Year 5 (2006) Monitoring Report

for Commencement Bay Habitat Restoration Sites

Prepared for the

Commencement Bay
Natural Resource Damage Assessment
and Restoration Trustees

YEAR 5 (2006) MONITORING REPORT

FOR COMMENCEMENT BAY HABITAT RESTORATION SITES

Prepared for the

Commencement Bay

Natural Resource Damage Assessment and Restoration Trustees

Prepared by

RIDOLFI Inc.

and

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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 5 (2006) monitoring at eight habitat restoration sites in or adjacent to Commencement Bay in Tacoma, Washington: Yowkwala, Squally Beach, Mowitch, Hylebos Creek Off-Channel (Jordan), Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), Olympic View, and Sha Dadx.

Four biological success criteria were monitored in various combinations at the different sites to evaluate marsh development, riparian vegetation, fish access and presence, and bird use. Not all criteria were required to be monitored at all sites in Year 5. In addition, physical success was assessed using aerial photography, and baseline chemical conditions were assessed using sediment chemistry.

The data collected were analyzed to evaluate whether the sites were meeting performance objectives, as summarized in Table ES-1.

Table ES-1. Performance summary for Year 5 (2006) monitoring.

Site Name	Biological Success Criteria			
	2	6	7 [a]	9[a]
	Marsh Development/ Species Composition	Riparian Vegetation/ Areal Coverage	Fish Access/Presence	Bird Use
Mowitch	+	+[b]		
Squally Beach	+	+		
Middle Waterway (Simpson/Trustees)	Y[b]	+[b]		
Sha Dadx				Y
Hylebos Creek Off-Channel			+	Y

Notes:
Y = Criterion met.
+ = Criterion partially met or improving.
N = Criterion not met.
[a] = Reference not available for quantitative comparison; evaluation based on site observations.
[b] = Variability is high and one limit of the confidence interval may not meet the criterion.

Key actions suggested for adaptive management of the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites include:

- Manually remove non-native and invasive species in the riparian areas at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites.
- Eradicate common reed (*Phragmites*) from the marsh at Mowitch to prevent this highly invasive species from spreading.
- Replant and stabilize the slope between the marsh and riparian areas along the eastern portion of the Middle Waterway (Simpson/Trustees) site. Portions of this slope are eroding and lack vegetation cover. Nootka rose and kinnikinnik have been successful at this site and are good candidate species for replanting these areas.

- Replace damaged goose-exclusion fences on the marsh lobes at Mowitch, and replant these enclosures with native marsh species.
- Remove stakes from trees in the southern riparian area at the Middle Waterway (Simpson/Trustees) site.
- Replant native trees and shrubs in the southern portion of the riparian area at Mowitch. Consider marking a designated trail through this area for volunteers to access the site.
- Remove debris from the Mowitch and Middle Waterway (Simpson/Trustees) sites.
- Locate the marsh and riparian sampling transects and plots using GPS in order to make relocating transects and plots more efficient during future years of monitoring.

Key actions suggested for adaptive management of the recently constructed Hylebos Creek Off-Channel (Jordan) site include:

- If sand continues to be deposited in the off-channel habitat area and Hylebos Creek, efforts should be made to determine and control the source and potentially to remove some of the excess material.
- Create more cover in the off-channel habitat area by adding additional large woody debris, root wads, and boulders.
- Monitor depth of openings, channels, and flow in the off-channel habitat area.
- Consider modifications to the openings in Reach 3 of the off-channel habitat area to ensure continued flow of water from Hylebos Creek through the site.
- Conduct an aquatic insect study at the site.

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LIST OF UNITS

°C	degree Celsius
cm	centimeter
ft	foot/feet
ha	hectare
in.	inch
m	meter
mm	millimeter
ppt	parts per thousand

LIST OF ABBREVIATIONS AND ACRONYMS

Adolfson	ESA Adolfson (formerly Adolfson Associates, Inc.)
ARI	Analytical Resources Inc.
Axys	Axys Analytical Services Ltd.
bgs	below ground surface
BSC	biological success criterion
Champion	Champion International Corporation
90CI	90 percent confidence interval
95CI	95 percent confidence interval
CPUE	catch per unit effort
CWT	coded wire tag
DDT	dichlorodiphenyltrichloroethane
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
NNI	non-native or invasive species
NOAA	National Oceanic and Atmospheric Administration
PCB	polychlorinated biphenyl
rebar	reinforcing steel bar
SAP	sampling and analysis plan
SCT	salinity-conductivity-temperature
Simpson	Simpson Tacoma Land Company
sp.	species
SR	species richness
TBT	tributyl tin
TerraStat	TerraStat Consulting Group

Trustees	Commencement Bay Natural Resource Trustees
WDFW	Washington Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources

1.0 INTRODUCTION

The National Oceanic and Atmospheric Administration (NOAA) issued Task Order No. TO022 under Contract 50ABNF-2-00013 to RIDOLFI Inc. (Ridolfi) to conduct Year 5 (2006) monitoring activities at eight habitat restoration sites on Commencement Bay in Tacoma, Washington (Figure 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 5 monitoring activities, presents the results of the field work, assesses progress toward meeting the success criteria, and recommends adjustments (adaptive management) for future monitoring years. Ridolfi personnel, with support from ESA Adolfson (formerly Adolfson Associates, Inc. [Adolfson]), collected the monitoring data.

Appendices contain detailed tables presenting the Year 5 monitoring data (Appendix A), a description of the sampling protocol selected for Year 5 riparian vegetation monitoring (Appendix B), and a detailed description of how transects were established for the riparian vegetation monitoring work (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.

The eight restoration sites at which monitoring occurred in Year 5 (2006) 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 Site

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 2). 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 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 in the pools, 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 Site

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 3). 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 sinuous 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) Site

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 4). 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) Site

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 (WDNR) parcel, and the 11th Street right-of-way, which collectively make up the Middle Waterway (City of Tacoma) site (Figure 5).

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 Olympic View Site

The Olympic View site is located at the northern tip of the peninsula that separates the Thea Foss Waterway and the Middle Waterway in Tacoma, Washington. It comprises two properties:

The Olympic View Resource Area (OVRA) 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 6). 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.

The Olympic View Triangle (OVT) is located on state-owned aquatic lands administered by WDNR, which is one of the Trustees. The site is bordered by the Thea Foss Waterway to the west, the Shore Terminal facility (formerly Superior Oil Company) to the south, Commencement Bay to the north, and the OVRA property to the west. Most of the site is at elevation 15 ft MLLW. The site is flat and mostly barren, with several grassy areas. Soil at the site is fill material consisting of silty sand, gravel, and cobbles. A riprap bank and sheet pile retaining wall run along the site's seaward perimeter, adjacent to the Thea Foss Waterway and Commencement Bay. The site, which is currently vacant, is approximately triangular in shape and occupies an area of about 1.2 acres (Figure 6); it serves as a breakwater and buffer area to protect the adjacent fuel storage facility. The only structures on the site are two groundwater monitoring wells and a sheet pile retaining wall. Historical uses of the site appear to have been limited to the staging of logs and storage of milled timber.

In May 2004, the Commissioner of Public Lands designated the site as a natural resource of great natural value and withdrew it from leasing except for uses consistent with habitat restoration or conservation. In conjunction with this designation, WDNR and the Trustees began to design a restoration project for the site. Ridolfi was contracted by WDNR and the Trustees to implement the restoration. A primary feature of the restoration plan is removal of soil from the central portion of the site to construct a tidal embayment. Design is in progress. According to current planning, final site grades over the central portion of the facility will be lowered from about

elevation 15 ft MLLW to between 10 and 12 ft MLLW. Soil will be excavated an additional 1-ft below final grades to accommodate backfilling with topsoil.

1.6 Yowkwala Site

The Yowkwala site, which is approximately 15 acres (6 ha) in size, is between the Tyee Marina and Browns Point (Figure 7). 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, 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.

1.7 Sha Dadx Site

The Sha Dadx site, formerly known as the Frank Albert Road site, is located in Fife, Washington. The site is bordered by the north levee of the Puyallup River to the south, Frank Albert Road to the west, the Union Pacific rail line to the north, and 54th Avenue East and a low density residential area to the east (Figure 8). The site is relatively flat, at an elevation of approximately 16 to 26 feet (4.9 to 7.9 m) above MLLW, with a slight slope towards the wetland area on the west side.

The portion of the site selected by the Trustees for habitat restoration encompasses approximately 11.5 acres of existing wetlands; it contains a meander section of the former channel of the Puyallup River that was abandoned when the river was realigned and the north and south levees were constructed at the beginning of the 20th century. The Trustees intend to create off-channel habitat for juvenile salmonids adjacent to the Puyallup River.

Several studies have been completed at the site, including a wetland delineation, topographic survey, geotechnical studies (test pits/borings), seepage modeling, Phase I environmental site assessment, cultural resources assessment, and hydrological studies. Restoration alternatives

were developed and reviewed by stakeholders and the Trustees. Permitting and detailed design are currently under way.

1.8 Hylebos Creek Off-Channel (Jordan) Site

The Hylebos Creek Off-Channel (Jordan) site, formerly known as the Jordan property, was acquired and annexed by the City of Fife, in cooperation with the Commencement Bay Natural Resources Trustees. The site includes 15.3 acres and is bounded on the west and southwest by Hylebos Creek, on the south by private property and 8th Street, on the east by a bluff, and on the north by the property line extending east from the end of 4th Street (Figure 9). The site was partially forested with a wetland area bordering Hylebos Creek, and an access road running north/south between the creek and the bluff.

The Trustees were responsible for the design, construction, and adaptive management of a stream restoration project, which includes a nature trail. The City of Fife is responsible for operating and maintaining the site after completion of the project. The project is intended to create off-channel habitat for juvenile salmonids adjacent to the Hylebos Creek.

Activities that took place at the site prior to construction included a Phase I Site Assessment; digging test pits to characterize soil conditions; installing piezometers and surface water transducers to monitor groundwater and surface water elevations; evaluating wetland conditions in relation to an adjacent site; and sampling soils and wood debris.

Construction was completed in the fall of 2005. A backwater channel that connects to Hylebos Creek via five inlets was constructed at the site. Pools and islands were created to add complexity to the habitat provided by the backwater channel. Native vegetation was planted at the newly constructed site in the winter and spring of 2006.

2.0 DESCRIPTION OF METHODS

This section describes the procedures used to evaluate the restoration sites. Table 1 summarizes by site the criteria evaluated during the Year 5 monitoring, which include biological success criteria (BSCs) as well as physical and chemical criteria.

Table 1. Monitoring conducted in Year 5 (2006) by site and parameter.

Site Name	Biological Success Criteria				**Physical Success:** Aerial Photography	**Baseline Chemical Conditions:** Sediment Chemistry
	2	**6**	**7**	**9**		
	Marsh Development/ Species Composition	Riparian Vegetation/ Areal Coverage	Fish Access/Presence	Bird Use		
Mowitch	X	X			X	X
Squally Beach	X	X			X	X
Middle Waterway (Simpson/Trustees)	X	X			X	X
Middle Waterway (City of Tacoma)					X	X
Olympic View					X	
Yowkwala					X	
Sha Dadx				X		
Hylebos Creek Off-Channel			X	X	X	X

The monitoring tasks performed to assess progress toward the project goals are described in this section.

The field work performed differed from the schedule outlined in the project work plan (Ridolfi and Adolfson, 2001). The Trustees determined that, based on the results from monitoring in Years 1, 2, and 3 (2002-2004), it would be more effective to reallocate efforts among sites and success criteria. In addition, methods for BSCs 6 (riparian vegetation/areal coverage) and 7 (fish access/presence) were modified from those described in the 2001 work plan; methods used are discussed below.

2.1 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)

2.1.1 BSC 2 Field Work

In September 2006, 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 (Ridolfi and Adolfson, 2003a). In Year 2 (2003), a new transect (Transect 1-3) was added on the Squally Beach site to capture the lower marsh vegetation establishment, and a new transect (Transect 1-2) was added on the Mowitch site to characterize marsh vegetation establishment on three lobes of intertidal habitat (Ridolfi and Adolfson, 2003b). In Year 3, a new transect (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. Reinforcing steel bars (rebar) were used to permanently mark the transect locations. 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 (Ridolfi and Adolfson, 2005).

Based on recommendations made at the end of Year 2 monitoring (Shelly, 2004a), the original sampling locations from Year 1 (or Year 2 for Mowitch Transect 1-2 and Squally Beach Transect 1-3, and Year 3 for Middle Waterway [Simpson/Trustees] Transect 1-2) were used to allow for paired comparisons.

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.

During Year 5, field crews used field notes and photographs from previous years, along with rebar markers, to relocate the marsh transects and sampling quadrats. However, some of the rebar installed to mark transect locations was missing in Year 5, presumably washed away by tides or removed to reconstruct herbivory fencing. Field crews encountered other challenges in attempting to relocate the marsh quadrats in the same locations sampled during previous years. New herbivory fencing had been added in some areas between the Year 3 and Year 5 sampling events, and these areas had been replanted with native marsh species. In addition, in some areas it appeared that erosion or scouring of beach sediments had occurred. Finally, the ability to relocate quadrats based on comparison with vegetation presence and cover from previous years was limited, as it appears that the marsh vegetation is dynamic, with some species spreading rapidly to colonize new areas, and other species declining.

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

During Year 5, the marsh area at each site was divided into management zones in order to facilitate maintenance activities at each of the sites. The zone boundaries (shown on the figures

in Appendix C) were initially determined by NOAA (Cereghino, 2006). These boundaries were then marked in the field by Adolfson biologists based on site features that can be seen on aerial photos, such as drainage channels, lobes, island, changes in vegetation, or structures such as fences or buildings.

2.1.2 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 5 percent cover data to those from the year of origin (Year 1, 2, or 3, depending on transect).

2.1.2.1 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.

2.1.2.2 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, 2, or 3 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 5.

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.

2.2 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 5, minimum percent coverage of vegetation layers should be: >50 percent (shrubs); > 40 percent (trees); and <5 percent (non-native invasive vegetation), and bare ground should not be >10 percent.* (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)

2.2.1 BSC 6 Field Work

2.2.1.1 Previous Monitoring Work

The riparian monitoring methods used in Years 1 – 3 are detailed in the Year 3 (2004) Monitoring Report for Commencement Bay Habitat Restoration Sites (Ridolfi and Adolfson, 2004) and summarized below. In Years 1, 2, and 3, percent cover in the riparian area was estimated using a 3.3-ft x 9.8-ft (1.0-m x 3.0-m) quadrat located along transects that generally followed contours. The transects were placed to adequately assess the areal coverage of the riparian vegetation.

The locations of quadrats were selected on the transects using random numbers from Elzinga et al. (1998) and recommendations provided by the project statistician (Shelly, 2004b). The percent cover of each species within the quadrat was estimated (viewed from the vertical) and recorded on standard data forms.

The extent of riparian vegetation was also mapped in Years 1 to 3 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. Dominant plant species were determined based on a visual estimate of area within the polygon and recorded for each identified polygon. Polygons locations were mapped.

2.2.1.2 Year 5 Monitoring

For Year 5, the Trustees established a new protocol for sampling riparian vegetation (Cereghino, 2006). Sampling changed from the use of randomly placed quadrats along a single transect, to the use of line intercept transects. The objective for this change was to produce a more representative random sample of riparian vegetation, reduce observer error, increase replicability, and reduce between-plot variation.

Riparian cover monitoring was conducted at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. As with the marsh areas, the riparian areas at each site were divided into management zones during Year 5. The purpose of these zones is to facilitate maintenance activities at the sites by dividing the riparian area into smaller units. The zone boundaries (shown on the figures in Appendix C) were initially determined by NOAA (Cereghino, 2006). Zone boundaries were marked in the field by Adolfson biologists based on site features that can be seen on aerial photos, such as changes in vegetation or structures such as fences or buildings.

NOAA determined the number of line intercept transects to be sampled at each site and within each riparian management zone (see Appendix B). A total of 20 line intercept transects were sampled at Middle Waterway (Simpson/Trustees); 12 at Squally Beach; and 24 at Mowitch. Appendix B presents a schematic of how line intercept transects locations were established within the riparian management zones. This process included first establishing a baseline transect along the outer (upland) edge of the riparian area. Offset transects were then located perpendicular to the baseline transect, extending into the riparian area (toward the water). A line intercept transect was then located perpendicular to each offset transect. The locations of offset and line intercept transects were determined in the office using a random number table (Elzinga et al. 1998). The range of random numbers used was based on the dimensions of each management zone as measured on

aerial photos of the sites, such that the line intercept transects did not overlap between management zones. Line intercept transect locations were adjusted in the field where needed; for example, to prevent the transect from extending into an unvegetated road median or into the marsh. The ends of each line intercept transect were marked in the field with wooden stakes and flagging.

Line intercept transects were 60 feet long; this length was selected in order to reduce variance (Cereghino, 2006). Using a measuring tape, field crews recorded the beginning and ending points where each woody species intercepted the tape. In portions of the transect where two or more woody species were intertwined, the starting and ending points of the intertwined group were recorded along with the relative percent cover of each species within the group. Several transects contained more than one distinct woody stratum (for example, a shrub layer beneath an overhead tree canopy, or a tall shrub layer above a low shrubby species). For these transects, each stratum was recorded separately, such that the total woody cover along the transect may total more than 100%. The percent cover of herbaceous and groundcover species and bare ground along each transect was visually estimated for the transect as a whole. The riparian data were recorded on standardized data forms.

2.2.2 BSC 6 Data Analysis

The riparian zones within each sampled site – Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) – were stratified into sampling zones, with different numbers of random transect locations within each zone. The cover estimate for each transect comprises one independent random sample from the sampling zone. Because the zones have different areas, the combined estimate of mean cover for each site is a weighted mean based on sizes of strata. The strata with associated sizes are displayed in Table 2.

Table 2. Zone names and sizes for each sampled site.

Zone Code	Zone Name	Area	
		sq. ft	acres
Mowitch			
F1	F1	8,580	0.197
F2	F2	4,237	0.097
F3	F3	3,798	0.087
F4	F4	5,250	0.121
F5	F5	3,941	0.090
F6	F6	5,391	0.124
F7	F7	2,953	0.068
Middle Waterway (Simpson/Trustees)			
NB	North Bank	19,280	0.443
NW	North Woods	10,487	0.241
SB	South Bank	19,622	0.450
SW	South Woods	26,047	0.598
Squally Beach			
AG	Alder Grove	5,619	0.129
EW	East Woods	10,179	0.234
WW	West Woods	5,886	0.135

The transect cover estimates for individual species contained a high proportion of zeros for most species, and most distributions were somewhat positively skewed with very few high values. The zero-modified log-normal distribution was assumed for the marsh quadrat data, and may also be appropriate for most riparian species. However, not all species conformed to this distribution. The formulas for confidence intervals on means of zero-modified lognormal distribution would also have to be modified to be used on stratified samples. In this case, the variances would have to be estimated within each strata, which consists of three to seven samples. These variance estimates are unstable, and the asymptotic properties of the estimators is in serious question.

Instead of assuming a distribution, bootstrapping was used to estimate the stratified mean and confidence limits for the mean cover of each species and group totals. The bootstrapping was

done within strata, with appropriate weights to estimate the stratified mean. The mean and bias-corrected 95 percent confidence interval (95CI) were estimated from 1,000 bootstrap samples using S-PLUS statistical software (S-PLUS 2000, professional release 3.0, copyright 1998-2000, MathSoft Inc.). In the tables prepared for section 3.2 of this report (A-11, A-12, A-14, A-15, A-17, and A-18, the standard stratified mean estimate is displayed along with the mean and confidence interval from the bootstrap sample.

2.3 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)

2.3.1 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 performed snorkel surveys at the Hylebos Creek Off-Channel (Jordan) site. Findings from the surveys were used to determine if fish, particularly juvenile Chinook and coho salmon, are able to access the site and if they are present within the system. Snorkel surveys provide an overall picture of species assemblages and diversity as well as fish usage of the underwater habitat being surveyed. Observations of the physical attributes of the underwater habitat in the study area can also aid in decision-making if adaptive management is necessary at the site.

Snorkel surveys were conducted at the site using an adapted monitoring approach outlined in Thurow (1994). Monitoring was conducted at the site from April through August 2006, on an approximately weekly schedule from April through June, and once per month schedule from July through August, for a total of 13 monitoring events.

A two-person crew, one snorkeler and one on-shore observer, conducted the surveys. The site was divided into two main sections; the off-channel habitat area and the Hylebos Creek area. Each area was further divided into survey reaches as shown on an aerial photograph of the site (Figure 10). The off-channel habitat area was subdivided into three distinct units characterized

by a series of channels and five pools. Numbering of the reaches and pools begins at the downstream end of the area.

Hylebos Creek was divided into five distinct units, beginning at the downstream end of the site. Hylebos Creek is a straight channel with shallow to deeper pools. The entire length of Reaches 4 and 5 are characterized by shallow water flowing over a sand and gravel substrate forming a glide. The shallow areas are estimated at less then eight inches deep. At the downstream edge of Reach 4 the creek deepens. Reaches 1, 2, and 3 are characterized by deeper water with pools. The deepest pools are estimated at just over six feet. Water depths in Reaches 1, 2, and 3 fluctuate with the tides.

The snorkeler was outfitted with a dark green dry-suit, neoprene gloves, wet-suit hood, snorkel and mask, and dive boots. To conduct the survey in the off-channel habitat area, the snorkeler started at the downstream end of each reach and moved slowly upstream in a zigzag pattern across the channel to complete one upstream pass for each reach (Figure 11). Pools were surveyed in a similar manner. In the Hylebos Creek area the snorkeler started at the downstream end of each reach and slowly moved upstream surveying the bank along the site. One upstream pass was conducted for each reach. The snorkeler was generally in the center of Hylebos Creek with head turned in the direction of the site. The snorkel surveys were generally planned around a mid to low tide and conducted between late morning and early afternoon when the sun was directly overhead. Scheduling surveys in this manner increases the likelihood of good visibility for the snorkeler. Turbid tidal waters and shadows from the sun can hamper water clarity. All portions of the site were surveyed if conditions allowed.

Salmonids were identified to species and counted. Total lengths for salmonids were estimated to the nearest size group (e.g., 50 to 80 millimeters [mm], 80 to 100 mm, and 100 to 120 mm). If possible, salmonids were also examined for hatchery marks, such as clipped adipose fins. All other species were identified to family, or species when possible, and counted. When large numbers of the same species were encountered counts were estimated to the nearest ten. Fish data and observations were called out by the snorkeler to the on-shore observer. The on-shore observer recorded the information in a water-proof field notebook. The on-shore observer also recorded any observations made from the bank during the survey.

For all sampling events, the following data were collected: location, reach, date, time, tide stage (time and height), water clarity, and weather conditions, including an approximation of air temperature, wind direction, precipitation, and cloud cover.

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. Any uncommon events or changes at the site were noted.

2.3.2 BSC 7 Data Analysis

All site condition and fish survey data were entered into an Excel spreadsheet. Tables summarizing these data are provided in Appendix A (A-19 and A-20).

2.4 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)

2.4.1 BSC 9 Field Work

Bird monitoring was conducted at the Sha Dadx and Hylebos Creek Off-Channel (Jordan) sites.

On 10 occasions between April and December 2006, bird use was observed and recorded for one hour per site visit. Bird use was approximated by documenting bird species observed at each site visit. The monitoring team identified a manner of approaching each site that would minimize disturbance, making observations from relatively inconspicuous locations. 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.

2.4.2 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).

2.5 Physical Success: Aerial Photography

Aerial photographs were recorded at the Mowitch, Squally Beach, Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), Olympic View, Yowkwala, and Hylebos Creek Off-Channel (Jordan) sites. These were used to examine overall site conditions and vegetation coverage. A color photograph of each site (not orthorectified) was produced. The extent of photos includes a buffer of a minimum of 100 feet on all sides of the property boundary.

2.6 Baseline Chemical Conditions: Sediment Chemistry

2.6.1 Field Work

Surface sediment chemistry data was collected from the Mowitch, Squally Beach, Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), and Hylebos Creek Off-Channel (Jordan) sites. The results will be used to inform the Trustees about current chemical conditions in the sediments. Station locations at each site were developed with Trustee input. Ridolfi developed a sampling and analysis plan (SAP), and the work was performed accordingly (Ridolfi, 2006).

One sediment sampling event occurred at each site. Two composite sediment samples, which were composed of sediment from three locations each, were collected at each of the sites. The samples were grab samples collected from 0 to 10 centimeters (cm) below ground surface (bgs). Horizontal coordinates for each sampling location were determined using a global positioning system (GPS) unit, and sampling locations were photo-documented.

2.6.2 Data Analysis

Samples were analyzed for chemistry, total organic carbon, and grain size, in accordance with the SAP (Ridolfi, 2006). An archival sample of the pre-composited sediments was retained in case further, more detailed investigation is warranted. Chemicals analyzed included the full-suite of chemicals identified in the State Sediment Management Standards (Washington Department of Ecology, 2006), plus DDT and tributyl tin (TBT). Total polychlorinated biphenyls (PCBs) were calculated using congener analysis.

3.0 MONITORING RESULTS

This section describes monitoring results by site and criterion. 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 (A-21 to A-26). Fish monitoring data, which were collected and summarized by Ridolfi personnel, were subsequently imported into the database for archival purposes.

3.1 Biological Success Criterion 2 – Marsh Development/Species Composition

Adolfson performed marsh vegetation monitoring at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. Statistical analysis was performed by TerraStat Consulting Group (TerraStat).

3.1.1 Mowitch

3.1.1.1 Transect 1-1

<u>*Summary*</u>. Native species represented approximately 80 percent cover along Mowitch Transect 1-1 in Year 5, while NNI species represented approximately 6.5 percent, with the rest bare ground. The most prevalent native species observed was pickleweed, followed by seashore saltgrass (*Distichlis spicata*) and seaside plantain (*Plantago maritima*). Both the diversity of native plant species and the average percent cover of native species have increased along the transect between Year 1 and Year 5. Although the percent cover for NNI species remained above the target of 5 percent, it has decreased since Year 3.

<u>*Description of Results*</u>. Of the 46 marsh quadrats sampled along Transect 1-1, 45 quadrats contained vegetation in Year 5. Most species encountered (10 out of 13) were native (Table A-1a). The most prevalent native species observed along Mowitch Transect 1-1, based on the average unbiased cover estimate, was pickleweed at 13.7 percent (Table A-2a). The next two most frequent species were seashore saltgrass with an average unbiased cover estimate of 11.7

percent and seaside plantain at 10.4 percent (Table A-2a). The 90 percent confidence interval (90CI) was calculated and is presented by species in Table A-2a (Appendix A).

Of the 46 quadrats along Transect 1-1, 23 quadrats were entirely within herbivory avoidance fencing (Table A-1a). The quadrats falling within the fenced area 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. Both native and non-native plant species typically occurred more frequently and appeared to have higher percent cover inside the herbivory avoidance devices. The exceptions were native spike-rush (*Eleocharis* sp.) and non-native brass buttons, which seemed to have equally high cover outside of the avoidance fencing.

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. During Year 5, 10 native plant species were observed, with a total unbiased average percent cover of 79.8 percent (Figure 11). The results for the non-parametric sign test indicate that the total native species have shown a statistically significant increase along the transect since Year 1 (Table A-3a). Therefore, both the diversity of native plant species and the average percent cover of native species increased along Transect 1-1 from Year 1 to Year 5.

The 90CI calculated by the project statistician for native, NNI, and all combined species are shown graphically on Figure 12. The total unbiased average percent cover of non-native species, which had increased along Mowitch Transect 1-1 from 2.7 percent in Year 1 to 16.8 percent in Year 3 (presented in Ridolfi and Adolfson, 2005), decreased to 6.5 percent in Year 5.

3.1.1.2 Transect 1-2

<u>*Summary*</u>. Native species represented approximately 45 percent cover along Mowitch Transect 1-2 in Year 5, while NNI species represented approximately 11 percent, with the rest bare ground. The most prevalent native species observed was spike-rush, followed by pickleweed and Canadian sandspurry (*Spergularia canadensis*). Both the diversity of native plant species and the average percent cover of native species have increased along the transect between Year 2

and Year 5. Although the percent cover for NNI species remained above the target of 5 percent, it has decreased since Years 2 and 3.

Description of Results. All of the 23 marsh quadrats sampled along Transect 1-2 at the Mowitch site contained vegetation. Nine out of the ten species observed in quadrats along this transect were native (Table A-1b). The most prevalent native species observed along Mowitch Transect 1-2, based on the average unbiased cover estimate, was spike-rush,

Of the 23 quadrats along Transect 1-2, twelve quadrats were entirely within herbivory avoidance fencing and eleven were entirely outside the fencing. The quadrats falling within the fenced areas generally had the greatest species diversity and greatest overall percent cover of native plants. Native plant species such as seaside plantain, pickleweed, Canadian sandspurry, and seaside arrowgrass generally showed a higher percent cover in fenced areas than in areas not fenced.

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 5, nine native species were observed, with a total average percent cover of 44.6 percent (Figure 11). An increase in average total cover by native species, statistically significant at the 95 percent confidence level, was observed between Years 2 and 5 (Table A-3b). Therefore, both the number of native species and the average percent cover of native species along Transect 1-2 have increased.

The 90CI calculated by the project statistician for native, NNI, and all combined species are shown graphically on Figure 12. The detailed results by species are available in Table A-2b, Appendix A. The total unbiased average percent cover of non-native species, which had increased along Mowitch Transect 1-2 from 20.4 percent in Year 2 to 87.9 percent in Year 3 (Ridolfi and Adolfson, 2005), decreased to 11.0 percent in Year 5.

3.1.1.3 Discussion

Comparison of Transects. Both Mowitch marsh transects show an increase in native vegetation (Tables A- 3a and A-3b). Both of the Mowitch transects exhibited greater than 5 percent cover of NNI species, but markedly decreased since Year 3.

Trends over Time. Total and native vegetation coverage appear to be stabilizing at Mowitch, while NNI coverage is declining. Although there is overlap between the 90CIs calculated around the unbiased cover estimates for Year 3 and Year 5, the 90CIs are becoming narrower.

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 5 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.

3.1.2 Squally Beach

3.1.2.1 Transect 1-1

Summary. Native species represented approximately 72 percent cover along Squally Beach Transect 1-1 in Year 5, while NNI species were not found, with the rest bare ground. The most prevalent native species observed was fleshy jaumea (*Jaumea carnosa*), followed by pickleweed and seashore saltgrass. Both the diversity of native plant species and the average percent cover of native species have increased along the transect between Year 1 and Year 5. The percent cover for NNI species was 0 percent, below the target of 5 percent.

Description of Results. Of the 24 marsh quadrats sampled along Transect 1-1, 21 quadrats contained vegetation in Year 5. Seven plant species were found along Transect 1-1, all identified as native plant species (Table A-4a). The most prevalent native species observed along Squally Beach Transect 1-1, based on the average unbiased cover estimate, was fleshy jaumea at 17.3 percent (Table A-5a). The next two most frequent species were pickleweed (18.4 percent) and seashore saltgrass (18.3 percent).

Of the 24 quadrats along Transect 1-1, 15 quadrats were entirely within herbivory avoidance fencing (Table A-4a). The quadrats falling within the fenced area generally had the greatest plant species diversity and greatest overall percent cover of native plant species. The exception

was the fleshy jaumea, pickleweed, and seashore saltgrass in quadrats 22 through 24 at the west end of the transect, which were sampled within a patch of existing native vegetation (i.e., these species were not planted). These species in this established patch of vegetation did not appear to have been affected by the lack of the herbivory fencing.

During Year 1, a total of six native plant species were observed along Transect 1-1, with a total average cover of 19.1 percent. During Year 5, seven native plant species were observed, with a total unbiased average cover of 71.5 percent (Figure 13). The average percent native cover among quadrats has significantly increased (Table A-6a). Therefore, both the diversity of native plant species and the percent cover of native species has increased along Transect 1-1 from Year 1 to Year 5.

The 90CI calculated by the project statistician for native, NNI, and all combined species are shown graphically on Figure 13.

There is no significant change in the percent cover of NNI species, which were not found along this transect in Year 3 or Year 5 (Table A-6a).

3.1.2.2 Transect 1-2

Summary. Native species represented approximately 100 percent cover along Squally Beach Transect 1-2 in Year 5, while NNI species represented approximately 8 percent cover (because of statistical methods used, the sum of estimate is greater than 100 percent). The most prevalent native species observed was Lyngby's sedge (*Carex lyngbyei*), followed by Hooker's willow (*Salix hookeriana*) and fleshy jaumea. Both the diversity of native plant species and the average percent cover of native species have increased along the transect between Year 1 and Year 5. Although the percent cover for NNI species remained above the target of 5 percent, it has decreased since Year 1.

Description of Results. All 15 marsh quadrats sampled along Transect 1-2 contained vegetation in Year 5. Of the 16 species found, 12 were native (Table A-4b). The most prevalent native species observed along Squally Beach Transect 1-1, based on the average unbiased cover

estimate, was Lyngby's sedge at 32.8 percent (Table A-5b). The next two most frequent species were Hooker's willow (26.9 percent) and fleshy jaumea (22.5 percent).

All 16 quadrats along Transect 1-2 were entirely within herbivory avoidance fencing (Table A-4b). These quadrats had a relatively high percent native cover, indicating that the fencing may be having a positive effect on native species establishment along this transect.

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 (90CI of 14.8 to 84.1 percent). During Year 5, 12 native species were observed, with a total average cover of 101.5 percent (90CI of 71.6 to 131.5 percent) (Figure 13). The average percent native cover across this transect showed a significant increase in Year 5 (Table A-6b). Thus, native species diversity decreased but average percent cover showed a statistically significant increase from Year 1 to Year 5.

The 90CI calculated by the project statistician for native, NNI, and all combined species are shown graphically on Figure 13. The total unbiased average percent cover of NNI species for Squally Beach Transect 1-2 was 8.1 percent. Both the total number of NNI species observed and the average percent cover of NNI species along Transect 1-2 decreased from Year 1 to Year 5. However, statistical analysis indicates the NNI average percent cover did not significantly change from Year 1 to Year 5 (Table A-6b).

3.1.2.3 Transect 1-3

Summary. Native species represented approximately 59 percent cover along Squally Beach Transect 1-3 in Year 5, while NNI species were not found, with the rest bare ground. The most prevalent native species observed was pickleweed (*Salicornia virginica*), followed by seashore saltgrass and fleshy jaumea. Both the diversity of native plant species and the average percent cover of native species have increased along the transect between Year 2 and Year 5. The percent cover for NNI species was 0 percent, below the target of 5 percent.

Description of Results. Of the 16 marsh quadrats sampled along Transect 1-3, 13 quadrats contained vegetation in Year 5. Six native plant species were found along Transect 1-3; no non-

native species were identified within the transect (Table A-4c). The two most prevalent native species observed along Squally Beach Transect 1-3, based on the average unbiased cover estimate, was pickleweed at 30.6 percent (Table A-5c). The next two most frequent species were seashore saltgrass with an average unbiased cover estimate of 21.9 percent and fleshy jaumea at 3.1 percent (Table A-5c). The 90CI was calculated and is presented by species in Table A-5c (Appendix A).

All 16 quadrats along Transect 1-3 were entirely within herbivory avoidance fencing (Table A-4c). Percent cover of individual species among different quadrats both within and outside fencing varied, and the fencing did not appear to have a strong influence on cover along this transect.

Five native plant species were observed during Year 2 (2003), with a total unbiased average cover for native plants of 16.1 percent. During Year 5 (2006), six native species were observed, with a total unbiased average percent cover of 59.4 percent (Figure 13). Therefore it appears that both the number of native plant species has increased and the unbiased average percent cover of native species has significantly increased from Year 2 to Year 5 (Table A-6c).

The 90CI calculated by the project statistician for native, NNI, and all combined species are shown graphically on Figure 13. The proportion of NNI species along Transect 1-3, calculated by the project statistician, was 0.0 percent.

3.1.2.4 Discussion

Comparison of Transects. All three Squally Beach marsh transects show an increase in native vegetation, significant at the 95 percent confidence level (Tables A-6a, A-6b, and A-6c). Transects 1-2 and 1-3 at the Squally Beach site show no significant change in percent cover of NNI species, while Transect 1-1 could not be evaluated because less than three non-zero changes were found in the quadrats sampled. Squally Beach Transect 1-2 has greater than 5 percent NNI cover, while on Transects 1-1 and 1-3 have less than 5 percent NNI cover.

Trends over Time. Total and native vegetation coverage appear to be stabilizing at Squally Beach, while NNI coverage seems to be declining. Although there is overlap between the 90CIs

calculated around the unbiased cover estimates for Year 3 and Year 5, the 90CIs are becoming narrower except around the NNI cover estimates.

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 5 monitoring, percent cover of native species has increased along all three transects and meets BSC 2 for percent cover of native species. Non-native cover for two transects was less than 5 percent, and therefore partially meets BSC 2 for non-native cover.

3.1.3 Middle Waterway (Simpson/Trustees)

3.1.3.1 Transect 1-1

Summary. Native species represented approximately 59 percent cover along Middle Waterway (Simpson/Trustees) Transect 1-1 in Year 5, while NNI species represented approximately 6.5 percent, with the rest bare ground. The most prevalent native species observed was pickleweed, followed by seashore saltgrass and Canadian sandspurry. Both the diversity of native plant species and the average percent cover of native species have increased along the transect between Year 1 and Year 5. The percent cover for NNI species was 0 percent, below the target of 5 percent.

Description of Results. Of the 26 marsh quadrats sampled along Middle Waterway (Simpson/Trustees) Transect 1-1, 21 quadrats contained vegetation in Year 5. Six species were observed along this transect, all of them native (Table A-7a). The most prevalent native species along Transect 1-1, based on the average unbiased cover estimate, was pickleweed at 35.0 percent. The next two most frequent species were seashore saltgrass with an average unbiased cover estimate of 20.1 percent and Canadian sandspurry at 2.9 percent. The 90CI was calculated and is presented by species in Table A-8a (Appendix A).

Of the 26 quadrats along Transect 1-1, nine were entirely within herbivory avoidance fencing and 17 were entirely outside of the fencing (Table A-7a). Seashore saltgrass was only found within herbivory fencing, and pickleweed cover was relatively unaffected by the fencing.

A total of five native plant species were observed during Year 1, with a total average cover of 24.2 percent. During Year 5, six native species were observed with 59.3 percent cover. The total number of species increased and the percent cover by native species showed a statistically significant increase from Year 1 to Year 5 (Table A-8a).

The 90CI calculated by the project statistician for native, NNI, and all combined species are shown graphically on Figure 14. No NNI species were observed in marsh Transect 1-1 during Year 1 or Year 5.

3.1.3.2 Transect 1-2

Summary. Native species represented approximately 59 percent cover along Middle Waterway (Simpson/Trustees) Transect 1-2 in Year 5, while NNI species represented approximately 6.5 percent, with the rest bare ground. The most prevalent native species observed was pickleweed, followed by seashore saltgrass and Canadian sandspurry. Both the diversity of native plant species and the average percent cover of native species have increased along the transect between Year 3 and Year 5. The percent cover for NNI species was 0 percent, below the target of 5 percent.

Description of Results. Of the seven marsh quadrats sampled along Transect 1-2, four quadrats contained vegetation in Year 5. Four plant species were identified along Transect 1-2, all of them native (Table A-7b). The most frequently occurring native species observed along Transect 1-2, based on the average unbiased cover estimate, was Canadian sandspurry (27.2 percent), followed by pickleweed (14.6 percent) . The 90CI was calculated and is presented by species in Table A-8b (Appendix A)

Marsh quadrat 3 was the only quadrat sampled along Transect 1-2 that was located within herbivory fencing. The quadrat within the herbivory fencing had the highest species diversity and highest percent cover (Table A-7b). All four native species identified along the transect

were found in quadrat 3. Fat-hen saltbush (*Atriplex patula*) and tufted hairgrass (*Deschampsia cespitosa*) were not observed along Transect 1-2 outside of the herbivory fencing.

During Year 3 monitoring, three native species were observed along Transect 1-2 with a total unbiased average percent cover of 26.1 percent. During Year 5 monitoring, four native species were identified within the transect. The unbiased average percent cover by native plant species was 45.9 percent in Year 5. While the number and percent cover of native species increased along Transect 1-2, this increase was not statistically significant (Table A-9b).

The 90CI calculated by the project statistician for native, NNI, and all combined species at the Middle Waterway (Simpson/Trustees) site are shown graphically on Figure 14. No NNI species were observed in the quadrats sampled during Year 3 or Year 5.

3.1.3.3 Discussion

Comparison of Transects. Middle Waterway (Simpson/Trustees) Transect 1-1 shows a statistically significant increase in percent cover of native species. Transect 1-2 also showed an increase in native cover but it was not statistically significant. Neither transect contained NNI species during Year 5 monitoring.

Trends over Time. Total and native vegetation coverage appear to be stabilizing or possibly slightly increasing at Middle Waterway (Simpson/Trustees), although overlap between the 90CIs calculated around the unbiased cover estimates for Year 3 and Year 5 makes the increase non-significant. NNI coverage remains null along Transects 1-1 and 1-2.

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 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 5 monitoring, percent cover of native species has increased significantly along Transect 1-1, meeting the success criterion for percent cover of native species. Native cover along Transect 1-2 showed a less than statistically significant increase, so it is possible, but uncertain, whether this transect also met the success criterion.

Non-native cover for both transects was less than 5 percent and therefore meets the success criterion for non-native cover.

3.2 Biological Success Criterion 6 – Riparian Vegetation/Areal Coverage Composition

Adolfson performed riparian vegetation monitoring at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites. Statistical analysis was performed by TerraStat.

3.2.1 Mowitch

Summary. Statistical analysis of data collected along riparian transects at Mowitch indicated a mean cover of 20 percent native shrubs, 19 percent native trees, and 4.9 percent NNI species. The dominant native tree, native shrub, and NNI species were red alder (*Alnus rubra*), an unidentified species of native rose (*Rosa sp.*), and Himalayan blackberry, respectively. A between-year trend cannot be estimated because the sampling approach was adjusted for Year 5. The criteria for native tree and native shrub cover are not being met at Mowitch; however, NNI species cover meets the target criterion.

Description of Results. Data on the percent cover of tree and shrub species and of non-native or invasive vegetation were collected from line intercept transects located within each riparian management zone at the Mowitch site (see Appendix C). Table A-10 shows the cover data collected from the 24 riparian line intercept transects at the site during Year 5. Table A-11 shows the stratified mean standard and bootstrap cover estimates calculated by species from the collected data, and Table A-12 presents the cover estimates for all native species, all NNI species, and all species combined for Years 1, 3, and 5. The stratified mean bootstrap estimate is used for this analysis because it has been statistically corrected for the skewed distribution of the riparian data. The cover estimates and 95CI by species are shown in Table A-11.

Dominant Species. Dominant species as discussed in this section indicates those species with the highest percent mean cover. The dominant shrub at Mowitch during Year 5 was unidentified species of native rose, and the second most dominant shrub was red-osier dogwood (*Cornus stolonifera*). The dominant tree species was red alder, followed by Scouler's willow (*Salix*

scouleriana). The dominant NNI species was Himalayan blackberry, followed by reed canarygrass.

Trends over Time. The field methods and the analytical methods used to estimate riparian cover have changed over the years, so a direct comparison is not possible. However, purely as a qualitative comparison, the values calculated in Years 1, 3 and 5 are presented in Table A-12.

Success Criterion Evaluation. BSC 6 for riparian vegetation and areal coverage composition in Year 5 is measured by percent cover of native riparian plant species that remain stable or increase over time, with bare ground representing less than 10 percent of the area; shrub species areal cover of no less than 50 percent; tree species areal cover of no less than 40 percent; and NNI species areal cover that is limited to less than 5 percent.

Based on the stratified mean estimate and the 95CI on the mean, the shrub and tree cover criteria are not met at Mowitch. The NNI criterion is met based on the stratified mean estimate, but the upper boundary of the 95CI on the mean exceeds the criterion.

3.2.2 Squally Beach

Summary. Statistical analysis of data collected along riparian transects at Squally Beach indicated a mean cover of 13 percent native shrubs, 64 percent native trees, and 21 percent NNI species. The dominant native tree, native shrub, and NNI species were red alder, an unidentified species of native rose, and Himalayan blackberry, respectively. A between-year trend cannot be estimated because the sampling approach was adjusted for Year 5. The criteria for native shrub and NNI species cover are not being met at Squally Beach; however, native tree cover meets the target criterion.

Description of Results. Data on the percent cover of tree and shrub species and of non-native or invasive vegetation were collected from line intercept transects located within each riparian management zone at the Squally Beach site (see Appendix C). Table A-13 shows the cover data collected from the 12 riparian line intercept transects at the site during Year 5. Table A-14 shows the stratified mean standard and bootstrap cover estimates calculated by species from the collected data, and Table A-15 presents the cover estimates for all native species, all NNI

species, and all species combined for Years 1, 3, and 5. The stratified mean bootstrap estimate is used for this analysis because it has been statistically corrected for the skewed distribution of the riparian data. The cover estimates and 95CI by species are shown in Table A-14.

Dominant Species. The dominant shrub species at Squally Beach during Year 5 was an unidentified species of native rose, followed by common snowberry (*Symphoricarpos albus*). The dominant tree species was red alder, followed by Hooker's willow. The dominant NNI species was Himalayan blackberry.

Trends over Time. The field methods and the analytical methods used to estimate riparian cover have changed over the years, so a direct comparison is not possible. However, purely as a qualitative comparison, the values calculated in Years 1, 3 and 5 are presented in Table A-15.

Success Criterion Evaluation. BSC 6 for riparian vegetation and areal coverage composition in Year 5 is measured by percent cover of native riparian plant species that remain stable or increase over time, with bare ground representing less than 10 percent of the area; shrub species areal cover of no less than 50 percent; tree species areal cover of no less than 40 percent; and NNI species areal cover that is limited to less than 5 percent.

Based on the stratified mean estimate and the 95CI on the mean, the tree cover criterion is met at Squally Beach, but the shrub criterion is not met. The NNI criterion is not met based, on the stratified mean estimate and the 95CI on the mean.

3.2.3 Middle Waterway (Simpson/Trustees)

Summary. Statistical analysis of data collected along riparian transects at Middle Waterway (Simpson/Trustees) indicated a mean cover of 20 percent native shrubs, 31 percent native trees, and 12 percent NNI species. The dominant native tree, native shrub, and NNI species were Douglas fir (*Pseudotsuga menziesii*), Nootka rose (*Rosa nutkana*), and Himalayan blackberry, respectively. A between-year trend cannot be estimated because the sampling approach was adjusted for Year 5. The criteria for native shrub, native tree and NNI species cover are not being met at Middle Waterway (Simpson/Trustees).

Description of Results. Data on the percent cover of tree and shrub species and of non-native or invasive vegetation were collected from line intercept transects located within each riparian management zone at the Middle Waterway (Simpson/Trustees) site (see Appendix C). Table A-16 shows the cover data collected from the 20 riparian line intercept transects at the site during Year 5. Table A-17 shows the stratified mean standard and bootstrap cover estimates calculated by species from the collected data, and Table A-18 presents the cover estimates for all native species, all NNI species, and all species combined for Years 1, 3, and 5. The stratified mean bootstrap estimate is used for this analysis because it has been statistically corrected for the skewed distribution of the riparian data. The cover estimates and 95CI by species are shown in Table A-14.

Dominant Species. The dominant shrub species at the Middle Waterway (Simpson/Trustees) site during Year 5 was Nootka rose, followed by kinnikinnik (*Arctostaphylos uva-ursi*). The dominant tree species was Douglas fir, followed by black cottonwood (*Populus balsamifera*). The dominant NNI species was Himalayan blackberry, followed by reed canarygrass.

Trends over Time. The field methods and the analytical methods used to estimate riparian cover have changed over the years, so a direct comparison is not possible. However, purely as a qualitative comparison, the values calculated in Years 1, 3 and 5 are presented in Table A-18.

Success Criterion Evaluation. BSC 6 for riparian vegetation and areal coverage composition in Year 5 is measured by percent cover of native riparian plant species that remain stable or increase over time, with bare ground representing less than 10 percent of the area; shrub species areal cover of no less than 50 percent; tree species areal cover of no less than 40 percent; and NNI species areal cover that is limited to less than 5 percent.

Based on the stratified mean estimate and the 95CI on the mean, the shrub and tree cover criteria are not met at Middle Waterway (Simpson/Trustees). The NNI criterion is not met based, on the stratified mean estimate and the 95CI on the mean.

3.3 Biological Success Criterion 7 – Fish Access/Presence

Ridolfi performed fish monitoring at the Hylebos Creek Off-Channel (Jordan) site. Substrate throughout Off-Channel Reaches 1 and 2 is generally comprised of a soft, unconsolidated mixture of silt, clay, and mud that is just over knee-deep. During the surveys the water depths in the channels of Off-Channel Reaches 1 and 2 were estimated at approximately 1 to 3 feet and the pools were estimated at just over 6 feet deep. These water depths fluctuate with the tides. Substrate in Off-Channel Reach 3 is generally comprised of sand. Water depths in Off-Channel Reach 3 are shallow and estimated at less than 8 inches deep. The water depths in Off-Channel Reach 3 are generally consistent because a sand plug at the upstream end of the reach limits the tidal influence.

In both the off-channel habitat area and the Hylebos Creek area juvenile salmonids were observed holding in deeper water in and around root wads or other woody cover. A total of six juvenile Chinook and 44 juvenile coho salmon were observed at the site, the majority of which were observed in the Hylebos Creek area. All salmon observed had intact adipose fins. Chinook ranged from 80 to 150 mm in length while coho ranged from 51 to 200 mm in length. Chinook were observed at the site in June. Coho were observed at the site in May, June, and July. All juvenile Chinook and coho salmon were observed in the Hylebos Creek area in the deeper portions of Reaches 2 and 3 with the exception of three coho observed in a root wad in Reach 1 of the off-channel habitat area. This root wad was one of the larger ones found in the site and provided refuge for the coho.

Seventeen trout were observed at the site during May, June, and July. Of these, six were identified as cutthroat trout and ten as rainbow trout. One trout was not identified because of low water clarity. All trout ranged from 150 to 350 mm in length and were observed in the Hylebos Creek area in the deeper portions of Reaches 1 and 3. The areas where the trout were observed had good flow and were downstream of submerged woody debris or a feature in the channel which created some turbulence. The trout appeared to be feeding in these areas. One cutthroat was observed in the off-channel habitat area in a root wad in Reach 1. The trout was observed in the root wad at the same time the above-mentioned coho were observed. Trout were also

observed top-feeding on terrestrial insects in Reaches 1, 2, and 3 of the Hylebos Creek area during every monitoring event.

Other fish observed throughout the entire site were numerous juvenile flat fish, sculpin, shiner perch, and stickleback. These species were encountered in large numbers in the off-channel habitat area in June, July, and August. The site seemed to be serving as a rearing area or nursery for these species. One of the species of flat fish observed at the site was starry flounder. Starry flounder commonly rear in estuarine habitats and can tolerate a wide range of salinities, including freshwater (Ralston, 2006). Adult stickleback and shiner perch were also observed within the site in large numbers during this time, indicating that spawning may be occurring at the site. Stickleback are a food source for trout and salmon (Wydoski and Whitney, 2003). One unidentified finfish, possibly a crappie or sunfish, was observed in the same root wad in Reach 1 with the coho salmon and cutthroat trout.

Water clarity in the off-channel habitat area was generally poor throughout the entire survey season. Factors contributing to this include algae blooms, unstable fine substrate, and people working or recreating at the site. Large algae blooms occurred in the five pools in the off-channel habitat area making it impossible to survey them. Water clarity was better in the channels the further the snorkeler moved from the pools. Fertilizers from the newly planted restoration site may have contributed to the algae blooms.

As a result of the newly constructed site, substrate in Reaches 1 and 2 of the off-channel habitat area consisted of a thick layer of unconsolidated silt and clay. Any movement of people, fish, or waterfowl disturbed these sediments and clouded the water column causing low visibility. In the later part of the survey season the sediments began to settle and dissipate. Gravel substrate and more stable sediments became more common, resulting in improved visibility.

It was not possible to snorkel Reach 3 of the off-channel habitat area because water depths were generally less than 8 inches. Instead, a visual survey from the bank was conducted in this reach. No fish were observed. Sand from Hylebos Creek settled out in Reach 3, causing the shallow depths. The openings or mouths of the channels connecting Hylebos Creek to Reach 3 of the off-channel habitat area were at times completely blocked by sand and sediments, thus restricting

water flow from Hylebos Creek. The source of the sand is unknown. The restricted flow may have contributed to the algae blooms because the system was not able to flush itself.

In comparison, water clarity in Hylebos Creek was generally good throughout the survey season, with the exception of one day in late May and one in early June. Heavy rains during this time caused turbid conditions in Hylebos Creek, resulting in no visibility in the water column. A full survey of the creek was not completed on these days. Snorkel surveys were not conducted in Reaches 4 and 5 in the Hylebos Creek area because of shallow depths. Depths in these Reaches were generally less than 8 inches. Sand from an unknown source had deposited in the area. Instead, a visual survey from the bank was conducted in these reaches. No fish were observed.

Several aquatic insect species were observed during the snorkel surveys but not identified, with the exception of caddis fly. These observations were made throughout the entire site and are available in Table A-19 (Appendix A). Overall water temperatures at the site ranged from approximately 12 to 17°C. Salinities ranged from approximately 0.1 to 0.4 parts per thousand (ppt). During the large algae blooms the highest temperatures and salinities were recorded in Pool 3 (19.3 ^{o}C and 15.5 ppt) and Pool 5 (24.3 ^{o}C and 11 ppt) in the off-channel habitat area. These measurements were recorded in late May. Juvenile salmonids will occupy waters with temperatures of approximately 13 to 18 ^{o}C. Water temperatures of approximately 23 to 25 ^{o}C can be lethal (Washington Department of Ecology, 2000). It is assumed that the water temperatures in the pools will be more consistent with the temperatures throughout the rest of the site once the newly planted riparian vegetation is established and has grown to a height to create sufficient shade and cover. Both Pool 3 and Pool 5 have sills at their entrances which may have blocked water from flowing in and out of the pools, thus resulting in the higher salinity temperature readings.

Species observed in 2006 at the site are presented in Table 3; detailed results are available in Table A-20 (Appendix A).

Table 3. Summary of fish species and numbers observed at the Hylebos Creek Off-Channel (Jordan) site.

Common Name	Scientific Name	Total
Chinook salmon	*Oncorhynchus tshawytscha*	6
Coho salmon	*Oncorhynchus kisutch*	44
Cutthroat trout	*Oncorhynchus clarkii*	6
Rainbow trout	*Oncorhynchus mykiss*	10
Unidentified trout	*Oncorhynchus clarkii/Oncorhynchus mykiss*	1
Flat fish	*Pleuronectidae spp./Pleuronectiformes spp.*	107
Sculpin	*Cottidae spp.*	89
Shiner perch	*Cymatogaster aggregata*	125
Stickleback	*Gasterosteus aculeatus*	2,430
Other	*Centrarchidae spp./Hexagrammidae spp.*	2

Success Criterion Evaluation. Based on the presence of salmonid and non-salmonid fish, BSC 7 appears to be met for resident non-salmonid species at the Hylebos Creek Off-Channel (Jordan) site, and partially met for salmonids. However, fish presence increase cannot be realistically assessed based on a single year of monitoring.

3.4 Biological Success Criterion 9 – Bird Use

Adolfson performed bird use monitoring at the Sha Dadx and Hylebos Creek Off-Channel (Jordan) sites.

3.4.1 Sha Dadx

Introduction. A total of 57 bird species was recorded at the Sha Dadx site during 10 field visits. The number of species observed at the Sha Dadx site between April and December ranged from 10 to 24 (Tables A-21 and A-22). The highest number of bird species was observed in late June, and the lowest in October. Because the restoration has not yet been constructed at this site, the majority of the site is characterized as riparian habitat. An area of forested wetland exists on the site, which provides an open water habitat type.

Use of riparian habitat ranged from five to 16 species per visit. Use of open water habitat was highest in November (40 individuals of 2 species) (Tables A-23 and A-24). Summer field visits recorded the highest number of species (31 species), although spring and fall use of the site, with 26 and 28 species respectively, was higher than winter use (18 species).

Descriptive Analysis. Bushtits (*Psaltriparus minimus*) were observed using the riparian vegetation in large numbers in October (22 individuals). Two species, Canada goose (*Branta canadensis*) and American goldfinch (*Carduelis tristis*), were observed in the highest numbers on a single field visit (50 individuals) in October and September respectively. These were records of birds flying over the site. Groups of tree swallows (*Tachycineta bicolor*) (15 individuals) and violet-green swallows (*Tachycineta thalassina*) (15 individuals) foraged over the site in April. Other species recorded in high numbers (10 to 30 individuals) flying over the site included Brewer's blackbird (*Euphagus cyanocephalus*), and crow (*Corvus* sp.).

Song sparrow (*Melospiza melodia*) and black-capped chickadee (*Poecile atricapilla*) were observed on all 10 of the site visits. American goldfinch was observed on 9 of 10 site visits, and American robin was present on eight field visits.

Waterfowl species observed using the open water at the Sha Dadx site included mallard (*Anas platyrhynchos*) and green-winged teal (*Anas crecca*). Waterfowl use of the site was observed only in November and December. Shorebird species use was limited to a single spotted sandpiper (*Actitis macularia*) present in May, and two killdeer (*Charadrius vociferous*) in November.

Raptor species observed at the site included red-tailed hawk (*Buteo jamaicensis*), northern harrier (*Circus cyaneus*), osprey (*Pandion haliiaetus*), peregrine falcon (*Falco peregrinus*), and barn owl (*Tyto alba*). A barn owl was observed on four occasions, flushing from the same grove of trees on the site. White-wash was present, also indicating a roost location. During the November field visit, evidence of a recent kill of a barn owl was recorded; this was assumed to be a kill by another raptor, due to the condition of the carcass.

Obvious evidence of breeding (singing, fighting or pursuit, "broken-wing" distraction technique, gathering nesting material, presence of young) was observed for 17 species: American robin

(*Turdus migratorius*), mourning dove (*Zenaida macroura*), song sparrow, common yellowthroat (*Geothylpis trichas*), Steller's jay (*Cyanocitta stelleri*), red-tailed hawk, downy woodpecker (*Picoides pubescens*), Western tanager (*Piranga ludoviciana*), black-capped chickadee, willow flycatcher (*Empidonax traillii*), yellow warbler (*Dendroica petechia*), Bewick's wren (*Thryomanes bewickii*), Swainson's thrush (*Catharus ustulatus*), warbling vireo (*Vireo gilvus*), black-headed grosbeak (*Pheucticus melanocephalus*), cliff swallow (*Petrochelidon pyrrhonota*), and house finch (*Carpodacus mexicanus*).

Use of the site by migratory passerine species[2] was highest in June (11 species) and lowest in December (no species). Eleven migratory species were observed in June at the site: American goldfinch, black-headed grosbeak, cedar wax-wing, rufous hummingbird (*Selasphorus rufus*), Swainson's thrush, tree swallow, warbling vireo, Savannah sparrow (*Passercullus sandwichensis*), common yellowthroat, western wood-pewee, and yellow warbler.

3.4.2 Hylebos Creek Off-Channel (Jordan)

Introduction. A total of 56 bird species was recorded at the Hylebos Creek Off-Channel (Jordan) site during 10 field visits. The number of species observed at the site between April and December ranged from 9 to 22 species per site visit (Table A-25). The highest number of bird species was observed in late June, and the lowest in late October. Bird use of newly re-planted habitats was low in December (no species observed) and April (4 species), and increased through the spring to a high of nine species in June. With the exception of the October site visit, use of riparian habitat (5 to 16 species) was consistently high. Use of open water habitat was highest in April (6 species) and October (6 species) (Table A-26). Bird use of the site was highest in summer (35 species) and lowest in winter (13 species).

Descriptive Analysis. American robin was observed in the highest numbers on a single field visit (80 individuals) in October. House finch and European starling (*Sturnus vulgaris*) were also observed in high numbers, with 40 or more individuals observed in November.

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[2] Migratory passerine species do not include those present year-round in Puget Sound. Although some individuals of species present year-round may also be migratory, they are excluded for the purposes of this discussion.

American robin was the sole species observed on all 10 of the site visits. Red-tailed hawk was observed on 9 of 10 site visits, and black-capped chickadee and mallard were present on eight field visits.

Waterfowl species observed at the site included: mallard, Canada goose, pied-billed grebe (*Podilymbus podiceps*), green-winged teal, hooded merganser (*Lophodytes cucullatus*), bufflehead (*Bucephala clangula*), and graylag goose (*Anser anser*), an escaped domestic species. Waterfowl use of the site was lowest in June and September (0 to 1 species present per site visit), and highest in December (5 species present). Shorebird species present included spotted sandpiper, present on three occasions, and semipalmated sandpiper (*Calidris pusilla*) present on one occasion. Great blue heron were observed in May and October (1 individual).

Raptor species observed at the site were limited to red-tailed hawk, but this species was observed on 9 of 10 site visits, as noted above. Calling indicated territorial behavior, and although no nest was observed on site, potential nest sites exist on the wooded hillside above the restoration site.

Obvious evidence of breeding (singing, fighting or pursuit, "broken-wing" distraction technique, gathering nesting material, presence of young) was observed for 20 species: American robin, black-headed grosbeak, common yellow-throat, house finch, olive-sided flycatcher (*Contopus cooperi*), song sparrow, Western wood-pewee, willow flycatcher, American goldfinch, marsh wren (*Cistothorus palustris*), warbling vireo, Western tanager, barn swallow (*Hirundo rustica*), black-capped chickadee, Canada goose, mourning dove, white-crowned sparrow (*Zonotrichia leucophrys*), red-winged blackbird (*Agelaius phoeniceus*), spotted towhee (*Pipilo maculatus*), and golden-crowned sparrow (*Zonotrichia atricapilla*)

It should be noted that almost all of this activity occurred outside of the recently replanted portion of the site.

Use of the site by migratory passerine species[3] was highest in June (10 species) and lowest in November (one species). Ten migratory species were observed in June: American goldfinch,

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[3] See note 2 on previous page.

black-headed grosbeak, cedar wax-wing, northern rough-winged swallow (*Stelgidopteryx serripennis*), red-winged blackbird, tree swallow, warbling vireo, western wood-pewee, white-crowned sparrow, and yellow warbler.

3.5 Physical Success: Aerial Photography

Walker and Associates, of Seattle, Washington, collected aerial photographs at the Mowitch, Squally Beach, Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), Olympic View, Yowkwala, and Hylebos Creek Off-Channel (Jordan) sites.

The photographs were presented as prints and electronic files in a separate deliverable in September 2006.

3.6 Baseline Chemical Conditions: Sediment Chemistry

Ridolfi performed sediment sampling at the Mowitch, Squally Beach, Middle Waterway (Simpson/Trustees), Middle Waterway (City of Tacoma), and Hylebos Creek Off-Channel (Jordan) sites. The sediment samples were analyzed by Analytical Resources Inc. (ARI), of Tukwila, Washington, except for the PCB congeners which were analyzed by Axys Analytical Services Ltd. (Axys), of Sidney, British Columbia.

Results of the sediment sampling and analysis are presented in a separate report entitled *Sediment Data Summary Report, Commencement Bay Habitat Restoration Sites, Tacoma, Washington* (Ridolfi, 2007).

4.0 SUMMARY AND RECOMMENDATIONS

4.1 Monitoring Summary and Other Observations for Selected Sites

Table 4 summarizes performance of the restoration sites during Year 5 relative to the BSCs applicable for this monitoring period.

Table 4. Performance summary for Year 5 (2006) monitoring.

Site Name	Biological Success Criteria			
	2	6	7 [a]	9[a]
	Marsh Development/ Species Composition	Riparian Vegetation/ Areal Coverage	Fish Access/Presence	Bird Use
Mowitch	+	+[b]		
Squally Beach	+	+		
Middle Waterway (Simpson/Trustees)	Y[b]	+[b]		
Sha Dadx				Y
Hylebos Creek Off-Channel (Jordan)			+	Y

Notes:
Y = Criterion met.
+ = Criterion partially met or improving.
N = Criterion not met.
[a] = Reference not available for quantitative comparison; evaluation based on site observations.
[b] = Variability remains high and one limit of the confidence interval may not meet the criterion.

4.1.1 BSC 2 – Marsh Development/Species Composition

The Year 5 data and general site observations by field crews indicate several trends that are occurring within the marsh at the three sites.

One observation is that, along most of the transects, pickleweed was a dominant species in terms of percent cover, and one of the most frequently occurring native species in the quadrats. Two exceptions to this trend were along Mowitch Transect 1-2 and Squally Beach Transect 1-2.

At Mowitch Transect 1-2, spike-rush and brass buttons were dominant. This may be due to the location of this transect on top of "lobes" within the Hylebos Creek channel with high exposure to sun and tidal flows, and where much of the herbivory fencing has deteriorated. Field crews observed ducks walking under the fencing near this transect, and it seems likely that waterfowl have grazed much of the native vegetation in this area. Signs of scouring were also noted along portions of Mowitch Transect 1-2, indicating that debris may be carried under the deteriorated fencing by the tides, resulting in damage to the substrate and herbaceous vegetation.

Squally Beach Transect 1-2 is located along the base of a riparian slope. The dominant herbaceous species along this transect was Lyngby's sedge. Hooker's willow, rooted in the adjacent slope and overhanging the marsh, was another dominant species. It seems possible that the shading provided by the willow, along with freshwater inflows from upland areas, could make this area more suitable for sedge instead of pickleweed.

A second observation is that the herbivory fencing appears to benefit the growth of native marsh species. While not based on statistical data, general observations during Year 5 were that marsh species in fenced areas had higher cover and more diversity than in the unfenced areas. An example of this, mentioned above, is where herbivory fencing has been damaged along Mowitch Transect 1-2 and relatively little native vegetation cover is present. This transect had a relatively high proportion of NNI species in Year 5 (almost 20 percent).

Another example of the effects of herbivory fencing is along Middle Waterway Transect 1-2, which is also located on an exposed lobe. Only a small portion of this lobe lies within herbivory fencing, and this fenced area contained dense vegetation cover while the surrounding unfenced area had very low vegetation cover in Year 5. This may also help explain why native cover did not significantly increase along Middle Waterway Transect 1-2 by Year 5 as it did on all the other transects sampled: There is limited suitable area available for native species growth (i.e., only the area within the fencing).

A third observation is that there was no statistically significant change in NNI species by Year 5 at Squally Beach and Middle Waterway, but there was an increase along both transects at Mowitch. This appears to be due in part to the increased cover of brass buttons along this transect. It may also result from the presence of two unidentified herbaceous species along this transect which were assumed to be non-native.

A fourth observation is the decline in cover of fat-hen saltbush, which was noted by field crews during Year 5. This observation is supported by statistical analysis, which indicates a significant decline in cover of this species along four of the seven sample transects (Mowitch Transect 1-1, Squally Transects 1-1 and 1-2, and Middle Waterway Transect 1-1). The reason for this decline is not readily apparent but could be influenced by drought conditions the previous summer, early senescence, or competition from other faster growing herbaceous species.

Finally, field crews observed that the herbaceous marsh plant communities seem to be quite dynamic, with some species such as pickleweed and seashore saltgrass having spread to colonize new areas since Year 3, and other species such as fat-hen saltbush declining. This was apparent in comparison with previous photos of the sampling quadrats, and observations made of areas where pin flags marking changes in vegetation communities were still present from previous years' field work. In addition, crews noted a new NNI species at Mowitch in Year 5, common reed (*Phragmites* sp.). Several small patches of this species were found at the base of the riparian slope at Mowitch.

4.1.2 BSC 6 – Riparian Vegetation/Areal Coverage

The Year 5 data and general site observations by field crews indicate several trends that are occurring within the riparian areas at the three sites.

4.1.2.1 Mowitch

At Mowitch, shrub and tree cover was notably higher at the north end of the site and sparse in much of the southern portion. The southern part of the site likely experiences heavier foot traffic than the rest of the riparian area, since this is a convenient spot for people to enter the site and traverse to the marsh. The riparian area at Mowitch is exposed to direct summer sunlight, and

crews noted that several red alder trees on the site had died, apparently due to drought. The Mowitch site had the lowest NNI cover of the three sites during Year 5. In addition to the NNI species listed in Table A-11, other NNI species noted at Mowitch included Scot's broom (*Cytisus scoparius*), thistle (*Cirsium* sp.), and fennel (*Foeniculum vulgare*). The NNI species were observed to be scattered in small patches.

4.1.2.2 Squally Beach

Several very dense willow and alder thickets are present in portions of the riparian area at Squally Beach. Shrubs were not observed to be growing beneath the willows, and shrub cover was also reduced beneath the alder canopy. Therefore even though much of the riparian zone at Squally Beach contains high shrub cover, the overall mean shrub cover at the site is relatively low because the tree canopy reduces shrub growth in some areas. In addition to the NNI species listed in Table A-14, other NNI species noted at Squally Beach included field bindweed (or field morning glory; *Convolvulus arvensis*), thistle, and bitter nightshade (*Solanum dulcamera*). The adjacent property immediately east of the riparian area is infested with field bindweed, which provides an ongoing source for this species to spread into the Squally Beach site. Himalayan blackberry was also noted to be present in dense patches, particularly in the riparian areas closest to the roadway.

4.1.2.3 Middle Waterway (Simpson/Trustees)

Much of the shrub cover at the Middle Waterway (Simpson/Trustees) site was observed to be concentrated in the southern and northern portions of the riparian zone. Areas with sparse shrub cover were present along East 11th Street and along the gravel access road into the Simpson log yard. Tree cover was particularly dense in the northern part of the riparian zone. This area consists of established forest vegetation, which may explain the dense tree cover observed. Black cottonwood is widespread in the eastern riparian area, and patches of Douglas fir also provide tree cover along the access road. This riparian zone is exposed to direct sunlight as well as exhaust and dust from adjacent roads, and soils appeared to be generally quite sandy. Field crews noted several dead western red cedars (*Thuja plicata*) along the gravel access road which may have been stressed by these conditions. Parts of the slope between the riparian area and the

marsh are bare and eroding. In addition to the NNI species listed in Table A-17, other NNI species noted at Middle Waterway included scattered Scot's broom, pampas grass (*Cortaderia* sp.), and thistle. This was the only one of the three sites observed to contain English ivy (*Hedera helix*), which was climbing trees in the northern part of the riparian zone. Butterfly bush (*Buddleia davidii*) was abundant along the gravel access road.

4.1.2.4 Other Observations

The most common native shrub at all three sites during Year 5 was native rose. Native roses are forming dense shrub thickets in portions of all three sites. Red alder was a dominant native tree at Mowitch and Squally Beach. At Middle Waterway, black cottonwood was the dominant deciduous tree.

Himalayan blackberry was the most dominant NNI species at all three sites, reaching 20 percent mean cover at Squally Beach. Reed canarygrass, another NNI species present at all three sites, appears to be most problematic in the southern riparian area at Middle Waterway.

4.2 Site Summaries

4.2.1.1 Mowitch

Percent cover by native species showed a significant increase along both marsh transects at Mowitch, meeting the success criterion for native marsh vegetation (BSC 2). However, non-native mash cover did not meet the success criterion under BSC 2 because it was above 5 percent for both marsh transects in Year 5.

In the riparian area at Mowitch, native tree and shrub cover was below the success criteria (BSC 6). The average NNI cover in the riparian area was less than the 5 percent threshold, although the upper confidence level was above 5 percent. Additional plantings of native tree and shrub species may be needed at Mowitch to increase native tree and shrub cover, particularly in the southern portion of the riparian area. NNI control measures are also recommended within the riparian habitat.

4.2.1.2 Squally Beach

Percent cover of native species increased significantly along all three marsh transects at Squally Beach, meeting the success criterion for native marsh vegetation (BSC 2). Two of the three marsh transects had less than 5 percent NNI species cover, while the third transect was above 5 percent. Therefore BSC 2 for NNI marsh cover was partly met at this site.

In the riparian area at Squally Beach, native shrub cover did not meet success criteria, although the tree cover criterion was met (BSC 6). The dense tree cover in some portions of the riparian area appears to be limiting shrub growth in the understory. NNI cover in the riparian area was greater than 5 percent. NNI control measures are recommended within the riparian habitat.

4.2.1.3 Middle Waterway (Simpson/Trustees)

Percent cover of native species increased significantly along one of the marsh transects at Middle Waterway (Simpson/Trustees) (BSC 2). Native cover along the second marsh transect showed a less than statistically significant increase, so it is possible but uncertain whether this transect also met BSC 2. Non-native cover for both marsh transects was less than 5 percent.

In the riparian area at Middle Waterway (Simpson/Trustees), native shrub cover was below the success criterion (BSC 6). The mean native tree coverage was below the BSC 6 criterion, although the upper confidence interval slightly exceeded the threshold. NNI cover in the riparian area was above 5 percent. Additional plantings of native tree and shrub species may be needed at Middle Waterway to increase cover, particularly in the eastern portion of the riparian area. NNI control measures are also recommended within the riparian habitat.

4.3 Monitoring and Adaptive Management Recommendations

Based on the results of the Year 5 monitoring of restoration sites near Commencement Bay, we have the following recommendations:

4.3.1 Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees)

- Manually remove NNI species in the riparian areas at the Mowitch, Squally Beach, and Middle Waterway (Simpson/Trustees) sites.
- Eradicate common reed (*Phragmites*) from the marsh at Mowitch to prevent this highly invasive species from spreading.
- Replant and stabilize the slope between the marsh and riparian areas along the eastern portion of the Middle Waterway (Simpson/Trustees) site. Portions of this slope are eroding and lack vegetation cover. Nootka rose and kinnikinnik have been successful at this site and are good candidate species for replanting these areas.
- Replace damaged fence on the marsh lobes at Mowitch, and replant these enclosures with native marsh species.
- Remove stakes from trees in the southern riparian area at the Middle Waterway (Simpson/Trustees) site.
- Replant native trees and shrubs in the southern portion of the riparian area at Mowitch. Consider marking a designated trail through this area for volunteers to access the site.
- Remove debris from the Mowitch and Middle Waterway (Simpson/Trustees) sites.
- Locate the marsh and riparian sampling transects and plots using GPS in order to make relocating transects and plots more efficient during future years of monitoring.

4.3.2 Hylebos Creek Off-Channel (Jordan) Site

- If sand continues to be deposited in the off-channel habitat area and Hylebos Creek, efforts should be made to determine and control the source and potentially to remove some of the excess material.
- Create more cover in the off-channel habitat area by adding additional large woody debris, root wads, and boulders.

- Monitor depth of openings, channels, and flow in the off-channel habitat area.
- Consider modifications to the openings in Reach 3 of the off-channel habitat area to ensure continued flow of water from Hylebos Creek through the site.
- Consider conducting a benthic indicator of biological integrity (IBI) study to gain a better understanding of the condition of the aquatic habitat at the site.

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FIGURES

Legend

Restoration Sites

N

0 1 2

Miles

Figure 1
Vicinity map and location of habitat restoration sites

Year 5 (2006) Monitoring Report
Commencement Bay
Habitat Restoration Sites

January 2007

RIDOLFI Inc.

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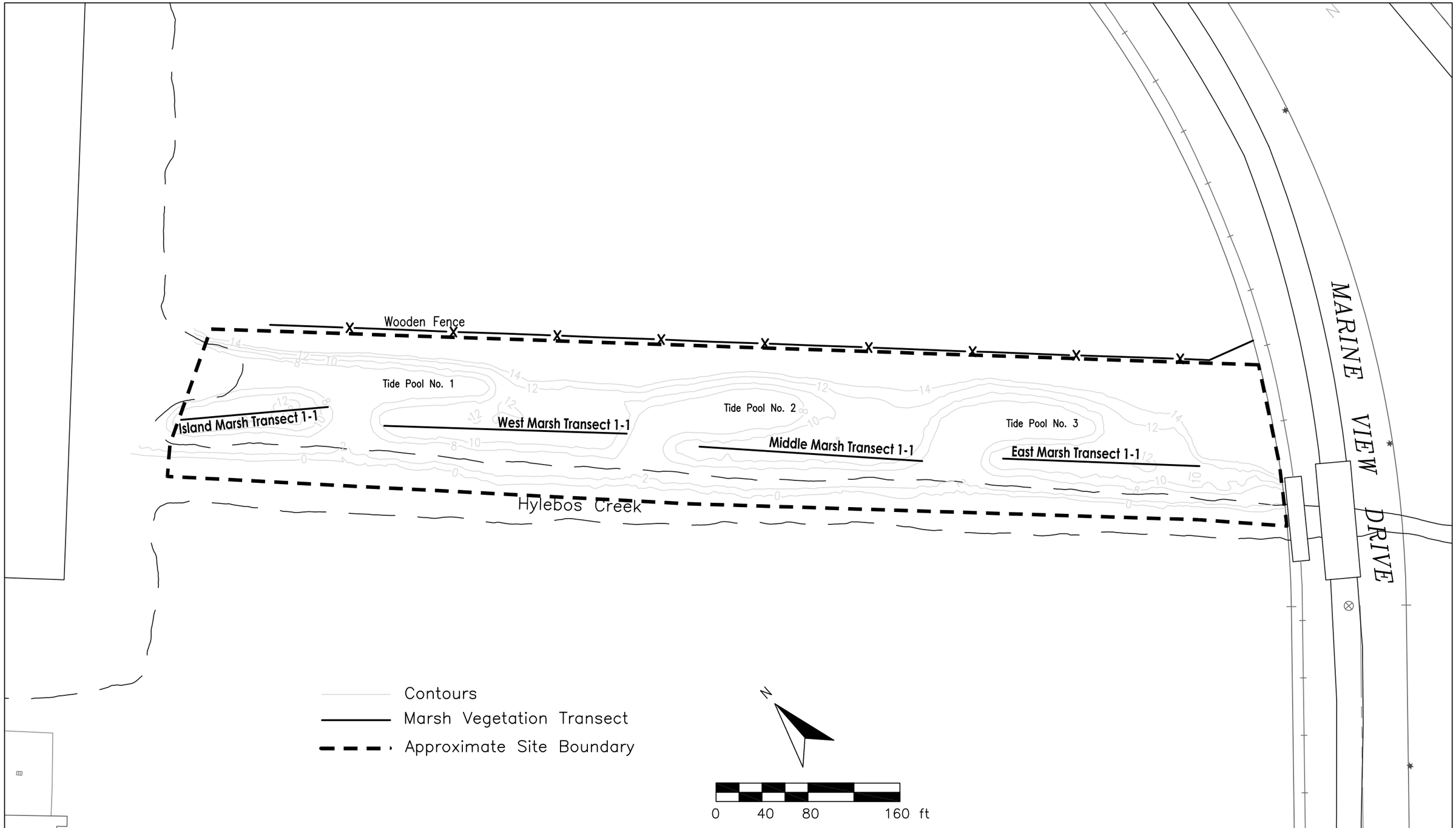

RIDOLFI Inc.	COMMENCEMENT BAY HABITAT RESTORATION SITES	January 2007	Figure 2
	YEAR 5 (2006) MONITORING REPORT	Mowitch site features	

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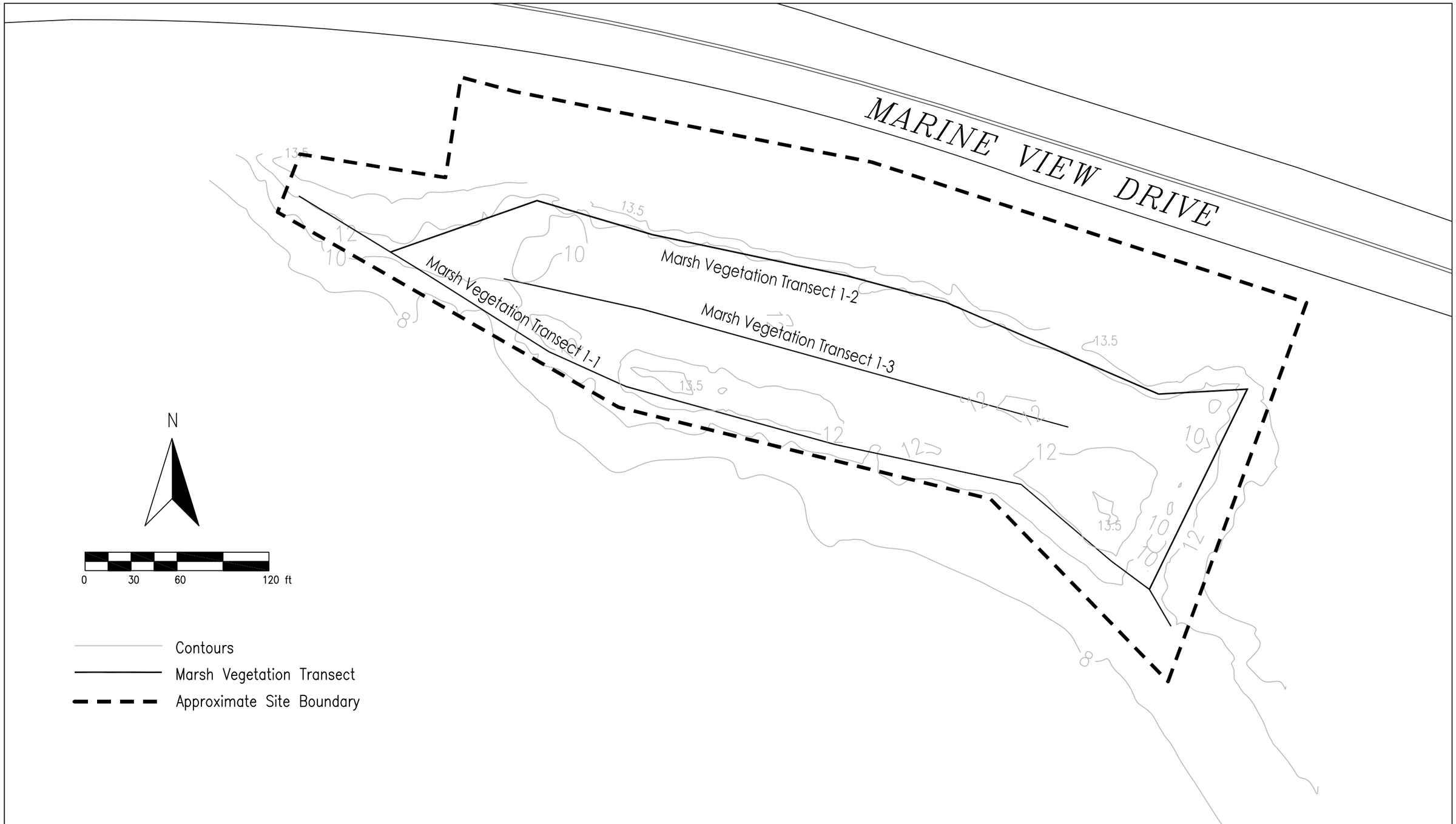

RIDOLFI Inc.	COMMENCEMENT BAY HABITAT RESTORATION SITES	January 2007	Figure 3
	YEAR 5 (2006) MONITORING REPORT	Squally Beach site features	

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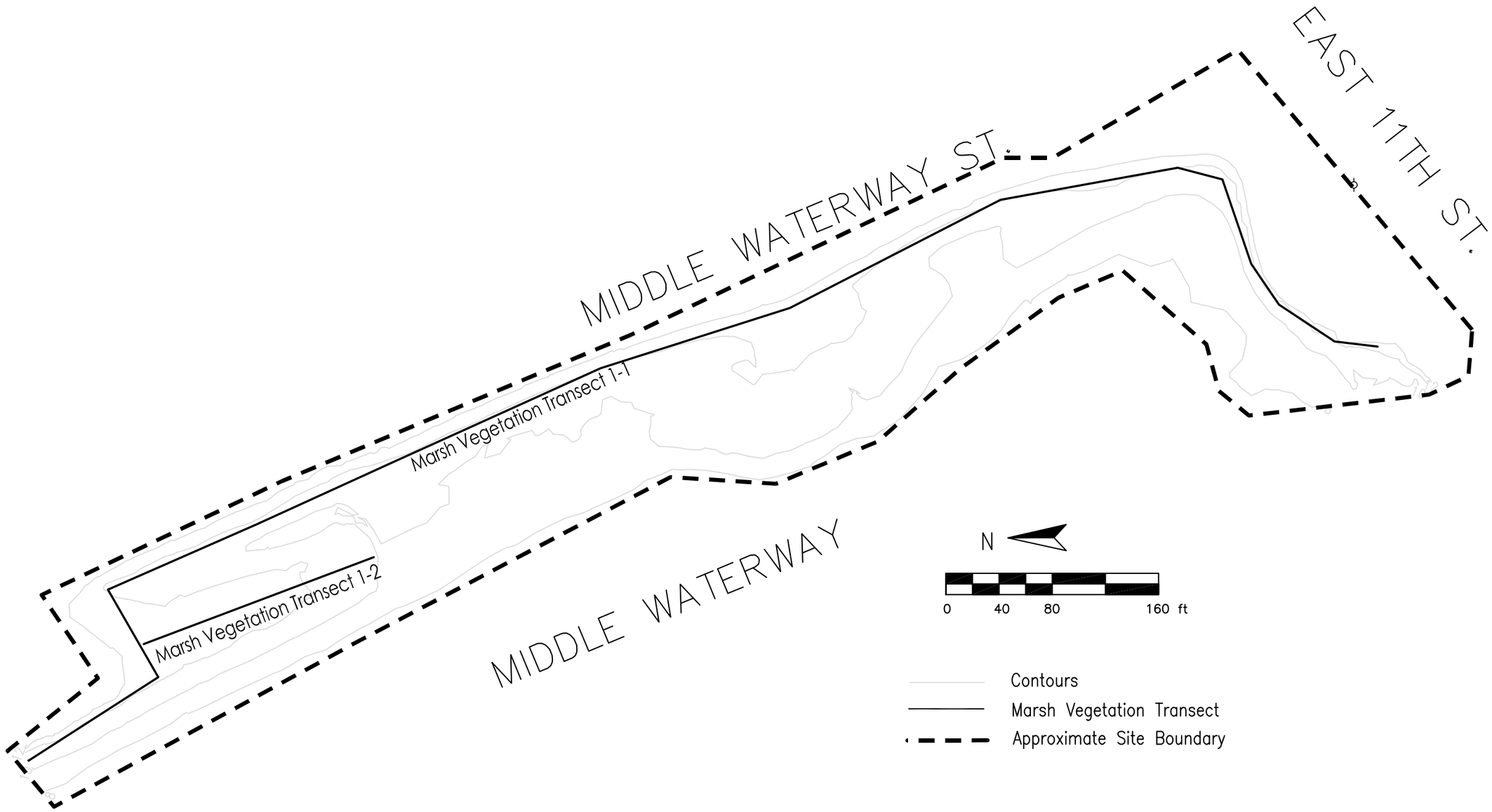

RIDOLFI Inc.	COMMENCEMENT BAY HABITAT RESTORATION SITES	January 2007	Figure 4
	YEAR 5 (2006) MONITORING REPORT	Middle Waterway (Simpson/Trustees) site features	

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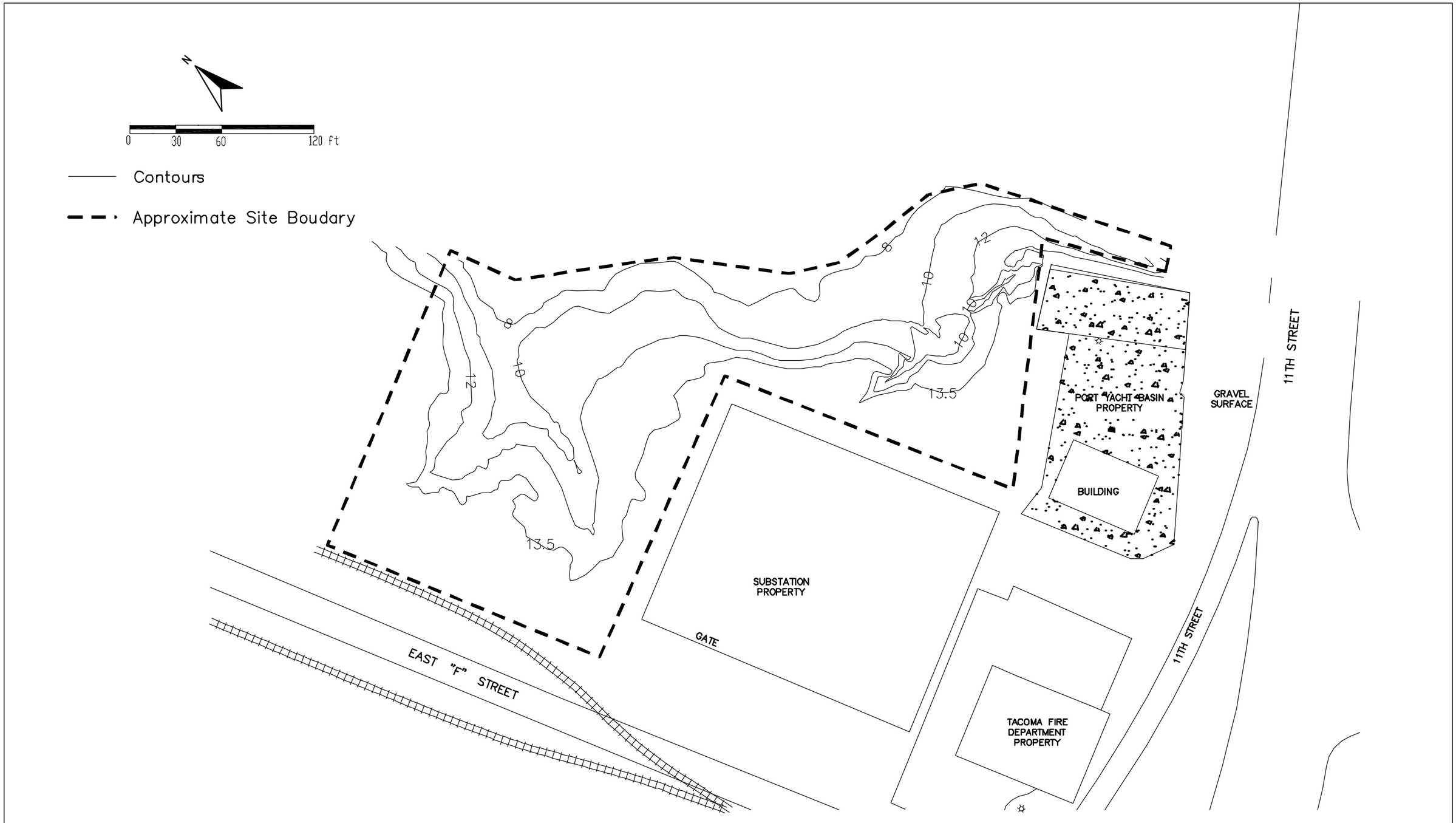

RIDOLFI Inc.	COMMENCEMENT BAY HABITAT RESTORATION SITES	January 2007	Figure 5
	YEAR 5 (2006) MONITORING REPORT	Middle Waterway – City of Tacoma site features	

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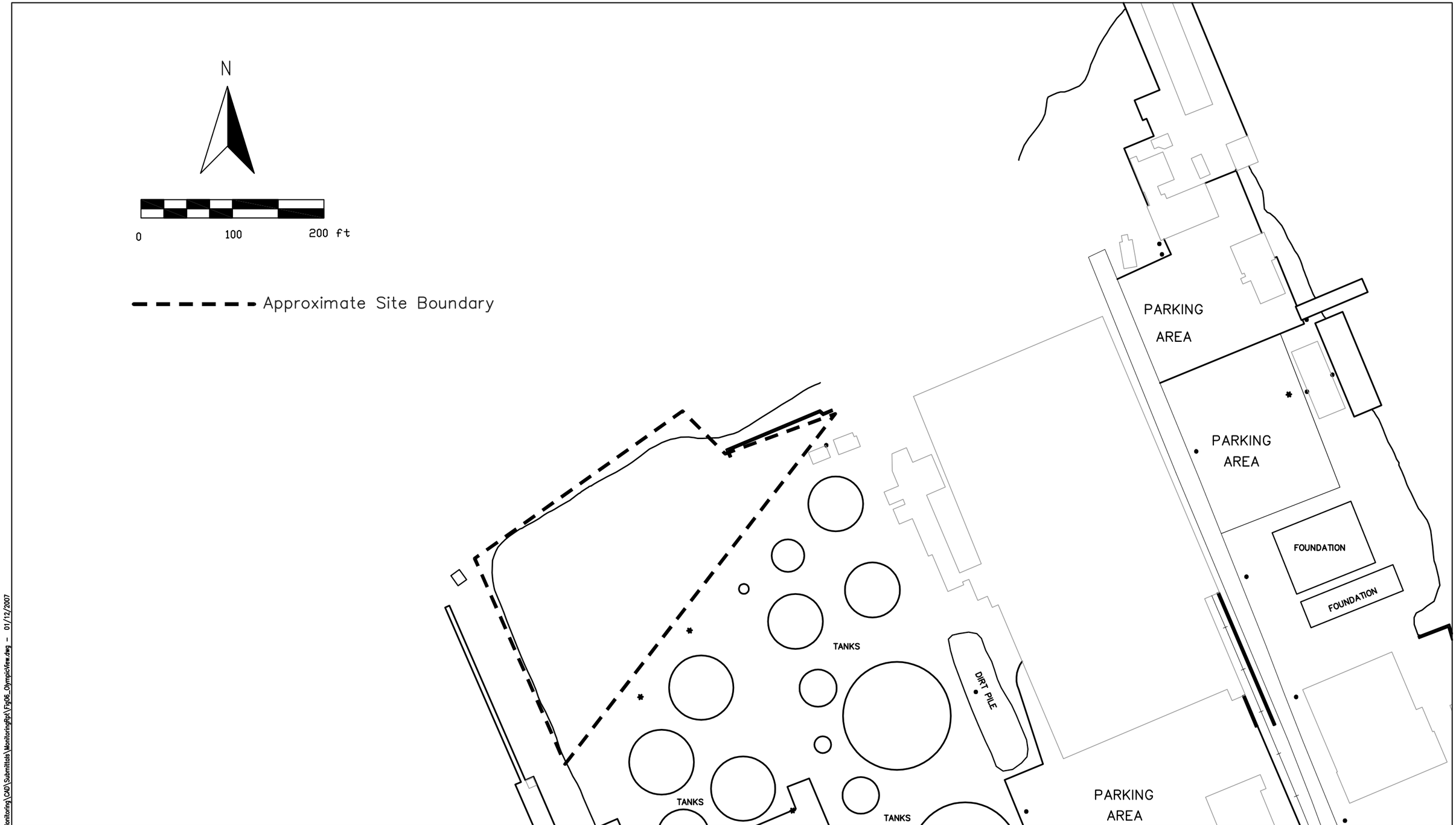

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COMMENCEMENT BAY HABITAT RESTORATION SITES

YEAR 5 (2006) MONITORING REPORT

January 2007

Figure 6

Olympic View site features

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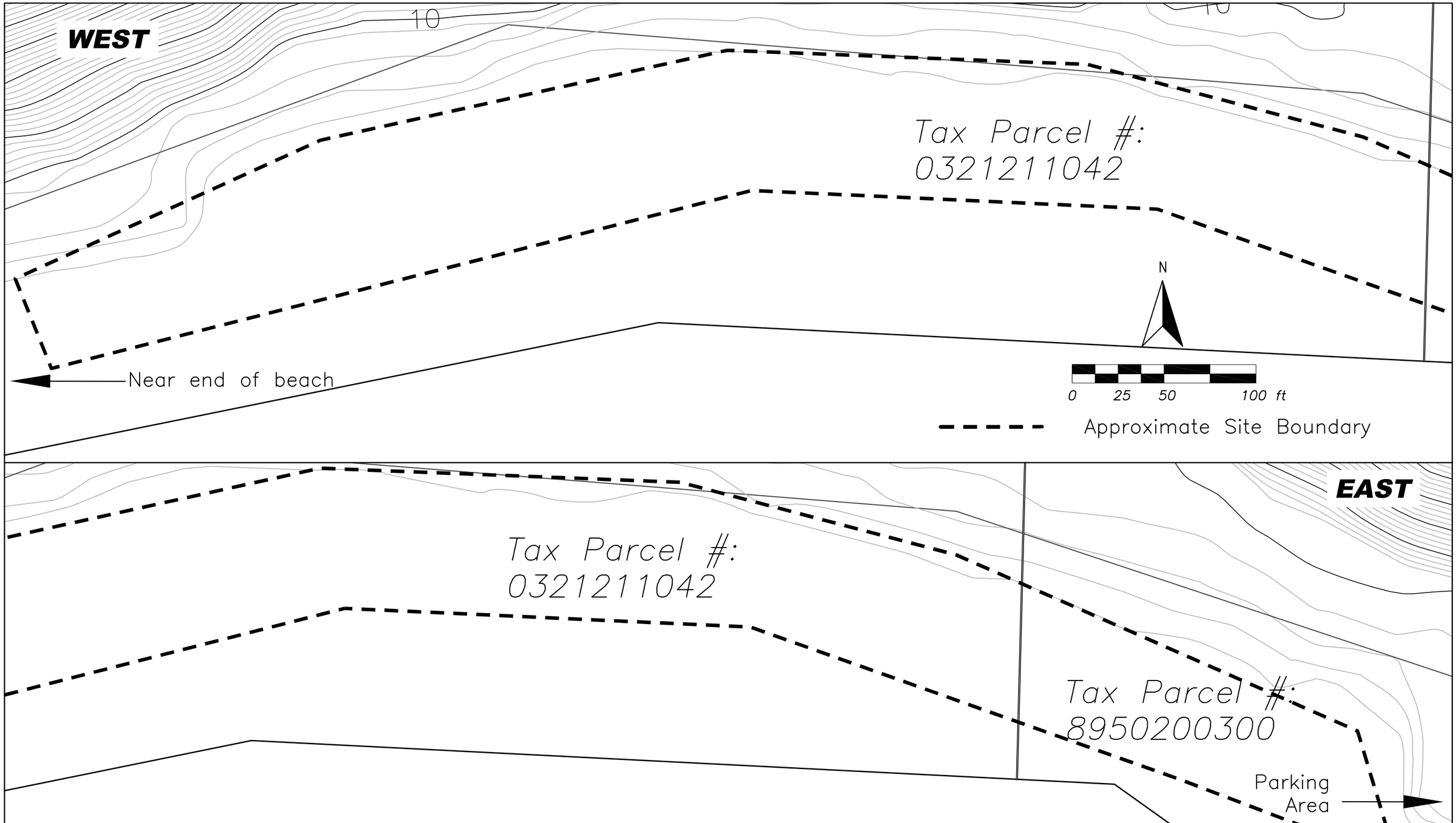

RIDOLFI Inc.	COMMENCEMENT BAY HABITAT RESTORATION SITES	January 2007	Figure 7
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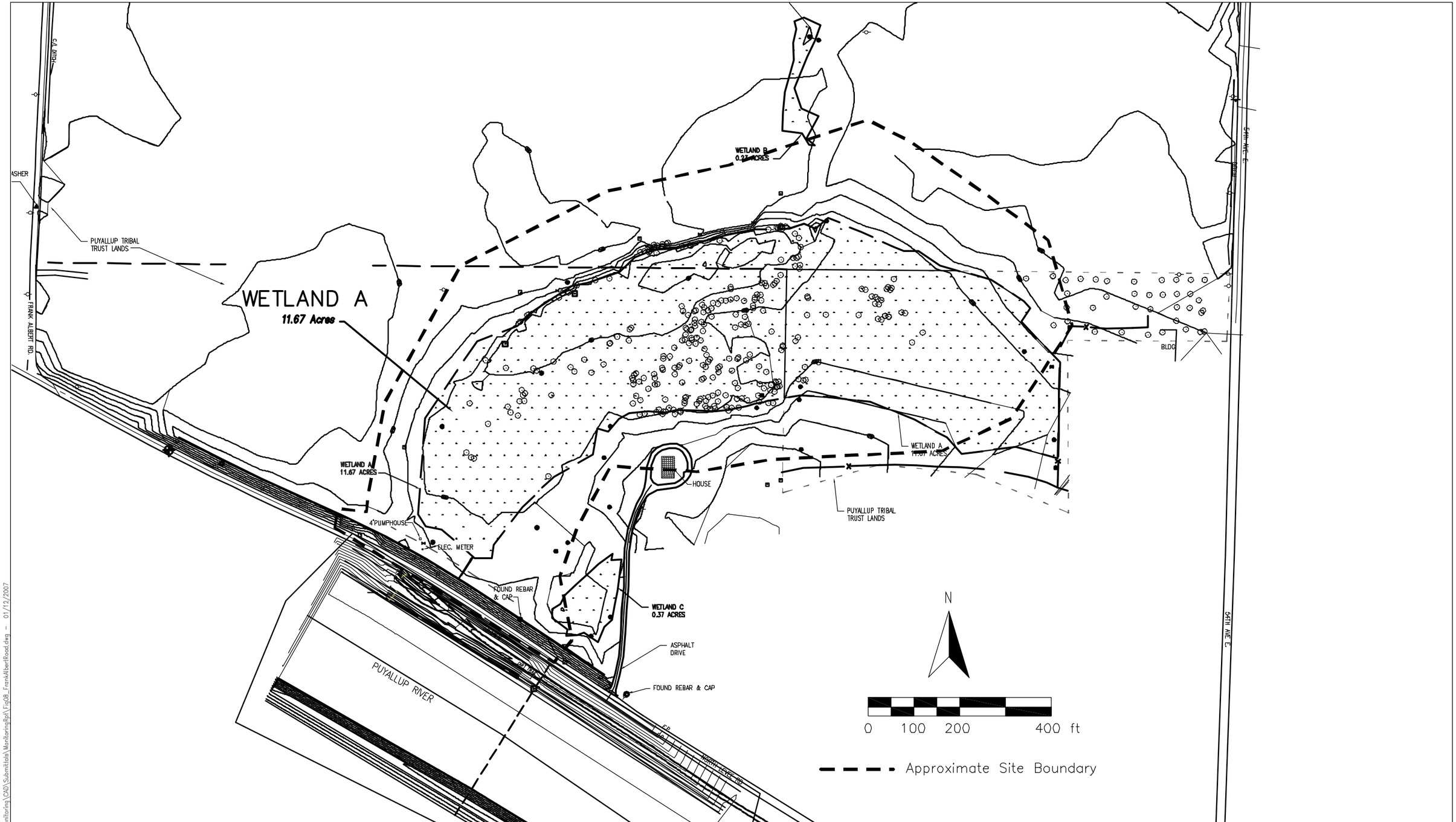

RIDOLFI Inc.	COMMENCEMENT BAY HABITAT RESTORATION SITES	January 2007	Figure 8
	YEAR 5 (2006) MONITORING REPORT	Sha Dadx site features	

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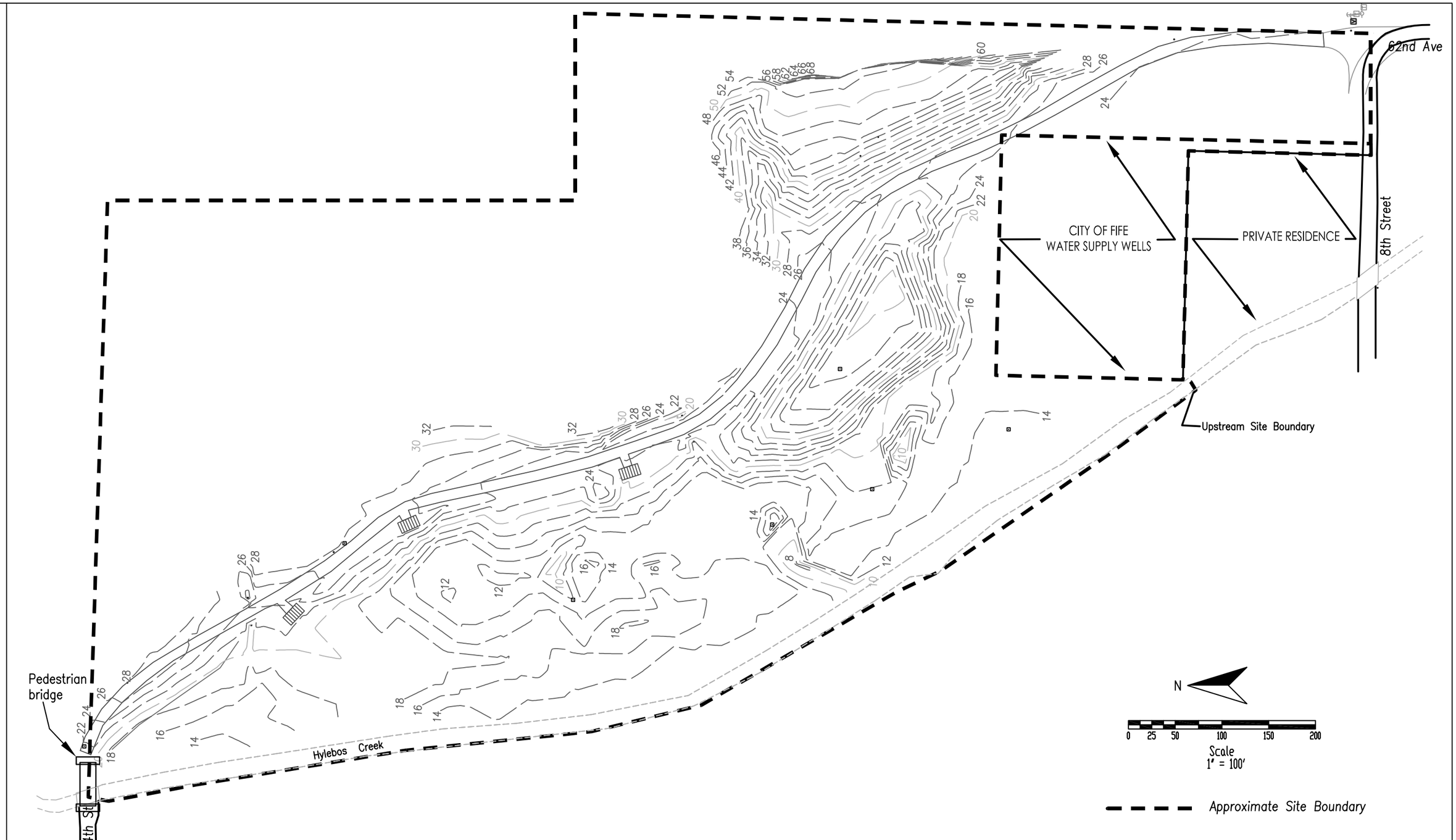

RIDOLFI Inc.	COMMENCEMENT BAY HABITAT RESTORATION SITES	January 2007	Figure 9
	YEAR 5 (2006) MONITORING REPORT	Hylebos Creek Off–Channel (Jordan) site features	

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LEGEND

Creek Reach

- Creek Reach 1
- Creek Reach 2
- Creek Reach 3
- Creek Reach 4
- Creek Reach 5

Off-Channel Reach

- Off-Channel Reach 1
- Off-Channel Reach 2
- Off-Channel Reach 3
- Property Boundary

Aerial Photo Source: Aero-Metric, Inc.
Date: August 2006

N

0 100 200
Feet

Figure 10
Hylebos Creek Off-Channel (Jordan) site fish monitoring reaches

Year 5 (2006) Monitoring Report
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RIDOLFI Inc.

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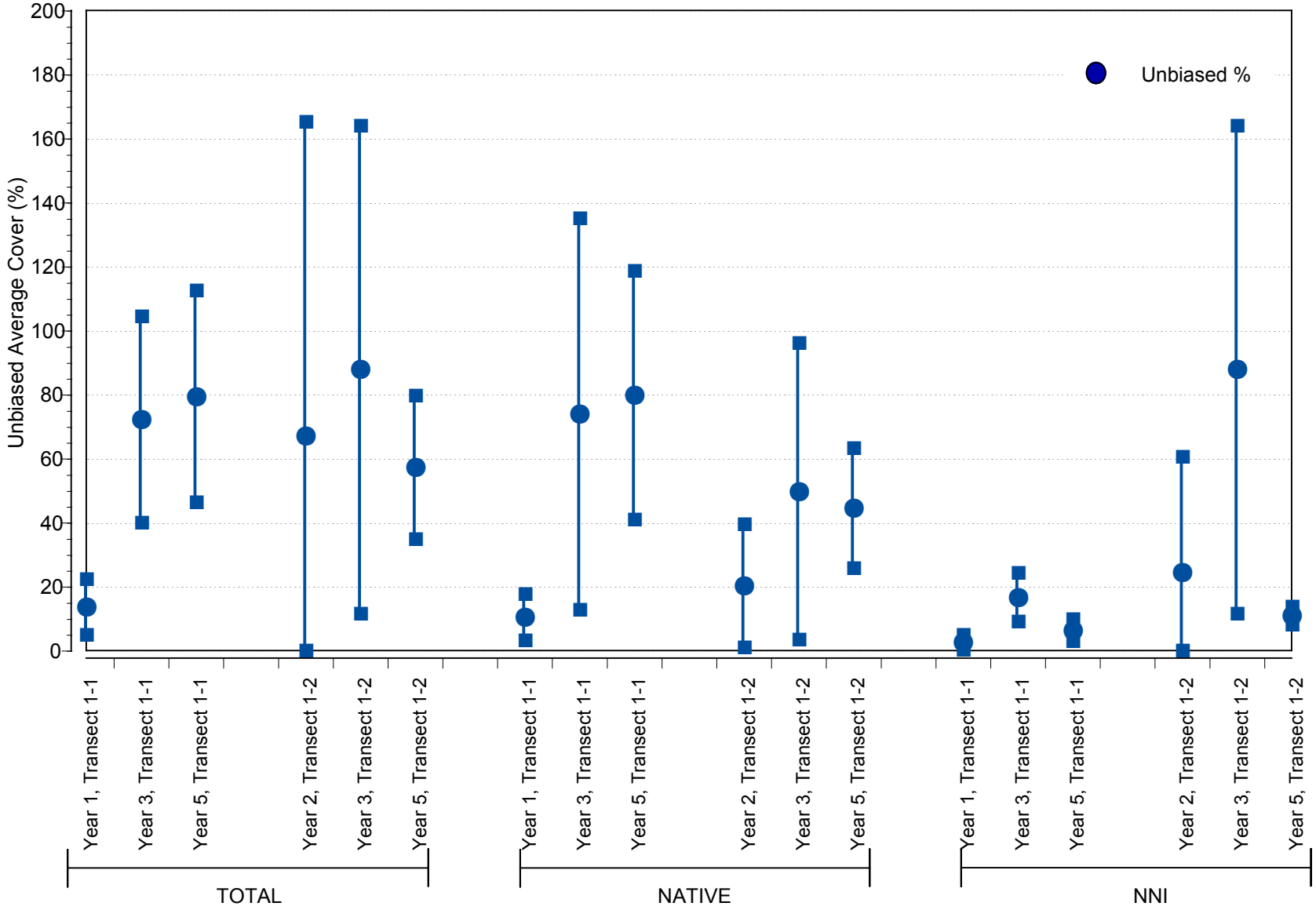
RIDOLFI Inc.	**COMMENCEMENT BAY RESTORATION**	January 2007	Figure 11
	YEAR 5 (2006) MONITORING REPORT	Snorkel fish survey at Hylebos Creek Off-Channel (Jordan) site	

Fig11_Photos.xls Photo1
Printed: 1/11/2007



RIDOLFI Inc.

COMMENCEMENT BAY HABITAT RESTORATION SITES

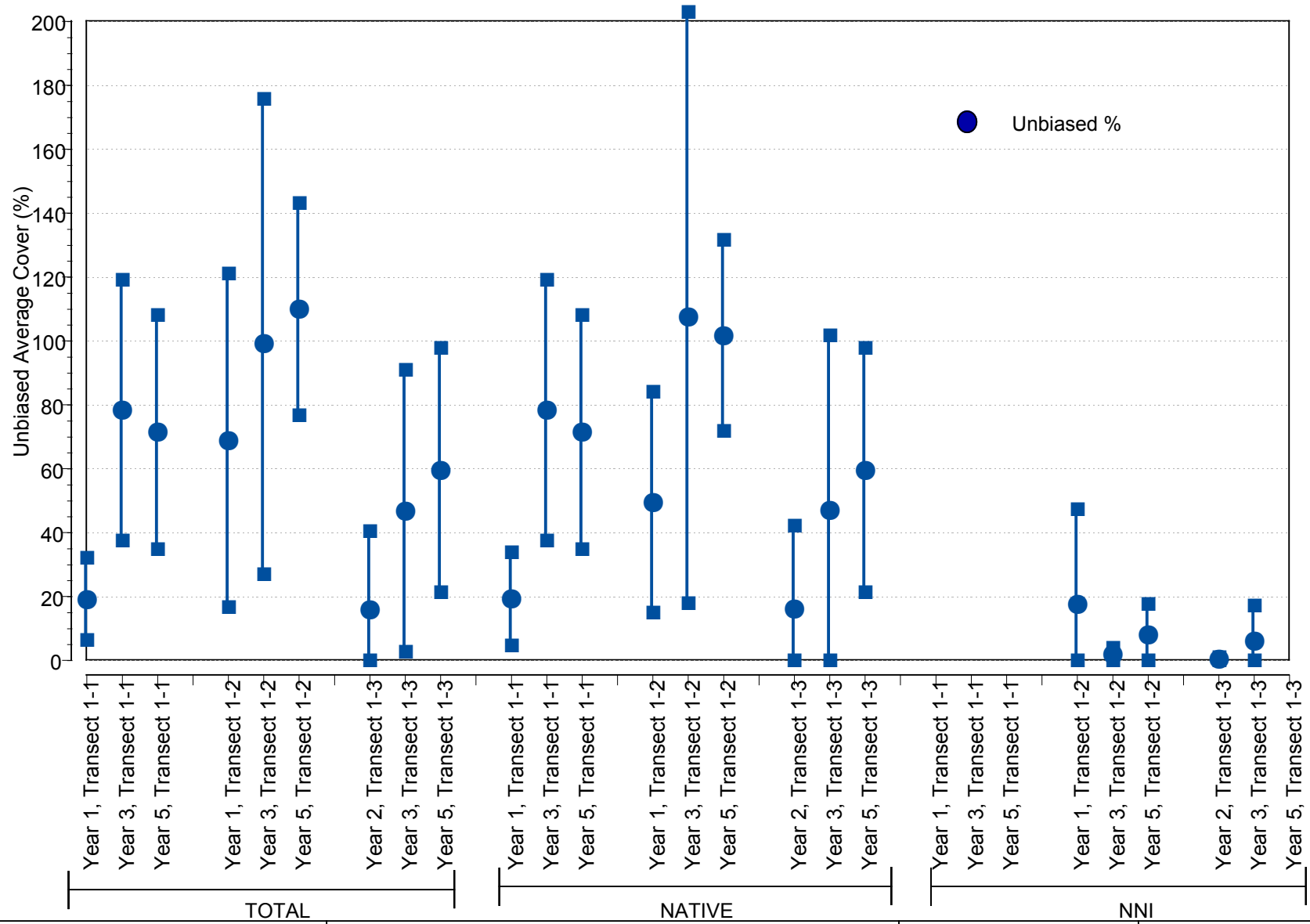
YEAR 5 (2006) MONITORING REPORT

January 2007

Figure 12

Confidence intervals for Mowitch marsh vegetation cover, by transect

PlantCoverConfInt2006.dg5



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COMMENCEMENT BAY HABITAT RESTORATION SITES

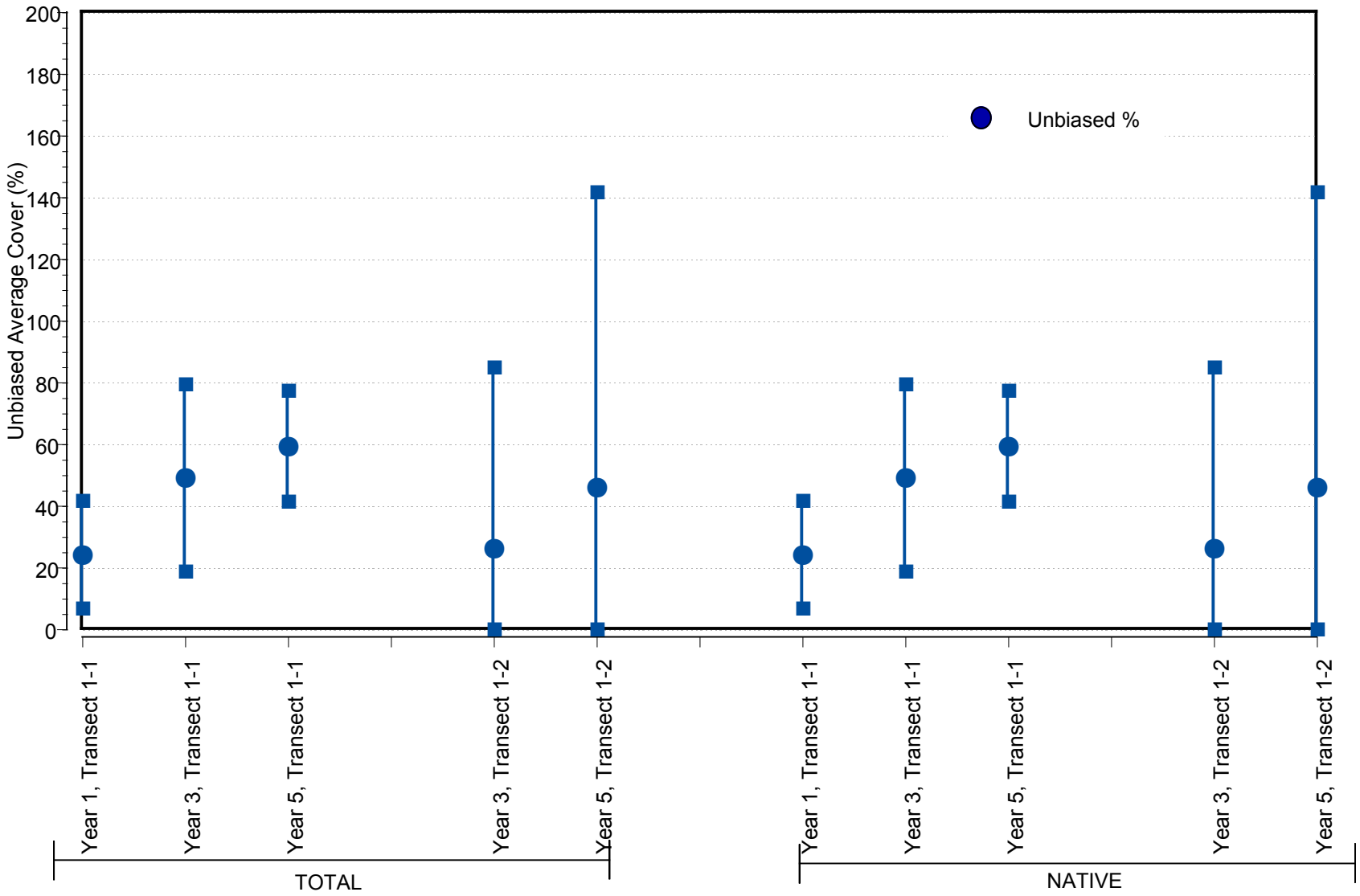
YEAR 5 (2006) MONITORING REPORT

January 2007

Figure 13

Confidence intervals for Squally Beach marsh vegetation cover, by transect

PlantCoverConfInt2006.dg5



NNI species have not been observed along Transects 1-1 and 1-2 in Years 1 to 5; therefore, confidence intervals could not be calculated for NNI species.

RIDOLFI Inc.	**COMMENCEMENT BAY HABITAT RESTORATION SITES**	January 2007	Figure 14
	YEAR 5 (2006) MONITORING REPORT	Confidence intervals for Middle Waterway (Simpson/Trustees) marsh vegetation cover, by transect.	

PlantCoverConfInt206.dg5

APPENDIX A

Data Tables

LIST OF DATA TABLES

Table A-1a. Year 5 (2006) Marsh Development at Mowitch, Transect 1-1 – Collected Data
Table A-1b. Year 5 (2006) Marsh Development at Mowitch, Transect 1-2 – Collected Data
Table A-2a. Year 5 (2006) Marsh Development at Mowitch, Transect 1-1 – Cover
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Table A-1a. Year 5 (2006) 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
Percent of quadrat situated within herbivory exclusion device				100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0
orache, fat-hen saltbush	*Atriplex patula*	0.6	4.3	2	1		1			5												10													7														
Lyngby's sedge	*Carex lyngbyei*	1.2	14.0												30	15	10	1																															
tufted hairgrass	*Deschampsia cespitosa*	1.0	6.9	5	5									10	5	3					5																	15												
seashore saltgrass	*Distichlis spicata*	8.6	26.4	30	30	2				1	30	5	70	85	15			100	10		2	1										5						10												
spike-rush	*Eleocharis sp.*	5.5	14.1	1		35	10				2				2								45	30	5	25	5	25		5	1			25									1	4	30		3		
fleshy jaumea	*Jaumea carnosa*	7.4	19.9			1		15	40	3			5			70	70			10	20	5													30		5	10	5	10							10	30	
seaside plantain	*Plantago maritima*	8.7	22.1	25	25	2	40	25	5		5	20	10			5	15	1	25	50	35	80													10		20												
pickleweed	*Salicornia virginica*	11.8	22.6	1				5	60	35	3	15	15		35	5	5		70	40	45	5						5	1			5		10	5	20	80	70	5					3					
Canadian sandspurry	*Spergularia canadensis*	2.8	9.1			10	5	5		5	40	10		1	10																	2		10					5		10						5	10	
seaside arrow-grass	*Triglochin maritimum*	5.2	23.9	30	30	30	30	10	5					2					2																30	70													
brass buttons	*Cotula coronopifolia*	2.0	5.1	1.0	5	2	5			2													10		5	10	2		2	15	15		3	5						1		5		1		3			
unclassified-herb	unclassified-herb	0.5	25.0							25																																							
unclassified-sedge	unclassified-sedge	3.3	16.7	5.0	5	15	10	30	10	15	20	40																																					

Table A-1b. Year 5 (2006) Marsh Development at Mowitch, Transect 1-2 – 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
Percent of quadrat situated within herbivory exclusion device				0	0	0	100	100	100	100	100	100	0	0	0	0	0	0	100	100	0	100	100	100	100	0
orache, fat-hen saltbush	*Atriplex patula*	0.6	4.3																			5		5	3	
seashore saltgrass	*Distichlis spicata*	3.7	42.5	45	40																					
spike-rush	*Eleocharis sp.*	15.7	21.2	25	15	60	40	30	25	10	50	20	10	10	3	10	20	25	2							5
fleshy jaumea	*Jaumea carnosa*	1.1	8.7							20															3	3
seaside plantain	*Plantago maritima*	3.0	35.0																			30	40			
pickleweed	*Salicornia virginica*	7.3	16.7	10	10					25								10	25			20	25	15	20	7
Canadian sandspurry	*Spergularia canadensis*	5.8	11.1	10	10				10	20	5	5						3	20	5			15	20	10	
seaside arrow-grass	*Triglochin maritimum*	2.1	12.0																10			30	5	3		
brass buttons	*Cotula coronopifolia*	10.9	13.2	5	20	25	15	10	10	10	25	25				5	5	20	10	15	10		10	10	10	10

Table A-2a. Year 5 (2006) Marsh Development at Mowitch, Transect 1-1 – Cover.

Common Name	Scientific Name	Exact Method - Continuous				Unbiased Average Quadrat Canopy Cover (%)	90% Confidence	
		Actual Total Canopy (%)	Average Quadrat Canopy Cover (%)	Frequency (%)	Species Composition (%)		Lower Bound	Upper Bound
Native								
orache, fat-hen saltbush	*Atriplex patula*	26.0	0.6	13.3	0.02	0.6	0.0	1.3
Lyngby's sedge	*Carex lyngbyei*	56.0	1.2	8.9	0.05	2.1	0.0	6.1
tufted hairgrass	*Deschampsia cespitosa*	48.0	1.0	15.6	0.04	1.1	0.4	1.7
seashore saltgrass	*Distichlis spicata*	396.0	8.6	33.3	0.32	11.7	0.0	23.7
spike-rush	*Eleocharis sp.*	254.0	5.5	40.0	0.20	6.8	1.6	12.0
fleshy jaumea	*Jaumea carnosa*	339.0	7.4	37.8	0.27	8.1	2.8	13.4
seaside plantain	*Plantago maritima*	398.0	8.7	40.0	0.32	10.4	3.8	17.0
pickleweed	*Salicornia virginica*	543.0	11.8	53.3	0.44	13.7	5.0	22.5
Canadian sandspurry	*Spergularia canadensis*	128.0	2.8	31.1	0.10	2.9	1.3	4.5
seaside arrow-grass	*Triglochin maritimum*	239.0	5.2	22.2	0.19	6.8	0.2	13.4
Canopy Cover, Native		*2427.0*	*52.8*		*1.96*	79.8	41.0	118.7
Non-Native or Invasive[1]								
brass buttons	*Cotula coronopifolia*	92.0	2.0	324.4	0.07	2.1	1.1	3.1
unclassified-herb	*unclassified-herb*	25.0	0.5	284.4	0.02	n/a	n/a	n/a
unclassified-sedge	*unclassified-sedge*	150.0	3.3	282.2	0.12	3.4	1.2	5.6
Canopy Cover, NNI		*267.0*	*5.8*		*0.22*	6.5	3.0	9.9
TOTAL		**2694**	**58.6**		**2.17**	**79.5**	**46.4**	**112.5**
Proportion of non-native or invasive plants (%):			**9.9%**			**7.5%**		

Actual Total Canopy: Obtained by summing the percent cover of all quadrats on the transect.

Average Quadrat Canopy Cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

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

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

Table A-2b. Year 5 (2006) Marsh Development at Mowitch, Transect 1-2 – Cover.

Common Name	Scientific Name	Exact Method - Continuous				Unbiased Average Quadrat Canopy Cover (%)	90% Confidence	
		Actual Total Canopy (%)	Average Quadrat Canopy Cover (%)	Frequency (%)	Species Composition (%)		Lower Bound	Upper Bound
Native								
orache, fat-hen saltbush	*Atriplex patula*	13.0	0.6	13.0	0.05	0.6	0.0	1.1
seashore saltgrass	*Distichlis spicata*	85.0	3.7	8.7	0.32	n/a	n/a	n/a
spike-rush	*Eleocharis sp.*	360.0	15.7	73.9	1.36	17.3	8.6	26.1
fleshy jaumea	*Jaumea carnosa*	26.0	1.1	13.0	0.10	1.3	0.0	3.5
seaside plantain	*Plantago maritima*	70.0	3.0	8.7	0.26	n/a	n/a	n/a
pickleweed	*Salicornia virginica*	167.0	7.3	43.5	0.63	7.4	3.9	10.9
Canadian sandspurry	*Spergularia canadensis*	133.0	5.8	52.2	0.50	6.0	3.2	8.8
seaside arrow-grass	*Triglochin maritimum*	48.0	2.1	17.4	0.18	2.3	0.0	5.3
Subtotal		*902*	*39.2*		*3.40*	44.6	25.9	63.3
Non-Native or Invasive[1]								
brass buttons	*Cotula coronopifolia*	250.0	10.9	82.6	0.94	11.0	8.1	13.9
Subtotal		*250*	*10.9*		*0.94*	11.0	8.1	13.9
TOTAL		**1152**	**50.1**		**4.35**	**57.3**	**34.9**	**79.6**
Proportion of non-native or invasive plants (%):			**21.7%**			**19.8%**		

Actual Total Canopy: Obtained by summing the percent cover of all quadrats on the transect.

Average Quadrat Canopy Cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

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

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

Table A-3a. Mowitch Marsh Transect 1-1: Change in percent cover 2002 to 2006.

	Species[b]	Percent of Quadrats with Decreased Cover	Percent of Quadrats with No Change	Percent of Quadrats with Increased Cover	Statistical Result[a]
Native	*Atriplex patula*	41%	54%	4%	–
	Carex lyngbyei	7%	87%	7%	
	Deschampsia cespitosa	0%	85%	15%	+
	Distichlis spicata	2%	65%	33%	+
	Eleocharis sp.	0%	61%	39%	+
	Plantago maritima	0%	61%	39%	+
	Salicornia virginica	0%	48%	52%	+
	Triglochin maritimum	2%	78%	20%	+
	Jaumea carnosa[c]	7%	61%	33%	+
Total Native		4%	4%	91%	+
NNI	*Cotula coronopifolia*	13%	48%	39%	+
Total NNI		22%	30%	48%	+
Total (All Species)		2%	0%	98%	+

Notes:

[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] This comparison is between 2004 and 2006; species was not observed in 2002.

Table A-3b. Mowitch Marsh Transect 1-2: Change in percent cover 2003 to 2006.

	Species[b]	Percent of Quadrats with Decreased Cover	Percent of Quadrats with No Change	Percent of Quadrats with Increased Cover	Statistical Result[a]
Native	*Atriplex patula*	17%	74%	9%	
	Distichlis spicata	0%	91%	9%	No Test[c]
	Eleocharis sp.	22%	26%	52%	
	Plantago maritima	9%	83%	9%	
	Salicornia virginica	0%	57%	43%	+
	Triglochin maritimum	9%	74%	17%	
Native Total		9%	4%	87%	+
NNI	*Cotula coronopifolia*	13%	13%	74%	+
	Spergularia marina	26%	74%	0%	–
NNI Total		35%	9%	57%	
Total (All Species)		17%	4%	78%	+

Notes:

[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-4a. Year 5 (2006) 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
Percent of quadrat situated within herbivory exclusion device				0	0	100	100	100	100	100	100	0	100	100	100	100	100	100	100	100	100	0	0	0	0	0	0
Douglas aster	*Aster subspicatus*	0.0	1.0																1								
orache, fat-hen saltbush	*Atriplex patula*	0.7	4.3			1											10	1									5
seashore saltgrass	*Distichlis spicata*	15.5	31.0	10	20	25	20										40	45	60	40	2				15	70	25
entire-leaved gumweed	*Grindelia integrifolia*	6.8	18.1		10	5	1	25	2	75							15		20	10							
fleshy jaumea	*Jaumea carnosa*	15.3	26.1	5		1	20	50	40	5	45	5							5	50	10				70	10	50
seaside plantain	*Plantago maritima*	0.5	6.0			10			2																		
pickleweed	*Salicornia virginica*	17.0	22.6		5	65	10	20	20		45	10	5	20	30	2	35	55	15		15				15	20	20

Table A-4b. Year 5 (2006) 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
Percent of quadrat situated within herbivory exclusion device				100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
orache, fat-hen saltbush	*Atriplex patula*	2.3	7.0				25	2						2	1	5		
Lyngby's sedge	*Carex lyngbyei*	27.3	51.3		90	90	35	5	20			50	80	40				
red-osier dogwood	*Cornus stolonifera*	0.7	10.0													10		
seashore saltgrass	*Distichlis spicata*	11.3	42.5							90				30			40	10
spike-rush	*Eleocharis sp.*	1.0	15.0															15
fleshy jaumea	*Jaumea carnosa*	14.1	30.1					85	60	20	30			10			5	1
seaside plantain	*Plantago maritima*	1.0	15.0											15				
Hooker's willow	*Salix hookeriana*	26.7	80.0								100	90	90		50	70		
pickleweed	*Salicornia virginica*	6.0	18.0	15			5		25								40	5
American bulrush	*Scirpus americanus*	3.7	18.3		5										40	10		
seacoast bulrush	*Scirpus maritimus*	0.1	2.0						2									
seaside arrow-grass	*Triglochin maritimum*	1.3	20.0													20		
bentgrass	*Agrostis sp.*	0.3	5.0		5													
reed canarygrass	*Phalaris arundinacea*	3.3	50.0			50												
Himalayan blackberry	*Rubus discolor*	2.0	10.0				10								5	15		
unclassified-composite	*unclassified-composite*	1.3	20.0				20											

Table A-4c. Year 5 (2006) 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
Percent of quadrat situated within herbivory exclusion device				100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
orache, fat-hen saltbush	*Atriplex patula*	1.6	25.0																25
seashore saltgrass	*Distichlis spicata*	20.0	40.0	45	40	60	60		10		10	75	20						
spike-rush	*Eleocharis sp.*	1.6	12.5					15								10			
entire-leaved gumweed	*Grindelia integrifolia*	1.9	10.0		5	10	15												
fleshy jaumea	*Jaumea carnosa*	2.7	7.2	2	1	5	10		20						5				
pickleweed	*Salicornia virginica*	21.7	43.4	55	60	30	20	30	60	90						2			

Table A-5a. Year 5 (2006) Marsh Development at Squally Beach, Transect 1-1 – Cover.

Common Name	Scientific Name	Exact Method - Continuous				Unbiased Average Quadrat Canopy Cover (%)	90% Confidence	
		Actual Total Canopy (%)	Average Quadrat Canopy Cover (%)	Frequency (%)	Species Composition (%)		Lower Bound	Upper Bound
Native								
Douglas aster	*Aster subspicatus*	25.0	1.0	8.3	0.08	n/a	n/a	n/a
orache, fat-hen saltbush	*Atriplex patula*	17.0	0.7	16.7	0.05	0.9	0.0	2.1
seashore saltgrass	*Distichlis spicata*	372.0	15.5	50.0	1.14	18.3	6.7	29.8
entire-leaved gumweed	*Grindelia integrifolia*	163.0	6.8	37.5	0.50	8.4	0.0	17.2
fleshy jaumea	*Jaumea carnosa*	366.0	15.3	58.3	1.12	19.4	3.9	34.9
seaside plantain	*Plantago maritima*	12.0	0.5	8.3	0.04	n/a	n/a	n/a
pickleweed	*Salicornia virginica*	407.0	17.0	75.0	1.25	18.4	10.3	26.5
Canopy Cover, Native		*1362.0*	*56.8*		*4.17*	71.5	34.8	108.1
Non-Native or Invasive[1]								
(None)						n/a	n/a	n/a
Canopy Cover, NNI		*0.0*	*0.0*		*0.00*	n/a	n/a	n/a
TOTAL		**1362**	**56.8**		**4.17**	**71.5**	**34.8**	**108.1**
Proportion of non-native or invasive plants (%):			**0.0%**			**0.0%**		

Actual Total Canopy: Obtained by summing the percent cover of all quadrats on the transect.

Average Quadrat Canopy Cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

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

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

Table A-5b. Year 5 (2006) Marsh Development at Squally Beach, Transect 1-2 – Cover.

Common Name	Scientific Name	Exact Method - Continuous				Unbiased Average Quadrat Canopy Cover (%)	90% Confidence	
		Actual Total Canopy (%)	Average Quadrat Canopy Cover (%)	Frequency (%)	Species Composition (%)		Lower Bound	Upper Bound
Native								
orache, fat-hen saltbush	*Atriplex patula*	35.0	2.3	33.3	0.15	2.5	0.0	6.0
Lyngby's sedge	*Carex lyngbyei*	410.0	27.3	53.3	1.78	32.8	5.7	59.8
red-osier dogwood	*Cornus stolonifera*	10.0	0.7	6.7	0.04	n/a	n/a	n/a
seashore saltgrass	*Distichlis spicata*	170.0	11.3	26.7	0.74	13.0	0.0	28.3
spike-rush	*Eleocharis sp.*	15.0	1.0	6.7	0.07	n/a	n/a	n/a
fleshy jaumea	*Jaumea carnosa*	211.0	14.1	46.7	0.91	22.5	0.0	57.2
seaside plantain	*Plantago maritima*	15.0	1.0	6.7	0.07	n/a	n/a	n/a
Hooker's willow	*Salix hookeriana*	400.0	26.7	33.3	1.73	26.9	9.1	44.7
pickleweed	*Salicornia virginica*	90.0	6.0	33.3	0.39	6.8	0.0	14.0
American bulrush	*Scirpus americanus*	55.0	3.7	20.0	0.24	4.4	0.0	11.4
seacoast bulrush	*Scirpus maritimus*	2.0	0.1	6.7	0.01	n/a	n/a	n/a
seaside arrow-grass	*Triglochin maritimum*	20.0	1.3	6.7	0.09	n/a	n/a	n/a
Subtotal		*1433*	*95.5*		*6.21*	101.5	71.6	131.5
Non-Native or Invasive[1]								
bentgrass	*Agrostis sp.*	5.0	0.3	6.7	0.02	n/a	n/a	n/a
reed canarygrass	*Phalaris arundinacea*	50.0	3.3	6.7	0.22	n/a	n/a	n/a
Himalayan blackberry	*Rubus discolor*	30.0	2.0	20.0	0.13	2.1	0.0	4.4
unclassified-composite	*unclassified-composite*	20.0	1.3	6.7	0.09	n/a	n/a	n/a
Subtotal		*105*	*7.0*		*0.46*	8.1	0.0	17.5
TOTAL		**1538**	**102.5**		**6.67**	**109.8**	**76.5**	**143.1**
Proportion of non-native or invasive plants (%):			**6.8%**			**7.4%**		

Actual Total Canopy: Obtained by summing the percent cover of all quadrats on the transect.

Average Quadrat Canopy Cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

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

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

Table A-5c. Year 5 (2006) Marsh Development at Squally Beach, Transect 1-3 – Cover.

Common Name	Scientific Name	Exact Method - Continuous				Unbiased Average Quadrat Canopy Cover (%)	90% Confidence	
		Actual Total Canopy (%)	Average Quadrat Canopy Cover (%)	Frequency (%)	Species Composition (%)		Lower Bound	Upper Bound
Native								
orache, fat-hen saltbush	*Atriplex patula*	25.0	1.6	6.3	0.10	n/a	n/a	n/a
seashore saltgrass	*Distichlis spicata*	320.0	20.0	50.0	1.30	21.9	7.1	36.7
spike-rush	*Eleocharis sp.*	25.0	1.6	12.5	0.10	n/a	n/a	n/a
entire-leaved gumweed	*Grindelia integrifolia*	30.0	1.9	18.8	0.12	2.0	0.0	4.0
fleshy jaumea	*Jaumea carnosa*	43.0	2.7	37.5	0.17	3.1	0.0	6.4
pickleweed	*Salicornia virginica*	347.0	21.7	50.0	1.41	30.6	0.2	61.1
Subtotal		*790*	*49.4*		*3.21*	59.4	21.3	97.6
Non-Native or Invasive[1]								
(None)						n/a	n/a	n/a
Subtotal		*0*	*0.0*		*0.00*	n/a	n/a	n/a
TOTAL		**790**	**49.4**		**3.21**	**59.4**	**21.3**	**97.6**
Proportion of non-native or invasive plants (%):			**0.0%**			**0.0%**		

Actual Total Canopy: Obtained by summing the percent cover of all quadrats on the transect.

Average Quadrat Canopy Cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

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

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

Table A-6a. Squally Beach Marsh Transect 1-1: Change in percent cover 2002 to 2006.

	Species[b]	Percent of Quadrats with Decreased Cover	Percent of Quadrats with No Change	Percent of Quadrats with Increased Cover	Statistical Result[a]
Native	*Atriplex patula*	43%	48%	9%	–
	Distichlis spicata	0%	52%	48%	+
	Grindelia integrifolia	0%	61%	39%	+
	Plantago maritima	9%	83%	9%	
	Salicornia virginica	9%	22%	70%	+
Native Total		13%	17%	70%	+
NNI Total		9%	91%	0%	No Test[c]
Total (All Species)		4%	13%	83%	+

Notes:

[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-6b. Squally Beach Marsh Transect 1-2: Change in percent cover 2002 to 2006.

	Species[b]	Percent of Quadrats with Decreased Cover	Percent of Quadrats with No Change	Percent of Quadrats with Increased Cover	Statistical Result[a]
Native	*Alnus rubra*	7%	93%	0%	No Test[c]
	Atriplex patula	67%	20%	13%	–
	Carex lyngbyei	7%	40%	53%	+
	Distichlis spicata	7%	67%	27%	
	Jaumea carnosa	0%	53%	47%	+
	Salicornia virginica	7%	60%	33%	
	Scirpus americanus	7%	87%	7%	No Test[c]
	Salix hookeriana[d]	13%	67%	20%	
Native Total		7%	0%	93%	+
NNI Total		33%	40%	27%	
Total (All Species)		7%	0%	93%	+

Notes:

[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.

[d] This comparison is between 2004 and 2006; species was not observed in 2002.

Table A-6c. Squally Beach Marsh Transect 1-3: Change in percent cover 2003 to 2006.

	Species[b]	Percent of Quadrats with Decreased Cover	Percent of Quadrats with No Change	Percent of Quadrats with Increased Cover	Statistical Result[a]
Native	*Atriplex patula*	19%	81%	0%	
	Distichlis spicata	0%	50%	50%	+
	Eleocharis sp.	6%	81%	13%	
	Jaumea carnosa	0%	63%	38%	+
	Salicornia virginica	0%	50%	50%	+
	Grindelia integrifolia[c]	0%	81%	19%	
Native Total		6%	19%	75%	+
NNI	*Cotula coronopifolia*	19%	81%	0%	
NNI Total		19%	81%	0%	
Total (All Species)		6%	19%	75%	+

Notes:

[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] This comparison is between 2004 and 2006; species was not observed in 2002.

Table A-7a. Year 5 (2006) 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
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
orache, fat-hen saltbush	*Atriplex patula*	0.2	5.0					5																					
seashore saltgrass	*Distichlis spicata*	19.8	64.4										50	95	80	80	30	60	60	60									
seaside plantain	*Plantago maritima*	0.6	15.0																					15					
pickleweed	*Salicornia virginica*	33.5	41.4				25	10	60	80	25	80	35	5	30	20	50	15	20	50		15	95	20	30	90	100	15	
American bulrush	*Scirpus americanus*	0.1	2.0															2											
Canadian sandspurry	*Spergularia canadensis*	2.3	20.0				30	25	5																				

Table A-7b. Year 5 (2006) 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	100	0	0	0	0
orache, fat-hen saltbush	*Atriplex patula*	0.4	3.0			3				
tufted hairgrass	*Deschampsia cespitosa*	3.6	25.0			25				
pickleweed	*Salicornia virginica*	10.3	18.0	10	20	40	2			
Canadian sandspurry	*Spergularia canadensis*	16.4	38.3		70	40	5			

Table A-8a. Year 5 (2006) Marsh Development at Middle Waterway (Simpson/Trustees), Transect 1-1 – Cover.

Common Name	Scientific Name	Exact Method - Continuous				Unbiased Average Quadrat Canopy Cover (%)	90% Confidence	
		Actual Total Canopy (%)	Average Quadrat Canopy Cover (%)	Frequency (%)	Species Composition (%)		Lower Bound	Upper Bound
Native								
orache, fat-hen saltbush	*Atriplex patula*	5.0	0.2	3.8	0.01	n/a	n/a	n/a
seashore saltgrass	*Distichlis spicata*	515.0	19.8	30.8	1.35	20.1	9.2	30.9
seaside plantain	*Plantago maritima*	15.0	0.6	3.8	0.04	n/a	n/a	n/a
pickleweed	*Salicornia virginica*	870.0	33.5	80.8	2.28	35.0	21.7	48.4
American bulrush	*Scirpus americanus*	2.0	0.1	3.8	0.01	n/a	n/a	n/a
Canadian sandspurry	*Spergularia canadensis*	60.0	2.3	11.5	0.16	2.9	0.0	7.2
Canopy Cover, Native		*1467.0*	*56.4*		*3.85*	59.3	41.5	77.2
Non-Native or Invasive[1]								
(None)						n/a	n/a	n/a
Canopy Cover, NNI		*0.0*	*0.0*		*0.00*			
TOTAL		**1467**	**56.4**		**3.85**	**59.3**	**41.5**	**77.2**
Proportion of non-native or invasive plants (%):			**0.0%**			**0.0%**		

Actual Total Canopy: Obtained by summing the percent cover of all quadrats on the transect.

Average Quadrat Canopy Cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

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

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

Table A-8b. Year 5 (2006) Marsh Development at Middle Waterway (Simpson/Trustees), Transect 1-2 – Cover.

Common Name	Scientific Name	Exact Method - Continuous				Unbiased Average Quadrat Canopy Cover (%)	90% Confidence	
		Actual Total Canopy (%)	Average Quadrat Canopy Cover (%)	Frequency (%)	Species Composition (%)		Lower Bound	Upper Bound
Native								
orache, fat-hen saltbush	*Atriplex patula*	3.0	0.4	14.3	0.20	n/a	n/a	n/a
tufted hairgrass	*Deschampsia cespitosa*	25.0	3.6	14.3	1.66	n/a	n/a	n/a
pickleweed	*Salicornia virginica*	72.0	10.3	57.1	4.78	14.6	0.0	41.1
Canadian sandspurry	*Spergularia canadensis*	115.0	16.4	42.9	7.64	27.2	0.0	91.2
Subtotal		*215*	*30.7*		*14.29*	45.9	0.0	141.7
Non-Native or Invasive[1]								
(None)						n/a	n/a	n/a
Subtotal		*0*	*0.0*		*0.00*			
TOTAL		**215**	**30.7**		**14.29**	**45.9**	**0.0**	**141.7**
Proportion of non-native or invasive plants (%):			**0.0%**			**0.0%**		

Actual Total Canopy: Obtained by summing the percent cover of all quadrats on the transect.

Average Quadrat Canopy Cover: Obtained by dividing the total canopy by the total number of quadrats sampled on the transect.

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

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

Table A-9a. Middle Waterway Marsh Transect 1-1: Change in percent cover 2002 to 2006.

	Species[b]	Percent of Quadrats with Decreased Cover	Percent of Quadrats with No Change	Percent of Quadrats with Increased Cover	Statistical Result[a]
Native	*Atriplex patula*	39%	61%	0%	–
	Distichlis spicata	4%	65%	30%	
	Salicornia virginica	0%	17%	83%	+
	Scirpus americanus	4%	96%	0%	No Test[c]
	Spergularia canadensis	35%	65%	0%	–
	Plantago maritima[d]	8%	92%	0%	No Test[c]
Native Total		9%	13%	78%	+
Total (All Species)		9%	13%	78%	+

Notes:

[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.

[d] This comparison is between 2004 and 2006; species was not observed in 2002.

Table A-9b. Middle Waterway Marsh Transect 1-2: Change in percent cover 2004 to 2006.

	Species[b]	Percent of Quadrats with Decreased Cover	Percent of Quadrats with No Change	Percent of Quadrats with Increased Cover	Statistical Result[a]
Native	*Atriplex patula*	14%	86%	0%	No Test[c]
	Salicornia virginica	14%	43%	43%	
	Spergularia canadensis	14%	57%	29%	
Native Total		0%	57%	43%	
Total (All Species)		0%	57%	43%	

Notes:

[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-10. Year 5 (2006) Riparian Development at Mowitch – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/20/2006	F1	F1-1	*Fraxinus latifolia*	Oregon ash		Tree	13.7	16	100%
			Cornus stolonifera	red-osier dogwood		Shrub	16	16.3	100%
			Salix scouleriana	Scouler's willow		Tree	16.8	24	100%
			Rosa sp.	rose		Shrub	28	32	40%
			Salix scouleriana	Scouler's willow		Tree	28	32	60%
			Alnus rubra	red alder		Tree	32	33.8	70%
			Rosa sp.	rose		Shrub	32	33.8	30%
			Alnus rubra	red alder		Tree	33.8	35.9	100%
			Alnus rubra	red alder		Tree	35.9	37.5	50%
			Symphoricarpos albus	common snowberry		Shrub	35.9	37.5	50%
			Alnus rubra	red alder		Tree	37.5	38.9	100%
			Fraxinus latifolia	Oregon ash		Tree	38.9	40.4	50%
			Alnus rubra	red alder		Tree	38.9	40.4	50%
			Rosa sp.	rose		Shrub	40.4	45.3	10%
			Alnus rubra	red alder		Tree	40.4	45.3	20%
			Pinus contorta	shore pine		Tree	40.4	45.3	70%
			Rosa sp.	rose		Shrub	45.3	47.4	100%
			Rosa sp.	rose		Shrub	49	50.3	100%
			Rosa sp.	rose		Shrub	51.6	53.5	100%
			Alnus rubra	red alder		Tree	58.4	60	100%
9/20/2006	F1	F1-2	*Lonicera involucrata*	twinberry honeysuckle		Shrub	13.3	14.4	100%
			Rosa sp.	rose		Shrub	29.9	31.5	100%
			Alnus rubra	red alder		Tree	56.3	60	100%
9/20/2006	F1	F1-3	*Alnus rubra*	red alder		Tree	0	11.3	50%
			Rosa sp.	rose		Shrub	0	11.3	50%
			Alnus rubra	red alder		Tree	11.3	14.4	100%
			Alnus rubra	red alder		Tree	16.6	17.2	80%
			Malus fusca	Oregon crabapple		Shrub	16.6	17.2	20%
			Alnus rubra	red alder		Tree	17.2	18.8	100%
			Alnus rubra	red alder		Tree	18.8	20.5	50%
			Symphoricarpos albus	common snowberry		Shrub	18.8	20.5	50%
			Alnus rubra	red alder		Tree	20.5	22.9	100%
			Alnus rubra	red alder		Tree	22.9	29.5	50%
			Ribes sanguineum	red-flowering currant		Shrub	22.9	29.5	50%
			Ribes sanguineum	red-flowering currant		Shrub	29.5	35.8	100%
			Rosa sp.	rose		Shrub	37	55.4	100%
			Rosa sp.	rose		Shrub	55.4	57	50%
			Symphoricarpos albus	common snowberry		Shrub	55.4	57	50%
			Rosa sp.	rose		Shrub	57	58.9	100%
			Alnus rubra	red alder		Tree	58.9	60	50%
			Rosa sp.	rose		Shrub	58.9	60	50%
9/20/2006	F1	F1-4	*Alnus rubra*	red alder		Tree	0	10.2	100%
			Rosa sp.	rose		Shrub	15.7	16	100%
			Spiraea douglasii	rose spirea		Shrub	26.8	27.7	100%
			Fraxinus latifolia	Oregon ash		Tree	36.1	36.8	100%
			Cornus stolonifera	red-osier dogwood		Shrub	40.3	47.8	100%
			Cornus stolonifera	red-osier dogwood		Shrub	54.8	58.1	100%
			Salix scouleriana	Scouler's willow		Tree	58.1	60	50%
			Alnus rubra	red alder		Tree	58.1	60	50%

Table A-10. Year 5 (2006) Riparian Development at Mowitch – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/20/2006	F2	F2-1	*Rosa sp.*	rose		Shrub	0	2	100%
			Rosa sp.	rose		Shrub	5	5.7	100%
			Rosa sp.	rose		Shrub	7.4	8	50%
			Cornus stolonifera	red-osier dogwood		Shrub	7.4	8	50%
			Rosa sp.	rose		Shrub	9.5	10.3	100%
			Cornus stolonifera	red-osier dogwood		Shrub	16.7	17.7	100%
			Symphoricarpos albus	common snowberry		Shrub	31	32.7	100%
			Rosa sp.	rose		Shrub	32.8	36.4	60%
			Symphoricarpos albus	common snowberry		Shrub	32.8	36.4	40%
			Alnus rubra	red alder		Tree	41.5	42.5	100%
			Alnus rubra	red alder		Tree	42.5	48.5	25%
			Salix scouleriana	Scouler's willow		Tree	42.5	48.5	25%
			Rosa sp.	rose		Shrub	42.5	48.5	25%
			Lonicera involucrata	twinberry honeysuckle		Shrub	42.5	48.5	25%
			Alnus rubra	red alder		Tree	48.5	53	33%
			Salix scouleriana	Scouler's willow		Tree	48.5	53	33%
			Rosa sp.	rose		Shrub	48.5	53	33%
			Alnus rubra	red alder		Tree	53	60	70%
			Populus balsamifera	black cottonwood		Tree	53	60	30%
9/20/2006	F2	F2-2	*Rosa sp.*	rose		Shrub	3	6	100%
9/20/2006	F2	F2-3	*Rosa sp.*	rose		Shrub	6	9.5	100%
			Physocarpus capitatus	Pacific ninebark		Shrub	13	14.3	100%
			Rosa sp.	rose		Shrub	18.3	18.7	100%
			Rosa sp.	rose		Shrub	20.8	26	70%
			Salix scouleriana	Scouler's willow		Tree	20.8	26	30%
			Alnus rubra	red alder		Tree	30	30.5	45%
			Rosa sp.	rose		Shrub	30	30.5	10%
			Salix scouleriana	Scouler's willow		Tree	30	30.5	45%
			Alnus rubra	red alder		Tree	33.5	47.5	50%
			Rosa sp.	rose		Shrub	33.5	47.5	50%
			Rosa sp.	rose		Shrub	47.5	48.5	100%
			Rosa sp.	rose		Shrub	50.8	51	100%
			Rosa sp.	rose		Shrub	54	54.5	100%
			Fraxinus latifolia	Oregon ash		Tree	55.5	56.5	100%
			Rosa sp.	rose		Shrub	57	60	100%
9/20/2006	F3	F3-1	*Alnus rubra*	red alder		Tree	0	2	100%
			Alnus rubra	red alder		Tree	2	5	80%
			Rosa sp.	rose		Shrub	2	5	20%
			Malus fusca	Oregon crabapple		Shrub	6.5	9	30%
			Rosa sp.	rose		Shrub	6.5	9	70%
			Rosa sp.	rose		Shrub	9	10	100%
			Symphoricarpos albus	common snowberry		Shrub	10	10.8	100%
			Physocarpus capitatus	Pacific ninebark		Shrub	11.8	14	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	16.5	17	100%
			Fraxinus latifolia	Oregon ash		Tree	20.5	22	100%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	25	31	100%
			Physocarpus capitatus	Pacific ninebark		Shrub	35.5	37.4	100%
			Symphoricarpos albus	common snowberry		Shrub	51	51.7	100%
			Prunus emarginata	bitter cherry		Tree	53.8	54.4	100%

Table A-10. Year 5 (2006) Riparian Development at Mowitch – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/20/2006	F3	F3-2	*Rosa sp.*	rose		Shrub	0	0.6	50%
			Alnus rubra	red alder		Tree	0	0.6	50%
			Alnus rubra	red alder		Tree	0.6	2.2	100%
			Alnus rubra	red alder		Tree	2.2	4.5	70%
			Spiraea douglasii	rose spirea		Shrub	2.2	4.5	30%
			Alnus rubra	red alder		Tree	4.5	6.3	60%
			Rosa sp.	rose		Shrub	4.5	6.3	40%
			Alnus rubra	red alder		Tree	6.3	10	60%
			Salix scouleriana	Scouler's willow		Tree	6.3	10	40%
			Salix scouleriana	Scouler's willow		Tree	10	12.7	100%
			Alnus rubra	red alder		Tree	12.7	16.1	50%
			Rosa sp.	rose		Shrub	12.7	16.1	30%
			Salix scouleriana	Scouler's willow		Tree	12.7	16.1	20%
			Alnus rubra	red alder		Tree	16.1	18.8	100%
			Pinus contorta	shore pine		Tree	18.8	20.7	30%
			Rosa sp.	rose		Shrub	18.8	20.7	20%
			Alnus rubra	red alder		Tree	18.8	20.7	50%
			Rosa sp.	rose		Shrub	22.9	23.9	100%
			Rosa sp.	rose		Shrub	25	26.4	100%
			Cornus stolonifera	red-osier dogwood		Shrub	30.7	31.3	100%
			Physocarpus capitatus	Pacific ninebark		Shrub	36.8	40.3	100%
			Lonicera involucrata	twinberry honeysuckle		Shrub	44.5	45.6	100%
			Physocarpus capitatus	Pacific ninebark		Shrub	48	49.8	100%
			Symphoricarpos albus	common snowberry		Shrub	51.3	52.7	50%
			Picea sitchensis	Sitka spruce		Tree	51.3	52.7	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	58.1	58.3	100%
9/20/2006	F3	F3-3	*Cornus stolonifera*	red-osier dogwood		Shrub	0	2	75%
			Salix scouleriana	Scouler's willow		Tree	0	2	25%
			Cornus stolonifera	red-osier dogwood		Shrub	2	3.8	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	9.7	10.3	100%
			Pinus contorta	shore pine		Tree	25	26.5	100%
9/20/2006	F4	F4-1	*Rosa sp.*	rose		Shrub	0	3.5	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	4.2	5	100%
			Rosa sp.	rose		Shrub	6.7	8.7	60%
			Fraxinus latifolia	Oregon ash		Tree	6.7	8.7	40%
			Rosa sp.	rose		Shrub	8.7	13.3	100%
			Rosa sp.	rose		Shrub	14.7	15.3	50%
			Salix lasiandra	Pacific willow		Tree	14.7	15.3	50%
			Salix lasiandra	Pacific willow		Tree	15.3	17.5	100%
			Thuja plicata	western red cedar		Tree	18.6	19.2	50%
			Salix lasiandra	Pacific willow		Tree	18.6	19.2	50%
			Lupinus sp.	lupine		Herbs/Forbs	21.8	24.5	50%
			Rosa sp.	rose		Shrub	21.8	24.5	50%
			Salix lasiandra	Pacific willow		Tree	24.5	25.6	40%
			Rubus discolor	Himalayan blackberry	X	Shrub	24.5	25.6	40%
			Rosa sp.	rose		Shrub	24.5	25.6	20%
			Salix lasiandra	Pacific willow		Tree	25.7	30	100%
			Lupinus sp.	lupine		Herbs/Forbs	30	32.6	20%
			Lonicera involucrata	twinberry honeysuckle		Shrub	30	32.6	40%
			Alnus rubra	red alder		Tree	30	32.6	40%
			Alnus rubra	red alder		Tree	32.6	35.3	100%
			Lupinus sp.	lupine		Herbs/Forbs	37.1	39.5	100%
			Lupinus sp.	lupine		Herbs/Forbs	39.5	41.7	40%
			Corylus cornuta	beaked hazelnut		Shrub	39.5	41.7	20%
			Rosa sp.	rose		Shrub	39.5	41.7	40%
			Rubus discolor	Himalayan blackberry	X	Shrub	42	42.5	100%
			Rosa sp.	rose		Shrub	42.5	44.5	40%
			Rubus discolor	Himalayan blackberry	X	Shrub	42.5	44.5	60%
			Rubus discolor	Himalayan blackberry	X	Shrub	44.5	50	30%
			Salix scouleriana	Scouler's willow		Tree	44.5	50	70%
			Salix scouleriana	Scouler's willow		Tree	50	56.3	100%
			Rosa sp.	rose		Shrub	56.3	57	20%
			Salix scouleriana	Scouler's willow		Tree	56.3	57	80%
			Salix scouleriana	Scouler's willow		Tree	57	60	100%

Table A-10. Year 5 (2006) Riparian Development at Mowitch – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/20/2006	F4	F4-2	*Fraxinus latifolia*	Oregon ash		Tree	3.7	5	100%
			Salix lasiandra	Pacific willow		Tree	6.5	15	100%
			Salix scouleriana	Scouler's willow		Tree	25.8	26.2	100%
			Lupinus sp.	lupine		Herbs/Forbs	36.7	37.1	100%
			Lupinus sp.	lupine		Herbs/Forbs	38	39.9	100%
			Fraxinus latifolia	Oregon ash		Tree	50.8	51.3	100%
			Rosa sp.	rose		Shrub	59	60	100%
9/20/2006	F4	F4-3	*Salix scouleriana*	Scouler's willow		Tree	0	1.7	100%
			Salix scouleriana	Scouler's willow		Tree	1.7	2.2	70%
			Rubus discolor	Himalayan blackberry	X	Shrub	1.7	2.2	30%
			Salix scouleriana	Scouler's willow		Tree	2.2	3	100%
			Salix scouleriana	Scouler's willow		Tree	5	6.8	50%
			Lupinus sp.	lupine		Herbs/Forbs	5	6.8	50%
			Lupinus sp.	lupine		Herbs/Forbs	7	8.8	33%
			Lonicera involucrata	twinberry honeysuckle		Shrub	7	8.8	33%
			Rubus discolor	Himalayan blackberry	X	Shrub	7	8.8	33%
			Lupinus sp.	lupine		Herbs/Forbs	8.8	14.5	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	8.8	14.5	20%
			Alnus rubra	red alder		Tree	8.8	14.5	30%
			Lupinus sp.	lupine		Herbs/Forbs	15.8	22	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	24.4	29.7	30%
			Lupinus sp.	lupine		Herbs/Forbs	24.4	29.7	70%
			Corylus cornuta	beaked hazelnut		Shrub	29.7	30.5	40%
			Lupinus sp.	lupine		Herbs/Forbs	29.7	30.5	60%
			Salix scouleriana	Scouler's willow		Tree	30.5	32.3	30%
			Lupinus sp.	lupine		Herbs/Forbs	30.5	32.3	70%
			Lupinus sp.	lupine		Herbs/Forbs	32.3	36	100%
			Salix scouleriana	Scouler's willow		Tree	36	39.1	75%
			Lupinus sp.	lupine		Herbs/Forbs	36	39.1	25%
			Rubus discolor	Himalayan blackberry	X	Shrub	40	41	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	48.3	51.4	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	51.4	56.1	20%
			Lupinus sp.	lupine		Herbs/Forbs	51.4	56.1	80%
			Alnus rubra	red alder		Tree	56.1	60	60%
			Rubus discolor	Himalayan blackberry	X	Shrub	56.1	60	40%
9/20/2006	F4	F4-4	*Rosa sp.*	rose		Shrub	2	6	50%
			Salix scouleriana	Scouler's willow		Tree	2	6	50%
			Salix scouleriana	Scouler's willow		Tree	6	9	35%
			Rosa sp.	rose		Shrub	6	9	35%
			Salix lasiandra	Pacific willow		Tree	6	9	10%
			Lupinus sp.	lupine		Herbs/Forbs	6	9	20%
			Salix scouleriana	Scouler's willow		Tree	9	13.5	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	13.5	14	50%
			Salix scouleriana	Scouler's willow		Tree	13.5	14	50%
			Salix scouleriana	Scouler's willow		Tree	14	18.4	100%
			Ribes sanguineum	red-flowering currant		Shrub	25.4	26.8	20%
			Rosa sp.	rose		Shrub	25.4	26.8	80%
			Corylus cornuta	beaked hazelnut		Shrub	29	30	100%
			Lupinus sp.	lupine		Herbs/Forbs	33	39.5	100%
			Alnus rubra	red alder		Tree	45	47	100%
			Alnus rubra	red alder		Tree	47	50.5	20%
			Lupinus sp.	lupine		Herbs/Forbs	47	50.5	80%
			Lupinus sp.	lupine		Herbs/Forbs	50.5	56	50%
			Rosa sp.	rose		Shrub	50.5	56	50%
			Alnus rubra	red alder		Tree	56	60	100%

Table A-10. Year 5 (2006) Riparian Development at Mowitch – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/20/2006	F5	F5-1	*Symphoricarpos albus*	common snowberry		Shrub	18.4	18.8	100%
			Rosa sp.	rose		Shrub	19.5	24.2	100%
			Rosa sp.	rose		Shrub	27	27.4	100%
			Lupinus sp.	lupine		Herbs/Forbs	27.4	30.7	100%
			Rosa sp.	rose		Shrub	30.7	36	50%
			Lupinus sp.	lupine		Herbs/Forbs	30.7	36	50%
			Lupinus sp.	lupine		Herbs/Forbs	36	39	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	39	39.5	100%
			Pseudotsuga menziesii	Douglas fir		Tree	39.5	40.6	100%
			Lupinus sp.	lupine		Herbs/Forbs	40.6	41.7	100%
			Symphoricarpos albus	common snowberry		Shrub	42.5	43.3	100%
			Lupinus sp.	lupine		Herbs/Forbs	44	45	100%
			Symphoricarpos albus	common snowberry		Shrub	45	45.5	100%
			Lupinus sp.	lupine		Herbs/Forbs	47.7	48.4	100%
			Lupinus sp.	lupine		Herbs/Forbs	55.4	56	100%
9/20/2006	F5	F5-2	*Lupinus sp.*	lupine		Herbs/Forbs	0	2	100%
			Pseudotsuga menziesii	Douglas fir		Tree	4.3	5.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	9.7	10.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	11	12	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	12.8	13.3	100%
			Lupinus sp.	lupine		Herbs/Forbs	23	28.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	28.3	28.8	100%
			Lupinus sp.	lupine		Herbs/Forbs	28.8	31.2	100%
			Lupinus sp.	lupine		Herbs/Forbs	31.2	32	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	31.2	32	50%
			Lupinus sp.	lupine		Herbs/Forbs	32	33	70%
			Melilotus alba	white sweet-clover	X	Herbs/Forbs	32	33	30%
			Melilotus alba	white sweet-clover	X	Herbs/Forbs	33	33.7	50%
			Symphoricarpos albus	common snowberry		Shrub	33	33.7	50%
			Melilotus alba	white sweet-clover	X	Herbs/Forbs	33.7	36	10%
			Lupinus sp.	lupine		Herbs/Forbs	33.7	36	90%
			Lupinus sp.	lupine		Herbs/Forbs	37	37.7	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	37	37.7	50%
			Lupinus sp.	lupine		Herbs/Forbs	37.7	46	100%
			Lupinus sp.	lupine		Herbs/Forbs	55.3	56.5	100%
			Lupinus sp.	lupine		Herbs/Forbs	59	59.5	100%

Table A-10. Year 5 (2006) Riparian Development at Mowitch – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/20/2006	F5	F5-3	*Rosa sp.*	rose		Shrub	12.2	13	100%
			Lupinus sp.	lupine		Herbs/Forbs	13	14	30%
			Rosa sp.	rose		Shrub	13	14	70%
			Pseudotsuga menziesii	Douglas fir		Tree	15.3	16.3	60%
			Melilotus alba	white sweet-clover	X	Herbs/Forbs	15.3	16.3	40%
			Rosa sp.	rose		Shrub	16.3	17.3	30%
			Pseudotsuga menziesii	Douglas fir		Tree	16.3	17.3	60%
			Lupinus sp.	lupine		Herbs/Forbs	16.3	17.3	10%
			Rosa sp.	rose		Shrub	17.3	20.6	50%
			Lupinus sp.	lupine		Herbs/Forbs	17.3	20.6	50%
			Rosa sp.	rose		Shrub	20.6	26.3	100%
			Lupinus sp.	lupine		Herbs/Forbs	27.5	28	100%
			Rosa sp.	rose		Shrub	28.8	29.2	100%
			Lupinus sp.	lupine		Herbs/Forbs	30.8	32.3	100%
			Lupinus sp.	lupine		Herbs/Forbs	35.3	35.8	100%
			Rosa sp.	rose		Shrub	36.4	36.7	100%
			Rosa sp.	rose		Shrub	38.3	40.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	54.8	55.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	56.6	57.8	100%
			Lupinus sp.	lupine		Herbs/Forbs	57.8	60	50%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	57.8	60	50%
9/29/2006	F6	F6-1	*Phalaris arundinacea*	reed canarygrass	X	Graminoid	0	3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	3	8	100%
			Rosa sp.	rose		Shrub	8.4	12	100%
			Rosa sp.	rose		Shrub	12	15	80%
			Rubus discolor	Himalayan blackberry	X	Shrub	12	15	20%
			Rosa sp.	rose		Shrub	16	19	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	16	19	50%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	19	20.5	100%
			Pinus contorta	shore pine		Tree	21	21.1	100%
			Alnus rubra	red alder		Tree	25	27	65%
			Oemleria cerasiformis	Indian plum		Shrub	25	27	35%
			Alnus rubra	red alder		Tree	27	31	100%
			Salix scouleriana	Scouler's willow		Tree	33	33.5	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	37	37.7	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	40	40.1	100%
			Mahonia aquifolium	tall Oregon grape		Shrub	55.8	56	100%
9/29/2006	F6	F6-2	*Salix scouleriana*	Scouler's willow		Tree	0	9.3	80%
			Rubus discolor	Himalayan blackberry	X	Shrub	0	9.3	20%
			Rosa sp.	rose		Shrub	10.4	10.7	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	12.5	13	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	19.5	20	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	22.7	23.3	100%
			Salix scouleriana	Scouler's willow		Tree	31.5	33.5	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	33.5	34	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	38.5	39.2	100%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	42.5	46	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	47.5	49	100%
			Cornus stolonifera	red-osier dogwood		Shrub	51.5	54	80%
			Alnus rubra	red alder		Tree	51.5	54	20%
			Alnus rubra	red alder		Tree	54	60	100%

Table A-10. Year 5 (2006) Riparian Development at Mowitch – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/29/2006	F6	F6-3	*Phalaris arundinacea*	reed canarygrass	X	Graminoid	0	2	100%
			Cornus stolonifera	red-osier dogwood		Shrub	8.7	12.5	100%
			Rosa sp.	rose		Shrub	17.8	19.3	50%
			Alnus rubra	red alder		Tree	17.8	19.3	50%
			Rosa sp.	rose		Shrub	19.3	25.6	20%
			Cornus stolonifera	red-osier dogwood		Shrub	19.3	25.6	60%
			Alnus rubra	red alder		Tree	19.3	25.6	20%
			Cornus stolonifera	red-osier dogwood		Shrub	25.6	30	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	30	34	20%
			Alnus rubra	red alder		Tree	30	34	80%
			Alnus rubra	red alder		Tree	34	36	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	47.8	50.5	100%
			Alnus rubra	red alder		Tree	50.5	53	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	50.5	53	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	55	60	100%
9/29/2006	F6	F6-4	*Rosa sp.*	rose		Shrub	5	5.5	100%
			Malus fusca	Oregon crabapple		Shrub	10	10.5	100%
			Fraxinus latifolia	Oregon ash		Tree	12	15.5	80%
			Rubus discolor	Himalayan blackberry	X	Shrub	12	15.5	20%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	18.2	20.3	100%
			Rosa sp.	rose		Shrub	20.3	23.3	100%
			Pinus contorta	shore pine		Tree	23.3	27	100%
			Robinia pseudoacacia	black locust	X	Tree	28	32.5	100%
			Rosa sp.	rose		Shrub	34	37	100%
			Alnus rubra	red alder		Tree	47	49.7	100%
			Pinus contorta	shore pine		Tree	58.5	60	100%
9/29/2006	F7	F7-1	*Cornus stolonifera*	red-osier dogwood		Shrub	0	5	50%
			Alnus rubra	red alder		Tree	0	5	50%
			Cornus stolonifera	red-osier dogwood		Shrub	6	6.5	100%
			Cornus stolonifera	red-osier dogwood		Shrub	9.5	12.8	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	12.8	12.9	100%
			Cornus stolonifera	red-osier dogwood		Shrub	12.9	15	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	17.5	17.6	100%
			Cornus stolonifera	red-osier dogwood		Shrub	19	21.3	100%
			Cornus stolonifera	red-osier dogwood		Shrub	21.3	21.5	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	21.3	21.5	50%
			Cornus stolonifera	red-osier dogwood		Shrub	21.5	27.7	80%
			Rubus discolor	Himalayan blackberry	X	Shrub	21.5	27.7	20%
			Cornus stolonifera	red-osier dogwood		Shrub	27.7	33.6	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	33.6	33.7	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	38	41.5	40%
			Cornus stolonifera	red-osier dogwood		Shrub	38	41.5	60%
			Rubus discolor	Himalayan blackberry	X	Shrub	48.5	48.6	100%
			Alnus rubra	red alder		Tree	58.5	60	100%

Table A-10. Year 5 (2006) Riparian Development at Mowitch – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/29/2006	F7	F7-2	*Cornus stolonifera*	red-osier dogwood		Shrub	1	2	100%
			Alnus rubra	red alder		Tree	2	5	100%
			Cornus stolonifera	red-osier dogwood		Shrub	5	9	60%
			Alnus rubra	red alder		Tree	5	9	40%
			Alnus rubra	red alder		Tree	9	12	100%
			Alnus rubra	red alder		Tree	12	24.5	40%
			Cornus stolonifera	red-osier dogwood		Shrub	12	24.5	60%
			Picea sitchensis	Sitka spruce		Tree	25.5	26.3	100%
			Alnus rubra	red alder		Tree	30	30.3	100%
			Cornus stolonifera	red-osier dogwood		Shrub	30.3	36	40%
			Alnus rubra	red alder		Tree	30.3	36	60%
			Alnus rubra	red alder		Tree	36	53	50%
			Rosa sp.	rose		Shrub	36	53	50%
			Rosa sp.	rose		Shrub	53	59.5	70%
			Thuja plicata	western red cedar		Tree	53	59.5	30%
			Rubus discolor	Himalayan blackberry	X	Shrub	59.5	60	50%
			Pinus contorta	shore pine		Tree	59.5	60	50%
9/29/2006	F7	F7-3	*Alnus rubra*	red alder		Tree	0	0.5	50%
			Salix sitchensis	Sitka willow		Tree	0	0.5	50%
			Alnus rubra	red alder		Tree	0.5	11	100%
			Alnus rubra	red alder		Tree	11	12.5	60%
			Cornus stolonifera	red-osier dogwood		Shrub	11	12.5	30%
			Rosa sp.	rose		Shrub	11	12.5	10%
			Alnus rubra	red alder		Tree	12.5	19	30%
			Rosa nutkana	nootka rose		Shrub	12.5	19	70%
			Rosa sp.	rose		Shrub	19.3	19.8	100%
			Rosa sp.	rose		Shrub	20.1	21	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	26.9	27	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	31	32	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	32	34.3	20%
			Alnus rubra	red alder		Tree	32	34.3	20%
			Symphoricarpos albus	common snowberry		Shrub	32	34.3	60%
			Rosa sp.	rose		Shrub	34.3	35	100%
			Alnus rubra	red alder		Tree	35	43	45%
			Rosa sp.	rose		Shrub	35	43	45%
			Lupinus sp.	lupine		Herbs/Forbs	35	43	10%
			Picea sitchensis	Sitka spruce		Tree	43	44.8	50%
			Rosa sp.	rose		Shrub	43	44.8	45%
			Alnus rubra	red alder		Tree	43	44.8	5%
			Rosa nutkana	nootka rose		Shrub	44.8	46	80%
			Alnus rubra	red alder		Tree	44.8	46	20%
			Rosa nutkana	nootka rose		Shrub	46	48.6	80%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	46	48.6	20%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	48.6	55	10%
			Rosa nutkana	nootka rose		Shrub	48.6	55	60%
			Thuja plicata	western red cedar		Tree	48.6	55	30%
			Pinus contorta	shore pine		Tree	56	58	20%
			Rosa sp.	rose		Shrub	56	58	70%
			Rubus discolor	Himalayan blackberry	X	Shrub	56	58	10%
			Rosa sp.	rose		Shrub	58	59.5	100%
			Pseudotsuga menziesii	Douglas fir		Tree	59.5	60	10%
			Physocarpus capitatus	Pacific ninebark		Shrub	59.5	60	10%
			Rosa sp.	rose		Shrub	59.5	60	80%

Table A-11. Year 5 (2006) Riparian Development at Mowitch – Cover

Cover Class	Plant Scientific Name	Stratified Mean (Standard Estimate)	Bootstrap Estimate		
			Stratified Mean	95% CI	
				Lower Limit	Upper Limit
Native					
	Cornus stolonifera	4.2%	4.2%	2.1%	7.7%
	Corylus cornuta	0.11%	0.11%	0.048%	0.22%
	Lonicera involucrata	0.39%	0.39%	0.11%	0.71%
	Mahonia aquifolium	0.013%	0.012%	0.00%	0.026%
	Malus fusca	0.092%	0.092%	0.013%	0.20%
	Oemleria cerasiformis	0.046%	0.045%	0%	0.092%
	Physocarpus capitatus	0.67%	0.67%	0.25%	1.2%
	Ribes sanguineum	1.0%	1.0%	0%	3.1%
	Rosa nutkana	0.30%	0.54%	0%	1.1%
	Rosa sp.	11%	11%	7.2%	18%
	Spiraea douglasii	0.14%	0.13%	0%	0.33%
	Symphoricarpos albus	0.81%	0.80%	0.33%	1.4%
Total Native Shrubs		19%	20%	14%	27%
	Alnus rubra	11%	11%	8.3%	14%
	Fraxinus latifolia	0.91%	0.92%	0.41%	1.8%
	Picea sitchensis	0.12%	0.13%	0.04%	0.21%
	Pinus contorta	0.87%	0.86%	0.21%	2.3%
	Populus balsamifera	0.14%	0.15%	0%	0.29%
	Prunus emarginata	0.037%	0.037%	0%	0.074%
	Pseudotsuga menziesii	0.21%	0.21%	0.20%	0.23%
	Salix lasiandra	1.0%	1.1%	0.038%	2.1%
	Salix scouleriana	4.5%	4.5%	2.6%	7.5%
	Salix sitchensis	0.012%	0.011%	0%	0.024%
	Thuja plicata	0.21%	0.21%	0.038%	0.32%
Total Native Trees		19%	19%	15%	24%
	Total Native	**39%**	**39%**	**30%**	**48%**
Non-Native or Invasive					
Graminoid	*Phalaris arundinacea*	1.2%	1.2%	0.74%	2.1%
Herb	*Lathyrus sp.*	0.056%	0.053%	0%	0.11%
	Melilotus alba	0.082%	0.081%	0%	0.17%
Total Non-native or Invasive Herbs		0.14%	0.14%	0.03%	0.28%
Shrubs	*Rubus discolor*	3.3%	3.3%	2.0%	4.8%
Trees	*Robinia pseudoacacia*	0.55%	0.29%	0%	0.59%
	Total Non-native or Invasive	**4.9%**	**4.9%**	**3.7%**	**6.4%**

Table A-12. Years 1, 3, and 5 (2006) Riparian Development at Mowitch – Cover

Cover Type	Year 1 (2002)			Year 3 (2004)				Year 5 (2006)				
	Unbiased Average Quadrat Canopy Cover	90% Confidence Interval		Year 3 Targets	Unbiased Average Quadrat Canopy Cover	90% Confidence Interval		Year 5 Targets	Stratified Mean (Standard Estimate)	Stratified Mean (Bootstrap Estimate)	95% Confidence Interval (Bias-Corrected Bootstrap Estimate)	
		Lower Bound	Upper Bound			Lower Bound	Upper Bound				Lower Bound	Upper Bound
NATIVE												
Herbs & Forbs	16.9%	11.6%	22.2%	>70%	120.4%	104.5%	136.3%	-	n/a	n/a	n/a	n/a
Shrubs	5.0%	3.3%	6.7%	>30%	20.5%	10.7%	30.3%	>50%	19.4%	19.7%	14.2%	27.1%
Trees	1.5%	0.1%	2.9%	>25%	26.1%	11.7%	40.5%	>40%	19.3%	19.3%	15.2%	23.6%
TOTAL NATIVE	10.7%	7.5%	13.8%		76.5%	55.6%	97.4%		38.6%	38.8%	29.7%	47.6%
TOTAL NNI	12.5%	8.6%	16.5%	<2%	89.4%	79.8%	99.0%	<5%	4.9%	4.9%	3.7%	6.4%

n/a = Not assessed

Note:
It is not appropriate to compare directly the results from various years because the estimates were calculated differently. Also note that the Years 1 and 3 results included herbs and forbs in the totals, while herbs and forbs were not a monitoring component in Year 5.

Table A-13. Year 5 (2006) Riparian Development at Squally Beach – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/27/2006	Alder Grove	AG-1	*Alnus rubra*	red alder		Tree	12	15.7	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	15.7	18.4	50%
			Alnus rubra	red alder		Tree	15.7	18.4	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	18.4	27.5	40%
			Salix hookeriana	Hooker's willow		Tree	18.4	27.5	30%
			Alnus rubra	red alder		Tree	18.4	27.5	30%
			Salix hookeriana	Hooker's willow		Tree	27.5	32.8	100%
			Salix hookeriana	Hooker's willow		Tree	32.8	34	50%
			Alnus rubra	red alder		Tree	32.8	34	50%
			Alnus rubra	red alder		Tree	34	40	20%
			Rubus discolor	Himalayan blackberry	X	Shrub	34	40	40%
			Salix hookeriana	Hooker's willow		Tree	34	40	40%
			Rubus discolor	Himalayan blackberry	X	Shrub	40	41.4	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	45	45.8	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	46.8	47.2	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	49.7	51	100%
			Salix hookeriana	Hooker's willow		Tree	51	55.1	100%
			Alnus rubra	red alder		Tree	55.1	60	40%
			Salix hookeriana	Hooker's willow		Tree	55.1	60	40%
			Rubus discolor	Himalayan blackberry	X	Shrub	55.1	60	20%
9/27/2006	Alder Grove	AG-2	*Ribes sanguineum*	red-flowering currant		Shrub	0	1.3	40%
			Rosa sp.	rose		Shrub	0	1.3	20%
			Alnus rubra	red alder		Tree	0	60	100%
			Rosa sp.	rose		Shrub	1.3	2	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	2.8	4	20%
			Symphoricarpos albus	common snowberry		Shrub	4	5.8	20%
			Rubus discolor	Himalayan blackberry	X	Shrub	4	5.8	20%
			Mahonia nervosa	dull Oregon-grape		Shrub	4	5.8	30%
			Ribes sanguineum	red-flowering currant		Shrub	14.4	16	40%
			Pseudotsuga menziesii	Douglas fir		Tree	20.7	21.1	50%
			Salix hookeriana	Hooker's willow		Tree	21.1	22.5	20%
			Pseudotsuga menziesii	Douglas fir		Tree	21.1	22.5	40%
			Pseudotsuga menziesii	Douglas fir		Tree	22.5	24.7	50%
			Pseudotsuga menziesii	Douglas fir		Tree	24.7	26	40%
			Corylus cornuta	beaked hazelnut		Shrub	24.7	26	10%
			Oemleria cerasiformis	Indian plum		Shrub	24.7	26	20%
			Oemleria cerasiformis	Indian plum		Shrub	26	27.1	20%
			Lonicera involucrata	twinberry honeysuckle		Shrub	26	27.1	30%
			Lonicera involucrata	twinberry honeysuckle		Shrub	27.1	30	30%
			Symphoricarpos albus	common snowberry		Shrub	30	32.3	20%
			Rubus discolor	Himalayan blackberry	X	Shrub	30	32.3	30%
			Symphoricarpos albus	common snowberry		Shrub	32.3	34.3	30%
			Cornus stolonifera	red-osier dogwood		Shrub	32.3	34.3	30%
			Rosa sp.	rose		Shrub	34.3	36	20%
			Symphoricarpos albus	common snowberry		Shrub	34.3	36	30%
			Corylus cornuta	beaked hazelnut		Shrub	36	37	20%
			Rosa sp.	rose		Shrub	36	37	40%
			Rosa sp.	rose		Shrub	36	41.7	50%
			Pseudotsuga menziesii	Douglas fir		Tree	41.7	47	40%
			Cornus stolonifera	red-osier dogwood		Shrub	41.7	47	20%
			Ribes sanguineum	red-flowering currant		Shrub	56	57	20%

Table A-13. Year 5 (2006) Riparian Development at Squally Beach – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/27/2006	Alder Grove	AG-3	*Rosa sp.*	rose		Shrub	0	5	30%
			Symphoricarpos albus	common snowberry		Shrub	0	5	30%
			Alnus rubra	red alder		Tree	0	60	100%
			Salix hookeriana	Hooker's willow		Tree	5	10	20%
			Symphoricarpos albus	common snowberry		Shrub	5	10	40%
			Rosa sp.	rose		Shrub	16.5	25	50%
			Salix hookeriana	Hooker's willow		Tree	16.5	25	20%
			Rosa sp.	rose		Shrub	25	27.5	40%
			Salix hookeriana	Hooker's willow		Tree	25	27.5	20%
			Cornus stolonifera	red-osier dogwood		Shrub	25	27.5	20%
			Rosa sp.	rose		Shrub	27.5	29	50%
			Salix hookeriana	Hooker's willow		Tree	27.5	29	20%
			Rosa sp.	rose		Shrub	29	32	50%
			Cornus stolonifera	red-osier dogwood		Shrub	29	32	20%
			Cornus stolonifera	red-osier dogwood		Shrub	32	36	40%
			Symphoricarpos albus	common snowberry		Shrub	32	36	30%
			Cornus stolonifera	red-osier dogwood		Shrub	36	38.4	30%
			Ribes sanguineum	red-flowering currant		Shrub	36	38.4	10%
			Symphoricarpos albus	common snowberry		Shrub	36	38.4	20%
			Symphoricarpos albus	common snowberry		Shrub	38.4	39	60%
			Gaultheria shallon	salal		Shrub	44.5	45.5	70%
			Cornus stolonifera	red-osier dogwood		Shrub	56.5	57	10%
			Cornus stolonifera	red-osier dogwood		Shrub	57	60	10%
			Rosa sp.	rose		Shrub	57	60	50%
9/27/2006	East Woods	EW-1	*Rubus discolor*	Himalayan blackberry	X	Shrub	0	8	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	8	33	30%
			Alnus rubra	red alder		Tree	8	33	70%
			Alnus rubra	red alder		Tree	33	42	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	42	46	20%
			Alnus rubra	red alder		Tree	42	46	80%
			Alnus rubra	red alder		Tree	46	51	100%
			Symphoricarpos albus	common snowberry		Shrub	51	53	30%
			Alnus rubra	red alder		Tree	51	53	70%
			Physocarpus capitatus	Pacific ninebark		Shrub	53	58	40%
			Alnus rubra	red alder		Tree	53	58	40%
			Rosa sp.	rose		Shrub	53	58	20%
			Physocarpus capitatus	Pacific ninebark		Shrub	58	59	70%
			Symphoricarpos albus	common snowberry		Shrub	58	59	30%
			Rosa sp.	rose		Shrub	59	60	40%
			Salix hookeriana	Hooker's willow		Tree	59	60	60%
9/27/2006	East Woods	EW-2	*Rubus discolor*	Himalayan blackberry	X	Shrub	0	5.8	100%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	5.8	6	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	8.8	9.6	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	10	10.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	11.8	13.4	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	14.3	16	100%
			Alnus rubra	red alder		Tree	16.8	17.5	100%
			Alnus rubra	red alder		Tree	17.5	18.3	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	17.5	18.3	50%
			Alnus rubra	red alder		Tree	18.3	21	100%
			Alnus rubra	red alder		Tree	21	49	60%
			Rubus discolor	Himalayan blackberry	X	Shrub	21	49	40%
			Rubus discolor	Himalayan blackberry	X	Shrub	49	52	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	52	53	50%
			Symphoricarpos albus	common snowberry		Shrub	52	53	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	56	57.5	100%
			Salix hookeriana	Hooker's willow		Tree	58	60	40%
			Rosa sp.	rose		Shrub	58	60	60%

Table A-13. Year 5 (2006) Riparian Development at Squally Beach – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/27/2006	East Woods	EW-3	*Alnus rubra*	red alder		Tree	0	11	50%
			Salix hookeriana	Hooker's willow		Tree	0	11	50%
			Salix hookeriana	Hooker's willow		Tree	11	15.5	100%
			Alnus rubra	red alder		Tree	15.5	17	50%
			Salix hookeriana	Hooker's willow		Tree	15.5	17	50%
			Salix hookeriana	Hooker's willow		Tree	17	30	100%
			Salix hookeriana	Hooker's willow		Tree	30	33	80%
			Alnus rubra	red alder		Tree	30	33	20%
			Salix hookeriana	Hooker's willow		Tree	33	43	100%
			Alnus rubra	red alder		Tree	43	49	40%
			Salix hookeriana	Hooker's willow		Tree	43	49	60%
			Salix hookeriana	Hooker's willow		Tree	49	58	100%
			Alnus rubra	red alder		Tree	58	60	100%
9/27/2006	East Woods	EW-4	*Salix hookeriana*	Hooker's willow		Tree	0	8	100%
			Salix hookeriana	Hooker's willow		Tree	9.3	18.6	100%
			Salix hookeriana	Hooker's willow		Tree	18.6	20	30%
			Populus balsamifera	black cottonwood		Tree	18.6	20	70%
			Salix hookeriana	Hooker's willow		Tree	21	21.5	100%
			Salix hookeriana	Hooker's willow		Tree	23	49	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	50	50.3	100%
			Salix hookeriana	Hooker's willow		Tree	52.5	53.5	100%
			Salix hookeriana	Hooker's willow		Tree	57.5	59	100%
			Salix hookeriana	Hooker's willow		Tree	59	60	80%
			Rubus discolor	Himalayan blackberry	X	Shrub	59	60	20%
9/29/2006	West Woods	WW-1	*Rosa sp.*	rose		Shrub	0	16	20%
			Rubus discolor	Himalayan blackberry	X	Shrub	0	16	40%
			Alnus rubra	red alder		Tree	0	16	40%
			Rosa sp.	rose		Shrub	16	22	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	16	22	50%
			Pseudotsuga menziesii	Douglas fir		Tree	22	27	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	22	27	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	27	32	100%
			Rosa sp.	rose		Shrub	34	36	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	36	37	100%
			Symphoricarpos albus	common snowberry		Shrub	38	40	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	40	40.5	100%
			Symphoricarpos albus	common snowberry		Shrub	45	49	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	45	49	50%
			Holodiscus discolor	oceanspray		Shrub	50	51	50%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	50	51	50%
			Rosa sp.	rose		Shrub	51	53	40%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	51	53	20%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	51	53	40%
			Rosa sp.	rose		Shrub	53	58	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	58	58.1	20%
			Rosa sp.	rose		Shrub	58	58.1	80%
			Rosa sp.	rose		Shrub	58.1	60	100%

Table A-13. Year 5 (2006) Riparian Development at Squally Beach – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/29/2006	West Woods	WW-2	*Rubus discolor*	Himalayan blackberry	X	Shrub	0	10	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	13	19.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	19.3	21	50%
			Rosa sp.	rose		Shrub	19.3	21	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	21	23	100%
			Rosa sp.	rose		Shrub	23	25	30%
			Rubus discolor	Himalayan blackberry	X	Shrub	23	25	70%
			Rubus discolor	Himalayan blackberry	X	Shrub	25	28.5	100%
			Rosa sp.	rose		Shrub	28.5	30.5	70%
			Rubus discolor	Himalayan blackberry	X	Shrub	28.5	30.5	30%
			Rubus discolor	Himalayan blackberry	X	Shrub	33	33.1	50%
			Pinus contorta	shore pine		Tree	33	33.1	50%
			Pinus contorta	shore pine		Tree	33.3	33.9	100%
			Symphoricarpos albus	common snowberry		Shrub	34.3	35.7	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	35.7	36.5	100%
			Holodiscus discolor	oceanspray		Shrub	36.5	39.5	45%
			Rubus discolor	Himalayan blackberry	X	Shrub	36.5	39.5	5%
			Cornus stolonifera	red-osier dogwood		Shrub	36.5	39.5	50%
			Alnus rubra	red alder		Tree	39.5	42.5	100%
			Alnus rubra	red alder		Tree	42.5	44	50%
			Rosa sp.	rose		Shrub	42.5	44	50%
			Pseudotsuga menziesii	Douglas fir		Tree	44	50	5%
			Holodiscus discolor	oceanspray		Shrub	44	50	35%
			Rubus discolor	Himalayan blackberry	X	Shrub	44	50	35%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	44	50	25%
			Rubus discolor	Himalayan blackberry	X	Shrub	50	54	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	54	60	5%
			Pseudotsuga menziesii	Douglas fir		Tree	54	60	75%
			Salix hookeriana	Hooker's willow		Tree	54	60	20%
9/29/2006	West Woods	WW-3	*Rubus discolor*	Himalayan blackberry	X	Shrub	0	6.8	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	8	8.5	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	10.6	15.8	50%
			Salix hookeriana	Hooker's willow		Tree	10.6	15.8	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	15.8	16.6	30%
			Rosa sp.	rose		Shrub	15.8	16.6	70%
			Rubus discolor	Himalayan blackberry	X	Shrub	16.6	31	100%
			Rosa sp.	rose		Shrub	31	31.5	20%
			Rubus discolor	Himalayan blackberry	X	Shrub	31	31.5	80%
			Rubus discolor	Himalayan blackberry	X	Shrub	31.5	32.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	32.3	36.5	70%
			Rosa sp.	rose		Shrub	32.3	36.5	30%
			Alnus rubra	red alder		Tree	36.5	60	34%
			Rubus discolor	Himalayan blackberry	X	Shrub	36.5	60	33%
			Rosa sp.	rose		Shrub	36.5	60	33%

Table A-13. Year 5 (2006) Riparian Development at Squally Beach – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/28/2006	West Woods	WW-4	*Rubus discolor*	Himalayan blackberry	X	Shrub	0	3	33%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	0	3	33%
			Holodiscus discolor	oceanspray		Shrub	0	3	33%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	3	5.5	15%
			Rosa sp.	rose		Shrub	3	5.5	35%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	3	5.5	15%
			Holodiscus discolor	oceanspray		Shrub	3	5.5	35%
			Rosa sp.	rose		Shrub	5.5	12	100%
			Rosa sp.	rose		Shrub	12	18	70%
			Rubus discolor	Himalayan blackberry	X	Shrub	12	18	30%
			Rubus discolor	Himalayan blackberry	X	Shrub	18	23.5	30%
			Holodiscus discolor	oceanspray		Shrub	18	23.5	50%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	18	23.5	20%
			Rosa sp.	rose		Shrub	23.5	31	80%
			Rubus discolor	Himalayan blackberry	X	Shrub	23.5	31	20%
			Salix hookeriana	Hooker's willow		Tree	31	34.5	40%
			Rosa sp.	rose		Shrub	31	34.5	60%
			Rubus discolor	Himalayan blackberry	X	Shrub	34.5	36	20%
			Salix hookeriana	Hooker's willow		Tree	34.5	36	80%
			Salix hookeriana	Hooker's willow		Tree	36	47	50%
			Rosa sp.	rose		Shrub	36	47	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	47	51	30%
			Salix hookeriana	Hooker's willow		Tree	47	51	70%
			Rubus discolor	Himalayan blackberry	X	Shrub	51	60	40%
			Rosa sp.	rose		Shrub	51	60	40%
			Alnus rubra	red alder		Tree	51	60	20%
9/28/2006	West Woods	WW-5	*Rubus discolor*	Himalayan blackberry	X	Shrub	0	14	10%
			Salix hookeriana	Hooker's willow		Tree	0	14	90%
			Cornus stolonifera	red-osier dogwood		Shrub	14	19.5	100%
			Salix hookeriana	Hooker's willow		Tree	19.5	42	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	42	46	30%
			Salix hookeriana	Hooker's willow		Tree	42	46	70%
			Rosa sp.	rose		Shrub	46	50	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	46	50	10%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	46	50	20%
			Salix hookeriana	Hooker's willow		Tree	46	50	20%
			Salix hookeriana	Hooker's willow		Tree	50	60	20%
			Rubus discolor	Himalayan blackberry	X	Shrub	50	60	10%
			Alnus rubra	red alder		Tree	50	60	70%

Table A-14. Year 5 (2006) Riparian Development at Squally Beach – Cover

Cover Class	Plant Scientific Name	Stratified Mean (Standard Estimate)	Bootstrap Estimate		
			Stratified Mean	95% CI	
				Lower Limit	Upper Limit
Native					
	Cornus stolonifera	1.4%	1.4%	0.48%	2.8%
	Corylus cornuta	0.048%	0.048%	0%	0.10%
	Gaultheria shallon	0.10%	0.10%	0%	0.20%
	Holodiscus discolor	0.77%	0.77%	0.090%	1.7%
	Lonicera involucrata	0.17%	0.18%	0%	0.35%
	Mahonia nervosa	0.078%	0.079%	0%	0.16%
	Oemleria cerasiformis	0.069%	0.068%	0%	0.14%
	Physocarpus capitatus	0.53%	0.53%	0%	1.1%
	Ribes sanguineum	0.23%	0.23%	0%	0.43%
	Rosa sp.	8.1%	8.0%	3.8%	13%
	Symphoricarpos albus	1.8%	1.8%	0.64%	3.4%
Total Native Shrubs		13%	13%	7.4%	19%
	Alnus rubra	35%	35%	21%	51%
	Pinus contorta	0.059%	0.061%	0%	0.12%
	Populus balsamifera	0.19%	0.19%	0%	0.38%
	Pseudotsuga menziesii	1.3%	1.3%	0%	2.6%
	Salix hookeriana	27%	27%	9.5%	49%
Total Native Trees		64%	64%	50%	78%
	Total Native	**77%**	**77%**	**59%**	**92%**
Non-Native or Invasive					
Graminoid	*Phalaris arundinacea*	0.28%	0.28%	0.019%	0.48%
Herb	*Lathyrus sp.*	0.38%	0.38%	0.12%	0.67%
	Rubus discolor	20%	20%	9.3%	30%
	Total Non-native or Invasive	**21%**	**21%**	**11%**	**30%**

Table A-15. Years 1, 3, and 5 (2006) Riparian Development at Squally Beach – Cover

Cover Type	Year 1 (2002)			Year 3 (2004)				Year 5 (2006)				
	Unbiased Average Quadrat Canopy Cover	90% Confidence Interval		Year 3 Targets	Unbiased Average Quadrat Canopy Cover	90% Confidence Interval		Year 5 Targets	Stratified Mean (Standard Estimate)	Stratified Mean (Bootstrap Estimate)	95% Confidence Interval (Bias-Corrected Bootstrap Estimate)	
		Lower Bound	Upper Bound			Lower Bound	Upper Bound				Lower Bound	Upper Bound
NATIVE												
Herbs & Forbs	38.7%	22.2%	55.1%	>70%	105.6%	39.5%	171.8%	-	n/a	n/a	n/a	n/a
Shrubs	3.2%	0.9%	5.4%	>30%	65.4%	0.0%	148.5%	>50%	13.3%	13.2%	7.4%	18.8%
Trees	2.7%	0.9%	4.4%	>25%	101.9%	37.8%	165.9%	>40%	63.7%	63.7%	49.5%	77.6%
TOTAL NATIVE	13.5%	3.0%	23.9%		117.9%	77.7%	158.2%		77.0%	77.3%	59.5%	92.5%
TOTAL NNI	38.1%	21.8%	54.5%	<2%	102.1%	75.4%	128.8%	<5%	20.5%	20.5%	10.9%	30.4%

n/a = Not assessed

Note:
It is not appropriate to compare directly the results from various years because the estimates were calculated differently. Also note that the Years 1 and 3 results included herbs and forbs in the totals, while herbs and forbs were not a monitoring component in Year 5.

Table A-16. Year 5 (2006) Riparian Development at Middle Waterway (Simpson/Trustees) – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/15/2006	North Bank	NB-1	*Thuja plicata*	western red cedar		Tree	5	9	100%
			Pseudotsuga menziesii	Douglas fir		Tree	10.7	21.5	100%
			Thuja plicata	western red cedar		Tree	29.7	35	100%
			Prunus emarginata	bitter cherry		Tree	35	36.3	30%
			Thuja plicata	western red cedar		Tree	35	36.3	70%
			Prunus emarginata	bitter cherry		Tree	36.3	41.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	41.4	41.6	100%
			Thuja plicata	western red cedar		Tree	49.7	57	100%
9/15/2006	North Bank	NB-2	*Populus balsamifera*	black cottonwood		Tree	0	5	100%
			Rosa nutkana	nootka rose		Shrub	17.1	23.4	100%
			Acer circinatum	vine maple		Shrub	24.6	29.3	40%
			Symphoricarpos albus	common snowberry		Shrub	24.6	29.3	40%
			Rosa nutkana	nootka rose		Shrub	24.6	29.3	20%
			Rubus discolor	Himalayan blackberry	X	Shrub	30.3	33.3	30%
			Rosa nutkana	nootka rose		Shrub	30.3	33.3	70%
			Acer circinatum	vine maple		Shrub	34.4	39	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	49.8	51.3	100%
9/15/2006	North Bank	NB-3	*Pseudotsuga menziesii*	Douglas fir		Tree	8	12	50%
			Populus balsamifera	black cottonwood		Tree	8	12	50%
			Populus balsamifera	black cottonwood		Tree	12	15	100%
			Holodiscus discolor	oceanspray		Shrub	15	19.5	80%
			Populus balsamifera	black cottonwood		Tree	15	19.5	20%
			Populus balsamifera	black cottonwood		Tree	19.5	22.8	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	22.8	26	90%
			Buddleja davidii	butterfly bush	X	Shrub	22.8	26	50%
			Populus balsamifera	black cottonwood		Tree	22.8	26	50%
			Pinus contorta	shore pine		Tree	26	30.4	80%
			Populus balsamifera	black cottonwood		Tree	26	30.4	20%
			Populus balsamifera	black cottonwood		Tree	30.4	37.3	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	37.3	39.8	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	41.5	43	20%
			Populus balsamifera	black cottonwood		Tree	41.5	43	80%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	43	46.7	100%
			Populus balsamifera	black cottonwood		Tree	57	60	50%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	57	60	50%
9/15/2006	North Bank	NB-4	*Pseudotsuga menziesii*	Douglas fir		Tree	0	12.5	100%
			unclassified-shrub	unclassified-shrub	X	Shrub	25	27.5	100%
			Pseudotsuga menziesii	Douglas fir		Tree	31.5	41.8	100%
			Populus balsamifera	black cottonwood		Tree	45.5	50.5	20%
			Pseudotsuga menziesii	Douglas fir		Tree	45.5	50.5	80%
			Prunus emarginata	bitter cherry		Tree	50.5	53.3	20%
			Pseudotsuga menziesii	Douglas fir		Tree	50.5	53.3	40%
			Symphoricarpos albus	common snowberry		Shrub	50.5	53.3	20%
			Prunus emarginata	bitter cherry		Tree	53.3	55.8	100%
			Pseudotsuga menziesii	Douglas fir		Tree	55.8	60	90%
			Prunus emarginata	bitter cherry		Tree	55.8	60	10%
9/15/2006	North Bank	NB-5	*Arctostaphylos uva-ursi*	kinnikinnick		Shrub	14.4	17.5	50%
			Populus balsamifera	black cottonwood		Tree	14.4	17.5	50%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	24	24.5	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	32	35.3	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	43.8	49.7	100%
			Thuja plicata	western red cedar		Tree	51	55	100%
			Pinus contorta	shore pine		Tree	55	60	100%

Table A-16. Year 5 (2006) Riparian Development at Middle Waterway (Simpson/Trustees) – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/15/2006	North Woods	NW-1	*Hedera helix*	English ivy	X	Vine	0	1.7	100%
			Symphoricarpos albus	common snowberry		Shrub	1.7	3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	3.2	3.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	3.8	4	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	4.6	4.8	100%
			Hedera helix	English ivy	X	Vine	6	6.3	100%
			Hedera helix	English ivy	X	Vine	7	13.5	10%
			Rubus discolor	Himalayan blackberry	X	Shrub	7	13.5	5%
			Pseudotsuga menziesii	Douglas fir		Tree	7	13.5	85%
			Pseudotsuga menziesii	Douglas fir		Tree	13.5	25.5	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	25.5	26	5%
			Pseudotsuga menziesii	Douglas fir		Tree	25.5	26	95%
			Pseudotsuga menziesii	Douglas fir		Tree	26	33.4	100%
			Rosa nutkana	nootka rose		Shrub	33.4	37	30%
			Pseudotsuga menziesii	Douglas fir		Tree	33.4	37	60%
			Symphoricarpos albus	common snowberry		Shrub	33.4	37	5%
			Populus balsamifera	black cottonwood		Tree	33.4	37	5%
			Populus balsamifera	black cottonwood		Tree	37	40.8	50%
			Rosa nutkana	nootka rose		Shrub	37	40.8	50%
			Rosa nutkana	nootka rose		Shrub	40.8	42.6	70%
			Arbutus menziesii	madrone		Tree	40.8	42.6	25%
			Rubus discolor	Himalayan blackberry	X	Shrub	40.8	42.6	5%
			Pinus contorta	shore pine		Tree	42.7	43	50%
			Rosa nutkana	nootka rose		Shrub	42.7	43	50%
			Pinus contorta	shore pine		Tree	43	50	100%
			Picea sitchensis	Sitka spruce		Tree	50	53	100%
			Thuja plicata	western red cedar		Tree	53	55	50%
			Picea sitchensis	Sitka spruce		Tree	53	55	50%
			Thuja plicata	western red cedar		Tree	55	59	100%
			Rosa nutkana	nootka rose		Shrub	59	60	100%
9/15/2006	North Woods	NW-2	*Symphoricarpos albus*	common snowberry		Shrub	0.8	1.8	100%
			Rosa nutkana	nootka rose		Shrub	1.8	24	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	24	29	10%
			Salix scouleriana	Scouler's willow		Tree	24	29	30%
			Lonicera involucrata	twinberry honeysuckle		Shrub	24	29	20%
			Rosa nutkana	nootka rose		Shrub	24	29	40%
			Salix scouleriana	Scouler's willow		Tree	29	37	50%
			Rosa nutkana	nootka rose		Shrub	29	37	50%
			Pseudotsuga menziesii	Douglas fir		Tree	37	40	50%
			Populus balsamifera	black cottonwood		Tree	37	40	50%
			Populus balsamifera	black cottonwood		Tree	40	42	5%
			Pseudotsuga menziesii	Douglas fir		Tree	40	42	60%
			Rosa nutkana	nootka rose		Shrub	40	42	35%
			Populus balsamifera	black cottonwood		Tree	42	60	40%
			Rosa nutkana	nootka rose		Shrub	42	60	60%

Table A-16. Year 5 (2006) Riparian Development at Middle Waterway (Simpson/Trustees) – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/15/2006	North Woods	NW-3	*Pseudotsuga menziesii*	Douglas fir		Tree	0	4	45%
			Rubus discolor	Himalayan blackberry	X	Shrub	0	4	5%
			Prunus emarginata	bitter cherry		Tree	0	4	45%
			Rosa pisocarpa	cluster rose		Shrub	0	4	5%
			Rosa pisocarpa	cluster rose		Shrub	4	29	100%
			Populus balsamifera	black cottonwood		Tree	29	35	50%
			Rosa pisocarpa	cluster rose		Shrub	29	35	50%
			Rosa pisocarpa	cluster rose		Shrub	35	38	80%
			Populus balsamifera	black cottonwood		Tree	35	38	20%
			Hedera helix	English ivy	X	Vine	38	41.5	20%
			Prunus emarginata	bitter cherry		Tree	38	41.5	80%
			Oemleria cerasiformis	Indian plum		Shrub	41.5	42.6	20%
			Prunus emarginata	bitter cherry		Tree	41.5	42.6	60%
			Populus balsamifera	black cottonwood		Tree	41.5	42.6	20%
			Populus balsamifera	black cottonwood		Tree	42.6	49	40%
			Pseudotsuga menziesii	Douglas fir		Tree	42.6	49	60%
			Pseudotsuga menziesii	Douglas fir		Tree	49	57	100%
			Pseudotsuga menziesii	Douglas fir		Tree	57	58.3	75%
			Rubus discolor	Himalayan blackberry	X	Shrub	57	58.3	5%
			Prunus emarginata	bitter cherry		Tree	57	58.3	20%
			Rubus discolor	Himalayan blackberry	X	Shrub	58.3	60	100%
9/13/2006	South Bank	SB-1	*Arctostaphylos uva-ursi*	kinnikinnick		Shrub	3.5	14	100%
			unclassified-shrub	unclassified-shrub	X	Shrub	14	14.8	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	18.8	19.8	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	23	26	70%
			Arbutus menziesii	madrone		Tree	23	26	30%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	33.4	34.7	50%
			Rosa nutkana	nootka rose		Shrub	33.4	34.7	50%
			Populus balsamifera	black cottonwood		Tree	35	43	100%
			Populus balsamifera	black cottonwood		Tree	43	44	70%
			Arbutus menziesii	madrone		Tree	43	44	30%
			Pseudotsuga menziesii	Douglas fir		Tree	44	50.4	50%
			Populus balsamifera	black cottonwood		Tree	44	50.4	50%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	52	53	100%
9/13/2006	South Bank	SB-2	*Populus balsamifera*	black cottonwood		Tree	0	30	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	30.5	31	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	34	38	10%
			Buddleja davidii	butterfly bush	X	Shrub	34	38	90%
			Rubus discolor	Himalayan blackberry	X	Shrub	41	41.1	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	43.5	44	100%
			Populus balsamifera	black cottonwood		Tree	45	60	95%
			Rubus discolor	Himalayan blackberry	X	Shrub	45	60	5%
9/13/2006	South Bank	SB-3	*Malus fusca*	Oregon crabapple		Shrub	0	4	60%
			Pseudotsuga menziesii	Douglas fir		Tree	0	4	40%
			Pseudotsuga menziesii	Douglas fir		Tree	4	9	100%
			Symphoricarpos albus	common snowberry		Shrub	9	14	40%
			Pseudotsuga menziesii	Douglas fir		Tree	9	14	60%
			Malus fusca	Oregon crabapple		Shrub	17	24	100%
			Ribes sanguineum	red-flowering currant		Shrub	24	32	100%
			Symphoricarpos albus	common snowberry		Shrub	44.3	45	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	50.2	50.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	52.3	52.4	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	53.3	60	50%
			Rosa nutkana	nootka rose		Shrub	53.3	60	50%

Table A-16. Year 5 (2006) Riparian Development at Middle Waterway (Simpson/Trustees) – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/13/2006	South Bank	SB-4	*Arbutus menziesii*	madrone		Tree	0	3.5	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	9.8	10	100%
			Symphoricarpos albus	common snowberry		Shrub	10.4	10.8	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	14.2	14.3	100%
			Pseudotsuga menziesii	Douglas fir		Tree	31.2	33	100%
			Populus balsamifera	black cottonwood		Tree	33	36.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	46.2	50.4	100%
			Populus balsamifera	black cottonwood		Tree	57	60	100%
9/13/2006	South Bank	SB-5	*Arctostaphylos uva-ursi*	kinnikinnick		Shrub	0	0.4	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	6.6	8.3	100%
			Pinus contorta	shore pine		Tree	8.3	10	95%
			Rubus discolor	Himalayan blackberry	X	Shrub	8.3	10	5%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	10	11	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	11	12	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	11	12	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	12	14.3	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	14.3	14.8	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	14.3	14.8	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	14.8	20	100%
			Populus balsamifera	black cottonwood		Tree	20	24	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	20	24	50%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	20	24	100%
			Buddleja davidii	butterfly bush	X	Shrub	24	26	80%
			Rubus discolor	Himalayan blackberry	X	Shrub	24	26	20%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	24	26	100%
			Arctostaphylos uva-ursi	kinnikinnick		Shrub	35	38.5	100%
9/12/2006	South Woods	SW-1	*Lathyrus sp.*	pea vine	X	Herbs/Forbs	2	3	100%
			Rosa nutkana	nootka rose		Shrub	9.4	11.7	100%
			Rosa pisocarpa	cluster rose		Shrub	18.2	22	100%
			Melilotus alba	white sweet-clover	X	Herbs/Forbs	25	28.4	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	27	27.7	100%
			Melilotus alba	white sweet-clover	X	Herbs/Forbs	30	33	100%
			Acer macrophyllum	bigleaf maple		Tree	47	59	100%
9/12/2006	South Woods	SW-2	*Acer macrophyllum*	bigleaf maple		Tree	12.5	34	100%
			Cornus stolonifera	red-osier dogwood		Shrub	19.3	19.7	100%
			Melilotus officinalis	yellow sweetclover	X	Herbs/Forbs	47	49	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	52.3	52.4	100%
			Arbutus menziesii	madrone		Tree	57	60	100%
9/12/2006	South Woods	SW-3	*Rubus discolor*	Himalayan blackberry	X	Shrub	0.8	1.3	100%
			Rosa pisocarpa	cluster rose		Shrub	1.3	2.5	100%
			Melilotus officinalis	yellow sweetclover	X	Herbs/Forbs	6	7.5	100%
			Arbutus menziesii	madrone		Tree	9.8	10.7	100%
			Melilotus alba	white sweet-clover	X	Herbs/Forbs	15.5	18	100%
			Salix scouleriana	Scouler's willow		Tree	19	20	100%
			Arbutus menziesii	madrone		Tree	36.5	38.5	100%
			Salix scouleriana	Scouler's willow		Tree	41.2	41.5	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	45	49	5%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	45	49	5%
			Rosa nutkana	nootka rose		Shrub	45	49	90%
			Rubus discolor	Himalayan blackberry	X	Shrub	50	50.1	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	51.2	56	5%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	51.2	56	95%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	58.5	60	100%

Table A-16. Year 5 (2006) Riparian Development at Middle Waterway (Simpson/Trustees) – Collected Data

Date	Zone	Transect	Scientific Name	Common Name	NNI	Cover Class	Start	End	Percent Cover
9/12/2006	South Woods	SW-4	*Pinus contorta*	shore pine		Tree	0	0.7	100%
			Rosa nutkana	nootka rose		Shrub	5.7	6.8	100%
			Rosa nutkana	nootka rose		Shrub	11	12.5	100%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	13.5	37.5	100%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	37.5	44	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	37.5	44	50%
			Salix sitchensis	Sitka willow		Tree	44	47	30%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	44	47	70%
			Salix sitchensis	Sitka willow		Tree	47	60	15%
			Rosa nutkana	nootka rose		Shrub	47	60	70%
			Phalaris arundinacea	reed canarygrass	X	Graminoid	47	60	10%
			Rubus discolor	Himalayan blackberry	X	Shrub	47	60	5%
9/12/2006	South Woods	SW-5	*Pseudotsuga menziesii*	Douglas fir		Tree	0	3	100%
			Amelanchier alnifolia	Saskatoon serviceberry		Shrub	3	4	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	10.6	12.3	100%
			Pinus contorta	shore pine		Tree	18.5	26	100%
			Pseudotsuga menziesii	Douglas fir		Tree	27	36	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	36	37	100%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	37	38.3	100%
			Pseudotsuga menziesii	Douglas fir		Tree	41	48	50%
			Picea sitchensis	Sitka spruce		Tree	41	48	50%
			Pinus contorta	shore pine		Tree	52.5	59.8	100%
			Symphoricarpos albus	common snowberry		Shrub	59.8	60	50%
			Pinus contorta	shore pine		Tree	59.8	60	50%
9/12/2006	South Woods	SW-6	*Phalaris arundinacea*	reed canarygrass	X	Graminoid	0	8	100%
			Rosa nutkana	nootka rose		Shrub	8	11	60%
			Holodiscus discolor	oceanspray		Shrub	8	11	40%
			Rubus discolor	Himalayan blackberry	X	Shrub	12	17	50%
			Symphoricarpos albus	common snowberry		Shrub	12	17	50%
			Rosa nutkana	nootka rose		Shrub	18	22	85%
			Rubus discolor	Himalayan blackberry	X	Shrub	18	22	10%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	18	22	5%
			Rosa nutkana	nootka rose		Shrub	22.5	26	70%
			Rubus discolor	Himalayan blackberry	X	Shrub	22.5	26	30%
			Rubus discolor	Himalayan blackberry	X	Shrub	26	29.5	100%
			Amelanchier alnifolia	Saskatoon serviceberry		Shrub	30	36	80%
			Rubus discolor	Himalayan blackberry	X	Shrub	30	36	20%
			Rubus discolor	Himalayan blackberry	X	Shrub	36.5	45.7	100%
			Amelanchier alnifolia	Saskatoon serviceberry		Shrub	45.7	51	80%
			Rubus discolor	Himalayan blackberry	X	Shrub	45.7	51	20%
			Rubus discolor	Himalayan blackberry	X	Shrub	51	60	100%
9/12/2006	South Woods	SW-7	*Rubus discolor*	Himalayan blackberry	X	Shrub	0	2	50%
			Rosa nutkana	nootka rose		Shrub	0	2	50%
			Rubus discolor	Himalayan blackberry	X	Shrub	2	5	100%
			Rosa nutkana	nootka rose		Shrub	6.8	6.9	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	8.3	15.4	30%
			Pinus contorta	shore pine		Tree	8.3	15.4	70%
			Rubus discolor	Himalayan blackberry	X	Shrub	15.4	21	100%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	21	23	30%
			Rosa nutkana	nootka rose		Shrub	21	23	70%
			Pinus contorta	shore pine		Tree	24.5	25.5	95%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	24.5	25.5	5%
			Pinus contorta	shore pine		Tree	25.5	28	100%
			Pinus contorta	shore pine		Tree	28	31.4	50%
			Rosa nutkana	nootka rose		Shrub	28	31.4	50%
			Rosa nutkana	nootka rose		Shrub	31.4	37.5	90%
			Lathyrus sp.	pea vine	X	Herbs/Forbs	31.4	37.5	10%
			Rosa nutkana	nootka rose		Shrub	38.5	39.2	100%
			Rosa nutkana	nootka rose		Shrub	41	45.5	100%
			Rubus discolor	Himalayan blackberry	X	Shrub	55.4	55.5	100%
			Rosa nutkana	nootka rose		Shrub	58.5	60	100%

Table A-17. Year 5 (2006) Riparian Development at Middle Waterway (Simpson/Trustees) – Cover

Cover Class	Plant Scientific Name	Stratified Mean (Standard Estimate)	Bootstrap Estimate		
			Stratified Mean	95% CI	
				Lower Limit	Upper Limit
Native					
Shrubs	*Acer circinatum*	0.55%	0.55%	0%	1.1%
	Amelanchier alnifolia	0.83%	0.82%	0%	3.0%
	Arctostaphylos uva-ursi	4.9%	4.9%	1.3%	9.4%
	Cornus stolonifera	0.033%	0.034%	0%	0.066%
	Holodiscus discolor	0.41%	0.40%	0%	1.2%
	Lonicera involucrata	0.077%	0.077%	0%	0.15%
	Malus fusca	0.82%	0.85%	0%	2.4%
	Oemleria cerasiformis	0.017%	0.017%	0%	0.034%
	Ribes sanguineum	0.69%	0.66%	0%	2.0%
	Rosa nutkana	8.0%	8.0%	3.6%	15%
	Rosa pisocarpa	2.8%	2.7%	0.20%	8.1%
	Symphoricarpos albus	0.88%	0.89%	0.35%	1.7%
Total Native Shrubs		20%	20%	13%	26%
Trees	*Acer macrophyllum*	2.8%	2.7%	0%	7.1%
	Arbutus menziesii	0.93%	0.93%	0.30%	1.8%
	Picea sitchensis	3.5%	0.60%	0%	1.2%
	Pinus contorta	0.60%	3.5%	1.4%	7.3%
	Populus balsamifera	9.4%	9.2%	4.3%	19%
	Prunus emarginata	1.2%	1.2%	0.30%	2.5%
	Pseudotsuga menziesii	9.8%	9.9%	5.3%	17%
	Salix scouleriana	0.53%	0.52%	0%	1.5%
	Salix sitchensis	0.23%	0.24%	0%	0.47%
	Thuja plicata	2.2%	2.3%	0.39%	6.3%
Total Native Trees		31%	31%	23%	42%
	Total Native	**51%**	**51%**	**45%**	**58%**
Non-Native or Invasive					
Graminoid	*Phalaris arundinacea*	3.3%	3.3%	0.25%	10%
Herb	*Lathyrus sp.*	0.70%	0.70%	0.26%	1.8%
	Melilotus alba	0.73%	0.76%	0%	2.0%
	Melilotus officinalis	0.29%	0.29%	0%	0.66%
Total Non-native or Invasive Herbs		5.0%	5.0%	2.4%	12%
Shrubs	*Buddleja davidii*	0.59%	0.60%	0.14%	1.3%
	Rubus discolor	5.8%	5.8%	3.1%	12%
	unclassified-shrub	0.28%	0.29%	0%	0.78%
Total Non-native or Invasive Shrubs		6.7%	6.8%	3.7%	13%
Vines	*Hedera helix*	0.26%	0.27%	0%	0.61%
	Total Non-native or Invasive	**12%**	**12%**	**7.3%**	**19%**

Table A-18. Years 1, 3, and 5 (2006) Riparian Development at Middle Waterway (Simpson/Trustees) – Cover

Cover Type	Year 1 (2002)			Year 3 (2004)				Year 5 (2006)				
	Unbiased Average Quadrat Canopy Cover	90% Confidence Interval		Year 3 Targets	Unbiased Average Quadrat Canopy Cover	90% Confidence Interval		Year 5 Targets	Stratified Mean (Standard Estimate)	Stratified Mean (Bootstrap Estimate)	95% Confidence Interval (Bias-Corrected Bootstrap Estimate)	
		Lower Bound	Upper Bound			Lower Bound	Upper Bound				Lower Bound	Upper Bound
NATIVE												
Herbs & Forbs	59.4%	42.5%	76.2%	>70%	64.0%	26.6%	101.5%	-	n/a	n/a	n/a	n/a
Shrubs	39.7%	13.1%	66.3%	>30%	50.5%	0.0%	103.8%	>50%	20.1%	20.2%	12.7%	26.4%
Trees	27.1%	4.3%	49.8%	>25%	30.8%	6.2%	55.3%	>40%	31.2%	31.3%	23.3%	41.8%
TOTAL NATIVE	70.4%	40.2%	100.6%		55.4%	36.5%	74.4%		51.2%	51.2%	44.7%	57.8%
TOTAL NNI	51.7%	33.4%	70.1%	<2%	69.1%	28.6%	109.6%	<5%	12.0%	11.9%	7.3%	19.0%

n/a = Not assessed

Note:
It is not appropriate to compare directly the results from various years because the estimates were calculated differently. Also note that the Years 1 and 3 results included herbs and forbs in the totals, while herbs and forbs were not a monitoring component in Year 5.

Table A-19. Year 5 (2006) Fish Monitoring: Site Data at Hylebos Creek Off-Channel (Jordan)

Date	Time	High Tide	Low Tide	Weather	Temperature/Salinity[1]					Overall Visibility	Temp./Sal.[1]		Overall Visibility	Comments
					Reach 1	Reach 2	Reach 3	Pool 3	Pool 5		Creek 1	Creek 5		
4/28/2006	11:30am	11.7' 5:06am	(-2.2') 12:04pm	Sunny						Poor			Good	No data collected; Equipment needed on another site
5/4/2006	12:30pm	8.0' 9:22am	0.8' 4:49pm	Sunny	15.2/0.2	14.2/0.1	14.3/0.1	15.3/0.5	17.3/4.2	Poor	15.3/0.2	13.3/0.1	Good	Visibility poor in Reaches 1-3 due to algae bloom
5/11/2006	12:00pm	10.2' 5:50pm	0.1' 10:46am	Sunny	12.8/0.2	12.5/0.1	12.6/0.1	19.5/8.5	14.5/0.2	Fair	12.8/0.2	12/0.1	Good	Visibility poor in Reaches 1-3 due to algae bloom
5/18/2006	11:30am	9.3' 7:45am	(-1.4') 3:23pm	Sunny/Hot ~80F	17/0.4	16/0.6	15.6/0.1	19.3/15.5	16.8/0.2	Poor	17.3/0.4	14.4/0.1	Poor	Visibility poor in Reaches 1-3 due to algae bloom
5/24/2006	1:05pm	10.1' 9:40am	(-0.6') 9:40am	Raining	14.8/0.2	14.2/0.2	13.7/0.2	15.2/0.2	24.3/11	Poor	15.1/0.2	14/0.2	None	Visibility low due to rain/runoff
6/8/2006	11:30am	9.8' 5:06pm	0.0' 9:37am	Overcast						Fair			None	No data collected; Equipment needed on another site
6/15/2006	12:00pm	9.7' 6:50am	(-2.3') 2:14pm	Partly cloudy	16/0.2	17/1.4	17.6/0.2	17.4/1.4	17.6/0.2	Good	14.9/0.1		Good	
6/23/2006	11:15am	11.2' 5:45pm	(-2.4') 10:02am	Sunny	17/0.2					Fair		14.3/0.1	Good	
7/20/2006	12:35pm	9.9' 3:47pm	(-1.0') 8:03am	Sunny						Fair			Good	No data collected; Equipment needed on another site
8/7/2006	11:40am	11.5' 5:50pm	(-2.0') 9:58am	Sunny						Fair			Good	No data collected; Equipment needed on another site

Notes:

[1] Water temperature measured in degrees Celsius, salinity measured in parts per thousand (ppt).

Table A-20. Year 5 (2006) Fish Monitoring: Fish Survey Results at Hylebos Creek Off-Channel (Jordan)

Off-Channel Area Reach 1								
Date	Chinook	Coho	Trout	Flat Fish	Sculpins	Stickleback	Other	Comments
4/28/2006						1		
5/4/2006						35		
5/11/2006					1			
5/18/2006				1 (larva)		50		
5/24/2006								No visibility
6/8/2006				5 (larvae)	4	115		
6/15/2006		3 (150-200mm)	1ct (150-350mm)	10 (larvae)	25	160	2 (1greenling?/1crappie?)	Coho and trout in rootwad
6/23/2006				18 (larvae)	4	250		
7/20/2006					1	50	15 (shiners)	
8/7/2006				20 (larvae)	5	200+	10 (shiners)	
Reach total	0	3	1	54	40	861+	17	

Off-Channel Area Reach 2								
Date	Chinook	Coho	Trout	Flat Fish	Sculpins	Stickleback	Other	Comments
4/28/2006						2		
5/4/2006								Algae; too shallow
5/11/2006								Algae; too shallow
5/18/2006								Algae; too shallow
5/24/2006				1 (larva)		1		
6/8/2006				10	5	10		
6/15/2006				4		200+		
6/23/2006								Algae; too shallow
7/20/2006						300+	5 (shiner)	
8/7/2006					10	200+		
Reach total	0	0	0	15	15	713+	5	

Off-Channel Area Reach 3								
Date	Chinook	Coho	Trout	Flat Fish	Sculpins	Stickleback	Other	Comments
All Dates								Too shallow

Table A-20. Year 5 (2006) Fish Monitoring: Fish Survey Results at Hylebos Creek Off-Channel (Jordan)

Creek Reach 1								
Date	Chinook	Coho	Trout	Flat Fish	Sculpins	Stickleback	Other	Comments
4/28/2006								
5/4/2006								
5/11/2006								
5/18/2006								
5/24/2006								
6/8/2006				2				
6/15/2006								
6/23/2006								
7/20/2006			9 (150-350mm) (6r, 3ct)		20 (~60-160 mm)			
8/7/2006					10	15	3 (shiner)	
Reach total	0	0	9	2	22	15	3	

Creek Reach 2								
Date	Chinook	Coho	Trout	Flat Fish	Sculpins	Stickleback	Other	Comments
4/28/2006								
5/4/2006								
5/11/2006		30 (80-100mm)				1		coho had adipose
5/18/2006								
5/24/2006								
6/8/2006								
6/15/2006				5	5			
6/23/2006	1 (120-150mm	1 (51-80mm)		10	1	10		
7/20/2006		1 (80-100mm)		6		100	100 (shiners)	
8/7/2006					5	500	2 (shiners)	
Reach total	1	32	0	21	11	611	102	

Table A-20. Year 5 (2006) Fish Monitoring: Fish Survey Results at Hylebos Creek Off-Channel (Jordan)

Creek Reach 3								
Date	Chinook	Coho	Trout	Flat Fish	Sculpins	Stickleback	Other	Comments
4/28/2006					1			
5/4/2006								
5/11/2006								
5/18/2006			1 (150-350mm)					
5/24/2006								
6/8/2006								
6/15/2006								
6/23/2006	5 (80-100mm)	3 (80-100mm)	6 (150-350mm) (4r,2ct)	10		30		
7/20/2006		6 (80-100mm)		5		200		
8/7/2006								
Reach total	5	9	7	15	1	230	0	
Creek Reach 4								
Date	Chinook	Coho	Trout	Flat Fish	Sculpins	Stickleback	Other	Comments
All Dates								Too shallow
Creek Reach 5								
Date	Chinook	Coho	Trout	Flat Fish	Sculpins	Stickleback	Other	Comments
All Dates								Too shallow
Overall total	**6**	**44**	**17**	**107**	**89**	**2430**	**127**	

Notes:
r = rainbow trout (*Oncorhynchus mykiss*)
ct = cutthroat trout (*Oncorhynchus clarkii*)

Table A-21. Year 5 (2006) Seasonal Bird Counts at Sha Dadx (Forest)

Common Name	Scientific Name	Total	Winter	Spring	Summer	Fall
American crow	*Corvus brachyrhynchos*	5				5
American goldfinch	*Carduelis tristis*	50	3	12	10	25
American robin	*Turdus migratorius*	16	1	6	7	2
barn owl	*Tyto alba*	3			2	1
Bewick's wren	*Thryomanes bewickii*	6			2	4
black-capped chickadee	*Poecile atricapilla*	34	2	3	10	19
black-headed grosbeak	*Pheucticus melanocephalus*	2			2	
bushtit	*Psaltriparus minimus*	36		13	1	22
Canada goose	*Branta canadensis*	50				50
cedar waxwing	*Bombycilla cedrorum*	8		4	4	
chestnut-backed chickadee	*Poecile rufescens*					
crow	*Corvus sp.*	16	16			
downy woodpecker	*Picoides pubescens*	11		2	3	6
glaucous-winged gull	*Larus glaucescens*	2	1			1
golden-crowned kinglet	*Regulus satrapa*	1				1
green-winged teal	*Anas crecca*	18				18
house finch	*Carpodacus mexicanus*	7			3	4
killdeer	*Charadrius vociferus*	2				2
mallard	*Anas platyrhynchos*	23	1			22
mourning dove	*Zenaida macroura*	1		1		
northern harrier	*Circus cyaneus*	1	1			
Oregon junco	*Junco hyemalis*	2	2			
red-shafted flicker	*Colaptes auratus cafer*	3				3
red-tailed hawk	*Buteo jamaicensis*	2			2	
ruby-crowned kinglet	*Regulus calendula*	3	1			2
rufous hummingbird	*Selasphorus rufus*	2			2	
song sparrow	*Melospiza melodia*	17	4	3	5	5
spotted towhee	*Pipilo maculatus*	2			1	1
Steller's jay	*Cyanocitta stelleri*	8	2			6
Swainson's thrush	*Catharus ustulatus*	5			5	
swallow	*Tachycineta sp.*	8		8		
varied thrush	*Ixoreus naevius*	2				2
warbling vireo	*Vireo gilvus*	8		3	5	
western scrub jay	*Aphelocoma californica*	1	1			
western tanager	*Piranga ludoviciana*	2		2		
western wood-pewee	*Contopus sordidulus*	1			1	
yellow warbler	*Dendroica petechia*	2		1	1	

Table A-22. Year 5 (2006) Seasonal Bird Counts at Sha Dadx (Meadow)

Common Name	Scientific Name	Total	Winter	Spring	Summer	Fall
American crow	Corvus brachyrhynchos	4				4
American goldfinch	Carduelis tristis	74		5	18	51
American robin	Turdus migratorius	14	1	6	2	5
barn owl	Tyto alba	1				1
barn swallow	Hirundo rustica	3			3	
Bewick's wren	Thryomanes bewickii	2		1		1
black-capped chickadee	Poecile atricapilla	11	2	1	3	5
black-headed grosbeak	Pheucticus melanocephalus	4			4	
Brewer's blackbird	Euphagus cyanocephalus	40	40			
Caspian tern	Sterna caspia	2			2	
cedar waxwing	Bombycilla cedrorum	3			3	
cliff swallow	Petrochelidon pyrrhonota	8			8	
common yellowthroat	Geothylpis trichas	11		4	7	
crow	Corvus sp.	37	1		6	30
double-crested cormorant	Phalacrocorax auritus	1		1		
downy woodpecker	Picoides pubescens	2			1	1
European starling	Sturnus vulgaris	25	10		15	
fox sparrow	Passerella iliaca	1	1			
glaucous-winged gull	Larus glaucescens	14	12			2
great blue heron	Ardea herodias	3			2	1
green-winged teal	Anas crecca	2	2			
house finch	Carpodacus mexicanus	26		1	2	23
Lincoln's sparrow	Melospiza lincolnii	1				1
mallard	Anas platyrhynchos	28	11	2		15
Oregon junco	Junco hyemalis	7	7			
osprey	Pandion haliaetus	1		1		
peregrine falcon	Falco peregrinus	1				1
red-shafted flicker	Colaptes auratus cafer	2				2
red-tailed hawk	Buteo jamaicensis	5		3	2	
red-winged blackbird	Agelaius phoeniceus	1	1			
rock dove	Columba livia	17	1			16
savannah sparrow	Passerculus sandwichensis	8			2	6
song sparrow	Melospiza melodia	28	3	3	11	11
spotted sandpiper	Actitis macularia	1		1		
spotted towhee	Pipilo maculatus	1		1		
Steller's jay	Cyanocitta stelleri	4		2		2
tree swallow	Tachycineta bicolor	17		15	2	
unknown	unknown	3			3	
violet-green swallow	Tachycineta thalassina	15		15		
western scrub jay	Aphelocoma californica	3	1	1	1	
western wood-pewee	Contopus sordidulus	1			1	
willow flycatcher	Empidonax traillii	2		1	1	
yellow warbler	Dendroica petechia	4		2	2	
yellow-rumped warbler	Dendroica coronata	1				1
yellow-throated warbler	Dendroica dominica	3			3	

Table A-23. Year 5 (2006) Bird Use at Sha Dadx (Forest)

Date	BirdCommonName	BirdScientificName	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier/Pilings	Riparian	Marsh	Intertidal	MudFlats	Open Water	Comments
4/26/2006	American goldfinch	*Carduelis tristis*	U	2	M		X		X							fly-over
	American robin	*Turdus migratorius*	M	3	M	X	X									2 seen, 2 heard; singing, 1 fledgling, scolding
	black-capped chickadee	*Poecile atricapilla*	U	3	M		X									foraging, calling
	bushtit	*Psaltriparus minimus*	U	13	M	X	X									foraging
	mourning dove	*Zenaida macroura*	U	1	M		X									singing
	song sparrow	*Melospiza melodia*	U	2	M		X									singing
	swallow	*Tachycineta sp.*	U	8	M	X	X									foraging
	yellow warbler	*Dendroica petechia*	U	1	M	X										foraging
5/31/2006	American goldfinch	*Carduelis tristis*	U	10			X		X							
	American robin	*Turdus migratorius*		3		X					X					
	cedar waxwing	*Bombycilla cedrorum*	U	4		X	X				X					foraging
	downy woodpecker	*Picoides pubescens*		2		X	X				X					entered nest hole
	song sparrow	*Melospiza melodia*	M	1		X					X					foraging; singing
	warbling vireo	*Vireo gilvus*	M	3		X	X				X					singing
	western tanager	*Piranga ludoviciana*	U	2			X				X					2 singing
6/20/2006	American goldfinch	*Carduelis tristis*	U	6	L	X	X		X		X					flyover
	American robin	*Turdus migratorius*		3	L		X				X					scolding
	barn owl	*Tyto alba*	U	1	L	X					X					sat ~30 mins, scolded by robins etc., then flew to another tree on-site
	Bewick's wren	*Thryomanes bewickii*	M	1	L		X				X					singing
	bushtit	*Psaltriparus minimus*	U	1	L	X	X				X					foraging
	red-tailed hawk	*Buteo jamaicensis*	U	1	L	X					X					perched; soaring
	rufous hummingbird	*Selasphorus rufus*	U	1	L		X		X		X					flyover
	song sparrow	*Melospiza melodia*	M	2	L	X					X					edge of meadow; singing
	Swainson's thrush	*Catharus ustulatus*	M	2	L		X				X					singing
	warbling vireo	*Vireo gilvus*	M	1	L		X				X					singing
6/29/2006	American robin	*Turdus migratorius*	U	4			X				X					
	barn owl	*Tyto alba*	U	1		X					X					Flushed from ivy-covered tree
	Bewick's wren	*Thryomanes bewickii*	M	1		X					X					
	black-capped chickadee	*Poecile atricapilla*	U	2			X				X					
	black-headed grosbeak	*Pheucticus melanocephalus*	M	2			X				X					
	cedar waxwing	*Bombycilla cedrorum*	U	4			X				X					number: 3-5
	downy woodpecker	*Picoides pubescens*	U	1		X	X				X					scolding me
	red-tailed hawk	*Buteo jamaicensis*	U	1			X		X		X					
	rufous hummingbird	*Selasphorus rufus*	M	1		X					X					foraging on insects
	song sparrow	*Melospiza melodia*	M	3			X				X					edge - 1 POW
	spotted towhee	*Pipilo maculatus*	U	1			X				X					
	Swainson's thrush	*Catharus ustulatus*	M	1			X				X					
	warbling vireo	*Vireo gilvus*		3			X				X					number: 2-3
	western wood-pewee	*Contopus sordidulus*	M	1			X				X					
	yellow warbler	*Dendroica petechia*	M	1			X				X					edge

Table A-23. Year 5 (2006) Bird Use at Sha Dadx (Forest)

Date	BirdCommonName	BirdScientificName	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier/Pilings	Riparian	Marsh	Intertidal	MudFlats	Open Water	Comments
7/20/2006	American goldfinch	*Carduelis tristis*	U	4			X		X		X					flyover and in riparian treetops
	black-capped chickadee	*Poecile atricapilla*	U	8		X	X					X				foraging; begging juveniles
	downy woodpecker	*Picoides pubescens*	U	2		X	X				X					scolding whinny
	house finch	*Carpodacus mexicanus*	M	3			X				X					singing
	Swainson's thrush	*Catharus ustulatus*		2			X				X					singing
	warbling vireo	*Vireo gilvus*	M	1			X				X					
9/29/2006	American goldfinch	*Carduelis tristis*	U	10	H		X		X							flyover
	barn owl	*Tyto alba*	U	1	H	X			X		X					roosting; scared it up twice
	Bewick's wren	*Thryomanes bewickii*	U	1	H	X	X				X					foraging
	downy woodpecker	*Picoides pubescens*		1	H		X				X					scolding
	golden-crowned kinglet	*Regulus satrapa*	U	1	H	X	X				X					foraging
	red-shafted flicker	*Colaptes auratus cafer*	U	1	H		X				X					scolding
	spotted towhee	*Pipilo maculatus*	U	1	H		X				X					scolding
	Steller's jay	*Cyanocitta stelleri*	U	2	H	X	X				X					scolding
10/4/2006	American goldfinch	*Carduelis tristis*	U	11	M	X	X		X							flyover
	black-capped chickadee	*Poecile atricapilla*	U	6	M		X				X					foraging□□foraging
	house finch	*Carpodacus mexicanus*	U	4	M		X		X							flyover
	song sparrow	*Melospiza melodia*	U	2	M	X	X				X					foraging
	Steller's jay	*Cyanocitta stelleri*	U	1	M	X	X				X					foraging
10/31/2006	American robin	*Turdus migratorius*	U	2		X	X									foraging
	Bewick's wren	*Thryomanes bewickii*	U	2		X	X				X					scolding
	black-capped chickadee	*Poecile atricapilla*	U	12		X	X				X					foraging
	bushtit	*Psaltriparus minimus*		22		X	X				X					foraging
	Canada goose	*Branta canadensis*	U	50		X	X		X							flyover
	chestnut-backed chickadee	*Poecile rufescens*									X					foraging
	downy woodpecker	*Picoides pubescens*		3		X	X				X					2 foraging; 1 scolding
	ruby-crowned kinglet	*Regulus calendula*	U	2		X	X				X					foraging
	song sparrow	*Melospiza melodia*	U	1		X	X				X					singing
	Steller's jay	*Cyanocitta stelleri*	U	2		X	X		X		X					scolding, foraging
11/30/2006	American crow	*Corvus brachyrhynchos*	U	5	H				X							flyover
	American goldfinch	*Carduelis tristis*	U	4	H		X		X							flyover
	Bewick's wren	*Thryomanes bewickii*	U	1	H		X				X					foraging
	black-capped chickadee	*Poecile atricapilla*	U	1	H		X				X					foraging
	downy woodpecker	*Picoides pubescens*	F	1	H		X				X					foraging
	downy woodpecker	*Picoides pubescens*	M	1	H	X	X				X					foraging
	glaucous-winged gull	*Larus glaucescens*	U	1	H				X							flyover
	green-winged teal	*Anas crecca*		18	H										X	loafing/foraging in POW
	killdeer	*Charadrius vociferus*	U	2	H		X		X							flyover
	mallard	*Anas platyrhynchos*		22	H	X						X			X	loafing/foraging in POW
	red-shafted flicker	*Colaptes auratus cafer*	U	2	H		X				X					
	song sparrow	*Melospiza melodia*	U	2	H	X	X				X					foraging
	Steller's jay	*Cyanocitta stelleri*	U	1	H		X				X					foraging
	varied thrush	*Ixoreus naevius*	U	2	H				X		X					flying tree to tree

Table A-23. Year 5 (2006) Bird Use at Sha Dadx (Forest)

Date	BirdCommonName	BirdScientificName	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier/Pilings	Riparian	Marsh	Intertidal	MudFlats	Open Water	Comments
12/5/2006	American goldfinch	*Carduelis tristis*	U	3	M		X				X					foraging; calling
	American robin	*Turdus migratorius*	U	1	M		X				X					foraging
	black-capped chickadee	*Poecile atricapilla*	U	2	M	X	X				X					foraging
	crow	*Corvus sp.*	U	16	M	X			X							flyover
	glaucous-winged gull	*Larus glaucescens*	U	1	M	X			X							flyover
	mallard	*Anas platyrhynchos*	F	1	M	X	X								X	foraging
	northern harrier	*Circus cyaneus*	M	1	M	X			X							flyover
	Oregon junco	*Junco hyemalis*	U	2	M	X	X				X					foraging
	ruby-crowned kinglet	*Regulus calendula*	U	1	M	X					X					foraging
	song sparrow	*Melospiza melodia*	U	4	M	X	X				X					singing
	Steller's jay	*Cyanocitta stelleri*	U	2	M	X	X									foraging, scolding
	western scrub jay	*Aphelocoma californica*	U	1	M		X				X					foraging

Table A-24. Year 5 (2006) Bird Use at Sha Dadx (Meadow)

Date	BirdCommonName	BirdScientificName	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier/Pilings	Riparian	Marsh	Intertidal	MudFlats	Open Water	Comments
4/26/2006	American robin	*Turdus migratorius*	F	3	M	X										foraging
	American robin	*Turdus migratorius*	M	3	M	X										singing, foraging
	Bewick's wren	*Thryomanes bewickii*	U	1	M		X									
	common yellowthroat	*Geothylpis trichas*	M	3	M		X									singing
	double-crested cormorant	*Phalacrocorax auritus*	U	1	M											
	house finch	*Carpodacus mexicanus*	U	1	M		X									
	red-tailed hawk	*Buteo jamaicensis*	U	2	M	X										foraging, soaring over site
	song sparrow	*Melospiza melodia*	M	2	M		X									singing
	spotted towhee	*Pipilo maculatus*	U	1	M											
	Steller's jay	*Cyanocitta stelleri*	M	1	M	X										foraging, continuously carrying nesting material
	Steller's jay	*Cyanocitta stelleri*	F	1	M	X										foraging, continuously carrying nesting material
	tree swallow	*Tachycineta bicolor*	U	15	M	X			X							foraging
	violet-green swallow	*Tachycineta thalassina*	U	15	M											
5/31/2006	American goldfinch	*Carduelis tristis*	U	5		X	X				X					flyover/trees
	black-capped chickadee	*Poecile atricapilla*	M	1			X				X					singing
	common yellowthroat	*Geothylpis trichas*	M	1			X				X					singing
	mallard	*Anas platyrhynchos*	M	1		X	X		X							headed toward P.O.W.
	mallard	*Anas platyrhynchos*	F	1		X	X		X							headed toward P.O.W.
	osprey	*Pandion haliaetus*		1		X			X							fly-over
	red-tailed hawk	*Buteo jamaicensis*		1		X			X							immature
	song sparrow	*Melospiza melodia*		1		X	X				X					singing
	spotted sandpiper	*Actitis macularia*	U	1			X				X					POW
	western scrub jay	*Aphelocoma californica*	M	1		X	X				X					scolded me
	willow flycatcher	*Empidonax traillii*		1		X	X				X					singing ("Fitzbew")
	yellow warbler	*Dendroica petechia*	M	2			X				X					singing, foraging

Table A-24. Year 5 (2006) Bird Use at Sha Dadx (Meadow)

Date	BirdCommonName	BirdScientificName	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier/Pilings	Riparian	Marsh	Intertidal	MudFlats	Open Water	Comments
6/20/2006	American goldfinch	*Carduelis tristis*		6	L				X							
	American robin	*Turdus migratorius*		1	L						X					
	barn swallow	*Hirundo rustica*		1	L				X							
	black-capped chickadee	*Poecile atricapilla*		1	L						X					
	black-headed grosbeak	*Pheucticus melanocephalus*		2	L	X	X				X					3 possible
	European starling	*Sturnus vulgaris*	U	9	L	X			X							
	savannah sparrow	*Passerculus sandwichensis*	M	1	L		X					X				
	song sparrow	*Melospiza melodia*	M	2	L	X						X				
	tree swallow	*Tachycineta bicolor*		2	L				X							foraging
	unknown	*unknown*	U	3	L						X					scolding sleeping raccoon
	western scrub jay	*Aphelocoma californica*		1	L	X			X		X					
	western wood-pewee	*Contopus sordidulus*	U	1	L	X			X							
	yellow warbler	*Dendroica petechia*		1	L	X	X		X			X				
	yellow-throated warbler	*Dendroica dominica*	M	3	L	X	X				X					
6/29/2006	American goldfinch	*Carduelis tristis*		6		X	X		X							flyover; singing
	American robin	*Turdus migratorius*		1		X			X			X				flyover
	barn swallow	*Hirundo rustica*		2		X			X			X				foraging
	black-capped chickadee	*Poecile atricapilla*		2			X				X					calling
	black-headed grosbeak	*Pheucticus melanocephalus*		1			X				X					singing
	cliff swallow	*Petrochelidon pyrrhonota*		8		X						X				foraging (8 together on ground)
	common yellowthroat	*Geothylpis trichas*	M	2			X					X				singing
	crow	*Corvus sp.*		4		X										on fence
	European starling	*Sturnus vulgaris*		6		X	X		X			X				
	great blue heron	*Ardea herodias*	U	1		X			X							
	red-tailed hawk	*Buteo jamaicensis*		2		X			X							soaring; calling
	savannah sparrow	*Passerculus sandwichensis*		1			X					X				singing
	song sparrow	*Melospiza melodia*	M	3		X	X				X					singing; foraging
	willow flycatcher	*Empidonax traillii*		1			X				X					singing
	yellow warbler	*Dendroica petechia*		1			X				X					singing

Table A-24. Year 5 (2006) Bird Use at Sha Dadx (Meadow)

Date	BirdCommonName	BirdScientificName	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier/Pilings	Riparian	Marsh	Intertidal	MudFlats	Open Water	Comments
7/20/2006	American goldfinch	*Carduelis tristis*		6			X		X							
	black-headed grosbeak	*Pheucticus melanocephalus*		1			X				X					singing in woods
	Caspian tern	*Sterna caspia*		2		X	X		X							
	cedar waxwing	*Bombycilla cedrorum*	U	3		X					X					foraging
	common yellowthroat	*Geothylpis trichas*	F	2		X	X				X					1 singing
	common yellowthroat	*Geothylpis trichas*	M	3		X	X				X					scolding in pairs; 1 w/ food in bill
	crow	*Corvus sp.*		2		X	X				X					perched - loafing
	downy woodpecker	*Picoides pubescens*	U	1			X				X					whinny
	great blue heron	*Ardea herodias*		1		X			X							
	house finch	*Carpodacus mexicanus*		2			X		X		X					
	song sparrow	*Melospiza melodia*		6		X	X				X					4 begging juveniles; 2 singing adults
9/29/2006	American goldfinch	*Carduelis tristis*	U	50	H	X	X		X		X					flyover, foraging
	black-capped chickadee	*Poecile atricapilla*		4	H		X				X					foraging
	great blue heron	*Ardea herodias*	U	1	H	X			X		X					fly over (to ponded area)
	red-shafted flicker	*Colaptes auratus cafer*	U	1	H		X				X					scolding
	rock dove	*Columba livia*	U	9	H	X			X							
	song sparrow	*Melospiza melodia*	U	1	H	X	X				X					foraging, singing
	Steller's jay	*Cyanocitta stelleri*		2	H	X	X				X					foraging, scolding
	yellow-rumped warbler	*Dendroica coronata*	U	1	H	X					X					foraging
10/4/2006	American goldfinch	*Carduelis tristis*	U		M	X	X		X							flyover
	American robin	*Turdus migratorius*	U	4	M	X	X									foraging
	barn owl	*Tyto alba*	U	1	M	X			X		X					as I got to site, flew off
	glaucous-winged gull	*Larus glaucescens*		1	M	X			X							flyover
	house finch	*Carpodacus mexicanus*	U	1	M		X		X							flyover
	red-shafted flicker	*Colaptes auratus cafer*	U	1	M	X			X							flyover
	savannah sparrow	*Passerculus sandwichensis*	U	3	M	X	X				X					foraging in meadow
	song sparrow	*Melospiza melodia*	U	2	M	X	X									foraging
10/31/2006	American robin	*Turdus migratorius*	U	1							X					scolding
	crow	*Corvus sp.*	U	30		X			X							
	downy woodpecker	*Picoides pubescens*		1		X			X							
	savannah sparrow	*Passerculus sandwichensis*	U	2		X					X					foraging
	song sparrow	*Melospiza melodia*		5		X					X					foraging

Table A-24. Year 5 (2006) Bird Use at Sha Dadx (Meadow)

Date	BirdCommonName	BirdScientificName	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier/Pilings	Riparian	Marsh	Intertidal	MudFlats	Open Water	Comments
11/30/2006	American crow	*Corvus brachyrhynchos*	U	4	H				X		X					flyover
	American goldfinch	*Carduelis tristis*	U	1	H		X		X							flyover
	Bewick's wren	*Thryomanes bewickii*	U	1	H						X					foraging
	black-capped chickadee	*Poecile atricapilla*	U	1	H		X				X					foraging, calling
	glaucous-winged gull	*Larus glaucescens*	U	1	H	X			X							flyover
	house finch	*Carpodacus mexicanus*	U	22	H				X		X					flyover
	Lincoln's sparrow	*Melospiza lincolnii*	U	1	H	X					X					
	mallard	*Anas platyrhynchos*	U	12	H				X		X					flyover
	mallard	*Anas platyrhynchos*	M	2	H		X		X		X					Using POW
	mallard	*Anas platyrhynchos*	F	1	H				X		X					Using POW
	peregrine falcon	*Falco peregrinus*	U	1	H				X							flyover
	rock dove	*Columba livia*	U	7	H				X		X					flyover
	savannah sparrow	*Passerculus sandwichensis*		1	H						X					
	song sparrow	*Melospiza melodia*	U	3	H		X		X		X					1 singing, 5 heard, 1+2 flyover
12/5/2006	American robin	*Turdus migratorius*	U	1	M	X			X							flyover
	black-capped chickadee	*Poecile atricapilla*	U	2	M	X					X					foraging
	Brewer's blackbird	*Euphagus cyanocephalus*	U	40	M				X							flyover
	crow	*Corvus sp.*	U	1	M	X			X							flyover
	European starling	*Sturnus vulgaris*	U	10	M	X			X							flyover
	fox sparrow	*Passerella iliaca*	U	1	M	X										foraging
	glaucous-winged gull	*Larus glaucescens*	U	12	M	X			X							flyover
	green-winged teal	*Anas crecca*	U	2	M	X			X							were in PFO nearby
	mallard	*Anas platyrhynchos*	U	11	M	X			X							flyovers
	Oregon junco	*Junco hyemalis*	U	7	M	X	X				X					foraging
	red-winged blackbird	*Agelaius phoeniceus*	U	1	M				X							singing, then flyover
	rock dove	*Columba livia*	U	1	M	X			X							flyover
	song sparrow	*Melospiza melodia*	U	3	M	X	X									singing, foraging
	western scrub jay	*Aphelocoma californica*	U	1	M	X	X				X					scolding; foraging

Table A-25. Year 5 (2006) Seasonal Bird Counts at Hylebos Creek Off-Channel Site (Jordan)

Common Name	Scientific Name	Total	Winter	Spring	Summer	Fall
American crow	*Corvus brachyrhynchos*	9		2	1	6
American goldfinch	*Carduelis tristis*	31		5	21	5
American robin	*Turdus migratorius*	175	26	6	7	136
Anna's hummingbird	*Calypte anna*	1				1
barn swallow	*Hirundo rustica*	2			2	
belted kingfisher	*Ceryle alcyon*	3			1	2
Bewick's wren	*Thryomanes bewickii*	2			1	1
black-capped chickadee	*Poecile atricapilla*	24		5	6	13
black-headed grosbeak	*Pheucticus melanocephalus*	5		2	3	
brown-headed cowbird	*Molothrus ater*	1			1	
bufflehead	*Bucephala albeola*	1	1			
bushtit	*Psaltriparus minimus*	23			12	11
Canada goose	*Branta canadensis*	21	3	2	16	
cedar waxwing	*Bombycilla cedrorum*	14		3	5	6
chestnut-backed chickadee	*Poecile rufescens*	8				8
common goldeneye	*Bucephala clangula*	1	1			
common yellowthroat	*Geothylpis trichas*	4		2	2	
crow	*Corvus sp.*	1	1			
downy woodpecker	*Picoides pubescens*	5		2	1	2
European starling	*Sturnus vulgaris*	63				63
golden-crowned kinglet	*Regulus satrapa*	1				1
golden-crowned sparrow	*Zonotrichia atricapilla*	1				1
graylag goose	*Anser anser*	1	1			
great blue heron	*Ardea herodias*	2		1		1
green-winged teal	*Anas crecca*	16		6		10
gull	*Larus sp.*	1				1
hermit thrush	*Catharus guttatus*	1				1
hooded merganser	*Lophodytes cucullatus*	1				1
house finch	*Carpodacus mexicanus*	51		1	1	49
mallard	*Anas platyrhynchos*	66	2	8	2	54
marsh wren	*Cistothorus palustris*	2			2	
mourning dove	*Zenaida macroura*	5		1	4	
Northern rough-winged swallow	*Stelgidopteryx serripennis*	3			3	
olive-sided flycatcher	*Contopus cooperi*	2		1	1	
Oregon junco	*Junco hyemalis*	12	9	1		2
pied-bill grebe	*Podilymbus podiceps*	1		1		
red-breasted nuthatch	*Sitta canadensis*	2		2		
red-breasted sapsucker	*Sphyrapicus ruber*	1		1		
red-shafted flicker	*Colaptes auratus cafer*	11	2		2	7
red-tailed hawk	*Buteo jamaicensis*	11	1	2	4	4
red-winged blackbird	*Agelaius phoeniceus*	5		1	4	
ruby-crowned kinglet	*Regulus calendula*	2	1			1
semipalmated sandpiper	*Calidris pusilla*	1		1		

Table A-25. Year 5 (2006) Seasonal Bird Counts at Hylebos Creek Off-Channel Site (Jordan)

Common Name	Scientific Name	Total	Winter	Spring	Summer	Fall
song sparrow	*Melospiza melodia*	28	3	7	7	11
spotted sandpiper	*Actitis macularia*	7			7	
spotted towhee	*Pipilo maculatus*	3			1	2
Steller's jay	*Cyanocitta stelleri*	14	2	1	3	8
Swainson's thrush	*Catharus ustulatus*	2			2	
teal	*Anas sp.*	3				3
tree swallow	*Tachycineta bicolor*	1			1	
warbling vireo	*Vireo gilvus*	4			4	
western tanager	*Piranga ludoviciana*	2			1	1
western wood-pewee	*Contopus sordidulus*	5		1	4	
white-crowned sparrow	*Zonotrichia leucophrys*	5		2	3	
willow flycatcher	*Empidonax traillii*	2		1	1	
yellow warbler	*Dendroica petechia*	1			1	
yellow-rumped warbler	*Dendroica coronata*	24				24

Table A-26. Year 5 (2006) Bird Use at Hylebos Creek Off-Channel Site (Jordan)

Date	Common Name	Scientific Name	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier/Pilings	Riparian	Marsh	Intertidal	Mud Flats	Open Water	Comments
4/26/2006	American goldfinch	*Carduelis tristis*	U	1	M		X				X					
	American robin	*Turdus migratorius*	U	1	M	X						X				
	black-capped chickadee	*Poecile atricapilla*	U	1	M		X				X					
	Canada goose	*Branta canadensis*	U	2	M		X		X						X	
	common yellowthroat	*Geothylpis trichas*	M	1	M		X				X					
	downy woodpecker	*Picoides pubescens*	U	1	M		X									on bank
	green-winged teal	*Anas crecca*		6	M	X									X	on-site; Hyl. Main channel (male and female)
	mallard	*Anas platyrhynchos*	F	3	M	X			X						X	
	mallard	*Anas platyrhynchos*	M	3	M	X			X						X	
	mallard	*Anas platyrhynchos*	M	1	M	X									X	on-site
	Oregon junco	*Junco hyemalis*	U	1	M		X				X					on bank
	pied-bill grebe	*Podilymbus podiceps*	U	1	M										X	
	red-breasted nuthatch	*Sitta canadensis*	U	1	M		X				X					
	red-tailed hawk	*Buteo jamaicensis*	U	1	M	X			X							foraging
	red-winged blackbird	*Agelaius phoeniceus*	M	1	M		X					X				
	song sparrow	*Melospiza melodia*	M	2	M		X				X	X				adjacent 50 ft
	white-crowned sparrow	*Zonotrichia leucophrys*	M	1	M		X				X					in Milgard mitigation site
	white-crowned sparrow	*Zonotrichia leucophrys*	M	1	M		X					X				
5/31/2006	American crow	*Corvus brachyrhynchos*		2	M	X	X		X							bombing red-tail
	American goldfinch	*Carduelis tristis*	U	4	M		X		X							
	American robin	*Turdus migratorius*		5	M	X	X				X	X				gathering mud/territorial chasing
	black-capped chickadee	*Poecile atricapilla*	U	4	M	X	X				X					foraging
	black-headed grosbeak	*Pheucticus melanocephalus*		2	M	X	X				X					singing, saw 1
	cedar waxwing	*Bombycilla cedrorum*		3	M	X	X				X					foraging
	common yellowthroat	*Geothylpis trichas*	M	1	M		X					X				singing
	downy woodpecker	*Picoides pubescens*	U	1	M		X				X					scolding
	great blue heron	*Ardea herodias*		1	M			X					X			tracks - intertidal
	house finch	*Carpodacus mexicanus*		1	M		X				X					singing
	mallard	*Anas platyrhynchos*	M	1	M	X									X	Hylebos
	mourning dove	*Zenaida macroura*	U	1	M	X	X		X		X					
	olive-sided flycatcher	*Contopus cooperi*		1	M	X	X				X					singing, foraging
	red-breasted nuthatch	*Sitta canadensis*		1	M						X					singing
	red-breasted sapsucker	*Sphyrapicus ruber*		1	M	X			X							flyover (twice)
	red-tailed hawk	*Buteo jamaicensis*		1	M	X			X							soaring
	semipalmated sandpiper	*Calidris pusilla*		1	M	X	X					X	X			foraging
	song sparrow	*Melospiza melodia*		5	M	X	X				X					4 singing; 1 feeding begging juvenile
	Steller's jay	*Cyanocitta stelleri*		1	M		X				X					scolding
	western wood-pewee	*Contopus sordidulus*		1	M		X				X					singing
	willow flycatcher	*Empidonax traillii*	M	1	M	X	X				X					singing
6/20/2006	American crow	*Corvus brachyrhynchos*	U	1	L		X				X					
	American goldfinch	*Carduelis tristis*	U	7	L	X	X		X							singing
	American robin	*Turdus migratorius*	M	3	L	X	X				X					carrying food; singing
	black-capped chickadee	*Poecile atricapilla*	U	1	L	X	X				X					flocking/foraging
	black-headed grosbeak	*Pheucticus melanocephalus*	M	1	L	X					X					
	cedar waxwing	*Bombycilla cedrorum*	U	2	L		X				X					
	marsh wren	*Cistothorus palustris*	U	1	L		X					X				singing
	mourning dove	*Zenaida macroura*	U	1	L	X	X		X							
	Northern rough-winged swallow	*Stelgidopteryx serripennis*	U	1	L	X		X	X							
	red-tailed hawk	*Buteo jamaicensis*	M	1	L	X			X		X					foraging over site
	red-tailed hawk	*Buteo jamaicensis*	F	1	L	X			X		X					foraging over site
	red-winged blackbird	*Agelaius phoeniceus*	M	1	L	X	X					X				foraging□foraging□foraging
	red-winged blackbird	*Agelaius phoeniceus*	F	1	L	X	X					X				foraging
	song sparrow	*Melospiza melodia*	U	2	L	X	X				X	X				singing
	spotted sandpiper	*Actitis macularia*	U	3	L	X					X	X	X	X		running through site
	Swainson's thrush	*Catharus ustulatus*	U	1	L		X				X					50' ?
	tree swallow	*Tachycineta bicolor*	U	1	L	X						X				
	warbling vireo	*Vireo gilvus*	M	2	L		X				X					singing
	western tanager	*Piranga ludoviciana*	M	1	L	X	X				X					singing/flyover
	western wood-pewee	*Contopus sordidulus*	M	1	L		X				X					singing
	white-crowned sparrow	*Zonotrichia leucophrys*	M	1	L		X				X					
	yellow warbler	*Dendroica petechia*	M	1	L		X				X					
6/29/2006	American goldfinch	*Carduelis tristis*	U	10	M	X	X		X		X					
	American robin	*Turdus migratorius*	F	1	M	X	X					X				carrying food
	American robin	*Turdus migratorius*	M	1	M	X	X					X				carrying food□carrying food
	barn swallow	*Hirundo rustica*		2	M	X	X		X							foraging; gathering mud
	black-capped chickadee	*Poecile atricapilla*	U	5	M	X	X				X					juveniles begging; adults foraging
	black-headed grosbeak	*Pheucticus melanocephalus*	M	2	M		X				X					singing
	brown-headed cowbird	*Molothrus ater*		1	M		X				X					
	Canada goose	*Branta canadensis*	U	10	M	X					X	X			X	adults + 1 juvenile, foraging in plant(unreadable)
	common yellowthroat	*Geothylpis trichas*		1	M	X					X					sining - Milgard
	house finch	*Carpodacus mexicanus*	M	1	M						X					singing
	marsh wren	*Cistothorus palustris*	M	1	M		X					X				scolding, singing
	mourning dove	*Zenaida macroura*	U	1	M		X				X	X				near water's edge; singing on hillside
	Northern rough-winged swallow	*Stelgidopteryx serripennis*		2	M	X			X							foraging
	red-shafted flicker	*Colaptes auratus cafer*	U	1	M		X				X					call notes
	red-tailed hawk	*Buteo jamaicensis*	U	1	M	X			X							flyover; foraging
	red-winged blackbird	*Agelaius phoeniceus*	M	2	M	X	X					X				singing
	song sparrow	*Melospiza melodia*	M	3	M		X				X	X				singing; Milgard and hillside
	spotted sandpiper	*Actitis macularia*	U	3	M	X	X				X		X			one calling from snag
	Steller's jay	*Cyanocitta stelleri*	U	1	M		X				X					scolding
	warbling vireo	*Vireo gilvus*	M	1	M		X				X					singing
	western wood-pewee	*Contopus sordidulus*	M	1	M		X				X					(hillside) singing
	white-crowned sparrow	*Zonotrichia leucophrys*	M	2	M		X				X	X				singing on Milgard site
	willow flycatcher	*Empidonax traillii*	M	1	M	X	X				X					foraging; singing
7/20/2006	American goldfinch	*Carduelis tristis*		4			X		X							
	American robin	*Turdus migratorius*	U	2							X	X				scolding; carrying food
	belted kingfisher	*Ceryle alcyon*	M	1		X	X		X		X					foraging; caught fish in stream
	Bewick's wren	*Thryomanes bewickii*	U	1												scolding
	bushtit	*Psaltriparus minimus*	U	12		X	X									2 sm flocks
	Canada goose	*Branta canadensis*	U	6		X						X			X	loafing
	cedar waxwing	*Bombycilla cedrorum*		3			X				X					foraging
	common yellowthroat	*Geothylpis trichas*	M	1		X	X				X	X				Milgard site - singing
	downy woodpecker	*Picoides pubescens*		1							X					singing
	mallard	*Anas platyrhynchos*	F	2		X						X			X	loafing
	mourning dove	*Zenaida macroura*	U	2		X					X					singing, foraging
	olive-sided flycatcher	*Contopus cooperi*	M	1			X				X					singing
	red-shafted flicker	*Colaptes auratus cafer*		1			X									singing
	red-tailed hawk	*Buteo jamaicensis*	U	1		X	X									soaring; calling; diving
	song sparrow	*Melospiza melodia*	M	2			X				X					singing, foraging
	spotted sandpiper	*Actitis macularia*	U	1		X	X				X	X				foraging
	spotted towhee	*Pipilo maculatus*	U	1			X				X					singing
	Steller's jay	*Cyanocitta stelleri*	U	2		X	X				X					scolding
	Swainson's thrush	*Catharus ustulatus*	U	1			X									scolding "whip"
	warbling vireo	*Vireo gilvus*		1							X					singing
	western wood-pewee	*Contopus sordidulus*	U	2		X	X				X	X				singing; foraging

Table A-26. Year 5 (2006) Bird Use at Hylebos Creek Off-Channel Site (Jordan)

Date	Common Name	Scientific Name	Gender	Count	Tide	Seen	Heard	Tracks	Flyover	Pier/Pilings	Riparian	Marsh	Intertidal	Mud Flats	Open Water	Comments
9/29/2006	American goldfinch	*Carduelis tristis*	U	4	H	X	X		X							
	American robin	*Turdus migratorius*	U	8	H	X	X				X					scolding, foraging
	belted kingfisher	*Ceryle alcyon*	U	1	H	X	X				X				X	scolding, foraging
	black-capped chickadee	*Poecile atricapilla*	U	6	H	X	X				X					foraging
	cedar waxwing	*Bombycilla cedrorum*	U	6	H	X	X				X					foraging
	chestnut-backed chickadee	*Poecile rufescens*	U	8	H	X	X				X					foraging
	downy woodpecker	*Picoides pubescens*	U	1	H		X				X					scolding
	golden-crowned sparrow	*Zonotrichia atricapilla*		1	H		X				X					singing
	house finch	*Carpodacus mexicanus*	U	6	H	X	X		X							
	mallard	*Anas platyrhynchos*	F	6	H	X						X			X	loafing, foraging
	mallard	*Anas platyrhynchos*	M	3	H	X						X			X	loafing, foraging
	red-shafted flicker	*Colaptes auratus cafer*	M	1	H	X	X				X					scolding
	red-tailed hawk	*Buteo jamaicensis*	U	2	H	X	X		X							foraging
	song sparrow	*Melospiza melodia*	U	3	H	X	X				X					foraging
	spotted towhee	*Pipilo maculatus*	U	2	H	X	X				X					scolding; foraging
	Steller's jay	*Cyanocitta stelleri*	U	4	H	X	X				X					scolding
	western tanager	*Piranga ludoviciana*	F	1	H	X					X					foraging
	yellow-rumped warbler	*Dendroica coronata*		4	H	X					X					foraging
10/4/2006	American robin	*Turdus migratorius*		80	M	X	X				X	X	X			bathing, foraging, singing, drinking
	Anna's hummingbird	*Calypte anna*		1	M		X				X					-
	belted kingfisher	*Ceryle alcyon*	M	1	M	X					X				X	foraging
	black-capped chickadee	*Poecile atricapilla*		2	M	X	X				X					males chasing each other
	downy woodpecker	*Picoides pubescens*		1	M		X				X					scolding
	European starling	*Sturnus vulgaris*		6	M	X			X		X					foraging
	green-winged teal	*Anas crecca*	M	1	M	X									X	foraging
	green-winged teal	*Anas crecca*	F	4	M	X									X	foraging
	hermit thrush	*Catharus guttatus*	U	1	M	X					X					foraging
	house finch	*Carpodacus mexicanus*	U	3	M	X	X				X					
	mallard	*Anas platyrhynchos*	F	5	M	X					X				X	foraging
	mallard	*Anas platyrhynchos*	M	5	M	X									X	foraging
	Oregon junco	*Junco hyemalis*		2	M	X	X				X	X				foraging
	red-shafted flicker	*Colaptes auratus cafer*		3	M	X	X						X			drinking
	song sparrow	*Melospiza melodia*	U	2	M	X	X				X	X	X			1 singing
	Steller's jay	*Cyanocitta stelleri*		2	M		X				X					scolding, foraging
	teal	*Anas sp.*		3	M	X									X	foraging
	yellow-rumped warbler	*Dendroica coronata*	U	20	M	X					X					foraging
10/31/2006	American robin	*Turdus migratorius*	F	4	H											loafing
	black-capped chickadee	*Poecile atricapilla*		4	H											foraging
	great blue heron	*Ardea herodias*	U	1	H	X						X				Milgard site
	green-winged teal	*Anas crecca*	F	4	H											foraging
	green-winged teal	*Anas crecca*	M	1	H											foraging
	mallard	*Anas platyrhynchos*	M	14	H	X	X									loafing
	mallard	*Anas platyrhynchos*	F	14	H	X	X									loafing
	red-shafted flicker	*Colaptes auratus cafer*		2	H											calling
	red-tailed hawk	*Buteo jamaicensis*	U	1	H	X			X							soaring
	song sparrow	*Melospiza melodia*		2	H											foraging
	Steller's jay	*Cyanocitta stelleri*	U	1	H											scolding
11/30/2006	American crow	*Corvus brachyrhynchos*	U	6	H	X			X							flyover
	American goldfinch	*Carduelis tristis*	U	1	H		X		X							flyover□flyover
	American robin	*Turdus migratorius*	U	44	H	X	X		X							flyover - large flock
	Bewick's wren	*Thryomanes bewickii*	U	1	H		X				X					
	black-capped chickadee	*Poecile atricapilla*	U	1	H	X	X				X					
	bushtit	*Psaltriparus minimus*	U	11	H	X			X		X					using planted area
	European starling	*Sturnus vulgaris*	U	57	H	X			X							large flock
	golden-crowned kinglet	*Regulus satrapa*	U	1	H	X			X		X					
	gull	*Larus sp.*	U	1	H				X							
	hooded merganser	*Lophodytes cucullatus*	M	1	H	X									X	floating in backwater habitat, using planted area
	house finch	*Carpodacus mexicanus*	U	40	H	X			X		X					large flock
	mallard	*Anas platyrhynchos*	U	7	H	X			X			X			X	Using marsh & POW
	red-shafted flicker	*Colaptes auratus cafer*	U	1	H		X									flyover
	red-tailed hawk	*Buteo jamaicensis*	U	1	H	X			X							soaring
	ruby-crowned kinglet	*Regulus calendula*	U	1	H	X			X		X					
	song sparrow	*Melospiza melodia*	U	4	H	X	X				X					singing
	Steller's jay	*Cyanocitta stelleri*	U	1	H		X				X					
12/5/2006	American robin	*Turdus migratorius*	U	26	M	X			X		X					loafing; flyover
	bufflehead	*Bucephala albeola*	F	1	M	X									X	foraging
	Canada goose	*Branta canadensis*	U	3	M	X	X								X	preening
	common goldeneye	*Bucephala clangula*	M	1	M	X									X	foraging
	crow	*Corvus sp.*	U	1	M				X							flyover
	graylag goose	*Anser anser*	U	1	M	X									X	foraging
	mallard	*Anas platyrhynchos*	F	1	M	X										foraging
	mallard	*Anas platyrhynchos*	M	1	M	X									X	foraging
	Oregon junco	*Junco hyemalis*	U	9	M	X					X					foraging
	red-shafted flicker	*Colaptes auratus cafer*	U	2	M		X				X					calling
	red-tailed hawk	*Buteo jamaicensis*	U	1	M	X			X							foraging
	ruby-crowned kinglet	*Regulus calendula*	U	1	M	X					X					foraging
	song sparrow	*Melospiza melodia*	U	3	M	X	X				X					foraging
	Steller's jay	*Cyanocitta stelleri*	U	2	M	X	X									foraging

APPENDIX B

Nested Line Intercept Sampling Protocol for Riparian Vegetation

Paul Cereghino, NOAA Restoration Center

B.1 Monitoring Objectives

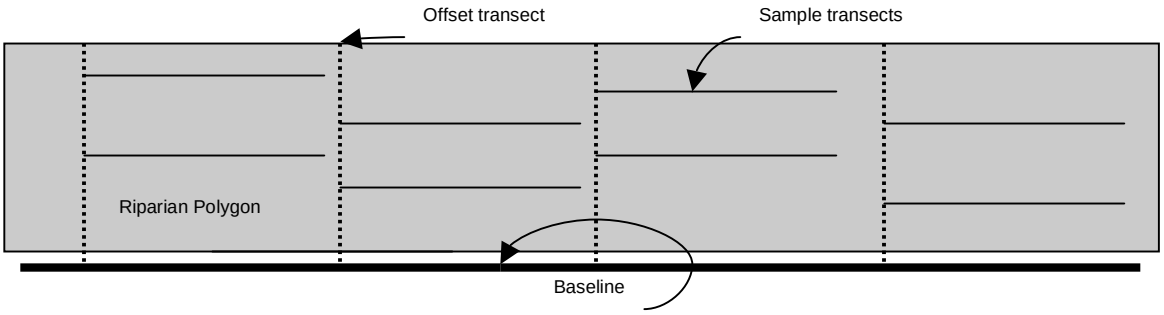
- Produce statistically robust population mean and variance estimates for cover of specified woody and ground vegetation layer taxa within a riparian zone.
- Detect change in mean cover between this sample and a future sample following management activity.
- Reduce potential for observer bias and reduce between sample variation to minimize confidence interval.

B.2 Tools Required

- Stakes for marking offset transects
- Data sheets
- (3) 50 Meter Tapes
- Random number table for placing transects and quadrats
- 0.5 x 2 m Quadrat for ground vegetation cover estimates

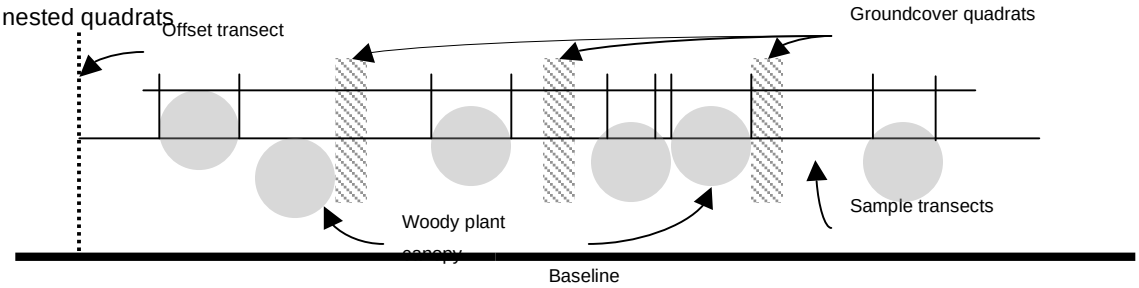
This sampling strategy aims to provide an efficient estimate of relative species dominance and canopy structure using a modified line-intercept technique. All sites described have a long narrow riparian buffer strip. Transects will be offset a random distance from a baseline located along the long side of the riparian buffer (Figure B-1). Each transect will be parallel to the baseline. The beginning, middle, and end of each offset transect will be permanently marked. No more than 25 transects will be completed per site. Transect length will not exceed 20 meters.

Figure B-1 – Transect Placement Diagram – The riparian polygon will be divided into sampling units by offset transects. Samples will be randomly placed along the offset transect.



Each transect will be a single observation. Woody plant cover will be measured using line intercept measurements. Groundcover will be estimated using the mean of three nested 1 m3 quadrats, each placed randomly within each third of the transect (Figure B-2).

Figure B-2 – Sample Design – Each transect is a single observation. Woody species cover will be estimated using line intercept. Groundcover will be estimated using mean visual estimates from three nested quadrats.



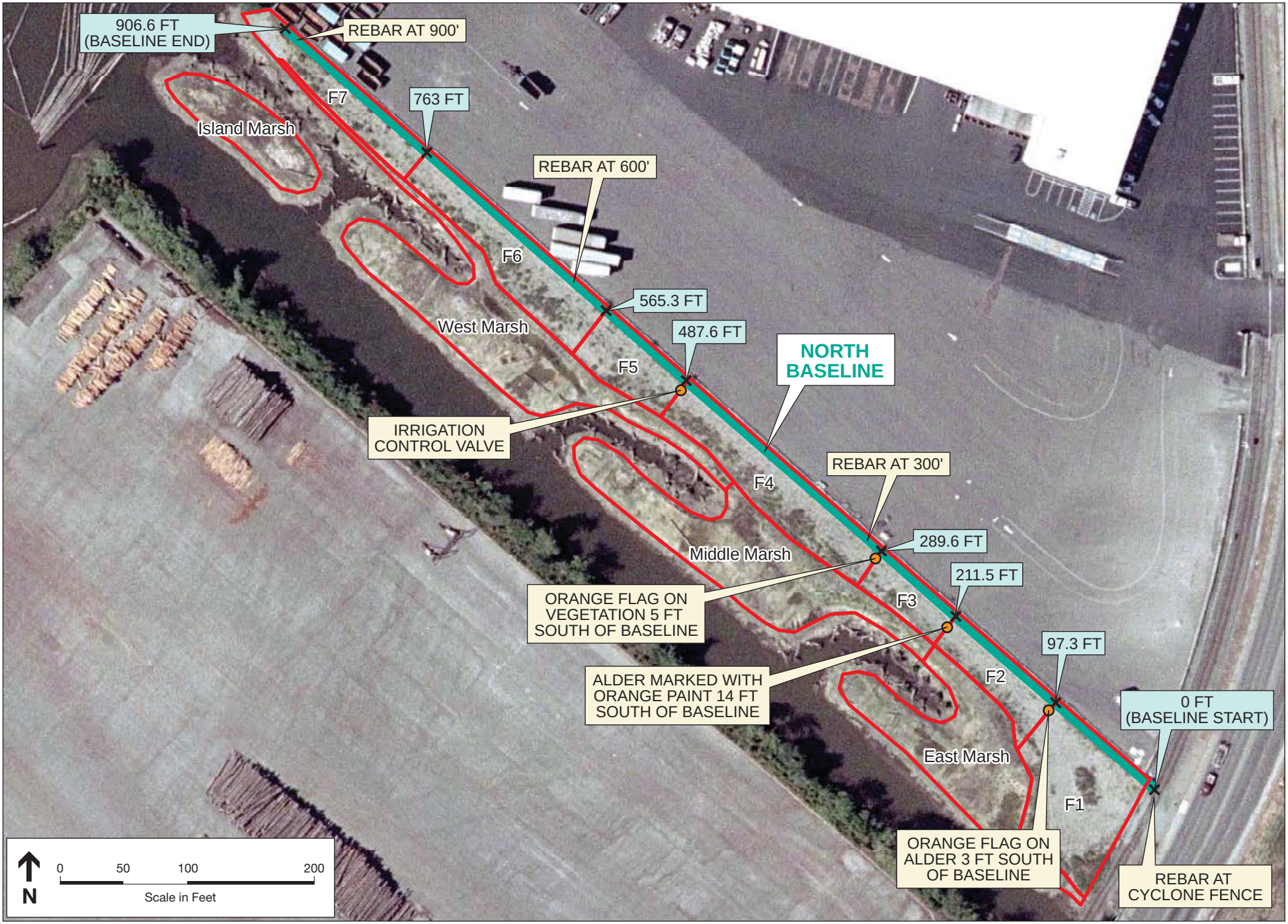
Woody, native, and 'invasive' taxa will be identified to species. Exotic herbaceous species will be identified as either forb or graminoid. Those taxa determined to be 'invasive' will be identified on a site by site basis depending on management concern. For groundcover samples, 0.5 m by 2 m plots will be used. Non plant cover will be classified as large wood, litter, moss, or soil. Quadrats should be subdivided into a 0.25 m grid with each grid square equal to 12.5% for the purpose of increasing replicability and accuracy of cover estimates.

Pilot sampling should be conducted to determine transect length and sample size. Transect length will be optimized to overcome patchiness of vegetation. A length-species curve and

length-variance curve will be used with an exploratory sample to determine optimal Transect length. Exploratory samples will be supplemented by additional samples to improve the mean.

If species cover data deviates substantially from a normal distribution, bootstrap-type resampling analysis will be used to provide a confidence interval estimate for each taxa. Groundcover plot data may be averaged by transect or considered independent samples for analysis.

Mowitch Management Zones and Riparian Transects



FILE NAME: Fig_mowitch.ai
CREATED BY: JAB / DATE LAST UPDATED: 12/05/06

SOURCE: NOAA Restoration Center (Paul Cereghino), 2006.

Commencement Bay Habitat Restoration . 99013

Mowitch Riparian Baseline and Management Zones, 2006

Tacoma, Washington

Riparian Baseline Location Information, Mowitch

NORTH BASELINE (total length: 906.6 ft) General location: Runs roughly east to west along north side of riparian area.	
Distance along baseline	***Landmarks***
0 ft (start – east end of baseline)	Installed rebar with orange cap and painted a rock orange near existing cyclone fence.
7.3 ft	First wood fence post.
50 ft	Painted orange mark on fence during 2006 site visit.
97.3 ft	Boundary between management zones F1 and F2 painted on fence. Tied orange flag to alder located 3 ft south of baseline during 2006 site visit.
150 ft	Painted orange mark on fence during 2006 site visit.
211.5 ft	Boundary between management zones F2 and F3 painted on fence. Marked alder located approx. 14 ft south of baseline with orange paint during 2006 site visit.
250 ft	Painted orange mark on fence during 2006 site visit.
289.6 ft	Boundary between management zones F3 and F4 painted on fence. Tied orange flag to vegetation approx. 5 ft south of baseline during 2006 site visit.
300 ft	Painted orange mark on fence during 2006 site visit. Installed rebar with orange cap next to fence.
350 ft	Painted orange mark on fence during 2006 site visit.
400 ft	Painted orange mark on fence during 2006 site visit.
450 ft	Painted orange mark on fence during 2006 site visit.
487.6 ft	Boundary between management zones F4 and F5 painted on fence. Existing irrigation control valve in ground located near baseline.
550 ft	Painted orange mark on fence during 2006 site visit.
565.3 ft	Boundary between management zones F5 and F6 painted on fence.
600 ft	Painted orange mark on fence during 2006 site visit. Installed rebar with orange cap next to fence.
650 ft	Painted orange mark on fence during 2006 site visit.
763 ft	Boundary between management zones F6 and F7 painted on fence.
800 ft	Painted orange mark on fence during 2006 site visit.
850 ft	Painted orange mark on fence during 2006 site visit.
900 ft	Painted orange mark on fence during 2006 site visit. Installed rebar with orange cap next to fence.
906.6 ft (end – west end of baseline)	End of fence.
Comments:	Run transect tape along south edge of square wood fence posts.

Rebar and fence at beginning of North Baseline, Mowitch (9-1-06).

Looking west from beginning of North Baseline, Mowitch (9-1-06).

Looking east along North Baseline at approx. 600 ft, Mowitch (9-1-06).

Looking east from end of North Baseline, Mowitch (9-1-06).

Mowitch Riparian Line Intercept Transect Locations

Total number line intercept transects: 24

Management Zone	Baseline Code	Line Intercept Transect Code	Distance along Baseline (ft)	Distance along Offset (ft)
F1	North	F1-1	3	25
		F1-2	7	44[a]
		F1-3	14	6
		F1-4	31	37
F2	North	F2-1	113	12
		F2-2	126	29
		F2-3	137	8
F3	North	F3-1	227	5
		F3-2	220 [b]	7
		F3-3	211	26 [c]
F4	North	F4-1	333	14
		F4-2	360	5
		F4-3	375	23 [d]
		F4-4	376	12 [e]
F5	North	F5-1	494	14
		F5-2	494	31 [f]
		F5-3	503	18 [g]
F6	North	F6-1	566	6
		F6-2	577	26
		F6-3	615	21
		F6-4	653	4
F7	North	F7-1	782	19 [h]
		F7-2	811	10 [h]
		F7-3	815	6 [h]

[a] Random offset distance selected for Transect F1-2 in the office was found to be south of the southern edge of riparian vegetation (i.e., within the marsh) when measured in the field. Offset distance was moved 17 feet north to the final offset location of 44 feet in order to keep Transect F1-2 within the edge of the riparian area.

[b] Boundary between management zones F3 and F4 was found to be different in the field than shown on original zone map used to select transect locations in the office. Distance along baseline for Transect F3-2 was adjusted in the field from 270 ft to 220 ft to avoid overlap of the transect into management zone F4.

[c] Baseline and offset distances for Transect F3-3 were adjusted in the field as described in notes (a) and (b) above.

[d] Moved offset distance for Transect F4-3 to the north 12 feet from the random location designated in the office to the final offset location of 23 feet in order to keep it located within riparian vegetation, as described in note (a).

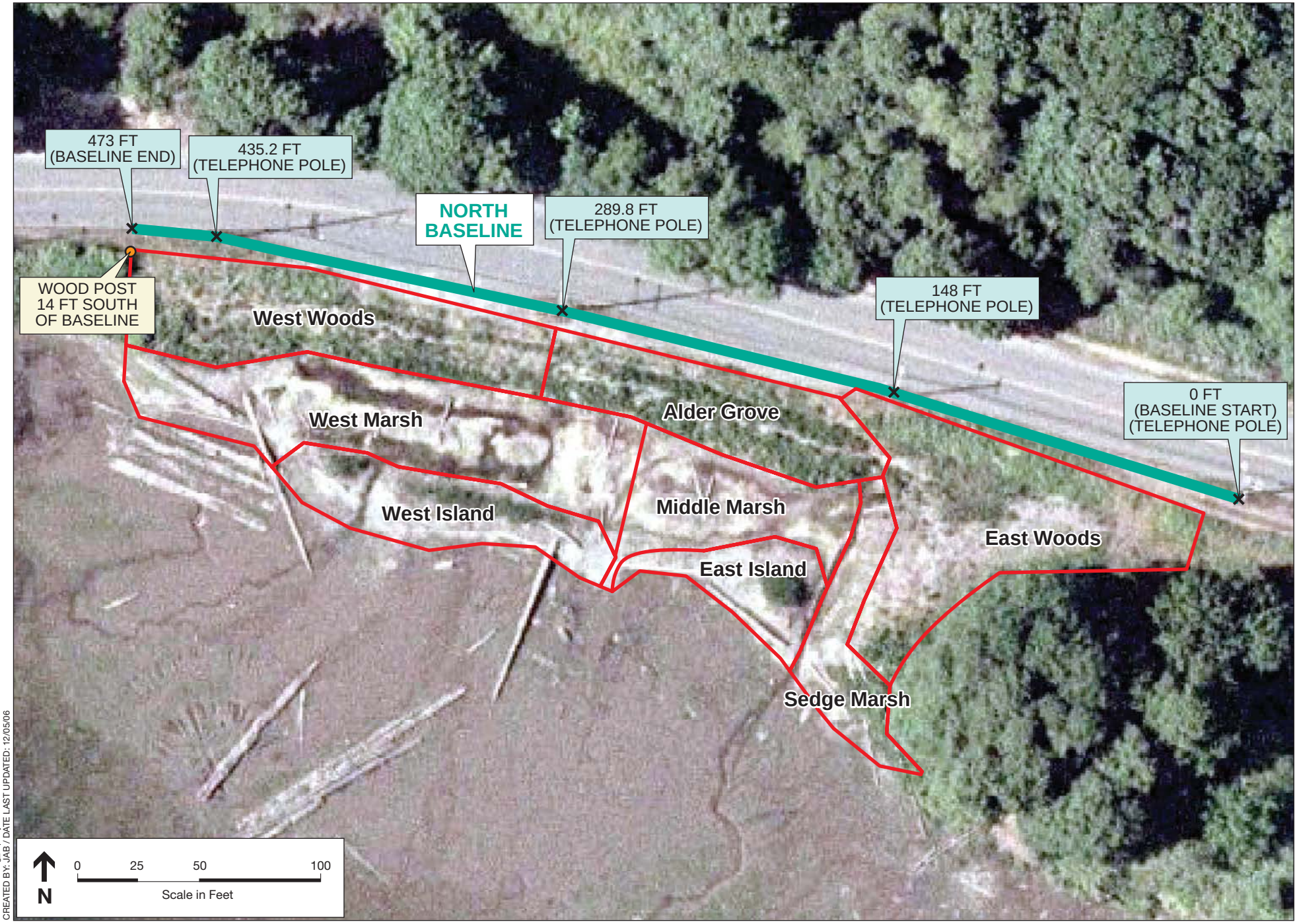
[e] Moved offset distance for Transect F4-4 to the north 12 feet (final offset location of 12 feet) in order to avoid overlap with the relocated Transect F4-3 (see note (d)).

[f] Moved offset distance for Transect F5-2 to the north 4 feet from the random location designated in the office to the final offset location of 31 feet in order to keep it located within riparian vegetation, as described in note (a).

[g] Moved offset distance for Transect F5-3 from the random location designated in the office to the north by 25 feet, resulting in a final offset location of 18 feet. This was done both to keep the transect within the riparian vegetation as described in note (a), and to prevent overlap with the other two transects in management zone F5.

[h] Moved offset distance for Transect F7-1 to the north 11 feet from the random location designated in the office to keep it within riparian vegetation, as described in note (a). The other two transects in this management zone (F7-2 and F7-3) were moved a corresponding 11 feet north to prevent transect overlap. The final offset locations used for these three transects were 19 feet, 10 feet, and 6 feet, respectively.

Squally Beach Management Zones and Riparian Transects



FILE NAME: Fig squallybeach.ai
CREATED BY: JAB / DATE LAST UPDATED: 12/05/06

SOURCE: NOAA Restoration Center (Paul Cereghino), 2006.

Commencement Bay Habitat Restoration . 99013

Squally Beach Riparian Baseline and Management Zones, 2006

Tacoma, Washington

Riparian Baseline Location Information, Squally Beach

NORTH BASELINE (total length: 473 ft) General location: Runs roughly east to west along north side of riparian area.	
Distance along baseline	***Landmarks***
0 ft (start – east end of baseline)	First telephone pole after overhead lines cross roadway, after curve in road. Pole has several metal bands near base, marked at base with orange paint.
136 ft	Telephone pole guy wire.
148 ft	Second telephone pole.
154.1 ft	NE 3200 sign.
279 ft	Square cement post.
289.8 ft	Third telephone pole.
295.3 ft	Utility box.
435.2 ft	Fourth telephone pole.
473 ft (end – west end of baseline)	End of baseline; square wood post located approx. 14.2 ft south of baseline.
Comments:	Run tape just inside telephone poles (i.e., side nearest to riparian area).

Looking northwest from beginning of North Baseline, Squally Beach (9-1-06).

Looking southeast from approx. 300 ft along North Baseline, Squally Beach (9-1-06).

Looking southeast from end of North Baseline, Squally Beach (9-1-06).

Squally Beach Riparian Line Intercept Transect Locations

Total number line intercept transects: 12

Management Zone	Baseline Code	Line Intercept Transect Code	Distance along Baseline (ft)	Distance along Offset (ft)
East Woods	North	EW-1	38	36
		EW-2	45	24
		EW-3	94 [a]	45 [a]
		EW-4	115 [a]	40 [a]
Alder Grove	North	AG-1	160	7
		AG-2	187	29
		AG-3	206	19
West Woods	North	WW-1	298	21
		WW-2	317	29
		WW-3	318	13 [b]
		WW-4	346	22 [c]
		WW-5	370	34 [d]

[a] The locations of Transects EW-3 and EW-4 were adjusted in the field because management zone EW is less than 60 feet wide along this portion of the baseline. In order to allow sampling of this part of the management zone, these two transects were adjusted to be perpendicular rather than parallel to the baseline. The baseline and offset distances were located as for the other transects, but the 60-foot-long line intercept transect continued roughly south from the offset location rather than running west.

[b] The random offset distance for Transect WW-3 designated in the office using aerial photos was found to be located within unvegetated gravel road right-of-way when measured in the field. The offset was moved to the south 7 feet to the final offset location of 13 feet in order to keep the transect located within riparian vegetation.

[c] The random offset distance for Transect WW-4 was adjusted by 7 feet to the final offset location of 22 feet in order to avoid overlap with the relocated Transect WW-3 (see note (b)).

[d] The random offset distance for Transect WW-5 designated in the office using aerial photos was found to be located within unvegetated gravel road right-of-way when measured in the field. A new random offset location was selected in the field, resulting in moving the offset to the south by 33 feet to the final offset location of 34 feet, in order to keep the transect located within riparian vegetation and avoid overlapping the other transects in this management zone.

Middle Waterway Management Zones and Riparian Transects

FILE NAME: Fig_middle.ai
CREATED BY: JAB / DATE LAST UPDATED: 12/11/06

SOURCE: NOAA Restoration Center (Paul Cereghino), 2006.

Commencement Bay Habitat Restoration . 99013

Middle Waterway (Simpson/Trustees) Riparian Baseline and Management Zones, 2006

Tacoma, Washington

Riparian Baseline Location Information, Middle Waterway

SOUTH BASELINE (total length: 335.5 ft) General location: Runs roughly west-east along south side of South Woods zone.	
Distance along baseline	***Landmarks***
0 ft (start – west end of baseline)	Start point located just west of railroad sign, where gravel parking lot meets asphalt/concrete driveway in front of Honda Marine. Marked asphalt at this point with orange spray paint during 2006 site visit.
44 ft	End of gravel area.
83 ft	First telephone pole.
113.5 ft	Concrete sidewalk begins.
168 ft	Second telephone pole.
169 ft	Utility box.
241 ft	Restoration area sign.
265.5 ft	Third telephone pole.
300 ft	Marked sidewalk with orange spray paint at this point during 2006 site visit.
303.5 ft	Sewer manhole.
321 ft	Railroad tracks.
335.5 ft (end – east end of baseline)	Southwest corner of rectangular metal utility cover within surface of East 11th Street (south of stop sign).
Comments:	Baseline is located approx. 1.2 ft north of north edge of sidewalk along East 11th Street.

Looking east from beginning of South Baseline, Middle Waterway (8-30-06).

Looking west from end of South Baseline, Middle Waterway (8-30-06).

EAST BASELINE (total length: 1,087.3 ft) General location: Runs roughly south-north along east side of South Woods, South Bank, and North Bank management zones.	
Distance along baseline	***Landmarks***
0 ft (start – south end of baseline)	Southwest corner of rectangular metal utility cover within surface of East 11th Street (south of stop sign). Note: this is end point for the South Baseline.
11.5 ft	Stop sign.
21 – 23 ft	Baseline crosses curb here. Marked pavement with orange spray paint at 21.5 ft during 2006 site visit.
136 ft	Installed two pieces of rebar approx. 46.6 ft and 105 ft west of baseline to mark boundary between South Woods and South Bank management zones.
288 ft	Telephone pole is located approx. 33.3 ft east of baseline at this point.
300 ft	Marked black cottonwood tree west of baseline at this point with orange paint during 2006 site visit.
543 ft	Metal fence post on gate. Installed one piece of rebar approx. 26 ft west of baseline to mark boundary between South Bank and North Bank management zones.
567.5 ft	Existing truck route sign located approx. 3.8 ft east of baseline.
629.8 ft	Existing yield sign located approx. 6.7 ft east of baseline.
733.6 ft	Marked black cottonwood tree approx. 9.5 ft west of baseline with orange paint during 2006 site visit.
818 ft	Existing control lathe marked “20” located approx. 6.5 ft west of baseline.
1,087.3 ft (end – north end of transect)	Existing fence located south of utility shed. Installed one piece of rebar approx. 32 ft west of baseline to mark boundary between North Bank and North Woods management zones.
Comments:	Baseline transect runs north through gravel parking lot and gravel truck access road, approx. 20 feet east of vegetated riparian area.

Looking north from near beginning of East Baseline, Middle Waterway (8-30-06).

Looking south from metal fence at approx. 543 feet along East Baseline, Middle Waterway (8-30-06).

Looking north from approx. 555 ft along East Baseline, Middle Waterway (8-30-06).

Looking south from end of East Baseline, Middle Waterway (8-30-06).

NORTH BASELINE (total length: 124.4 ft) General location: Runs roughly east-west along north side of North Woods zone.	
Distance along baseline	***Landmarks***
0 ft (start – east end of baseline)	Installed rebar with orange cap approx. 19 ft north of large black cottonwood, 22.5 ft from NW corner of utility shed.
77.5 ft	Marked Sitka spruce located approx. 43 inches south of baseline with orange paint during 2006 site visit.
120.7 ft	Edge of existing metal plate/rock marker located approx. 12 inches south of baseline.
124.4 ft (end – west end of baseline)	Installed rebar with orange cap at baseline end.

Looking west from beginning of North Baseline, Middle Waterway (8-30-06).

Looking east from end of North Baseline, Middle Waterway (8-30-06).

Middle Waterway Riparian Line Intercept Transect Locations

Total number line intercept transects: 20

Management Zone	Baseline Code	Line Intercept Transect Code	Distance along Baseline (ft)	Distance along Offset (ft)
South Woods	South	SW-1	42	48
		SW-2	72	46
		SW-3	95	10
		SW-4	131	16
		SW-5	155	63
		SW-6	227	26
		SW-7	256	34
South Bank	East	SB-1	150	45 [a]
		SB-2	167	26 [a]
		SB-3	274	29 [a]
		SB-4	360	40 [a]
		SB-5	478	17
North Bank	East	NB-1	543	25 [a]
		NB-2	605	33 [b]
		NB-3	700	31
		NB-4	743	20
		NB-5	884	32 [c]
North Woods	North	NW-1	27	23
		NW-2	52	46
		NW-3	58	29

[a] The random offset locations designated in the office using aerial photos for Transects SB-1 through SB-4 and NB-1 were found to be located within a gravel parking area when measured in the field. Each of these offset distances was moved 20 feet to the west to the final locations shown in the table above, so that the line intercept transects would be located within the vegetated riparian area.

[b] Random offset distance selected for Transect NB-2 in the office was found to be west of the western edge of riparian vegetation (i.e., within the marsh) when measured in the field. Offset distance was moved 5 feet east to the final offset location of 33 feet in order to keep Transect NB-2 within the edge of the riparian area.

[c] Random offset distance selected for Transect NB-5 in the office was found to be west of the western edge of riparian vegetation (i.e., within the marsh) when measured in the field. Offset distance was moved 7 feet east to the final offset location of 32 feet in order to keep Transect NB-5 within the edge of the riparian area.