 3, two of the three orders likely to be consumed by juvenile salmonids (Hemiptera Saldidae and Trichoptera) were collected in the fallout traps. Amphipoda were collected in the substrate samples during Year 3, but not in the fallout traps. During Year 1, all three orders likely to be consumed by juvenile salmonids (Hemiptera Saldidae, Trichoptera, and Amphipoda) were collected in the fallout traps. Individual numbers of Hemiptera Saldidae decreased from 50 individuals/m^2 in Year 1 to four individuals/m^2 in Year 3. Individual numbers of Trichoptera remained the same at four individuals/m^2. Comparisons between the number of Amphipoda present during Year 1 and Year 3 could not be made because of the different collection methods.

Success Criterion Evaluation. The success criterion for invertebrate prey resource production is measured by the production of invertebrate prey taxa known to be important to juvenile salmonids. Based on the data collected during the Year 3 monitoring, the number of orders likely to be important to juvenile salmonids has remained the same, while the number of individuals within these orders has decreased or remained stable. Therefore, the Mowitch site

does not appear to be meeting BSC 8. This may be due in part to the fact that Year 3 samples were collected later in the year than were Year 1 samples.

3.1.9 Biological Success Criterion 9 – Bird Use

Introduction. A total of 42 bird species were recorded at the Mowitch site in Year 3 (Table A-15). Thirty species were recorded in Year 1, and 35 in Year 2. (Note: The number of field surveys increased from seven in Year 1 to 10 in Year 2 and 12 in Year 3.) The number of species observed between January and November 2004 during a single monitoring event ranged from a low of eight in May to a high of 21 in June (Table A-16). The average number of species observed per visit was 12.8 in Year 3, down from 13.9 in Year 1 and 13.5 in Year 2.

The presence of three dogs harassing geese on this site was recorded on June 29 and August 27, 2004. The dogs were chasing Canada geese *(Branta canadensis)*, which were flightless due to molting, and staff observed one dog kill and eat a goose, while another goose was severely maimed. Low numbers of species were recorded in all habitats on the occasions when dogs were harassing geese, which will affect the overall analysis of bird use, but the degree of influence is unknown.

Descriptive Analysis. The number of species observed in the riparian habitat was greatest in late June (eight species) and least in January (two species). In total, 20 species were observed in the riparian habitat. As at other sites, and in other years, the noise from surrounding land uses forced staff to rely primarily on visual observations. Because bird species are often identified by sound, it is therefore likely that additional individuals or species may have been present in the riparian habitat but went unobserved. Noise levels are likely to be relatively similar from year to year, however, providing consistency in monitoring.

Use of marsh and intertidal habitat was greatest (seven species) in April (high tide) and May (mid-tide and falling). The fewest number of species (two) was recorded in January, March, May, June, and September at various tide levels.

The open-water habitats in and around the restoration site were used by various species of waterfowl, swallows, purple martin *(Progne subis)*, great-blue heron *(Ardea herodias)*, and belted

kingfisher *(Ceryle alcyon)*. Numbers ranged from zero species observed in May to seven in April, with 3.5 species as the average.

Song sparrow *(Melospiza melodia)* was the single species recorded on every field visit, and mallard *(Anas platyrhynchos)* was observed on 11 of 12 site visits. European starling *(Sturnus vulgaris)* and killdeer *(Charadrius vociferous)* were observed on 10 of 12 visits. The species recorded in the greatest numbers at one time was European starling, with approximately 120 birds present in August compared to 100 in Year 1 and 60 in Year 2. Other species present in large numbers included Canada goose (up to 38 individuals), barn swallow *(Hirundo rustica)* (10 individuals), and cliff swallow *(Petrochelidon pyrrhonota)* (10 individuals).

Waterfowl species using the restoration site and nearby open-water habitat included American coot *(Fulica americana)*, American wigeon *(Anas americana)*, bufflehead *(Bucephala albeola)*, Canada goose, common goldeneye *(Bucephala clangula)*, double-crested cormorant *(Phalacrocorax auritus)*, gadwall *(Anas strepera)*, green-winged teal *(Anas crecca)*, hooded merganser *(Lophodytes cucullatus)*, mallard, and pied-billed grebe *(Podilymbus podiceps)*. Great-blue heron was present during seven of 12 site visits. Other wading birds included snipe *(Gallinago delicate)*, spotted sandpiper *(Actitis macularia)*, and killdeer.

A single raptor species, red-tailed hawk *(Buteo jamaicensis)*, was recorded on March 25 and September 20, 2004.

Eleven of the bird species observed – American robin (*Turdus migratorius*), belted kingfisher, Canada goose, cliff swallow, European starling, killdeer, mallard, mourning dove (*Zenaida macroura*), song sparrow, spotted sandpiper, and white-crowned sparrow (*Zonotrichia leucophrys*) – displayed obvious signs of breeding or territorial behavior such as singing, fighting or pursuit, gathering of nesting material, "broken-wing" behavior, or the presence of young. Eleven species were recorded in Year 2 displaying such signs, and eight species were recorded in Year 1. European starling, cliff swallow, and belted kingfisher likely nested off the restoration site, but collected nest material, brought young to forage, or defended territorially at the site.

Species recorded as using the Mowitch restoration site only in spring included bufflehead, green-winged teal, tree swallow *(Tachycineta bicolor)*, western sandpiper *(Calidris mauri)*, and white-crowned sparrow. Common goldeneye was the single species observed only in winter. American coot and hooded merganser were observed only in fall. The total number of species counted in spring was less in Year 3 (25) than in Year 2 (27) but higher than in Year 1 (15). Species totals were higher in summer (31) than in either Year 2 (18) or Year 1 (22), but were lower in fall, with 13 species observed in Year 3 as compared to 18 in Year 2 and 21 in Year 1.

Success Criterion Evaluation. BSC 9 is being met at Mowitch based on the presence of numerous birds in a variety of species, although there is no reference site against which a definitive comparison can be made. Overall, the number of species using the restoration site (42) was higher than in past years (31-32), although more site visits occurred this year than in the past, so a statistical analysis is not possible.

3.2 Squally Beach

Information collected at the Squally Beach site included vegetation (marsh and riparian), invertebrate, and avian data. Ridolfi performed the surveying; Adolfson collected the vegetation, invertebrate, and avian data. The data are discussed below in terms of the success criteria applicable to the Squally Beach site for Year 3 monitoring.

3.2.1 Biological Success Criterion 1 – Marsh Development/Areal Coverage

Introduction. Figure 3-7 shows the vegetation polygons mapped in the marsh area at Squally Beach during Year 3. The areal extent and percent cover of marsh vegetation were compared between Years 1 and 3. Tables A-17a through A-17d provide the overall marsh area and vegetation cover of polygons at Squally Beach in Year 3, as well as the total marsh area vegetated in Year 1.

Fifty-five quadrats were sampled along Transects 1-1, 1-2, and 1-3 at Squally Beach (Figure 3-7). The location of each quadrat along each transect is shown in Table A-18. The native and non-native marsh species found along the marsh transects at Squally Beach and their percent cover

are shown in Tables A-19a through A-19c (Years 1 and 2) and Tables A-21a through A-21c (Year 3). Tables A-20a through A-20d show the percent cover data collected during Year 3.

The percent cover data for Year 3 and previous monitoring years were compared to assess changes in the median coverage of marsh vegetation. Percent cover is discussed here in terms of the unbiased average quadrat canopy cover and the corresponding 90CI on the estimate (see Section 2.2.2 for discussion of these terms).

Marsh Vegetation Mapping. Based on polygon mapping, the vegetated marsh area at Squally Beach during Year 1 was approximately 0.06 acre, compared to a vegetated marsh area of approximately 0.2 acre during Year 3 (Table A-17 series). This is an increase of 0.14 acre, or approximately 220 percent, in the areal extent of marsh vegetation over the timeframe. Marsh vegetation cover has increased, particularly in the central portion of the site.

Percent Cover Along Transects (Comparison Between Years). During Year 1, the unbiased average percent cover along Squally Beach Transect 1-1 was 19.0 percent (90CI of 6.2 to 31.9 percent) (Table A-19a). During Year 3, the unbiased average percent cover along this transect increased to 78.3 percent (90CI of 37.5 to 119.1 percent) (Table A-21a). As shown in Table A-22, the median percent cover has significantly increased.

During Year 1, the unbiased average percent cover along Squally Beach Transect 1-2 was 68.8 percent (90CI of 16.6 to 121.0 percent) (Table A-19b). During Year 3, the unbiased average percent cover along this transect increased to 99.1 percent (90CI of 27.0 to 175.7 percent) (Table A-21b). However, as shown in Table A-22, the median difference along the transect is not significantly changed.

Transect 1-3 was added at Squally Beach during Year 2; therefore, the Year 3 data are compared to Year 2 data for this transect. During Year 2, the unbiased average percent cover along Transect 1-3 was 15.7 percent (90CI of 0.0 to 40.3 percent) (Table A-19c). During Year 3, the unbiased average cover increased to 46.7 percent along this transect (90CI of 2.5 to 90.8 percent) (Table A-21c). As shown in Table A-22, the median percent cover has significantly increased.

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Figure 3-7. Squally Beach marsh and riparian vegetation coverage.

[Placeholder. Color landscape figure, 11″ x 17″.]

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Success Criterion Evaluation. BSC 1 requires a stable or increasing areal extent of marsh vegetation. Based on polygon mapping, the area of marsh vegetation has increased between Years 1 and 3 at the Squally Beach site. In addition, the percent cover of marsh vegetation increased along Transects 1-1, 1-2, and 1-3 between the transect year of origin (Year 1 or 2) and Year 3, although the median increase in vegetation among transects is not significant for Transect 1-2. Therefore, BSC 1 has been met at Squally Beach during Year 3.

3.2.2 Biological Success Criterion 2 – Marsh Development/Species Composition

3.2.2.1 Transect 1-1

Descriptive Analysis. Of the 24 marsh quadrats sampled along Squally Beach Transect 1-1, 20 contained vegetation in Year 3. Seven species, all native plants, were observed along this transect. The most prevalent native species observed was fleshy jaumea, which occurred within 14 of 24 quadrats (Table A-21a).

The average percent canopy covers for seven species identified along the transect are presented in Table A-21a. The species with the highest unbiased average percent cover was fleshy jaumea (47.5 percent with a 90CI of 4.8 to 90.3). The percent cover for this species is considerably higher than that of any other species found along the transect. The average percent cover values for individual species, based only on those quadrats where the species were found, are also presented in Table A-21a. Based on these data, the species with the highest percent cover was also fleshy jaumea (53.3 percent).

The unbiased average percent cover for native species is 78.3 percent (90CI of 37.5 to 119.1 percent), as shown in Table A-21a and on Figure 3-8. No non-natives occurred within the quadrats sampled.

Figure 3-8. Confidence intervals for Squally Beach marsh vegetation cover, by transect.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Of the 24 quadrats along Transect 1-1, 16 were entirely within herbivory avoidance fencing, and eight were entirely outside of the fencing. Table A-20a shows that the quadrats falling within the fenced areas generally had the greatest plant species diversity and greatest overall percent cover of native plant species. The exceptions were quadrats 22 through 24 (at the western end of the transect), which showed species diversity and percent cover similar to quadrats within the fenced area.

Comparison Between Years. During Year 1, a total of seven native plant species were observed along Transect 1-1, with a total average cover of 19.1 percent (Table A-19a). During Year 3, seven native species were observed, with a total unbiased average cover of 78.3 percent. The median percent cover among quadrats has significantly increased (Table A-22). Therefore, the diversity of native plant species has remained the same along Transect 1-1 from Year 1 to Year 3, but the percent cover of native species has increased.

During Year 1, three non-native plant species were observed, with a total average cover of less than 1 percent. During Year 3, no non-native species were observed along Transect 1-1. There is no significant change in the median percent cover of non-native species (TableA-22), but this is likely because most quadrats have zero percent cover for non-natives. Based on the Year 3 monitoring data, it appears that the number of non-native species and possibly the average percent cover of non-native species have decreased along Transect 1-1. The proportion of non-native cover to native cover is essentially zero and has remained the same from Year 1 to Year 3.

3.2.2.2 Transect 1-2

Descriptive Analysis. Of the 15 marsh quadrats sampled along Transect 1-2 at the Squally Beach site, 14 contained vegetation during Year 3. Of the 17 species observed along this transect, 15 species are native and two are non-native (one of the non-native species observed, Himalayan blackberry, provided cover from the adjacent riparian area, but was not rooted in the quadrat). The most prevalent native species observed along this transect in Year 3 was fat-hen saltbush (*Atriplex patula*), which was observed within 6 of 15 quadrats (Table A-21b).

The average percent cover for the 17 species within all quadrats identified along this transect are presented in Table A-21b. The two species with the highest unbiased average percent cover are Lyngby's sedge (20.5 percent with a 90CI of 0.0 to 41.3 percent) and Hooker's willow (*Salix hookeriana*) (19.0 percent with a 90CI of 3.1 to 35.9 percent); both are native species. Note, however, that Hooker's willow provided cover from adjacent riparian areas and was not rooted in the quadrat. American bulrush (*Scirpus americanus*) also was observed to have high average cover (12.3 percent with a 90CI of 0.0 to 25.8 percent).

The unbiased average percent cover for native species is 107.5 percent (90CI of 17.8 to 202.9 percent), as shown in Table A-21b and on Figure 3-8. The native cover was substantially higher than that for non-native species, which have an unbiased average percent cover of 1.7 percent (90CI of 0.0 to 3.8 percent).

Average percent cover data based only on those quadrats where the species were found are presented in Table A-21b. Based on these data, the species with the highest percent cover are Hooker's willow (95.0 percent), American bulrush (56.7 percent), and Lyngby's sedge (53.0 percent). Hooker's willow provides cover from the adjacent riparian areas and is not rooted in the quadrat.

All 15 quadrats along this transect were entirely within herbivory avoidance fencing. Percent cover ranged from very low (0 and 3 percent) to very high (greater than 100 percent). Therefore, fencing does not appear to have a strong influence on plant species composition for this transect.

Comparison Between Years. Thirteen native plant species were observed along Transect 1-2 at the Squally Beach site during the Year 1 monitoring, with a total unbiased average cover of approximately 49.5 percent (Table A-19b). During Year 3, 15 native species were observed, with a total average cover of approximately 107.5 percent. However, the median percent cover across all quadrats is not significantly different in Year 3 (Table A-22). Thus, the number of native species and the average percent cover of native species along Transect 1-2 have increased from Year 1 to Year 3. However, the increase is not consistent along the transect and is therefore not statistically significant.

During Year 1, five non-native plant species were observed, with a total unbiased average cover of 17.5 percent. During Year 3, two non-native species were observed, with a total average cover of 1.7 percent. Both the total number of non-native species observed and the average percent cover of non-native species along Transect 1-2 have decreased from Year 1 to Year 3. In addition, the proportion of NNI plant cover to native plant cover has decreased from 25.5 percent in Year 1 to 1.7 percent in Year 3. However, the median percent cover has not significantly changed (Table A-22).

3.2.2.3 Transect 1-3

Descriptive Analysis. Of the 16 marsh quadrats sampled along Transect 1-3 at the Squally Beach site, 12 contained vegetation during Year 3. Nine species were observed in quadrats along this transect, eight native and one non-native. The most prevalent native species was pickleweed, which occurred within seven of 16 quadrats. Brass buttons was the most prevalent non-native plant species observed, occurring within five of 16 quadrats.

The unbiased average percent cover for native species is 46.8 percent (90CI of 0.0 to 101.6 percent), as shown in Table A-21c and Figure 3-8. The native cover was greater than that for non-native species, which have an unbiased average percent cover of 6.0 percent (90CI of 0.0 to 17.2 percent).

The average percent covers for all nine species within all quadrats identified along the transect are presented in Table A-21c. The species with the highest average percent cover was seashore saltgrass (22.4 percent with a 90CI of 0.0 to 48.2 percent), a native marsh plant.

Average percent cover data based only on those quadrats where the species were found are presented in Table A-21c. Based on these data, the species with the highest percent cover were seashore saltgrass (42.2 percent) and fleshy jaumea (30.0 percent).

All of the 16 quadrats along Transect 1-3 were entirely within herbivory avoidance fencing. Percent cover ranged from very low (0 and 3 percent) to very high (greater than 100 percent). Therefore, fencing does not appear to have a strong influence on marsh development for this transect.

Comparison Between Years. Five native plant species were observed during Year 2 (2003), with a total unbiased average cover for native plants of 16.1 percent (Table A-19c). During Year 3 (2004), eight native species were observed, with a total unbiased average cover of 46.8 percent. The median percent cover significantly increased along the transect (Table A-22). Therefore, it appears that both the number of native plant species and the average percent cover of native species have increased along Transect 1-3 from Year 2 to Year 3.

During Year 2, one non-native plant species was observed, with a total unbiased average cover of 0.4 percent. During Year 3, one non-native species was observed, with an unbiased average percent cover of 6.0 percent. The median percent cover has not significantly increased (Table A-22). Based on the Year 3 monitoring data, it appears that the number of non-native species has remained the same, and there is no significant change to average percent cover of non-native species along Transect 1-3 from Year 2 to Year 3. The proportion of NNI plant cover to native cover has also increased, from 2.5 percent in Year 1 to 12.8 percent in Year 3.

3.2.2.4 Discussion

*Comparison of Transects and Sites***.** All three Squally Beach marsh transects show an increase in native vegetation. While the other transects are showing a decrease in the percent cover of NNI species, Transect 1-3 at the Squally Beach site shows no significant change in percent cover of NNI species. Squally Beach Transects 1-1 and 1-2 have less than 5 percent NNI cover, while Transect 1-3 has greater than 5 percent NNI cover.

*Success Criterion Evaluation***.** BSC 2 for marsh development and plant species composition at the Squally Beach site is measured by percent cover of native marsh plant species that remain stable or increase over time and percent cover of NNI species that is limited to less than 5 percent. Based on data collected during the Year 3 monitoring, percent cover of native species has remained stable or increased along all three transects and meets BSC 2 for percent cover of native species.

Non-native cover for Transect 1-1 and Transect 1-2 has decreased and is less than 5 percent; therefore, these two transects meet BSC 2 for non-native cover. Non-native cover for Transect 1-3 has increased to 6 percent, which does not meet BSC 2 for non-native cover.

3.2.3 Biological Success Criterion 3 – Marsh Development/Plant Vigor

Introduction. To assess plant vigor in marsh areas, the stem height and shoot density of Lyngby's sedge were measured along Transect 1-2 at the Squally Beach site during Year 3. These measurements were compared to similar measurements taken along a reference transect (Transect C-1) at Squally Beach during Year 3. Transect locations are shown on Figure 3-7. Where possible, data were also compared between years. Stem heights of Lyngby's sedge could not be compared between years because of the difference in sampling techniques used during different years (see Section 2.3.2). Shoot densities of Lyngby's sedge in quadrats along Transect 1-2 were compared to densities measured during Year 1. Lyngby's sedge was not planted along Transects 1-1 and 1-3 or found along those transects during Year 3, so only Transect 1-2 was used for the statistical analysis. Stem height and shoot density data for Year 3 at Squally Beach are shown in Tables A-23a and A-23b; data for Year 1 are provided in Tables 3-17 and 3-18 of the Year 1 (2002) monitoring report (Ridolfi and Adolfson, 2003a). Tables A-24a and A-24b show the results of statistical analyses of these data for Squally Beach.

Year 3 Quadrat Sampling Results. Of the 15 quadrats sampled along Squally Beach Transect 1-2 during Year 3, five quadrats contained Lyngby's sedge. The stem height of Lyngby's sedge within these five quadrats ranged from 4 to 37 in. (Table A-23a), with an average of 19.9 in. (Table A-24a). The shoot density of Lyngby's sedge within these five quadrats ranged from 4 to 140 per quadrat (Table A-23b), with an average of 46.6 stems per quadrat (Table A-24a).

All three of the quadrats sampled along reference Transect C-1 during Year 3 contained Lyngby's sedge. The stem height of Lyngby's sedge within these three quadrats ranged from 1.5 to 30 in. (Table A-23a), with an average of 14.4 in. (Table A-24a). The shoot density of Lyngby's sedge within these three quadrats ranged from 30 to 83 (Table A-23b), with an average of 47.7 (Table A-24a).

Comparison with Reference Transect. Statistical testing indicated that the stem height and shoot density of Lyngby's sedge were not significantly different between Squally Beach marsh Transect 1-2 and Squally Beach reference Transect C-1 during Year 3 (Table A-24a). The average stem height along Transect 1-2 (19.9 in.) was greater than along the reference transect (14.4 in.), while the average shoot density along Transect 1-2 (46.6) was 98 percent of the average shoot density along the reference transect (47.7).

Comparison Between Years. Lyngby's sedge was not present (shoot density of zero) in many of the quadrats sampled along Transect 1-2 during Year 1 or Year 3. As a result, 60 percent of the 15 quadrats sampled along Squally Beach Transect 1-2 showed no change in Lyngby's sedge shoot density between Year 1 and Year 3 (Table A-24b). Lyngby's sedge was found in two quadrats along Squally Beach Transect 1-2 during Year 1 (Table 3-18 in Ridolfi and Adolfson, 2003a) and in five quadrats during Year 3 (Tables A-23a and A-23b). One quadrat (7 percent) of the 15 sampled showed a dramatic decline in shoot density over this two-year timeframe, from 142 shoots during Year 1 to zero shoots during Year 3. Five quadrats (33 percent) of the 15 sampled showed an increase in shoot density (Table A-24b), including four quadrats that increased from zero shoots during Year 1 to up to 36 shoots in Year 3 and a fifth quadrat that increased from 38 to 140 shoots over the timeframe. However, the changes in shoot density were not consistent across the transect, and the median difference is not significant (Table A-24b). Some of the rebar installed to mark transect locations during Year 1 had been removed by Year 3, so some of the quadrats along the transect may not have been placed in exactly the same locations during Year 3 as in Year 1. This fact may account for some of the changes in shoot densities.

Success Criterion Evaluation. Statistical testing indicated that the stem height and shoot density of Lyngby's sedge along Squally Beach Transect 1-2 were not significantly different (at the 90 percent confidence level) from those along the reference transect during Year 3; therefore, the first part of BSC 3 is being met at Squally Beach Transect 1-2. Squally Beach Transect 1-2 did not exhibit a statistically significant change in shoot density between Years 1 and 3; therefore, the criterion of increasing shoot density over time has not been met during Year 3 for this transect.

3.2.4 Biological Success Criterion 4 – Marsh Vegetation Herbivory Avoidance

Introduction. One large herbivory avoidance device is located on the Squally Beach site (Figure 3-9). Five-foot wire fencing borders the southern edge, while the majority of the site is covered by cross strings with cables above the string. The avoidance area was constructed with rebar, wood stakes, cable, rope, and metal posts with wire fencing.

Descriptive Analysis. The southern side of the herbivory fencing was intact at the time of inspection, although in some areas the strings across the top were drooping or had broken completely. Rope used around the outer edge of the north, east, and west sides of the structure was, for the most part, no longer intact. Although some portions of the fence may have been in disrepair due to wear and tear, the site steward was also in the process of dismantling some sections. A few sedges were missing tips of leaves and had worn edges, possibly the result of grazing. Overall, much of the herbivory fencing appeared intact and the vegetation generally appeared healthy.

Success Criterion Evaluation. Although some areas of fencing showed signs of wear and some vegetation showed possible signs of grazing, most fencing was intact and the vast majority of vegetation appeared healthy with little evidence of grazing. Fencing on this site appears to be a barrier to geese. Therefore, the BSC 4 has been met for the Squally Beach site.

3.2.5 Biological Success Criterion 5 – Riparian Vegetation Survival

Introduction. Riparian plant survival results presented in this section are qualitative and are based on observations made at the Squally Beach site during Year 3.

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Figure 3-9. Squally Beach herbivory avoidance fencing.

[Placeholder. Color landscape figure, 11" x 17".]

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Descriptive Analysis. The majority of the trees and shrubs at Squally Beach were surviving and appeared healthy and robust during Year 3. Trees had grown considerably since Year 2 (many were approximately 15 feet in height or higher), with red alder and willow having increased markedly, not only in height but also in cover. All willows observed on this site during Year 3 monitoring were alive and appeared healthy. The majority of alders on the site were alive and appeared healthy, although five dead young alders were observed. Other tree species observed were alive and appeared to be healthy, including black cottonwood, shore pine, and Douglas fir. Three dead young trees were no longer unidentifiable. Most of the dead trees were generally small plants interspersed in the northeastern portion of the site. Given the growth of established species, it appears that environmental conditions on the site are appropriate for the riparian species. Therefore, the dead plants may have been either shaded out by the larger trees or were unhealthy when planted.

Most of the shrubs on this site were alive, providing a dense understory. Rose was the most abundant shrub species during Year 3, with no dead plants observed. Other shrubs that appeared robust were currant, red-osier dogwood, and snowberry. Few red elderberry (*Sambucus racemosa*), vine maple, or bitter cherry (*Prunus emarginata*) plants were present. Those that were observed were alive but generally appeared stressed. The stressed plants may have been responding to seasonality or may have been unhealthy.

Success Criterion Evaluation. No baseline information is available to allow an accurate determination of survival rate of the initial plantings; therefore, it cannot be quantitatively determined whether the goal of 75 percent survival is being met. However, based on qualitative observations, it appears that at least 75 percent of the native trees and shrubs observed at the Squally Beach site were during Year 3 and that many of the alder, willow, and rose plants observed in Year 1 are thriving.

3.2.6 Biological Success Criterion 6 – Riparian Vegetation/Areal Coverage

Introduction. Figure 3-7 shows the vegetation polygons mapped in the riparian area at Squally Beach during Year 3. The areal extent and percent cover of riparian vegetation mapped in polygons at Squally Beach were compared between Years 1 and 3. Table A-17e provides the

overall riparian area and vegetation cover at Squally Beach in Year 3, as well as the total riparian area vegetated in Year 1.

Data on the percent cover of herb, tree, and shrub layers and of NNI vegetation were collected from quadrats located along a transect through on-site riparian habitat at Squally Beach (transect location is shown on Figure 3-7). Table A-26 shows the percent cover data collected from each of the 10 riparian quadrats sampled during Year 3. Table A-26 also shows the corresponding quadrat numbers from Year 1.

The herb, shrub, tree, and NNI species found along the riparian transect at Squally Beach and their percent cover are shown in Table A-25 (Year 1) and Table A-27 (Year 3). Percent cover data for Year 3 were compared to the minimum cover criterion for each vegetation layer under BSC 6 (70 percent for herbs, 30 percent for shrubs, 25 percent for trees, and less than 2 percent for NNI species). Percent cover is discussed here in terms of the unbiased average quadrat canopy percentage and the 90CI (see Section 2.2.2). The unbiased average percent cover for riparian vegetation and the 90CIs are shown on Figure 3-10.

Comparison of Areal Extent between Years. Based on polygon mapping, riparian vegetation at Squally Beach covered approximately 0.20 acre during Year 1, compared to approximately 0.37 acre during Year 3 (Table A-17e). This is an increase of 0.17 acre, or approximately 91 percent, of riparian vegetation over this timeframe.

Quadrat Vegetation Cover. During Year 1, species planted at the Squally Beach site were still small and provided limited coverage. All three of the vegetation layers increased in cover by Year 3, with the growth of both planted native species and NNI species over this timeframe.

Figure 3-10. Confidence intervals for Squally Beach riparian vegetation cover, by cover type

[Placeholder. B&W landscape figure, 8.5" x 11".]

The unbiased average percent cover of the tree layer in the riparian quadrats at Squally Beach increased between Year 1 and Year 3 (Tables A-25 and A-27). The tree layer increased from an unbiased average of 2.7 percent in Year 1 (90CI of 0.9 to 4.4 percent) to an unbiased average of 101.9 percent in Year 3 (90CI of 37.8 to 165.9 percent). The unbiased average percent cover of the herb and shrub layers at Squally Beach also increased between Years 1 and 3. The herb layer increased from an unbiased average percent cover of 38.7 percent in Year 1 (90CI of 22.2 to 55.1 percent) to an unbiased average of 105.6 percent in Year 3 (90CI of 39.5 to 171.8 percent). The shrub layer increased from an unbiased average percent cover of 3.2 percent in Year 1 (90CI of 0.9 to 5.4 percent) to an unbiased average of 65.4 percent in Year 3 (90CI of 0.0 to 148.5 percent).

The percent cover of all native riparian vegetation (herbs, shrubs, and trees combined) in the quadrats at Squally Beach increased from an unbiased average of 13.5 percent in Year 1 (90CI of 3.0 to 23.9 percent) to an unbiased average of 117.9 percent in Year 3 (90CI of 77.7 to 158.2 percent). Native riparian species that contributed to the increase in native cover included rose, red-osier dogwood, willow, and red alder (Tables A-25 and A-27).

The percent cover of all NNI species in the quadrats at Squally Beach increased from an unbiased average of 38.1 percent in Year 1 (90CI of 21.8 to 54.5 percent) to an unbiased average of 102.1 percent in Year 3 (90CI of 75.4 to 128.8 percent). Herbaceous vegetation made up much of the NNI coverage along the transect during both years. The frequency and percent cover of Himalayan blackberry have also increased along the transect between Years 1 and 3.

Success Criterion Evaluation. The area of riparian vegetation within mapped polygons at Squally Beach increased by approximately 0.17 acre between Years 1 and 3. Therefore, the extent of riparian vegetation is increasing over time, although a portion of this cover is being contributed by NNI species.

During Year 3, the unbiased average cover of the herb layer along the riparian transect (105.6 percent) exceeded the success criterion of 70 percent (90CI for herbs was 39.5 to 171.8 percent). The unbiased average cover of the shrub layer along the transect (65.4 percent) exceeded the success criterion of 30 percent for Year 3 (90CI for shrubs was 0.0 to 148.5 percent). The unbiased average cover in the tree layer along the riparian transect at Squally Beach

substantially exceeded the success criterion of 25 percent (unbiased average tree cover was 101.9 percent with a 90CI of 37.8 to 165.9 percent). Based on the unbiased average percent cover, all three vegetation layers met BSC 6 for Year 3. Note that there is wide variability in the cover data, as indicated by the 90CIs.

The riparian transect did not meet the criterion of having less than 2 percent cover of NNI species during Year 3 (unbiased average cover of non-natives was 102.1 percent with a 90CI of 75.4 to 128.8 percent).

3.2.7 Biological Success Criterion 8 – Invertebrate Prey Resource Production

Introduction. Invertebrate samples for the Squally Beach site were collected on September 24, 2004. Samples were collected from fallout traps and substrate samples.

Fallout Samples. The results of the fallout trap sampling are shown in Table A-28a. During the September sampling, seven different orders of invertebrates were observed within the traps. Flies (Diptera) were found in all six traps and included four identified families. The dominant family was the shorefly (Diptera Ephydridae). Amphipoda (amphipods), Araneae (spider), Hemiptera (true bugs), Hymenoptera (wasp), and Opiliones (daddy longlegs) were also identified, along with an unknown order.

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

- Amphipoda: 130 individuals/m^2;
- Araneae: four individuals/m^2;
- Diptera: 459 individuals/m^2;
- Hemiptera: 30 individuals/m^2;
- Hymenoptera: 48 individuals/m^2;
- Opiliones: four individuals/m^2; and
- Unknown: seven individuals/m^2.

Samples collected for Year 1 (2002) and Year 3 (2004) occurred in different numbers and were collected at different times of the year. The Year 3 samples were collected in September (one visit), while samples for Year 1 were collected in July and August (one visit each). Seven invertebrate orders were identified in fallout traps during Year 3 monitoring, compared to eight orders observed during the July site visit and six orders observed during the August site visit in Year 1. Eleven invertebrate families were identified in fallout traps during Year 3 monitoring, compared to 21 families observed during the July site visit and 16 families observed during the August site visit in Year 1. The orders observed in Year 1 but not in Year 3 included Coleoptera, Homoptera, Lepidoptera, and Orthoptera.

Substrate Samples. The results of the substrate sampling are shown in Table A-28b. Although substrate samples were collected at a lower elevation during Year 3 than in Year 1, no invertebrate species were observed at this site during Year 3 monitoring.

Taxa Analysis. It is likely that juvenile salmonids will feed on whatever invertebrates are found within the water column. Of the seven orders observed at the Squally Beach site during Year 3, the two most likely to be consumed by juvenile salmonids are Amphipoda and the family Saldidae in the order Hemiptera. These invertebrates can be found in the water column at some point in their lives. The other orders observed at the site spend most of their lives on land, although they may be consumed if they happen to fall into the water.

Comparison Between Years. Invertebrate samples collected in September of Year 3 were compared to invertebrate samples collected in August of Year 1, since these dates were closest to each other. During Year 3 and Year 1, both orders likely to be consumed by juvenile salmonids (Amphipoda and Hemiptera Saldidae) were collected in the fallout traps. Individual numbers of Hemiptera Saldidae decreased from approximately 86 individuals/m^2 in Year 1 to 30 individuals/m^2 in Year 3. Individual numbers of Amphipoda decreased from 462 individuals/m^2 in Year 1 to 130 individuals/m^2 in Year 3.

Success Criterion Evaluation. The success criterion for invertebrate prey resource production is measured by the production of invertebrate prey taxa known to be important to juvenile salmonids. Based on the data collected during Year 3 monitoring, the number of orders likely

to be important to juvenile salmonids has remained the same, while the number of individuals within these orders has decreased. Therefore the Squally Beach site does not appear to be meeting BSC 8. This may be due in part to the fact that Year 3 samples were collected later in the year than were Year 1 samples.

3.2.8 Biological Success Criterion 9 – Bird Use

Introduction. A total of 51 bird species were recorded at the Squally Beach site in Year 3 (Table A-29). Twenty-seven species were recorded in Year 1 and 38 in Year 3. (Note: the number of field surveys increased from seven in Year 1, to 10 in Year 2, and 12 in Year 3.) The number of species observed between January and November 2004 during a single monitoring event ranged from a low of eight in August to a high of 15 in April (Table A-30). The average number of species observed per visit was 10.8 in Year 3, slightly up from 10.6 in Year 1 and slightly down from 11.1 in Year 2.

Descriptive Analysis. The number of species observed in the riparian habitat was greatest in June and September (five species) and least in late April (zero). In total, 18 species were observed in the riparian habitat. As at other sites, and in other years, the noise from surrounding land uses forced staff to rely primarily on visual observations. Because bird species are often identified by sound, it is therefore likely that additional individuals or species may have been present in the riparian habitat but went unobserved. Noise levels are likely to be relatively similar from year to year, however, providing consistency in monitoring.

Use of marsh and intertidal habitat was greatest (three species) in April and May. No species were recorded in intertidal and marsh habitats in January, June, August, September, and November.

The open-water habitats in and around the restoration site were used by 16 species of waterfowl: American widgeon; Barrow's goldeneye (*Bucephala islandica*); bufflehead; Canada goose; common goldeneye; common merganser *(Mergus merganser)*; double-crested cormorant; gadwall; green-winged teal; horned grebe (*Podiceps auritus*); mallard; northern pintail *(Anas acuta)*; pied-billed grebe (*Podillymbus podiceps*); red-breasted merganser *(Mergus serrator)*; ruddy

duck (*Oxyura jamaicensis*); and surf scoter (*Melanitta perspicillata*). Other species using open-water habitat included glaucous-winged gull *(Larus glaucescens)*, Caspian tern *(Sterna caspia)*, great-blue heron, and belted kingfisher. Numbers ranged from seven species in March to zero in June, with 3.2 species as the average.

Song sparrow was the single species recorded on every field visit; glaucous-winged gull was observed on 10 of 12 visits; and mallard was observed on nine of 12 visits. The species recorded in the greatest numbers on any one field visit was American widgeon, with approximately 125 and 64 individuals present in two visits in September 2004. Large numbers of American widgeon were also recorded in April (22) and November (75). Other species present in large numbers included Canada goose (up to 40 individuals) and western sandpiper (50 individuals in April).

Great-blue heron was present on six of 12 site visits. Other wading birds included western sandpiper, spotted sandpiper, and killdeer.

Three raptor species were recorded at the Squally Beach site: red-tailed hawk, peregrine falcon *(Falco peregrinus)*, and bald eagle *(Haliaeetus leucocephalus)*.

Ten of the bird species observed — black-capped chickadee *(Poecile atricapilla)*, Canada goose, mallard, purple martin, red-winged blackbird *(Agelaius phoeniceus)*, song sparrow, spotted sandpiper, Steller's jay (*Cyanocitta stelleri*), tree swallow, and Wilson's warbler (*Wilsonia pursilla*) — displayed obvious signs of breeding or territorial behavior such as singing, fighting or pursuit, gathering of nesting material, "broken-wing" behavior, or the presence of young. Four species were recorded in Year 2 displaying such signs, and five species were recorded in Year 1. Belted kingfisher likely nested off of the restoration site, but defended it territorially.

Species recorded as using the Squally Beach restoration site only in spring included common merganser, horned grebe, killdeer, northern pintail, orange-crowned warbler *(Vermivora celata)*, peregrine falcon, and white-crowned sparrow. Bald eagle was the single species observed only in winter. Anna's hummingbird *(Calypte anna)*, pied-billed grebe, red-tailed hawk, surf scoter,

and western gull *(Larus occidentalis)* were observed only in fall. The total number of species counted in spring was higher in Year 3 (33) than in Year 2 (22) or Year 1 (9).

Success Criterion Evaluation. BSC 9 is being met at Squally Beach based on the presence of numerous birds in a variety of species, although there is no reference site against which a definitive comparison can be made. Overall, the number of species using the restoration site in Year 3 (51) was higher than in Years 1 and 2 (27 and 38, respectively), although more site visits occurred this year than in the past, so a comparable analysis is not possible.

3.3 Middle Waterway (Simpson/Trustees)

Information collected at the Middle Waterway (Simpson/Trustees) site included vegetation (marsh and riparian), fish, invertebrate, and avian data. Ridolfi performed the surveying and fish monitoring; Adolfson collected the vegetation, invertebrate, and avian data. The data are discussed below in terms of the success criteria applicable to the Middle Waterway (Simpson/Trustees) site for Year 3 monitoring.

3.3.1 Biological Success Criterion 1 – Marsh Development/Areal Coverage

Introduction. Figure 3-11 shows the vegetation polygons mapped in the marsh area at Middle Waterway (Simpson/Trustees) during Year 3. The areal extent and percent cover of marsh vegetation were compared between Years 1 and 3. Tables A-31a though A-31d provide the overall marsh area and vegetation cover of polygons at Middle Waterway (Simpson/Trustees) in Year 3, as well as the total marsh area vegetated in Year 1.

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Figure 3-11. Middle Waterway (Simpson/Trustees) marsh and riparian vegetation coverage.

[Placeholder. Color landscape figure, 11″ x 17″.]

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Thirty-three quadrats were sampled along two marsh transects at the site, designated as Transects 1-1 and 1-2 (Figure 3-11). The location of each quadrat along each transect is shown in Table A-32. The native and non-native marsh species found along the marsh transects at Middle Waterway (Simpson/Trustees) and their percent cover are shown in Table A-33 (Year 1) and Tables A-35a and A-35b (Year 3). Tables A-34a and A-34b show the percent cover data collected during Year 3. The percent cover data for Year 3 and previous monitoring years were compared to assess changes in the coverage of marsh vegetation over time. Percent cover is discussed here in terms of the unbiased average quadrat canopy cover and the corresponding 90CI on the estimate (see Section 2.2.2 for discussion of these terms).

Marsh Vegetation Mapping. Based on polygon mapping, the vegetated marsh area at Middle Waterway (Simpson/Trustees) during Year 1 was approximately 0.11 acre, compared to approximately 0.37 acre in Year 3 (Table A-31 series). This is an increase of 0.26 acre, or approximately 250 percent, in the areal extent of marsh vegetation over the timeframe. It appears that new patches of marsh vegetation have become established and that existing patches have increased in areal extent along the length of the site. This increase occurred even though a portion of the marsh extending southwest from approximately polygon MA along the edge of riparian polygon RC (Figure 3-11) was cleared of vegetation during remediation activities.

Percent Cover Along Transects (Comparison Between Years). During Year 1, the unbiased average percent cover along Middle Waterway (Simpson/Trustees) Transect 1-1 was 24.2 percent (90CI of 6.6 to 41.7 percent) (Table A-33). During Year 3, the unbiased average percent cover along this transect increased to 49.1 percent (90CI of 18.8 to 79.4 percent) (Table A-35a). The increase is not consistent along the transect, however, and the median total percent cover is not significantly changed (Table A-36).

Transect 1-2 was first established at the Middle Waterway (Simpson/Trustees) site during Year 3. The unbiased average percent cover along Transect 1-2 was 26.1 percent (90CI of 0.0 to 84.9 percent) (Table A-35b) during Year 3.

Success Criterion Evaluation. BSC 1 requires a stable or increasing areal extent of marsh vegetation. Based on polygon mapping, the area of marsh vegetation increased between Years 1 and 3 at the Middle Waterway (Simpson/Trustees) site. In addition, the unbiased average percent cover of marsh vegetation increased along Transect 1-1 between Years 1 and 3, although this change was not statistically significant. Therefore, BSC 1 has been met at Middle Waterway (Simpson/Trustees) during Year 3.

3.3.2 Biological Success Criterion 2 – Marsh Development/Species Composition

3.3.2.1 Transect 1-1

Descriptive Analysis. Of the 26 marsh quadrats sampled along Middle Waterway (Simpson/Trustees) Transect 1-1, 20 contained vegetation in Year 3. Six species were observed along this transect, all of them native. The most prevalent native plant species was pickleweed, which occurred within 18 of the 25 quadrats (Table A-35a).

The unbiased average percent cover data for all six species identified along Transect 1-1 are presented in Table A-35a. The species with the highest unbiased average percent cover is seashore saltgrass (46.5 percent with a 90CI of 0.0 to 121.2 percent) , a native species. The variability in the confidence interval reflects the variability in the data.

The unbiased average percent cover for native species is 49.1 percent (90CI of 18.8 and 79.4 percent), as shown in Table A-35a and on Figure 3-12. There were no NNI species along this transect.

The average percent cover values for individual species, based only on those quadrats where the species were found, are presented in Table A-35a. Based on these data, the species with the highest percent cover is seashore saltgrass (66.4 percent). This percent cover is substantially higher than that of any other species occurring along this transect. Some relatively large patches of seashore saltgrass occur on this site, as represented in these results.

Figure 3-12. Confidence intervals for Middle Waterway (Simpson/Trustees) marsh vegetation cover, by transect.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Of the 26 quadrats along Transect 1-1 at the Middle Waterway (Simpson/Trustees) site, nine were entirely within herbivory avoidance fencing and 17 were entirely outside of the fencing. Table A-34a shows that plant species had similar percent cover both inside and outside of the herbivory exclusion fencing, except for seashore saltgrass, which showed a considerably higher percent cover within the fenced areas.

Comparison Between Years. A total of five native plant species were observed during Year 1, with a total average cover of 24.2 percent (Table A-33). During Year 3, six native species were observed, with a total average cover of 49.1 percent. Because of decreases in the first seven quadrats, there was no significant change in the median native cover along the transect (Table A-36). Therefore, although the number of native plants species increased along Transect 1-1 from Year 1 to Year 3, the median percent cover did not significantly increase. During both Year 1 and Year 3, no non-native plant species were observed along Transect 1-1.

3.3.2.2 Transect 1-2

Descriptive Analysis. Of the seven marsh quadrats sampled along Middle Waterway (Simpson/Trustees) Transect 1-2, four contained vegetation during Year 3. Of the three species observed along this transect, all are considered native plants. The most prevalent native species was pickleweed, which occurred within four of seven quadrats (Table A-35a).

The unbiased average percent cover values for the three species identified along the transect are presented in Table A-35b. The species with the highest unbiased average percent cover was Canadian sandspurry (30.7 percent, with a 90CI of 0.0 to 135.1 percent), a native species.

The average unbiased cover for native species is 26.1 percent (90CI 0.0 to 84.9 percent), as shown in Table A-35b and on Figure 3-12. No NNI species occurred along this transect.

The average percent cover data for individual species, based only on those quadrats where the species were found, are presented in Table A-35b. Based on these data, the species with the highest percent cover are Canadian sandspurry (30.7 percent) and fat-hen saltbush (28.0 percent).

None of the seven quadrats along this transect was located within herbivory avoidance fencing.

Comparison Between Years. Transect 1-2 was established during Year 3; therefore, no comparison between years is yet available.

3.3.2.3 Discussion

Comparison of Transects. Middle Waterway (Simpson/Trustees) Transect 1-1 shows an increase in percent cover of native species. Transect 1-1 on the Middle Waterway (Simpson/Trustees) site has stable percent cover of NNI species.

Success Criterion Evaluation. BSC 2 for marsh development and plant species composition at the Middle Waterway (Simpson/Trustees) site is measured by percent cover of native marsh plant species that remains stable or increases over time and percent cover of NNI species that is limited to less than 5 percent. Based on data collected during the Year 3 monitoring, percent cover of native species has increased along Transect 1-1 (although the difference is not statistically significant), meeting the success criterion for percent cover of native species.

Non-native cover for Transect 1-1 appears to be less than 5 percent and, therefore, meets the success criterion for non-native cover.

Transect 1-2 was first established at the Middle Waterway (Simpson/Trustees) site during Year 3 and so is not assessed for BSC 2 in Year 3.

3.3.3 Biological Success Criterion 3 – Marsh Development/Plant Vigor

Because Lyngby's sedge was not present in the quadrats along the marsh transects at the Middle Waterway (Simpson/Trustees) site during Years 1 and 3, BSC 3 cannot be evaluated.

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Figure 3-13. Middle Waterway (Simpson/Trustees) herbivory avoidance fencing.

[Placeholder. Color landscape figure, 11" x 17".]

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3.3.4 Biological Success Criterion 4 – Marsh Vegetation Herbivory Avoidance

Introduction. Some of the herbivory avoidance structures present along the south and east edges of the marsh habitat at Middle Waterway (Simpson/Trustees) were in disrepair (due to wear) by Year 3 and were no longer functional (Figure 3-13). Of the fencing structures originally installed on this site, eight were mostly intact in 2004. The structures consisted of rebar and chicken wire that surrounded the perimeter, with rope and/or cross strings across the top.

Descriptive Analysis. Overall, the eight herbivory fences that were intact and functioning in Year 3 appeared undamaged, although some cross strings were broken in areas HFE, HFG, and HFH. Vegetation appeared healthy in all of the fenced areas and was expanding outside of them in HFA and HFD. In areas where the fences were in a state of disrepair, the vegetation did not appear to have been grazed.

Success Criterion Evaluation. Vegetation remaining within the remaining intact fencing structures was generally ungrazed and healthy. Fencing on this site appears to be a barrier to geese. Therefore, BSC 4 has been met for the Middle Waterway (Simpson/Trustees) site.

3.3.5 Biological Success Criterion 5 – Riparian Vegetation Survival

Introduction. Baseline information needed to quantify riparian plant survival at Middle Waterway (Simpson/Trustees) is not available. Therefore, riparian plant survival results presented here are qualitative and are based on observations made during Year 3. Dredging and capping operations were being conducted during Year 3 monitoring, and the southwestern portion of the site was cleared to provide access for heavy equipment. These activities may have affected riparian vegetation in that area.

Descriptive Analysis. Black cottonwood is a prevalent deciduous tree on this site, and all but one of the cottonwoods observed were alive during Year 3. Other trees common to the site that generally appeared alive and healthy during Year 3 monitoring included Douglas fir, madrone (*Arbutus menziesii*), bitter cherry, and shore pine. Approximately 50 percent of the western red cedars observed were either dead or stressed. Two other small conifers that could not be identified were dead.

Rose was the most abundant shrub observed within the vegetated riparian area during Year 3; approximately half of these plants were dead. Snowberry and a blueberry species (*Vaccinium* sp.) occurred less frequently than rose, but more than half of those observed were also dead. Other shrub species were alive and appeared healthy, including Oregon grape (*Mahonia nervosa*), kinnikinnick (*Arctostaphylos uva-ursi*), currant, and strawberry (*Fragaria chiloensis*). Most of the vine maples observed were alive; however, some plants appeared stressed.

Prior to Year 1 monitoring, native plants were installed within a patch of established vegetation in the northern portion of the riparian area (roughly the area identified as polygon MA). A large black cottonwood, which may have been a seed source for this site, blew down during the past winter. Woody debris from the blowdown remains in the riparian area.

Success Criterion Evaluation. No baseline information is available to allow an accurate determination of survival rate of the initial plantings; therefore, it cannot be quantitatively determined whether the goal of 75 percent survival is being met. However, based on qualitative observations, the overall percent survival of native species in the riparian area at this site is likely to be less than 75 percent.

3.3.6 Biological Success Criterion 6 – Riparian Vegetation/Areal Coverage

Introduction. Figure 3-11 shows the vegetation polygons mapped in the riparian area at the Middle Waterway (Simpson/Trustees) site during Year 3. The areal extent and percent cover of riparian vegetation mapped in polygons were compared between Years 1 and 3. Table A-31e provides the overall riparian area and vegetation cover at Middle Waterway (Simpson/Trustees) in Year 3, as well as the total riparian area vegetated in Year 1.

Data on the percent cover of herb, tree, and shrub layers and of NNI vegetation were collected from quadrats located along a transect through on-site riparian habitat at the Middle Waterway (Simpson/Trustees) site (Figure 3-11). Table A-38 shows the percent cover data collected from the 16 riparian quadrats sampled during Year 3, as well as the corresponding quadrat numbers from Year 1. One new quadrat was added during Year 3.

The herb, shrub, tree, and NNI species found along the riparian transect at Middle Waterway (Simpson/Trustees) and their percent cover values are shown in Table A-37 (Year 1) and Table A-39 (Year 3). Percent cover data for Year 3 were compared to the minimum cover criterion for each vegetation layer under BSC 6 (70 percent for herbs, 30 percent for shrubs, 25 percent for trees, and less than 2 percent for NNI species). Percent cover is discussed here in terms of the unbiased average quadrat canopy percentage and the corresponding 90CI on this estimate (see Section 2.2.2). The unbiased average percent cover for riparian vegetation and the 90CIs are shown on Figure 3-14.

Comparison of Areal Extent Between Years. Based on polygon mapping, riparian vegetation at the Middle Waterway (Simpson/Trustees) site covered approximately 0.94 acre during Year 1. Riparian vegetation covered approximately 0.82 acre during Year 3 (Table A-31e). This decrease of 0.12 acre, or approximately 12 percent, of riparian vegetation over the timeframe may be due in part to the clearing of riparian vegetation along the edge of polygon RC (Figure 3-11) to provide access for heavy equipment. It is also possible that the limits of the project area, which have not been formally surveyed, differed slightly between years, resulting in a slightly different area of riparian vegetation covered by polygon mapping each year.

Figure 3-14. Confidence intervals for Middle Waterway (Simpson/Trustees) riparian vegetation cover, by cover type.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Quadrat Vegetation Cover. All three of the vegetation layers (herbs, shrubs, and trees) at Middle Waterway (Simpson/Trustees) increased marginally in cover by Year 3, as did the cover of non-native species (Tables A-37 and A-39). The herb layer increased from an unbiased average of 59.4 percent in Year 1 (90CI of 42.5 to 76.2 percent) to an unbiased average of 64.0 percent in Year 3 (90CI of 26.6 to 101.5 percent). The shrub layer increased from an unbiased average of 39.7 percent in Year 1 (90CI of 13.1 to 66.3 percent) to an unbiased average of 50.5 percent in Year 3 (90CI of 0.0 to 103.8 percent). The tree layer increased from an unbiased average of 27.1 percent in Year 1 (90CI of 4.3 to 49.8 percent) to an unbiased average of 30.8 percent in Year 3 (90CI of 6.2 to 55.3 percent). The percent cover of all native riparian vegetation (herbs, shrubs, and trees combined) in the quadrats at Middle Waterway (Simpson/Trustees) decreased from an unbiased average of 70.4 percent in Year 1 (90CI of 40.2 to 100.6 percent) to an unbiased average of 55.4 percent in Year 3 (90CI of 36.5 to 74.4 percent). Some native species, such as nootka rose (*Rosa nutkana*) and vine maple, increased slightly in frequency and cover along the transect over the timeframe, while others, such as strawberry and kinnikinnick, decreased along the transect. Some native shrub and tree species found in the riparian quadrats during Year 1 were not found during Year 3.

The percent cover of all NNI species in the quadrats at Middle Waterway (Simpson/Trustees) increased from an unbiased average of 51.7 percent in Year 1 (90CI of 33.4 to 70.1 percent) to an unbiased average of 69.1 percent in Year 3 (90CI of 28.6 to 109.6 percent). Herbaceous vegetation, along with Himalayan blackberry, made up much of the NNI coverage along the transect during both years. Butterfly bush (*Buddleja davidii*) increased in frequency and percent cover along the transect between Years 1 and 3.

Success Criterion Evaluation. The area of riparian vegetation within mapped polygons at the Middle Waterway (Simpson/Trustees) site decreased by approximately 0.12 acre between Years 1 and 3. Because a portion of this decrease may be due to clearing associated with site remediation activities, it is not possible to determine whether this component of BSC 6 (increasing extent of riparian vegetation) is being met at Middle Waterway (Simpson/Trustees).

The unbiased average cover of the herb layer along the transect (64.0 percent, 90CI of 26.6 to 101.5 percent) was below the success criterion of 70 percent during Year 3. The unbiased average cover of the shrub layer along the transect (50.5 percent, 90CI of 0.0 to 103.8 percent) exceeded the success criterion of 30 percent. The unbiased average cover of the tree layer along the transect (30.8 percent, 90CI of 6.2 to 55.3 percent) exceeded the success criterion of 25 percent. Based on the unbiased average percent cover, the shrub and tree layers met their success criteria for Year 3 along the riparian transect, while the herb layer did not. Note that a portion of the herb and shrub cover was being provided NNI species, and there is wide variability in the cover data, as indicated by the 90CIs.

The riparian area did not meet the criterion of less than 2 percent cover of NNI species during Year 3 (unbiased average cover of non-natives of 69.1 percent, with a 90CI of 28.6 to 109.6 percent).

3.3.7 Biological Success Criterion 7 – Fish Access/Presence

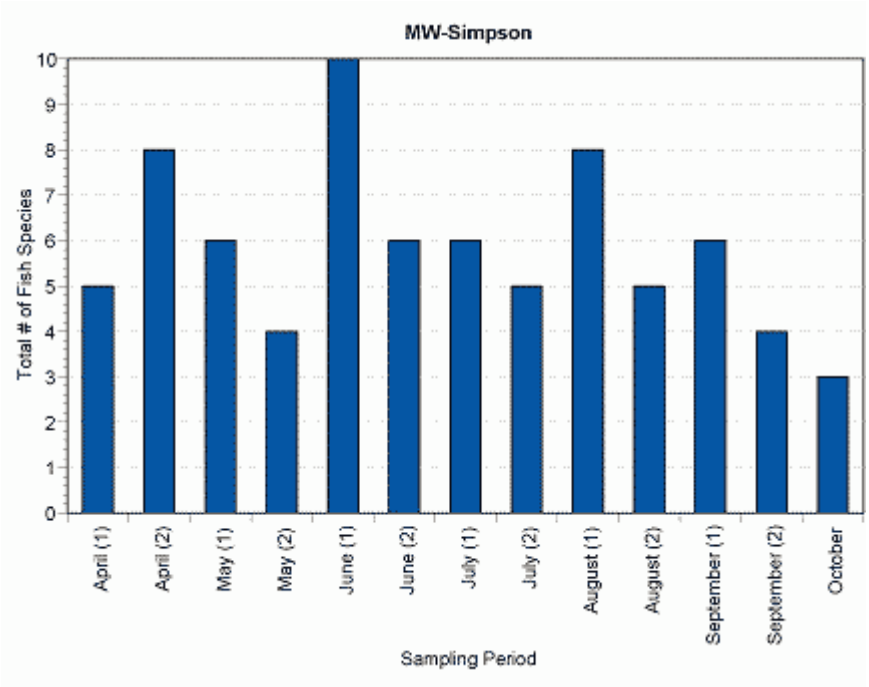
Introduction. The Middle Waterway (Simpson/Trustees) site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Table A-40. Fish sampling occurred on 17 occasions between early April and early October on an approximately biweekly basis, with only one event in October, which was the final event of the season.

The customized fishing gear built for the project functioned as intended. Sampling events scheduled for September 30 and October 15 were cancelled due to a dredging operation in the Middle Waterway, because a hanging silt curtain was deployed across the lower Middle Waterway, blocking access to the site. Over the sampling period, 45 individual beach seine net sets were completed at the Middle Waterway (Simpson/Trustees) site during 17 sampling events. Beach seine sampling was conducted as described in Section 2.7.1.2.

Descriptive Analysis. Complete catch records were kept for all sampling events, and lengths were recorded for selected species as described in Section 2.7. The SR per sampling event ranged from three to 10; 14 different species (total SR), including four salmonid species, were

caught at the site during various sampling events. The Middle Waterway (Simpson/Trustees) site ranked fifth among the sites in SR (Figure 4-1), which peaked in early June (Figure 3-15). Shiner perch were the most abundant species present, followed by Pacific staghorn sculpin and starry flounder. Peak catches occurred for these three species from early May to early August. The complete catch results are listed in Table A-41.

Figure 3-15. Total number of fish species captured at Middle Waterway (Simpson/Trustees) per sampling event in 2004.



The most abundant salmonid species was pink salmon, which reached peak abundance in early April. Coho was the second most abundant salmon species encountered at the site, with peak catches occurring in late April. The chum salmon catch peaked in mid-April, while peak catches of chinook occurred in early June (Figure 3-16). No trout were caught during any of the sampling events. Table 3-2 summarizes the CPUE for juvenile salmon caught at the Middle Waterway (Simpson/Trustees) site.

Figure 3-16. Average chinook caught per set at Middle Waterway (Simpson/Trustees) in 2004.

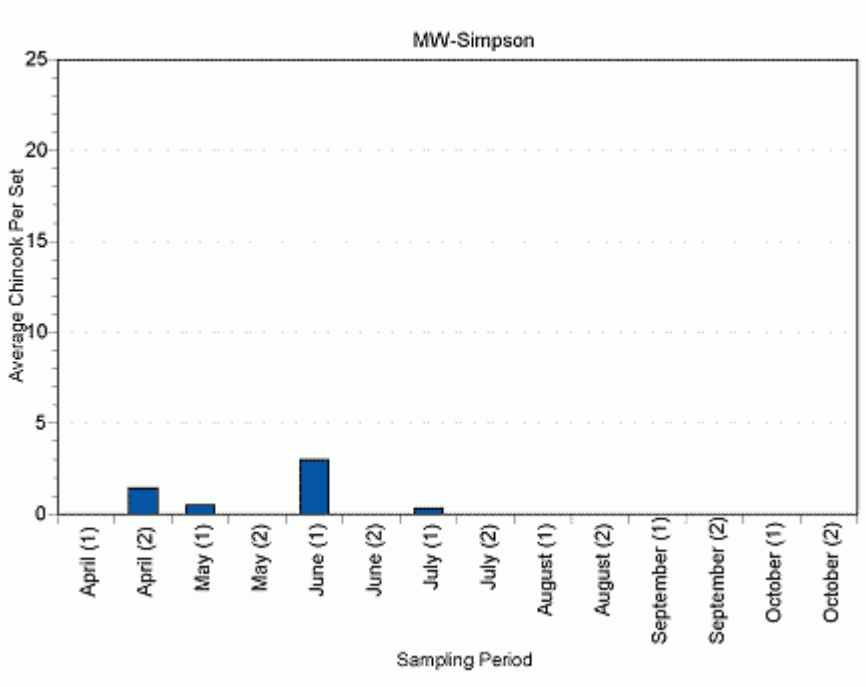


Table 3-2. Summary of total juvenile salmon caught and average numbers of salmon per set observed at the Middle Waterway (Simpson/Trustees) site for Year 3 (2004).

Species	Number of Salmon Caught	Average per Set/Catch per Unit Effort
Chinook	20	0.44
Coho	26	0.58
Chum	25	0.56
Pink	80	1.78
Total Salmon	151	3.36

Success Criterion Evaluation. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Middle Waterway (Simpson/Trustees) site.

3.3.8 Biological Success Criterion 8 – Invertebrate Prey Resource Production

Introduction. Invertebrate samples for the Middle Waterway (Simpson/Trustees) site were collected on September 23, 2004. Samples were collected from fallout traps and substrate cores.

Fallout Samples. The results of the fallout trap sampling are shown in Table A-42a. During the September sampling, five different orders of invertebrates were observed within the traps. Flies (Diptera) were found in all six traps and included seven identified families. The dominant family was the snipefly (Diptera Rhagionidae). Coleoptera (beetles), Hemiptera (true bugs), and Hymenoptera (wasp) were also identified, along with an unknown order.

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

- Coleoptera: four individuals/m^2;
- Diptera: 425 individuals/m^2;
- Hemiptera: 15 individuals/m^2;
- Hymenoptera: 107 individuals/m^2; and
- Unknown: seven individuals/m^2.

Samples collected for Year 1 and Year 3 occurred in different numbers and were collected at different times of the year. The Year 3 samples were collected in September (one visit), while samples for Year 1 were collected in July (one visit) and August (one visit). Five invertebrate orders were identified in fallout traps during Year 3 monitoring, compared to eight orders observed in fallout traps during Year 1 monitoring. Fifteen invertebrate families were identified in fallout traps during Year 3, compared to 21 invertebrate families observed during Year 1 monitoring. Although the number of orders decreased between Year 1 and Year 3, the number of families within each order were close, with the exception of Coleoptera, which had four identified families in Year 1 and one identified family in Year 3. The reduction may be due to the time of year for the Year 3 monitoring.

Substrate Samples: The results of the substrate sampling are shown in Table A-42b. During the September sampling, one order (Amphipoda) was observed in one of the six samples. In Year 1,

Amphipoda was observed within fallout traps, but not in the sediment samples. During Year 3, Amphipoda was observed in sediment samples, but not in the fallout traps.

Taxa Analysis. It is likely that juvenile salmonids will feed on whatever invertebrates are found within the water column. Of the five orders observed at the Middle Waterway (Simpson/Trustees) site during Year 3, the two most likely to be consumed by juvenile salmonids are Amphipoda (collected from the sediment) and the family Saldidae in the order Hemiptera. Each of these invertebrates can be found in the water column at some point in their lives. The other orders observed at the site spend most of their lives on land, although they may be consumed if they happen to fall into the water.

Comparison Between Years. Invertebrate samples collected in September of Year 3 were compared to invertebrate samples collected in August of Year 1, since these dates were closest to each other. During Year 3, both orders likely to be consumed by juvenile salmonids (Amphipoda and Hemiptera Saldidae) were collected, Amphipoda in substrate samples and Hemiptera Saldidae in the fallout traps; Hemiptera Saldidae was also collected in the fallout traps during Year 1. Individual numbers of Hemiptera Saldidae increased from eight individuals/m^2 in Year 1 to approximately 11 individuals/m^2 in Year 3. Individual numbers of Amphipoda increased from zero individuals in Year 1 to one individual in Year 3.

Success Criterion Evaluation. The success criterion for invertebrate prey resource production is measured by the production of invertebrate prey taxa known to be important to juvenile salmonids. Based on the data collected during the Year 3 monitoring, the number of orders and the number of individuals at the Middle Waterway (Simpson/Trustees) site increased; therefore, the Middle Waterway (Simpson/Trustees) site appears to meet BSC 8.

3.3.9 Biological Success Criterion 9 – Bird Use

Introduction. A total of 31 bird species were recorded at the Middle Waterway (Simpson/Trustees) site in Year 3 (Table A-44). Thirty species were recorded in Year 1 and 37 in Year 2. (Note: The number of field surveys increased from seven in Year 1 to 10 in Year 2 and 12 in Year 3.) The number of species observed between January and November 2004 ranged

from a low of six in January and September to a high of 12 in March and June (Table A-43). The average number of species observed per visit was 8.1 in Year 3, down from 10.4 in Year 1 and 10.7 in Year 2.

Descriptive Analysis. The number of species observed in the riparian habitat was greatest in March and April (four species) and least in August (zero species). In total, 14 species were observed in the riparian habitat. As at other sites, and in other years, the noise from surrounding land uses forced staff to rely primarily on visual observations. Because bird species are often identified by sound, it is therefore likely that additional individuals or species may have been present in the riparian habitat but went unobserved. Noise levels are likely to be relatively similar from year to year, however, providing consistency in monitoring.

Use of marsh, intertidal, and mudflat habitat was greatest (four species) in June (low tide). The fewest number of species (one) was recorded in May, June, and September.

The open-water habitats in and around the restoration site were used by various species of waterfowl, great-blue heron, and belted kingfisher. Numbers ranged from six species in March, to zero species present in open water in April, May, June, and August; on average, 1.4 species per visit were present in open-water habitat.

No single species was recorded on every field visit, although glaucous-winged gull was observed on 11 of 12 visits. The species recorded in the greatest numbers at one time was also glaucous-winged gull, with 45 present in April. Other species present in large numbers included Canada goose, crow, double-crested cormorant, and house finch.

Waterfowl species using the restoration site and nearby open-water habitat included American widgeon, Canada goose, common goldeneye, double-crested cormorant, hooded merganser, horned grebe, and mallard. Great-blue heron, a wading bird, was present on six of 12 site visits. Other wading birds included spotted sandpiper and killdeer.

No raptor species were recorded at this site in Year 3; two raptor species were observed in Year 2 and none in Year 1.

Six of the bird species observed — American goldfinch (*Carduelis tristis*), Bewick's wren (*Thryomanes bewickii*), house finch (*Carpodacus mexicanus*), Savannah sparrow (*Passerculus sandwichensis*), song sparrow, and white-crowned sparrow —displayed obvious signs of breeding or territorial behavior such as singing, fighting or pursuit, gathering of nesting material, "broken-wing" behavior, or the presence of young. Three species were recorded in Year 2 displaying such signs, and five species were recorded in Year 1.

Species recorded as using the restoration site only in spring included belted kingfisher, Bewick's wren, common goldeneye, house sparrow *(Passer domesticus)*, mallard, and spotted sandpiper. American widgeon and horned grebe were observed only in fall and winter at the restoration site. The total number of species counted in spring was higher in Year 3 (23) than in Year 2 (13) or Year 1 (21). Species totals in summer were higher in Year 3 (28) than in either Year 2 (26) or Year 1 (20). The least number of species (6) was recorded in winter during Year 3 monitoring; in previous years, no winter count was conducted.

Success Criterion Evaluation. BSC 9 is being met at the Middle Waterway (Simpson/Trustees) site based on the presence of numerous birds in a variety of species. Overall, the number of species using the restoration site (31) decreased from Year 2 (37) and increased from Year 1 (30), although more site visits occurred this year than in the past, so a comparable analysis is not possible.

3.4 Middle Waterway (City of Tacoma)

Information collected at the Middle Waterway (City of Tacoma) site was limited to fish access and presence. The fish monitoring was performed by Ridolfi.

3.4.1 Biological Success Criterion 7 – Fish Access/Presence

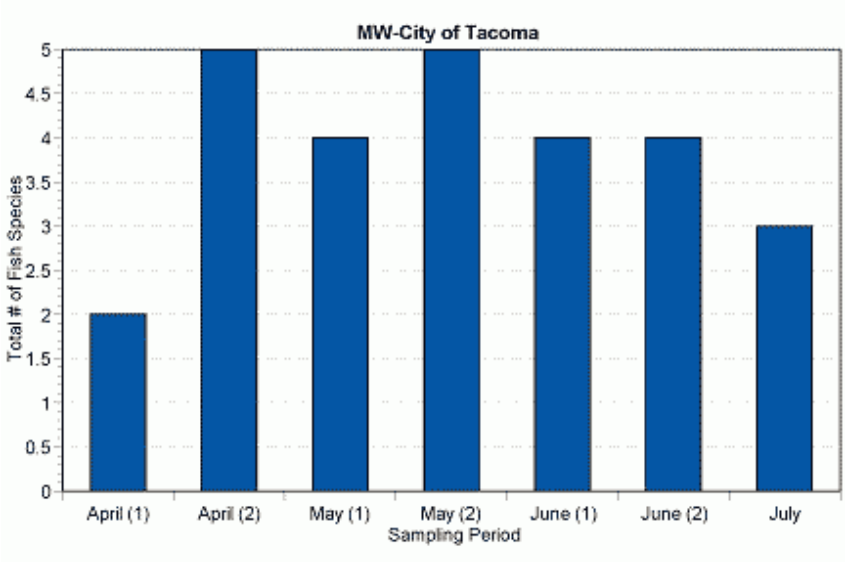
Introduction. The Middle Waterway (City of Tacoma) site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Table A-45. Fish sampling occurred on nine occasions between early April and early July on an approximately biweekly

basis, with only one event in July, which was the final event of the season. Fish sampling was not performed at the Middle Waterway (City of Tacoma) site after July 8 because of a dredging project that was being conducted at the head of the Middle Waterway.

The customized fishing gear built for the project functioned as intended. Over the four-month sampling period, 10 individual beach seine sets were completed at the Middle Waterway (City of Tacoma) site during nine sampling events. Beach seine sampling was conducted as described in Section 2.7.1.2.

Descriptive Analysis. Complete catch records were kept for all sampling events, and lengths were recorded for selected species as described in Section 2.7. Species richness per sampling event ranged from two to five. In total, nine different species (total SR) were caught at the site during the various sampling events (Figure 3-17). The Middle Waterway (City of Tacoma) site had the lowest SR of all six sites sampled for fish assemblage composition (Figure 4-1); SR peaked during late April and again in late May. Shiner perch was the most abundant species observed at the site, with the peak occurring in mid-May, although no shiner perch were caught during the April and early July sampling events. Catches for staghorn sculpin peaked in late May, and chum salmon numbers peaked in mid-April.

Figure 3-17. Total number of fish species captured at Middle Waterway (City of Tacoma) per sampling event in 2004.



Four salmonid species were encountered at the site over the course of seven of the nine sampling events, with chum salmon the most abundant. The peak catch for chum salmon occurred in mid-April. The peak catches for chinook (Figure 3-18) and coho occurred in early June and mid-April, respectively. Peak catches for pink salmon occurred in mid-April. No trout were caught at the site. Table 3-3 summarizes the CPUE for juvenile salmon caught at the Middle Waterway (City of Tacoma) site. The catch results for this site are listed in Table A-46.

Figure 3-18. Average chinook caught per set at Middle Waterway (City of Tacoma) in 2004.

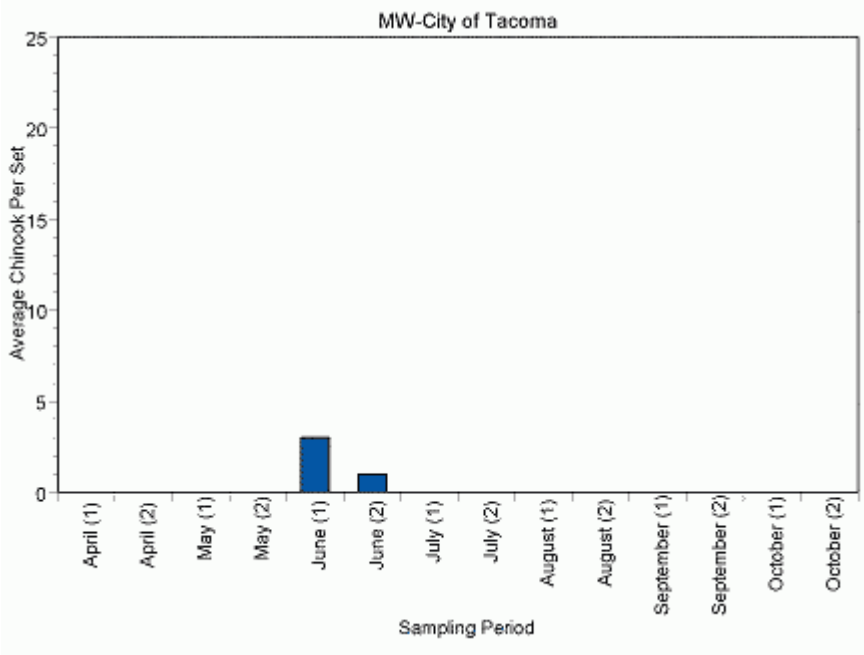


Table 3-3. Summary of total juvenile salmon caught and average numbers of salmon per set observed at the Middle Waterway (City of Tacoma) site for Year 3 (2004).

Species	Number of Salmon Caught	Average per Set/Catch per Unit Effort
Chinook	4	0.40
Coho	6	0.60
Chum	64	6.40
Pink	3	0.30
Total Salmon	77	7.7

Success Criterion Evaluation. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Middle Waterway (City of Tacoma) site.

3.5 Yowkwala

Information collected at the Yowkwala site included marsh vegetation and fish data. Adolfson collected the vegetation data, while Ridolfi personnel obtained the fish data.

3.5.1 Biological Success Criterion 1 – Marsh Development/Areal Coverage

Introduction. Figure 3-19 shows the vegetation polygons mapped in the marsh area at the Yowkwala site during Year 3. The areal extent and percent cover of marsh vegetation at the Yowkwala site were compared between Years 2 and 3. Tables A-47a and A-47b provide the overall marsh area and vegetation cover of polygons at Yowkwala in Year 3 as well as the total marsh area vegetated in Year 2. No marsh transects have been monitored at this site.

Marsh Vegetation Mapping. Based on polygon mapping, the vegetated marsh area at Yowkwala during Year 2 was approximately 0.02 acre, compared to approximately 0.14 acre during Year 3 (Tables A-47a and A-47b). This is an increase of 0.12 acre, or approximately 475 percent, in the areal extent of marsh vegetation over the timeframe. It appears that new patches of marsh vegetation have become established and that existing patches have increased in areal extent.

Comparison of Sites. All four sites monitored for BSC 1 (Mowitch, Squally Beach, Middle Waterway [Simpson/Trustees], and Yowkwala) showed an increase in the area of marsh vegetation since Year 1 or Year 2, based on Year 3 polygon mapping. Mowitch had the greatest areal increase in marsh vegetation (0.29 acre increase since Year 1), followed by Middle Waterway (Simpson/Trustees) (0.26 acre increase since Year 1), Squally Beach (0.14 acre increase since Year 1), and Yowkwala (0.12 acre increase since Year 2).

Success Criterion Evaluation. BSC 1 requires a stable or increasing areal extent of marsh vegetation. Based on polygon mapping alone, the area of marsh vegetation has increased between Years 2 and 3 at the Yowkwala site. Therefore, it appears that BSC 1 has been met at Yowkwala during Year 3.

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Figure 3-19. Yowkwala marsh vegetation coverage.

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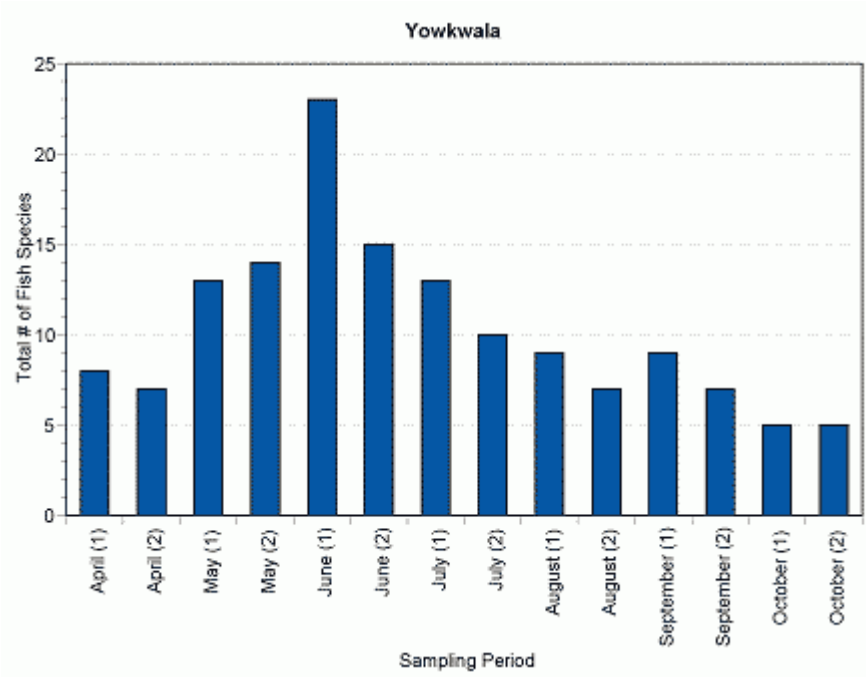
3.5.2 Biological Success Criterion 7 – Fish Access/Presence

Introduction. The Yowkwala site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Table A-48. Fish sampling occurred on 28 occasions between early April and mid-October, which was the final event of the season, on an approximately biweekly basis (approximately weekly in June).

The customized fishing gear built for the project functioned as intended. Over the seven-month sampling period, 81 individual net sets were completed at the Yowkwala site during a total of 28 sampling events. Beach seine sampling was conducted as described in Section 2.7.1.2.

Descriptive Analysis. Complete catch records were kept for all sampling events, and lengths were recorded for selected species as described in Section 2.7. The SR per sampling event ranged from five to 23. In total, 29 different species (total SR) were caught at the site during the various sampling events. The Yowkwala site had the highest SR of any of the sites (Figure 4-1), and the number of different species observed at the site peaked in early June (Figure 3-20). Shiner perch were the most abundant species observed at the Yowkwala site, followed by herring, and coho. The catch results for Yowkwala are listed in Table A-49.

Figure 3-20. Total number of fish species captured at Yowkwala per sampling event in 2004.



Seven salmonid species were observed, including steelhead, cutthroat trout, and bull trout/Dolly Varden. The peak salmonid catch occurred from late April to early May. Salmonid species were caught at the site throughout the seven-month sampling period. Coho were the most abundant salmonid species, peaking in mid-May. The chinook catch peaked in late May (Figure 3-21). Peak numbers for pink salmon occurred in late April, while peak numbers for chum salmon occurred in late May. Thirty-one cutthroat trout were sampled at the site, with peak numbers occurring in early May. Seven steelhead trout were caught, with peaks occurring in early July. One bull trout/Dolly Varden was caught at the site in early July. Table 3-4 summarizes the CPUE for juvenile salmon caught at the Yowkwala site.

Figure 3-21. Average chinook caught per set at Yowkwala in 2004.

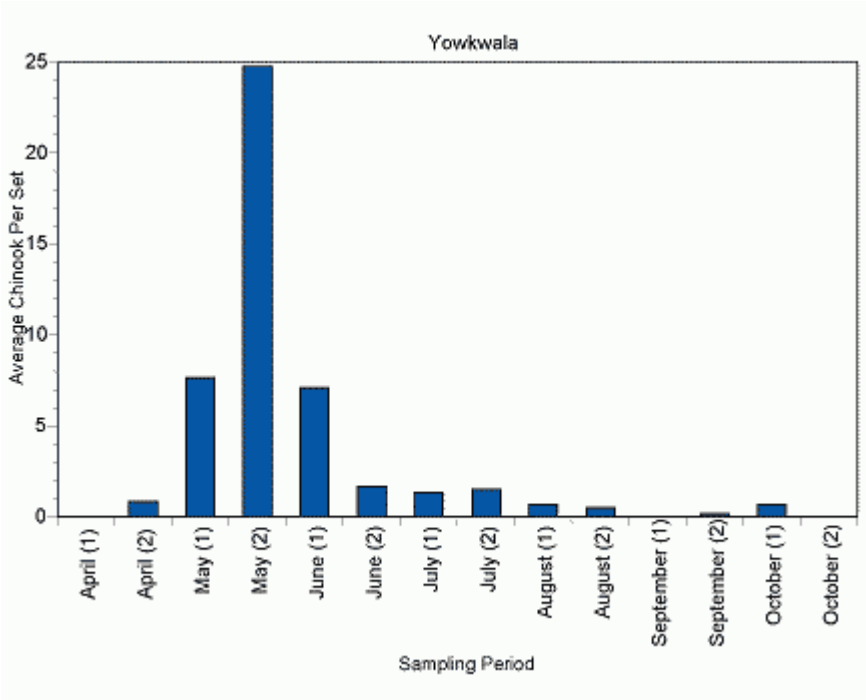


Table 3-4. Summary of total juvenile salmon caught and average numbers of salmon per set observed at the Yowkwala site for Year 3 (2004).

Species	Number of Salmon Caught	Average per Set/Catch per Unit Effort
Chinook	406	5.01
Coho	836	10.32
Chum	242	2.99
Pink	291	3.59
Total Salmon	1,775	21.91

Although only juvenile salmon were counted, it is of interest to note that approximately 10 adult chinook and coho salmon were caught at the site from August through September. The adults were using the site as a "staging area," an area in which adult salmon congregate before returning to their freshwater spawning grounds. Adult salmon hold in nearshore estuarine waters close to the mouth of their natal stream. Once water conditions such as depth, temperature, and flow are optimal in the natal stream, the salmon enter the river and return to their spawning grounds.

Success Criterion Evaluation. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Yowkwala site.

3.6 Skookum Wulge

Information collected at the Skookum Wulge site was limited to fish access and presence. The fish monitoring was performed by Ridolfi.

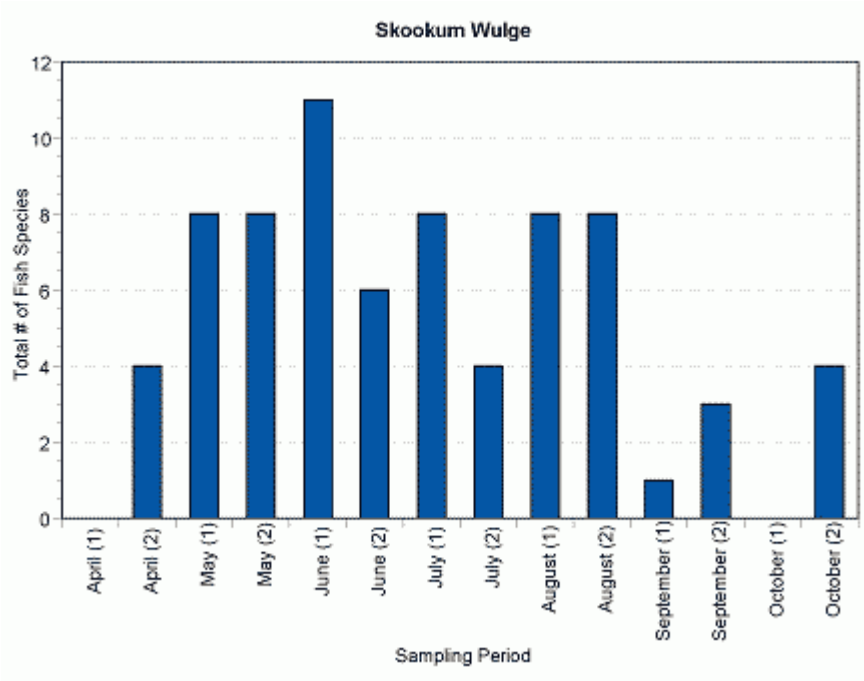
3.6.1 Biological Success Criterion 7 – Fish Access/Presence

Introduction. The Skookum Wulge site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in Table A-50. Fish sampling occurred on 25 occasions between early April and mid-October, the final event of the season, on an approximately weekly or biweekly basis except in July, when two events occurred within two days.

The customized fishing gear built for the project functioned as intended. Over the seven-month sampling period, 25 individual net sets were completed at the Skookum Wulge site during a total of 25 sampling events. Beach seine sampling was conducted as described in Section 2.7.1.2.

Descriptive Analysis. Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The SR per sampling event ranged from one to 11. In total, 20 different species (total SR) were caught at the site during the various sampling events. Species richness was fairly constant, with peak numbers of species observed in early June (Figure 3-22). The Skookum Wulge site had the third-highest SR of any of the sites (Figure 4-1). Herring and shiner perch were the most abundant species, with peak catches in early July and mid-June, followed by chinook salmon that peaked in early June (Figure 3-23). The catch results for the Skookum Wulge site are listed in Table A-51.

Figure 3-22. Total number of fish species captured at Skookum Wulge per sampling event in 2004.



Five salmonid species were present at the site, including cutthroat trout. Salmonids were encountered during most sampling events except the last two (early to mid-October). Chinook was the most abundant salmon species observed, with the peak catch occurring in early June (Figure 3-23). Peak catches of coho, chum, and pink salmon occurred in early June as well. Two cutthroat trout were caught at the site in late April and late May. Table 3-5 summarizes the CPUE for juvenile salmon caught at the Skookum Wulge site.

Figure 3-23. Average chinook caught per set at Skookum Wulge in 2004.

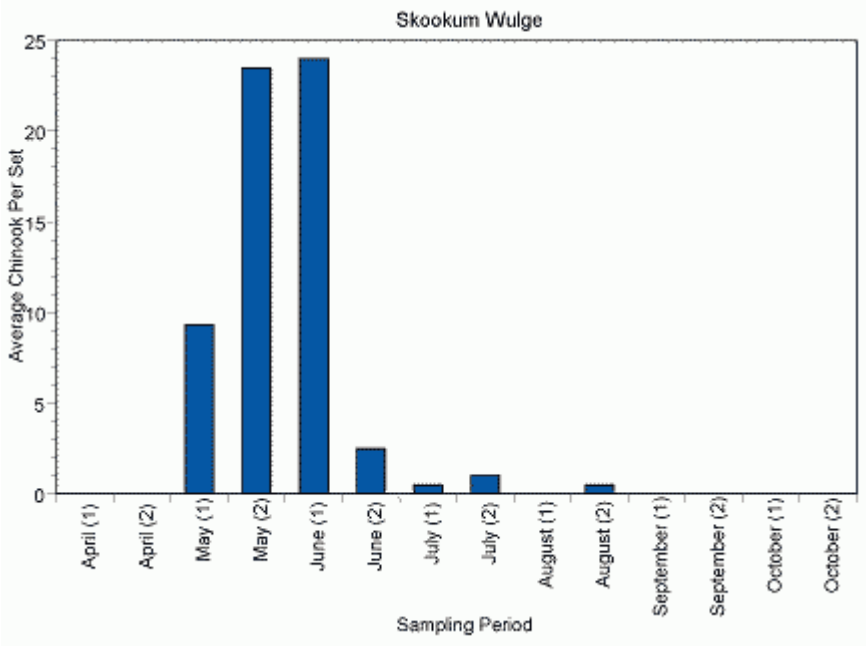


Table 3-5. Summary of total juvenile salmon caught and average numbers of salmon per set observed at the Skookum Wulge site for Year 3 (2004).

Species	Number of Salmon Caught	Average per Set/Catch per Unit Effort
Chinook	155	6.20
Coho	125	5.00
Chum	12	0.48
Pink	58	2.32
Total Salmon	350	14.00

Success Criterion Evaluation. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Skookum Wulge site.

3.7 Olympic View

Information collected at the Olympic View site was limited to fish access and presence. The fish monitoring was performed by Ridolfi.

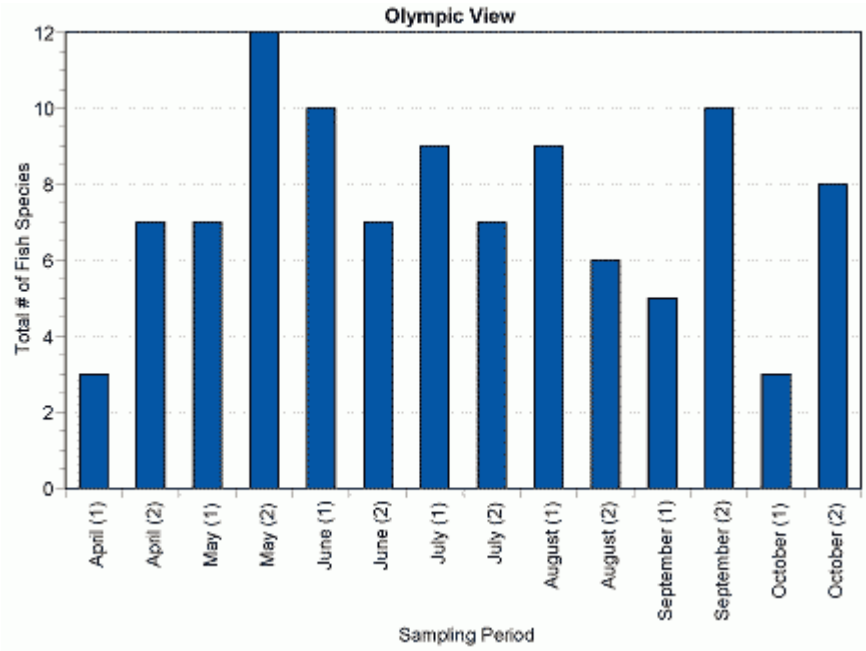
3.7.1 Biological Success Criterion 7 – Fish Access/Presence

Introduction. The Olympic View site was successfully sampled for fish assemblage composition. Sampling details such as date, time, temperature, weather conditions, and results for field parameter measurements are summarized in TableA-52. Fish sampling occurred on 20 occasions between early April and mid-October, the final event of the season, on an approximately biweekly basis (weekly in June).

The customized fishing gear built for the project functioned as intended. Over the seven-month sampling period, 60 individual net sets were completed at the Olympic View site during a total of 20 sampling events. Beach seine sampling was conducted as described in Section 2.7.1.1.

Descriptive Analysis. Complete catch records were kept for all sampling events, and lengths were recorded for selected species. The Olympic View site had the second-highest SR of any of the sites (Figure 4-1). The SR per sampling event ranged from three to 12. In total, 24 different species (total SR), including four salmonid species, were caught at the Olympic View site during the various sampling events. The peak number of species observed occurred in late May (Figure 3-24). Pink salmon were the most abundant species encountered at the site with peak catches in mid-April, followed by herring catches, which peaked in mid-August, and shiner perch, which peaked during early June. The catch results for the Olympic View site are listed in Table A-53.

Figure 3-24. Total number of fish species captured at Olympic View per sampling event in 2004.



The most abundant salmonid species at the Olympic View site was pink, with peak catches occurring during the mid-April sampling event. The chinook salmon catch peaked in early June (Figure 3-25). Chum salmon were present at the site, with peak catches in mid-April. Coho were encountered at the site from late May through late September. Steelhead and cutthroat trout were not observed during any of the sampling events. Table 3-6 summarizes the total catch and average per set for juvenile salmon caught at the Olympic View site.

Figure 3-25. Average chinook caught per set at Olympic View in 2004.

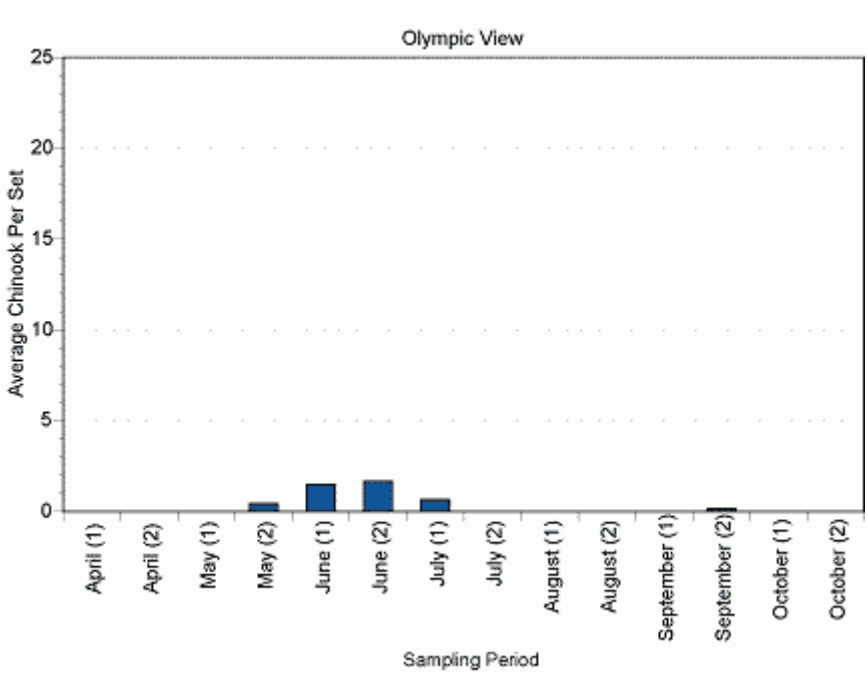


Table 3-6. Summary of total juvenile salmon caught and average numbers of salmon per set observed at the Olympic View site for Year 3 (2004).

Species	Number of Salmon Caught	Average per Set/Catch per Unit Effort
Chinook	26	0.43
Coho	10	0.17
Chum	49	0.82
Pink	1,816	30.27
Total Salmon	1,901	31.69

Success Criterion Evaluation. Based on the presence of salmonid and non-salmonid fish, BSC 7 is being met at the Olympic View site.

4.0 DISCUSSION OF MONITORING TO DATE AND COMPARISON OF SITES

4.1 Marsh Development: BSC 1, 2, 3, and 4

4.1.1 Areal Coverage: BSC 1

All four sites monitored for BSC 1 (Mowitch, Squally Beach, Middle Waterway [Simpson/Trustees], and Yowkwala) showed an increase in the area of marsh vegetation since Year 1 or Year 2, based on Year 3 polygon mapping. Mowitch had the greatest areal increase in marsh vegetation (0.29 acre increase since Year 1), followed by Middle Waterway (Simpson/Trustees) (0.26 acre increase since Year 1), Squally Beach (0.14 acre increase since Year 1), and Yowkwala (0.12 acre increase since Year 2).

Table 4-1. Commencement Bay marsh areal change at all monitored sites.

Site	Year of Origin	Marsh Area (acres)		Change	
		Year of Origin	Year 3	(acres)	(percent) [1]
Mowitch	Year 1	0.08	0.37	+0.29	+375%
Squally Beach	Year 1	0.06	0.20	+0.14	+220%
Middle Waterway (Simpson/Trustees)	Year 1	0.11	0.37	+0.26	+250%
Yowkwala	Year 2	0.02	0.14	+0.12	+475%

Note:
[1] Percent change calculated from unrounded areas.

4.1.2 Species Composition: BSC 2

Both Mowitch marsh transects show an increase in native vegetation, along with all three Squally Beach marsh transects and the Middle Waterway (Simpson/Trustees) marsh transect (Transect 1-1). Unlike at Squally Beach and Middle Waterway (Simpson/Trustees), however, both of the Mowitch transects have greater than 15 percent cover of NNI species.

4.1.3 Plant Vigor: BSC 3

In general, it appears that the plant vigor of Lyngby's sedge along the Squally Beach transects was greater than along the Mowitch transects during Year 3. Lyngby's sedge was found in 33 percent of the quadrats along Squally Beach Transect 1-2 (five of 15 quadrats), compared to 4 percent of the quadrats along each of the two Mowitch transects (two of 46 and one of 23 quadrats, respectively). The average stem heights and shoot densities were similar among the Squally Beach and Mowitch transects (somewhat lower along Mowitch Transect 1-2). However, the maximum stem heights measured in quadrats at Squally Beach (37 in.) were higher than the maximum at Mowitch (28 in.) (Tables A-7a and A-23a). The maximum shoot density in quadrats at Squally Beach (140) was also dramatically higher than the maximum shoot density in quadrats at Mowitch (79) (Tables A-7b and A-23b). This may reflect the presence of the pre-existing seed source for Lyngby's sedge at Squally Beach.

4.1.4 Herbivory Avoidance: BSC 4

Although some areas of fencing at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites showed signs of wear and some vegetation showed possible signs of grazing, most fencing was intact and the vast majority of vegetation appeared healthy with little evidence of grazing. Fencing on this site appears to be a barrier to geese.

4.2 Riparian Development: BSC 5 and 6

4.2.1 Vegetation Survival: BSC 5

Squally Beach showed the greatest plant vigor relative to the Middle Waterway (Simpson/Trustees) and Mowitch sites during Year 3 monitoring, as evidenced by the increase in tree height and shrub cover. Fewer dead plants were observed at Squally Beach than at Mowitch and Middle Waterway (Simpson/Trustees). Red alder, willow, and rose were generally alive, abundant, and healthy at both the Mowitch and Squally Beach sites during Year 3. Willow and red alder are not as common at the Middle Waterway (Simpson/Trustees) site. Rose had a higher mortality at the Middle Waterway (Simpson/Trustees) site than at the Mowitch and Squally Beach sites. At both the Middle Waterway (Simpson/Trustees) site and

the Mowitch site, western red cedar was the species with the greatest observed mortality. Rose and snowberry, which generally appeared healthy at Mowitch and Squally Beach, were not surviving as well at Middle Waterway (Simpson/Trustees). However, species observed only at Middle Waterway (Simpson/Trustees) (such as madrone, kinnikinnick, and strawberry) were alive and appeared healthy.

4.2.2 Areal Coverage: BSC 6

During Year 3, the Mowitch transect had the highest unbiased average percent cover of herbs compared to the Squally Beach and Middle Waterway (Simpson/Trustees) transects, although part of this percent cover was attributable to non-native herbaceous species. The Squally Beach riparian transect had the highest unbiased average percent cover of trees and shrubs of all the riparian transects at the three sites sampled (Squally Beach, Mowitch, and Middle Waterway [Simpson/Trustees]). Squally Beach also had the highest percent cover of overall native vegetation (trees, shrubs, and herbs combined), as well as the highest cover of NNI species.

Table 4-2. Commencement Bay riparian areal change at all monitored sites.

Site	Marsh Area (acres)		Change	
	Year 1	Year 3	(acres)	(percent)[1]
Mowitch	0.38	0.64	+0.26	+68%
Squally Beach	0.20	0.37	+0.17	+91%
Middle Waterway (Simpson/Trustees)	0.94	0.82	-0.08	-12%

Note:
[1] Percent change calculated from unrounded areas.

4.3 Fish Access/Presence: BSC 7

The sampling schedule was modified in Year 3. Instead of the biweekly schedule used in Year 1 and Year 2, sampling took place on an approximately weekly basis from late April through June in Year 3. The increase in sampling events allowed more frequent sampling during the peak outmigration for juvenile salmonids and improved the chances of gaining a clearer picture of the abundance and assemblage of juvenile salmonids at the sites. Because of differences in

habitats, the gear used, and the areas sampled, it is important to be cautious when comparing catch results among sites and from year to year. With that in mind, all three seasons showed fish abundance and assemblage at all six of the restoration sites studied. Juvenile salmonids and forage fish were also observed at the restoration sites during Years 1, 2, and 3.

Data from the six sites sampled for fish assemblage in Year 3 were analyzed and compared to data from Years 1 and 2. This comparison was made to determine trends in fish abundance and assemblage over time. The total catch data from all three seasons were analyzed to compare species richness. The CPUE and mean average length for salmonids (chinook, coho, chum, and pink) data provided a means of comparing salmonid use of the restoration sites over time.

During Year 1 and Year 2 sampling, NOAA Fisheries personnel retained a fraction of the fish catch for further analysis of stomach contents and fish chemistry. This task was discontinued in Year 3, which allowed more time for processing fish catches. A total of 232 sets were completed in Year 3, compared to 108 sets in Year 1 and 128 sets in Year 2.

Table 4-3 summarizes total catch data for Year 3. Table 4-4 presents some highlights of the fish monitoring results for the Years 1, 2, and 3; these highlights are discussed below.

Table 4-3. Commencement Bay fish and total catch for Year 3 (2004) monitoring.

Common Name	Scientific Name	Total Catch
bay pipefish	*Syngnathus leptorhynchus*	43
buffalo sculpin	*Enophrys bison*	16
chinook salmon	*Oncorhynchus tshawytscha*	613
chum salmon	*Oncorhynchus keta*	395
coho salmon	*Oncorhynchus kisutch*	1,019
crescent gunnel	*Pholis laeta*	6
cutthroat	*Oncorhynchus clarki*	33
Dolly Varden/bull trout	*Salvelinus malma/Salvelinus confluentus*	1
English sole	*Pleuronectes vetulus*	2
great sculpin	*Myoxocephalus polyacanthocephalus*	8
kelp	*Ulvicola sanctaerosae*	2
Pacific herring	*Clupea pallasii*	4,409
Pacific sandlance	*Ammodytes hexapterus*	145
Pacific staghorn sculpin	*Leptocottus armatus*	4,600
penpoint gunnel	*Apodichthys flavidus*	15
pile perch	*Rhacochilus vacca*	86
pink salmon	*Oncorhynchus gorbuscha*	2,248
rock sole	*Pleuronectes bilineatus*	13
saddleback gunnel	*Pholis ornata*	76
sailfin sculpin	*Nautichthys oculofasciatus*	1
shiner perch	*Cymatogaster aggregata*	20,740
snake prickleback	*Lumpenus sagitta*	15
speckled sanddab	*Citharicthys stigmaeus*	3
starry flounder	*Platichthys stellatus*	1,370
steelhead	*Onchorynchus mykiss*	7
striped perch	*Embiotoca lateralis*	18
surf smelt	*Hypomesus pretiosus*	547
threespine stickleback	*Gasterosteus aculeatus*	637
tidepool sculpin	*Oligocottus maculosus*	11
tubesnout	*Aulorhynchus flavidus*	2
whitespotted greenling	*Hexagrammos stelleri*	4

Table 4-4. Highlights of Commencement Bay fish monitoring for Years 1 through 3.

Parameter	Year 1	Year 2	Year 3
Number of species observed (SR)			
Total SR	36	31	31
Site with highest SR	Olympic View	Olympic View	Yowkwala
Site with second highest SR	Yowkwala	Mowitch	Olympic View
Site with third highest SR	Mowitch	Yowkwala	Skookum Wulge
Site with lowest SR	Middle Waterway (City of Tacoma)	Middle Waterway (City of Tacoma)	Middle Waterway (City of Tacoma)
Individual species abundance			
Most abundant species	Shiner perch	Shiner perch	Shiner perch
Second most abundant species	Coho salmon	Pacific staghorn sculpin	Pacific staghorn sculpin
Third most abundant species	Pacific staghorn sculpin	Surf smelt	Pacific herring
Salmonid species			
Peak period of salmon	Early May	Late May	Late April
Greatest abundance of cutthroat trout	Yowkwala and Skookum Wulge	Yowkwala and Skookum Wulge	Yowkwala and Skookum Wulge
Greatest abundance of coho salmon	Yowkwala	Yowkwala	Yowkwala
Greatest abundance of chinook salmon	Yowkwala	Yowkwala	Yowkwala
Greatest abundance of salmon	Yowkwala	Yowkwala	Olympic View
Percentage of coho checked for hatchery marks	4%	54%	95%
Percentage of wild fish among coho checked for hatchery marks	25%	24%	38%
Percentage of chinook checked for hatchery marks	89%	84%	91%
Percentage of wild fish among chinook checked for hatchery marks	12%	23%	18%

A comparison of data from Years 1, 2, and 3 shows a similar trend in SR for each site (Figure 4-1). Species richness was slightly higher during the Year 1 season, with a total of 36 species observed at the sites over time, compared to 31 species in Year 2 and Year 3. The total number of species peaked in late spring/early summer (Figure 4-2).

The Olympic View site had the highest SR during the Year 1 and Year 2 sampling seasons; in Year 3, the Olympic View site ranked second in SR. High species richness at the Olympic View site likely reflects the presence of eelgrass beds adjacent to the site. Eelgrass beds provide nursery habitat and feeding grounds for a wide variety of fish species, as well as shelter and food for numerous invertebrate and plant species.

Yowkwala had the highest SR in Year 3. In Year 1, the Yowkwala site had the second highest SR, while in Year 2 it had the third highest SR. The reason for the increase in species richness at the Yowkwala site in Year 3 is unknown, but may be related to the site's location within Commencement Bay. The Yowkwala site is on historical and modern outmigration routes (Figure 4-3) (Graeber, 1999, as cited in Simenstad, 2000) and is an undeveloped beach in a protected area with little marine traffic. The site is characterized by a gently sloping cobble beach with a highly vegetated buffer and headland. Large woody debris predominates on the upper edges of the beach. Calm waters and the undeveloped beach may provide a significant food source and habitat for numerous species.

The Skookum Wulge site ranked third in SR in Year 3 and fourth in Years 1 and 2. The Mowitch site ranked fourth in SR in Year 3, second in Year 2 and third in Year 1. The Middle Waterway (Simpson/Trustees) site ranked fifth in SR in all three years. The Middle Waterway (City of Tacoma) site had the lowest SR in all three years, although a rise in SR was seen in Year 3, most likely as a result of the change in method at this site from block netting to beach seining. Beach seining appeared to be more efficient at covering the area sampled, resulting in higher SR.

Again, differences in SR among sites may be related to their locations throughout Commencement Bay. The Mowitch, Yowkwala, Skookum Wulge, and Olympic View sites are on historical and modern outmigration routes (Figure 4-3) (Graeber, 1999, as cited in Simenstad, 2000), whereas the Middle Waterway (City of Tacoma) site is farther inland in a highly industrialized area. Large ships docked in the Middle Waterway create overwater structures that might interfere with fish migration. In addition, during a 2003 and 2004 dredging project conducted in the Middle Waterway, a silt curtain was at times placed across the waterway and may have blocked or interfered with fish migration. In Year 3, a dredging project at the head of

the Middle Waterway blocked all access to the Middle Waterway (City of Tacoma) site, preventing sampling after early July. In addition, the Middle Waterway is dry for a few hours twice per day because of elevation and changes in tide height; sampling generally occurred around high tide, and fish may not have reached or may have left the upper end of the waterway by the time sampling was completed.

Shiner perch was the most abundant species in all three years and was observed at every site during all three sampling seasons. This was expected, as shiner perch are resident fish in the Puget Sound region. Shiner perch also have one of the broadest distributions of all perch species found along the Pacific coast and use bays and estuaries as nurseries (Froese and Pauly, 2003).

In Year 1 (2002), the second most abundant species for the sampling season was coho. The majority of these coho were caught during mid-May on two consecutive days at the Yowkwala site. The large numbers probably relate to hatchery releases from the Puyallup River basin. In a study of the Duwamish estuary in 1995, it was found that a large pulse of juvenile chinook observed in May was related to a hatchery release from the Green River basin (Warner and Fritz, 1995, as cited in King County Department of Natural Resources, 2001). Coho likely congregate at the Yowkwala site because of food availability, protection from predators, and the site's location within Commencement Bay. As discussed above, the Yowkwala site's geometry, structure, and location on historical and modern outmigration paths may be factors in the higher catches. Compared to the other five sites, the Yowkwala site has the least amount of industrial development and a highly vegetated beach and headlands. In addition, the Yowkwala site experiences some of the highest currents of all six sites during tidal cycles. These currents provide food and well-oxygenated waters and likely carry outmigrating salmonids into the area of the Yowkwala site.

Pacific staghorn sculpin, a resident fish, was the second most abundant species for Year 2 and Year 3 and the third most abundant for Year 1. The largest quantities of Pacific staghorn sculpin were caught at the Middle Waterway (Simpson/Trustees) site in Year 2 and Year 3 and

at the Mowitch site in Year 1. Both sites have fine, light substrates, creating mudflat habitat with calm waters.

The third most abundant species in Year 2 was surf smelt, with the highest numbers observed at the Middle Waterway (Simpson/Trustees) site. The surf smelt found there were generally smaller than the surf smelt encountered at other sites, indicating the smelt were using the Middle Waterway (Simpson/Trustees) site as a nursery.

The third most abundant species in Year 3 was Pacific herring, with the highest numbers occurring at the Olympic View site. Pacific herring were observed at all sites except for Middle Waterway (City of Tacoma). Forage fish numbers in general increased at all the sites in Year 3. There was a 66 percent increase in total forage fish catches from Year 1 to Year 3 and a 73 percent increase in total forage fish catches from Year 2 to Year 3. This increase may indicate overall favorable conditions at the sites for forage fish species such as Pacific herring, Pacific sandlance, and surf smelt. This is a good sign for overall health and function of the sites, as forage fish provide an important food source for salmon.

Juvenile salmon (chinook, coho, chum, and pink) were encountered at all sites during all three sampling seasons, with the exception of pink salmon at the Mowitch site in Year 3. A comparison of Years 1, 2, and 3 data showed peak abundances of salmon occurring in late spring/early summer (Figure 4-4). The peak numbers of salmon were observed in late April in Year 3, compared to early May during Year 1 and late May in Year 2. The peak for both seasons occurred over a two-day period, while in Year 3 the peak catch occurred on one day. Overall, greater numbers of salmon were observed in Year 1 (Figure 4-5). Total catch numbers for Year 1 were 78 percent greater than total catch numbers for Year 2 and 34 percent greater than total catch numbers for Year 3. The larger numbers of juvenile salmon seen in Year 1 may reflect the sampling methods employed. When large numbers of juvenile salmon are caught in the net, approximately 40 fish are removed for identification and measurement and to determine whether they are hatchery or wild salmon. The remaining fish numbers and identification are estimated by using the information gained from the approximately 40 fish checked. During this estimation process, the fish are released as soon as possible. This method ensures survival of

fragile juvenile salmon, but may elevate the estimates. Salmon numbers for Year 2 may be lower as a result of infrequent sampling events, since constraints inherent to the study design mean that fish monitoring does not always occur concurrent with the peak runs. In Year 3, more frequent sampling events were scheduled during the peak outmigration, and Year 3 may therefore reflect a more accurate picture of salmon abundance and assemblage at the sites.

The majority of cutthroat trout sampled over all three seasons were caught at the Yowkwala and Skookum Wulge sites, with Year 2 having the highest counts. Steelhead were also observed at these two sites in Year 2. In Year 3, steelhead were observed only at the Yowkwala site, while no steelhead were caught at either site in Year 1. In Year 3, one bull trout/Dolly Varden was encountered at the Yowkwala site. Bull trout/Dolly Varden is listed as a threatened species by the U.S. Fish and Wildlife Service and are also a State species of concern in Washington North Puget Sound Region 4, which encompasses Commencement Bay (WDFW, 2004). Bull trout/Dolly Varden are rarely encountered in Commencement Bay; it is likely that this particular fish was foraging at the Yowkwala site as it migrated through the area, possibly to spawn in the Puyallup River.

The greatest numbers of coho and chinook salmon were observed at the Yowkwala site in all three seasons. During all three years, the time when chinook peaked was latest. Although chinook had the broadest temporal distribution in Year 1, the data show fairly uniform temporal distribution of chinook and coho during the Year 2 and Year 3 sampling seasons.

Data for all three seasons show a definite decline in salmon observed after late July, although in Year 3 salmon were observed through the last sampling event in mid-October. During Year 1 and Year 2, the Yowkwala site had the greatest number of salmon observed; the majority were coho salmon. In Year 3, the Olympic View site had the highest number of salmon observed; the majority were pink salmon. In Year 1, the Olympic View site had the fewest number of salmon observed; in Year 2, the Middle Waterway (City of Tacoma) site had the fewest number of salmon (one pink) observed; and in Year 3, the Mowitch site had the fewest number of salmon observed (Figure 4-6). Figure 4-7 compares the chinook catch over the sampling season by site.

In all three years, the majority of chinook and coho observed at the sites were hatchery fish. Seventy-eight percent of chinook caught in Year 1 were hatchery marked, compared to 65 percent in Year 2 and 78 percent in Year 3 (Figure 4-8). Three percent of coho caught in Year 1 were identified as hatchery marked, compared to 41 percent in Year 2 and 64 percent in Year 3 (Figure 4-9).

However, sampling procedures may be behind the differences in hatchery marked fish for the three years. During the Year 1 sampling, large numbers of coho (more than 1,000) were caught, most of them at the Yowkwala site over a two-day period in May. Forty-four of the fish were examined to determine species, length, and hatchery marks. To expedite the sampling procedure and ensure the coho were not harmed, the overall count was then estimated on the basis of the 44 coho that were examined as a representative sample. In making that estimate, no assumptions were made about hatchery marks. As a result, 96 percent of the coho catch was identified as "not checked" for marks. In Year 2, approximately 46 percent of the coho were identified as "not checked" for marks. In Year 3, a concerted effort was made to check each chinook and coho salmon for hatchery marks and only 9 percent of the chinook and 5 percent of the coho catch were identified as "not checked."

The weekly sampling events conducted during the peak outmigration resulted in a more uniform catch; as a result the crew was able to meet the goal of checking larger numbers of chinook and coho for hatchery marks. In addition, unlike in Years 1 and 2, it was not necessary to retain a fraction of the catch for chemical analysis, which allowed more time for the salmon to be checked. Overall, these efforts may have resulted in a clearer picture of hatchery versus wild chinook and coho salmon utilizing the sites in Year 3.

Among the coho and chinook that were checked for hatchery marks, the proportion of wild to hatchery fish remained relatively similar over the three monitoring seasons. The percentage of wild coho varied from 24 to 38 percent among the coho that were checked for marks, and wild chinook varied from 12 to 23 percent among those checked for marks.

Chinook mean average fork lengths for all three seasons (Figure 4-10) show evidence of multiple life history types migrating through, and possibly rearing within, the system. Coho

mean average lengths for all three seasons were fairly similar over time (Figure 4-11), indicating a transitory and uniform population moving through the system. In Year 3, a number of adult chinook and coho were caught at the Yowkwala site in late July through mid-October; as a result, increased lengths were seen for chinook and coho in the latter part of the sampling season for Year 3. It is assumed that the adult salmon were accessing the site for foraging and/or staging purposes. During all three seasons, chum and pink salmon increased in size over time (Figures 4-12 and 4-13), indicating both species may have been using the sites for rearing.

4.4 Invertebrate Prey Resource Production: BSC 8

The total normalized number of orders present at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites was relatively similar, with both Mowitch and Squally Beach having slightly more orders present (7) than Middle Waterway (Simpson/Trustees) (6). However, fewer families were found at Mowitch (9) than either Squally Beach (11) or Middle Waterway (Simpson/Trustees) (16). In addition, the total normalized number of individuals present at Mowitch (58) was considerably less than that at Squally Beach (184) and Middle Waterway (Simpson/Trustees) (152). The production of invertebrates was diverse at Mowitch, but the total number of invertebrates was low compared to the other two sites.

It is likely that juvenile salmonids will feed on whatever invertebrates are found within the water column. Of the seven orders observed at Mowitch, the three most likely to be consumed by juvenile salmonids are Amphipoda, Trichoptera, and Hemiptera (in the family Saldidae). Amphipoda and Hemiptera (Saldidae) occured at all three sites. Only one individual of Trichoptera was observed at Mowitch; this order was not present on either the Squally Beach or Middle Waterway (Simpson/Trustees) sites. Of the orders most likely to be used by juvenile salmonids, 18 individuals were present on Mowitch, while 43 and 4 were found at Squally Beach and Middle Waterway (Simpson/Trustees), respectively.

4.5 Bird Use: BSC 9

Compared with the Mowitch and Middle Waterway (Simpson/Trustees) sites for Year 3, Squally Beach was used by the highest number of bird species overall (50). Mowitch, however, had the highest average number of species observed per visit (12.8), the highest total number of species using riparian habitat (20), the highest total number of species using the marsh, intertidal, and mudflats (7), and the highest total number of species observed displaying breeding behavior (11). Squally Beach had the highest number of species of waterfowl observed for the year (16) and the highest number of individuals of any species present at one time (approximately 125 American widgeon), but Mowitch had the highest average number of waterfowl species using open water habitat per visit (3.5).

Table 4-5. Highlights of Commencement Bay bird monitoring for Year 3.

Parameter	Mowitch	Squally Beach	Middle Waterway (Simpson/Trustees)
Total number of species observed	42	50	31
Average number of species observed per visit	12.8	10.8	8.1
Riparian areas: Average number of species observed per visit	20	18	14
Marsh/intertidal/mudflat areas: Highest number of species present per visit	7	3	4
Open water: average number of species present per visit	3.5	3.2	1.4
Total number of breeding species observed	11	10	6
Total number of waterfowl species observed	11	16	9

Figure 4-1. Total number of fish species caught per site in Years 1 to 3.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Figure 4-2. Total number of fish species caught per month at all sites in Years 1 to 3.

[Placeholder. Color landscape figure, 8.5″ x 11″.]

Figure 4-3. Map of fish species caught by month and by site in Year 3.

[Placeholder. Color landscape figure, 11" x 17".]

Figure 4-4. Modern use of Puyallup Delta and Commencement Bay by juvenile salmon.

[Placeholder. Color landscape figure, 8.5″ x 11″.]

Figure 4-5. Average number of salmon caught per set in Years 1 to 3.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Figure 4-6. Average number of salmon caught per site in Years 1 to 3.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Figure 4-7. Map of chinook caught by month and by site in Year 3.

[Placeholder. Color landscape figure, 11" x 17".]

Figure 4-8. Percent of chinook that were wild, hatchery, or not checked in Years 1 to 3.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Figure 4-9. Percent of coho that were wild, hatchery, or not checked in Years 1 to 3.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Figure 4-10. Average length of chinook salmon caught at all sites combined in Years 1 to 3.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Figure 4-11. Average length of coho salmon caught at all sites combined in Years 1 to 3.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Figure 4-12. Average length of chum salmon caught at all sites combined in Years 1 to 3.

[Placeholder. B&W landscape figure, 8.5" x 11".]

Figure 4-13. Average length of pink salmon caught at all sites combined in Years 1 to 3.

[Placeholder. B&W landscape figure, 8.5" x 11".]

5.0 SUMMARY AND RECOMMENDATIONS

5.1 Monitoring Summary and Other Observations for Selected Sites

Table 5-1 summarizes performance of the seven restoration sites during Year 3 relative to the BSCs applicable for this monitoring period.

Table 5-1. Performance summary for Year 3 (2004) monitoring.

	Biological Success Criteria								
	1	2	3	4	5[a]	6	7[a]	8[a]	9[a]
Site Name	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	Y	+[b]	N	Y	Y	+[b]	Y	N	Y
Squally Beach	Y	+[b]	+	Y	Y	+[b]		N	Y
Middle Waterway (Simpson/Trustees)	Y	Y[b]	n/a	Y	N	+[b]	Y	Y	Y
Middle Waterway (City of Tacoma)							Y		
Yowkwala	Y						Y		
Skookum Wulge							Y		
Olympic View							Y		

Notes:
Y = Criterion met.
+ = Criterion partially met or improving.
N = Criterion not met, no trend assessed.
n/a = Criterion could not be assessed.
[a] = Reference not available for quantitative comparison; evaluation based on site observations or trends over time.
[b] = Results of statistical analysis using the unbiased average percent cover indicate that the average percent cover meets the BSC. However, variability remains high within the 90CIs, and the lower bound of the confidence interval may not necessarily meet the criterion.

5.1.1 Mowitch

Areal cover for marsh (BSC 1) and riparian (BSC 6) vegetation increased on the Mowitch site. Based on qualitative assessments, the survival of plant species in the riparian habitat likely met the 75 percent threshold for survival (BSC 5). The percent cover of NNI plant species in the marsh increased slightly along one transect, but decreased slightly along the other (BSC 2). However, the percent cover of NNI species appeared to increase significantly in the riparian area (BSC 6). Additional plantings of native shrub and tree species that have proven successful at the site, such as red-osier dogwood, rose, western red cedar, and willow, may be necessary to shade out non-native herbaceous species and increase the cover of trees and shrubs in the riparian habitat over the coming years. Other control measures for NNI species may also need to be implemented to reduce their percent cover to acceptable levels.

In general, the herbivory avoidance fencing appeared to be intact and effective (BSC 4). There was no obvious indication of waterfowl foraging on marsh plants. However, there did not appear to be a statistically significant increase in plant vigor (BSC 3) for sedges on the site.

Invertebrates used as prey by salmonids (BSC 8) do not appear to be significantly produced at the site. However, fish in general and salmonids in particular (BSC 7) are using the site.

5.1.2 Squally Beach

Areal cover for marsh (BSC 1) and riparian (BSC 6) vegetation increased on the Squally Beach site. Based on qualitative assessments, the survival of plant species in the riparian habitat likely met the 75 percent threshold for survival (BSC 5). Percent cover of NNI plant species in the marsh appeared to be decreasing (with the exception of Transect 1-3 in the lower marsh, which was increasing) (BSC 2). Percent cover of NNI plant species in the riparian habitat increased at Squally Beach (BSC 6). Additional plantings of native shrub species that have proven successful at Squally Beach, such as red-osier dogwood and rose, may be necessary to shade out non-native herbaceous species and increase the cover of shrubs over the coming years. Other control measures for NNI species may also need to be implemented to reduce their percent cover to acceptable levels.

In general, the herbivory avoidance fencing appeared to be intact and effective (BSC 4). There was little to no obvious indication of waterfowl foraging on marsh plants. However, there did not appear to be a statistically significant increase in plant vigor (BSC 3) for sedges on the site.

Invertebrates used as prey by salmonids (BSC 8) do not appear to be significantly produced at the site.

5.1.3 Middle Waterway (Simpson/Trustees)

The areal extent of marsh (BSC 1) vegetation increased markedly at the Middle Waterway (Simpson/Trustees) site, while the areal extent of riparian (BSC 6) vegetation decreased. This decrease may have been a result of the dredging and capping activities being conducted this year, during which a portion of the riparian zone was cleared to provide access for heavy equipment. Non-native or invasive plant species comprise less than 5 percent of the marsh vegetation cover (BSC 2), while NNI cover increased in the riparian habitat on the site (BSC 6). Additional plantings of native shrub and tree species that have proven successful at the site may be necessary to shade out non-native herbaceous species and increase the cover of trees and shrubs within the riparian habitat over the coming years. Other control measures for NNI species within the riparian habitat may also need to be implemented to reduce their percent cover to acceptable levels.

In general, the herbivory avoidance fencing appeared to be intact and effective (BSC 4). There was no obvious indication of waterfowl foraging on marsh plants.

Invertebrates used as prey by salmonids (BSC 8) do not appear to be significantly produced at the site. However, fish in general and salmonids in particular (BSC 7) are using the site. Smurf smelt are believed to use the site as a nursery.

5.1.4 Middle Waterway (City of Tacoma)

Fish in general and salmonids in particular (BSC 7) are using the site. However, the site had the lowest species richness of all the sites monitored.

5.1.5 Yowkwala

Based on polygon mapping, areal cover of marsh vegetation increased markedly on this site from Year 2 to Year 3 (BSC 1).

Fish in general and salmonids in particular (BSC 7) are using the site. The site is on historical and modern outmigration routes and is well used by salmonid species.

5.1.6 Skookum Wulge

Fish in general and salmonids in particular (BSC 7) are using the site. The site is on historical and modern outmigration routes and is well used by salmonid species.

5.1.7 Olympic View

Fish in general and salmonids in particular (BSC 7) are using the site. The site is on historical and modern outmigration routes and is well used by salmonid species.

5.2 Monitoring and Adaptive Management Recommendations

Based on the results of the Year 3 monitoring of restoration sites near Commencement Bay, we have the following recommendations:

- Reinstall rebar as needed along the transects in Year 5. Protect rebar/stakes marking transect and quadrat locations.
- Survey site boundaries and install permanent, easily identifiable markers so that the extent of polygon mapping of marsh and riparian areas can more accurately be compared over time.
- Evaluate means of controlling brass buttons on the sites.
- Conduct riparian plant survival (BSC 5) determinations earlier in the year (July to August).

- Conduct additional invertebrate monitoring (BSC 8) earlier in the year: twice a month during the spring months of April and May and the summer months of July and August. This would increase the chances of documenting emerging aquatic invertebrates on the sites.

- Provide greater control of non-native or invasive species, especially in the riparian area of the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites.

- Reevaluate the vegetation monitoring protocols relative to the level of effort required, especially with regard to polygon mapping. As vegetation cover has increased, the field effort required to monitor vegetation has also increased substantially.

- Conduct future fish monitoring events weekly from early March through June (rather than mid-April to late June as in Year 3). This would increase the chances of documenting the onset and peak of salmonid migration.

- Conduct fish monitoring in Year 4, in addition to the next scheduled monitoring season (Year 5). This would allow better assessment of long-term trends in fish use of the restoration sites.

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APPENDIX B

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APPENDIX C

Statistical Analysis Methods

Table A-1a. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Mowitch (Marsh Area at the Mouth of Mowitch)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	10	80	8	*Salicornia virginica, Cotula coronopifolia*
MB	1	50	1	*Eleocharis* sp.
MC	6	25	2	*Cotula coronopifolia*
MD	1	30	0	*Eleocharis* sp.
ME	4	80	3	*Cotula coronopifolia*
MF	50	75	38	*Eleocharis* sp.
MG	105	30	32	*Cotula coronopifolia*
MH	28	60	17	*Eleocharis* sp.
MI	32	35	11	*Eleocharis* sp.
MJ	7	80	6	*Eleocharis* sp.
MK	4	75	3	*Eleocharis* sp.
ML	point	90	1	*Eleocharis* sp.
MM	point	90	1	*Eleocharis* sp.
MN	13	25	3	*Eleocharis* sp.
MO	point	90	1	*Eleocharis* sp.
MP	50	50	25	*Distichlis spicata, Atriplex patula*
MQ	42	30	13	*Atriplex patula*
MR	29	25	7	*unknown herb*
MS	25	85	21	*Jaumea carnosa*
MT	83	75	62	*unknown herb*
MU	15	25	4	*Atriplex patula*
MV	351	30	105	*Cotula coronopifolia, Eleocharis* sp.
MW	97	25	24	*Cotula coronopifolia, Atriplex patula*
MX	18	30	5	*Eleocharis* sp.
MY	83	25	21	*Salicornia virginica, Atriplex patula*
MZ	115	60	69	*Cotula coronopifolia, Atriplex patula, Eleocharis* sp.
Total (sq. ft.)	**1,169**		**482**	
Total (acres)	**0.03**		**0.01**	

Table A-1b. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Mowitch (North Lobe Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	248	40	99	*Salicornia virginica, Atriplex patula*
MB	680	90	612	*Distichlis spicata*
MC	336	80	269	*Plantage maritima, Triglochin maritima*
MD	683	80	546	*Triglochin maritima*
ME	165	50	83	*Triglochin maritima, Cotula coronopifolia*
MF	201	60	121	*Cotula coronopifolia*
MG	110	40	44	*Cotula coronopifolia*
MH	92	80	74	*Triglochin maritima*
MI	235	50	118	*Atriplex patula, Plantago maritima*
MJ	167	35	58	*Triglochin maritima, unknown sedge*
MK	178	45	80	*unknown herb*
ML	104	25	26	*Cotula coronopifolia*
MM	43	25	11	*Cotula coronopifolia*
MN	176	30	53	*Cotula coronopifolia*
MO	34	80	27	*Eleocharis* sp.
MP	point	80	1	*Eleocharis* sp.
MQ	point	30	1	*Eleocharis* sp.
MR	7	90	6	*Eleocharis* sp.
MS	1	30	0	*Eleocharis* sp.
MT	40	50	20	*Eleocharis* sp.
MU	point	80	1	*Atriplex patula*
MV	1,637	70	1,146	*Cotula coronopifolia, Eleocharis* sp.
MW	556	70	389	*Eleocharis* sp.
MX	334	40	134	*Eleocharis* sp.
MY	126	70	88	*Atriplex patula, Aster douglasii*
MZ	486	65	316	*Cotula coronopifolia*
Total (sq. ft.)	**6,639**		**4,322**	
Total (acres)	**0.15**		**0.10**	

Table A-1c. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Mowitch (Center Lobe Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	13	80	10	*Eleocharis* sp.
MB	2,740	60	1,644	*Cotula coronopifolia, Eleocharis* sp.
MC	631	90	568	*Triglochin maritima, Cotula coronopifolia, Salicornia virginica*
MD	335	90	302	*Salicornia virginica, Cotula coronopifolia, Eleocharis* sp.
ME	542	90	488	*Salicornia virginica, Plantago maritima*
MF	884	95	840	*Carex lyngbyei, Distichlis spicata, Plantage maritima*
MG	242	80	194	*Distichlis spicata, Atriplex patula*
MH	60	50	30	*Eleocharis* sp.
MI	4	30	1	*Eleocharis* sp.
MJ	4	75	3	*Eleocharis* sp.
MK	172	25	43	*Eleocharis* sp.
ML	21	50	11	*Eleocharis* sp.
MM	144	65	94	*Eleocharis* sp.
MN	51	75	38	*Cotula coronopifolia, unknown herb*
MO	464	40	186	*Eleocharis* sp.
MP	point	40	1	*Eleocharis* sp.
MQ	3	30	1	*Eleocharis* sp.
MR	83	80	66	*Triglochin maritima, Cotula coronopifolia, Eleocharis* sp.
MS	248	30	74	*Cotula coronopifolia, Eleocharis* sp.
MT	162	40	65	*Cotula coronopifolia, Eleocharis* sp.
MU	327	20	65	*Eleocharis* sp.
MV	205	50	103	*Eleocharis* sp.
MW	58	50	29	*Eleocharis* sp.
MX	380	40	152	*Eleocharis* sp.
MY	150	80	120	*Carex lyngbyei, Cotula coronopifolia, Eleocharis* sp., *unknown herb*
MZ	30	45	14	*Eleocharis* sp.
Total (sq. ft.)	**7,953**		**5,140**	
Total (acres)	**0.18**		**0.12**	

Table A-1d. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Mowitch (South Lobe Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	260	85	221	*Eleocharis* sp.
MB	464	75	348	*Eleocharis* sp.
MC	101	30	30	*Eleocharis* sp.
MD	628	90	565	*Carex lyngbyei*
ME	15	50	8	*Eleocharis* sp.
MF	213	75	160	*Distichlis spicata, Atriplex patula*
MG	1,621	65	1,054	*Cotula coronopifolia*
MH	point	25	1	*Eleocharis* sp.
MI	149	30	45	*Eleocharis* sp.
MJ	19	25	5	*Eleocharis* sp.
MK	26	40	10	*Eleocharis* sp.
ML	27	65	18	*unknown herb*
MM	69	50	35	*Cotula coronopifolia, Eleocharis* sp.
MN	71	80	57	*Salicornia virginica, Atriplex patula, unknown succulent*
MO	137	65	89	*Triglochin maritima, Carex lyngbyei, unknown succulent*
MP	161	75	121	*Cotula coronopifolia, Eleocharis* sp.
MQ	3	30	1	*Eleocharis* sp.
MR	182	65	118	*Eleocharis* sp.
MS	167	85	142	*Triglochin maritima, Eleocharis* sp.
MT	966	60	580	*Cotula coronopifolia, Eleocharis* sp., unknown succulent
MU	167	40	67	*Eleocharis* sp.
MV	192	65	125	*Plantago maritima, Triglochin maritima, Eleocharis* sp., *unknown succulent*
MW	21	25	5	*Eleocharis* sp.
MX	82	20	16	*Eleocharis* sp.
MY	55	50	28	*Eleocharis* sp.
MZ	195	60	117	*Eleocharis* sp.
Total (sq. ft.)	**5,991**		**3,963**	
Total (acres)	**0.14**		**0.09**	

Table A-1e. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Mowitch (South End Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	85	80	68	*Atriplex patula, Aster douglasii*
MB	563	60	338	*Cotula coronopifolia*
MC	1,147	85	975	*Plantago maritima*
MD	148	90	133	*Typha angustifolia, Juncus balticus, Carex lyngbyei*
ME	646	85	549	*Plantago maritima*
MF	56	70	39	*Distichlis spicata*
MG	306	70	214	*Cotula coronopifolia, Eleocharis* sp.
MH	147	70	103	*Eleocharis* sp.
Total (sq. ft.)	**3,098**		**2,419**	
Total (acres)	**0.07**		**0.06**	

Total Year 3 Vegetated Marsh Area:

(sq.ft.)	**16,327**
(acres)	**0.37**

For comparison:
Total Year 1 Vegetated Marsh Area:

(sq.ft.)	**3,436**
(acres)	**0.08**

Table A-1f. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Mowitch (Riparian Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
RA	116	100	116	*Alnus rubra*
RB	482	95	458	*Alnus rubra, Cornus stolonifera, Lotus corniculatus*
RC	1,254	100	1,254	*Alnus rubra, Lotus corniculatus*
RD	1,754	55	965	*Lotus corniculatus*
RE	293	100	293	*Salix hookeriana, Achillea millefolium*
RF	1,401	80	1,121	*Lupinus sp., Lotus corniculatus, Achillea millefolium*
RG	4,791	95	4,551	*Lotus corniculatus, Aster douglasii, Achillea millefolium*
RH	316	100	316	*Lotus corniculatus, Achillea millefolium, Alnus rubra, Rubus discolor*
RI	151	100	151	*Alnus rubra, Lotus corniculatus, Achillea millefolium, Rubus discolor*
RJ	165	100	165	*Cornus stolonifera, Salix hookeriana, Achillea millefolium, Melilotus alba*
RK	1,987	90	1,788	*Lupinus sp., Lotus corniculatus, Achillea millefolium, Daucus carota, unknown herb*
RL	2,969	75	2,227	*Lotus corniculatus, Alnus rubra*
RM	1,768	95	1,680	*Lotus corniculatus,Achillea millefolium, Alnus rubra, Lupinus albicaulis*
RN	1,940	95	1,843	*Aster douglasii, Lotus corniculatus, Daucus carota, Melilotus alba*
RO	422	98	414	*Lotus corniculatus, Achillea millefolium, Distichlis spicata*
RP	470	80	376	*Lotus corniculatus, Melilotus alba, Lepidium latifolium*
RQ	1,049	80	839	*Lotus corniculatus, melilotus alba*
RR	306	90	275	*Alnus rubra, Lotus corniculatus*
RS	144	95	137	*Alnus rubra, Melilotus alba, Populus balsaifera, Lotus corniculatus*
RT	1,506	100	1,506	*Lotus corniculatus, melilotus alba*
RU	889	90	800	*Lotus corniculatus, Alnus rubra*
RV	6,111	80	4,889	*Lotus corniculatus*
RW	627	80	502	*Deschampsia, Aster subspicatus, Distichlis spicata*
RX	613	98	601	*Alnus rubra*
RY	589	95	560	*Lotus corniculatus, Alnus rubra*
Total (sq. ft.)	**32,113**		**27,825**	
Total (acres)	**0.74**		**0.64**	

For comparison:

Total Year 1 Vegetated Riparian Area:

(sq.ft.)	**16,567**
(acres)	**0.38**

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

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	37	1	16	1	3
2	39	2	18	2	62
3	80	3	63	3	104
4	86	4	77	4	147
5	137	5	104	5	153
6	142	6	217	6	232
7	158	7	242	7	273
8	165	8	259	8	310
9	171	9	274	9	343
10	206	10	311	10	421
11	243	11	317	11	443
12	245	12	348	12	511
13	272	13	358	13	548
14	274	14	393	14	603
15	315	15	417	15	619
16	354	16	452	16	655
17	366	17	465	17	741
18	370	18	477	18	757
19	375	19	484	19	801
20	440	20	505	20	837
21	444	21	519	21	870
22	446	22	521	22	926
23	472	23	529	23	930
24	474				
25	481				
26	483				
27	519				
28	536				
29	552				
30	573				
31	588				
32	640				
33	656				
34	669				
35	674				
36	690				
37	695				
38	718				
39	734				
40	748				
41	758				
42	770				
43	803				
44	859				
45	861				
46	898				

Table A-3a. Year 1 (2002) Marsh Development at Mowitch, Transect 1-1 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy Cover (%)	90% Confidence: Lower Bound	90% Confidence: Upper Bound
Native								
pickleweed	*Salicornia virginica*	0.01	2.2%	1/46	0.5	n/a	n/a	n/a
Lyngby's sedge	*Carex lyngbyei*	0.6	8.7%	4/46	7.0	0.8	0.0	2.2
orache, fat-hen saltbush	*Atriplex patula*	4.1	47.8%	22/46	8.5	4.9	2.2	7.7
seaside arrow-grass	*Triglochin maritimum*	1.9	6.5%	3/46	28.7	6.1	0.0	29.2
seaside plantain	*Plantago maritima*	0.8	8.7%	4/46	9.0	1.5	0.0	6.0
seashore saltgrass	*Distichlis spicata*	0.5	4.3%	2/46	10.5	n/a	n/a	n/a
spike-rush	*Eleocharis sp.*	0.01	2.2%	1/46	0.5	n/a	n/a	n/a
tufted hairgrass	*Deschampsia cespitosa*	0.1	4.3%	2/46	1.3	n/a	n/a	n/a
Canopy Cover, Native		7.9			15.8	10.5	3.2	17.8
Non-Native or Invasive								
brass buttons	*Cotula coronopifolia*	1.8	19.6%	9/46	9.3	1.9	0.0	4.2
colonial bentgrass	*Agrostis tenuis*	0.1	2.2%	1/46	3.0	n/a	n/a	n/a
English plantain	*Plantago lanceolata*	0.3	2.2%	1/46	15.0	n/a	n/a	n/a
fireweed	*Epilobium angustifolium*	0.1	6.5%	3/46	1.2	0.1	0.0	0.2
hairy catsear	*Hypochaeris radicata*	0.04	2.2%	1/46	2.0	n/a	n/a	n/a
white sweet-clover	*Melilotus alba*	0.02	2.2%	1/46	1.0	n/a	n/a	n/a
unclassified-grass	*unknown*	0.1	10.9%	5/46	0.9	0.1	0.0	0.2
unclassified-herb	*unknown*	0.3	17.4%	8/46	1.5	0.3	0.1	0.4
Canopy Cover, NNI		2.7			7.8	2.7	0.4	5.0
TOTAL		10.6			23.5	13.7	5.0	22.3
Proportion of non-native or invasive plants (%):		25.6%			33.1%	19.7%		

Table A-3b. Year 2 (2003) Marsh Development at Mowitch, Transect 1-2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence Lower Bound	90% Confidence Upper Bound
Native								
pickleweed	*Salicornia virginica*	0.0	4.3%	1/23	1.0	n/a	n/a	n/a
Lyngby's sedge	*Carex lyngbyei*	0.0	4.3%	1/23	1.0	n/a	n/a	n/a
orache, fat-hen saltbush	*Atriplex patula*	1.3	17.4%	4/23	7.4	1.9	0.0	6.2
seashore saltgrass	*Distichlis spicata*	0.4	8.7%	2/23	5.0	n/a	n/a	n/a
seaside arrow-grass	*Triglochin maritimum*	0.8	13.0%	3/23	6.0	0.8	0.0	1.7
seaside plantain	*Plantago maritima*	0.3	13.0%	3/23	2.3	0.3	0.0	0.7
spike-rush	*Eleocharis sp.*	11.3	47.8%	11/23	23.6	16.0	0.0	33.7
Canopy Cover, Native		14.2			23.3	20.3	0.9	39.6
Non-Native or Invasive								
brass buttons	*Cotula coronopifolia*	5.2	56.5%	13/23	9.2	5.5	0.0	11.4
saltmarsh sandspurry	*Spergularia marina*	6.1	26.1%	6/23	23.3	6.7	0.4	13.0
unclassified-herb	*unclassified-herb*	1.2	34.8%	8/23	3.6	1.1	0.0	2.3
Canopy Cover, NNI		12.5	56.5%	13/23	22.1	24.5	0.0	60.5
TOTAL		26.7			45.4	67.3	0.0	165.2
Proportion of non-native or invasive plants (%):		46.8%			48.7%	36.4%		

Table A-4a. Year 3 (2004) Marsh Development at Mowitch, Transect 1-1 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	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	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Corresponding quadrat in year of origin (Year 1 - 2002)				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
Percent of quadrat situated within herbivory exclusion device				100	100	100	100	0	0	0	0	0	0	0	0	100	100	100	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	25	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0
Native																																																	
fleshy jaumea	*Jaumea carnosa*	4.5	34.3													60	35			75	25														10	1												
Lyngby's sedge	*Carex lyngbyei*	1.0	22.5													30	15																																
orache, fat-hen	*Atriplex patula*	1.7	6.6	1					2							5	<0.5	1		<0.5	1	20								30	5			3	3	5		3											
Pacific silverweed	*Potentilla pacifica*	0.1	3.0															3																															
pickleweed	*Salicornia virginica*	3.0	10.7						4	3					3				45	15	35	10									3				5			7	5	3		1							
seashore saltgrass	*Distichlis spicata*	2.9	26.6		35													85			2														1			10											
seaside arrow-grass	*Triglochin maritimum*	4.6	14.1	42	30	10	25						2			1		5	10		10					1				2	3			10	20	40	<0.5										<0.5		
seaside plantain	*Plantago maritima*	6.8	20.9	45	40	30	70	5	3							5	5	3	10	25	25	25												2		20													
spike-rush	*Eleocharis sp.*	8.7	17.4			45	30	1	2	5	1	<0.5	2	<0.5	5								65	85	20		1			1		5	1	35	3				2	1	1	<0.5	30	40	20				<0.5
tufted hairgrass	*Deschampsia cespitosa*	2.0	15.0				10										25			5		20														10		20											
Non-Native or Invasive[1]																																																	
brass buttons	*Cotula coronopifolia*	9.8	12.5	15	1	5	2	2	35	40	35	45	35	30	20			1				3	10			15	5	25	2	10	7		25	5	5	1	10	10	5	1	20	3	10	3	5		1	2	
saltmarsh sandspurry	*Spergularia marina*	4.6	10.7			2	2	15	35	25	20	15	5	10	20		2	<0.5		2	1	25											3	3	20	3	3		2										
unclassified-herb	*unclassified-herb*	0.3	6.5																10			3																											

Table A-4b. Year 3 (2004) Marsh Development at Mowitch, Transect 1-2 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	Quadrats, Transect 1-2																					
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Corresponding quadrat in year of origin (Year 2 - 2003)				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Percent of quadrat situated within herbivory exclusion device				100	100	0	100	100	100	100	100	100	0	0	0	0	0	0	100	100	0	100	100	100	100	0
Native																										
Lyngby's sedge	*Carex lyngbyei*	0.9	20.0																						20	
orache, fat-hen	*Atriplex patula*	0.9	20.0																			20				
pickleweed	*Salicornia virginica*	0.3	4.0																			5				3
seashore saltgrass	*Distichlis spicata*	3.5	40.0	60	20																					
seaside arrow-grass	*Triglochin maritimum*	5.6	11.7	3	20		25		1	1	2								3	1		70	2	1		
seaside plantain	*Plantago maritima*	0.3	3.5																	2		5				
spike-rush	*Eleocharis sp.*	22.0	33.7	50	70	40	95	50	5	20	50	70	1	3	1	15	15	20								
Non-Native or Invasive[1]																										
brass buttons	*Cotula coronopifolia*	11.8	17.0	15	7	20	<0.5	15	25	30	20	25				<0.5	25	20	25	15	25		3		1	1
saltmarsh sandspurry	*Spergularia marina*	4.9	10.2	25	15	3	10	15										2	20	10	2	7	<0.5		3	

Table A-5a. Year 3 (2004) Marsh Development at Mowitch, Transect 1-1 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy Cover (%)	90% Confidence Interval: Lower Bound	90% Confidence Interval: Upper Bound
Native								
fleshy jaumea	*Jaumea carnosa*	4.5	13.0%	6/46	34.3	8.6	0.0	23.2
Lyngby's sedge	*Carex lyngbyei*	1.0	4.3%	2/46	22.5	n/a	n/a	n/a
orache, fat-hen saltbush	*Atriplex patula*	1.7	30.4%	14/46	5.7	1.7	0.4	3.1
Pacific silverweed	*Potentilla pacifica*	0.1	2.2%	1/46	3.0	n/a	n/a	n/a
pickleweed	*Salicornia virginica*	3.0	28.3%	13/46	10.7	3.0	0.9	5.1
seashore saltgrass	*Distichlis spicata*	2.9	10.9%	5/46	26.6	5.6	0.0	18.7
seaside arrow-grass	*Triglochin maritimum*	4.6	37.0%	17/46	12.5	6.3	0.6	12.0
seaside plantain	*Plantago maritima*	6.8	32.6%	15/46	20.9	7.8	2.3	13.3
spike-rush	*Eleocharis sp.*	8.8	58.7%	27/46	14.9	10.8	1.3	20.2
tufted hairgrass	*Deschampsia cespitosa*	2.0	13.0%	6/46	15.0	2.1	0.5	3.6
Canopy Cover, Native		35.3			38.7	74.0	12.8	135.2
Non-Native or Invasive								
brass buttons	*Cotula coronopifolia*	9.8	78.3%	36/46	12.5	11.0	6.1	15.9
saltmarsh sandspurry	*Spergularia marina*	4.6	45.7%	21/46	10.2	5.3	2.0	8.7
unclassified-herb	*unclassified-herb*	0.3	4.3%	2/46	6.5	n/a	n/a	n/a
Canopy Cover, NNI		14.7			16.9	16.8	9.2	24.4
TOTAL		50.0			55.6	72.3	40.0	104.5
Proportion of non-native or invasive plants (%):		29.4%			30.4%	23.2%		

Table A-5b. Year 3 (2004) Marsh Development at Mowitch, Transect 1-2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy Cover (%)	90% Confidence Interval: Lower Bound	90% Confidence Interval: Upper Bound
Native								
Lyngby's sedge	*Carex lyngbyei*	0.9	4.3%	1/23	20.0	n/a	n/a	n/a
orache, fat-hen saltbush	*Atriplex patula*	0.9	4.3%	1/23	20.0	n/a	n/a	n/a
pickleweed	*Salicornia virginica*	0.3	8.7%	2/23	4.0	n/a	n/a	n/a
seashore saltgrass	*Distichlis spicata*	3.5	8.7%	2/23	40.0	n/a	n/a	n/a
seaside arrow-grass	*Triglochin maritimum*	5.6	47.8%	11/23	11.7	5.4	0.0	11.6
seaside plantain	*Plantago maritima*	0.3	8.7%	2/23	3.5	n/a	n/a	n/a
spike-rush	*Eleocharis sp.*	22.0	65.2%	15/23	33.7	34.8	0.7	68.9
Canopy Cover, Native		33.4			35.0	49.9	3.6	96.1
Non-Native or Invasive								
brass buttons	*Cotula coronopifolia*	11.9	78.3%	18/23	15.2	19.4	2.8	36.0
saltmarsh sandspurry	*Spergularia marina*	4.9	52.2%	12/23	9.4	6.0	1.2	10.9
Canopy Cover, NNI		16.8			20.3	23.9	8.2	39.6
TOTAL		50.2			55.2	87.9	11.7	164.1
Proportion of non-native or invasive plants (%):		33.4%			36.7%	27.2%		

Table A-6. Year 3 (2004) Marsh Development at Mowitch - Change in Percent Cover, Year 1 to Year 3

	Species[b]	Percent of Quadrats with Decreased Cover	Percent of Quadrats with No Change	Percent of Quadrats with Increased Cover	Statistical Result[a]
Mowitch Marsh Transect 1-1					
Native	*Atriplex patula*	46%	46%	9%	-
	Carex lyngbyei	7%	89%	4%	
	Deschampsia cespitosa	4%	83%	13%	
	Distichlis spicata	2%	87%	11%	
	Eleocharis sp.	0%	41%	59%	+
	Plantago maritima	0%	67%	33%	+
	Salicornia virginica	0%	72%	28%	+
	Triglochin maritimum	2%	63%	35%	+
Total Native		15%	7%	78%	+
NNI	*Cotula coronopifolia*	7%	20%	74%	+
Total NNI		11%	15%	74%	+
Total (All Species)		13%	0%	87%	+
Mowitch Marsh Transect 1-2					
Native	*Atriplex patula*	17%	83%	0%	
	Carex lyngbyei	4%	91%	4%	No Test[c]
	Distichlis spicata	0%	91%	9%	No Test
	Eleocharis sp.	9%	35%	57%	+
	Plantago maritima	9%	83%	9%	
	Salicornia virginica	0%	91%	9%	No Test
	Triglochin maritimum	9%	48%	43%	+
Native Total		0%	13%	87%	+
NNI	*Cotula coronopifolia*	17%	13%	70%	+
	Spergularia marina	26%	35%	39%	
NNI Total		30%	9%	61%	
Total (All Species)		9%	4%	87%	+

[a] "+" indicates a significant increase (two-tailed sign test, alpha = 0.05); "-" indicates a significant decrease; other species are not significantly changed

[b] Displayed species are species observed in both years - NNI and Native totals include species observed in either year.

[c] Species with less than three non-zero changes could not be statistically tested.

Table A-7a. Year 3 (2004) Marsh Development at Mowitch - *Carex* Stem Height Collected Data

Common Name	Scientific Name	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	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Lyngby's sedge	*Carex lyngbyei*													15, 13, 13, 28, 13.5, 24, 28, 19	19.5, 10, 12, 13.5																																		

Common Name	Scientific Name	Quadrats, Transect 1-2																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Lyngby's sedge	*Carex lyngbyei*																						11, 9, 9, 9	

Notes:

Stem height in inches
Blank indicates no vegetation was observed in the quadrat
The measurements presented in this table represent the stem height of each plant sampled within the quadrat.

Table A-7b. Year 3 (2004) Marsh Development at Mowitch - *Carex* Shoot Density Collected Data

Common Name	Scientific Name	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	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Lyngby's sedge	*Carex lyngbyei*													79	16																																	

Common Name	Scientific Name	Quadrats, Transect 1-2																						
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Lyngby's sedge	*Carex lyngbyei*																						22	

Notes:

Shoot density in shoots per quadrat. Quadrats are 0.25 m^2 in area.
Blank indicates no vegetation was observed in the quadrat
The measurements presented in this table represent the stem height of each plant sampled within the quadrat.

Table A-8a. Year 3 (2004) Marsh Development at Mowitch - *Carex* Stem Height and Shoot Density Analysis

	Site Transect	Squally Beach Reference	Mowitch 1-1	Mowitch 1-2
	Total Number of Quadrats	3	46	23
	Number of Quadrats with *Carex*	3	2	1
Stem Height	Average of Non-Zero Cells	14.4	16.5	9.5
	Standard Deviation	6.2	n/a	n/a
	t-test p-value[a]		n/a[b]	n/a
	Significantly Different from Reference?		n/a	n/a
Shoot Density	Average of Non-Zero Cells	47.7	47.5	22
	Standard Deviation	30.6	n/a	n/a
	t-test p-value[a]		n/a	n/a
	Significantly Different from Reference?		n/a	n/a

[a] t-test was performed on log-transformed data to approximate normality; p-value is the probability of obtaining the observed result or a more extreme result, under the null hypothesis of no difference in population means.
[b] Species with less than three non-zero changes could not be statistically tested.

Table A-8b. Year 3 (2004) Marsh Development at Mowitch - Comparison of *Carex* Shoot Density, Years 1 - 3

Transect	Total Number of Quadrats	Total Quadrats with Decreased Shoot Density	Percent of Total Quadrats with No Change	Total Quadrats with Increased Shoot Density	Statistical Result[c]
Mowitch 1-1[d]	46	7%	89%	4%	No significant change
Mowitch 1-2[e]	23	0%	96%	4%	No Test[b]

[b] Species with less than three non-zero changes could not be statistically tested.
[c] "+" indicates a significant increase (two-tailed sign test, alpha = 0.05);
"-" indicates a significant decrease; other species are not significantly changed
[d] Comparison between Year 1 (2002) and Year 3 (2004) data.
[e] Comparison between Year 2 (2003) and Year 3 (2004) data.

Table A-9. Year 1 (2002) Riparian Development at Mowitch, Transect 2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence: Lower Bound	90% Confidence: Upper Bound
Native								
Herbs and Forbes								
bluegrass	*Poa sp.*	0.0	9.5%	2/21	0.5	n/a	n/a	n/a
lupine	*Lupinus sp.*	5.9	61.9%	13/21	9.5	3.7	0.3	7.1
purple-leaved willowherb	*Epilobium ciliatum*	1.2	38.1%	8/21	3.1	0.6	0.2	0.9
speedwell	*Veronica sp.*	0.3	14.3%	3/21	2.0	0.1	0.0	0.3
willowherb	*Epilobium sp.*	1.9	71.4%	15/21	2.7	1.0	0.5	1.5
Shrubs								
beaked hazelnut	*Corylus cornuta*	0.6	9.5%	2/21	6.0	n/a	n/a	n/a
common snowberry	*Symphoricarpos albus*	2.0	33.3%	7/21	5.9	0.9	0.3	1.5
dull Oregon-grape	*Mahonia nervosa*	0.1	4.8%	1/21	3.0	n/a	n/a	n/a
oceanspray	*Holodiscus discolor*	1.0	14.3%	3/21	7.3	0.5	0.0	1.0
red-flowering current	*Ribes sanguineum*	0.2	4.8%	1/21	5.0	n/a	n/a	n/a
red-osier dogwood	*Cornus stolonifera*	0.5	4.8%	1/21	10.0	n/a	n/a	n/a
rose	*Rosa sp.*	4.5	47.6%	10/21	9.4	2.1	1.0	3.2
salal	*Gaultheria shallon*	1.4	23.8%	5/21	6.0	0.7	0.2	1.2
Trees								
bigleaf maple	*Acer macrophyllum*	0.0	0.0%	0/21	n/a	n/a	n/a	n/a
Douglas fir	*Pseudotsuga menziesii*	1.2	9.5%	2/21	13.0	n/a	n/a	n/a
red alder	*Alnus rubra*	0.9	14.3%	3/21	6.0	0.4	0.0	0.9
western hemlock	*Tsuga heterophylla*	0.7	9.5%	2/21	7.5	n/a	n/a	n/a
Non-Native or Invasive								
Herbs and Forbes								
bentgrass	*Agrostis sp.*	0.0	0.0%	0/21	n/a	n/a	n/a	n/a
birds-foot trefoil	*Lotus corniculatus*	5.0	85.7%	18/21	5.9	2.4	1.1	3.7
black medick	*Medicago lupulina*	0.4	52.4%	11/21	0.8	0.2	0.1	0.3
brome	*Bromus sp.*	0.2	23.8%	5/21	0.7	0.1	0.0	0.1
bull thistle	*Cirsium vulgare*	0.2	9.5%	2/21	2.0	n/a	n/a	n/a
Canada thistle	*Cirsium arvense*	0.3	14.3%	3/21	2.0	0.2	0.0	0.5
cheatgrass	*Bromus tectorum*	0.0	0.0%	0/21	n/a	n/a	n/a	n/a
colonial bentgrass	*Agrostis tenuis*	0.1	4.8%	1/21	2.0	n/a	n/a	n/a
common dandelion	*Taraxacum officinale*	0.0	9.5%	2/21	0.5	n/a	n/a	n/a
common plantain	*Plantago major*	0.2	9.5%	2/21	1.8	n/a	n/a	n/a
common stork's-bill	*Erodium cicutarium*	0.0	0.0%	0/21	n/a	n/a	n/a	n/a
common velvet-grass	*Holcus lanatus*	0.5	47.6%	10/21	1.0	0.2	0.1	0.3
creeping buttercup	*Ranunculus repens*	0.1	19.0%	4/21	0.6	0.1	0.0	0.1
curly dock	*Rumex crispus*	0.1	4.8%	1/21	2.0	n/a	n/a	n/a
English plantain	*Plantago lanceolata*	1.0	47.6%	10/21	2.0	0.4	0.2	0.7
hairy catsear	*Hypochaeris radicata*	0.3	42.9%	9/21	0.6	0.1	0.1	0.2
knotweed	*Polygonum sp.*	0.1	9.5%	2/21	0.8	n/a	n/a	n/a
oxeye daisy	*Chrysanthemum leucanthemum*	0.0	0.0%	0/21	n/a	n/a	n/a	n/a
perennial ryegrass	*Lolium perenne*	10.8	100.0%	21/21	10.8	5.3	3.3	7.2
pineapple weed	*Matricaria discoidea*	0.0	9.5%	2/21	0.5	n/a	n/a	n/a
quackgrass	*Agropyron repens*	0.0	0.0%	0/21	n/a	n/a	n/a	n/a
rabbitfoot clover	*Trifolium arvense*	0.0	4.8%	1/21	1.0	n/a	n/a	n/a
red clover	*Trifolium pratense*	0.2	23.8%	5/21	1.0	0.1	0.0	0.2
redtop	*Agrostis alba*	0.4	9.5%	2/21	4.0	n/a	n/a	n/a
Siberian bitter-cress	*Cardamine oligosperma*	0.0	4.8%	1/21	1.0	n/a	n/a	n/a
thistle	*Cirsium sp.*	0.8	38.1%	8/21	2.0	0.4	0.1	0.6
toad rush	*Juncus bufonius*	0.0	4.8%	1/21	1.0	n/a	n/a	n/a
unclassified-composite	*unclassified-composite*	0.2	19.0%	4/21	1.3	0.1	0.0	0.2
unclassified-grass	*unclassified-grass*	0.1	9.5%	2/21	1.5	n/a	n/a	n/a
unclassified-herb	*unclassified-herb*	0.5	61.9%	13/21	0.9	0.2	0.1	0.4
western dock	*Rumex occidentalis*	0.0	0.0%	0/21	n/a	n/a	n/a	n/a
white clover	*Trifolium repens*	0.1	19.0%	4/21	0.6	0.1	0.0	0.1
white sweet-clover	*Melilotus alba*	3.1	100.0%	21/21	3.1	1.5	1.0	1.9
yarrow	*Achillea millefolium*	1.0	100.0%	21/21	1.0	0.5	0.3	0.6
yellow parentucellia	*Parentucellia viscosa*	0.0	4.8%	1/21	0.5	n/a	n/a	n/a
Shrubs								
Himalayan blackberry	*Rubus discolor*	0.0	4.8%	1/21	0.5	n/a	n/a	n/a
Scot's broom	*Cytisus scoparius*	0.1	9.5%	2/21	1.0	n/a	n/a	n/a
unknown	*unknown*	0.0	0.0%	0/21	n/a	n/a	n/a	n/a
	Total Herbs					16.9	11.6	22.2
	Total Shrubs					5.0	3.3	6.7
	Total Trees					1.5	0.1	2.9
	Total NNI					12.5	8.6	16.5
	Total Native					10.7	7.5	13.8

Table A-10. Year 3 (2004) Riparian Development at Mowitch, Transect 2 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	Quadrats, Transect 2																						
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Corresponding quadrat in year of origin (Year 1 - 2002)				n/a	n/a	1	3	4	8	10	11	14	16	19	21	25	28	29	31	35	36	39	42	43	44	45
Native																										
Emergents																										
bulrush	*Scirpus sp.*	0.0	1.0	1																						
Herbs and Forbes																										
aster	*Aster sp.*	0.2	4.0														5		3							
Douglas aster	*Aster subspicatus*	0.7	10.7																	15		15	2			
sicklekeel lupine	*Lupinus albicaulis*	2.3	8.8		10			10		5		5		20		10	30	5					1	5	0	5
western pearly everlasting	*Anaphalis margaritacea*	0.0	1.0														1									
yarrow	*Achillea millefolium*	14.2	38.3							1	40	50	10	10	40	55	80	90	40	60	50	30	25	30	15	25
Shrubs																										
beaked hazelnut	*Corylus cornuta*	0.7	15.0													5			25							
cluster rose	*Rosa pisocarpa*	3.2	24.2	10	30			15												5					40	45
common snowberry	*Symphoricarpos albus*	0.1	1.7							1		1					3									
currant	*Ribes sp.*	0.7	15.0			20							10													
nootka rose	*Rosa nutkana*	0.4	10.0								5									15						
red-osier dogwood	*Cornus stolonifera*	1.4	32.5																				25	40		
rose	*Rosa sp.*	0.8	9.5											5						20	3			10		
twinberry honeysuckle	*Lonicera involucrata*	0.0	1.0																						1	
vine maple	*Acer circinatum*	0.0	2.0															2								
Trees																										
black cottonwood	*Populus balsamifera*	0.2	10.0						10																	
Douglas fir	*Pseudotsuga menziesii*	0.4	6.0		5						10							3								
Oregon ash	*Fraxinus latifolia*	0.6	5.8				10						5		8			1						5		
red alder	*Alnus rubra*	5.4	22.5			15			10	3			40	15	10	30					10	45	35	35		
Sitka spruce	*Picea sitchensis*	0.1	3.0																							3
western red cedar	*Thuja plicata*	1.5	35.0																					25		45
willow	*Salix sp.*	3.2	16.4	3			1		1	45			3	25	10							15	45			
Non-Native or Invasive (NNI)																										
Herbs and Forbes																										
white sweet-clover	*Melilotus alba*	10.0	28.7	12		50	60	60	45		45	40	55	15	10	15	15	25	10	2	1					
non-natives/invasives		32.4	64.8	60	95	40	50	20	50	35	60	85	30	55	95	90	50	75	85	80	85	100	85	45	65	55
Shrubs																										
Himalayan blackberry	*Rubus discolor*	2.0	7.0						5			5		5	5			3	10	20	15	10	2	5	3	3

Table A-11. Year 3 (2004) Riparian Development at Mowitch, Transect 2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence Interval: Lower Bound	90% Confidence Interval: Upper Bound
Native								
Emergents								
bulrush	*Scirpus sp.*	0.04	4.3%	1/23	1.0	n/a	n/a	n/a
Herbs and Forbes								
aster	*Aster sp.*	0.3	8.7%	2/23	4.0	n/a	n/a	n/a
Douglas aster	*Aster subspicatus*	1.4	13.0%	3/23	10.7	2.0	0.0	5.3
sicklekeel lupine	*Lupinus albicaulis*	4.6	52.2%	12/23	8.9	5.6	1.3	9.9
western pearly everlasting	*Anaphalis margaritacea*	0.0	4.3%	1/23	1.0	n/a	n/a	n/a
yarrow	*Achillea millefolium*	28.3	73.9%	17/23	38.3	36.1	15.4	56.8
Shrubs								
beaked hazelnut	*Corylus cornuta*	1.3	8.7%	2/23	15.0	n/a	n/a	n/a
cluster rose	*Rosa pisocarpa*	6.3	26.1%	6/23	24.2	7.0	0.7	13.4
common snowberry	*Symphoricarpos albus*	0.2	13.0%	3/23	1.7	0.2	0.0	0.5
currant	*Ribes sp.*	1.3	8.7%	2/23	15.0	n/a	n/a	n/a
nootka rose	*Rosa nutkana*	0.9	8.7%	2/23	10.0	n/a	n/a	n/a
red-osier dogwood	*Cornus stolonifera*	2.8	8.7%	2/23	32.5	n/a	n/a	n/a
rose	*Rosa sp.*	1.7	17.4%	4/23	9.5	1.8	0.0	3.8
twinberry honeysuckle	*Lonicera involucrata*	0.0	4.3%	1/23	1.0	n/a	n/a	n/a
vine maple	*Acer circinatum*	0.1	4.3%	1/23	2.0	n/a	n/a	n/a
Trees								
black cottonwood	*Populus balsamifera*	0.4	4.3%	1/23	10.0	n/a	n/a	n/a
Douglas fir	*Pseudotsuga menziesii*	0.8	13.0%	3/23	6.0	0.8	0.0	1.7
Oregon ash	*Fraxinus latifolia*	1.3	21.7%	5/23	5.8	1.5	0.0	3.0
red alder	*Alnus rubra*	10.8	47.8%	11/23	22.5	11.8	4.7	18.8
Sitka spruce	*Picea sitchensis*	0.1	4.3%	1/23	3.0	n/a	n/a	n/a
western red cedar	*Thuja plicata*	3.0	8.7%	2/23	35.0	n/a	n/a	n/a
willow	*Salix sp.*	6.4	39.1%	9/23	16.4	9.1	0.0	20.8
Non-Native or Invasive								
Herbs and Forbes								
white sweet-clover	*Melilotus alba*	20.0	69.6%	16/23	28.7	26.3	8.1	44.5
unknown	*unknown*	64.8	100.0%	23/23	64.8	65.6	55.8	75.5
Shrubs								
Himalayan blackberry	*Rubus discolor*	4.0	56.5%	13/23	7.0	4.0	2.1	5.8
	Total Herbs					120.4	104.5	136.3
	Total Shrubs					20.5	10.7	30.3
	Total Trees					26.1	11.7	40.5
	Total NNI					89.4	79.8	99.0
	Total Native					76.5	55.6	97.4

Table A-12. Year 3 (2004) Fish Monitoring Data at Mowitch

Date	High Tide	Low Tide	Time	Gear	Temperature (degree Celcius)		Salinity (ppt)		Weather
					Surface	Bottom	Surface	Bottom	
04/09/04	H 11.49' 6:30	L -2.58' 13:30	8:15 AM	Block Net	12.5	10.6	19.3	26.2	sunny
04/23/04	H 10.11' 6:12	L -0.07' 14:00	8:18 AM	Block Net	12.2	10.3	22.3	27.6	cloudy-rain
05/07/04	H 11.57' 5:38	L -3.2 12:52	7:37 AM	Block Net	12.7	11.2	16	27	hard rain
05/24/04	H 9.04' 7:34	L -0.5' 15:12	8:20 AM	Block Net	14.8	11.6	16.1	27.3	sunny
06/07/04	H 9.98' 7:44	L -2.0' 15:04	9:30 AM	Block Net	12.9	11.5	15.2	28.4	sunny
06/22/04	H 9.04' 7:25	L -0.7' 14:43	8:38 AM	Block Net	17.7	13.5	22.7	27.8	partly cloudy
07/07/04	H 8.84' 9:02	L 0.5' 15:31	10:08 AM	Block Net	15.5	14.5	22.3	25	partly cloudy
07/21/04	H 9.26' 7:28	L -0.1' 14:15	9:42 AM	Block Net	16.2	15.8	3.9	25.4	sunny
08/04/04	H 9.88' 7:54	L 0.4' 14:19	8:48 AM	Block Net	16.5	15.4	22.6	27.7	sunny
08/19/04	H 9.88' 7:32	L 1.2' 13:50	7:57 AM	Block Net	18.1	17.4	24.1	26	partly cloudy
09/01/04	H 10.6' 7:00	L 1.0' 13:14	8:00 AM	Block Net	16.9	16.3	23.2	25.7	raining

Table A-13. Year 3 (2004) Total Fish Catch at Mowitch

			Chinook				Coho								Steelhead																																					
No. of Sets	Date	Time	Unmarked	Marked	Not checked	Total	Unmarked	Marked	Not checked	Total	Chum	Pink	Cutthroat	Dolly Varden/Bull Trout	Unmarked	Marked	Not checked	Total	Total Salmonids	English Sole	Starry Flounder	Rock Sole	Speckled Sandab	Right Eyed Flatfish	Staghorn Sculpin	Silverspot Sculpin	Great Sculpin	Northern Sculpin	Buffalo Sculpin	Cabezon Sculpin	Tidepool Sculpin	Sailfin Sculpin	Surf Smelt	Shiner Perch	Striped Perch	Pile Perch	Kelp Perch	Penpoint Gunnel	Crescent Gunnel	Saddleback Gunnel	Tubesnout	Pipefish	Stickleback	Snake Prickleback	Herring	Sandlance	Shad	Greenling- white spot	Sturgeon Poacher	Ratfish	Northern Anchovy	Total
1	04/09/04	12:00 PM				0	1			1	2							0	**3**		2				20						1		2										8								**36**
1	04/23/04	12:15 PM				0				0								0	**0**						1						1																				**2**
1	05/07/04	11:06 AM				0	2			2	1		1					0	**4**		52				340				1					704					1				23	1	2						**1128**
1	05/24/04	12:15 PM				0				0								0	**0**		215				539		1		3					690									1	1							**1450**
1	06/07/04	12:15 PM	1	1		2	2	10		12								0	**14**		100				180									2650								1	19	3	132						**3099**
1	06/22/04	12:30 PM				0			1	1								0	**1**		104				84				3		1			2980		1							6	1							**3181**
1	07/07/04	1:30 PM				0				0								0	**0**		22				98				5		1			1260									3	6							**1395**
1	07/21/04	12:24 PM				0				0								0	**0**		7				7									200									2					1			**217**
1	08/04/04	12:41 PM				0	1			1								0	**1**		6				15				1					200									29								**252**
1	08/19/04	10:18 AM				0				0								0	**0**		5				14		1		0					800									200					1			**1021**
1	09/01/04	12:20 PM				0				0								0	**0**		5				10						2			195									149								**361**
11	**TOTAL**		**1**	**1**	**0**	**2**	**6**	**10**	**1**	**17**	**3**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**23**	**0**	**518**	**0**	**0**	**0**	**1308**	**0**	**2**	**0**	**13**	**0**	**6**	**0**	**2**	**9679**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**1**	**440**	**12**	**134**	**0**	**0**	**2**	**0**	**0**	**0**	**12142**

Table A-14a. Year 3 (2004) Invertebrate Presence at Mowitch - Fallout Samples

Sample Type		Sample No.						Grand
Order	**Family**	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Coleoptera	(not identified)			1				**1**
Diptera	Ephydridae				19	7		**26**
	Rhagionidae	1	2		2	1		**6**
	Tipulidae		1	3	1			**5**
Hemiptera	Saldidae					1		**1**
Homoptera	(not identified)			1				**1**
Trichoptera	(not identified)		1					**1**
Unknown	(not identified)	1						**1**
Grand Total		**2**	**4**	**5**	**22**	**9**	**0**	**42**

Table A-14b. Year 3 (2004) Invertebrate Presence at Mowitch - Substrate Samples

Sample Type		Sample No.						Grand
Order	**Family**	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Amphipoda	(not identified)	8				8		**16**
Grand Total		**8**	**0**	**0**	**0**	**8**	**0**	**16**

Table A-15. Year 3 (2004) Seasonal Bird Counts at Mowitch

Common Name	Scientific Name	Total	Winter	Spring	Summer	Fall
American coot	*Fulica americana*	1				1
American crow	*Corvus brachyrhynchos*	76	1			75
American goldfinch	*Carduelis tristis*	19		3	16	
American robin	*Turdus migratorius*	5		4	1	
American wigeon	*Anas americana*	35	8	6	3	18
barn swallow	*Hirundo rustica*	15		5	10	
belted kingfisher	*Ceryle alcyon*	9			8	1
Brewer's blackbird	*Euphagus cyanocephalus*	1			1	
bufflehead	*Bucephala albeola*	1		1		
bushtit	*Psaltriparus minimus*	4			4	
Canada goose	*Branta canadensis*	113	2	31	80	
cedar waxwing	*Bombycilla cedrorum*	2			2	
cliff swallow	*Petrochelidon pyrrhonota*	18		15	3	
common goldeneye	*Bucephala clangula*	2	2			
common yellowthroat	*Geothylpis trichas*	2			2	
cowbird	*Molothrus sp.*	1			1	
crow	*Corvus sp.*	3			3	
double-crested	*Phalacrocorax auritus*	5		2	3	
European starling	*Sturnus vulgaris*	219		50	148	21
gadwall	*Anas strepera*	12		12		
glaucous-winged gull	*Larus glaucescens*	31	1	5	7	18
great blue heron	*Ardea herodias*	9		1	6	2
green-winged teal	*Anas crecca*	6		6		
hooded merganser	*Lophodytes cucullatus*	1				1
house finch	*Carpodacus mexicanus*	28	5	5	13	5
killdeer	*Charadrius vociferus*	35	2	22	11	
kingfisher	*Ceryle sp.*	1			1	
mallard	*Anas platyrhynchos*	95	4	18	71	2
mallard cross		1				1
mourning dove	*Zenaida macroura*	26		12	14	
Oregon junco	*Junco hyemalis*	1			1	
pied-bill grebe	*Podilymbus podiceps*	6			4	2
purple martin	*Progne subis*	2			2	
red-tailed hawk	*Buteo jamaicensis*	2		1	1	
savannah sparrow	*Passerculus sandwichensis*	9	2	1	6	
snipe	*Gallinago delicata or Lymnocryptes minimus*	1			1	
song sparrow	*Melospiza melodia*	24	1	9	12	2
spotted sandpiper	*Actitis macularia*	17		9	8	
tree swallow	*Tachycineta bicolor*	8		8		
violet-green swallow	*Tachycineta thalassina*	6		3	3	
western sandpiper	*Calidris mauri*	6		6		
white-crowned sparrow	*Zonotrichia leucophrys*	5		5		
TOTAL		**863**	**28**	**240**	**446**	**149**

Notes:
Blank indicates no bird was observed.

Winter = December to February
Spring = March to May
Summer = June to August
Fall = September to November

Table A-16. Year 3 (2004) 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
1/30/2004	American crow	*Corvus brachyrhynchos*	U	1	H	x			x							
	American wigeon	*Anas americana*	F	8	H	x									x	
	Canada goose	*Branta canadensis*	U	2	H	x							x			loafing
	common goldeneye	*Bucephala clangula*	U	2	H	x									x	male & female
	glaucous-winged gull	*Larus glaucescens*	U	1	H	x			x							
	house finch	*Carpodacus mexicanus*	U	2	H	x	x		x							
	house finch	*Carpodacus mexicanus*	U	3	H	x							x			foraging
	killdeer	*Charadrius vociferus*	U	2	H	x									x	
	mallard	*Anas platyrhynchos*	U	4	H	x									x	male & female
	savannah sparrow	*Passerculus sandwichensis*	U	2	H		x				x					
	song sparrow	*Melospiza melodia*	U	1	H	x					x					foraging
3/25/2004	American wigeon	*Anas americana*	F	3	H	x									x	
	American wigeon	*Anas americana*	M	3	H	x									x	
	bufflehead	*Bucephala albeola*	F	1	H	x									x	
	Canada goose	*Branta canadensis*	U	5	H	x	x				x				x	1 on nest in riparian
	double-crested cormorant	*Phalacrocorax auritus*	U	1	H	x			x							
	glaucous-winged gull	*Larus glaucescens*	U	1	H				x							
	killdeer	*Charadrius vociferus*	U	2	H	x	x				x		x			riparian nest w/ 4 eggs; broken-wing behavior
	mallard	*Anas platyrhynchos*	M	1	H	x									x	large dark male, half-mallard cross, paired w/ mallard
	mallard	*Anas platyrhynchos*	M	1	H	x									x	
	mallard	*Anas platyrhynchos*	F	2	H	x									x	
	mourning dove	*Zenaida macroura*	U	1	H	x			x	x						
	red-tailed hawk	*Buteo jamaicensis*	U	1	H	x			x							2 flyovers; pearched east of site
	song sparrow	*Melospiza melodia*	U	2	H	x					x					
	spotted sandpiper	*Actitis macularia*	U	1	H	x							x			
4/13/2004	Canada goose	*Branta canadensis*	U	11	H	x			x			x	x	x		1 pr w/ goslings, 2 fem on nests @ far end of site near water
	Canada goose	*Branta canadensis*	U	4	H	x										4 chicks w/ pair in the water
	double-crested cormorant	*Phalacrocorax auritus*	U	1	H	x									x	
	European starling	*Sturnus vulgaris*	U	4	H	x			x		x	x				
	gadwall	*Anas strepera*	M	4	H	x						x	x		x	
	gadwall	*Anas strepera*	F	4	H	x						x	x		x	
	glaucous-winged gull	*Larus glaucescens*	U	2	H	x			x		x	x				
	green-winged teal	*Anas crecca*	M	3	H	x							x		x	
	green-winged teal	*Anas crecca*	F	3	H	x							x			
	house finch	*Carpodacus mexicanus*	M	1	H	x			x		x					
	house finch	*Carpodacus mexicanus*	U	1	H	x					x					
	killdeer	*Charadrius vociferus*	U	6	H	x	x					x		x		calling lots - all appear to be paired
	mallard	*Anas platyrhynchos*	U	1	H	x									x	"domestic mall" = mallard cross?
	mallard	*Anas platyrhynchos*	M	1	H	x										loafing
	mallard	*Anas platyrhynchos*	F	1	H	x										loafing
	mourning dove	*Zenaida macroura*	U	4	H	x			x	x	x					flying & landing continuous
	savannah sparrow	*Passerculus sandwichensis*	U	1	H	x	x				x	x				
	song sparrow	*Melospiza melodia*	U	1	H	x										
	spotted sandpiper	*Actitis macularia*	U	1	H	x								x		foraging
	white-crowned sparrow	*Zonotrichia leucophrys*	M	2	H	x	x			x	x					singing repeatedly - nesting behavior
4/29/2004	American goldfinch	*Carduelis tristis*	U	1	M	x	x		x							
	American robin	*Turdus migratorius*	U	2	M	x					x					male & female; carrying food to S. side of waterway
	barn swallow	*Hirundo rustica*	U	2	M	x			x							
	Canada goose	*Branta canadensis*	U	2	M	x	x									
	cliff swallow	*Petrochelidon pyrrhonota*	U	2	M	x			x							
	European starling	*Sturnus vulgaris*	U	6	M	x			x			x				
	gadwall	*Anas strepera*	U	4	M	x									x	
	killdeer	*Charadrius vociferus*	U	4	M	x	x					x	x			territorial scoulding
	mallard	*Anas platyrhynchos*	M	3	M	x										
	mallard	*Anas platyrhynchos*	F	2	M	x										
	mallard	*Anas platyrhynchos*	U	1	M	x										cross-bred; paired w/ male mallard
	mourning dove	*Zenaida macroura*	U	6	M	x					x					2 flush repeatedly from mid-raparian
	song sparrow	*Melospiza melodia*	U	2	M	x	x				x					
	spotted sandpiper	*Actitis macularia*	U	1	M	x	x						x			
	violet-green swallow	*Tachycineta thalassina*	U	1	M	x			x							
	western sandpiper	*Calidris mauri*	U	6	M	x	x					x	x			
	white-crowned sparrow	*Zonotrichia leucophrys*	M	2	M	x	x				x					2 males singing
5/21/2004	American goldfinch	*Carduelis tristis*	M	2	M	x	x		x							
	American robin	*Turdus migratorius*	U	2	M	x					x					male & female; 1 singing
	barn swallow	*Hirundo rustica*	U	2	M	x				x						foraging
	Canada goose	*Branta canadensis*	U	9	M	x									x	2 w/ 2 goslings; 5 others
	cliff swallow	*Petrochelidon pyrrhonota*	U	10	M	x			x				x			collecting feathers; foraging
	European starling	*Sturnus vulgaris*	U	30	M	x	x				x		x			foraging; lots of young birds
	great blue heron	*Ardea herodias*	M	1	M	x							x			foraging
	house finch	*Carpodacus mexicanus*	U	3	M	x							x			foraging
	killdeer	*Charadrius vociferus*	U	6	M	x	x					x	x			
	mallard	*Anas platyrhynchos*	M	4	M	x									x	loafing
	mallard	*Anas platyrhynchos*	U	1	M	x						x				mallard cross; loafing
	mourning dove	*Zenaida macroura*	U	1	M	x					x					flushed twice from riparian; nest? - could not find it
	song sparrow	*Melospiza melodia*	U	2	M	x	x				x					1 singing
	spotted sandpiper	*Actitis macularia*	U	2	M	x	x						x			
	tree swallow	*Tachycineta bicolor*	U	2	M	x			x						x	foraging
	violet-green swallow	*Tachycineta thalassina*	U	2	M	x			x	x						2-3; foraging
	white-crowned sparrow	*Zonotrichia leucophrys*	M	1	M	x	x				x					1 singing
5/26/2004	barn swallow	*Hirundo rustica*	U	1	M	x			x							
	cliff swallow	*Petrochelidon pyrrhonota*	U	3	M	x			x							
	European starling	*Sturnus vulgaris*	U	10	M	x	x		x							Approximate number
	glaucous-winged gull	*Larus glaucescens*	U	2	M	x			x							
	killdeer	*Charadrius vociferus*	U	4	M	x	x				x		x			
	song sparrow	*Melospiza melodia*	U	2	M	x	x				x					
	spotted sandpiper	*Actitis macularia*	U	4	M	x	x				x		x			1 pair displayed broken wing behavior. Both males and females seen.
	tree swallow	*Tachycineta bicolor*	U	6	M	x			x							
6/28/2004	American goldfinch	*Carduelis tristis*	M	2	L	x	x				x					
	belted kingfisher	*Ceryle alcyon*	M	1	L	x	x								x	
	belted kingfisher	*Ceryle alcyon*	F	1	L	x	x								x	belted kingfishers appear to be pair, juvenile & parent
	Canada goose	*Branta canadensis*	U	38	L	x							x		x	
	European starling	*Sturnus vulgaris*	U	7	L	x	x				x					
	great blue heron	*Ardea herodias*	U	1	L	x						x	x			
	house finch	*Carpodacus mexicanus*	M	1	L	x						x				

Table A-16. Year 3 (2004) 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
	killdeer	*Charadrius vociferus*	U	3	L	x	x						x			
	mallard	*Anas platyrhynchos*	U	15	L	x							x		x	male & female
	mourning dove	*Zenaida macroura*	U	2	L	x					x					flushed from ground - nesting?
	purple martin	*Progne subis*	U	2	L	x									x	foraging, perching on geese w.res [?] 2 juvs.
	savannah sparrow	*Passerculus sandwichensis*	U	3	L	x					x					2 juvs, 1 adult
	song sparrow	*Melospiza melodia*	U	1	L	x						x				
	spotted sandpiper	*Actitis macularia*	U	2	L	x	x				x					
	violet-green swallow	*Tachycineta thalassina*	U	2	L	x									x	
6/29/2004	American goldfinch	*Carduelis tristis*	U	8	L	x	x		x		x		x			
	American robin	*Turdus migratorius*	M	1	L	x					x					on fence
	American wigeon	*Anas americana*	U	3	L	x									x	
	belted kingfisher	*Ceryle alcyon*	U	2	L	x										chase
	Brewer's blackbird	*Euphagus cyanocephalus*	U	1	L	x			x							
	bushtit	*Psaltriparus minimus*	U	4	L	x					x					foraging
	Canada goose	*Branta canadensis*	U	15	L	x	x		x						x	
	cliff swallow	*Petrochelidon pyrrhonota*	U	3	L	x			x					x		
	common yellowthroat	*Geothylpis trichas*	U	2	L	x										immature
	cowbird	*Molothrus sp.*	M	1	L	x			x							
	European starling	*Sturnus vulgaris*	U	8	L	x	x				x					
	glaucous-winged gull	*Larus glaucescens*	U	1	L	x			x							
	great blue heron	*Ardea herodias*	U	1	L	x							x			
	killdeer	*Charadrius vociferus*	U	3	L											
	mallard	*Anas platyrhynchos*	F	8	L	x									x	female w/ 4 ducklings
	mourning dove	*Zenaida macroura*	U	4	L	x	x		x		x					
	Oregon junco	*Junco hyemalis*	M	1	L	x					x					
	savannah sparrow	*Passerculus sandwichensis*	U	1	L	x	x									
	song sparrow	*Melospiza melodia*	M	2	L	x					x					singing
	spotted sandpiper	*Actitis macularia*	U	4	L											
	violet-green swallow	*Tachycineta thalassina*	M	1	L	x					x					preening on fence (white surrounding eye)
8/27/2004	American goldfinch	*Carduelis tristis*	U	4	L		x		x		x					
	barn swallow	*Hirundo rustica*	U	10	L	x			x							foraging (saw all 10 together on the adj. parking lot!)
	belted kingfisher	*Ceryle alcyon*	U	2	L	x	x		x		x					
	European starling	*Sturnus vulgaris*	U	120	L	x	x				x		x			flocking; foraging
	glaucous-winged gull	*Larus glaucescens*	U	1	L				x							
	great blue heron	*Ardea herodias*	U	2	L	x			x				x			loafing
	house finch	*Carpodacus mexicanus*	U	6	L	x	x		x		x	x				
	killdeer	*Charadrius vociferus*	U	4	L	x	x						x			2 prs.
	mallard	*Anas platyrhynchos*	U	2	L	x			x							
	mallard	*Anas platyrhynchos*	U	24	L	x							x		x	loafing, W end of site
	mourning dove	*Zenaida macroura*	U	4	L						x		x			
	song sparrow	*Melospiza melodia*	U	3	L	x	x				x					
9/20/2004	American goldfinch	*Carduelis tristis*	U	2	H		x									
	cedar waxwing	*Bombycilla cedrorum*	U	2	H	x	x				x					
	European starling	*Sturnus vulgaris*	U	10	H	x			x		x					
	glaucous-winged gull	*Larus glaucescens*	U	2	H	x			x							
	great blue heron	*Ardea herodias*	U	1	H	x					x					in cedar across waterway
	house finch	*Carpodacus mexicanus*	U	2	H	x	x					x			x	
	kingfisher	*Ceryle sp.*	M	1	H	x			x		x					perched in alder
	mallard	*Anas platyrhynchos*	M	3	H	x						x			x	loafing
	mallard	*Anas platyrhynchos*	F	3	H	x						x			x	loafing
	mallard	*Anas platyrhynchos*	M	1	H	x										mallard-cross; loafing
	mourning dove	*Zenaida macroura*	U	2	H	x					x					
	pied-bill grebe	*Podilymbus podiceps*	U	2	H	x									x	foraging; preening
	red-tailed hawk	*Buteo jamaicensis*	U	1	H	x			x							pale juvenile - hunting
	savannah sparrow	*Passerculus sandwichensis*	U	2	H		x									
	song sparrow	*Melospiza melodia*	U	4	H	x										
	spotted sandpiper	*Actitis macularia*	U	2	H	x										
9/30/2004	belted kingfisher	*Ceryle alcyon*	U	2	H	x	x		x	x						male on piling
	Canada goose	*Branta canadensis*	U	27	H	x	x		x							
	crow	*Corvus sp.*	U	3	H	x						x	x			
	double-crested cormorant	*Phalacrocorax auritus*	U	3	H	x				x					x	on logs loafing
	European starling	*Sturnus vulgaris*	U	3	H	x			x		x					
	glaucous-winged gull	*Larus glaucescens*	U	3	H	x			x						x	
	great blue heron	*Ardea herodias*	U	1	H	x						x	x			
	house finch	*Carpodacus mexicanus*	M	4	H	x	x				x	x				
	killdeer	*Charadrius vociferus*	U	1	H	x						x	x			
	mallard	*Anas platyrhynchos*	M	1	H	x									x	mallard-cross
	mallard	*Anas platyrhynchos*	F	8	H	x									x	2 flyover
	mallard	*Anas platyrhynchos*	M	6	H	x									x	1 flyover
	mourning dove	*Zenaida macroura*	U	2	H	x										
	pied-bill grebe	*Podilymbus podiceps*	U	2	H	x									x	foraging
	snipe	*Gallinago delicata or Lymnocryptes minimus*	U	1	H	x					x					
	song sparrow	*Melospiza melodia*	U	2	H	x	x				x					
11/12/2004	American coot	*Fulica americana*	U	1	H	x									x	
	American crow	*Corvus brachyrhynchos*	U	75	H	x										Flying to roost
	American wigeon	*Anas americana*	U	18	H	x									x	Loafing, some foraging at shoreline
	belted kingfisher	*Ceryle alcyon*	M	1	H	x	x									
	European starling	*Sturnus vulgaris*	U	21	H	x					x					Loafing
	glaucous-winged gull	*Larus glaucescens*	U	18	H	x				x					x	9 on pilings, 2 on open water
	great blue heron	*Ardea herodias*	U	2	H	x				x						Loafing
	hooded merganser	*Lophodytes cucullatus*	M	1	H	x									x	
	house finch	*Carpodacus mexicanus*	U	2	H		x									At least 2
	house finch	*Carpodacus mexicanus*	U	3	H	x	x				x					
	mallard	*Anas platyrhynchos*	F	1	H	x						x				
	mallard	*Anas platyrhynchos*	M	1	H	x						x				
	mallard cross		U	1	H	x									x	
	pied-bill grebe	*Podilymbus podiceps*	U	2	H	x									x	
	song sparrow	*Melospiza melodia*	U	2	H	x	x				x	x				Foraging

Table A-17a. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Squally Beach (East Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	639	100	639	*Carex lyngbyei*
MB	154	90	139	*Carex lyngbyei, Grindelia integrifolia, Distichlis spicata*
MC	62	60	37	*Grindelia integrifolia, Salicornia virginica*
MD	255	100	255	*Carex lyngbyei, Distichlis spicata*
ME	238	100	238	*Scirpus americanus*
MF	221	100	221	*Distichlis spicata*
MG	26	100	26	*Distichlis spicata*
MH	150	80	120	*Grindelia integrifolia*
MI	156	90	140	*Grindelia integrifolia, Atriplex patula*
MJ	69	80	55	*Distichlis spicata, Atriplex patula*
MK	96	80	77	*Grindelia integrifolia, Salicornia virginica*
ML	57	100	57	*Distichlis spicata*
MM	22	100	22	*Atriplex patula, Lotus corniculatus*
MN	99	90	89	*Distichlis spicata, Plantago maritima, Salicornia virginica*
MO	70	75	53	*Distichlis spicata, Atriplex patula*
MP	6	100	6	*Grindelia integrifolia, Jaumea carnosa*
MQ	176	90	158	*Plantago maritima, Scirpus maritimus, Grindelia integrifolia, Salicornia virginica*
MR	141	100	141	*Carex lyngbyei, Distichlis spicata*
MS	311	90	280	*Carex lyngbyei*
MT	16	100	16	*Typha angustifolia*
MU	206	100	206	*Atriplex patula*
MV	1	100	1	*Scirpus maritimus, Salicornia virginica*
MW	35	80	28	*Scirpus maritimus*
MX	214	95	203	*Distichlis spicata, Salicornia virginica*
MY	211	80	169	*Salicornia virginica, Cotula coronopifolia*
MZ	267	60	160	*Salicornia virginica*
Total (sq. ft.)	**3,898**		**3,536**	
Total (acres)	**0.09**		**0.08**	

Table A-17b. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Squally Beach (Center and Fill-in Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	827	90	744	*Distichlis spicata*
MB	73	75	55	*Salicornia virginica*
MC	69	90	62	*Jaumea carnosa, Atriplex patula*
MD	12	80	10	*Cotula coronopifolia*
ME	111	75	83	*Salicornia virginica*
MF	131	50	66	*Jaumea carnosa, Atriplex patula*
MG	56	30	17	*Eleocharis* sp.
MH	37	30	11	*Eleocharis* sp.
MI	3	25	1	*Eleocharis* sp.
MJ	3	30	1	*Eleocharis* sp.
MK	101	25	25	*Eleocharis* sp.
ML	4	35	1	*Eleocharis* sp.
MM	point	25	1	*Eleocharis* sp.
MN	72	25	18	*Eleocharis* sp.
MO	8	60	5	*Eleocharis* sp.
MP	26	60	16	*Eleocharis* sp.
MQ	47	95	45	*Jaumea carnosa*
MR	4	30	1	*Eleocharis* sp.
MS	137	98	134	*Distichlis spicata, Salicornia virginica, Glaux maritima, Jaumea carnosa*
MT	22	95	21	*Grindelia integrifolia, Atriplex patula, Distichlis spicata*
MU	25	95	24	*Distichlis spicata, Jaumea carnosa, Atriplex patula*
MV	46	75	35	*Grindelia integrifolia, Atriplex patula*
MW	186	25	47	*Salicornia virginica, Jaumea carnosa, Atriplex patula*
MX	582	70	407	*Salicornia virginica, Jaumea carnosa, Grindelia integrifolia*
MY	900	30	270	*Salicornia virginica*
MZ	77	100	77	*Carex lyngbyei*
Total (sq. ft.)	**3,559**		**2,175**	
Total (acres)	**0.08**		**0.05**	

Table A-17c. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Squally Beach (South Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	104	80	83	*Jaumea carnosa, Atriplex patula, Eleocharis* sp., *Cotula coronopifolia*
MB	1,213	100	1,213	*Scirpus americanus, Scirpus acutus, Scirpus maritimus* .
MC	128	98	125	*Scirpus acutus, Scirpus* sp., Atriplex patula
MD	46	80	37	*Scirpus maritimus*
ME	239	80	191	*Atriplex patula, Distichlis spicata, Grindelia integrifolia*
MF	22	65	14	*Scirpus maritimus*
MG	155	65	101	*Atriplex patula, Distichlis spicata, Jaumea carnosa*
MH	385	65	250	*Atriplex patula, Grindelia integrifolia, Aster douglasii*
MI	37	65	24	*Atriplex patula, Salicornia virginica*
MJ	163	80	130	*Atriplex patula, Distichlis spicata, Grindelia integrifolia, Jaumea carnosa*
MK	14	75	11	*Atriplex patula, Grindelia integrifolia*
ML	436	55	240	*Atriplex patula, Cotula coronopifolia*
MM	183	80	146	*Scirpus americanus, Scirpus maritimus*
MN	68	60	41	*Distichlis spicata, Plantage maritima, Jaumea carnosa*
MO	145	85	123	*Distichlis spicata*
MP	140	95	133	*Carex lyngbyei, Jaumea carnosa*
MQ	79	100	79	*Distichlis spicata*
MR	104	75	78	*Jaumea carnosa*
MS	point	98	1	*Atriplex patula*
MT	16	60	10	*Atriplex patula, Grindelia integrifolia*
MU	2	30	1	*Eleocharis* sp.
MV	24	30	7	*Eleocharis* sp., *Cotula coronopifolia*
MW	point	30	1	*Eleocharis* sp.
MX	point	80	1	*Eleocharis* sp.
MY	point	90	1	*Eleocharis* sp.
MZ	point	90	1	*Eleocharis* sp.
Total (sq. ft.)	**3,703**		**3,043**	
Total (acres)	**0.09**		**0.07**	

Table A-17d. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Squally Beach (Fill-in Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	point	90	1	*Eleocharis* sp.
MB	point	80	1	*Eleocharis* sp.
MC	point	80	1	*Eleocharis* sp.
MD	point	100	1	*Elymus* sp.
Total (sq. ft.)	**-**		**4**	
Total (acres)	**-**		**0.00**	

Total Year 3 Vegetated Marsh Area:

(sq.ft.)	**8,758**
(acres)	**0.20**

For comparison:
Total Year 1 Vegetated Marsh Area:

(sq.ft.)	**2,754**
(acres)	**0.06**

Table A-17e. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Squally Beach (Riparian Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
RA	4,521	100	4,521	*Alnus rubra, Juncus effusus, Lotus corniculatus, Rosa sp., Salix* sp.
RB	3,505	100	3,505	*Alnus rubra, Salix* sp., *Symphoricarpos albus, Rosa* sp.
RC	4,031	98	3,950	*Rubus discolor, Rosa sp., Lotus corniculatus, grasses*
RD	3,806	100	3,806	*Alnus rubra, Rosa sp., Rubus discolor, Equisetum telmateia*
RE	101	100	101	*Lotus corniculatus*
RF	223	90	201	*Lotus corniculatus, Dypsacus sylvestris, Circium vulgare*
RG	25	90	23	*Lotus corniculatus*
Total (sq. ft.)	**16,212**		**16,107**	
Total (acres)	**0.37**		**0.37**	

For comparison:
Total Year 1 Vegetated Riparian Area:

(sq.ft.)	**8,922**
(acres)	**0**

Table A-18. Quadrat Locations Along Marsh and Riparian Transects at Squally Beach.

Marsh Transect 1-1		Marsh Transect 1-2		Marsh Transect 1-3		Marsh Transect C-1		Riparian Transect 2	
Quadrat	Distance Along Transect (ft)	Quadrat	Distance Along Transect (ft)	Quadrat	Distance Along Transect (ft)	Quadrat	Distance Along Transect (ft)	Quadrat	Distance Along Transect (ft)
1	29	1	3	1	3	1	20	1	37
2	31	2	86	2	7	2	50	2	72
3	50	3	111	3	9	3	80	3	86
4	79	4	116	4	17			4	134
5	87	5	135	5	53			5	209
6	94	6	137	6	68			6	230
7	109	7	142	7	75			7	272
8	128	8	166	8	94			8	317
9	130	9	173	9	96			9	353
10	135	10	177	10	103			10	365
11	144	11	259	11	108				
12	151	12	315	12	115				
13	159	13	317	13	120				
14	166	14	344	14	132				
15	170	15	361	15	153				
16	199			16	192				
17	236								
18	238								
19	252								
20	265								
21	267								
22	308								
23	310								
24	326								

Table A-19a. Year 1 (2002) Marsh Development at Squally Beach, Transect 1-1 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence Lower Bound	90% Confidence Upper Bound
Native								
pickleweed	*Salicornia virginica*	1.7	26.1%	6/23	6.4	2.0	0.0	4.3
fleshy jaumea	*Jaumea carnosa*	9.2	30.4%	7/23	30.1	13.8	0.0	39.2
Lyngby's sedge	*Carex lyngbyei*	0.4	4.3%	1/23	10.0	n/a	n/a	n/a
orache, fat-hen salt bush	*Atriplex patula*	5.3	47.8%	11/23	11.2	4.6	1.8	7.4
seaside plantain	*Plantago maritima*	0.2	8.7%	2/23	2.8	n/a	n/a	n/a
seashore saltgrass	*Distichlis spicata*	2.1	21.7%	5/23	9.7	2.9	0.0	7.8
Canopy Cover, Native		19.0			33.5	19.1	4.5	33.7
Non-Native or Invasive								
broadleaved pepperweed	*Lepidium latifolium*	0.4	8.7%	2/23	5.0	n/a	n/a	n/a
bull thistle	*Cirsium vulgare*	0.2	4.3%	1/23	5.0	n/a	n/a	n/a
white sweet-clover	*Melilotus alba*	0.2	4.3%	1/23	5.0	n/a	n/a	n/a
Canopy Cover, NNI		0.9			10.0	n/a	n/a	n/a
TOTAL		19.8			43.5	19.0	6.2	31.9
Proportion of non-native or invasive plants (%):		4.4%			23.0%	n/a		

Table A-19b. Year 1 (2002) Marsh Development at Squally Beach, Transect 1-2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence Lower Bound	90% Confidence Upper Bound
Native								
American bulrush	*Scirpus americanus*	7.7	20.0%	3/15	38.3	12.7	0.0	39.5
pickleweed	*Salicornia virginica*	1.0	6.7%	1/15	15.0	n/a	n/a	n/a
creeping spike-rush	*Eleocharis palustris*	0.3	6.7%	1/15	5.0	n/a	n/a	n/a
fleshy jaumea	*Jaumea carnosa*	1.0	6.7%	1/15	15.0	n/a	n/a	n/a
Lyngby's sedge	*Carex lyngbyei*	7.5	13.3%	2/15	56.5	n/a	n/a	n/a
orache, fat-hen salt bush	*Atriplex patula*	12.8	80.0%	12/15	16.0	19.0	0.6	37.5
perennial ryegrass	*Lolium perenne*	0.1	13.3%	2/15	0.5	n/a	n/a	n/a
red alder	*Alnus rubra*	0.3	6.7%	1/15	5.0	n/a	n/a	n/a
Scouler's willow	*Salix scouleriana*	2.0	6.7%	1/15	30.0	n/a	n/a	n/a
seashore saltgrass	*Distichlis spicata*	0.8	13.3%	2/15	6.0	n/a	n/a	n/a
soft-stemmed bulrush	*Scirpus validus*	1.3	13.3%	2/15	10.0	n/a	n/a	n/a
tufted hairgrass	*Deschampsia cespitosa*	1.7	6.7%	1/15	25.0	n/a	n/a	n/a
unclassified-sedge	*unclassified-sedge*	0.7	6.7%	1/15	10.0	n/a	n/a	n/a
Canopy Cover, Native		37.2			39.8	49.5	14.8	84.1
Non-Native or Invasive								
birds-foot trefoil	*Lotus corniculatus*	5.7	13.3%	2/15	42.5	n/a	n/a	n/a
creeping buttercup	*Ranunculus repens*	0.7	6.7%	1/15	10.0	n/a	n/a	n/a
lambsquarters	*Chenopodium sp.*	1.7	6.7%	1/15	25.0	n/a	n/a	n/a
white clover	*Trifolium repens*	0.3	6.7%	1/15	5.0	n/a	n/a	n/a
white sweet-clover	*Melilotus alba*	3.7	20.0%	3/15	18.5	14.2	0.0	77.0
Canopy Cover, NNI		12.0			45.1	17.5	0.0	47.2
TOTAL		49.2			52.7	68.8	16.6	121.0
Proportion of non-native or invasive plants (%):		24.5%			85.6%	25.5%		

Table A-19c. Year 2 (2003) Marsh Development at Squally Beach, Transect 1-3 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence Lower Bound	90% Confidence Upper Bound
Native								
pickleweed	*Salicornia virginica*	1.4	18.8%	3/16	7.3	2.3	0.0	8.4
fleshy jaumea	*Jaumea carnosa*	0.2	6.3%	1/16	3.0	n/a	n/a	n/a
orache, fat-hen saltbush	*Atriplex patula*	6.3	18.8%	3/16	33.3	6.5	0.2	12.7
seashore saltgrass	*Distichlis spicata*	0.9	6.3%	1/16	15.0	n/a	n/a	n/a
spike-rush	*Eleocharis sp.*	0.3	12.5%	2/16	2.5	n/a	n/a	n/a
Canopy Cover, Native		9.1			24.2	16.1	0.0	42.1
Non-Native or Invasive								
brass buttons	*Cotula coronopifolia*	0.4	18.8%	3/16	2.0	0.4	0.0	0.8
Canopy Cover, NNI		0.4			2.0	0.4	0.0	0.8
TOTAL		9.4			18.9	15.7	0.0	40.3
Proportion of non-native or invasive plants (%):		4.0%			10.6%	2.5%		

Table A-20a. Year 3 (2004) Marsh Development at Squally Beach, Transect 1-1 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	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
Corresponding quadrat in year of origin (Year 1 - 2002)				3	4	5	6	7	8	9	22	10	11	12	13	23	14	15	16	24	17	25	18	19	20	21	n/a
Percent of quadrat situated within herbivory exclusion device				0	0	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0	0	0	0	0	0
Native																											
Canadian sandspurry	*Spergularia canadensis*	0.5	4.3				10	3	<0.5																		
entire-leaved gumweed	*Grindelia integrifolia*	2.0	16.0							8						10											30
fleshy jaumea	*Jaumea carnosa*	31.1	53.3	15	5	10	1	50	80		15							20	90	95	75				100	100	90
orache, fat-hen saltbush	*Atriplex patula*	8.8	16.2			5	5	40	30	30			2	2	10	10		20	50							2	5
pickleweed	*Salicornia virginica*	12.4	24.8			35	3	5	25		5			20	30		40	90			15				15	15	
seashore saltgrass	*Distichlis spicata*	7.9	19.0	20	20	85											5	10		10	10				5	10	15
seaside plantain	*Plantago maritima*	0.5	4.3			10		<0.5	3																		
Non-Native or Invasive[1]																											
(none)		0.0	0.0																								

Table A-20b. Year 3 (2004) Marsh Development at Squally Beach, Transect 1-2 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	Quadrats, Transect 1-2														
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Corresponding quadrat in year of origin (Year 1 - 2002)				1	2	3	4	12	5	6	13	7	8	14	9	10	15	11
Percent of quadrat situated within herbivory exclusion device				100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Native																		
American bulrush	*Scirpus americanus*	11.3	56.7		25										75	70		
fleshy jaumea	*Jaumea carnosa*	6.0	30.0					10	25					55				
Hooker's willow	*Salix hookeriana*	19.0	95.0								85				100	100		
Lyngby's sedge	*Carex lyngbyei*	17.7	53.0			10	80					90	35	50				
narrowleaf cattail	*Typha angustifolia*	0.2	3.0		3													
orache, fat-hen saltbush	*Atriplex patula*	8.1	20.3			80	25		3					10	2	2		
panicled bulrush	*Scirpus microcarpus*	2.7	20.0		10	30												
pickleweed	*Salicornia virginica*	2.2	11.0	3				20										10
red alder	*Alnus rubra*	1.7	25.0			25												
seacoast bulrush	*Scirpus maritimus*	0.3	5.0			5												
seashore saltgrass	*Distichlis spicata*	3.2	16.0		15	30				3								
seaside arrow-grass	*Triglochin maritimum*	0.3	5.0													5		
seaside plantain	*Plantago maritima*	0.7	10.0											10				
softstem bullrush	*Scirpus tabernaemontani*	0.1	2.0													2		
spike-rush	*Eleocharis sp.*	0.3	5.0															5
Non-Native or Invasive[1]																		
brass buttons	*Cotula coronopifolia*	0.7	3.7							5		1	5					
Himalayan blackberry	*Rubus discolor*	0.7	10.0												10			

Table A-20c. Year 3 (2004) Marsh Development at Squally Beach, Transect 1-3 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	Quadrats, Transect 1-3															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Corresponding quadrat in year of origin (Year 2 - 2003)				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Percent of quadrat situated within herbivory exclusion device				100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Native																			
Canadian sandspurry	*Spergularia canadensis*	0.1	2.0			2													
entire-leaved gumweed	*Grindelia integrifolia*	0.3	5.0			5													
fleshy jaumea	*Jaumea carnosa*	1.9	30.0			30													
orache, fat-hen saltbush	*Atriplex patula*	4.6	14.6		25	10	10			25								3	
pickleweed	*Salicornia virginica*	6.6	15.0	60	10	3	5	5	2	20									
seashore saltgrass	*Distichlis spicata*	15.8	42.2		60	65	35				30	60	3						
seaside plantain	*Plantago maritima*	0.2	1.5		3	<0.5													
spike-rush	*Eleocharis sp.*	0.1	1.0	1															
Non-Native or Invasive[1]																			
brass buttons	*Cotula coronopifolia*	3.3	10.4	15			2	0.5					25				10		

Table A-20d. Year 3 (2004) Marsh Development at Squally Beach, Reference Transect C-1 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	Quadrats, C-1		
				1	2	3
Percent of quadrat situated within herbivory exclusion device				0	0	0
Native						
Lyngby's sedge	*Carex lyngbyei*	60.0	60.0	65	65	50
spike-rush	*Eleocharis sp.*	8.3	25.0	25		
Non-Native or Invasive[1]						
(none)		0.0	0.0			

Table A-21a. Year 3 (2004) Marsh Development at Squally Beach, Transect 1-1 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy Cover (%)	90% Confidence Interval: Lower Bound	90% Confidence Interval: Upper Bound
Native								
Canadian sandspurry	*Spergularia canadensis*	0.6	12.5%	3/24	4.5	1.0	0.0	3.1
entire-leaved gumweed	*Grindelia integrifolia*	2.0	12.5%	3/24	16.0	2.1	0.0	4.6
fleshy jaumea	*Jaumea carnosa*	31.1	58.3%	14/24	53.3	47.5	4.8	90.3
orache, fat-hen saltbush	*Atriplex patula*	8.8	54.2%	13/24	16.2	10.0	2.5	17.4
pickleweed	*Salicornia virginica*	12.4	50.0%	12/24	24.8	13.5	4.8	22.2
seashore saltgrass	*Distichlis spicata*	7.9	41.7%	10/24	19.0	7.5	2.9	12.2
seaside plantain	*Plantago maritima*	0.6	12.5%	3/24	4.5	1.0	0.0	3.1
Canopy Cover, Native		63.3			76.0	78.3	37.5	119.1
Non-Native or Invasive								
(None)		0.0	0.0%	0/24	0.0	n/a	n/a	n/a
Canopy Cover, NNI		0.0			0.0			
TOTAL		63.3			76.0	78.3	37.5	119.1
Proportion of non-native or invasive plants (%):		0.0%			0.0%	0.0%		

Table A-21b. Year 3 (2004) Marsh Development at Squally Beach, Transect 1-2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy Cover (%)	90% Confidence Interval: Lower Bound	90% Confidence Interval: Upper Bound
Native								
American bulrush	*Scirpus americanus*	11.3	20.0%	3/15	56.7	12.3	0.0	25.8
fleshy jaumea	*Jaumea carnosa*	6.0	20.0%	3/15	30.0	6.9	0.0	16.0
Hooker's willow	*Salix hookeriana*	19.0	20.0%	3/15	95.0	19.0	3.1	35.9
Lyngby's sedge	*Carex lyngbyei*	17.7	33.3%	5/15	53.0	20.5	0.0	41.3
narrowleaf cattail	*Typha angustifolia*	0.2	6.7%	1/15	3.0	n/a	n/a	n/a
orache, fat-hen saltbush	*Atriplex patula*	8.1	40.0%	6/15	20.3	9.9	0.0	26.2
panicled bulrush	*Scirpus microcarpus*	2.7	13.3%	2/15	20.0	n/a	n/a	n/a
pickleweed	*Salicornia virginica*	2.2	20.0%	3/15	11.0	2.7	0.0	6.5
red alder	*Alnus rubra*	1.7	6.7%	1/15	25.0	n/a	n/a	n/a
seacoast bulrush	*Scirpus maritimus*	0.3	6.7%	1/15	5.0	n/a	n/a	n/a
seashore saltgrass	*Distichlis spicata*	3.2	20.0%	3/15	16.0	4.4	0.0	12.2
seaside arrow-grass	*Triglochin maritimum*	0.3	6.7%	1/15	5.0	n/a	n/a	n/a
seaside plantain	*Plantago maritima*	0.7	6.7%	1/15	10.0	n/a	n/a	n/a
softstem bullrush	*Scirpus tabernaemontani*	0.1	6.7%	1/15	2.0	n/a	n/a	n/a
spike-rush	*Eleocharis sp.*	0.3	6.7%	1/15	5.0	n/a	n/a	n/a
Canopy Cover, Native		73.9			79.1	107.5	17.8	202.9
Non-Native or Invasive								
brass buttons	*Cotula coronopifolia*	0.7	20.0%	3/15	3.7	0.9	0.0	2.2
Himalayan blackberry	*Rubus discolor*	0.7	6.7%	1/15	10.0	n/a	n/a	n/a
Canopy Cover, NNI		1.4			5.3	1.7	0.0	3.8
TOTAL		75.3			84.4	99.1	27.0	175.7
Proportion of non-native or invasive plants (%):		1.9%			6.2%	1.7%		

Table A-21c. Year 3 (2004) Marsh Development at Squally Beach, Transect 1-3 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy Cover (%)	90% Confidence Interval: Lower Bound	90% Confidence Interval: Upper Bound
Native								
Canadian sandspurry	*Spergularia canadensis*	0.1	6.3%	1/16	2.0	n/a	n/a	n/a
entire-leaved gumweed	*Grindelia integrifolia*	0.3	6.3%	1/16	5.0	n/a	n/a	n/a
fleshy jaumea	*Jaumea carnosa*	1.9	6.3%	1/16	30.0	n/a	n/a	n/a
orache, fat-hen saltbush	*Atriplex patula*	4.6	31.3%	5/16	14.6	5.2	0.2	10.2
pickleweed	*Salicornia virginica*	6.6	43.8%	7/16	15.0	6.8	0.0	14.0
seashore saltgrass	*Distichlis spicata*	15.8	37.5%	6/16	42.2	22.4	0.0	48.2
seaside plantain	*Plantago maritima*	0.2	12.5%	2/16	1.8	n/a	n/a	n/a
spike-rush	*Eleocharis sp.*	0.1	6.3%	1/16	1.0	n/a	n/a	n/a
Canopy Cover, Native		29.5			43.0	46.8	0.0	101.6
Non-Native or Invasive								
brass buttons	*Cotula coronopifolia*	3.3	31.3%	5/16	10.5	6.0	0.0	17.2
Canopy Cover, NNI		3.3			10.5	6.0	0.0	17.2
TOTAL		32.8			53.5	46.7	2.5	90.8
Proportion of non-native or invasive plants (%):		10.0%			19.6%	12.8%		

Table A-22. Year 3 (2004) Marsh Development at Squally Beach - Change in Percent Cover, Year 1 to Year 3

	Species[b]	Percent of Quadrats with Decreased Cover	Percent of Quadrats with No Change	Percent of Quadrats with Increased Cover	Statistical Result[a]
Squally Beach Marsh Transect 1-1					
Native	*Atriplex patula*	29%	29%	42%	
	Distichlis spicata	13%	54%	33%	
	Grindelia integrifolia	4%	88%	8%	
	Plantago maritima	8%	79%	13%	
	Salicornia virginica	8%	46%	46%	+
Native Total		13%	17%	71%	+
NNI Total		13%	88%	0%	
Total (All Species)		13%	17%	71%	+
Squally Beach Marsh Transect 1-2					
Native	*Alnus rubra*	0%	93%	7%	No Test[c]
	Atriplex patula	67%	13%	20%	
	Carex lyngbyei	7%	60%	33%	
	Distichlis spicata	7%	73%	20%	
	Jaumea carnosa	7%	80%	13%	
	Salicornia virginica	0%	80%	20%	
	Scirpus americanus	7%	80%	13%	
Native Total		27%	0%	73%	
NNI Total		40%	47%	13%	
Total (All Species)		40%	0%	60%	
Squally Beach Marsh Transect 1-3					
Native	*Atriplex patula*	19%	63%	19%	
	Distichlis spicata	0%	63%	38%	+
	Eleocharis sp.	13%	81%	6%	
	Jaumea carnosa	0%	94%	6%	No Test[c]
	Salicornia virginica	0%	56%	44%	+
Native Total		6%	25%	69%	+
NNI	*Cotula coronopifolia*	13%	56%	31%	
NNI Total		13%	56%	31%	
Total (All Species)		6%	19%	75%	+

[a] "+" indicates a significant increase (two-tailed sign test, alpha = 0.05); "-" indicates a significant decrease; other species are not significantly changed

[b] Displayed species are species observed in both years - NNI and Native totals include species observed in either year.

[c] Species with less than three non-zero changes could not be statistically tested.

Table A-23a. Year 3 (2004) Marsh Development at Squally Beach - *Carex* Stem Height Collected Data

Common Name	Scientific Name	Quadrats, Transect 1-2														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lyngby's sedge	*Carex lyngbyei*			16, 27, 23, 13.5	36.5, 31, 32.5, 26.5, 17.5, 30, 5, 34.5, 28					21, 18, 14.5, 37, 30.5, 13, 10, 34.5	16, 21.5, 14.5, 16	19.5, 4, 13.5, 17				

Common Name	Scientific Name	Quadrats, C-1		
		1	2	3
Lyngby's sedge	*Carex lyngbyei*	24, 19, 12.5, 9.5, 11, 14, 21, 8.5	16, 14, 21, 10, 27, 15.5, 20.5, 30, 28.5	6.5, 14, 8, 9, 5, 12, 1.5

Notes:
Stem height in inches
Blank indicates no vegetation was observed in the quadrat
The measurements presented in this table represent the stem height of each plant sampled within the quadrat.

Table A-23b. Year 3 (2004) Marsh Development at Squally Beach - *Carex* Shoot Density Collected Data

Common Name	Scientific Name	Quadrats, Transect 1-2														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Lyngby's sedge	*Carex lyngbyei*			4	140					36	32	21				

Common Name	Scientific Name	Quadrats, C-1		
		1	2	3
Lyngby's sedge	*Carex lyngbyei*	30	30	83

Notes:
Shoot density in shoots per quadrat. Quadrats are 0.25 m^2 in area.
Blank indicates no vegetation was observed in the quadrat
The measurements presented in this table represent the stem height of each plant sampled within the quadrat.

Table A-24a. Year 3 (2004) Marsh Development at Squally Beach - *Carex* Stem Height and Shoot Density Analysis

	Site Transect	Squally Beach Reference	Squally Beach 1-2
	Total Number of Quadrats	3	15
	Number of Quadrats with *Carex*	3	5
Stem Height	Average of Non-Zero Cells	14.4	19.9
	Standard Deviation	6.2	5.1
	t-test p-value[a]		0.22
	Significantly Different from Reference?		NO
Shoot Density	Average of Non-Zero Cells	47.7	46.6
	Standard Deviation	30.6	53.7
	t-test p-value[a]		0.59
	Significantly Different from Reference?		NO

[a] t-test was performed on log-transformed data to approximate normality; p-value is the probability of obtaining the observed result or a more extreme result, under the null hypothesis of no difference in population means.

Table A-24b. Year 3 (2004) Marsh Development at Squally Beach - Comparison of *Carex* Shoot Density, Years 1 - 3

Transect	Total Number of Quadrats	Total Quadrats with Decreased Shoot Density	Percent of Total Quadrats with No Change	Total Quadrats with Increased Shoot Density	Statistical Result[c]
Squally Beach 1-2[d]	15	7%	60%	33%	No significant change

[c] "+" indicates a significant increase (two-tailed sign test, alpha = 0.05);
"-" indicates a significant decrease; other species are not significantly changed

[d] Comparison between Year 1 (2002) and Year 3 (2004) data.

Table A-25. Year 1 (2002) Riparian Development at Squally Beach, Transect 2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence Lower Bound	90% Confidence Upper Bound
Native								
Herbs and Forbes								
bluegrass	*Poa sp.*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
lupine	*Lupinus sp.*	3.6	60.0%	6/10	5.9	1.9	0.0	4.1
purple-leaved willowherb	*Epilobium ciliatum*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
red fescue	*Festuca rubra*	1.3	30.0%	3/10	4.3	0.5	0.0	1.0
willowherb	*Epilobium sp.*	0.8	30.0%	3/10	2.7	0.3	0.0	0.6
Shrubs								
beaked hazelnut	*Corylus cornuta*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
common snowberry	*Symphoricarpos albus*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
dull Oregon-grape	*Mahonia nervosa*	0.1	10.0%	1/10	1.0	n/a	n/a	n/a
nootka rose	*Rosa nutkana*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
oceanspray	*Holodiscus discolor*	0.5	10.0%	1/10	5.0	n/a	n/a	n/a
red-flowering current	*Ribes sanguineum*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
red-osier dogwood	*Cornus stolonifera*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
rose	*Rosa sp.*	3.0	40.0%	4/10	7.5	1.3	0.1	2.4
trailing blackberry	*Rubus ursinus*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
Trees								
Douglas fir	*Pseudotsuga menziesii*	2.2	30.0%	3/10	7.3	1.1	0.0	2.6
red alder	*Alnus rubra*	4.2	70.0%	7/10	6.0	2.0	0.1	3.9
Scouler's willow	*Salix scouleriana*	12.0	40.0%	4/10	30.0	4.9	0.8	9.0
Non-Native or Invasive								
Herbs and Forbes								
birds-foot trefoil	*Lotus corniculatus*	11.0	80.0%	8/10	13.8	5.0	0.7	9.4
black medick	*Medicago lupulina*	1.6	40.0%	4/10	4.0	0.7	0.0	1.5
brome	*Bromus sp.*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
bull thistle	*Cirsium vulgare*	2.3	20.0%	2/10	11.5	n/a	n/a	n/a
Canada thistle	*Cirsium arvense*	1.5	10.0%	1/10	15.0	n/a	n/a	n/a
cheatgrass	*Bromus tectorum*	0.5	10.0%	1/10	5.0	n/a	n/a	n/a
colonial bentgrass	*Agrostis tenuis*	2.9	70.0%	7/10	4.1	1.2	0.3	2.1
common dandelion	*Taraxacum officinale*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
common horsetail	*Equisetum arvense*	11.0	50.0%	5/10	22.0	4.9	0.0	10.0
common rush	*Juncus effusus*	0.3	10.0%	1/10	3.0	n/a	n/a	n/a
common St. John's-wort	*Hypericum perforatum*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
common stork's-bill	*Erodium cicutarium*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
common velvet-grass	*Holcus lanatus*	2.1	40.0%	4/10	5.3	1.0	0.0	2.3
creeping buttercup	*Ranunculus repens*	0.1	10.0%	1/10	1.0	n/a	n/a	n/a
English plantain	*Plantago lanceolata*	1.0	40.0%	4/10	2.5	0.4	0.0	0.8
hairy catsear	*Hypochaeris radicata*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
hedge mustard	*Sisymbrium officinale*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
Japanese knotweed	*Polygonum cuspidatum*	0.1	10.0%	1/10	0.5	n/a	n/a	n/a
lettuce	*Lactuca sp.*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
oxeye daisy	*Chrysanthemum leucanthemum*	0.2	10.0%	1/10	2.0	n/a	n/a	n/a
pea vine	*Lathyrus sp.*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
perennial ryegrass	*Lolium perenne*	17.4	90.0%	9/10	19.3	7.4	2.4	12.3
quackgrass	*Agropyron repens*	0.5	10.0%	1/10	5.0	n/a	n/a	n/a
rabbitfoot clover	*Trifolium arvense*	0.7	20.0%	2/10	3.5	n/a	n/a	n/a
red clover	*Trifolium pratense*	1.8	30.0%	3/10	6.0	1.1	0.0	3.0
toad rush	*Juncus bufonius*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
unclassified-composite	*unclassified-composite*	0.4	20.0%	2/10	1.8	n/a	n/a	n/a
unclassified-grass	*unclassified-grass*	1.8	40.0%	4/10	4.5	0.8	0.0	1.9
unclassified-herb	*unclassified-herb*	0.1	10.0%	1/10	0.5	n/a	n/a	n/a
unclassified-wheat	*unclassified-wheat*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
white clover	*Trifolium repens*	0.7	30.0%	3/10	2.2	0.3	0.0	0.8
white sweet-clover	*Melilotus alba*	33.2	100.0%	10/10	33.2	16.7	4.0	29.3
yarrow	*Achillea millefolium*	0.1	10.0%	1/10	0.5	n/a	n/a	n/a
yellow salsify	*Tragopogon dubius*	0.0	0.0%	0/10	n/a	n/a	n/a	n/a
Shrubs								
Himalayan blackberry	*Rubus discolor*	3.2	40.0%	4/10	7.9	2.1	0.0	7.0
Scot's broom	*Cytisus scoparius*	0.4	20.0%	2/10	2.0	n/a	n/a	n/a
	Total Herbs	95.9	100.0%	10/10	95.9	38.7	22.2	55.1
	Total Shrubs	7.6	70.0%	7/10	10.8	3.2	0.9	5.4
	Total Trees	6.4	80.0%	8/10	8.0	2.7	0.9	4.4
	Total NNI	94.6	100.0%	10/10	94.6	38.1	21.8	54.5
	Total Native	27.7	100.0%	10/10	27.7	13.5	3.0	23.9

Table A-26. Year 3 (2004) Riparian Development at Squally Beach, Transect 2 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	Quadrats, Transect 2									
				1	2	3	4	5	6	7	8	9	10
Corresponding quadrat in year of origin (Year 1 - 2002)				23	2	4	6	9	11	25	14	17	18
Native													
Emergents													
American bulrush	*Scirpus americanus*	0.7	7.0			7							
Lyngby's sedge	*Carex lyngbyei*	0.7	7.0			7							
Herbs and Forbes													
sicklekeel lupine	*Lupinus albicaulis*	0.2	2.0		2								
Shrubs													
beaked hazelnut	*Corylus cornuta*	0.7	3.5						2	5			
currant	*Ribes sp.*	1.0	10.0							10			
Indian plum	*Oemleria cerasiformis*	1.5	7.5				5			10			
oceanspray	*Holodiscus discolor*	5.0	50.0								50		
red-osier dogwood	*Cornus stolonifera*	5.0	16.7						35			5	10
rose	*Rosa sp.*	11.8	29.5				2			1		65	50
salal	*Gaultheria shallon*	0.5	5.0					5					
Trees													
Douglas fir	*Pseudotsuga menziesii*	3.0	30.0					30					
Hooker's willow	*Salix hookeriana*	38.0	47.5	40	80	85		85	10	10		60	10
lodgepole pine	*Pinus contorta*	2.7	13.5						25			2	
red alder	*Alnus rubra*	43.6	54.5	60	1	60	90	50	10			80	85
western hemlock	*Tsuga heterophylla*	0.1	1.0				1						
Non-Native or Invasive (NNI)													
Herbs and Forbes													
Japanese knotweed	*Polygonum cuspidatum*	2.2	11.0					2	20				
white sweet-clover	*Melilotus alba*	0.0	0.0	0									
non-natives/invasives		81.3	81.3	85	90	95	98	85	95	5	100	70	90
Shrubs													
Himalayan blackberry	*Rubus discolor*	15.8	17.6		4	2	25	2	25	25	35	10	30

Table A-27. Year 3 (2004) Riparian Development at Squally Beach, Transect 2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence Interval: Lower Bound	90% Confidence Interval: Upper Bound
Native								
Emergents								
American bulrush	*Scirpus americanus*	0.7	10.0%	1/10	7.0	n/a	n/a	n/a
Lyngby's sedge	*Carex lyngbyei*	0.7	10.0%	1/10	7.0	n/a	n/a	n/a
Herbs and Forbes								
sicklekeel lupine	*Lupinus albicaulis*	0.2	10.0%	1/10	2.0	n/a	n/a	n/a
Shrubs								
beaked hazelnut	*Corylus cornuta*	0.7	20.0%	2/10	3.5	n/a	n/a	n/a
currant	*Ribes sp.*	1.0	10.0%	1/10	10.0	n/a	n/a	n/a
Indian plum	*Oemleria cerasiformis*	1.5	20.0%	2/10	7.5	n/a	n/a	n/a
oceanspray	*Holodiscus discolor*	5.0	10.0%	1/10	50.0	n/a	n/a	n/a
red-osier dogwood	*Cornus stolonifera*	5.0	30.0%	3/10	16.7	5.9	0.0	14.7
rose	*Rosa sp.*	11.8	40.0%	4/10	29.5	36.7	0.0	167.5
salal	*Gaultheria shallon*	0.5	10.0%	1/10	5.0	n/a	n/a	n/a
Trees								
Douglas fir	*Pseudotsuga menziesii*	3.0	10.0%	1/10	30.0	n/a	n/a	n/a
Hooker's willow	*Salix hookeriana*	38.0	80.0%	8/10	47.5	44.2	7.1	81.3
lodgepole pine	*Pinus contorta*	2.7	20.0%	2/10	13.5	n/a	n/a	n/a
red alder	*Alnus rubra*	43.6	80.0%	8/10	54.5	87.6	0.0	219.2
western hemlock	*Tsuga heterophylla*	0.1	10.0%	1/10	1.0	n/a	n/a	n/a
Non-Native or Invasive								
Herbs and Forbes								
Japanese knotweed	*Polygonum cuspidatum*	2.2	20.0%	2/10	11.0	n/a	n/a	n/a
white sweet-clover	*Melilotus alba*	0.1	10.0%	1/10	0.5	n/a	n/a	n/a
unknown	*unknown*	81.3	100.0%	10/10	81.3	102.0	39.1	164.8
Shrubs								
Himalayan blackberry	*Rubus discolor*	15.8	90.0%	9/10	17.6	20.2	1.3	39.1
	Total Herbs					105.6	39.5	171.8
	Total Shrubs					65.4	0.0	148.5
	Total Trees					101.9	37.8	165.9
	Total NNI					102.1	75.4	128.8
	Total Native					117.9	77.7	158.2

Table A-28a. Year 3 (2004) Invertebrate Presence at Squally Beach - Fallout Samples

Sample Type		Sample No.						Grand
Order	**Family**	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Amphipoda	(not identified)	2	11		8	13	1	**35**
Araneae	(not identified)					1		**1**
Diptera	Chironomidae					1		**1**
	Ephydridae		3	12	1		66	**82**
	Rhagionidae		3	20	2	2	4	**31**
	Tipulidae	1	5		3	1		**10**
Hemiptera	Saldidae	1	2		3		2	**8**
Hymenoptera	Formicidae				1	1	3	**5**
	(not identified)	7	1					**8**
Opiliones	Phalangiidae		1					**1**
Unknown	(not identified)	1				1		**2**
Grand Total		**12**	**26**	**32**	**18**	**20**	**76**	**184**

Table A-28b. Year 3 (2004) Invertebrate Presence at Squally Beach - Substrate Samples

Sample Type		Sample No.						Grand
Order	**Family**	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
None								**0**
Grand Total		**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table A-29. Year 3 (2004) Seasonal Bird Counts at Squally Beach

Common Name	Scientific Name	Total	Winter	Spring	Summer	Fall
American crow	*Corvus brachyrhynchos*	37	11	5	18	3
American goldfinch	*Carduelis tristis*	5		2	3	
American robin	*Turdus migratorius*	2		2		
American wigeon	*Anas americana*	305		33	197	75
Anna's hummingbird	*Calypte anna*	1				1
bald eagle	*Haliaeetus leucocephalus*	1	1			
band-tailed pigeon	*Columba fasciata*	1			1	
Barrow's goldeneye	*Bucephala islandica*	6				6
belted kingfisher	*Ceryle alcyon*	5		3	2	
black-capped chickadee	*Poecile atricapilla*	7		1	2	4
bufflehead	*Bucephala albeola*	7	3	2		2
bushtit	*Psaltriparus minimus*	1			1	
Canada goose	*Branta canadensis*	75	7	19	49	
Caspian tern	*Sterna caspia*	13		6	7	
common goldeneye	*Bucephala clangula*	9	5	4		
common merganser	*Mergus merganser*	1		1		
cormorant	*Phalacrocorax sp.*	13			13	
crow	*Corvus sp.*	19		16	3	
double-crested cormorant	*Phalacrocorax auritus*	47	1	17	29	
downy woodpecker	*Picoides pubescens*	1			1	
European starling	*Sturnus vulgaris*	10		8	2	
gadwall	*Anas strepera*	22		16	6	
glaucous-winged gull	*Larus glaucescens*	33	8	14	10	1
great blue heron	*Ardea herodias*	11		3	8	
green-winged teal	*Anas crecca*	6		1	4	1
horned grebe	*Podiceps auritus*	1		1		
house finch	*Carpodacus mexicanus*	6		1	5	
house wren	*Troglodytes aedon*	1			1	
killdeer	*Charadrius vociferus*	1		1		
mallard	*Anas platyrhynchos*	52		27	25	
Northern pintail	*Anas acuta*	2		2		
orange-crowned warbler	*Vermivora celata*	3		3		
peregrine falcon	*Falco peregrinus*	1		1		
pied-bill grebe	*Podilymbus podiceps*	1				1
purple martin	*Progne subis*	19		13	6	
red-breasted merganser	*Mergus serrator*	3		3		
red-shafted flicker	*Colaptes auratus cafer*	1			1	
red-tailed hawk	*Buteo jamaicensis*	1				1
red-winged blackbird	*Agelaius phoeniceus*	1		1		
rock dove	*Columba livia*	5			5	
ruddy duck	*Oxyura jamaicensis*	1			1	
song sparrow	*Melospiza melodia*	18	1	7	9	1
spotted sandpiper	*Actitis macularia*	5		1	4	
spotted towhee	*Pipilo maculatus*	1			1	
Steller's jay	*Cyanocitta stelleri*	4		2	2	
surf scoter	*Melanitta perspicillata*	1				1
tree swallow	*Tachycineta bicolor*	2			2	
western gull	*Larus occidentalis*	1				1
western sandpiper	*Calidris mauri*	50		50		
white-crowned sparrow	*Zonotrichia leucophrys*	1		1		
Wilson's warbler	*Wilsonia pusilla*	2		1	1	
TOTAL		**822**	**37**	**268**	**419**	**98**

Notes:
Blank indicates no bird was observed.

Winter = December to February
Spring = March to May
Summer = June to August
Fall = September to November

Table A-30. Year 3 (2004) 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
1/30/2004	American crow	*Corvus brachyrhynchos*	U	11	H	x			x							
	bald eagle	*Haliaeetus leucocephalus*	U	1	H	x			x							immature
	bufflehead	*Bucephala albeola*	M	1	H	x									x	foraging
	bufflehead	*Bucephala albeola*	F	2	H	x									x	foraging
	Canada goose	*Branta canadensis*	U	7	H	x			x							
	common goldeneye	*Bucephala clangula*	M	2	H	x									x	
	common goldeneye	*Bucephala clangula*	F	3	H	x									x	
	double-crested cormorant	*Phalacrocorax auritus*	U	1	H	x			x						x	
	glaucous-winged gull	*Larus glaucescens*	U	8	H	x			x							
	song sparrow	*Melospiza melodia*	M	1	H	x	x				x					singing
3/25/2004	American crow	*Corvus brachyrhynchos*	U	2	H	x	x			x	x	x				perching
	American robin	*Turdus migratorius*	U	1	H	x					x					
	American wigeon	*Anas americana*	M	3	H	x									x	foraging
	American wigeon	*Anas americana*	F	3	H	x									x	foraging
	bufflehead	*Bucephala albeola*	F	1	H	x									x	foraging
	bufflehead	*Bucephala albeola*	M	1	H	x									x	foraging
	common goldeneye	*Bucephala clangula*	M	2	H	x									x	foraging
	common goldeneye	*Bucephala clangula*	F	2	H	x									x	foraging
	horned grebe	*Podiceps auritus*	U	1	H	x									x	foraging
	mallard	*Anas platyrhynchos*	M	2	H	x									x	loafing
	mallard	*Anas platyrhynchos*	F	2	H	x									x	loafing
	Northern pintail	*Anas acuta*	M	1	H	x									x	
	Northern pintail	*Anas acuta*	F	1	H	x									x	
	red-breasted merganser	*Mergus serrator*	M	1	H	x										loafing, sleeping; ? On ID
	red-breasted merganser	*Mergus serrator*	F	1	H	x									x	foraging
	song sparrow	*Melospiza melodia*	U	1	H	x					x					foraging
4/13/2004	American crow	*Corvus brachyrhynchos*	U	2	H	x	x		x	x						calling
	American robin	*Turdus migratorius*	U	1	H	x	x				x					
	American wigeon	*Anas americana*	M	12	H	x									x	foraging
	American wigeon	*Anas americana*	F	10	H	x									x	foraging
	belted kingfisher	*Ceryle alcyon*	U	1	H		x				x					
	black-capped chickadee	*Poecile atricapilla*	M	1	H	x	x				x	x				breeding song
	gadwall	*Anas strepera*	F	4	H	x									x	
	gadwall	*Anas strepera*	M	8	H	x									x	
	glaucous-winged gull	*Larus glaucescens*	U	3	H	x			x							
	green-winged teal	*Anas crecca*	M	1	H	x				x						resting
	killdeer	*Charadrius vociferus*	U	1	H	x						x				foraging
	mallard	*Anas platyrhynchos*	M	3	H	x									x	foraging
	mallard	*Anas platyrhynchos*	F	3	H	x									x	foraging
	orange-crowned warbler	*Vermivora celata*	M	2	H		x									out of study area - across rd on forest slope
	song sparrow	*Melospiza melodia*	M	2	H	x	x				x	x				
	spotted sandpiper	*Actitis macularia*	U	1	H	x				x						foraging
4/29/2004	American goldfinch	*Carduelis tristis*	U	2	M	x	x		x							
	American wigeon	*Anas americana*	U	5	M	x									x	male & female
	belted kingfisher	*Ceryle alcyon*	U	1	M	x	x									
	Canada goose	*Branta canadensis*	U	1	M	x										
	crow	*Corvus sp.*	U	10	M	x							x			
	double-crested cormorant	*Phalacrocorax auritus*	U	1	M	x				x						
	European starling	*Sturnus vulgaris*	U	2	M	x			x							
	gadwall	*Anas strepera*	U	2	M	x									x	male & female
	glaucous-winged gull	*Larus glaucescens*	U	2	M					x						
	glaucous-winged gull	*Larus glaucescens*	U	6	M	x			x						x	
	house finch	*Carpodacus mexicanus*	U	1	M	x	x									number unknown
	mallard	*Anas platyrhynchos*	U	6	M	x						x			x	male & female
	red-breasted merganser	*Mergus serrator*	F	1	M	x										
	song sparrow	*Melospiza melodia*	M	1	M		x									
	western sandpiper	*Calidris mauri*	U	50	M	x							x			~50; feeding and loafing on logs
	white-crowned sparrow	*Zonotrichia leucophrys*	M	1	M	x	x									
5/21/2004	belted kingfisher	*Ceryle alcyon*	F	1	H	x	x			x						fishing from alders E of site
	Canada goose	*Branta canadensis*	U	7	H	x									x	
	Caspian tern	*Sterna caspia*	U	3	H	x										
	common merganser	*Mergus merganser*	M	1	H	x				x						loafing
	crow	*Corvus sp.*	U	6	H	x				x			x			
	double-crested cormorant	*Phalacrocorax auritus*	U	16	H	x				x					x	foraging; loafing; drying wings
	European starling	*Sturnus vulgaris*	U	5	H	x			x				x			foraging
	glaucous-winged gull	*Larus glaucescens*	U	2	H	x			x							
	great blue heron	*Ardea herodias*	U	2	H	x			x							landed in madrones on bluff
	mallard	*Anas platyrhynchos*	U	3	H	x										ducklings
	mallard	*Anas platyrhynchos*	F	2	H	x						x			x	1 fem. w/ 3 sm. Ducklings
	mallard	*Anas platyrhynchos*	M	2	H	x						x			x	foraging
	orange-crowned warbler	*Vermivora celata*	U	1	H	x										
	peregrine falcon	*Falco peregrinus*	U	1	H	x			x							bombed by martins
	purple martin	*Progne subis*	U	12	H	x	x			x						12-16 counted; using nest boxes
	red-winged blackbird	*Agelaius phoeniceus*	M	1	H	x	x									singing
	song sparrow	*Melospiza melodia*	M	1	H		x				x					singing
	Steller's jay	*Cyanocitta stelleri*	U	1	H	x										scolding
	Wilson's warbler	*Wilsonia pusilla*	M	1	H	x	x				x					scolding me
5/26/2004	American crow	*Corvus brachyrhynchos*	U	1	M	x			x							
	Canada goose	*Branta canadensis*	U	11	M	x							x	x	x	3 goslings
	Caspian tern	*Sterna caspia*	U	3	M	x			x							
	European starling	*Sturnus vulgaris*	U	1	M	x			x							
	gadwall	*Anas strepera*	U	2	M	x									x	
	glaucous-winged gull	*Larus glaucescens*	U	1	M	x							x			
	great blue heron	*Ardea herodias*	U	1	M	x	x			x						
	mallard	*Anas platyrhynchos*	F	1	M	x									x	
	mallard	*Anas platyrhynchos*	M	3	M	x									x	

Table A-30. Year 3 (2004) 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
	purple martin	*Progne subis*	U	1	M		x									
	song sparrow	*Melospiza melodia*	M	2	M	x	x				x					Singing
	Steller's jay	*Cyanocitta stelleri*	U	1	M		x				x					Scolding
6/28/2004	American crow	*Corvus brachyrhynchos*	U	10	H	x	x					x				
	American goldfinch	*Carduelis tristis*	M	1	H	x	x		x							
	Canada goose	*Branta canadensis*	U	40	H	x	x			x					x	juveniles & adults
	Caspian tern	*Sterna caspia*	U	7	H	x			x						x	circling & squawking
	double-crested cormorant	*Phalacrocorax auritus*	U	3	H	x									x	foraging
	European starling	*Sturnus vulgaris*	U	1	H	x				x						
	gadwall	*Anas strepera*	U	6	H	x									x	juveniles & adults
	glaucous-winged gull	*Larus glaucescens*	U	3	H											
	house finch	*Carpodacus mexicanus*	M	1	H		x				x					
	mallard	*Anas platyrhynchos*	U	10	H	x				x		x			x	
	song sparrow	*Melospiza melodia*	M	1	H		x				x					
	tree swallow	*Tachycineta bicolor*	U	1	H	x				x						bird flew into nest box - 7th from left. Quick ID - not 100% sure
6/29/2004	American crow	*Corvus brachyrhynchos*	U	8	L	x					x			x		
	American goldfinch	*Carduelis tristis*	U	2	L	x	x		x							
	American wigeon	*Anas americana*	U	8	L	x								x		
	band-tailed pigeon	*Columba fasciata*	U	1	L	x			x							
	European starling	*Sturnus vulgaris*	U	1	L		x				x					
	glaucous-winged gull	*Larus glaucescens*	U	2	L	x			x					x		
	great blue heron	*Ardea herodias*	U	4	L	x								x		
	house finch	*Carpodacus mexicanus*	U	2	L		x				x					
	house wren	*Troglodytes aedon*	U	1	L		x				x					? On ID
	mallard	*Anas platyrhynchos*	F	4	L	x								x		
	purple martin	*Progne subis*	U	6	L	x	x		x	x						
	song sparrow	*Melospiza melodia*	U	2	L		x				x					
	tree swallow	*Tachycineta bicolor*	U	1	L	x			x	x						using nest box on piling
8/27/2004	bushtit	*Psaltriparus minimus*	U	1	L		x				x					
	Canada goose	*Branta canadensis*	U	9	L	x			x							landed ~200 yds away on mud
	cormorant	*Phalacrocorax sp.*	U	13	L	x			x							
	crow	*Corvus sp.*	U	1	L	x			x							
	great blue heron	*Ardea herodias*	U	1	L	x				x						
	house finch	*Carpodacus mexicanus*	U	1	L		x				x					
	rock dove	*Columba livia*	U	5	L	x			x							
	song sparrow	*Melospiza melodia*	U	2	L	x					x					1 singing
9/20/2004	American wigeon	*Anas americana*	U	64	H	x									x	
	black-capped chickadee	*Poecile atricapilla*	U	2	H		x				x					
	double-crested cormorant	*Phalacrocorax auritus*	U	11	H	x				x						loafing, drying wings
	glaucous-winged gull	*Larus glaucescens*	U	2	H	x			x						x	
	great blue heron	*Ardea herodias*	U	2	H	x				x						1 preening; loafing
	green-winged teal	*Anas crecca*	U	4	H	x									x	
	house finch	*Carpodacus mexicanus*	U	1	H	x	x		x							
	mallard	*Anas platyrhynchos*	M	3	H	x									x	
	mallard	*Anas platyrhynchos*	F	2	H	x									x	
	song sparrow	*Melospiza melodia*	U	2	H	x	x				x	x				
	spotted sandpiper	*Actitis macularia*	U	4	H	x	x					x	x			calling
	spotted towhee	*Pipilo maculatus*	U	1	H		x				x					
	Steller's jay	*Cyanocitta stelleri*	U	2	H		x				x					
	Wilson's warbler	*Wilsonia pusilla*	U	1	H	x					x					1st yea bird
9/30/2004	American wigeon	*Anas americana*	U	125	H	x	x			x						
	belted kingfisher	*Ceryle alcyon*	U	2	H	x	x		x	x					x	~15 loafing on logs; most head in wing
	crow	*Corvus sp.*	U	2	H		x									
	double-crested cormorant	*Phalacrocorax auritus*	U	15	H	x										
	downy woodpecker	*Picoides pubescens*	U	1	H		x				x					heard twice
	glaucous-winged gull	*Larus glaucescens*	U	3	H	x	x			x						
	great blue heron	*Ardea herodias*	U	1	H	x					x					
	mallard	*Anas platyrhynchos*	M	4	H	x	x			x					x	3 loafing on logs
	mallard	*Anas platyrhynchos*	F	2	H	x	x								x	
	red-shafted flicker	*Colaptes auratus cafer*	U	1	H		x				x					
	ruddy duck	*Oxyura jamaicensis*	M	1	H		x								x	non-breeding plumage and foraging, w/ wigeons
	song sparrow	*Melospiza melodia*	U	2	H	x	x				x					singing
11/12/2004	American crow	*Corvus brachyrhynchos*	U	3	H	x	x		x							
	American wigeon	*Anas americana*	U	75	H	x	x			x					x	
	Anna's hummingbird	*Calypte anna*	U	1	H	x					x					Foraging on Lathyrus
	Barrow's goldeneye	*Bucephala islandica*	M	3	H	x										
	Barrow's goldeneye	*Bucephala islandica*	F	3	H	x										
	black-capped chickadee	*Poecile atricapilla*	U	4	H	x	x									
	bufflehead	*Bucephala albeola*	F	1	H	x									x	
	bufflehead	*Bucephala albeola*	M	1	H	x									x	
	glaucous-winged gull	*Larus glaucescens*	U	1	H	x										
	green-winged teal	*Anas crecca*	M	1	H	x									x	
	pied-bill grebe	*Podilymbus podiceps*	U	1	H	x									x	
	red-tailed hawk	*Buteo jamaicensis*	U	1	H	x					x					Pale juvenile, sitting on telephone wire, foraging on site
	song sparrow	*Melospiza melodia*	U	1	H		x									
	surf scoter	*Melanitta perspicillata*	F	1	H	x									x	Foraging; brought up what looked like a mussel
	western gull	*Larus occidentalis*	U	1	H	x				x						

Table A-31a. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Middle Waterway (Simpson/Trustees) (South Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	3	50	2	*Salicornia virginica*
MB	586	95	557	*Salicornia virginica*
MC	15	95	14	*Deschampsia caespitosa*
MD	16	95	15	*Deschampsia caespitosa, Distichlis spicata*
ME	65	80	52	*Deschampsia caespitosa, Atriplex patula*
MF	163	85	139	*Deschampsia caespitosa, Atriplex patula*
MG	853	55	469	*Salicornia virginica*
MH	1,390	60	834	*Salicornia virginica*
MI	571	75	428	*Spergularia canadensis*
MJ	603	75	452	*Atriplex patula, Spergularia canadensis*
MK	193	25	48	*Atriplex patula, Spergularia canadensis, Salicornia virginica*
ML	233	20	47	*Salicornia virginica*
MM	614	20	123	*Salicornia virginica*
MN	167	20	33	*Eleocharis* sp.
MO	496	70	347	*Eleocharis* sp.
MP	276	40	110	*Salicornia virginica*
MQ	57	60	34	*Salicornia virginica*
MR	105	35	37	*Atriplex patula*
MS	60	30	18	*Salicornia virginica, Eleocharis* sp.
MT	10	65	7	*Salicornia virginica, Eleocharis* sp.
MU	12	60	7	*Distichlis spicata, Eleocharis* sp.
MV	393	75	295	*Salicornia virginica*
MW	1,635	25	409	*Salicornia virginica*
MX	488	90	439	*Salicornia virginica, Distichlis spicata, Spergularia canadensis*
MY	343	90	309	*Salicornia virginica, Distichlis spicata*
MZ	3	35	1	*Scirpus maritimus*
Total (sq. ft.)	**9,350**		**5,226**	
Total (acres)	**0.21**		**0.12**	

Table A-31b. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Middle Waterway (Simpson/Trustees) (Center Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	153	85	130	*Atriplex patula, Salicornia virginica*
MB	675	25	169	*Salicornia virginica*
MC	660	50	330	*Deschampsia* caespitosa, *Distichlis spicata, Aira* sp.
MD	138	80	110	*Deschampsia caespitosa, Atriplex patula, Salicornia virginica*
ME	3	65	2	*Salicornia virginica*
MF	9	80	7	*Atriplex patula*
MG	377	80	302	*Atriplex patula, Spergularia canadensis, Salicornia virginica*
MH	365	40	146	*Salicornia virginica*
MI	301	50	151	*Salicornia virginica, Eleocharis* sp.
MJ	438	60	263	*Salicornia virginica*
MK	42	35	15	*Spergularia canadensis*
ML	13	80	10	*Scirpus americanus*
MM	196	25	49	*Deschampsia caespitosa*
MN	204	90	184	*Distichlis spicata*
MO	398	85	338	*Distichlis spicata, Salicornia virginica, Atriplex patula*
MP	6	25	2	*Eleocharis* sp.
MQ	45	25	11	*Deschampsia caespitosa*
MR	27	55	15	*Scirpus maritimus*
MS	29	25	7	*Salicornia virginica*
MT	109	40	44	*Salicornia virginica, Atriplex patula*
MU	4	50	2	*Atriplex patula*
MV	33	25	8	*Atriplex patula*
MW	26	65	17	*Salicornia virginica, Atriplex patula*
MX	113	40	45	*Eleocharis* sp.
MY	81	35	28	*Deschampsia caespitosa, Atriplex patula*
MZ	961	25	240	*Salicornia virginica, Atriplex patula*
Total (sq. ft.)	**5,406**		**2,625**	
Total (acres)	**0.12**		**0.06**	

Table A-31c. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Middle Waterway (Simpson/Trustees) (North Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	91	25	23	*Salicornia virginica, Atriplex patula, Deschampsia caespitosa*
MB	173	25	43	*Salicornia virginica, Atriplex patula*
MC	245	80	196	*Distichlis spicata*
MD	500	30	150	*Salicornia virginica*
ME	767	75	575	*Salicornia virginica, Atriplex patula*
MF	1,184	40	474	*Salicornia virginica*
MG	391	55	215	*Eleocharis* sp.
MH	128	60	77	*Deschampsia* sp.
MI	457	60	274	*Deschampsia* sp.
MJ	354	70	248	*Gnaphalium microcephalum, Atriplex patula, Deschampsia caespitosa, Rosa* sp.
MK	681	90	613	*Salicornia virginica*
ML	140	50	70	*Salicornia virginica, Atriplex patula, Spergularia canadensis*
MM	211	40	84	*Distichlis spicata*
MN	62	80	50	*Gnaphalium* microcephalum, *Distichlis spicata, Rosa* sp.
MO	480	75	360	*Distichlis spicata, Aira sp.*
MP	215	80	172	*Distichlis spicata*
MQ	86	90	77	*Gnaphalium microcephalum, Distichlis spicata*
MR	462	90	416	*Distichlis spicata, Atroplex patula*
MS	1,049	90	944	*Salicornia virginica, Distichlis spicata*
MT	8	55	4	*Distichlis spicata*
MU	134	80	107	*Salicornia virginica, Spergularia canadensis*
MV	152	50	76	*Salicornia virginica*
MW	26	75	20	*Salicornia virginica, Plantago maritima*
MX	13	90	12	*Salicornia virginica, Plantago maritima*
MY	463	40	185	*Salicornia virginica*
MZ	76	50	38	*Salicornia virginica*
Total (sq. ft.)	**8,548**		**5,503**	
Total (acres)	**0.20**		**0.13**	

Table A-31d. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Middle Waterway (Simpson/Trustees) (North Lobe Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	1,430	40	572	*Salicornia virginica, Spergularia* sp.
MB	93	40	37	*Salicornia virginica*
MC	89	20	18	*Salicornia virginica, Spergularia* sp.
MD	362	85	308	*Spergularia sp., Plantago maritima*
ME	85	80	68	*Spergularia sp., Atriplex patula*
MF	910	50	455	*Salicornia virginica, Spergularia* sp.
MG	21	100	21	*Salicornia virginica*
MH	22	100	22	*Salicornia virginica*
MI	71	80	57	*Plantago maritima*
MJ	44	20	9	*Spergularia sp.*
MK	point	80	1	*Salicornia virginica, Atriplex patula*
ML	1,114	70	780	*Salicornia virginica*
MM	16	30	5	*Salicornia virginica, Atriplex patula*
MN	26	75	20	*Salicornia virginica, Atriplex patula*
MO	39	25	10	*Salicornia virginica*
MP	280	80	224	*Distichlis spicata*
MQ	159	100	159	*Distichlis spicata*
MR	38	95	36	*Distichlis spicata*
MS	27	95	26	*Distichlis spicata, Juncus balticus*
MT	129	75	97	*Distichlis spicata*
MU	22	30	7	*Atriplex patula*
Total (sq. ft.)	**4,977**		**2,929**	
Total (acres)	**0.11**		**0.07**	

Total Year 3 Vegetated Marsh Area:

(sq.ft.)	**16,282**
(acres)	**0.37**

For comparison:

Total Year 1 Vegetated Marsh Area:

(sq.ft.)	**4,683**
(acres)	**0.11**

Table A-31e. Year 3 (2004) Marsh and Riparian Areal Cover by Polygon at Middle Waterway (Simpson/Trustees) (Riparian Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
RA	9,433	75	7,075	*Populus balsamifera, Pseudotsuga menziesii, Rosa* sp.
RB	29,239	60	17,543	*Populus balsamifera, Pinus contorta, Thuja plicata, Rosa* sp., *Holodiscus discolor, Gnaphalium microcephalum, Fragaria* sp., *Arctostaphylos uva-ursi, Buddeja davidii*
RC	11,082	100	11,082	*Pinus contorta, Buddeja* davidii, *Rubus discolor, grasses*
RD	258	25	65	*Gnaphalium microcephalum*
Total (sq. ft.)	**50,012**		**35,765**	
Total (acres)	**1.15**		**0.82**	

For comparison:
Total Year 1 Vegetated Riparian Area:

(sq.ft.)	**40,748**
(acres)	**0.94**

Table A-32. Quadrat Locations Along Marsh Transects at Middle Waterway (Simpson/Trustees)

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	115	1	24	1	115
2	117	2	51	2	122
3	177	3	79	3	177
4	271	4	106	4	271
5	273	5	133	5	342
6	327	6	160	6	370
7	342	7	187	7	378
8	370			8	428
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	827
16	603			16	986
17	637				
18	690				
19	702				
20	715				
21	744				
22	748				
23	922				
24	986				
25	1085				
26	1229				

Table A-33. Year 1 (2002) Marsh Development at Middle Waterway (Simpson/Trustees), Transect 1-1 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence: Lower Bound	90% Confidence: Upper Bound
Native								
American bulrush	*Scirpus americanus*	0.1	4.3%	1/23	3.0	n/a	n/a	n/a
pickleweed	*Salicornia virginica*	1.2	8.7%	2/23	14.0	n/a	n/a	n/a
Canadian sand-spurry	*Spergularia canadensis*	5.7	34.8%	8/23	16.4	11.6	0.0	32.2
orache, fat-hen saltbush	*Atriplex patula*	3.7	43.5%	10/23	8.4	3.5	1.3	5.7
seashore saltgrass	*Distichlis spicata*	8.9	21.7%	5/23	41.0	9.4	1.9	16.8
Canopy Cover, Native		19.6			34.7	24.2	6.6	41.7
Non-Native or Invasive								
(none)		0.0	0.0%	0/23	n/a	n/a	n/a	n/a
Canopy Cover, NNI		0.0			0.0			
TOTAL		19.6			34.7	24.2	6.6	41.7
Proportion of non-native or invasive plants (%):		0.0%			0.0%	0.0%		

Table A-34a. Year 3 (2004) Marsh Development at Middle Waterway (Simpson/Trustees), Transect 1-1 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	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
Corresponding quadrat in year of origin (Year 1 - 2002)				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	n/a	23	n/a	n/a
Percent of quadrat situated within herbivory exclusion device				0	0	0	0	0	0	0	0	0	100	100	100	100	100	100	100	100	0	0	0	100	0	0	0	0	0
Native																													
American bulrush	*Scirpus americanus*	0.4	10.0															10											
Canadian sandspurry	*Spergularia canadensis*	2.4	7.0				15	10	10	5			10	1			2			5			5						
orache, fat-hen	*Atriplex patula*	3.0	7.1				3	1	1					<0.5			1	10		2			15	10			30	5	
pickleweed	*Salicornia virginica*	10.9	15.8			20	3	10	2	5	3		5	1	40	2	2		2	2			50		2	45	80	10	
seashore saltgrass	*Distichlis spicata*	20.4	66.4										40	100	95	100	95		10	90			1						
seaside plantain	*Plantago maritima*	1.3	16.5						3															30					
Non-Native or Invasive[1]																													
(none)		0.0	0.0																										

Table A-34b. Year 3 (2004) Marsh Development at Middle Waterway (Simpson/Trustees), Transect 1-2 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	Quadrats, Transect 1-2						
				1	2	3	4	5	6	7
Percent of quadrat situated within herbivory exclusion device				0	0	0	0	0	0	0
Native										
Canadian sandspurry	*Spergularia canadensis*	13.1	30.7		20	70	2			
orache, fat-hen	*Atriplex patula*	4.0	28.0			28				
pickleweed	*Salicornia virginica*	1.6	2.8	3	1	2	5			
Non-Native or Invasive[1]										
(none)		0.0	0.0							

Table A-35a. Year 3 (2004) Marsh Development at Middle Waterway (Simpson/Trustees), Transect 1-1 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy Cover (%)	90% Confidence Interval: Lower Bound	90% Confidence Interval: Upper Bound
Native								
American bulrush	*Scirpus americanus*	0.4	4.0%	1/25	10.0	n/a	n/a	n/a
Canadian sandspurry	*Spergularia canadensis*	2.5	36.0%	9/25	7.0	2.8	0.8	4.9
orache, fat-hen saltbush	*Atriplex patula*	3.1	44.0%	11/25	7.1	3.6	0.0	7.3
pickleweed	*Salicornia virginica*	11.4	72.0%	18/25	15.8	11.6	2.4	20.8
seashore saltgrass	*Distichlis spicata*	21.2	32.0%	8/25	66.4	46.5	0.0	121.2
seaside plantain	*Plantago maritima*	1.3	8.0%	2/25	16.5	n/a	n/a	n/a
Canopy Cover, Native		40.0	100.0%	25/25	50.0	49.1	18.8	79.4
Non-Native or Invasive								
(none)		0.0	0.0%	0/25	n/a	n/a	n/a	n/a
Canopy Cover, NNI		0.0			0.0			
TOTAL		40.0			50.0	49.1	18.8	79.4
Proportion of non-native or invasive plants (%):		0.0%			0.0%	0.0%		

Table A-35b. Year 3 (2004) Marsh Development at Middle Waterway (Simpson/Trustees), Transect 1-2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy Cover (%)	90% Confidence Interval: Lower Bound	90% Confidence Interval: Upper Bound
Native								
Canadian sandspurry	*Spergularia canadensis*	13.1	42.9%	3/7	30.7	30.7	0.0	135.1
orache, fat-hen saltbush	*Atriplex patula*	4.0	14.3%	1/7	28.0	n/a	n/a	n/a
pickleweed	*Salicornia virginica*	1.6	57.1%	4/7	2.8	1.7	0.0	3.3
Canopy Cover, Native		18.7	100.0%	7/7	32.8	26.1	0.0	84.9
Non-Native or Invasive								
(none)		0.0	0.0%	0/7	n/a	n/a	n/a	n/a
Canopy Cover, NNI		0.0			0.0			
TOTAL		18.7			32.8	26.1	0.0	84.9
Proportion of non-native or invasive plants (%):		0.0%			0.0%	0.0%		

Table A-36. Year 3 (2004) Marsh Development at Middle Waterway (Simpson/Trustees) - Change in Percent Cover, Year 1 to Year 3

	Species[b]	Percent of Quadrats with Decreased Cover	Percent of Quadrats with No Change	Percent of Quadrats with Increased Cover	Statistical Result[a]
Middle Waterway Marsh Transect 1-1					
	Atriplex patula	35%	35%	30%	
	Distichlis spicata	0%	65%	35%	+
Native	*Salicornia virginica*	4%	30%	65%	+
	Scirpus americanus	0%	96%	4%	No Test[c]
	Spergularia canadensis	30%	48%	22%	
Native Total		22%	17%	61%	
Total (All Species)		22%	17%	61%	

[a] "+" indicates a significant increase (two-tailed sign test, alpha = 0.05);
"-" indicates a significant decrease; other species are not significantly changed

[b] Displayed species are species observed in both years - NNI and Native totals include species observed in either year.

[c] Species with less than three non-zero changes could not be statistically tested.

Table A-37. Year 1 (2002) Riparian Development at Middle Waterway (Simpson/Trustees), Transect 2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence Interval: Lower Bound	90% Confidence Interval: Upper Bound
Native								
Herbs and Forbes								
lupine	*Lupinus sp.*	1.4	33.3%	5/15	4.3	1.6	0.0	4.0
strawberry	*Fragaria sp.*	11.3	73.3%	11/15	15.5	12.9	4.1	21.6
Shrubs								
common snowberry	*Symphoricarpos albus*	2.8	20.0%	3/15	14.0	3.2	0.0	7.8
kinnikinnick	*Arctostaphylos uva-ursi*	13.7	26.7%	4/15	51.3	14.5	1.3	27.8
nootka rose	*Rosa nutkana*	1.3	6.7%	1/15	20.0	n/a	n/a	n/a
oceanspray	*Holodiscus discolor*	0.7	6.7%	1/15	10.0	n/a	n/a	n/a
rose	*Rosa sp.*	9.4	40.0%	6/15	23.5	13.4	0.0	35.6
trailing blackberry	*Rubus ursinus*	0.2	6.7%	1/15	3.0	n/a	n/a	n/a
vine maple	*Acer circinatum*	0.3	6.7%	1/15	5.0	n/a	n/a	n/a
Trees								
bigleaf maple	*Acer macrophyllum*	0.3	6.7%	1/15	5.0	n/a	n/a	n/a
black cottonwood	*Populus balsamifera*	10.0	40.0%	6/15	25.0	11.9	0.0	24.6
Douglas fir	*Pseudotsuga menziesii*	1.0	6.7%	1/15	15.0	n/a	n/a	n/a
lodgepole pine	*Pinus contorta*	0.3	6.7%	1/15	5.0	n/a	n/a	n/a
madrone	*Arbutus menziesii*	0.5	20.0%	3/15	2.3	0.5	0.0	1.3
Scouler's willow	*Salix scouleriana*	5.0	6.7%	1/15	75.0	n/a	n/a	n/a
western red cedar	*Thuja plicata*	3.7	20.0%	3/15	18.3	4.4	0.0	11.0
Non-Native or Invasive								
Herbs and Forbes								
brome	*Bromus sp.*	21.0	73.3%	11/15	28.6	21.3	13.6	29.0
colonial bentgrass	*Agrostis tenuis*	14.0	46.7%	7/15	30.0	28.6	0.0	92.8
common St. John's-wort	*Hypericum perforatum*	4.1	46.7%	7/15	8.9	4.5	0.0	9.3
common velvet-grass	*Holcus lanatus*	0.4	20.0%	3/15	1.8	0.4	0.0	1.1
English plantain	*Plantago lanceolata*	1.1	26.7%	4/15	4.3	1.2	0.0	2.4
hairy catsear	*Hypochaeris radicata*	0.6	40.0%	6/15	1.6	0.7	0.2	1.2
orchard grass	*Dactylis glomerata*	0.4	13.3%	2/15	3.0	n/a	n/a	n/a
pea vine	*Lathyrus sp.*	0.7	20.0%	3/15	3.7	1.2	0.0	4.7
red clover	*Trifolium pratense*	0.2	6.7%	1/15	3.0	n/a	n/a	n/a
sheep sorrel	*Rumex acetosella*	0.5	13.3%	2/15	3.8	n/a	n/a	n/a
silver hairgrass	*Aira caryophyllea*	1.7	20.0%	3/15	8.3	1.8	0.0	3.8
unclassified-herb	*unclassified-herb*	0.1	20.0%	3/15	0.7	0.1	0.0	0.3
Shrubs								
Himalayan blackberry	*Rubus discolor*	4.9	26.7%	4/15	18.3	5.9	0.0	14.5
butterfly bush	*Buddleja davidii*	0.3	6.7%	1/15	5.0	n/a	n/a	n/a
unknown	*unknown*	0.3	13.3%	2/15	2.5	n/a	n/a	n/a
	Total Herbs	57.7	93.3%	14/15	61.8	59.4	42.5	76.2
	Total Shrubs	33.6	93.3%	14/15	36.0	39.7	13.1	66.3
	Total Trees	20.8	80.0%	12/15	26.0	27.1	4.3	49.8
	Total NNI	50.4	93.3%	14/15	54.0	51.7	33.4	70.1
	Total Native	62.0	100.0%	15/15	62.0	70.4	40.2	100.6

Table A-38. Year 3 (2004) Riparian Development at Middle Waterway (Simpson/Trustees), Transect 2 - Collected Data

Common Name	Scientific Name	Average % Cover	Average % Where Found	Quadrats, Transect 2															
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Corresponding quadrat in year of origin (Year 1 - 2002)				1	2	3	4	5	6	7	8	9	10	11	12	13	14	n/a	15
Native																			
Herbs and Forbes																			
sicklekeel lupine	*Lupinus albicaulis*	0.1	2.0														2		
strawberry	*Fragaria sp.*	5.5	12.6					10	30		10			5	20	10	3		
Shrubs																			
common snowberry	*Symphoricarpos albus*	0.6	10.0								10								
kinnikinnick	*Arctostaphylos uva-ursi*	3.8	20.0				50	5						5					
nootka rose	*Rosa nutkana*	15.3	40.8	80	15					40		15				55	40		
rose	*Rosa sp.*	0.2	3.0						3										
tall Oregon grape	*Mahonia aquifolium*	0.2	3.0		3														
vine maple	*Acer circinatum*	1.4	7.3					2						15			5		
Trees																			
black cottonwood	*Populus balsamifera*	12.2	48.8			25					90							5	75
Douglas fir	*Pseudotsuga menziesii*	8.1	32.5					50					25	45				10	
western red cedar	*Thuja plicata*	6.4	25.8						15						3	25			60
Non-Native or Invasive (NNI)																			
Herbs and Forbes																			
non-natives/invasives		44.8	47.8	10	90	25	75	25	75	50	10	65	50	70	55	60	55	2	
Shrubs																			
Himalayan blackberry	*Rubus discolor*	6.8	13.6	5	15	1					5	50	3	20			10		
butterfly bush	*Buddleja davidii*	3.1	16.7	10	15					25									

Table A-39. Year 3 (2004) Riparian Development at Middle Waterway (Simpson/Trustees), Transect 2 - Cover

Common Name	Scientific Name	Average Quadrat Canopy Cover (%)	Frequency (%)	Frequency: Quadrats Containing Species	Average Where Found (%)	Unbiased Average Quadrat Canopy	90% Confidence: Lower Bound	90% Confidence: Upper Bound
Native								
Herbs and Forbes								
sicklekeel lupine	*Lupinus albicaulis*	0.1	6.3%	1/16	2.0	n/a	n/a	n/a
strawberry	*Fragaria sp.*	5.5	43.8%	7/16	12.6	5.8	1.4	10.2
Shrubs								
common snowberry	*Symphoricarpos albus*	0.6	6.3%	1/16	10.0	n/a	n/a	n/a
kinnikinnick	*Arctostaphylos uva-ursi*	3.8	18.8%	3/16	20.0	4.9	0.0	14.8
nootka rose	*Rosa nutkana*	15.3	37.5%	6/16	40.8	16.2	3.7	28.7
rose	*Rosa sp.*	0.2	6.3%	1/16	3.0	n/a	n/a	n/a
tall Oregon grape	*Mahonia aquifolium*	0.2	6.3%	1/16	3.0	n/a	n/a	n/a
vine maple	*Acer circinatum*	1.4	18.8%	3/16	7.3	1.7	0.0	4.2
Trees								
black cottonwood	*Populus balsamifera*	12.2	25.0%	4/16	48.8	18.3	0.0	50.0
Douglas fir	*Pseudotsuga menziesii*	8.1	25.0%	4/16	32.5	9.0	0.0	18.3
western red cedar	*Thuja plicata*	6.4	25.0%	4/16	25.8	8.9	0.0	23.4
Non-Native or Invasive								
Herbs and Forbes								
unclassified-herb	*unclassified-herb*	44.8	93.8%	15/16	47.8	56.5	23.1	89.9
Shrubs								
Himalayan blackberry	*Rubus discolor*	6.8	50.0%	8/16	13.6	8.0	0.0	16.5
butterfly bush	*Buddleja davidii*	3.1	18.8%	3/16	16.7	3.2	0.0	6.5
	Total Herb					64.0	26.6	101.5
	Total Shrub					50.5	0.0	103.8
	Total Trees					30.8	6.2	55.3
	Total NNI					69.1	28.6	109.6
	Total Native					55.4	36.5	74.4

Table A-40. Year 3 (2004) Fish Monitoring Data at Middle Waterway (Simpson/Trustees)

Date	High Tide	Low Tide	Time	Gear	Temperature (degree Celcius)		Salinity (ppt)		Weather
					Surface	Bottom	Surface	Bottom	
04/09/04	H 11.49' 6:30	L -2.58' 13:30	10:40 AM	Beach Seine	11.1	10.2	18.9	27.9	sunny
04/20/04	H 11.7' 4:48	L -0.03' 11:18	10:15 AM	Beach Seine	9.8	9.8	29.2	29.2	partly cloudy
04/23/04	H 10.11' 6:12	L -0.07' 14:00		Beach Seine	No water data was collected for the site				overcast-high winds
04/27/04	H 8.1' 10:00	L 1.1' 17:38	10:15 AM	Beach Seine	12.7	12	22.4	27.7	overcast-high winds
05/11/04	H 8.52' 10:21	L 0.2' 17:28	11:32 AM	Beach Seine	10.8	11.6	24.2	27	partly cloudy
05/12/04	H 8.00' 12:05	L 1.4' 18:37	1:00 PM	Beach Seine	12.6	12.3	25.7	25.6	partly cloudy
05/20/04	H 10.4' 16:19	L -1.4' 13:06	8:30 AM	Beach Seine	11.8	11.5	17.9	25.5	partly cloudy
05/25/04	H 8.42' 8:28	L 0.2' 15:58	10:00 AM	Beach Seine	13.4	14.1	19.1	22	sunny
06/08/04	H 8.94' 8:58	L -0.5' 15:59	11:32 AM	Beach Seine	14.3	13	15.9	20.2	partly cloudy
06/15/04	H 11.12' 18:11	L 7.4' 23:00	5:32 PM	Beach Seine	15.9	12.6	17.2	26.6	sunny
07/08/04	H 8.11' 10:27	L 2.3' 16:21	1:55 PM	Beach Seine	15.4	13.5	25.1	28.4	overcast
07/22/04	H 8.84' 8:25	L 1.0' 14:54	10:29 AM	Beach Seine	17.7	15.8	19.4	25.6	sunny
08/03/04	H 10.5' 6:57	L -1.1' 13:36	9:10 AM	Beach Seine	14.1	13.4	28.5	29.4	sunny
08/20/04	H 9.67' 8:29	L 2.5' 14:29	10:27 AM	Beach Seine	16.9	14.8	23.7	25.7	sunny
09/03/04	H 9.98' 8:57	L 3.8' 14:37	9:56 AM	Beach Seine	14.3	13.7	26.5	29.2	cloudy
09/16/04	H 10.7' 6:45	L 2.2' 12:50	8:56 AM	Beach Seine	13.4	13.5	29.4	29.7	sunny
10/05/04	H 10.5' 12:11	L 7.6' 17:22	11:59 AM	Beach Seine	13.9	13.4	27.2	30.2	partly cloudy

Table A-41. Year 3 (2004) Total Fish Catch at Middle Waterway (Simpson/Trustees)

			Chinook				Coho								Steelhead																																					
No. of Sets	Date	Time	Unmarked	Marked	Not checked	Total	Unmarked	Marked	Not checked	Total	Chum	Pink	Cutthroat	Dolly Varden/Bull Trout	Unmarked	Marked	Not checked	Total	Total Salmonids	English Sole	Starry Flounder	Rock Sole	Speckled Sandab	Right Eyed Flatfish	Staghorn Sculpin	Silverspot Sculpin	Great Sculpin	Northern Sculpin	Buffalo Sculpin	Cabezon Sculpin	Tidepool Sculpin	Sailfin Sculpin	Surf Smelt	Shiner Perch	Striped Perch	Pile Perch	Kelp Perch	Penpoint Gunnel	Crescent Gunnel	Saddleback Gunnel	Tubesnout	Pipefish	Stickleback	Snake Prickleback	Herring	Sandlance	Shad	Greenling- white spot	Sturgeon Poacher	Ratfish	Northern Anchovy	Total
3	04/09/04	9:27 AM				0				0	11	75						0	**86**		1				27								4																		**118**
2	04/20/04	8:25 AM				0	2	1		3	2							0	**5**						104																										**109**
1	04/23/04	9:30 AM	3			3		1		1	9	5						0	**18**						116								9																		**143**
3	04/27/04	9:15 AM	3	1		4	4	8		12	3							0	**19**		5				76									1																	**101**
3	05/11/04	10:30 AM		2		2				0								0	**2**		26				326								4	9																	**367**
3	05/12/04	12:21 PM		1		1		1	1	2								0	**3**		89				732									198																	**1022**
3	05/20/04	7:55 AM				0				0								0	**0**		7				453								4	208																	**672**
2	05/25/04	9:20 AM				0				0								0	**0**		23				202									446																	**671**
3	06/08/04	10:23 AM	5	4		9	1	2		3								0	**12**		53	2			141									1025								1									**1234**
3	06/15/04	4:39 PM				0				0								0	**0**		9				24								1	1481	1	1															**1517**
3	07/08/04	10:20 AM	1			1	1			1								0	**2**		20				93									1825																	**1940**
3	07/22/04	9:35 AM				0		1		1								0	**1**		21				96																	2									**120**
3	08/03/04	8:11 AM				0	2	1		3								0	**3**		322				75								2	437																	**839**
3	08/20/04	9:16 AM				0				0								0	**0**		35				206									375								1		174							**791**
2	09/03/04	9:25 AM				0				0								0	**0**		7				16								4	91								1		6							**125**
2	09/16/04	8:05 AM				0				0								0	**0**		9				18								6	330																	**363**
3	10/05/04	11:38 AM				0				0								0	**0**		5				2									330																	**337**
30			**6**	**4**	**0**	**10**	**4**	**4**	**0**	**8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**18**	**0**	**511**	**2**	**0**	**0**	**1326**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**17**	**6548**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**4**	**0**	**180**	**0**	**0**	**0**	**0**	**0**	**0**	**8609**

Table A-42a. Year 3 (2004) Invertebrate Presence at Middle Waterway (Simpson/Trustees) - Fallout Samples

Sample Type		Sample No.						Grand
Order	**Family**	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Coleoptera	Staphylinidae		1					**1**
Diptera	Blephariceridae		1					**1**
	Chironomidae	1		2				**3**
	Ephydridae		2		5	8		**15**
	Rhagionidae			2	3	18	68	**91**
	Simuliidae					1		**1**
	Tabanidae				1			**1**
	Tipulidae				1			**1**
	(not identified)					1	1	**2**
Hemiptera	Saldidae		1			2		**3**
	(not identified)			1				**1**
Hymenoptera	Formicidae		1	4	18	2	2	**27**
	Vespidae				1			**1**
	(not identified)	1						**1**
Unknown	(not identified)		1	1				**2**
Grand Total		**2**	**7**	**10**	**29**	**32**	**71**	**151**

Table A-42b. Year 3 (2004) Invertebrate Presence at Middle Waterway (Simpson/Trustees) - Substrate Samples

Sample Type		Sample No.						Grand
Order	**Family**	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
Amphipoda	(not identified)						1	**1**
Grand Total		**0**	**0**	**0**	**0**	**0**	**1**	**1**

Table A-43. Year 3 (2004) Seasonal Bird Counts at Middle Waterway (Simpson/Trustees)

Common Name	Scientific Name	Total	Winter	Spring	Summer	Fall
American crow	*Corvus brachyrhynchos*	121		12	9	100
American goldfinch	*Carduelis tristis*	16		5	11	
American robin	*Turdus migratorius*	1			1	
American wigeon	*Anas americana*	6	2			4
barn swallow	*Hirundo rustica*	4		2	2	
belted kingfisher	*Ceryle alcyon*	1		1		
Bewick's wren	*Thryomanes bewickii*	1		1		
Canada goose	*Branta canadensis*	22	12	8	2	
Caspian tern	*Sterna caspia*	10		6	4	
cliff swallow	*Petrochelidon pyrrhonota*	3			3	
common goldeneye	*Bucephala clangula*	6		6		
crow	*Corvus sp.*	52	2	23	27	
double-crested cormorant	*Phalacrocorax auritus*	49			48	1
European starling	*Sturnus vulgaris*	13		13		
glaucous-winged gull	*Larus glaucescens*	192	30	134	23	5
great blue heron	*Ardea herodias*	9			8	1
hooded merganser	*Lophodytes cucullatus*	8		2		6
horned grebe	*Podiceps auritus*	4	2	1		1
house finch	*Carpodacus mexicanus*	44	17	3	22	2
house sparrow	*Passer domesticus*	2		2		
killdeer	*Charadrius vociferus*	2			2	
mallard	*Anas platyrhynchos*	4		4		
red-shafted flicker	*Colaptes auratus cafer*	1			1	
red-winged blackbird	*Agelaius phoeniceus*	1		1		
savannah sparrow	*Passerculus sandwichensis*	1			1	
song sparrow	*Melospiza melodia*	6		4	1	1
spotted sandpiper	*Actitis macularia*	1		1		
tree swallow	*Tachycineta bicolor*	6		4	2	
violet-green swallow	*Tachycineta thalassina*	9		5	4	
white-crowned sparrow	*Zonotrichia leucophrys*	13		10	3	
Wilson's warbler	*Wilsonia pusilla*	2		1	1	
TOTAL		**610**	**65**	**249**	**175**	**121**

Notes:
Blank indicates no bird was observed.

Winter = December to February
Spring = March to May
Summer = June to August
Fall = September to November

Table A-44. Year 3 (2004) 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
1/30/2004	American wigeon	*Anas americana*	F	2	H	x							x			
	Canada goose	*Branta canadensis*	U	12	H	x	x		x							
	crow	*Corvus sp.*	U	2	H	x			x							
	glaucous-winged gull	*Larus glaucescens*	U	30	H	x			x				x			~30
	horned grebe	*Podiceps auritus*	M	2	H	x									x	foraging; 1 chasing; aggressive
	house finch	*Carpodacus mexicanus*	U	17	H	x	x		x							
3/25/2004	belted kingfisher	*Ceryle alcyon*	M	1	H	x				x						loafing
	Bewick's wren	*Thryomanes bewickii*	U	1	H	x					x					coll. Nesting material
	Canada goose	*Branta canadensis*	U	2	H	x									x	loafing
	common goldeneye	*Bucephala clangula*	F	3	H	x									x	foraging
	common goldeneye	*Bucephala clangula*	M	3	H	x									x	foraging
	crow	*Corvus sp.*	U	6	H	x			x		x	x				foraging
	glaucous-winged gull	*Larus glaucescens*	U	35	H	x	x		x				x		x	35+; bathing
	hooded merganser	*Lophodytes cucullatus*	F	1	H	x									x	foraging
	hooded merganser	*Lophodytes cucullatus*	M	1	H	x									x	foraging
	horned grebe	*Podiceps auritus*	U	1	H	x									x	foraging
	mallard	*Anas platyrhynchos*	F	2	H	x									x	loafing
	mallard	*Anas platyrhynchos*	M	2	H	x									x	loafing
	red-winged blackbird	*Agelaius phoeniceus*	U	1	H		x									
	song sparrow	*Melospiza melodia*	U	2	H	x	x				x					foraging; singing
	white-crowned sparrow	*Zonotrichia leucophrys*	M	1	H	x	x				x					1 singing
4/13/2004	American crow	*Corvus brachyrhynchos*	U	8	H	x	x		x	x						
	Canada goose	*Branta canadensis*	U	2	H	x							x			foraging
	European starling	*Sturnus vulgaris*	U	2	H	x					x					
	glaucous-winged gull	*Larus glaucescens*	U	45	H					x			x			Poss 2 or 3 are hybrid Western x Glaucous-winged
	house finch	*Carpodacus mexicanus*	M	1	H		x				x					
	song sparrow	*Melospiza melodia*	M	1	H		x				x					
	tree swallow	*Tachycineta bicolor*	U	2	H				x							
	white-crowned sparrow	*Zonotrichia leucophrys*	M	3	H	x	x				x					3 males singing - dispersed around site
4/29/2004	American goldfinch	*Carduelis tristis*	U	1	H				x							
	barn swallow	*Hirundo rustica*	U	2	H	x	x		x							
	crow	*Corvus sp.*	U	10	H	x			x							
	European starling	*Sturnus vulgaris*	U	3	H	x			x	x		x				
	glaucous-winged gull	*Larus glaucescens*	U	11	H	x							x			
	house finch	*Carpodacus mexicanus*	U	2	H	x	x		x							
	house sparrow	*Passer domesticus*	M	1	H						x					
	house sparrow	*Passer domesticus*	F	1	H						x					
	spotted sandpiper	*Actitis macularia*	U	1	H	x										
	tree swallow	*Tachycineta bicolor*	U	2	H	x			x							
	white-crowned sparrow	*Zonotrichia leucophrys*	M	3	H	x	x				x					singing - East end of riparian and another mid-site
5/21/2004	American crow	*Corvus brachyrhynchos*	U	2	M		x						x			
	American goldfinch	*Carduelis tristis*	U	4	M	x			x							
	Canada goose	*Branta canadensis*	U	4	M										x	
	crow	*Corvus sp.*	U	7	M	x	x		x				x			
	European starling	*Sturnus vulgaris*	U	8	M				x							
	glaucous-winged gull	*Larus glaucescens*	U	18	M				x				x			
	violet-green swallow	*Tachycineta thalassina*	U	5	M				x							
	white-crowned sparrow	*Zonotrichia leucophrys*	U	1	M		x				x					
5/26/2004	American crow	*Corvus brachyrhynchos*	U	2	M	x			x							
	Caspian tern	*Sterna caspia*	U	6	M	x	x		x							
	glaucous-winged gull	*Larus glaucescens*	U	25	M	x			x	x			x	x		
	song sparrow	*Melospiza melodia*	U	1	M	x	x				x					Singing
	white-crowned sparrow	*Zonotrichia leucophrys*	U	2	M		x				x					Singing
	Wilson's warbler	*Wilsonia pusilla*	M	1	M		x				x					
6/28/2004	American crow	*Corvus brachyrhynchos*	U	3	L	x			x							
	American goldfinch	*Carduelis tristis*	U	1	L	x	x		x		x					
	American robin	*Turdus migratorius*	U	1	L	x					x					
	barn swallow	*Hirundo rustica*	U	2	L	x	x						x			foraging over water
	Caspian tern	*Sterna caspia*	U	2	L	x									x	diving & foraging
	cliff swallow	*Petrochelidon pyrrhonota*	U	3	L	x									x	
	double-crested cormorant	*Phalacrocorax auritus*	U	1	L	x									x	foraging
	glaucous-winged gull	*Larus glaucescens*	U	5	L	x	x		x				x		x	
	great blue heron	*Ardea herodias*	U	2	L	x							x	x		foraging @ water's edge
	house finch	*Carpodacus mexicanus*	U	4	L	x	x				x					family group?; male & female
	violet-green swallow	*Tachycineta thalassina*	U	4	L	x	x						x			foraging over water; male & female
	white-crowned sparrow	*Zonotrichia leucophrys*	M	2	L	x	x				x					2 males singing - alternating
6/29/2004	American crow	*Corvus brachyrhynchos*	U	6	L	x	x				x					
	American goldfinch	*Carduelis tristis*	U	10	L	x	x									2 singing territorially in riparian zone
	Caspian tern	*Sterna caspia*	U	2	L	x										foraging
	great blue heron	*Ardea herodias*	U	2	L	x										foraging
	house finch	*Carpodacus mexicanus*	U	2	L	x	x					x				1 male foraging in marsh
	savannah sparrow	*Passerculus sandwichensis*	U	1	L		x				x					scoulding
	tree swallow	*Tachycineta bicolor*	U	2	L	x	x									
	white-crowned sparrow	*Zonotrichia leucophrys*	M	1	L		x				x					singing
8/27/2004	Canada goose	*Branta canadensis*	U	2	L	x			x							
	crow	*Corvus sp.*	U	5	L				x					x		
	glaucous-winged gull	*Larus glaucescens*	U	6	L									x		foraging
	great blue heron	*Ardea herodias*	U	1	L	x								x		
	song sparrow	*Melospiza melodia*	U	1	L		x				x					
	Wilson's warbler	*Wilsonia pusilla*	M	1	L	x					x					foraging in rose bushes
9/20/2004	crow	*Corvus sp.*	U	2	H	x							x			
	double-crested cormorant	*Phalacrocorax auritus*	U	1	H	x				x						
	glaucous-winged gull	*Larus glaucescens*	U	1	H	x										
	great blue heron	*Ardea herodias*	U	1	H	x					x					landed in cottonwood
	house finch	*Carpodacus mexicanus*	U	1	H		x		x							

Table A-44. Year 3 (2004) 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
	red-shafted flicker	*Colaptes auratus cafer*	U	1	H	x			x							
9/30/2004	crow	*Corvus sp.*	U	20	H	x	x		x							
	double-crested cormorant	*Phalacrocorax auritus*	U	40	H				x							headed southeast
	double-crested cormorant	*Phalacrocorax auritus*	U	6	H	x									x	immature plumage; all foraging
	glaucous-winged gull	*Larus glaucescens*	U	11	H	x	x		x	x			x			1 following foraging cormorant
	great blue heron	*Ardea herodias*	U	2	H	x				x			x			1 foraging; 1 loafing
	house finch	*Carpodacus mexicanus*	U	15	H	x	x		x							
	killdeer	*Charadrius vociferus*	U	2	H	x	x					x				resting
11/12/2004	American crow	*Corvus brachyrhynchos*	U	100	H	x	x		x	x	x	x				Foraging in water, intertidal
	American wigeon	*Anas americana*	F	2	H	x										Loafing
	American wigeon	*Anas americana*	M	2	H	x									x	Loafing
	double-crested cormorant	*Phalacrocorax auritus*	U	1	H	x									x	
	glaucous-winged gull	*Larus glaucescens*	U	5	H	x			x							Loafing
	great blue heron	*Ardea herodias*	U	1	H	x							x			Scared it off from site; landed on a roof.
	hooded merganser	*Lophodytes cucullatus*	F	3	H	x									x	Foraging
	hooded merganser	*Lophodytes cucullatus*	M	3	H	x									x	Foraging
	horned grebe	*Podiceps auritus*	U	1	H	x									x	Foraging
	house finch	*Carpodacus mexicanus*	M	1	H	x	x				x					
	house finch	*Carpodacus mexicanus*	F	1	H	x	x				x					
	song sparrow	*Melospiza melodia*	U	1	H	x					x					

Table A-45. Year 3 (2004) Fish Monitoring Data at Middle Waterway (City of Tacoma)

Date	High Tide	Low Tide	Time	Gear	Temperature (degree Celcius)		Salinity (ppt)		Weather
					Surface	Bottom	Surface	Bottom	
04/09/04	H 11.49' 6:30	L -2.58' 13:30	10:30 AM	Beach Seine	11.1	10.2	18.9	27.9	sunny
04/20/04	H 11.7' 4:48	L -.03' 11:18	10:15 AM	Beach Seine	9.8	9.8	29.2	29.2	partly cloudy
05/11/04	H 8.52' 10:21	L .2' 17:28	11:32 AM	Beach Seine	10.8	11.6	24.2	27	partly cloudy
05/12/04	H 8.00' 12:05	L 1.4' 18:37	1:00 PM	Beach Seine	12.6	12.3	25.7	25.6	partly cloudy
05/20/04	H 10.4' 16:19	L -1.4' 13:06	8:30 AM	Beach Seine	11.8	11.5	17.9	25.5	partly cloudy
05/25/04	H 8.42' 8:28	L .2' 15:58	10:00 AM	Beach Seine	13.4	14.1	19.1	22	sunny
06/08/04	H 8.94' 8:58	L -.5' 15:59	11:32 AM	Beach Seine	14.3	13	15.9	20.2	partly cloudy
06/15/04	H 11.12' 18:11	L 7.4' 23:00	5:32 PM	Beach Seine	15.9	12.6	17.2	26.6	sunny
07/08/04	H 8.11' 10:27	L 2.3' 16:21	1:55 PM	Beach Seine	15.4	13.5	25.1	28.4	overcast

Table A-46. Year 3 (2004) Total Fish Catch at Middle Waterway (City of Tacoma)

			Chinook				Coho								Steelhead																																							
No. of Sets	Date	Time	Unmarked	Marked	Not checked	Total	Unmarked	Marked	Not checked	Total	Chum	Pink	Cutthroat	Dolly Varden/Bull Trout	Unmarked	Marked	Not checked	Total	Total Salmonids	English Sole	Starry Flounder	Rock Sole	Speckled Sandab	Right Eyed Flatfish	Staghorn Sculpin	Silverspot Sculpin	Great Sculpin	Northern Sculpin	Buffalo Sculpin	Cabezon Sculpin	Tidepool Sculpin	Sailfin Sculpin	Surf Smelt	Shiner Perch	Striped Perch	Pile Perch	Kelp Perch	Penpoint Gunnel	Crescent Gunnel	Saddleback Gunnel	Tubesnout	Pipefish	Stickleback	Snake Prickleback	Herring	Sandlance	Shad	Greenling- white spot	Sturgeon Poacher	Ratfish	Northern Anchovy	Total
1	04/09/04	10:30 AM				0				0	1	1						0	**2**																																	**2**
2	04/20/04	7:40 AM				0		3		3	61	2						0	**66**						13							17																			**96**
1	05/11/04	10:00 AM				0				0								0	**0**						36								78																		**114**
1	05/12/04	11:50 AM				0				0	1							0	**1**		2				38								52																		**93**
1	05/20/04	7:08 AM				0				0	1							0	**1**		1				30							1	265																		**298**
1	05/25/04	8:50 AM				0				0								0	**0**		4				59								219									1									**283**
1	06/08/04	10:05 AM	2	1		3				0								0	**3**		1				16								122																		**142**
1	06/15/04	4:14 PM	1			1	1	1		2								0	**3**						1								41																		**45**
1	07/08/04	9:58 AM				0	1			1								0	**1**		4				15																										**20**
10			**3**	**1**	**0**	**4**	**2**	**4**	**0**	**6**	**64**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**77**	**0**	**12**	**0**	**0**	**0**	**208**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**18**	**777**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1093**

Table A-47a. Year 3 (2004) Marsh Areal Cover by Polygon at Yowkwala (East Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	91	95	86	*Grindelia integrifolia, grasses*
MB	68	85	58	*Elymus* sp.
MC	342	85	291	*Lepidium latifolium*
MD	55	95	52	*Lepidium latifolium, Grindelia integrifolia*
ME	196	75	147	*Elymus* sp.
MF	28	70	20	*Lepidium latifolium, Atriplex patula*
MG	240	100	240	*Lepidium latifolium*
MH	163	60	98	*Elymus* sp.
MI	64	55	35	*Atriplex patula*
MJ	28	25	7	*Atriplex patula*
MK	342	65	222	*Atriplex patula*
ML	478	90	430	*Lepidium latifolium, Atriplex patula, Elymus* sp.
MM	107	70	75	*Atriplex patula*
MN	521	100	521	*Lepidium latifolium, Rubus discolor*
MO	84	50	42	*Atriplex patula*
MP	238	45	107	*Atriplex patula*
MQ	226	65	147	*Lepidium latifolium, Atriplex patula*
MR	20	30	6	*Atriplex patula*
MS	97	60	58	*Grindelia integrifolia, Cytisus scoparius, plantago lanceolata, grasses*
MT	15	80	12	*Distichlis spicata, Lepidium latifolium, Atriplex patula*
MU	102	80	82	*Atriplex patula*
MV	6	80	5	*Atriplex patula*
MW	21	35	7	*Atriplex patula*
MX	6	60	4	*Distichlis spicata, Atriplex patula*
MY	187	35	65	*Distichlis spicata*
MZ	1,781	100	1,781	*Lepidium latifolium*
Total (sq. ft.)	**5,506**		**4,598**	
Total (acres)	**0.13**		**0.11**	

Table A-47b. Year 3 (2004) Marsh Areal Cover by Polygon at Yowkwala (West Marsh Area)

Flag	Area (sq. ft.)	Percent Cover	Vegetated Area (sq. ft.)	Dominant Species
MA	516	50	258	*Distichlis spicata, Atriplex patula, Grindelia integrifolia*
MB	8	65	5	*Atriplex patula*
MC	70	30	21	*Atriplex patula*
MD	257	100	257	*Distichlis spicata*
ME	208	70	146	*Atriplex patula*
MF	578	30	173	*Atriplex patula*
MG	869	30	261	*Atriplex patula*
MH	157	65	102	*Atriplex patula*
MI	134	80	107	*Atriplex patula*
MJ	29	85	25	*Atriplex patula*
MK	17	20	3	*Atriplex patula*
ML	6	30	2	*Atriplex patula*
MM	7	85	6	*Atriplex patula*
MN	27	55	15	*Lepidium latifolium, Atriplex patula*
MO	84	60	50	*Atriplex patula*
MP	10	100	10	*Atriplex patula*
MQ	14	90	13	*Atriplex patula*
Total (sq. ft.)	**2,991**		**1,454**	
Total (acres)	**0.07**		**0.03**	

Total Year 3 Vegetated Marsh Area:

(sq.ft.)	**6,052**
(acres)	**0.14**

For comparison:
Total Year 2 Vegetated Marsh Area:

(sq.ft.)	**1,046**
(acres)	**0.02**

Table A-48. Year 3 (2004) Fish Monitoring Data at Yowkwala

Date	High Tide	Low Tide	Time	Gear	Temperature (degree Celcius)		Salinity (ppt)		Weather
					Surface	Bottom	Surface	Bottom	
04/08/04	H 11.94' 5:54	L -2.24' 12:54	12:30 PM	Beach Seine	10.2	9.2	11.2	28.7	sunny
04/23/04	H 10.11' 6:12	L -0.07' 14:00	11:32 AM	Beach Seine	10.3	10.4	19.8	25.7	overcast-high winds
04/27/04	H 8.1' 10:00	L 1.1' 17:38		Beach Seine	No water data collected due to extemely high winds.				overcast-high winds
05/07/04	H 11.57' 5:38	L -3.2 12:52	9:45 AM	Beach Seine	10.7	10.4	18	27.8	hard rain
05/11/04	H 8.52' 10:21	L 0.2' 17:28	2:58 PM	Beach Seine	11.3	10.2	21.1	28.5	partly cloudy
05/12/04	H 8.00' 12:05	L 1.4' 18:37	5:10 PM	Beach Seine	13.5	10.2	13.1	29	partly cloudy
05/24/04	H 9.04' 7:34	L -0.5' 15:12	9:30 AM	Beach Seine	12.2	10.2	17.7	29.1	sunny
05/25/04	H 8.42' 8:28	L 0.2' 15:58	3:07 PM	Beach Seine	14.1	12	18.7	26.2	sunny
05/27/04	H 7.38' 11:14	L 1.9' 17:43	1:00 PM	Beach Seine	11.3	11	19.4	22.9	sunny
06/04/04	H 11.96' 5:02	L -4.1' 13.04	2:34 PM	Beach Seine	15.1	14.4	20.5	21.6	sunny
06/08/04	H 8.94' 8:58	L -0.5' 15:59	4:04 PM	Beach Seine	15.2	11.1	10.2	28.9	partly cloudy
06/15/04	H 11.12' 18:11	L 7.4' 23:00	3:43 PM	Beach Seine	14	11.5	25.5	28.7	sunny
06/22/04	H 9.04' 7:25	L -0.7' 14:43	11:30 AM	Beach Seine	15.5	13	15.3	28.4	partly cloudy
06/24/04	H 7.9' 9:37	L 1.3' 16:08	12:08 PM	Beach Seine	14.2	12.9	21.3	27.5	overcast
07/07/04	H 8.84' 9:02	L 0.5' 15:31	12:06 PM	Beach Seine	15.3	12.4	17.5	29.3	partly cloudy
07/08/04	H 8.11' 10:27	L 2.3' 16:21	1:55 PM	Beach Seine	13.4	12.4	27.7	29.2	overcast
07/21/04	H 9.26' 7:28	L -0.1' 14:15	11:18 AM	Beach Seine	16.1	13	23.6	28.6	sunny
07/22/04	H 8.84' 8:25	L 1.0' 14:54	2:03 PM	Beach Seine	16.7	13.2	23.3	29.1	sunny
08/03/04	H 10.5' 6:57	L -1.1' 13:36	12:33 PM	Beach Seine	17.1	13.5	20	29	sunny
08/04/04	H 9.88' 7:54	L 0.4' 14:19	11:40 AM	Beach Seine	15.3	13.2	25	29.5	sunny
08/19/04	H 9.88' 7:32	L 1.2' 13:50		Beach Seine	No water data collected for Yowkwala				partly cloudy
08/20/04	H 9.67' 8:29	L 2.5' 14:29	1:57 PM	Beach Seine	18.2	14.6	22.4	28.2	sunny
09/01/04	H 10.6' 7:00	L 1.0' 13:14	9:52 AM	Beach Seine	15.1	13.9	23.1	28.6	raining
09/03/04	H 9.98' 8:57	L 3.8' 14:37	8:50 AM	Beach Seine	14.5	13.7	19.6	29	cloudy
09/16/04	H 10.7' 6:45	L 2.2' 12:50	11:07 AM	Beach Seine	13.6	13.4	20.3	27.1	sunny
09/30/04	H 11.02' 7:09	L 3.5' 12:52	12:39 PM	Beach Seine	13.4	13.4	21.2	28.3	cloudy
10/05/04	H 10.5' 12:11	L 7.6' 17:22	2:22 PM	Beach Seine	13.8	13.3	29	30.2	partly cloudy
10/15/04	H 11.65' 6:50	L 4.5' 12:28	10:37 AM	Beach Seine	13.2	13.2	18.5	28.2	foggy/cloudy

Table A-49. Year 3 (2004) Total Fish Catch at Yowkwala

			Chinook				Coho								Steelhead																																				
No. of Sets	Date	Time	Unmarked	Marked	Not checked	Total	Unmarked	Marked	Not checked	Total	Chum	Pink	Cutthroat	Dolly Varden/Bull Trout	Unmarked	Marked	Not checked	Total	Total Salmonids	English Sole	Starry Flounder	Rock Sole	Speckled Sandab	Right Eyed Flatfish	Staghorn Sculpin	Silverspot Sculpin	Great Sculpin	Northern Sculpin	Buffalo Sculpin	Cabezon Sculpin	Tidepool Sculpin	Sailfin Sculpin	Surf Smelt	Shiner Perch	Striped Perch	Pile Perch	Kelp Perch	Penpoint Gunnel	Crescent Gunnel	Saddleback Gunnel	Tubesnout	Pipefish	Stickleback	Snake Prickleback	Herring	Sandlance	Shad	Greenling- white spot	Sturgeon Poacher	Ratfish	Northern Anchovy	Total
3	04/08/04	11:30 AM				0	3	2		5		11	3					0	**19**																																	**19**
3	04/23/04	10:30 AM	1	1		2	20	124	0	144	34	90						0	**270**														21																		**291**
1	04/27/04	12:25 PM		1		1		5		5	5	107						0	**118**						1									2																	**121**
3	05/07/04	9:00 AM	1	3		4	79	30		109	6	24	4					0	**147**												1														1					**149**
3	05/11/04	1:30 PM	31	8		39	98	136	5	239		1	2					0	**281**						1								4	7																	**293**
3	05/12/04	3:40 PM	2	23	1	26	67	54	3	124	14	10	3					0	**177**		3	1			4						1			2							1										**189**
2	05/24/04	9:44 AM	2	3		5	1			1	24	6						0	**36**						1																						1				**38**
4	05/25/04	12:47 PM	10	37	3	50	13	10	1	24	99	28	3					0	**204**		1	1			1									175		2						1	1								**386**
3	05/27/04	11:20 AM	8	169	1	178	2	25		27	33	7	1					0	**246**		2	1			1									74	1	1						1	2								**329**
3	06/04/04	1:30 PM	1	17	5	23	2	1	5	8	1	1	2					0	**35**	1	2				3									346	8	13	2	1	2	1		1	5	1	1						**422**
3	06/08/04	2:11 PM	4	21	4	29	14	51		65	26	2	2					0	**124**			2			1				1		1			291	2	32				4		1		1							**460**
3	06/15/04	2:51 PM	4	8		12	4	15	1	20		2	2					0	**36**						1								1	81									35								**154**
3	06/22/04	9:58 AM	1	5		6	11	12		23			2					0	**31**		1				1								7	100		2								1	1	1					**145**
3	06/24/04	11:42 AM	1	3		4	2	7		9		2	1			1		1	**17**						1							1	4	14		4						1								**42**
3	07/07/04	11:35 AM	2	3		5		3		3			1	1				0	**10**															26		1						1		130						**168**
3	07/08/04	1:14 PM		3		3	6	2		8			3			6		6	**20**	1					3								2									2		2	1					**31**
3	07/21/04	10:30 AM		5		5	1	1		2								0	**7**														3	35								7		763						**815**
3	07/22/04	1:22 PM		4		4	3	2	1	6								0	**10**		1	1											3	3	1	5						5								**29**
3	08/03/04	10:56 AM		3		3	2	1		3								0	**6**			2			1		1							10	4															**24**
3	08/04/04	10:25 AM		1		1	2	2		4								0	**5**						1								31	76	1									2						**116**
3	08/19/04	9:17 AM				0				0								0	**0**														3	6										1	25					**35**
3	08/20/04	1:11 PM		3		3				0								0	**3**						0								8	7					3		1		31							**53**
3	09/01/04	9:10 AM				0	2	1		3			2					0	**5**		1				1								132	99								1		2						**241**
2	09/03/04	8:20 AM				0				0								0	**0**														1															1			**2**
3	09/16/04	10:49 AM		1		1				0								0	**1**														14	18								1		1						**35**
3	09/30/04	12:28 PM				0	2	1		3								0	**3**															1					1			1								**6**
3	10/05/04	2:13 PM		2		2		1		1								0	**3**								1															1								**5**
3	10/15/04	9:15 AM				0				0								0	**0**														3	5										11						**19**
81			**68**	**324**	**14**	**406**	**334**	**486**	**16**	**836**	**242**	**291**	**31**	**1**	**0**	**7**	**0**	**7**	**1814**	**2**	**11**	**8**	**0**	**0**	**22**	**0**	**2**	**0**	**1**	**0**	**3**	**1**	**237**	**1378**	**17**	**60**	**2**	**1**	**2**	**9**	**0**	**6**	**63**	**3**	**945**	**28**	**0**	**2**	**0**	**0**	**0**	**4617**

Table A-50. Year 3 (2004) Fish Monitoring Data at Skookum Wulge

Date	High Tide	Low Tide	Time	Gear	Temperature (degree Celcius)		Salinity (ppt)		Weather
					Surface	Bottom	Surface	Bottom	
04/09/04	H 11.49' 6:30	L -2.58' 13:30	11:15 AM	Beach Seine	11.6	10	18.1	21.2	sunny
04/20/04	H 11.7' 4:48	L -0.03' 11:18	10:50 AM	Beach Seine	10.1	9.5	19.9	28.3	partly cloudy
04/27/04	H 8.1' 10:00	L 1.1' 17:38	12:12 PM	Beach Seine	12.2	10.8	11.7	27	overcast-high winds
05/07/04	H 11.57' 5:38	L -3.2 12:52	8:30 AM	Beach Seine	11.1	10.4	18.5	27.9	hard rain
05/11/04	H 8.52' 10:21	L 0.2' 17:28	12:57 PM	Beach Seine	11.3	10.6	21.6	27.7	partly cloudy
05/12/04	H 8.00' 12:05	L 1.4' 18:37	10:10 AM	Beach Seine	11.2	10.2	18.4	29	partly cloudy
05/24/04	H 9.04' 7:34	L -0.5' 15:12	9:30 AM	Beach Seine	13.6	11.4	20.6	27.2	sunny
05/27/04	H 7.38' 11:14	L 1.9' 17:43	10:30 AM	Beach Seine	12.3	10.8	16.7	28.7	sunny
06/04/04	H 11.96' 5:02	L -4.1' 13.04	10:30 AM	Beach Seine	14.6	12.8	18.9	25.7	sunny
06/07/04	H 9.98' 7:44	L-2.0' 15:04	10:30 AM	Beach Seine	12.9	12	20.5	27.4	sunny
06/15/04	H 11.12' 18:11	L 7.4' 23:00	2:35 PM	Beach Seine	13.2	13.4	22.4	24.7	sunny
06/22/04	H 9.04' 7:25	L -0.7' 14:43	9:40 AM	Beach Seine	15.4	14.1	14.6	26.9	partly cloudy
06/24/04	H 7.9' 9:37	L 1.3' 16:08	11:07 AM	Beach Seine	15.1	12.8	15.1	28.3	overcast
07/07/04	H 8.84' 9:02	L 0.5' 15:31	11:05 AM	Beach Seine	14.2	13.2	24.9	27.9	partly cloudy
07/08/04	H 8.11' 10:27	L 2.3' 16:21	12:59 PM	Beach Seine	15.2	13.5	22.8	28	overcast
08/03/04	H 10.5' 6:57	L -1.1' 13:36	11:07 AM	Beach Seine	15.8	13.6	22.7	28.9	sunny
08/04/04	H 9.88' 7:54	L 0.4' 14:19	9:42 AM	Beach Seine	15.3	14.1	21.2	28.5	sunny
08/19/04	H 9.88' 7:32	L 1.2' 13:50	10:26 AM	Beach Seine	16.3	14.7	20.9	28.4	partly cloudy
08/20/04	H 9.67' 8:29	L 2.5' 14:29	12:17 PM	Beach Seine	17.4	15.9	21.7	26.5	sunny
09/01/04	H 10.6' 7:00	L 1.0' 13:14	10:19 AM	Beach Seine	15.4	14.3	21.8	27.6	raining
09/03/04	H 9.98' 8:57	L 3.8' 14:37	8:20 AM	Beach Seine	14.2	14.1	18	27.6	cloudy
09/16/04	H 10.7' 6:45	L 2.2' 12:50	10:16 AM	Beach Seine	13	13.7	21.8	28.7	sunny
09/30/04	H 11.02' 7:09	L 3.5' 12:52	11:51 AM	Beach Seine	13.1	13.5	18	26.7	cloudy
10/05/04	H 10.5' 12:11	L 7.6' 17:22	1:38 PM	Beach Seine	13.9	13.6	26.3	29.3	partly cloudy
10/15/04	H 11.65' 6:50	L 4.5' 12:28	9:23 AM	Beach Seine	13.4	13.2	23	28.7	foggy/cloudy

Table A-51. Year 3 (2004) Total Fish Catch at Skookum Wulge

			Chinook				Coho								Steelhead																																					
No. of Sets	Date	Time	Unmarked	Marked	Not checked	Total	Unmarked	Marked	Not checked	Total	Chum	Pink	Cutthroat	Dolly Varden/Bull Trout	Unmarked	Marked	Not checked	Total	Total Salmonids	English Sole	Starry Flounder	Rock Sole	Speckled Sandab	Right Eyed Flatfish	Staghorn Sculpin	Silverspot Sculpin	Great Sculpin	Northern Sculpin	Buffalo Sculpin	Cabezon Sculpin	Tidepool Sculpin	Sailfin Sculpin	Surf Smelt	Shiner Perch	Striped Perch	Pile Perch	Kelp Perch	Penpoint Gunnel	Crescent Gunnel	Saddleback Gunnel	Tubesnout	Pipefish	Stickleback	Snake Prickleback	Herring	Sandlance	Shad	Greenling- white spot	Sturgeon Poacher	Ratfish	Northern Anchovy	Total
1	04/08/04	11:00 AM				0				0								0	**0**																																	**0**
1	04/20/04	10:40 AM				0				0	2	15						0	**17**		4																														**21**
1	04/27/04	11:45 AM				0				0	5	40	1					0	**46**																																**46**
1	05/07/04	8:30 AM				0				0								0	**0**														1																		**1**
1	05/11/04	12:49 PM				0				0								0	**0**															2											1						**3**
1	05/12/04	9:45 AM	3	25		28	1	3		4								0	**32**		1	1												9								1									**44**
1	05/24/04	9:19 AM				0				0								0	**0**						1									8																	**9**
1	05/27/04	10:20 AM		45	2	47	6	42	3	51	1		1					0	**100**														5								18									**123**
1	06/04/04	9:45 AM	4	26	41	71	3	17	34	54	3	3						0	**131**		2		2		21									155							2									**313**
1	06/07/04	10:20 AM		1		1	1	3		4								0	**5**														1	75																**81**
1	06/15/04	2:21 PM				0		3		3	1							0	**4**						1									236								87									**328**
1	06/22/04	9:23 AM		2		2		2		2								0	**4**						1								9	35																**49**
1	06/24/04	10:55 AM	1	2		3		3		3								0	**6**															82										1							**89**
1	07/07/04	10:59 AM		1		1				0								0	**1**															1		1								1500							**1503**
1	07/08/04	12:52 PM				0	1	1		2								0	**2**		3	1			1									66										1							**74**
1	07/22/04	12:41 PM		1		1				0								0	**1**		16				28																	1									**46**
1	08/03/04	10:56 AM				0				0								0	**0**		16	1	1		18				1													9									**46**
1	08/04/04	9:31 AM				0		1		1								0	**1**																							1		11							**13**
1	08/19/04	10:18 AM				0				0								0	**0**		1				1								5	47																**54**
1	08/20/04	12:06 PM		1		1				0								0	**1**		12												1						5			3		1							**23**
1	09/03/04	7:58 AM				0				0								0	**0**															2																	**2**
1	09/16/04	10:10 AM				0				0								0	**0**		2																														**2**
1	09/30/04	11:50 AM				0				0								0	**0**		21				1		1																								**23**
1	10/05/04	1:20 PM				0				0								0	**0**																																**0**
1	10/15/04	9:15 AM				0		1		1								0	**1**																				1		1									**3**
25			**8**	**104**	**43**	**155**	**12**	**76**	**37**	**125**	**12**	**58**	**2**	**0**	**0**	**0**	**0**	**0**	**352**	**0**	**78**	**3**	**3**	**0**	**73**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**22**	**718**	**0**	**1**	**0**	**0**	**0**	**5**	**1**	**2**	**121**	**0**	**1514**	**1**	**0**	**0**	**0**	**0**	**0**	**2896**

Table A-52. Year 3 (2004) Fish Monitoring Data at Olympic View

Date	High Tide	Low Tide	Time	Gear	Temperature (degree Celcius)		Salinity (ppt)		Weather
					Surface	Bottom	Surface	Bottom	
04/08/04	H 11.94' 5:54	L -2.24' 12:54	11:15 AM	Beach Seine	10.7	9.9	21.2	27.5	sunny
04/20/04	H 11.7' 4:48	L -0.03' 11:18	7:00 AM	Beach Seine	9.3	9.4	29.4	28.2	partly cloudy
05/11/04	H 8.52' 10:21	L 0.2' 17:28	12:25 PM	Beach Seine	11.2	10.5	22.5	28.6	partly cloudy
05/12/04	H 8.00' 12:05	L 1.4' 18:37	11:29 AM	Beach Seine	11.3	10.4	27.1	28.9	partly cloudy
05/20/04	H 10.4' 16:19	L -1.4' 13:06	10:00 AM	Beach Seine	11.9	11.6	16.9	20.4	partly cloudy
05/25/04	H 8.42' 8:28	L 0.2' 15:58	12:27 PM	Beach Seine	14.6	12.5	17.4	26.2	sunny
05/27/04	H 7.38' 11:14	L 1.9' 17:43	3:30 PM	Beach Seine	10.8	10.6	29	29.3	sunny
06/04/04	H 11.96' 5:02	L -4.1' 13.04	11:00 AM	Beach Seine	14.7	14.2	13.3	20.9	sunny
06/08/04	H 8.94' 8:58	L -0.5' 15:59	12:45 PM	Beach Seine	12.6	12.3	24.4	27.1	partly cloudy
06/15/04	H 11.12' 18:11	L 7.4' 23:00	6:30 PM	Beach Seine	14.6	12.8	13.6	24.6	sunny
06/24/04	H 7.9' 9:37	L 1.3' 16:08	10:25 AM	Beach Seine	14.1	12.4	20.1	29.1	overcast
07/08/04	H 8.11' 10:27	L 2.3' 16:21	12:27 PM	Beach Seine	14.6	12.9	21.3	29.3	overcast
07/22/04	H 8.84' 8:25	L 1.0' 14:54	12:12 PM	Beach Seine	17.5	14.2	18.3	27.4	sunny
08/03/04	H 10.5' 6:57	L -1.1' 13:36	10:27 AM	Beach Seine	14.2	13.5	28.4	29.2	sunny
08/20/04	H 9.67' 8:29	L 2.5' 14:29	11:37 AM	Beach Seine	17.1	14.6	20.9	28.1	sunny
09/03/04	H 9.98' 8:57	L 3.8' 14:37	10:42 AM	Beach Seine	14.1	13.8	28.2	29.4	cloudy
09/16/04	H 10.7' 6:45	L 2.2' 12:50	9:47 AM	Beach Seine	13.4	13.3	29.6	30	sunny
09/30/04	H 11.02' 7:09	L 3.5' 12:52	11:00 AM	Beach Seine	13.1	13.3	21.7	28.2	cloudy
10/05/04	H 10.5' 12:11	L 7.6' 17:22	3:02 PM	Beach Seine	14.5	13.5	28.2	30	partly cloudy
10/15/04	H 11.65' 6:50	L 4.5' 12:28	11:51 AM	Beach Seine	13.6	13.3	23.3	29.2	foggy/cloudy

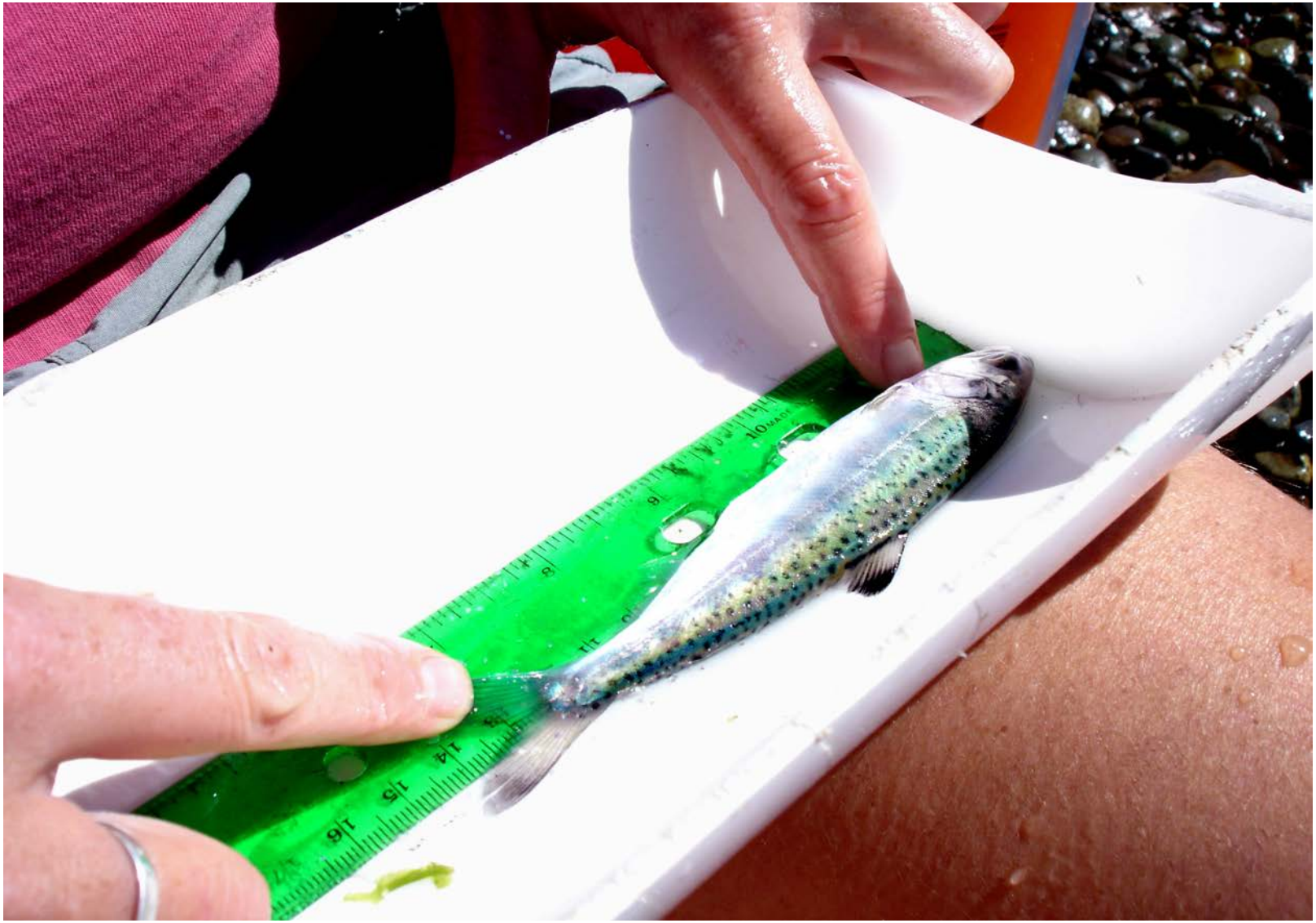
Table A-53. Year 3 (2004) Total Fish Catch at Olympic View

			Chinook				Coho								Steelhead																																			
No. of Sets	Date	Time	Unmarked	Marked	Not checked	Total	Unmarked	Marked	Not checked	Total	Chum	Pink	Cutthroat	Dolly Varden/Bull Trout	Unmarked	Marked	Not checked	Total	Total Salmonids	English Sole	Starry Flounder	Rock Sole	Speckled Sandab	Right Eyed Flatfish	Staghorn Sculpin	Silverspot Sculpin	Great Sculpin	Northern Sculpin	Buffalo Sculpin	Cabezon Sculpin	Tidepool Sculpin	Sailfin Sculpin	Surf Smelt	Shiner Perch	Striped Perch	Pile Perch	Kelp Perch	Penpoint Gunnel	Crescent Gunnel	Saddleback Gunnel	Tubesnout	Pipefish	Stickleback	Snake Prickleback	Herring	Sandlance	Shad	Greenling- white spot	Sturgeon Poacher	Ratfish	Northern Anchovy	Total
3	04/08/04	10:38 AM				0				0	1	9						0	**10**		1																														**11**
3	04/20/04	9:23 AM				0				0	33	1800						0	**1833**		1				2									1																**1837**
3	04/27/04	9:40 AM				0				0		1						0	**1**		1				2																1	1								**6**
3	05/11/04	11:51 AM				0				0		1						0	**1**														1	2								1			13					**18**
3	05/12/04	10:35 AM				0				0	15	4						0	**19**		3												5	3											15					**45**
3	05/20/04	9:25 AM				0				0		1						0	**1**		8				16				1					66				1	1	8		7									**109**
3	05/25/04	11:20 AM		1		1				0								0	**1**		13				27									64				2		1		3									**111**
3	05/27/04	3:15 PM		3		3		1		1								0	**4**		56				68													7		4		4	1								**144**
1	06/04/04	11:02 AM				0				0								0	**0**		1				4													2	2	4		1									**14**
3	06/08/04	12:01 PM	3	6		9		2		2								0	**11**						2									749				1		1		2	2								**768**
3	06/15/04	5:53 PM	2	5		7		2		2								0	**9**		3				5									32		4							4								**57**
3	06/24/04	9:44 AM	2	1		3		1		1								0	**4**		1				11									25		6															**47**
3	07/08/04	11:48 AM	1	1		2	1			1								0	**3**		4				17									30		4						5				65					**128**
3	07/22/04	11:19 AM		0		0	1			1								0	**1**		13				96									53						10		9									**182**
3	08/03/04	9:45 AM				0	1			1								0	**1**		6				52								1	34				1		2		1									**98**
2	08/20/04	11:00 AM				0				0								0	**0**		3				15								32	45						6					1631						**1732**
3	09/03/04	10:11 AM				0				0								0	**0**		1						1						92	3												22					**119**
3	09/16/04	9:15 AM	1			1				0								0	**1**		1												0	6												1					**9**
3	09/30/04	10:25 AM				0		1		1								0	**1**		2				6		2						76	18		3				9					1						**118**
3	10/05/04	2:38 PM				0				0								0	**0**						3						2			1																		**6**
3	10/15/04	11:00 AM				0				0								0	**0**		1				4								27	300		6				20	1				4						**363**
60			**9**	**17**	**0**	**26**	**3**	**7**	**0**	**10**	**49**	**1816**	**0**	**0**	**0**	**0**	**0**	**0**	**1901**	**0**	**119**	**0**	**0**	**0**	**330**	**0**	**3**	**0**	**1**	**0**	**2**	**0**	**234**	**1432**	**0**	**23**	**0**	**14**	**3**	**65**	**1**	**33**	**9**	**0**	**1636**	**116**	**0**	**0**	**0**	**0**	**0**	**5922**

RIDOLFI Inc.	**COMMENCEMENT BAY RESTORATION**	Dec-04	Photo 1
	YEAR 3 (2004) MONITORING REPORT	Block net is set to close off a tidal pool at Mowitch.	

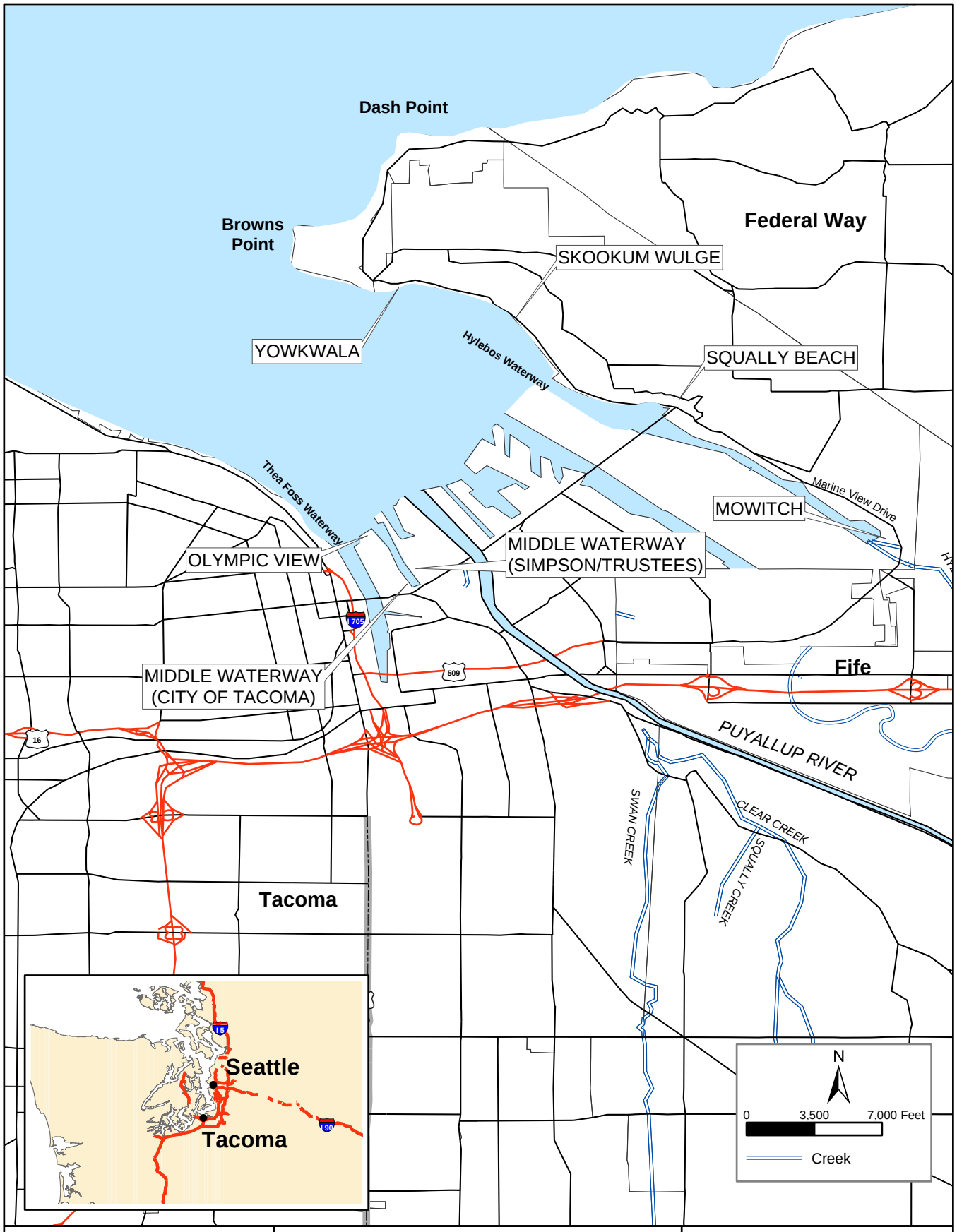
RIDOLFI Inc.	**COMMENCEMENT BAY RESTORATION**	Dec-04	Photo 2
	YEAR 3 (2004) MONITORING REPORT	A YSI 30 SCT meter is used to measure the temperature and salinity of the water.	

RIDOLFI Inc.	**COMMENCEMENT BAY RESTORATION**	Dec-04	Photo 3
	YEAR 3 (2004) MONITORING REPORT	Closing the beach seine net.	



RIDOLFI Inc.	**COMMENCEMENT BAY RESTORATION**	Dec-04	Photo 4
	YEAR 3 (2004) MONITORING REPORT	Salmon measurement at Yowkwala.	

RIDOLFI Inc.	**COMMENCEMENT BAY RESTORATION**	Dec-04	Photo 5
	YEAR 3 (2004) MONITORING REPORT	Geese avoidance fencing and vegetation flagging at Squally Beach.	



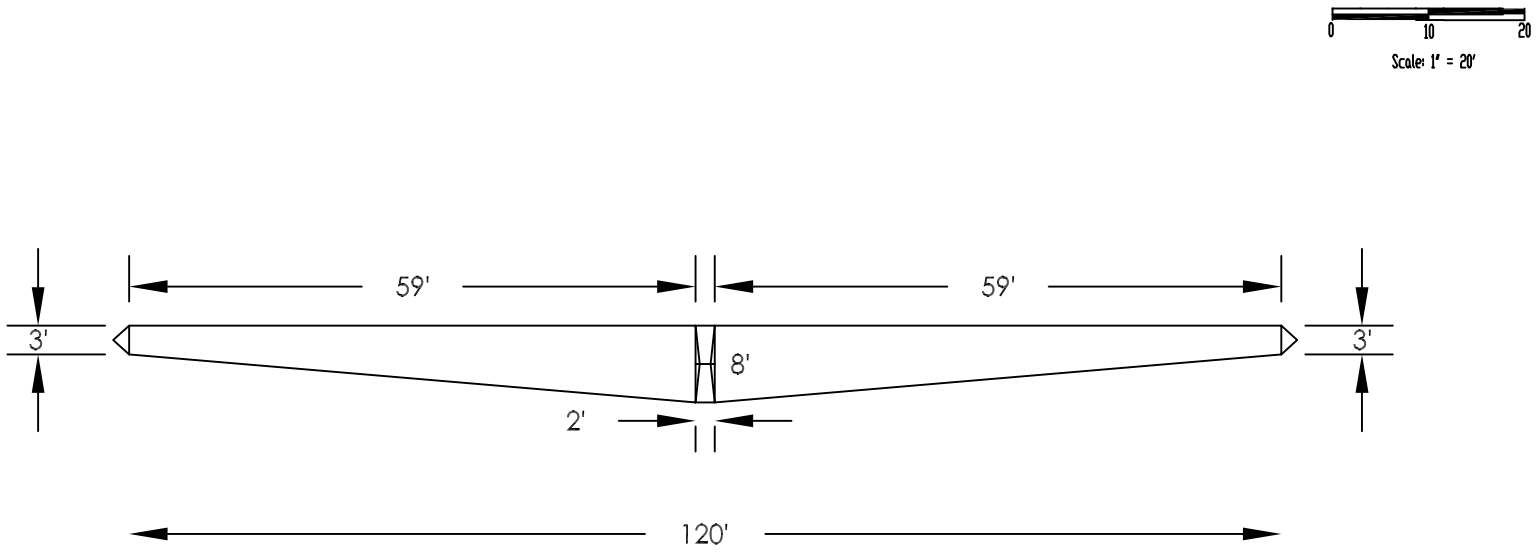
RIDOLFI Inc.

Commencement Bay Restoration
Year 3 (2004) Monitoring Report

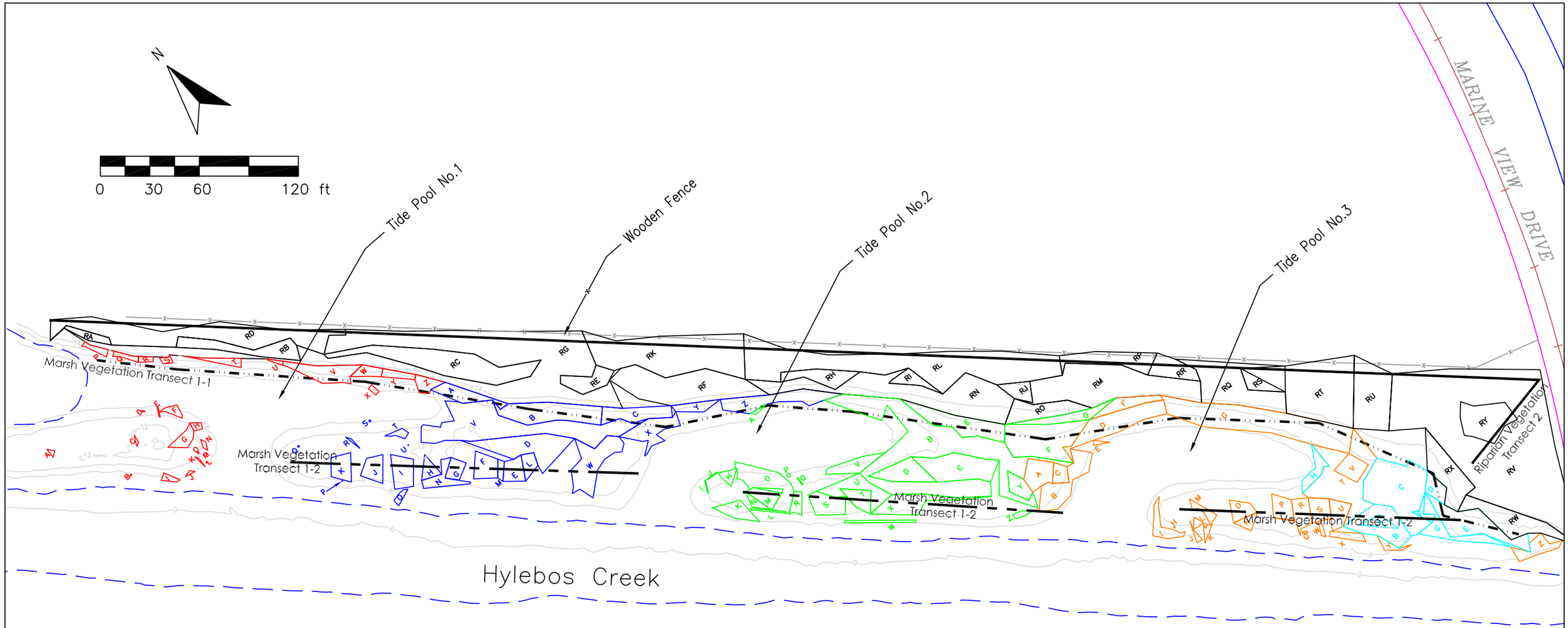
Figure 1-1

Vicinity map and location of habitat restoration sites.

YR3_SiteMap.mxd



RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 2-1
	YEAR 3 (2004) MONITORING REPORT	Puget Sound 37 m (120 ft) beach seine net.	



A North marsh vegetation polygons

A North lobe marsh vegetation polygons

A Center lobe marsh vegetation polygons

A South lobe marsh vegetation polygons

A South end marsh vegetation polygons

RA Riparian vegetation polygons

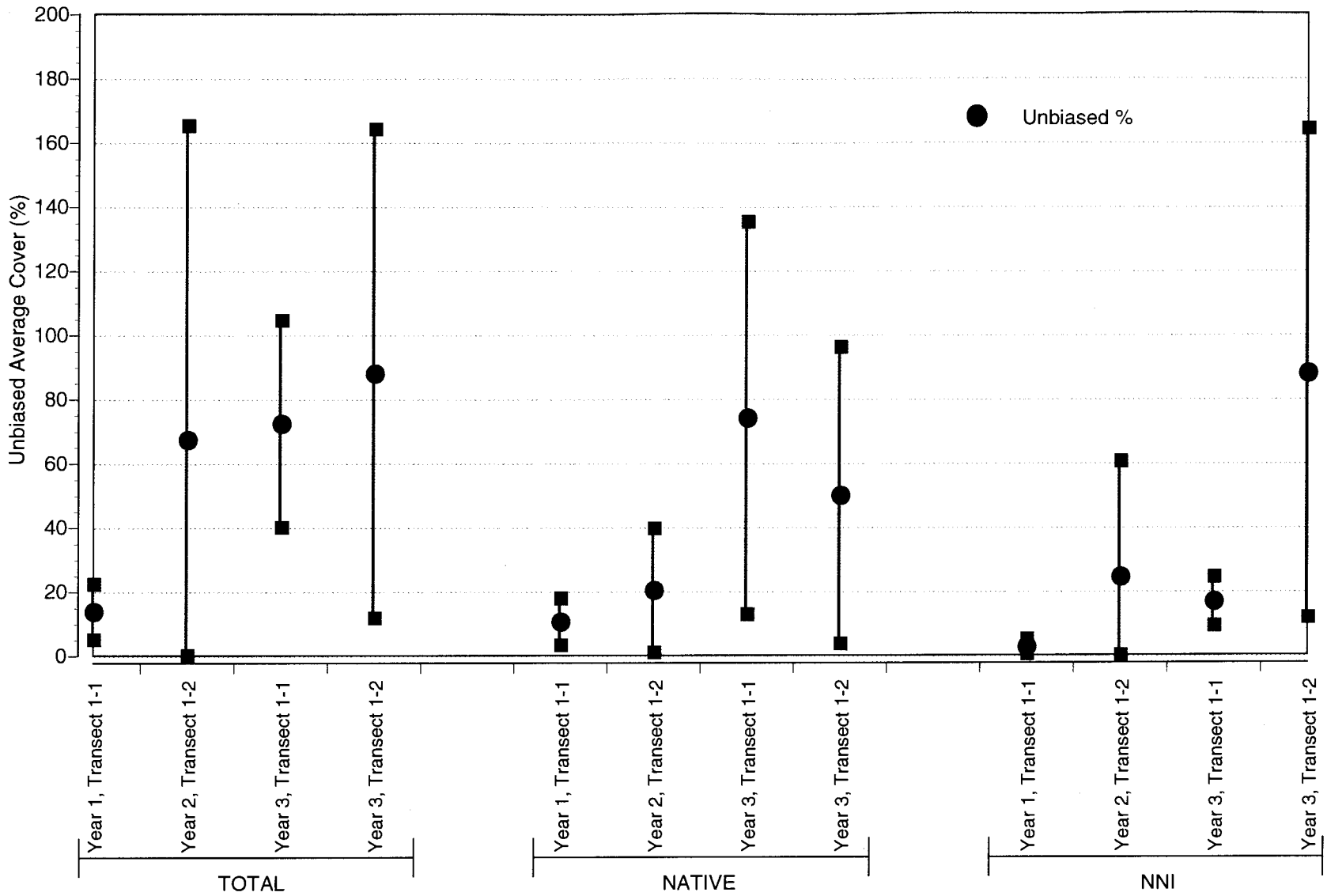
Marsh Vegetation Transect 1–1

Marsh Vegetation Transect 1–2

Riparian Vegetation Transect 2

NOTE: Marsh Vegetation Transect 1–2 is in three sections but forms a single transect.

RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 3–1
	YEAR 3 (2004) MONITORING REPORT	Mowitch marsh and riparian vegetation coverage.	



RIDOLFI Inc.

COMMENCEMENT BAY RESTORATION

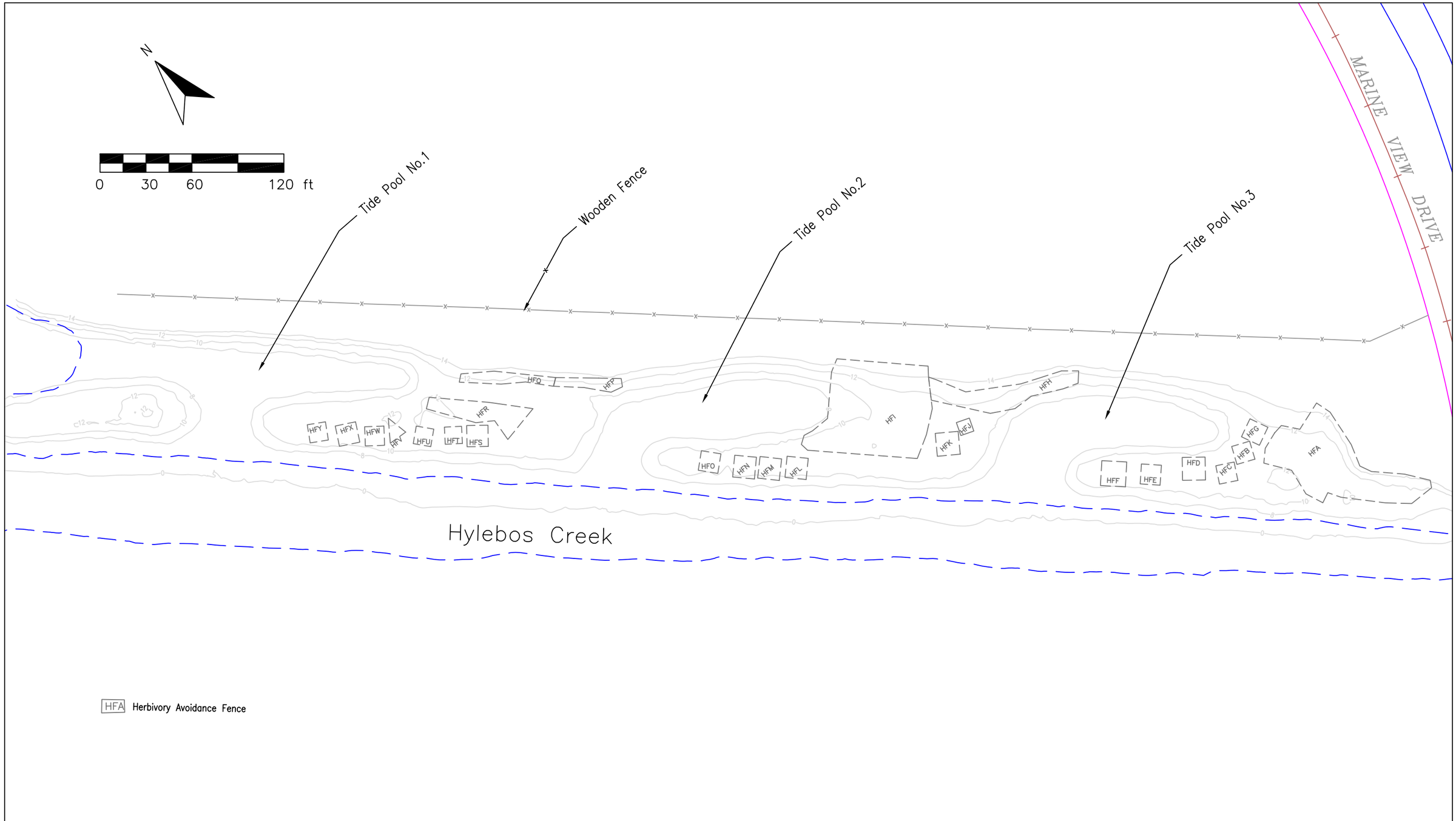
YEAR 3 (2004) MONITORING REPORT

January 2005

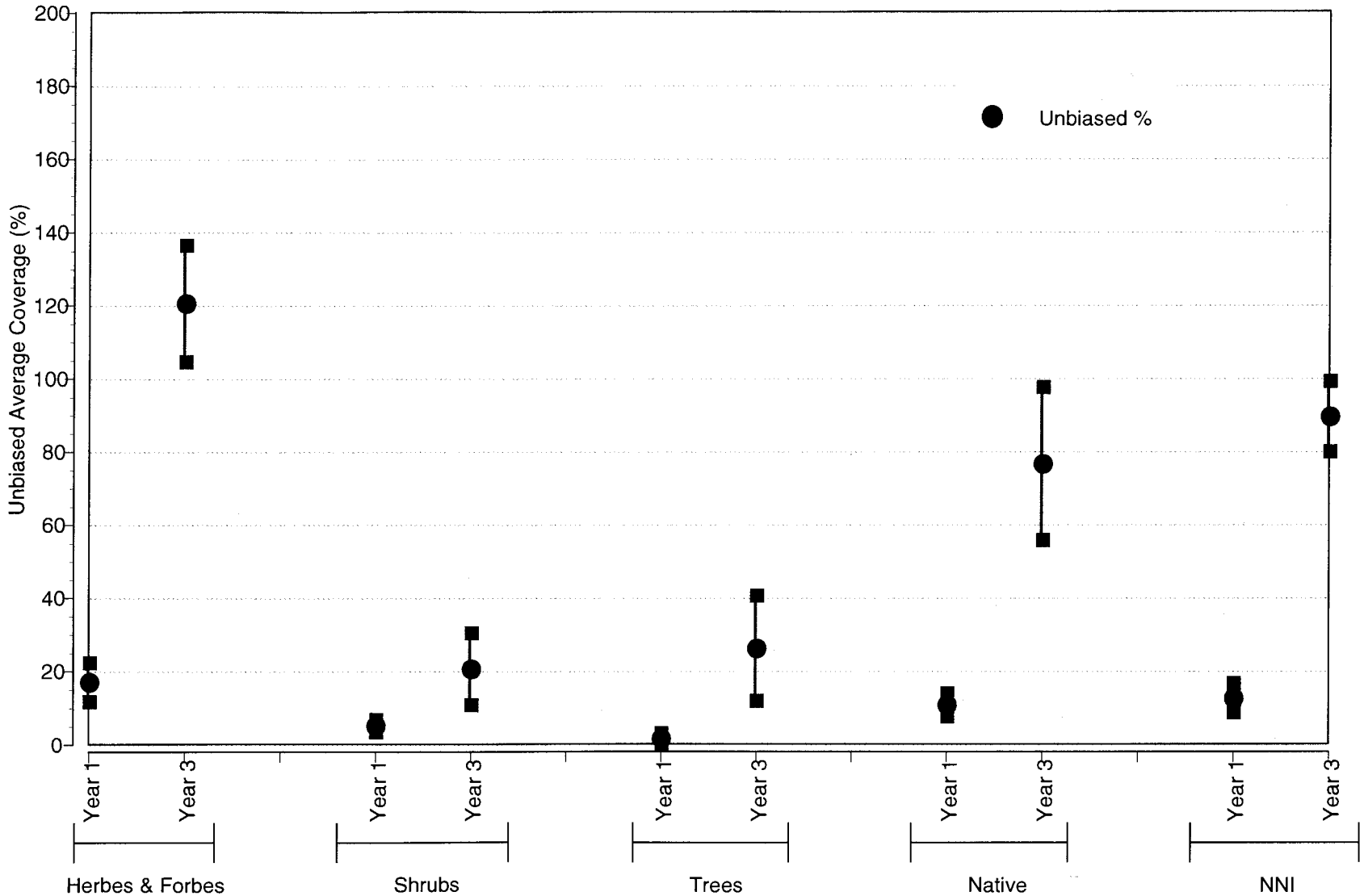
Figure 3-2

Confidence intervals for Mowitch marsh vegetation cover, by transect.

PlantCoverConfInt.dg5



RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 3–3
	YEAR 3 (2004) MONITORING REPORT	Mowitch herbivory avoidance fencing.	



RIDOLFI Inc.

COMMENCEMENT BAY RESTORATION

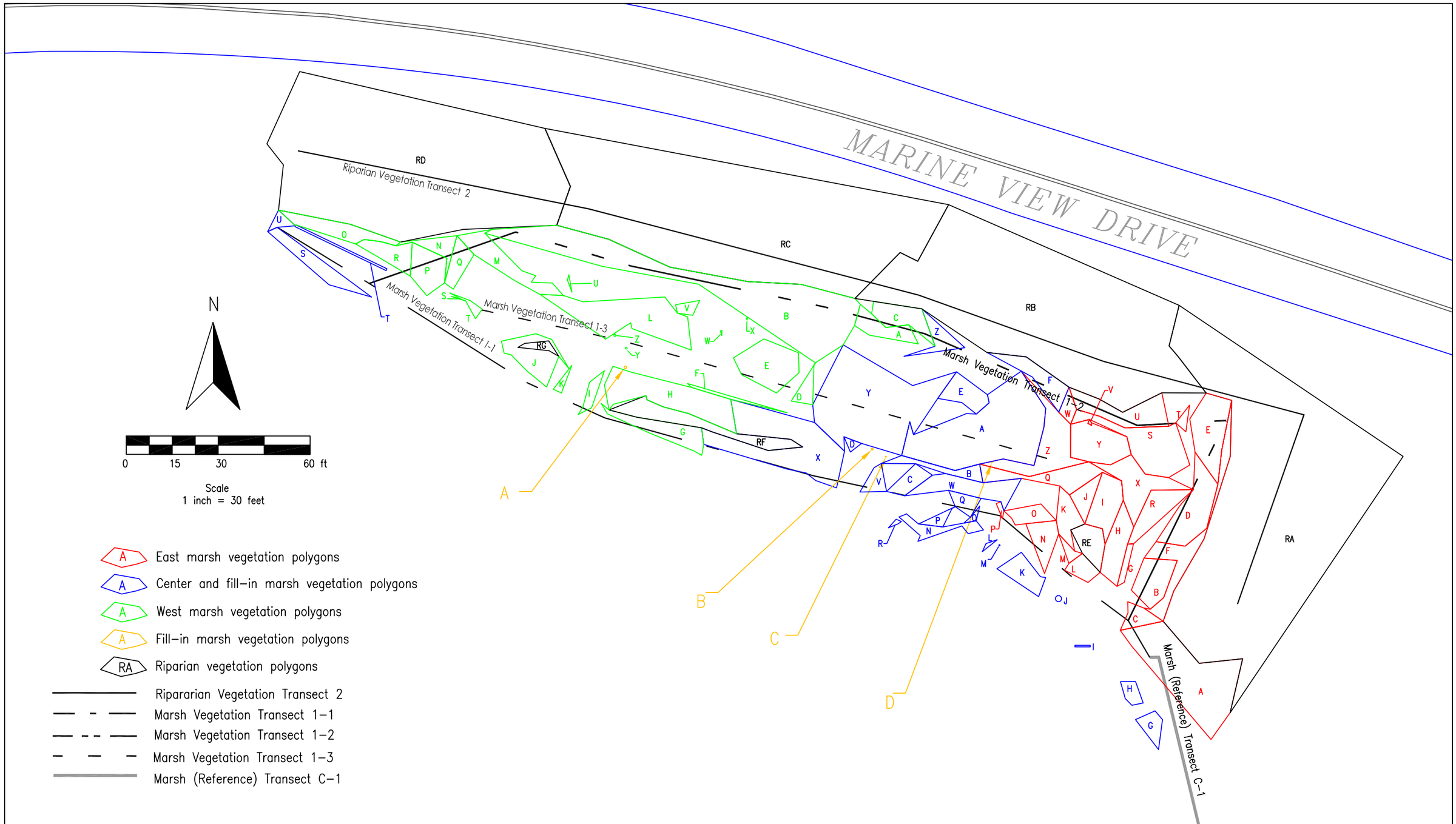
YEAR 3 (2004) MONITORING REPORT

January 2005

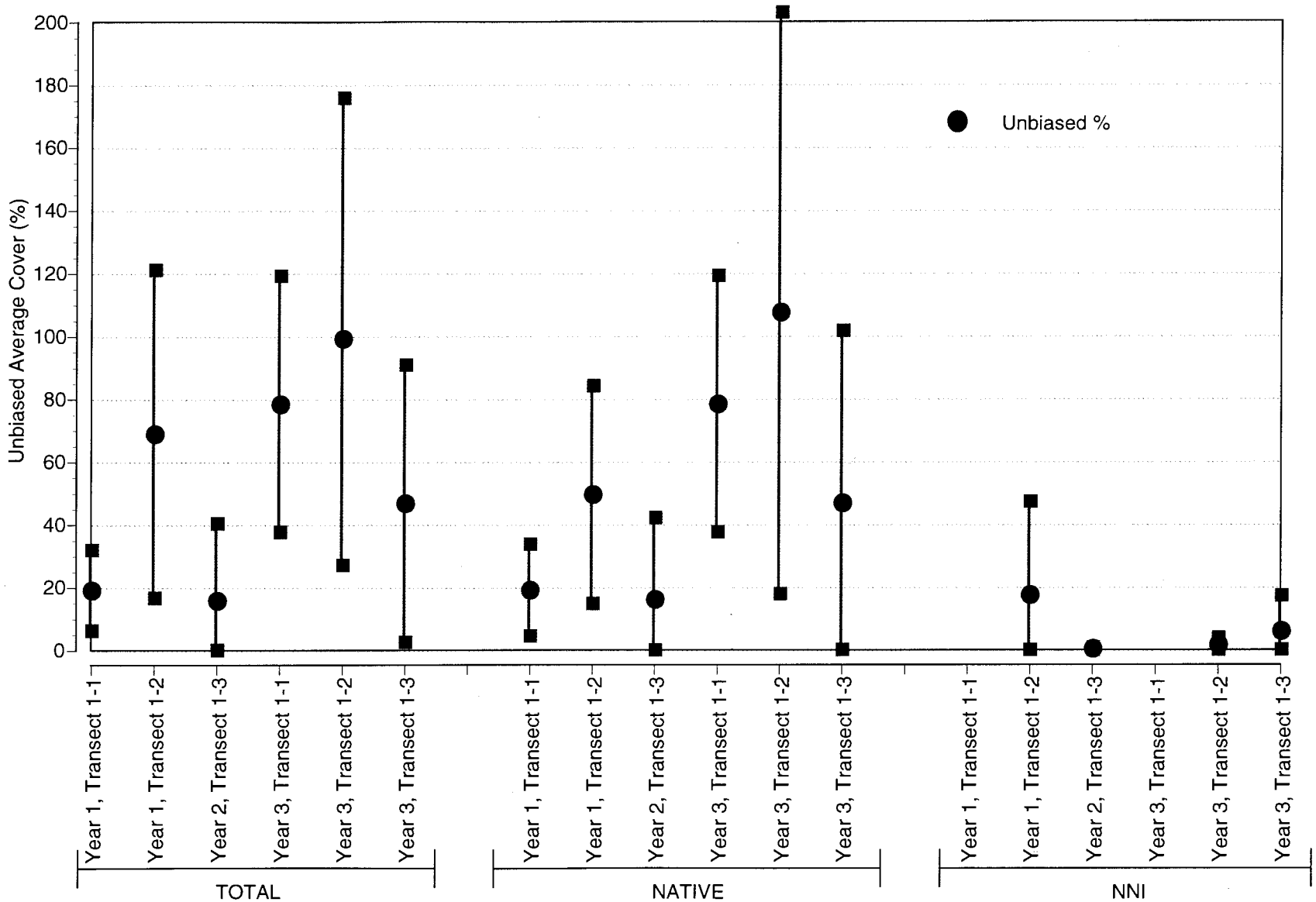
Figure 3-4

Confidence intervals for Mowitch riparian vegetation cover, by cover type.

PlantCoverConfInt.dg5



RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 3-7
	YEAR 3 (2004) MONITORING REPORT	Squally Beach marsh and riparian vegetation coverage.	



RIDOLFI Inc.

COMMENCEMENT BAY RESTORATION

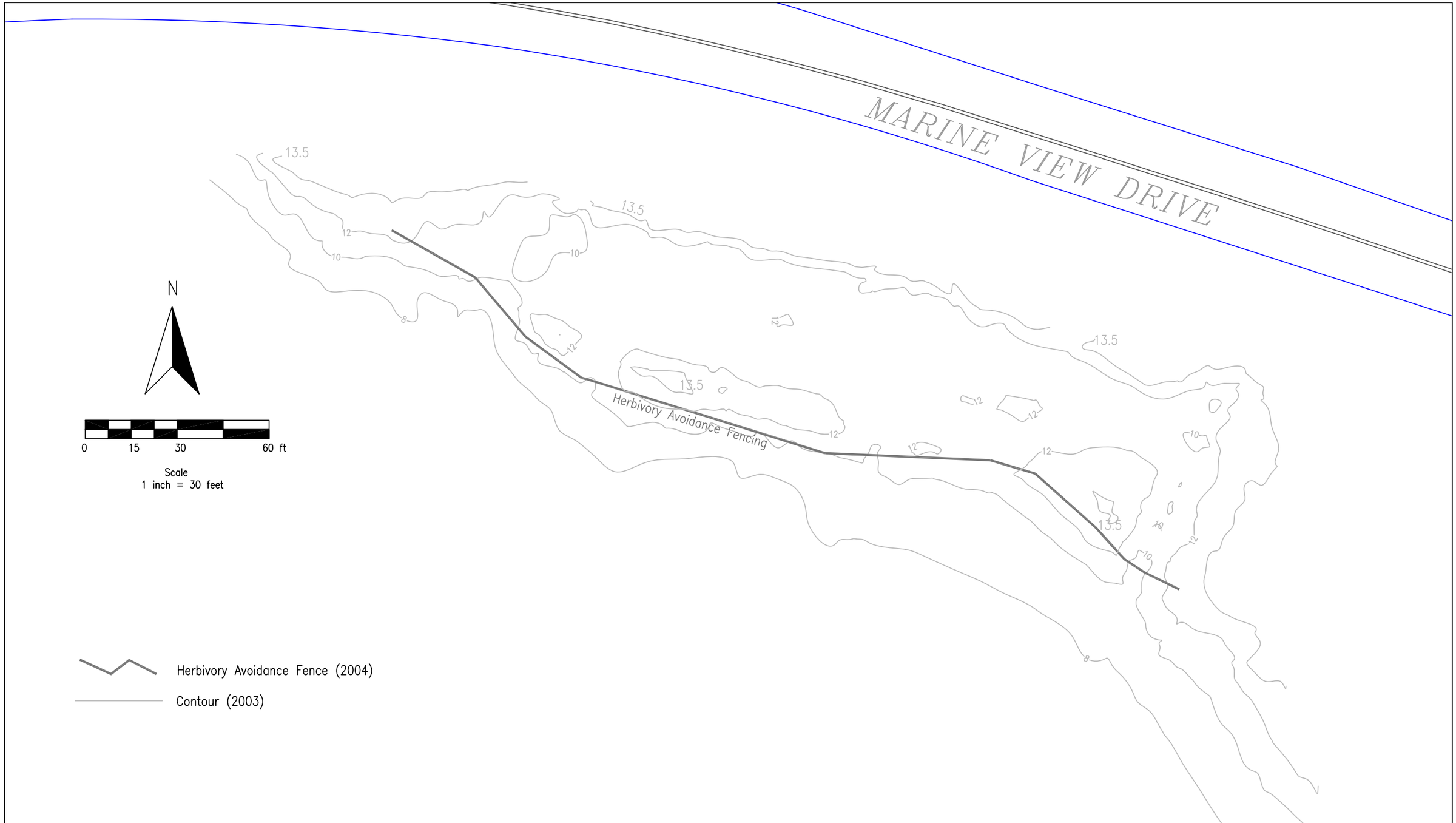
YEAR 3 (2004) MONITORING REPORT

January 2005

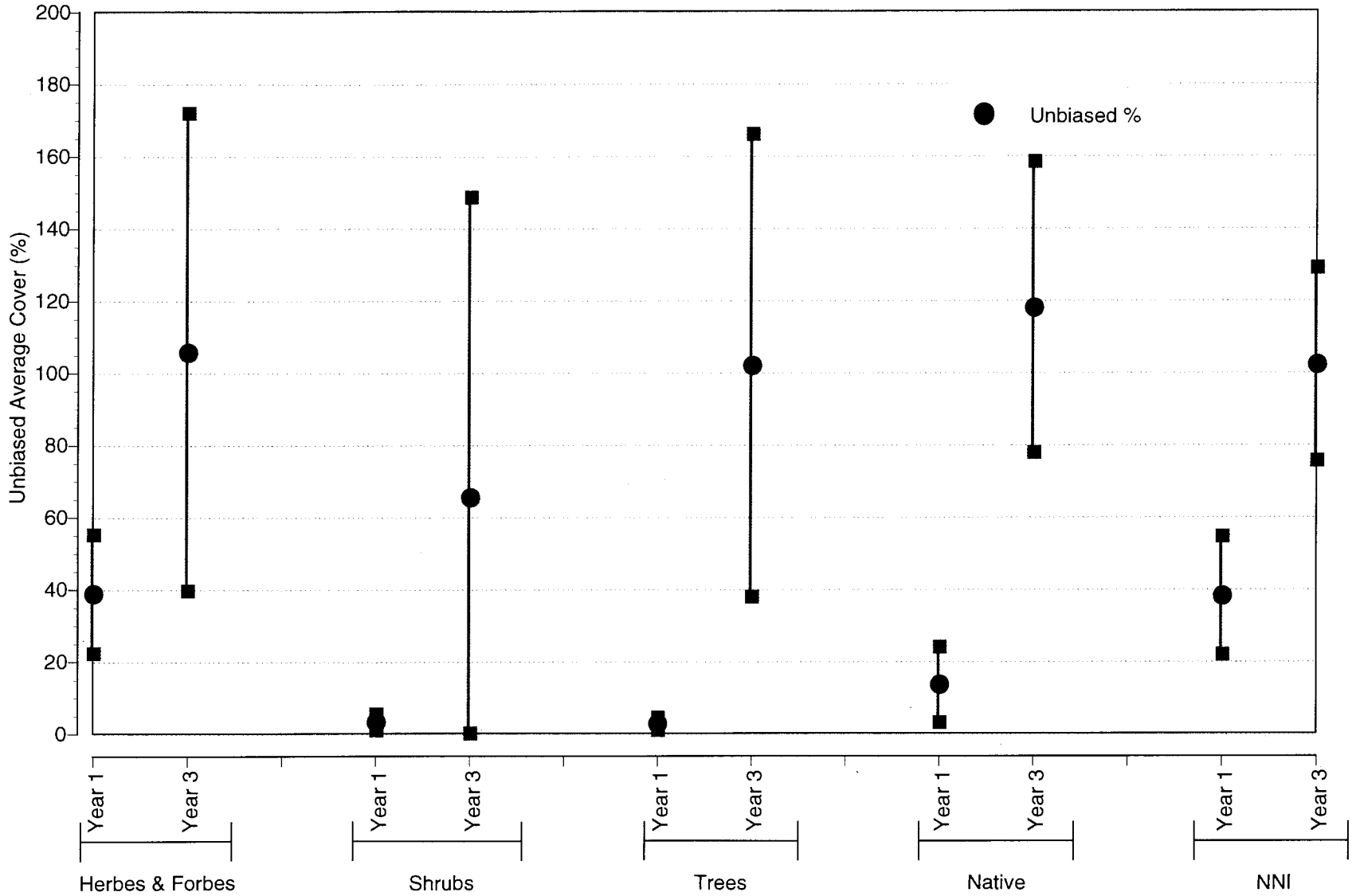
Figure 3-8

Confidence intervals for Squally Beach marsh vegetation cover, by transect.

PlantCoverConfInt.dg5



RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 3–9
	YEAR 3 (2004) MONITORING REPORT	Squally Beach herbivory avoidance fencing.	



RIDOLFI Inc.

COMMENCEMENT BAY RESTORATION

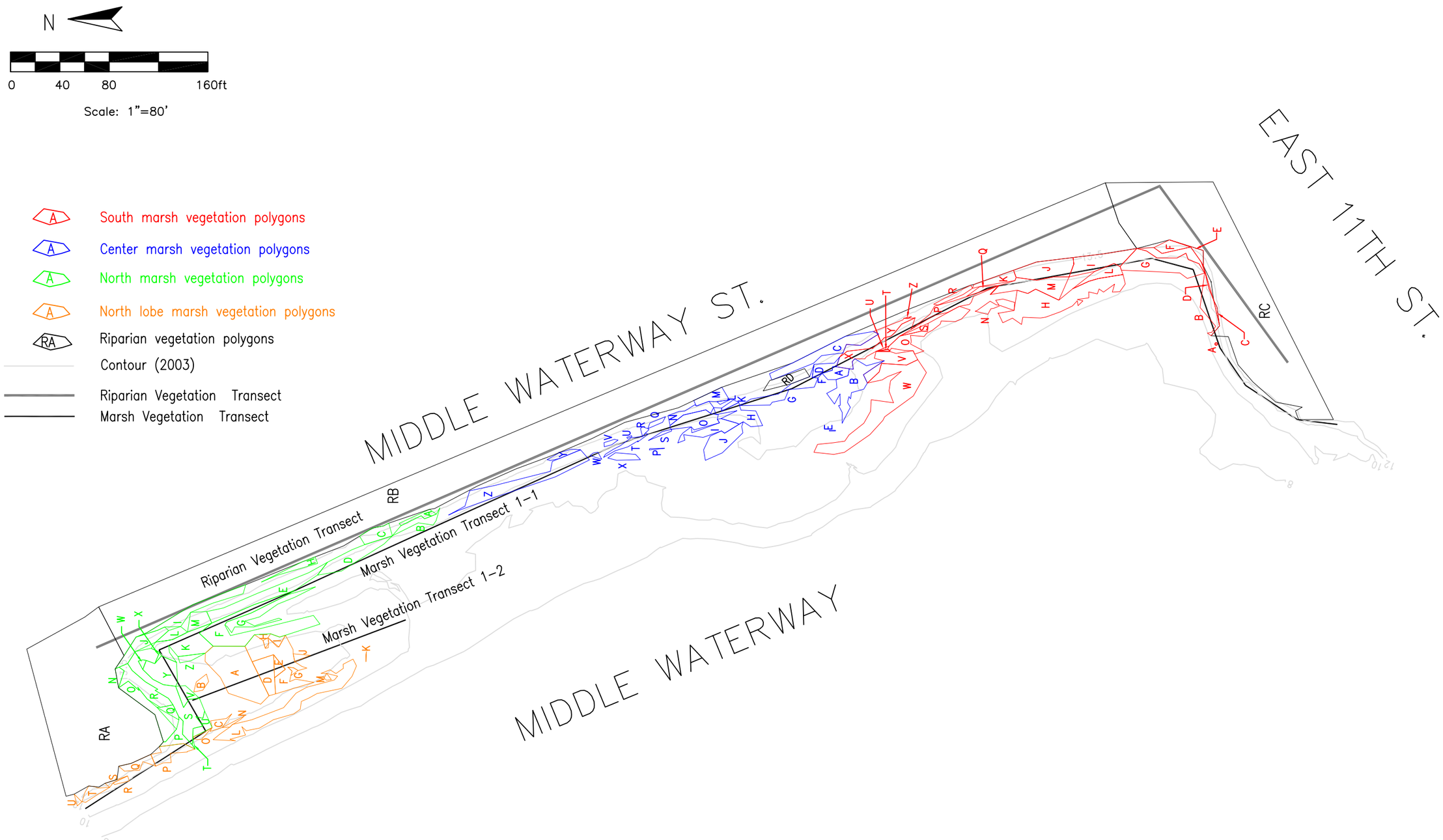
YEAR 3 (2004) MONITORING REPORT

January 2005

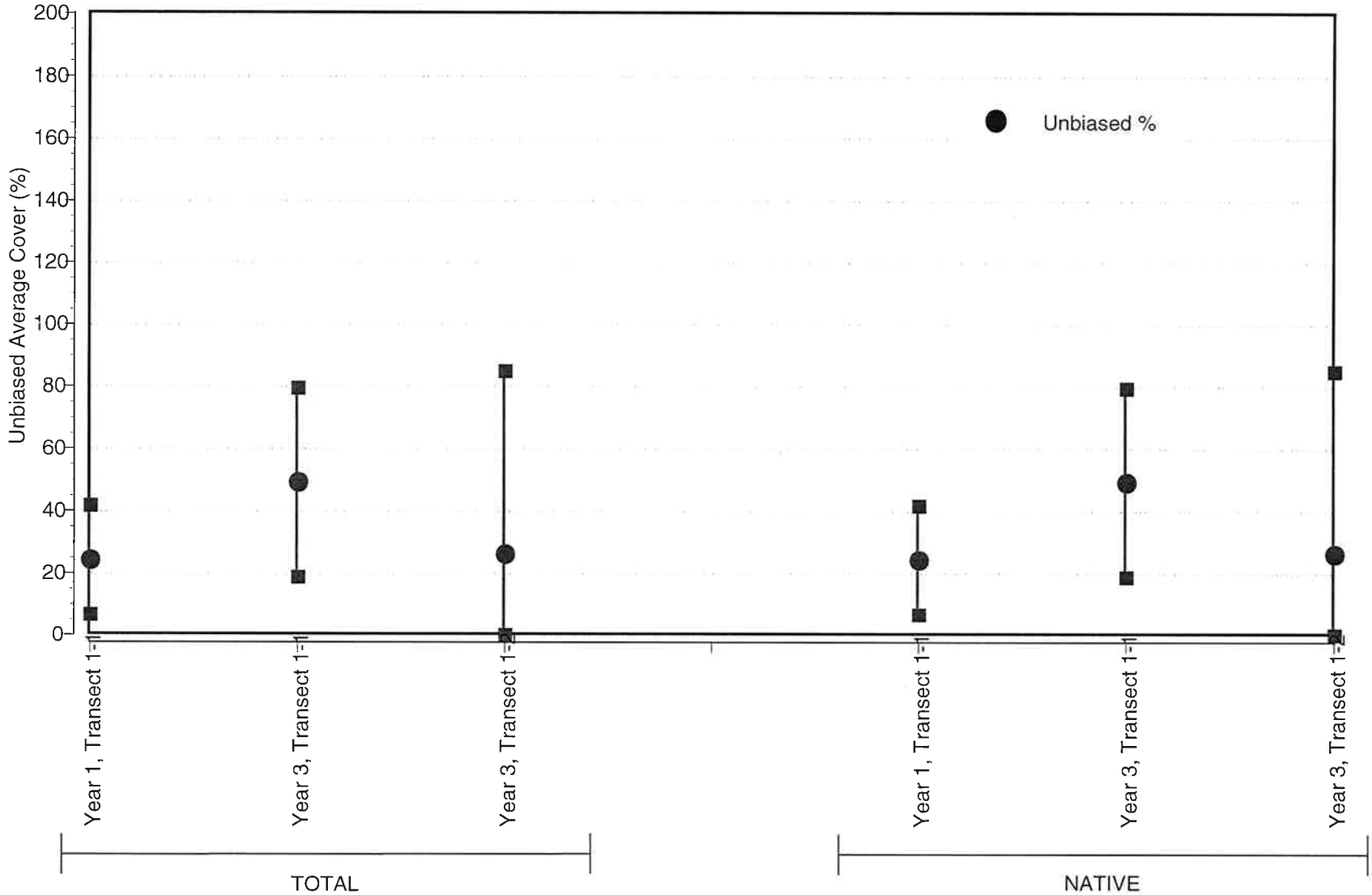
Figure 3-10

Confidence intervals for Squally Beach riparian vegetation cover, by cover type.

PlantCoverConfInt.dg5



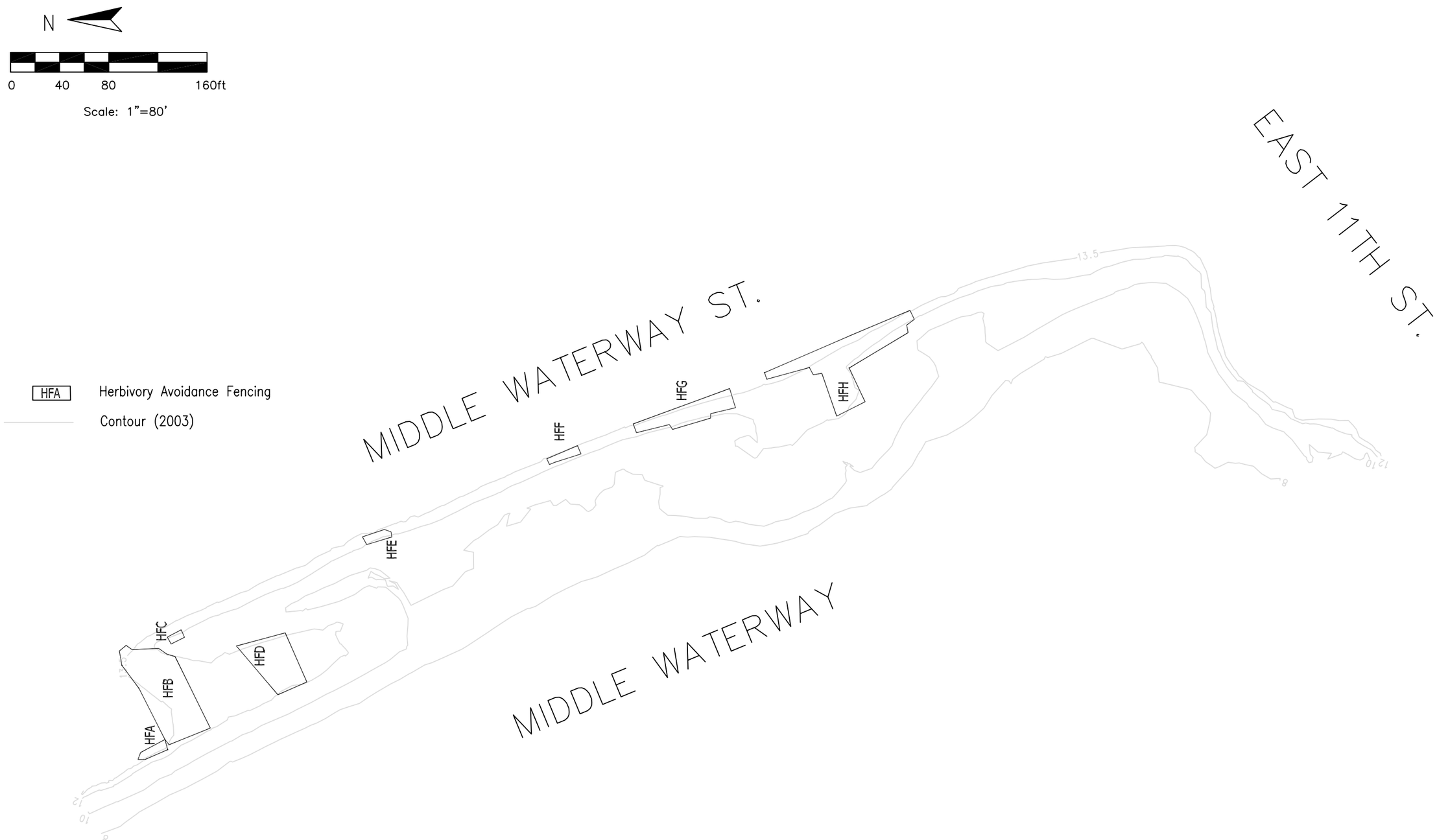
RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 3-11
	YEAR 3 (2004) MONITORING REPORT	Middle Waterway (Simpson/Trustees) marsh and riparian vegetation coverage.	



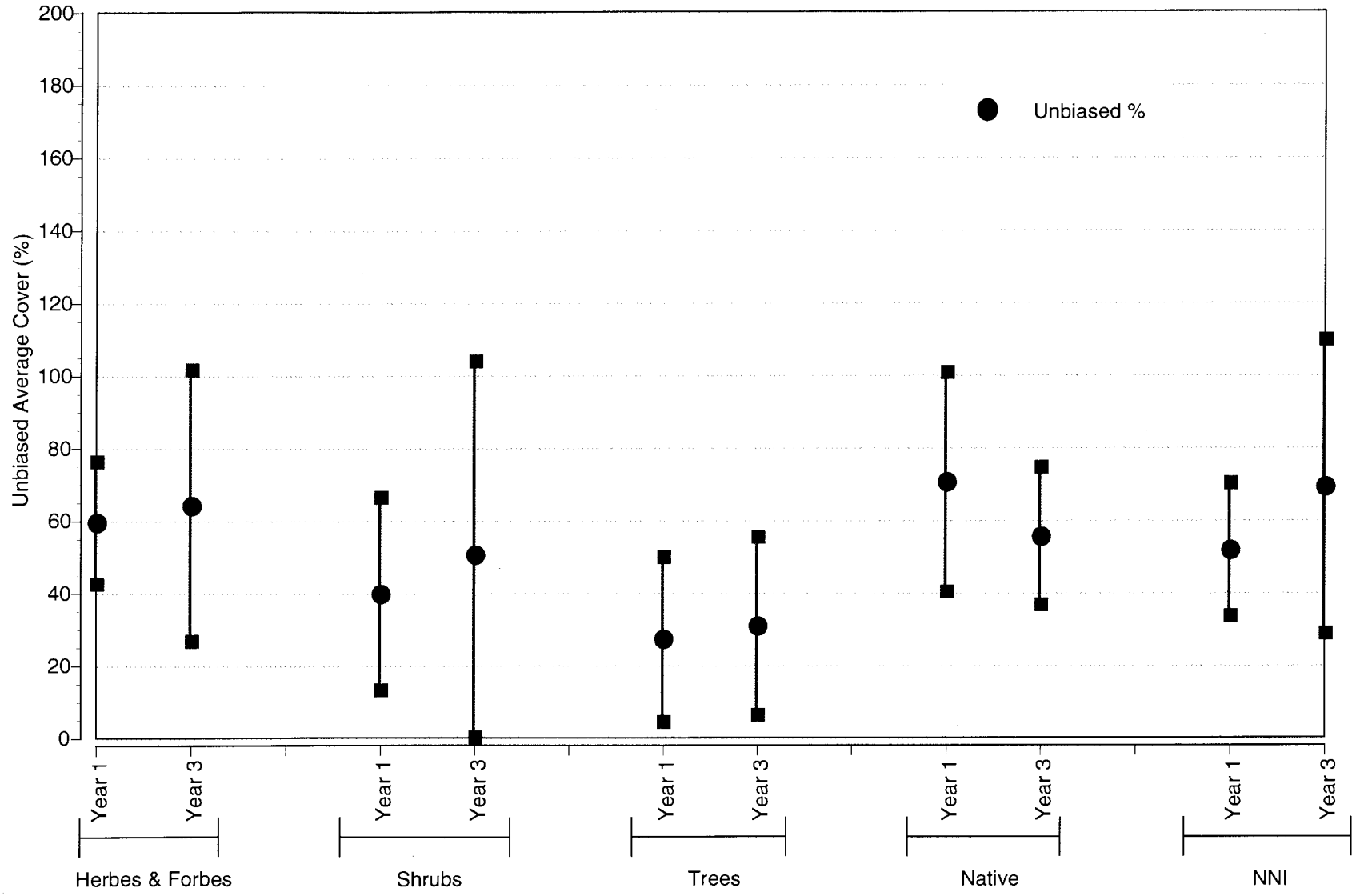
No NNI species found.

RIDOLFI Inc.	**COMMENCEMENT BAY RESTORATION**	January 2005	Figure 3-12
	YEAR 3 (2004) MONITORING REPORT	Confidence intervals for Middle Waterway (Simpson/Trustees) marsh vegetation cover, by transect.	

PlantCoverConfInt.dg5



RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 3–13
	YEAR 3 (2004) MONITORING REPORT	Middle Waterway (Simpson/Trustees) herbivory avoidance fencing.	



RIDOLFI Inc.

COMMENCEMENT BAY RESTORATION

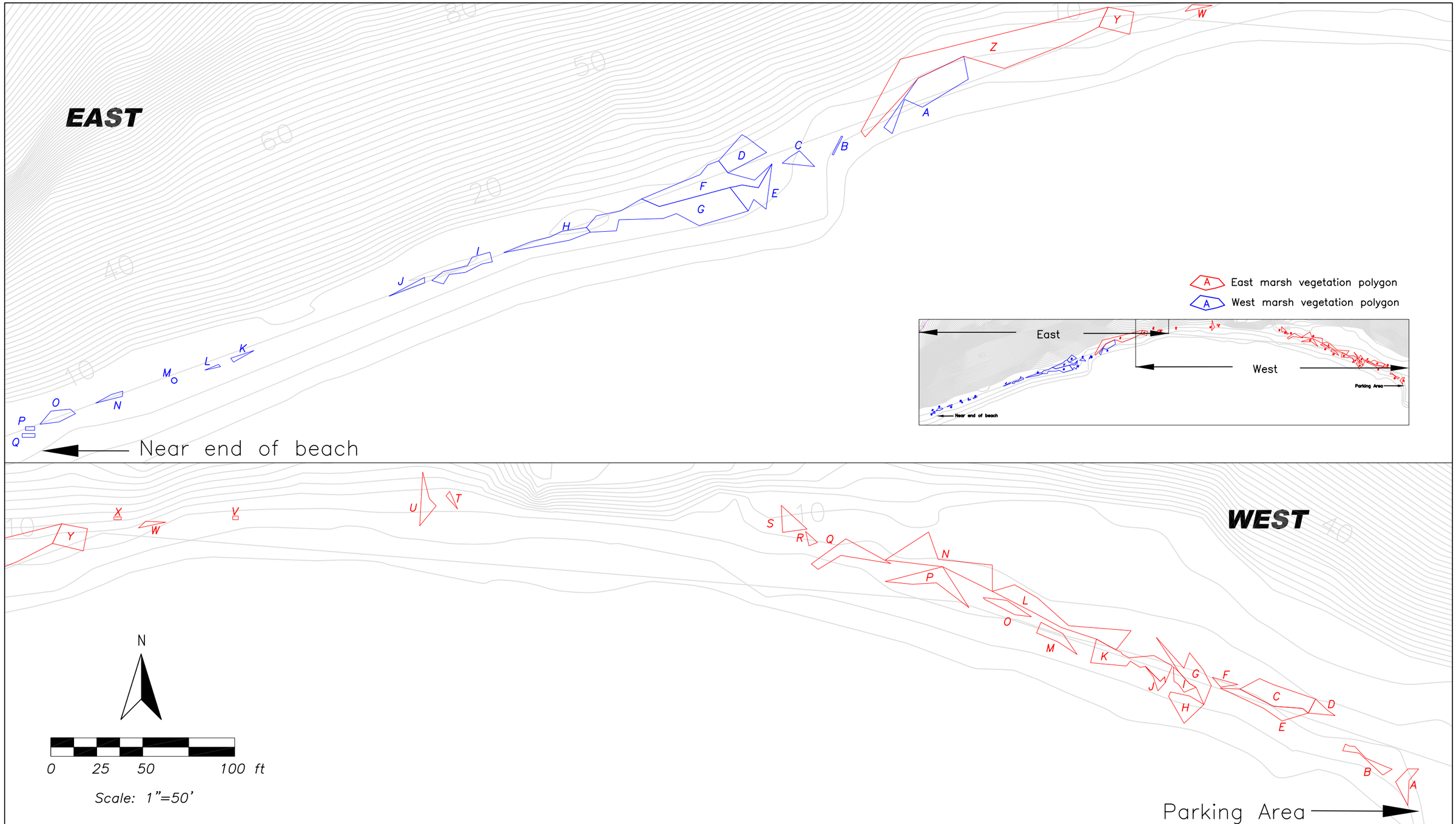
YEAR 3 (2004) MONITORING REPORT

January 2005

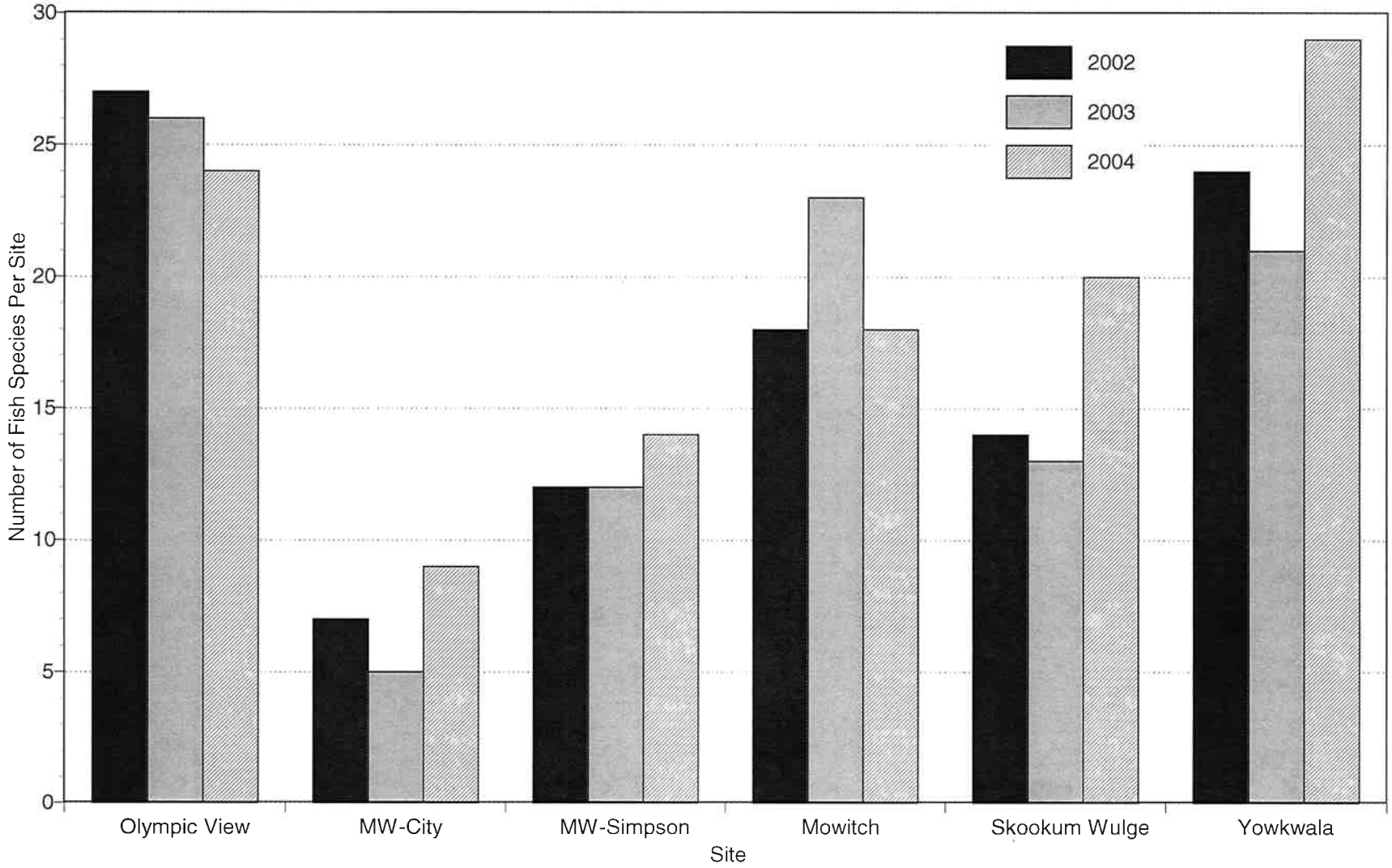
Figure 3-14

Confidence intervals for Middle Waterway (Simpson/Trustees) riparian vegetation cover, by cover type.

PlantCoverConfInt.dg5

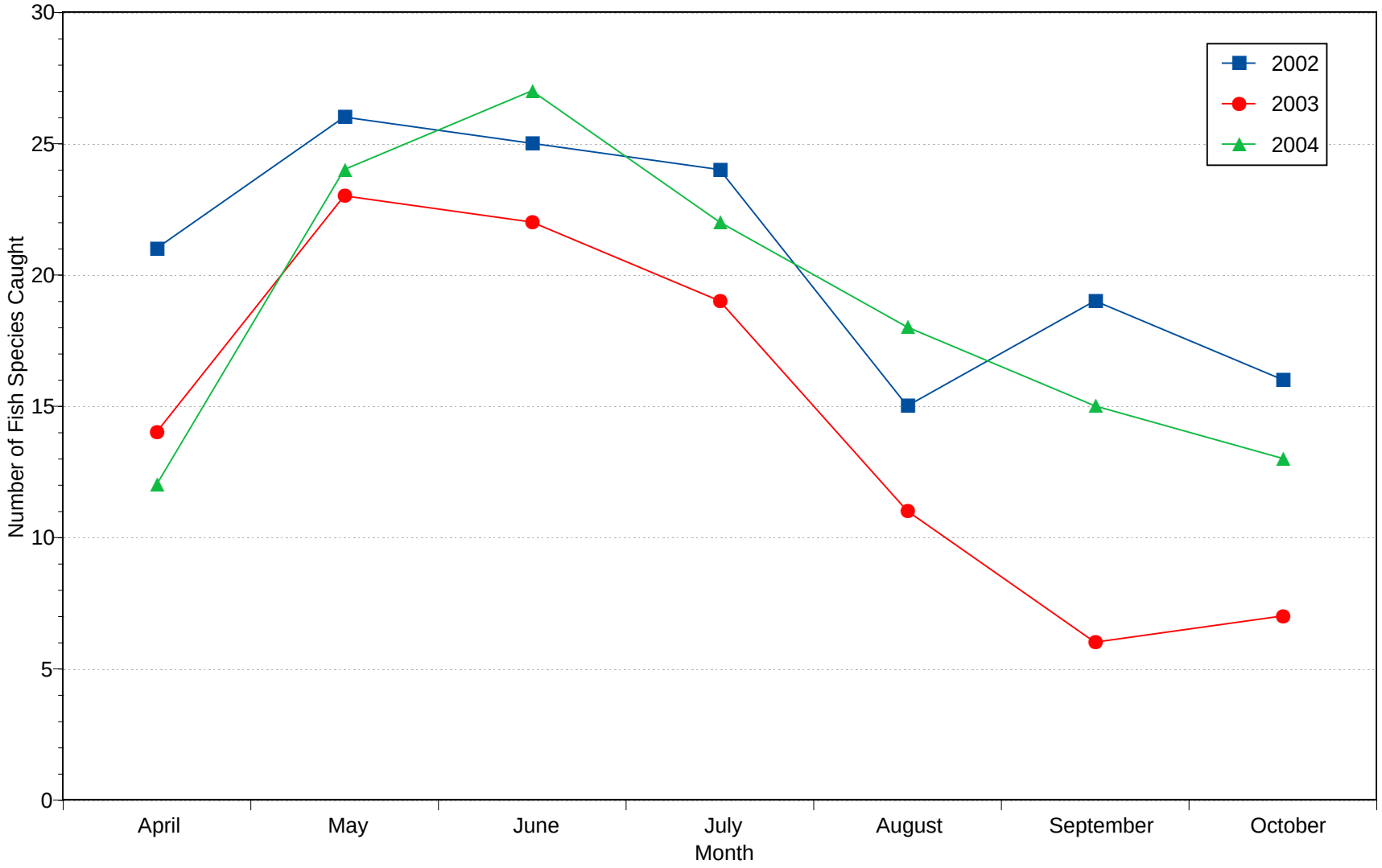


RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 3-19
	YEAR 3 (2004) MONITORING REPORT	Yowkwala marsh vegetation coverage	



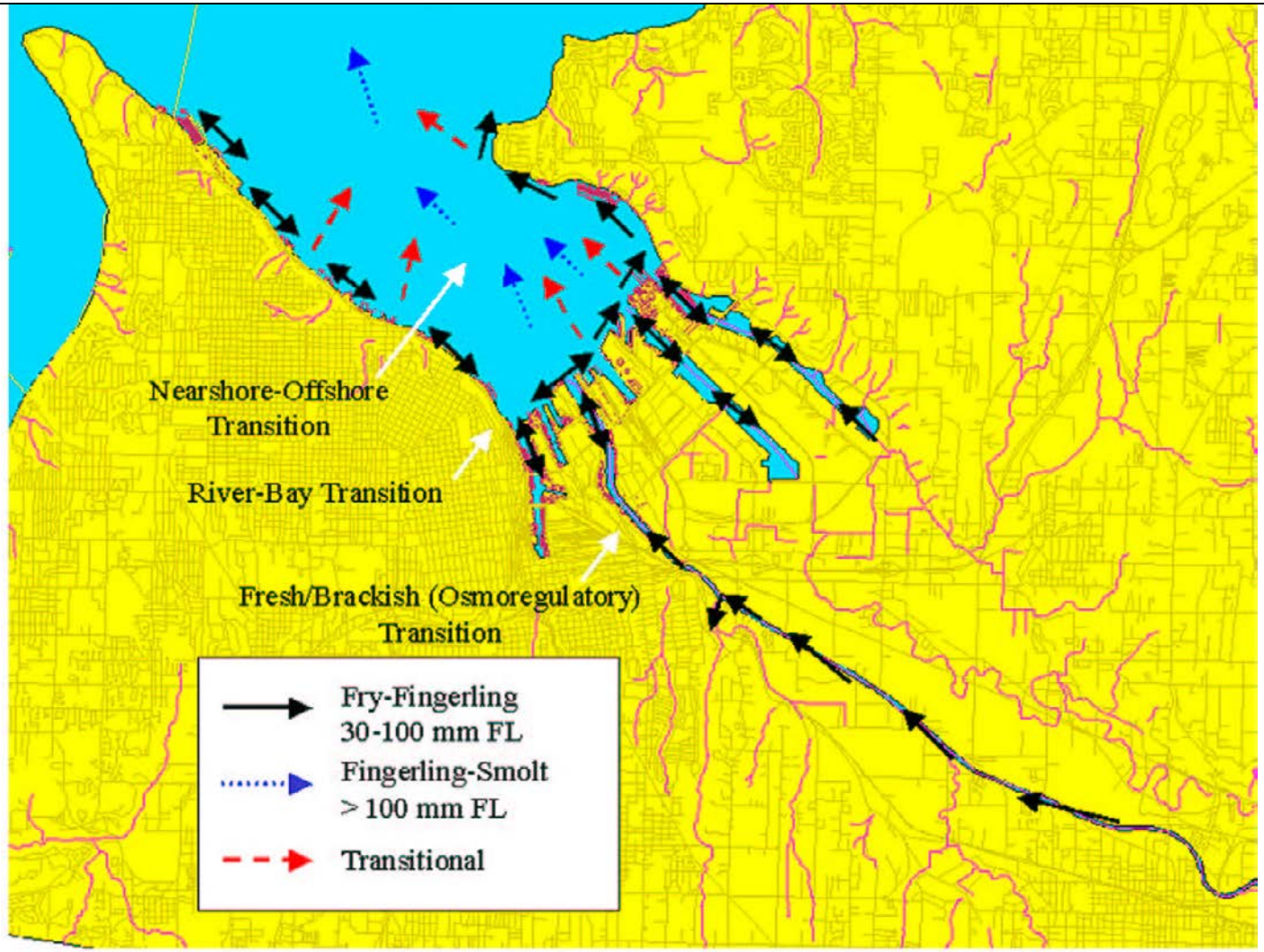
RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 4-1
	YEAR 3 (2004) MONITORING REPORT	Total number of fish species caught per site in Years 1 to 3.	

YR3_2002-2003-2004_Comparison.dg5



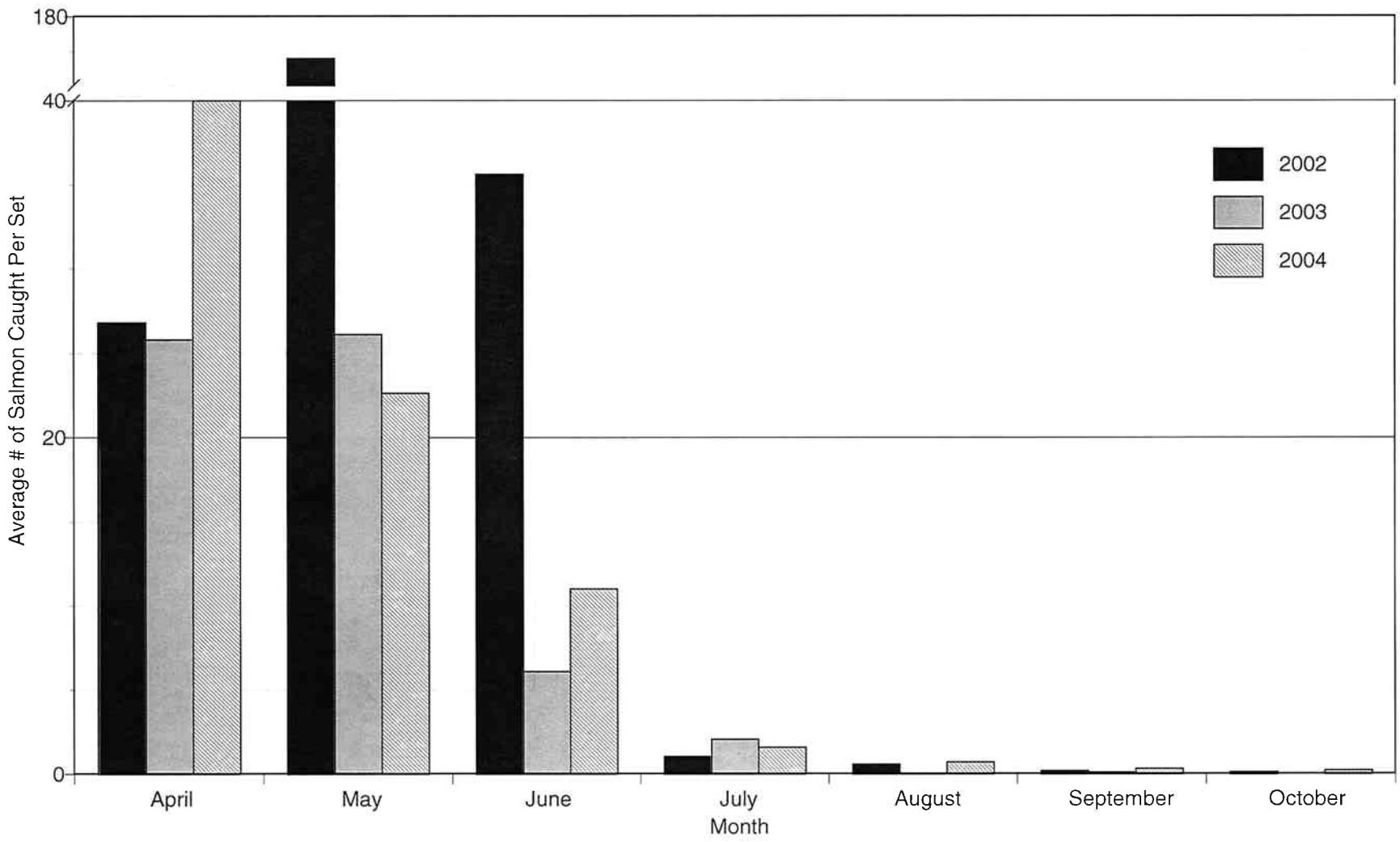
RIDOLFI Inc.	**COMMENCEMENT BAY RESTORATION**	January 2005	Figure 4-2
	YEAR 3 (2004) MONITORING REPORT	Total number of fish species caught per month at all site in Year 1 to 3.	

YR3_2002-2003-2004_Comparison.dg5



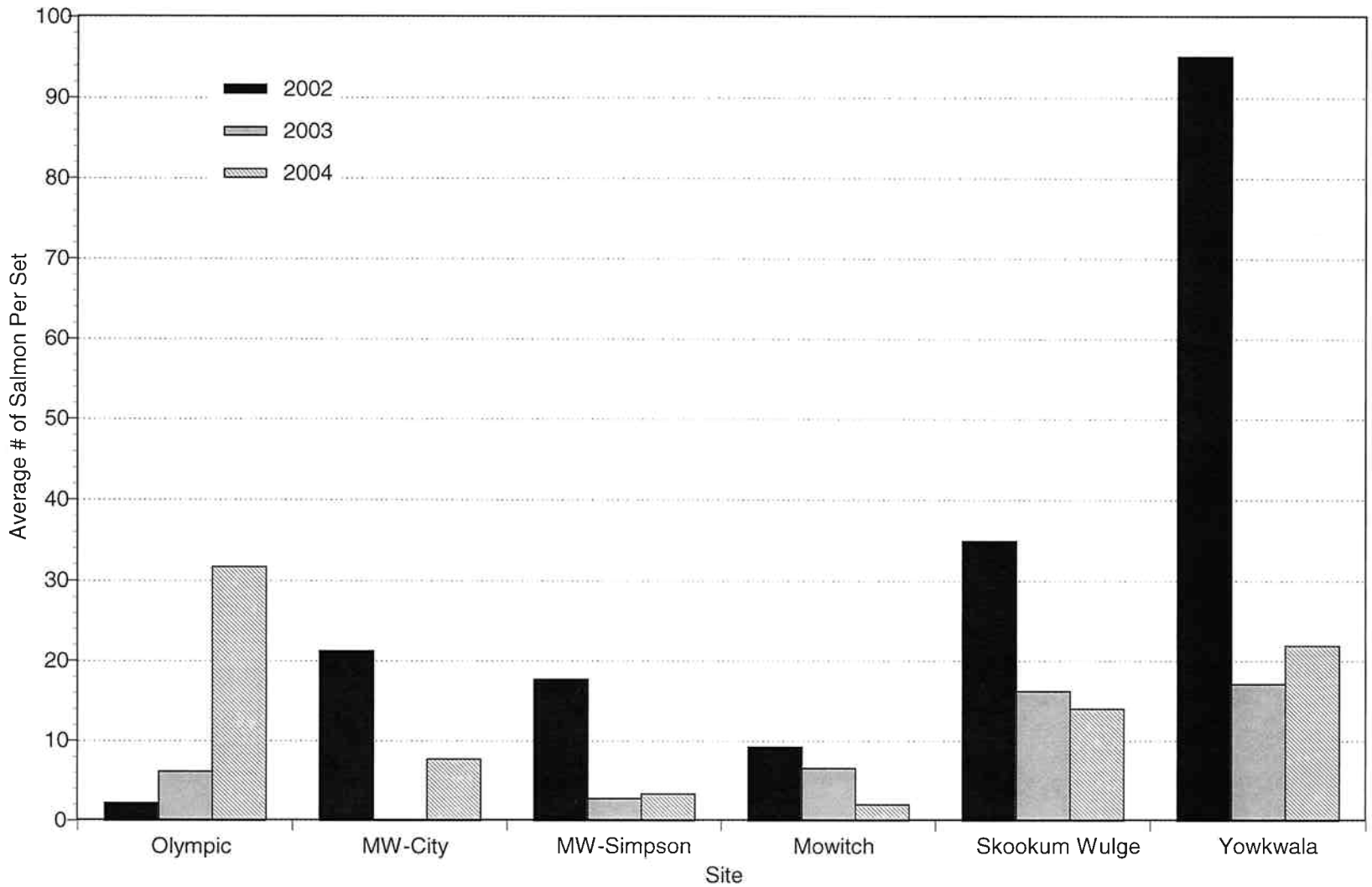
RIDOLFI Inc.	**COMMENCEMENT BAY RESTORATION**	January 2005	Figure 4-4
	Year 3 (2004) MONITORING REPORT	Modern use of Puyallup River delta and Commencement Bay by juvenile salmon.	

Modified from GIS data from Washington Department of Natural Resources; see also Graeber, in prep.



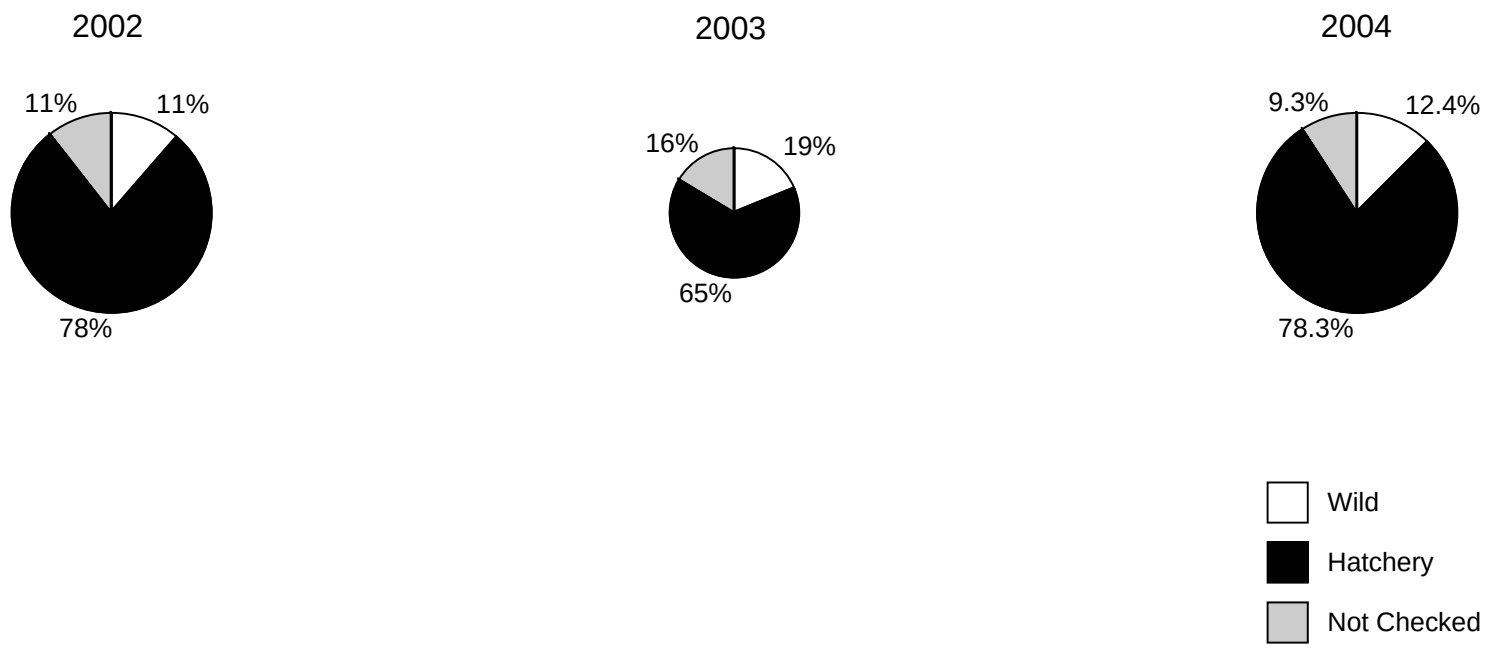
RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 4-5
	YEAR 3 (2004) MONITORING REPORT	Average number of salmon caught per set in Years 1 to 3.	

YR3_2002-2003-2004_Comparison.dg5



RIDOLFI Inc.	**COMMENCEMENT BAY RESTORATION**	January 2005	Figure 4-6
	YEAR 3 (2004) MONITORING REPORT	Average number of salmon caught per site in Years 1 to 3.	

YR3_2002-2003-2004_Comparison.dg5



RIDOLFI Inc.

COMMENCEMENT BAY RESTORATION

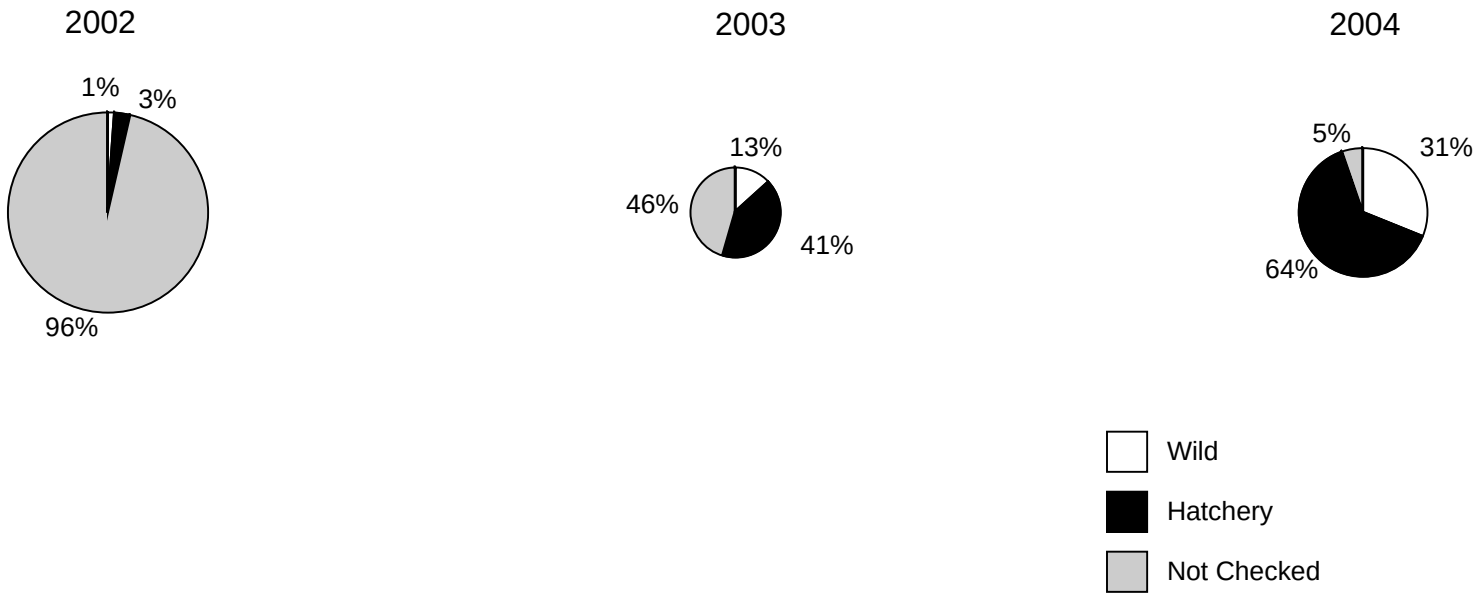
YEAR 3 (2004) MONITORING REPORT

January 2005

Figure 4-8

Percent of chinook that were wild, hatchery, or not checked in Years 1 to 3.

YR3__total_salmon.dg5



RIDOLFI Inc.

COMMENCEMENT BAY RESTORATION

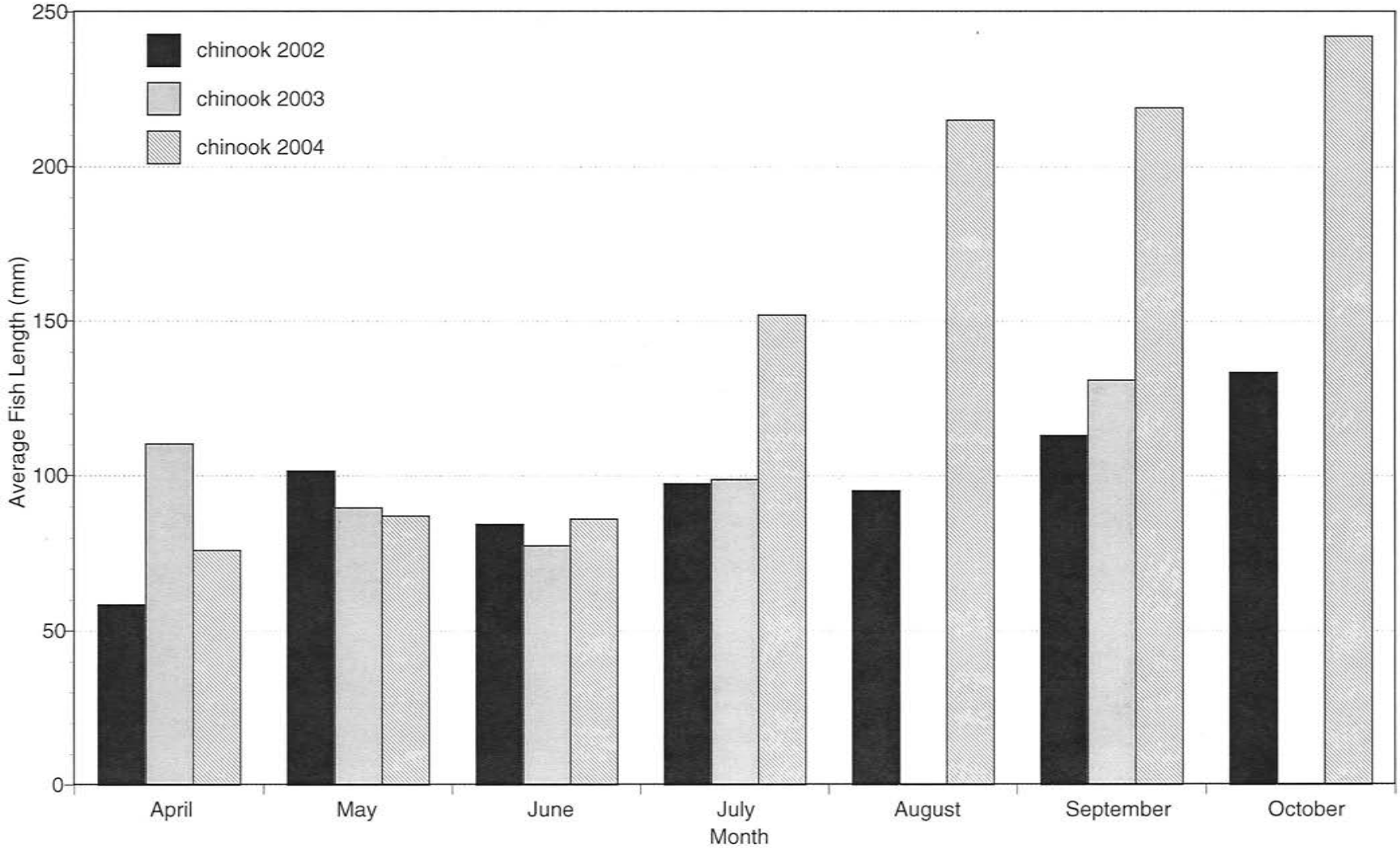
YEAR 3 (2004) MONITORING REPORT

January 2005

Figure 4-9

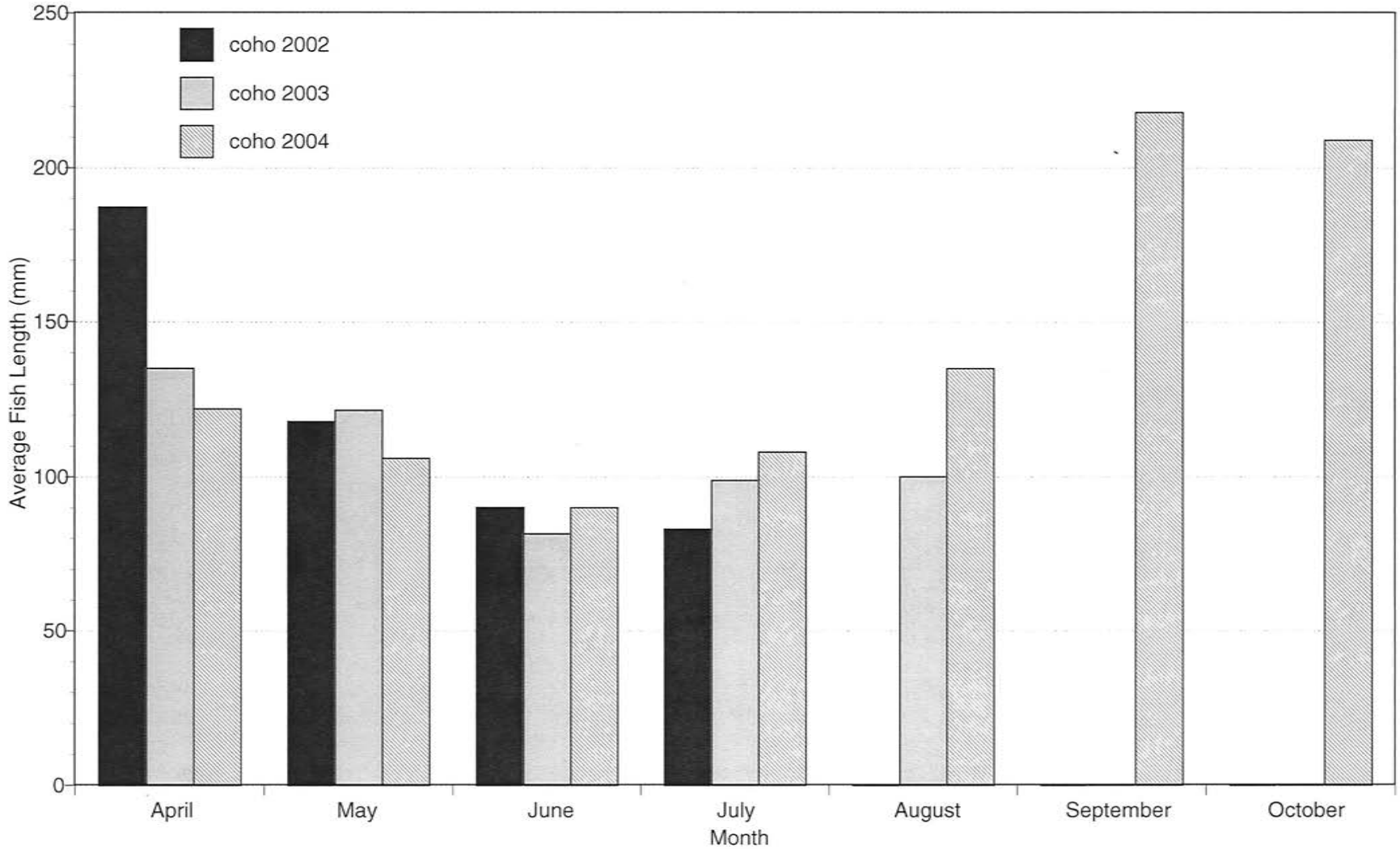
Percent of coho that were wild, hatchery, or not checked in Years 1 to 3.

YR3__total_salmon.dg5



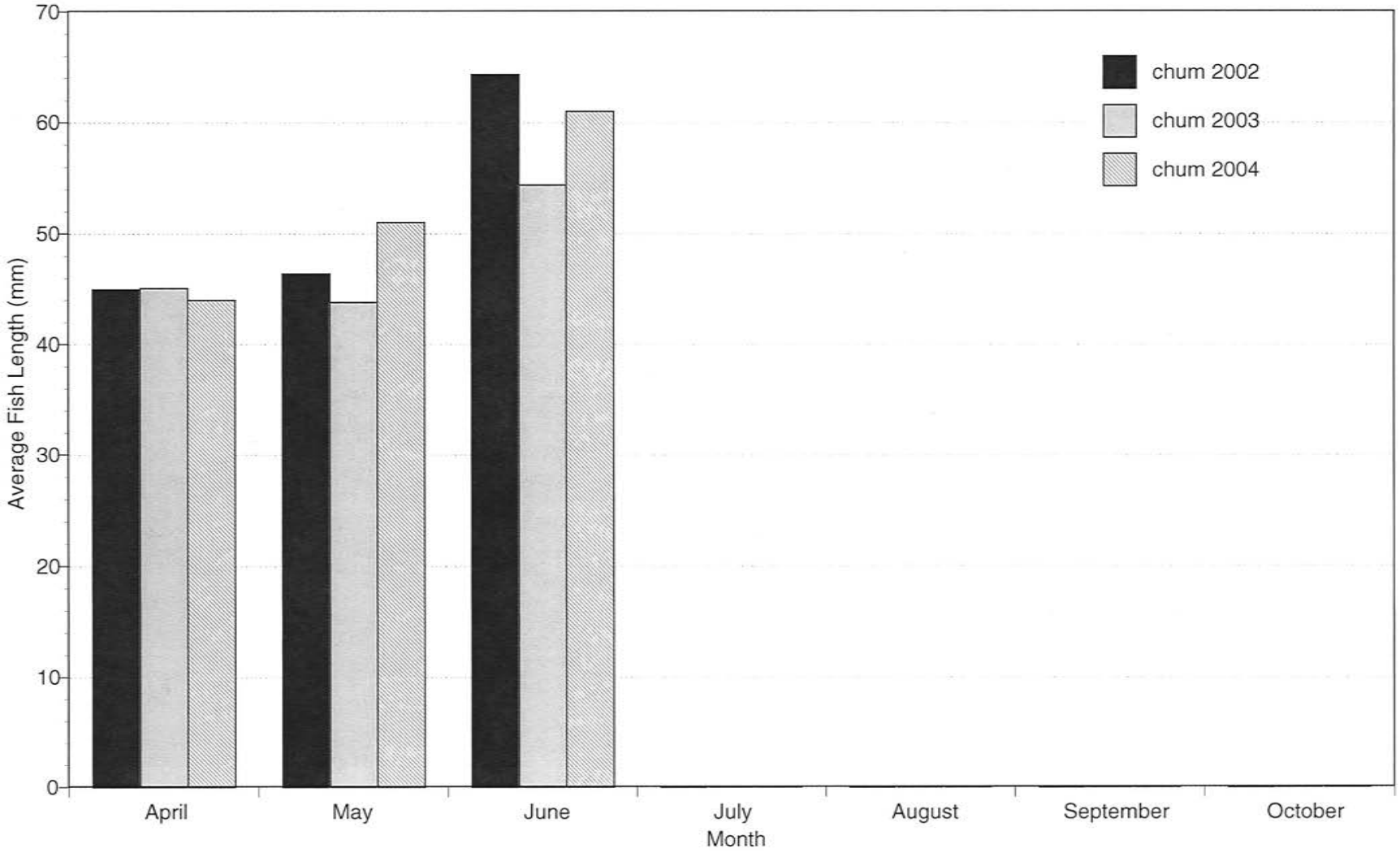
RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 4-10
	YEAR 3 (2004) MONITORING REPORT	Average length of chinook salmon caught at all sites combined in Years 1 to 3.	

YR3__total_salmon.dg5



RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 4-11
	YEAR 3 (2004) MONITORING REPORT	Average length of coho salmon caught at all sites combined in Years 1 to 3.	

YR3__total_salmon.dg5



RIDOLFI Inc.

COMMENCEMENT BAY RESTORATION

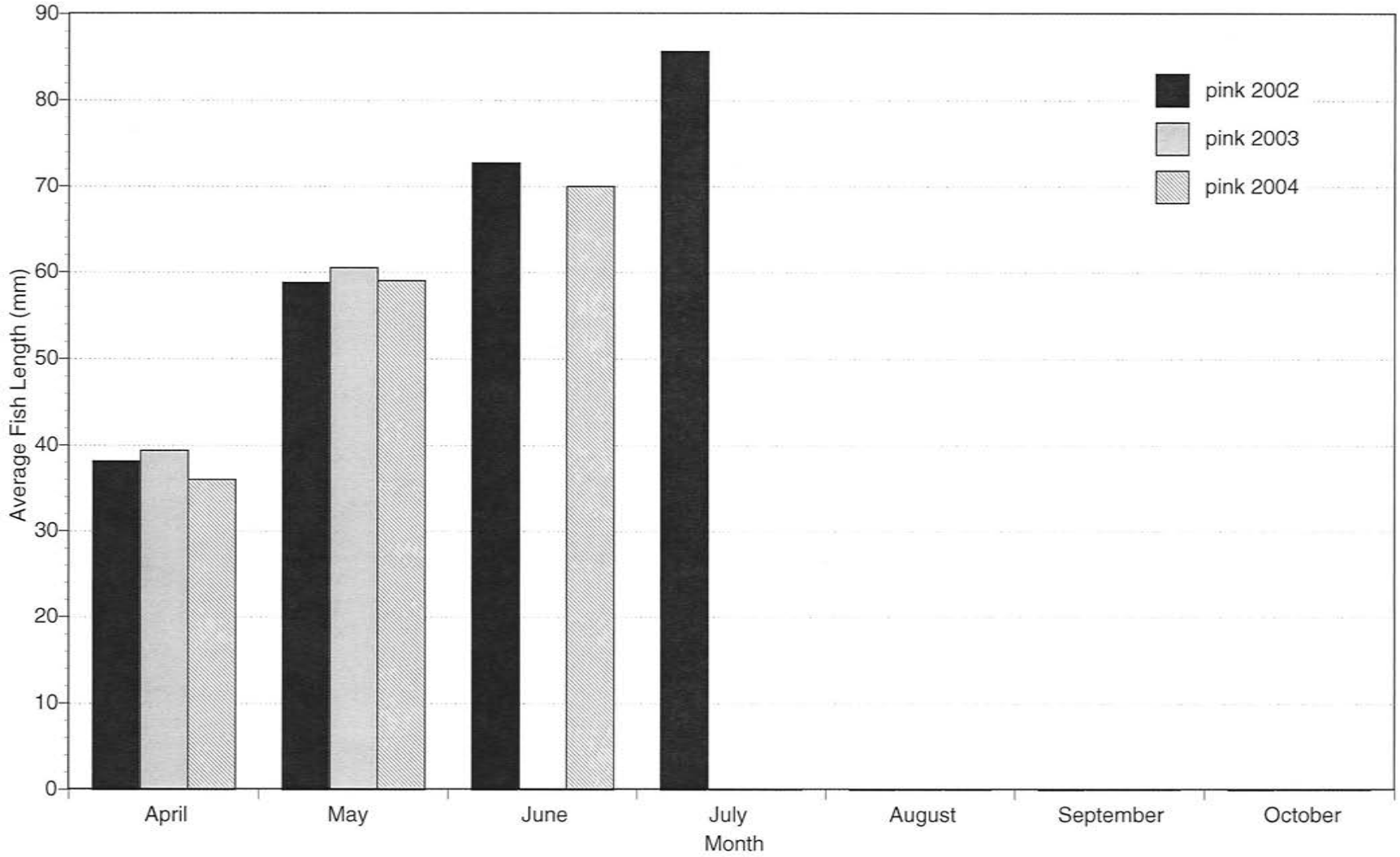
YEAR 3 (2004) MONITORING REPORT

January 2005

Figure 4-12

Average length of chum salmon caught at all sites combined in Years 1 to 3.

YR3__total_salmon.dg5



RIDOLFI Inc.	COMMENCEMENT BAY RESTORATION	January 2005	Figure 4-13
	YEAR 3 (2004) MONITORING REPORT	Average length of pink salmon caught at all sites combined in Years 1 to 3.	

YR3__total_salmon.dg5