BLAINE HARBOR MOORAGE EXPANSION AND DREDGING PROJECT

POST-PROJECT MITIGATION SITE MONITORING REPORT, 2005

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1. INTRODUCTION

This report describes the results of the 2005 (year 6) monitoring efforts at the mitigation sites in Drayton Harbor and Blaine Harbor. A total of five mitigation sites were constructed to offset the impacts of the Blaine Harbor Moorage Expansion and Dredging Project as described in the Mitigation Plan (Parametrix 1997) and amended by the Mitigation Plan Supplement (Pacific International Engineering 1998). Performance standards were established for each of the mitigation sites, in order to track whether the mitigation goals are being accomplished. In total, 17 performance standards were established for the Blaine Harbor and Drayton Harbor mitigation sites. Two of these performance standards (D.2.A, D.2.B) are a preliminary test against results of 2005 monitoring and will provide a means of tracking the progress of each of the sites, as specified in the Post-Project Mitigation Site Monitoring Plan (Monitoring Plan; Pacific International Engineering 1999).

Following the submittal of the 2003 monitoring report, the Port of Bellingham (Port) and the U.S. Army Corps of Engineers (USACE) initiated discussions on the monitoring schedule. It was decided that post-project monitoring efforts for 2004 would be reduced and that monitoring efforts in 2005 would entail full physical and biological monitoring activities as prescribed for year 6 monitoring.

The primary and largest mitigation site associated with the Blaine Harbor Moorage Expansion Project is the approximately 14.2-acre site located in the southern end of Drayton Harbor (Figure 1). This action involved the beneficial use of dredged material to convert subtidal habitat to intertidal and shallow subtidal habitat. Surface substrate at this site is comprised primarily of silty sand. The goal of the mitigation at the Drayton Harbor site was to provide a feature that has a high probability of supporting eelgrass. Although the dredging project did not adversely affect eelgrass beds, the potential for beneficial use of dredged material offered a unique opportunity to provide this habitat type that is of regional and statewide significance. To promote colonization of the site, eelgrass turions were transplanted from a nearby bed in 1999 through 2003. This resulted in the transplanting of a total of 25 eelgrass plots (5 per year). Due to the extent of eelgrass establishment, the USACE agreed to cease eelgrass transplants following the 2003 monitoring.

In addition to the Drayton Harbor Mitigation Site four smaller mitigation sites were constructed within Blaine Harbor: Boardwalk Area, Salt Marsh Area 1, Salt Marsh Area 2 and Overflow Area (Figures 1 and 2). Boardwalk Area, Salt Marsh Area 1 and Salt Marsh Area 2 were constructed of fine sand at a slope and elevation to promote the establishment of salt marsh vegetation. Overflow Area was created with a matrix of cobbles, gravel and mixed fine sands to improve habitat for juvenile salmonids and to support establishment by macroalgae. Section 2 provides a more detailed description of these four sites.

Construction of the mitigation sites began with earth moving activities in the winter of 1998 and was completed with eelgrass planting at the Drayton Harbor Mitigation Site in the late spring of 1999. The initial "as-built" surveys for each of the five mitigation sites were completed in 1999 and submitted to the USACE (Pacific International Engineering 2000).

Three separate State and Federal agency permits for the Blaine Harbor Moorage Expansion Project contain specific conditions for the construction of the mitigation sites. Permits applying to the construction of the mitigation sites are the Department of Ecology's Water Quality Certification #97-2-00960 General Conditions - Section 9; the USACE permit #97-2-00960 General Conditions c and e; and the Washington State Department of Fish and Wildlife Hydraulic Project Approval Permit #00-D0315-03.

2. SITE DESCRIPTIONS

The location of the mitigation sites within Drayton Harbor and Blaine Harbor are shown on Figures 1 and 2. Detailed descriptions of each of the sites are provided below.

2.1 BOARDWALK AREA

The Boardwalk Area is located adjacent to the boardwalk in the newly expanded area of the Blaine Harbor (Figures 2-4; Photograph 1). The action involved replacing a retaining board and reconstructing a relatively flat-sloped beach (0.1 acre). The elevation of the Boardwalk Area mitigation site is between approximately +7.0 ft and +10.0 ft mean lower low water (MLLW). The objective in this area was to increase protection of the approximately 0.1 acre of salt marsh habitat landward of the retaining board and to increase the overall coverage of salt marsh vegetation at the site. Photo 1 shows the southwestern portion of the Boardwalk Area.

Photograph 1. Boardwalk Area, August 2005. Photo facing SW.
Tidal Elevation: -2.6 ft MLLW

2.2 SALT MARSH AREA 1

Salt Marsh Area 1 is located in the newly expanded portion of the Blaine Harbor immediately adjacent to the Boardwalk Area (Figure 2, 5, and 6 and Photographs 2 and 3). This approximately 0.15-acre site was constructed using imported topsoil that was formed into a gently sloping beach between approximately elevation +9.0 ft and +11.0 ft MLLW. The objective at this site was to increase the area within the appropriate elevation ranges for the establishment of salt marsh vegetation.

Photograph 2. Salt Marsh Area 1, August 2005. Photo from corner facing SE. Tidal Elevation: -2.6 ft MLLW.

Photograph 3. Salt Marsh Area 1, August 2005. Photo from corner facing west. Tidal Elevation: -2.6 ft MLLW.

2.3 SALT MARSH AREA 2

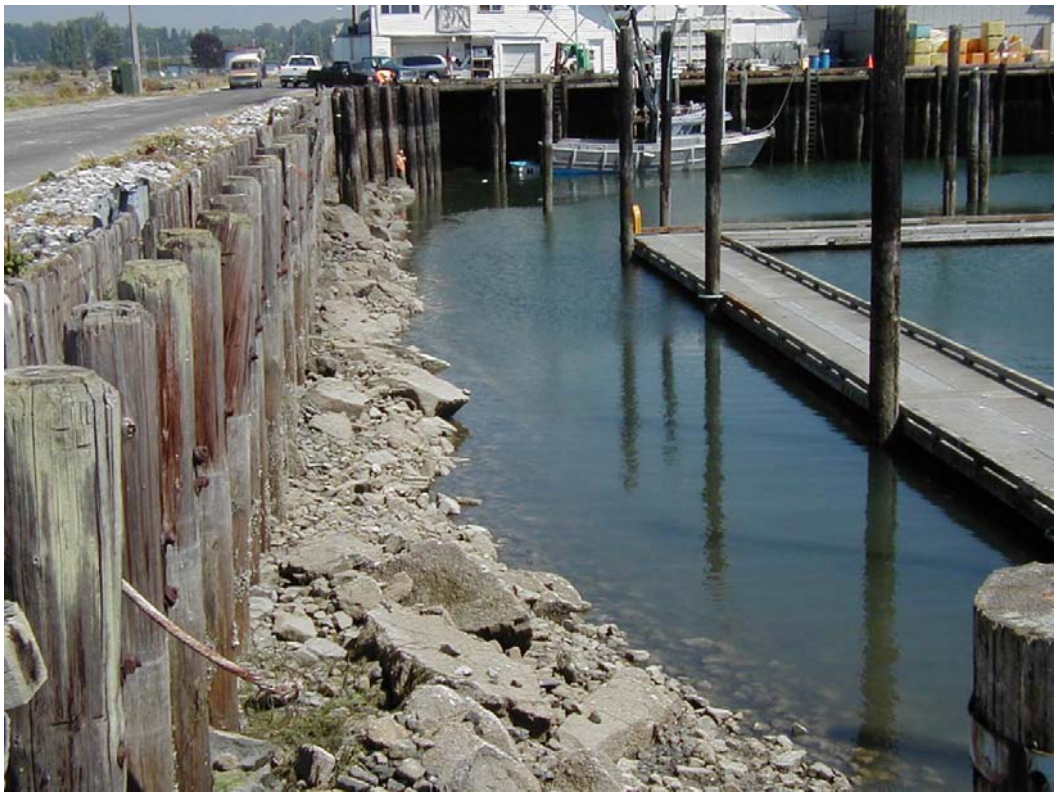
Salt Marsh Area 2 is located along the southeastern boundary of Blaine Harbor, near the boat launch ramp (Figures 2 and 7). This approximately 0.25-acre marsh was constructed with imported topsoil and contoured to provide a gently sloping beach (Photographs 4 and 5). The site ranges in elevation from +6.0 ft to +11.0 ft MLLW. The objective in this area was to establish suitable conditions for the establishment of salt marsh vegetation.

Photograph 4. Salt Marsh Area 2, August 2005. Photo facing SW.
Tidal Elevation: -2.6 ft MLLW.

Photograph 5. Salt Marsh Area 2, August 2005. Photo facing NW.
Tidal Elevation: -2.6 ft MLLW.

2.4 OVERFLOW AREA

The Overflow Area was constructed inside of Blaine Harbor near the west side breakwater entrance (Figures 2 and 8; Photograph 6). The objective at this site was to enhance approximately 0.2-acre of steep riprap intertidal habitat for juvenile salmonids through modification of slope and substrate. The habitat was constructed by placing gravel, cobble and mixed fines between elevation +6.0 ft and –4.0 ft MLLW. The smaller sized substrates were used to contour the existing steeply sloped revetment into a more gently sloping beach with a higher percentage of fines (Photo 6). The objective acreage of approximately 0.2-acre was based on an estimate of the available potential enhancement acreage and was determined before a thorough survey of the site could be completed. A post construction survey between +6.0 ft and –5.0 ft MLLW revealed the site to be slightly smaller than the targeted area, at approximately 0.17-acre. Full site utilization for habitat enhancement was accomplished within the physical boundaries of the site.



Photograph 6. Overflow Area, August 2005. Photo from west end facing NE. Tidal Elevation: -2.0 ft MLLW.

2.5 DRAYTON HARBOR MITIGATION SITE

The Drayton Harbor Mitigation Site is a constructed intertidal and shallow subtidal mudflat located near the southern end of Drayton Harbor (Figures 1 and 9; Photographs 7 and 8). The goal at the site was to provide a minimum of 12 acres and a target of 15 acres of persistent functional aquatic rearing habitat for juvenile salmonids. The "as built" survey from 1999

indicated that the area above elevation –6.0 ft MLLW was approximately 15 acres, with the footprint of the site covering 18.8 acres (Pacific International Engineering 1999).

Construction at the site consisted of depositing a retaining friction berm of fine sands along the outer edge of the site to contain the barge-dumped sediments within the mitigation site. Clay dredged from Blaine Harbor was then deposited upon the existing subtidal substrate within the boundary of the friction berm. The deposited clay was subsequently covered with dredged silty sands. The deposition of the dredged clays and sands served to convert the original subtidal habitat into an intertidal and shallow subtidal mudflat.

Although eelgrass habitat was not adversely affected by the Blaine Harbor Moorage Expansion and Dredging Project, construction of the mitigation site within the range of elevations known to support adjacent eelgrass beds offered the benefit of providing this habitat type of regional and statewide significance. The Port of Bellingham (Port) is committed to developing eelgrass colonization at the site as a means of maximizing the quality of the habitat. It is expected that natural colonization of the mitigation site by eelgrass will occur, and the Port has committed to monitoring and planting activities to track and encourage eelgrass establishment. Specifically, five plots, each approximately 100 ft^2 in size, were planted within the Drayton Harbor Mitigation Site in 1999-2002 (Figure 9).

Photograph 7. Drayton Harbor Mitigation Site, August 2005.
Tidal Elevation: -3.5 ft MLLW.

Photograph 8. Drayton Harbor Mitigation Site, August 2005.
Tidal Elevation: -3.5 ft MLLW.

3. PHYSICAL MONITORING ACTIVITIES AND METHODS

3.1 BLAINE HARBOR MITIGATION SITE

3.1.1 Physical Survey

Acreage and elevation changes at the mitigation actions in Blaine Harbor were documented using standard land surveying techniques. Survey data was collected using Trimble 4000 SSI GPS. A survey benchmark was subsequently used to convert the measurements to state plane coordinates. Elevations were referenced to the USACEs' datum for MLLW. All survey points measured included both coordinates (WASHDOT NAD 83-91) and elevation. All habitat data points were recorded in CADD (computer aided drafting and design) format for mapping.

The Boardwalk Area, Salt Marsh Area 1, and Salt Marsh Area 2 were surveyed as part of the year 2005 monitoring efforts. The Boardwalk Area is the only mitigation action within Blaine Harbor with a performance standard pertaining specifically to habitat acreage. The performance standard for the Boardwalk Area is:

- B.2 Existence of at least 0.1 acre of salt marsh substrates

Table 1. Results of the physical survey at the Boardwalk Area.

	1999 Acreage "As-Built"	**2000 Acreage**	**2005 Acreage**
Boardwalk Area (Area Landward of the retaining board)	0.1 acre	0.1 acre	0.1 acre

Results of the physical monitoring surveys are presented in Table 1. In 2005, the Boardwalk Area contained 0.1 acre of substrates suitable for salt marsh establishment, passing performance standard B.2.(Figure 3) There are no performance standards associated with the acreages of the other two mitigation actions (Salt Marsh Areas 1 and 2) but surveys were conducted in these areas as a means of evaluating any changes in elevation within these areas and to accurately assess the coverage by salt marsh vegetation (Figures 5 and 7).

As specified in the schedule presented in the Monitoring Plan, the Overflow Area was not surveyed as part of the 2005 monitoring efforts (Pacific International Engineering 1999). The performance standard for the Overflow Area is:

- B.1 Within enhanced areas, document presence and extent of quarry spall and gravel at approx. elevation +6 to +2 ft MLLW, presence and extent of gravel and topsoil at approx. elevation +2 to –4 ft MLLW, and presence and extent of scattered quarry spall at approx. elevation +2 to –4 ft MLLW.

The presence of gravel between +2 ft to –4 ft MLLW and quarry spall between –2 ft and –4 ft MLLW at the Overflow Area was verified during the 2005 monitoring, even though this observation was not required as part of the scheduled 2005 monitoring activities.

3.1.2 Photo Points

Photographs were taken from permanent photo points established at each of the Blaine Harbor mitigation sites. These photographs were presented in Section 2 as part of the site descriptions.

3.2 DRAYTON HARBOR MITIGATION SITE

3.2.1 Physical Survey

As specified in the Monitoring Plan, a bathymetric survey was performed at the mitigation site in Drayton Harbor. Acreage calculations were performed using a differential Global Positioning System (dGPS). Linear distance between each survey transect was approximately 50 ft. A survey benchmark was subsequently used to convert the measurements to state plane coordinates and elevations were referenced to the USACE datum for MLLW. All survey points measured included both coordinates (WASHDOT NAD 83-91) and elevation. All habitat data points were recorded in CADD (Computer Aided Drafting and Design) format for mapping.

The 2005 physical site survey was conducted to document acreage and elevation changes of the Drayton Harbor Mitigation Site in relation to established reference points. In addition, the results of the year 2005 survey can be used as a preliminary test to assess whether the site is expected to meet its objectives for year 10. The performance standard for the Drayton Harbor Mitigation Site is:

- D.1 Areal extent of aquatic habitat located above elevation –6 ft MLLW must equal or exceed 12 acres at year 6 and 10.

The 2005 survey at the Drayton Harbor Mitigation Site indicated that there are approximately 14.22 acres of habitat above elevation –6 ft MLLW, which satisfies performance standard D.1. (Figure 9, Table 2)

Table 2. Results of the physical survey at the Drayton Harbor Mitigation Site.

	1999 Acreage "As-Built"	**2000 Acreage***	**2002 Acreage**	**2005 Acreage**
Aquatic Habitat (above elevation –6ft MLLW)	14.98 acres	14.91 acres	14.98 acres	14.22 acres

* Acreage from the 2000 Monitoring Report was corrected in this report upon discovering incorrect data within one transect line.

3.2.2 Underwater Photo Points

The Monitoring Plan calls for underwater photographs at five locations at the Drayton Harbor Mitigation Site. However, due to the turbid conditions in Drayton Harbor during eelgrass monitoring, underwater photographs were not obtained, supplemental photographs of the site were obtained during aerial exposure and on an extreme low tide. The aerial photograph is presented in Photograph 9 (Section 4.3.2.2/page 24) and the photographs of the individual transplant plots are presented in Appendix A.

4. BIOLOGICAL MONITORING ACTIVITIES AND METHODS

4.1 INTRODUCTION

The purpose of the long-term biological monitoring program is to document changes in flora and fauna at the mitigation sites and test conditions against performance standards. Year 2005 biological monitoring at the Blaine Harbor mitigation sites included sampling of plant assemblage (species present) and coverage. Year 2005 biological monitoring at the Drayton Harbor Mitigation Site included epibenthic plankters, eelgrass establishment and avifauna observations.

4.2 BLAINE HARBOR SITES

4.2.1 Plant Assemblage and Coverage

4.2.1.1 Sampling

Composition and percent coverage of rooted vascular plants within each of the three salt marsh areas (Boardwalk Area, Salt Marsh Area 1, and Salt Marsh Area 2) were assessed on August 18, 2005. Between ten to twenty 0.25 m^2 quadrats were sampled along permanent transects within each site. Plant assemblage and percent cover for each species present were recorded. Percent cover was visually estimated for each taxon within the quadrat using the cover classes listed in the Monitoring Plan (<1 percent; 1-5 percent; 6-15 percent; 16-25 percent; 26-50 percent; 51-75 percent; 76-95 percent; 96-100 percent). In quadrats with multiple layers of vegetation, actual percentages were recorded, but total coverage was limited to 100 percent. For example, in a quadrat with 100 percent pickleweed and 15 percent salt grass, the total coverage would be 100 percent, not 115 percent. Representative samples of unknown species were collected for later identification using *Seashore Life of Puget Sound, the Strait of Georgia, and the San Juan Archipelago* (Kozloff 1983), the *Plants of the Pacific Northwest Coast* (Pojar and MacKinnon 1994), and *Wetland Plants of the Pacific Northwest* (Corps 1984).

The Monitoring Plan specifies that results of monitoring efforts at these three salt marsh areas are to be tested against a number of performance standards. Final evaluation of these performance standards will occur in year 10 (2009). Although specific performance standards were not established for years 1 through 5, the results of previous years' monitoring efforts were compared to the final performance standards in order to track the progress of salt marsh establishment. The final performance standards for each of the three salt marsh sites are as follows:

Boardwalk Area:

- B.3.A. Survival of a minimum of three planted salt marsh species (year 6).
- B.3.B. Minimum of 5 percent coverage by each of the three species (year 6).
- B.3.C. Minimum of 70 percent coverage by all salt marsh species (year 6).
- B.3.D. No more than 10 percent coverage by invasive weedy species [(Includes all upland species, reed canary grass (*Phalaris arundinacea*), and non-native cordgrasses (*Spartina* spp.); (year 6)].

Salt Marsh Area 1:

- B.4.A. Existence of approximately 0.15 acre of salt marsh vegetation (year 6).
- B.4.B. Presence of three species of salt marsh vegetation (year 6).
- B.4.C. Minimum of 70 percent coverage by all salt marsh species (year 6).
- B.4.D. No more than 10 percent coverage by invasive weedy species [(Includes all upland species, reed canary grass (*Phalaris arundinacea*), and non-native cordgrasses (*Spartina* spp.); (year 6)].

Salt Marsh Area 2:

- B.5.A. Existence of approximately 0.25 acre of salt marsh (year 6).
- B.5.B. Presence of three species of salt marsh vegetation (year 6).
- B.5.C. Minimum of 70 percent coverage by all salt marsh species (year 6).
- B.5.D. No more than 10 percent coverage by invasive weedy species [Includes all upland species, reed canary grass (*Phalaris arundinacea*), and non-native cordgrasses (*Spartina* spp.); (year 6)].

4.2.1.2 Results

The salt marsh vegetation in the Boardwalk Area was continuing to establish itself. There were a total of five species present, three of which had greater than 15 percent coverage. Salt marsh vegetation coverage at the Boardwalk Area was 99.9 percent and was dominated by pickleweed (*Salicornia virginica*) and saltgrass (*Distichlis spicata*) (Table 3). No invasive species were observed at the site. Based on the results of the 2005 monitoring, salt marsh vegetation in the Boardwalk Area met performance standards B.3.A, B.3.B, B.3.C, and B.3.D (Table 16).

Salt Marsh Area 1 is supporting approximately 0.11 acre of salt marsh vegetation, based on the percent cover. Salt marsh vegetation coverage in Salt Marsh Area 1 was 75 percent. A total of fourteen different species were identified within Salt Marsh Area 1, ten of which were salt marsh species. Salt marsh vegetation was dominated by saltgrass *(Distichlis spicata)* and pickleweed (*Salicornia virginica;* Table 3; Figure 10). Two invasive species; reed canary grass (*Phalaris arundinacea*) and Himalayan blackberry (*Rubus discolor*) were present with a total percent coverage of less than 1%. Based on the results of the 2005 monitoring, salt marsh vegetation in Salt Marsh Area 1 met performance standards B.4.B., B.4.C., and B.4.D. Salt marsh vegetation did not satisfy performance standard B.4.A., requiring approximately 0.15 acre of salt marsh vegetation.

Salt Marsh Area 2 is supporting approximately 0.12 acre of salt marsh vegetation, based on the percent cover (Figure 11). Salt marsh vegetation coverage in Salt Marsh Area 2 was 46 percent.

As part of the physical survey, the edge of the salt marsh vegetation in Salt Marsh Area 2 was also delineated, which resulted in a total area of salt marsh vegetation of approximately 0.15 acre. The difference in areal coverage of salt marsh vegetation between the percent coverage and surveyed coverage is based on the dense coverage of salt marsh along the northern and eastern (near the boat launch) edges of the site and the sparse coverage in the center of the site. A total of six salt marsh species were present at the site with pickleweed as the dominant species (Table 3). No invasive species were observed. Results of the 2005 monitoring, salt marsh vegetation in Salt Marsh Area 2 met performance standards B.5.B., B.5.C, and B.5.D. Salt marsh vegetation did not satisfy performance standard B.5.A., requiring approximately 0.25 acre of salt marsh vegetation.

Table 3. Percent of salt marsh vegetation coverage by species, at the Blaine Harbor mitigation sites.

Average Coverage /m2	Boardwalk Area	Salt Marsh Area 1	Salt Marsh Area 2
Atriplex patula	N/A	1%	<1%
Carex lyngbyei	N/A	<1%	1%
Distichlis spicata	33%	40%	2%
Equisetum sp.	N/A	<1%	N/A
Grindelia integrifolia	N/A	<1%	<1%
Jaumea carnosa	N/A	4%	N/A
Potentilla pacifica	N/A	<1%	N/A
Phalaris arundinacea	N/A	<1%	N/A
Plantago maritima	2%	<1%	N/A
Puccinellia nutkaensis	2%	N/A	N/A
Rubus discolor	N/A	<1%	N/A
Salicornia virginica	37%	40%	96%
Spergularia marina	N/A	<1%	N/A
Taraxacum sp.	N/A	<1%	N/A
Triglochin maritimum	18%	13%	<1%

4.3 DRAYTON HARBOR MITIGATION SITE

4.3.1 Epibenthic Zooplankton

4.3.1.1 Sampling

Sampling for epibenthic plankters was conducted once in April and once in June. In keeping with previous years' monitoring, samples were taken from Drayton Harbor Mitigation Site ("mitigation") and the reference site ("reference") located south of breakwater on the outside of Blaine Harbor (Figure 1). Within each site, fifteen (15) replicate samples were taken along the –4 ft MLLW contour. Samples were taken randomly throughout the mitigation site, most of which were collected on bare mud. The reference site was located within a well-established eelgrass bed, as a suitable reference site devoid of eelgrass was not present within Drayton Harbor. Within the well-established reference bed, reference samples were collected in smaller areas void of eelgrass (approximately 4 ft^2). To account for the difference in eelgrass coverage between the mitigation and reference sites, an additional set of fifteen (15) replicate samples were taken each month from small bare patches within established eelgrass patches at the mitigation site ("mitigation eelgrass"). The fifteen (15) samples collected randomly at the

mitigation site were labeled as mitigation mud to differentiate the two set of samples collected at the mitigation site. These sampling locations were more similar to the sample locations at the reference site. Information gained from this additional sampling was not intended to replace the comparisons of the randomly collected samples against the performance standards, but instead to provide additional information regarding functional trajectory of the mitigation site.

Epifauna were collected using a 0.018 m^2 epibenthic suction sampler. Samples were collected in a 253 µm sieve, which allowed water to pass while trapping epibenthic fauna. Samples were rinsed with filtered seawater, put in 8-ounce plastic jars, fixed with a 10 percent formalin solution with Rose Bengal stain, then rescreened (253 µm sieve) and stored in a 70 percent alcohol solution.

4.3.1.2 Laboratory Analysis

Epibenthic samples were checked in at Grette Associates as soon as they were received from the field. Chain-of-custody forms were completed and accompanied the samples during transfer to Mr. J.R. Cordell, University of Washington, Wetland Ecosystems Team. All ninety (90) samples from the mitigation site and reference site were analyzed.

At the lab, the samples were washed using freshwater from a low-pressure faucet and re-screened with a 200 µm sieve to ensure that the organisms collected in the field would be retained. Samples with large numbers of organisms were separated into large and small fauna size fractions with a 1 mm sieve. All organisms in the large (less abundant) size fraction were sorted, counted, and identified. When necessary, smaller organisms were sub-sampled into a manageable number (minimum of either 200 total organisms or 100 of the most abundant taxon) using either a Folsom plankton splitter or Henson-Stempel pipette. Each sample, or sub-sample, was then rinsed with fresh water into Petri dishes for sorting, counting, and identification of organisms. Following identification of epifauna to species of greatest possible taxonomic resolution, excess water was drawn off of each sorted taxon and the remaining moisture was blotted with absorbent paper. Organisms were air dried for 30 seconds prior to weighing and weighed on an analytical balance. Samples were then returned to their original sample jars with their original labels.

Count and biomass data for each sample or sub-sample were recorded onto data sheets. When sub-sampling was used, the small fauna counts and biomasses were then multiplied and summed with the large fauna to get total sample values. 100 percent of the enumerations were recorded. Once the data was entered into a computer spreadsheet, an electronic version, hard copies of the electronic version, the samples, and the data sheets were returned to Grette Associates. Grette Associates personnel verified 100 percent of the data entries against the computer spreadsheet before using the electronic data for statistical analysis. Epibenthic samples contained both epibenthic and non-epibenthic organisms. A complete taxonomic catalog of all organisms collected is presented in Appendix B. Salmonid prey species were separated from other epibenthic organisms based on the species listed in Table 4.

Table 4. Epibenthic species considered salmonid prey.

Anisogammaridae, Juv.	*Eogammarus confervicolus*
Anisogammarus pugettensis	*Eurytemora americana*
Calliopiidae, Juv.	*Eurytemora* sp. Indet.
Ceratopogonidae larvae	*Harpacticus arcticus* (or *septentrionalis*)
Chironomidae larvae	*Harpacticus compressus*
Corophium acherusicum	*Harpacticus* sp. A
Corophium crassicorne	*Harpacticus* sp. Indet. copepodites
Corophium salmonis	*Harpacticus spinulosus*
Corophium sp. Indet.	*Harpacticus uniremus*
Corophium sp. Indet., Juv.	*Harpacticus-obscurus* group
Cumella vulgaris	*Leimia vaga*
Dactylopusia crassipes	*Microarthridion littorale*
Dactylopusia sp. Indet.	*Neomysis mercedis*
Dactylopusia sp. Indet. Copepodites	*Tachidius discipes*
Dactylopusia tisboides	*Tachidius triangularis*
Dactylopusia vulgaris	*Tisbe* sp. Indet.
Diptera pupa	*Zaus* sp. Indet.

4.3.1.3 Results

Overview

The epibenthic samples contained both epibenthic and non-epibenthic organisms. A complete list of all organisms collected is presented in Appendix B. All of the analysis reported below is based on the subset of the epibenthic assemblage considered prey for salmonids (see Table 4). A summary of salmonid epibenthic prey taxa sampled at the Drayton Harbor Mitigation Site and the reference site is presented in Table 5.

The following are the performance standards for epibenthic zooplankton at the Drayton Harbor Mitigation Site. As specified in the Monitoring Plan, results from 2005 monitoring were used as a preliminary test against the performance standards. Monitoring to occur in year 10 (2009) will be the final test against the performance standards.

- D.2.A. Total numerical abundance of salmonid prey epifauna not statistically less (α=0.05 and β=0.2) than reference site.
- D.2.B. Total wet-weight biomass of salmonid prey epifauna not statistically less (α=0.05 and β=0.2) than reference site.

Both parametric (two sample *t* test, ANOVA) and non-parametric (Kruskal-Wallis) statistical tests were employed for data comparison to these performance standards. Prior to statistical analysis, samples were pooled by cluster analysis (Bray-Curtis) using natural log-transformed numerical abundance data. Cluster analyses were used to generate dissimilarity percentages for each sample within all date and site combinations. In previous years, statistical analysis protocol for this study used those percentages (also called dissimilarity indices) to remove samples values of greater than 75 percent. In 2005, two (2) samples were removed from the June mitigation mud samples, one (1) from the June mitigation eelgrass samples, and four (4) from the June reference samples. Dissimilarity matrices are presented in Appendix B.

Performance curves were plotted for all biological data evaluated with respect to performance based standards (Pacific International Engineering 1998). Performance curves are presented in Appendix B.

Table 5. Epibenthic taxa as a percentage of total abundance.[1]

	April			June		
	Drayton Harbor Mitigation Site (mud)[2]	Drayton Harbor Mitigation Site (eelgrass)[3]	Reference Site (eelgrass)[4]	Drayton Harbor Mitigation Site (mud)[2]	Drayton Harbor Mitigation Site (eelgrass)[3]	Reference Site (eelgrass)[4]
Corophium sp. Indet.			<0.1			
Cumella vulgaris			0.2			2.0
Dactylopusia copepodites	0.1		<0.1			
Dactylopusia sp.		0.3	0.1	17.9	16.8	3.0
Dactylopusia vulgaris	0.9		0.3		1.6	
Harpacticus arcticus (or *septentrionalis*)			<0.1			
Harpacticus obscurus group	0.2	0.4	0.2	6.0	2.4	1.0
Harpacticus sp. Indet.						
Copepodites			<0.1			
Harpacticus spinulosus			1.0			2.0
Harpacticus uniremis	0.1	<0.1		0.9		
Leimia vaga						1.0
Tachidius triangularis		<0.1				
Tisbe sp. Indet.	98.0	98.9	97.9	75.2	75.2	83.1
Zaus sp. Indet	0.7	0.3	0.2		4.0	7.9

[1]Only salmonid prey taxa are shown.
[2]Samples taken at random locations within the mitigation area.
[3]Samples taken at eelgrass plots within the mitigation area.
[4]Samples taken at eelgrass plots from within the reference area.

Numerical Abundance

In the April sampling, numerical abundance of salmonid prey at the mitigation site (mud) was less than that at the reference site (Table 6). Results of both parametric and non-parametric analyses demonstrated that this difference was statistically significant for April sample comparisons (Table 7). In the June sampling, numerical abundance of salmonid prey was greater in the mitigation site (mud) than at the reference site. Results of the statistical analyses indicated that the performance standard D.2.A was met for the June samples, but not for the April samples. Based on this performance standard D.2.A was not met in 2005. Numerical abundance data for all species and statistical summary tables for the salmonid prey epibenthos are presented in Appendix B.

Analyses on the additional fifteen (15) samples taken within established eelgrass at the mitigation site (mitigation eelgrass) were also conducted. Numerical abundance of salmonid prey from the mitigation eelgrass samples were greater than that of the reference site in both April and June (Table 6). Results of both parametric and non-parametric analyses demonstrated that these differences were not statistically significant (Table 7).

Table 6. Taxa richness and total abundance of epibenthic salmonid prey.

	April			June		
	Drayton Harbor Mitigation Site (mud)	Drayton Harbor Mitigation Site (eelgrass)	Reference Site (eelgrass)	Drayton Harbor Mitigation Site (mud)[2]	Drayton Harbor Mitigation Site (eelgrass)[3]	Reference Site (eelgrass)[4]
Taxa richness	6	6	11	4	5	7
Mean	69.9	340.8	221.1	9.0	11.4	7.2
Mean density[1]	3,885	18,948	12,295	500	632	401

[1] Mean density is abundance per square meter. Mean density is calculated as: mean abundances x 1/area of sampler. The sampler was 0.018 m^2; therefore, the listed mean abundances, with appropriate significant digits, were multiplied by a factor 55.6 to yield a mean density.
[2] Based on 13 samples instead of 15.
[3] Based on 14 samples instead of 15.
[4] Based on 11 samples instead of 15.

Table 7. Results of parametric (ANOVA) and nonparametric (Kruskal-Wallis) comparison of mitigation and reference site means for salmonid prey abundance, 2005.

	Comparison of Means[1]	ANOVA[2]	Kruskal-Wallis[2]	Significantly Different
EELGRASS REFERENCE to MITIGATION MUD[3]				
April	R>M	0.004	0.002	Yes
June	R<M	0.762	0.684	No
MITIGATION EELGRASS to MITIGATION MUD[4]				
April	E>M	0.011	0.003	Yes
June	E>M	0.772	0.326	No
EELGRASS REFERENCE to MITIGATION EELGRASS[4]				
April	R<E	0.963	0.885	No
June	R<E	0.508	0.332	No

[1] M = mitigation mud samples, E = mitigation eelgrass samples, R = reference samples
[2] The lower the p-level, the more we can believe that the observed relation between variables in the sample is a reliable indicator of the relation between the respective variables in the population.
[3] Comparison on which the salmonid prey abundance performance standard is based.
[4] Additional comparisons for informational purposes, not for performance standard evaluation.

Wet-weight Biomass

Biomass of salmonid prey in the mitigation site (mud) was less than that at the reference site in April, but greater than that at the reference site in June (Table 8). Results of both parametric and non-parametric analyses demonstrated that the difference in the April sampling was statistically significant, but the difference in the June sampling was not statistically significant (Table 9). Results of the statistical analyses indicated that the performance standard D.2.B was met for the June samples, but not for the April samples. Based on this performance standard D.2.B was not met in 2005. Biomass data for all species and statistical summary tables for salmon prey epibenthos are presented in Appendix B.

Analyses on the additional 15 samples taken within the transplant plots were also conducted. Numerical abundance of salmonid prey at the mitigation eelgrass was greater than that of the reference site in both April and June (Table 8). Results of both parametric and non-parametric analyses demonstrated that these differences were not statistically significant (Table 9).

Table 8. Wet-weight biomass of epibenthic salmonid prey.

	April			June		
	Drayton Harbor Mitigation Site (mud)	Drayton Harbor Mitigation Site (eelgrass)	Reference Site (eelgrass)	Drayton Harbor Mitigation Site (mud)[2]	Drayton Harbor Mitigation Site (eelgrass)[3]	Reference Site (eelgrass)[4]
Wet-weight Biomass (g)	0.0998	0.3753	0.3696	0.0060	0.0060	0.0054
Mean (g)	0.0067	0.0250	0.0246	0.0005	0.0005	0.0004
Mean density (g)[1]	0.3701	1.3911	1.3700	0.0257	0.0303	0.0214

[1] Mean density is abundance per square meter. Mean density is calculated as: mean abundances x 1/area of sampler. The sampler was 0.018 m^2; therefore, the listed mean abundances, with appropriate significant digits, were multiplied by a factor 55.6 to yield a mean density.
[2] Based on 13 samples instead of 15.
[3] Based on 14 samples instead of 15.
[4] Based on 11 samples instead of 15.

Table 9. Results of parametric (ANOVA) and nonparametric (Kruskal-Wallis) comparison of mitigation and reference site means for salmonid prey wet-weight biomass, 2005.

	Comparison of Means[1]	ANOVA[2]	Kruskal-Wallis[2]	Significantly Different
EELGRASS REFERENCE to MITIGATION MUD[3]				
April	R>M	0.004	0.002	Yes
June	R<M	0.762	0.684	No
MITIGATION EELGRASS to MITIGATION MUD[3]				
April	E>M	0.011	0.003	Yes
June	E>M	0.772	0.326	No
EELGRASS REFERENCE to MITIGATION EELGRASS[4]				
April	R<E	0.963	0.885	No
June	R<E	0.508	0.332	No

[1] M = mitigation mud samples, E = mitigation eelgrass samples, R = reference eelgrass samples
[2] The lower the p-level, the more we can believe that the observed relation between variables in the sample is a reliable indicator of the relation between the respective variables in the population.
[3] Comparison on which the salmonid prey abundance performance standard is based.
[4] Additional comparisons for informational purposes, not for performance standard evaluation.

4.3.2 Eelgrass Establishment Monitoring

4.3.2.1 Sampling

Eelgrass establishment monitoring at the Drayton Harbor Mitigation Site was assessed on July 20-21, 2005. Monitoring occurred during the lowest tides cycles, allowing biologists to walk the entire site. Observations were made at each of twenty surviving transplant plots planted in 1999 through 2004, and along the six permanent transects established to identify volunteer eelgrass (Figure 9).

Detailed surveying at each of the eelgrass transplant plots included patch size and density measurements to evaluate growth. To determine patch size a tape measure was placed running north to south through the middle of the plot to record patch diameter. Five diameter measurements were taken at each plot starting at due north and continuing clockwise, then the diameters were averaged to determine total area. Turion density was assessed by placing a 0.25 m^2 quadrat, within the radius of the original plot (each plot starts with a radius of approximately

5.6 ft) at approximately the 2, 6 and 10 o'clock positions relative to the center of the plot (with due north representing 12 o'clock). Additional densities were taken by placing the quadrat outside of the original 5.6 ft radius, again sampling was conducted at approximately the 2, 6 and 10 o'clock positions relative to the center of the plot. The number of turions and condition of the turions within each of the quadrats were recorded. The approximate number of reproductive shoots was also recorded for each transplant plot.

In addition to monitoring eelgrass at the transplant plots, volunteer eelgrass colonization at the Drayton Harbor Mitigation Site was also assessed by biologists walking the site. Monitoring the volunteer eelgrass colonization was accomplished by recording eelgrass (individual shoots and patches) within six belt transects. Five belt transects were established across the mitigation site running due north to either edge of the site. The sixth transect was marked in an east-west direction. Monitoring along each transect consisted of biologists walking the transect recording all eelgrass present within 15 ft of the transect on either side.

4.3.2.2 Results

TRANSPLANT PLOT COVERAGE

When originally planted, each eelgrass transplant plot had an average radius of approximately 5.6 ft. Collectively, the five plots planted each year covered a total area of approximately 500 ft^2. Plots 1 through 10 and 16 through 25 are flourishing and results from monitoring are presented below (Table 10; Figure 12). Plots 11 through 15 died over the course of the winter of 2001 and are not included in this section. Photos of the transplant plots are presented in Appendix A.

The success of volunteer eelgrass adjacent to transplant plots 1 through 5 (planted in 1999) has made it impractical to assess the average radius of the plots and thus the total area covered by each of the plots. Transplant plots 1 through 5 and the adjacent volunteer plots have formed large eelgrass patches making it impossible to determine the locations of the edges of the original transplant plots.

Eelgrass plots 6 through 10 (planted in 2000) had an average radius of 10.7 ft. The plots cover a total area of approximately 1,812 ft^2, up slightly from 2004. The radii of the plots ranged from 9.9 ft to 12.5 ft (Table 10).

Eelgrass plots 16 through 20 (planted in 2002) had an average radius of 8.6 ft. The plots now cover a total area of approximately 1,157 ft^2, down slightly from 2004. The radii of the plots ranged from 7.8 ft to 9.8 ft.

Eelgrass plots 21 through 25 (planted in 2003) had an average radius of 5.7 ft. The plots have expanded to cover a total area of approximately 524 ft^2, up slightly from 2004. The radii of the plots ranged from 4.2 ft to 6.8 ft.

TRANSPLANT PLOT TURION DENSITIES

Average turion density within transplant plots 1 through 5 was 119.5 turions per m^2 (Table 11). The highest average turion densities (126 turions per m^2) were observed within the originally

planted 5.6 ft radius. Slightly higher densities were recorded inside of the original 5.6 ft radius transplant areas (Table 11). Turions within the transplanted plots were noted as being in good condition with reproductive shoots present at all five transplant plots. The reproductive shoots were distributed evenly throughout each of the transplant plots.

Transplant plots 6 through 10, had an average turion density of 122.0 turions per m^2 (Table 11). Average turion density within the originally planted 5.6 ft radius transplant plots was 142 turions per m^2, while average density outside the original 5.6 ft transplant area was 102 turions per m^2. All turions observed within the quadrats were in good condition and reproductive shoots were observed within all five of the transplanted plots.

Average turion density at transplant plots 16 through 20 and 21 through 25 was 72 and 84 turions per m^2 respectively (Table 11). Densities from these plots were only recorded from within the 5.6 ft transplant area. Turions present were in good condition and reproductive shoots were observed on all of the plots.

Table 10. Eelgrass transplant plot average radii at the Drayton Harbor Mitigation Site

	Radius (ft)						
Plot #	**1999**	**2000***	**2001***	**2002***	**2003**	**2004**	**2005**
1	5.6	7.5	10.7	10.7	16.6	-	-
2	5.6	9.1	10.5	12.0	12.4	-	-
3	5.6	8.7	12.4	12.5	16.9	-	-
4	5.6	7.4	9.4	11.3	12.9	-	-
5	5.6	6.6	10.1	12.8	13.8	-	-
Mean Plot radius (1-5)	**5.6**	**7.9**	**10.6**	**11.9**	**14.5**	**-**	**-**
6	-	5.6	6.1	5.7	7.4	9.1	9.9
7	-	5.6	6.3	3.0	7.2	9.5	10.6
8	-	5.6	7.9	5.8	8.3	10.0	10.3
9	-	5.6	6.2	6.1	7.8	11.9	10.3
10	-	5.6	6.8	5.7	10.0	11.5	12.5
Mean Plot radius (6-10)	**-**	**5.6**	**6.7**	**5.3**	**8.1**	**10.4**	**10.7**
16	-	-	-	5.6	6.0	9.3	9.8
17	-	-	-	5.6	6.7	8.6	8.2
18	-	-	-	5.6	7.0	9.5	7.8
19	-	-	-	5.6	5.8	8.2	9.2
20	-	-	-	5.6	5.4	7.3	7.8
Mean Plot radius (16-20)	**-**	**-**	**-**	**5.6**	**6.2**	**8.6**	**8.6**
21					5.6	4.6	5.6
22					5.6	6.0	6.8
23					5.6	6.2	6.7
24					5.6	4.8	4.2
25					5.6	4.8	5.3
Mean Plot radius (21-25)					**5.6**	**5.3**	**5.7**

Data presented for previous sampling years was compiled from previous monitoring reports (PIE 2001A, PIE 2001B, Grette Associates 2003).

Table 11. Transplant plot average turion density at the Drayton Harbor Mitigation Site

Average Turion Density (Turions per m^2)										
	1999	**2000***	**2001***		**2002***		**2003**		**2005**	
Plot #	Within 5.6 ft radius	Within 5.6 ft radius	Within 5.6 ft radius	Outside 5.6 ft radius	Within 5.6 ft radius	Outside 5.6 ft radius	Within 5.6 ft radius	Outside 5.6 ft radius	Within 5.6 ft radius	Outside 5.6 ft radius
1	43	64	77	59	109	69	132	125	125	84
2	43	80	113	92	77	49	136	125	92	107
3	43	45	87	73	107	51	145	152	117	96
4	43	113	63	61	109	61	137	169	132	140
5	43	88	68	52	77	116	177	72	163	140
Mean Turion Density (Plots 1-5)	**43**	**78**	**82**	**67**	**96**	**69**	**146**	**129**	**126**	**113**
6	-	43	45	23	77	0	218	168	209	111
7	-	43	45	21	53	24	87	95	113	91
8	-	43	59	16	75	16	84	113	112	-
9	-	43	28	0	81	0	124	127	99	-
10	-	43	68	47	84	27	120	139	176	105
Mean Turion Density (Plots 6-10)		**43**	**49**	**21**	**74**	**13**	**127**	**128**	**142**	**102**
16	-	-	-	-	43	-	100	-	47	-
17	-	-	-	-	43	-	96	-	47	-
18	-	-	-	-	43	-	103	-	69	111
19	-	-	-	-	43	-	55	-	95	-
20	-	-	-	-	43	-	31	-	103	-
Mean Turion Density (Plots 16-20)	-	-	-	-	**43**	-	**77**	-	**72**	-
21	-	-	-	-	-	-	-	-	67	-
22	-	-	-	-	-	-	-	-	103	-
23	-	-	-	-	-	-	-	-	128	-
24	-	-	-	-	-		-	-	59	-
25									65	
Mean Turion Density (Plots 21-25)	-	-	-	-	-	-	-	-	**84**	-

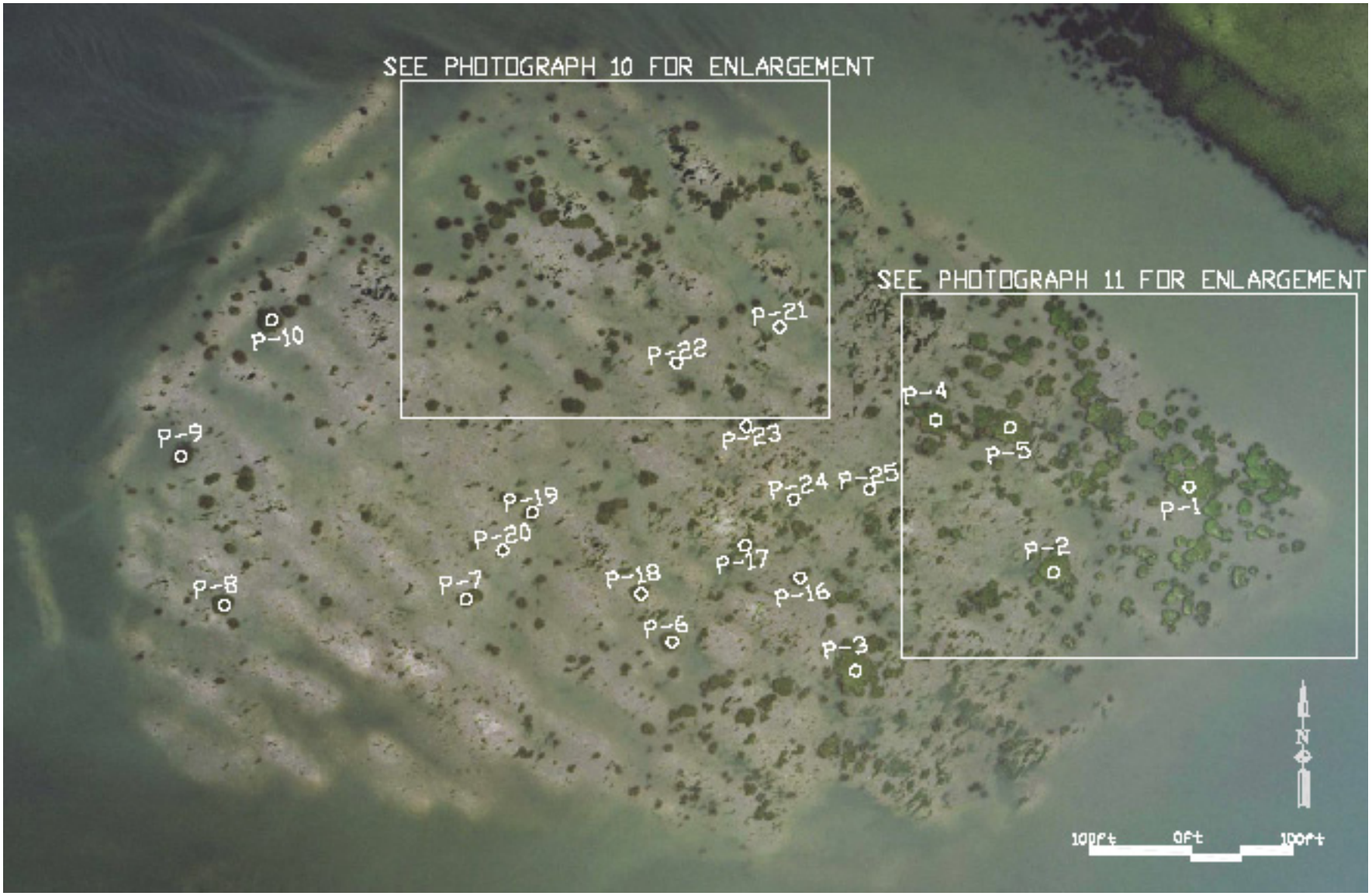
* Data presented for previous sampling years was compiled from previous monitoring reports (PIE 2001A, PIE 2001B, Grette Associates 2003).

VOLUNTEER EELGRASS

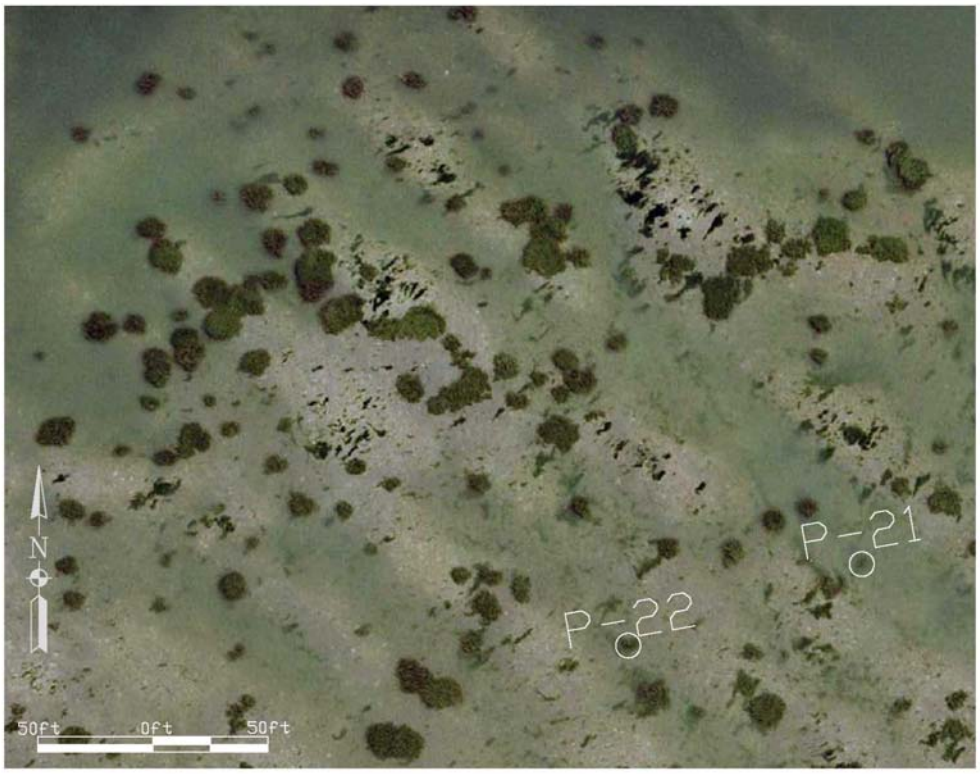
Volunteer eelgrass colonization was assessed by means of a belt transect survey (Figure 9). The six belt transects covered a total of approximately 2,900 lineal ft, encompassing an area of approximately 87,000 ft^2 (~2.0 acres). Eelgrass was observed along all six transects and ranged in size from individual turions (seedlings) to large patches approximately 4,500 ft^2. Many of the smaller eelgrass patches observed in prior years of sampling have expanded to form larger patches. Within the belt transects, a total of 245 volunteer eelgrass points (either patches or individual turions) were encountered, covering approximately 20,750 ft^2. On average, volunteer eelgrass was encountered every 11.8 lineal ft of belt transect. Of the 245 volunteer eelgrass points, 90 were seedlings ranging between one and five seedlings.

TOTAL EELGRASS COVERAGE

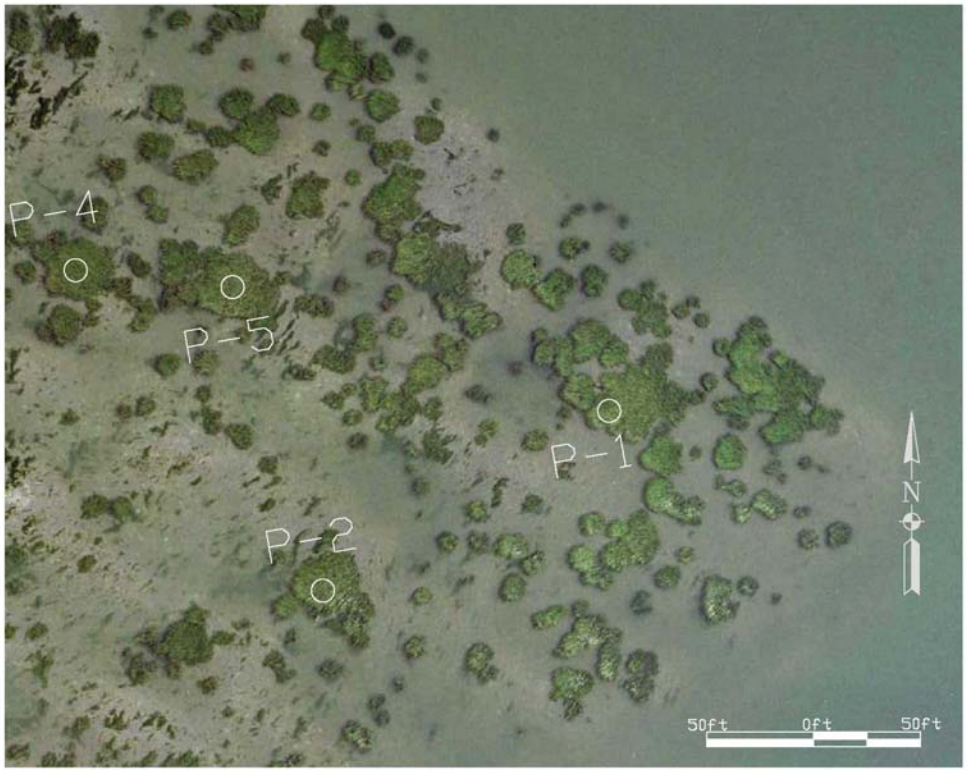
Total eelgrass coverage of both transplanted and volunteer eelgrass increased between 2004 and 2005. The estimated eelgrass coverage in 2004 was approximately 68,411 ft^2 (1.57 acres). In 2005, the estimated eelgrass coverage was approximately 82,724 ft^2 (1.90 acres), an increase of approximately 21% (Figure 12). These estimates were calculated using the aerial photographs from each year with ground truthing to verify the presence of eelgrass versus macroalgae.



Photograph 9. Drayton Harbor Mitigation Site, August 2005.



Photograph 10. Drayton Harbor Mitigation Site, August 2005.



Photograph 11. Drayton Harbor Mitigation Site, August 2005.

4.3.3 Avifauna

4.3.3.1 Sampling

Avifauna sampling was conducted at the Drayton Harbor Mitigation Site and in adjacent areas. Observations were made from a vessel anchored within 100 ft of the mitigation site using binoculars to record species occurrence and abundance. Avifauna was surveyed for four hours (two hours before and two hours after low tide) on days with the lowest tides during daylight hours. Observations were made in the mitigation site and in adjacent areas. Surveys were conducted on June 23, 2005, August 18, 2005, November 18, 2005, and February 28, 2006.

4.3.3.2 Results

Avifauna abundance and diversity varied with season. The August survey resulted in the highest counts and the November survey resulted in the highest numbers of species observed. During the four sampling periods at the Drayton Harbor Mitigation Site, a total of 2,005 birds were observed representing 19 species. Avifuana presence at the adjacent areas resulted in higher counts and species diversity during all of the surveys. No statistics were performed on avifauna survey data. Many of the birds present at the mitigation site and the adjacent areas continuously roamed throughout the entire harbor, among and beyond the monitored areas. Birds present in multiple areas during monitoring were noted as such but identified and counted only as were first observed. Results for these surveys are tabulated below (Tables 12–15).

Table 12. Results of avifauna surveys at the Drayton Harbor Mitigation Site, June 23, 2005.

	Mitigation Site		Adjacent Areas		
Species	**Shallows at Mitigation Site**	**Eelgrass Plots**	**Open Water (North & South)**	**Open Water (East & West)**	**Shoreline Eelgrass**
Great Blue Heron[4]		1			342
Common Loon[4]	2 (adults)		6 (adults)	3 (adults)	
Double-crested cormorant			12	7	
Canada Goose			13 (adults)		
Osprey[3]					1
Bald Eagle[3]					3
Glaucous-winged Gull[4,1,2]	3 (adults)	27 (22 adults.)			38
Arctic Tern[4,1]		31 (adults)			4
American Crow		2			6

[1] Moved in and out of mitigation site, number of individuals recorded where they were original observed
[2] Spent time foraging around eelgrass plots
[3] Same individuals hovered at mitigation site and adjacent areas
[4] Foraging in the areas where they were observed

Table 13. Results of avifauna surveys at the Drayton Harbor Mitigation Site, August 18, 2005.

	Mitigation Site		Adjacent Areas		
Species	**Shallows at Mitigation Site**	**Eelgrass Plots**	**Open Water (North & East)**	**Open Water (South & West)**	**Shoreline; Eelgrass**
Great Blue Heron[1,4]					152
Common Loon[4]	4	1	24	3	
Double-crested cormorant[1,4]	3	1	2	17	
Surf Scoter		2♂			
White-winged scoter[1]	47 (28♂ 19♀)	19 (9♂ 10♀)	249	>250	
Herring Gull					1
Western Gull					6
Arctic Tern[3,4]	14	10	14	9	5
Glaucous-winged Gull[1]	4		1		

[1] Moved in and out of mitigation site, number of individuals recorded where they were original observed
[2] Spent time foraging around eelgrass plots
[3] Same individuals hovered at mitigation site and adjacent areas
[4] Foraging in the areas where they were observed

Table 14. Results of avifauna surveys at the Drayton Harbor Mitigation Site, November 18, 2005.

	Mitigation Site		Adjacent Areas		
Species	**Shallows at Mitigation Site**	**Eelgrass Plots**	**Open Water (North & South)**	**Open Water (East & West)**	**Shoreline; Eelgrass**
Great Blue Heron[1,4]					29
Common Loon[2,4,5]			13	6	
Double-crested cormorant[4,5]	1		11	4	
Surf scoter[5]	5 (3♂2 ♀)		38 (18♂ 20♀)	11 (6♂ 5♀)	
Black scoter[5]	10 (4♂ 6♀)		5 (2♂ 3♀)	7 (5♂ 2♀)	
White-winged scoter[5]	84 (55♂ 29♀)		32 (18♂ 14♀)	19 (8♂ 11♀)	
Glaucous-winged Gull[3,5]	3 (3 adults)		8 (7 adults)	16 (14 adults)	
Oldsquaw				3♂	
Canada Goose	4		11	6	
Redhead			1		
Western Grebe[2,4,5]	1				4
Bufflehead[5]			12 (7♂ 5♀)		

[1] Moved from tidal mudflat into eelgrass beds
[2] Spent time foraging around eelgrass plots
[3] Same individuals hovered at mitigation site and adjacent areas
[4] Foraging in the areas where they were observed
[5] Moved in and out of mitigation site, number of individuals recorded where they were original observed

Table 15. Results of avifauna surveys at the Drayton Harbor Mitigation Site, February 28, 2006.

	Mitigation Site		Adjacent Areas		
Species	**Shallows at Mitigation Site**	**Eelgrass Plots**	**Open Water (North & East)**	**Open Water (South & West)**	**Shoreline; Eelgrass**
Common Loon[1,2]	6		10	7	
Horned Grebe[1,2]				2	
Double-crested Cormorant[2]			21	8	
Black Scoter[2]	12 (8♂ 5♀)		4 (3♂ 1♀)	29 (13♂ 16♀)	
White-winged Scoter[1,2]	31 (14♂ 17♀)		67 (30♂ 37♀)	44 (24♂ 20♀)	
Bufflehead[1,2]			8 (3♂ 5♀)	25 (16♂ 9♀)	
Arctic Tern	22				
Glaucous-winged Gull[1,2]				5	21

[1] Moved in and out of mitigation site, number of individuals recorded where they were original observed
[2] Foraging in the areas where they were observed

5. DISCUSSION

The 2005 monitoring efforts provide an indication as to the success of the Blaine Harbor and Drayton Harbor mitigation sites in relation to the performance standards presented in the Monitoring Plan. The discussion below identifies how conditions at the mitigation sites during 2005 monitoring compared to the year 6 performance standards and considers whether the performance standards are expected to be achieved in the final monitoring effort, which will be conducted in 2009.

Blaine Harbor Mitigation Sites

The results of the 2005 monitoring activities represented the first test against the performance standards (year 6). Salt marsh vegetation within the three areas (Salt Marsh Area 1, Salt Marsh Area 2, and Boardwalk Area) has developed enough to pass 9 of the 12 performance standards. The Boardwalk Area met all four of the respective performance standards and is providing a dense coverage of salt marsh habitat. Salt Marsh Area 1 met three of the four performance standards, failing the performance standard requiring approximately 0.15 acre of salt marsh vegetation. Approximately 0.11 acre of salt marsh vegetation currently exists in Salt Marsh Area 1, which is approximately 0.035 acre more than what existed in 2002. Salt Marsh Area 2 met two of the four performance standards, failing the performance standards requiring approximately 0.15 acre of salt marsh vegetation and minimum coverage of 70 percent of all salt marsh species. Approximately 0.12 acre of salt marsh vegetation currently exists in Salt Marsh Area 2, which is approximately 0.025 acre more than what existed in 2002. Overall, it is expected that salt marsh vegetation will continue to flourish in these areas and that at the current rate, coverage will be adequate to meet all 12 performance standards in the final year of monitoring year 10 (2009).

Drayton Harbor Mitigation Site

The primary goal of the Drayton Harbor Mitigation Site is to provide a feature with suitable physical and biological conditions for the establishment of eelgrass beds. The mitigation site in Drayton Harbor provides 14.22 acre of persistent aquatic habitat above elevation –6 ft MLLW in the southern portion of Drayton Harbor. This acreage meets performance standard D.1, which requires at least 12 acres of aquatic habitat by year 6 (Table 17).

Salmonid prey epifauna abundance and wet-weight biomass were monitored at two locations within the Drayton Harbor Mitigation Site and compared to a nearby reference site. As with previous sampling (2002), the comparison of the reference site to the mitigation mud resulted in a failure to meet both performance standards for salmonid prey epifauna (D.2.A and D.2.B) (Table 17). In 2005, the mitigation mud (abundance and biomass) failed in April and passed in June, however if one of the months fail the performance standard was not met. Comparisons between the reference site and the mitigation eelgrass met both performance standards for both months.

The Mitigation Plan specified that epibenthic zooplankton samples were to be collected from a reference site that did not contain eelgrass (Parametrix 1997). As discussed in the 2000 Monitoring Report (PIE 2001), no suitable reference sites devoid of eelgrass were located. Because of this the reference samples were collected from small bare patches within an existing

eelgrass bed in an attempt to collect samples more similar to the conditions of the random sampling points at the mitigation site (primarily devoid of eelgrass). As part of the 2002 monitoring activities, small bare patches within the transplanted eelgrass plots at the mitigation site were added to the sampling regime in order to provide a better comparison between the mitigation site and the reference site. While the overall comparison between samples among the mitigation and reference areas results in a failure to meet performance measures of statistically similar prey availability, both in terms of abundance and biomass, the additional sampling of the mitigation eelgrass demonstrates that the eelgrass transplant plots have significantly higher prey availability than the unvegetated substrates of the mitigation site. This provides evidence that the transplanted eelgrass at the mitigation site is satisfying the intended ecological functions proposed for the mitigation site. As the volunteer eelgrass continues to expand in coverage and density, it is expected that the mitigation site will also increasingly fill this function.

The mitigation site is accomplishing the functional goal of providing suitable conditions for the establishment of eelgrass. Eelgrass coverage at the site is comprised of both the transplanted plots (planted each year beginning in 1999) and volunteer eelgrass. A total of 8,000 turions have been successfully transplanted at the site (the 2,000 turions planted in 2001 did not survive). These transplants appear to be the source for the volunteer eelgrass patches noted at the site. Volunteer eelgrass was observed throughout the entire site with the highest concentration noted along the northern (bayward) edge. Total eelgrass coverage by both transplanted and volunteer eelgrass increased between 2004 and 2005. The estimated eelgrass coverage was approximately 68,411 ft^2 (1.57 acres) in 2004. In 2005, the estimated eelgrass coverage was approximately 82,724 ft^2 (1.90 acres), an increase of approximately 21%.

Transplant Plots

The majority of the transplanted eelgrass plots (1-10, 16-25) at the Drayton Harbor Mitigation Site are surviving and thriving. Transplant plots 11-15, which were planted June 25th, 2001, did not survive. The total coverage by the transplanted plots was not able to be determined due to the fact that Plots 1-5 have expanded to encompass several volunteer patches. This made it impossible to determine where the edge was between the transplanted plots and the volunteer patches.

Eelgrass continues to thrive and spread near transplant plots 1 through 5. Reproductive shoots were present within all five plots. Each of the plots was also noted as being in good condition.

Eelgrass coverage at transplant plots 6 through 10, which were planted in 2000, increased from 2004, covering an area of 1,812 ft^2 (Table 16). Reproductive shoots were present within all five plots. The shoots present within these plots were in good condition.

Transplant plots 11-15, which were planted 2001, did not survive. These plots were planted in areas with similar depths and substrates as the 1999 transplant plots. Heavy algal loads (primarily *Enteromorpha* sp.) were observed in 2002 and 2003, which covered a large portion of the site. Dense mats of algae have been shown to shade and smother eelgrass within the Puget Sound (Thom et al. 1988). With a similar algal load in the summer of 2001, it is possible that the transplanted shoots were smothered or shaded, thus decreasing their growth and energy storage for the winter dormant season resulting in poor survival. The poor survival of these plots was discussed in depth in the 2002 monitoring report (Grette Associates 2003).

Transplant plots 16-20, which were planted in 2002, remained approximately the same size, covering an area of 1,157 ft^2 (Table 16). Reproductive shoots were present within all five plots and the shoots present within these plots were in good condition.

Transplant plots 21-25, which were planted in 2003, survived and are providing 524 ft^2 of eelgrass coverage at the site (Table 16). This coverage is slightly higher than the area originally planted. Reproductive shoots were present within four of the five plots and the shoots present within these plots were in good condition.

Table 16. Total areal coverage and total turion counts from the twenty transplant plots at the Drayton Harbor Mitigation Site from 1999-2005.

	1999	2000	2001	2002	2003	2004	2005
Plots 1-5[1]							
Total Areal Coverage (ft^2)	500	980	1,765	2,224	3,365	-	-
Average Areal Coverage (ft^2 (m^2))	100 (9.3)	196 (18.2)	353 (32.8)	445 (41.3)	673 (62.5)	-	-
Average Turion Density (per m^2)	43	78	74.5	82.5	137.5	-	119.5
Total Turion Count	2,000	7,100	12,220	17,035	42,969	-	-
Average Number of Reproductive Shoots	-	-[2]	-[2]	~17	59	-	~15-20%
Plots 6-10							
Total Areal Coverage (ft^2)		500	705	441	1,054	1,700	1,812
Average Areal Coverage (ft^2 (m^2))		100 (9.3)	141 (13.1)	88.2 (8.4)	211 (19.6)	340 (31.6)	362 (33.6)
Average Turion Density (per m^2)		43	37.9	74	127.5	-	122.0
Total Turion Count		2,000	2,485	3,100	12,495	-	20,537
Average Number of Reproductive Shoots		-	-[2]	~5	28	-	~15%
Plots 16-20							
Total Areal Coverage (ft^2)				500	608	1,160	1,157
Average Areal Coverage (ft^2 (m^2))				100 (9.3)	122 (11.3)	232 (21.6)	231 (21.5)
Average Turion Density (per m^2)				43	77	-	72.0
Total Turion Count				2,000	4,350	-	7,739
Average Number of Reproductive Shoots				-	0	-	~41
Plots 21-25							
Total Areal Coverage (ft^2)					500	441	524
Average Areal Coverage (ft^2 (m^2))					100 (9.3)	88.2 (8.2)	105 (9.8)
Average Turion Density (per m^2)					43	-	84
Total Turion Count					2,000	-	4089
Average Number of Reproductive Shoots						-	~16

[1] Volunteer plots 1 through 5 and adjacent volunteer plots have joined to form a larger plot. Because of this the edges of the transplant plots were impossible to determined.

VOLUNTEER EELGRASS

The most notable observation from the monitoring was the abundant volunteer eelgrass present throughout the entire Drayton Harbor Mitigation Site (Photographs 7-11). Overall coverage from the volunteer eelgrass has surpassed that of the transplanted plots. The highest concentration of volunteer eelgrass was noted along the northern (bayward) edge of the mitigation site.

In 1999, approximately 500 ft^2 of eelgrass was transplanted at the site. Eelgrass coverage at the site developed gradually during the following years and was comprised primarily of transplanted eelgrass (Figure 4). During the 2005 belt transects monitoring, a total of 245 volunteer eelgrass points (either patches or individual turions) were encountered, covering approximately 20,750 ft^2. On average, volunteer eelgrass was encountered every 11.8 lineal ft of belt transect. Of the 245 volunteer eelgrass points, 90 of the points were patches of seedlings ranging from one to five turions.

Table 17. Performance Standards and Monitoring Conclusion – Blaine Harbor Mitigation Site

Objective	Performance Standard	Results	Performance Standard Met?
B.1 Enhance approximately 0.2 acres of intertidal habitat for juvenile salmonids through modification of substrates along the shore of Blaine Harbor.	B.1 Within enhanced areas, document presence and extent of quarry spall and gravel at approx. elevation +6 to +2 ft MLLW, presence and extent of gravel and topsoil at approx. elevation +2 to –4 ft, and presence and extent of scattered quarry spall at approx. elevation +6 to –4 ft.	Not surveyed as part of the 2005 monitoring	SEE SECTION 3.11
B.2 Protect approximately 0.1 acre of existing salt marsh habitat near the boardwalk by constructing a retaining board and backfilling eroded areas.	B.2 Existence of at least 0.1 acre of salt marsh substrates.	0.1 acre of salt marsh substrates were present at the Boardwalk Area	Yes
B.3 Increase overall coverage of salt marsh vegetation within the approximately 0.1 acre area near the boardwalk.	B.3.A Survival of a minimum of three planted salt marsh species (year 6).	Five salt marsh species	Yes
	B.3.B Minimum of 5% coverage by each of the three species (year 6).	Three species are present at percentages greater than 5 percent	Yes
	B.3.C Minimum of 70% coverage by all salt marsh species (year 6).	Approx. 99.9% salt marsh coverage	Yes
	B.3.D No more than 10% coverage by invasive weedy species (year 6). (Includes all upland species, *Phalaris*, and *Spartina*)	No invasive species observed	Yes
B.4 Establish condition suitable for salt marsh in Area 1.	B.4.A Existence of approx. 0.15 acre of salt marsh vegetation (year 6).	Approx. 0.11 acre of salt marsh vegetation	No
	B.4.B Presence of three species of salt marsh vegetation (year 6).	Ten salt marsh species	Yes
	B.4.C Minimum of 70% coverage by all salt marsh species (year 6).	Approx. 75% salt marsh coverage	Yes
	B.4.D No more than 10% coverage by invasive weedy species (year 6). (Includes all upland species, *Phalaris*, and *Spartina*)	1% coverage by invasive species	Yes
B.5 Establish conditions suitable for salt marsh in Area 2.	B.5.A Existence of approx. 0.25 acre of salt marsh (year 6).	Approx. 0.12 acre of salt marsh vegetation (percent coverage).	No
	B.5.B Presence of three species of salt marsh vegetation (year 6).	Six salt marsh species	Yes
	B.5.C Minimum of 70% coverage by all salt marsh species (year 6).	Approx. 43.8% salt marsh coverage	No
	B.5.D No more than 10% coverage by invasive weedy species (year 6). (Includes all upland species, *Phalaris*, and *Spartina*)	No invasive species observed	Yes

Table 18. Performance Standards and Monitoring Conclusion – Drayton Harbor Mitigation Site

Objective	Performance Standard	Results	Performance Standard Met?
D.1 Provide a minimum of 12 acres and a target of 15 acres of persistent aquatic habitat.	D.1 Areal extent of aquatic habitat located above elevation –6 ft MLLW must equal or exceed 12 acres at year 6 and 10.	Approx. 14.22acres above elevation –6 ft MLLW	Yes
D.2 Provide a productive and functioning rearing habitat for juvenile salmonids as demonstrated by a diverse and abundant assemblage of epibenthic organisms.	D.2.A Total numerical abundance of salmonids prey epifauna not statistically less ($\alpha = 0.05$ and $\beta = 0.2$, one-tailed test) than reference site.[1]	Reference>Mitigation (mud); statistically significant in April, not significant in June. There was no significant difference between mitigation (eelgrass) and the reference site. Note that this was an informal comparison between reference site and mitigation (eelgrass).	PRELIMINARY No Final test in Year 10 (2009)
	D.2.B Total wet-weight biomass of salmonid prey epifauna not statistically less ($\alpha = 0.05$ and $\beta = 0.2$, one-tailed test) than reference site.[1]	Reference>Mitigation (mud); statistically significant in April, not significant in June. There was no significant difference between mitigation (eelgrass) and the reference site. Note that this was an informal comparison between reference site and mitigation (eelgrass).	PRELIMINARY No Final test in Year 10 (2009)

[1] Preliminary test against performance standards.

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