Macrophyte Evaluation 2008
Rich Passage Beach Nourishment

Prepared for

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INTRODUCTION

This technical report describes the monitoring of marine macrophytes (intertidal macro algae) observed in sample quadrats (plots) along surveyed transects at two locations in Rich Passage where beach nourishment enhancement activities are proposed in the near future. These sites were previously selected for beach nourishment due to substantial erosion of intertidal sediment in recent years. Bull kelp present within the general vicinity of the beach nourishment locations was also surveyed.

Beach nourishment is the general process of providing sand gravel and cobble size soils to maintain the supply of materials essential in the natural shore processes that form and maintain Puget Sound beaches. Beach nourishment can be either a natural or a man-produced action. As a natural process it results both from shoreline bluff erosion resulting in land slides, and river discharge of bed load material. Puget Sound's bluffs are naturally subjected to wave erosion at their base (toe) resulting in intermittent mass wasting events (landslides) that deposit large amounts of soils on the intertidal beaches. Thus, the periodic deposition of large amounts of soils on intertidal beaches is a natural component of Puget Sound's shoreline processes. The majority (90%) of beach material in Puget Sound has originated from bluff erosion (Keuler 1979)

Because storm driven wave and vessel wake energy regularly redistributes the silt to cobble size substrate along Puget Sound beaches, it is necessary to have supplies of new material at the upstream end of a drift sector or offshore movement location to maintain a periodic, but relatively constant source of new material. The integrity of Puget Sound beaches is dependent on the long-term, but periodic supply of new substrate material that dramatically changes local conditions during the landslides that naturally contribute this new material. Without a supply of new material the beach physical characteristics change as the smaller material is transported along shore and off shore until the beach develops sufficient armoring to resist the wave energy.

Puget Sound's shorelines currently suffer from various shoreline modifications (bulkheads, docks, breakwaters, etc.) that interrupt both the natural supply of new substrate material to beaches and that reflect, resist, or block the wave energy that drives normal shoreline processes.

Puget Sound intertidal biota inhabiting sandy to cobble beaches have naturally developed along with the shoreline processes that provide periodic as well as low level constant movement of beach materials. Thus, macrophytes removed or buried by beach nourishment actions should rapidly reestablish at the same locations unless tidal elevations are markedly changed.

The macrophyte monitoring discussed in this report is a descriptive rather than a hypothesis testing effort. The basic objective is to identify and describe macrophyte communities present at the two locations where beach nourishment actions will occur, and subsequently describe conditions following beach nourishment. The beach nourishment and paired adjacent reference sites will be monitored annually for several years to identify the nature and extent of changes occurring with and without beach nourishment. The reference sites are included to help identify annual changes in the macrophyte communities that are not related to the beach nourishment actions. Macrophyte monitoring is intended to identify the algal species present at the sites and provide quantitative information on macrophyte presence at the beach nourishment sites.

Macrophytes are a valuable biological resource because they provide shelter and food to a wide variety of fish and invertebrates that are important prey for nearshore fishes and shorebirds. Macrophytes help promote reestablishment of intertidal and nearshore faunal communities and general habitat characteristics following physical perturbation.

OBJECTIVE

The objective of this investigation is to evaluate the potential biological effects of beach nourishment (additional substrate) on macrophytes at Rich Passage sites where waves and boat wakes produce erosion and movement of beach sediment. Beach nourishment has the potential to modify substrate composition and surface elevations within the intertidal and shallow subtidal zones thereby influencing the biological community inhabiting these substrates. Previous investigations of the intertidal biological communities in Rich Passage have provided general descriptions of the species and abundance of invertebrates and macrophytes occupying the intertidal and shallow subtidal zones at specific locations. None of this work focused on the beach nourishment sites covered by this report, and none has quantitatively address the macrophyte community as has been done in this investigation. This investigation focuses on the existing and changing macrophyte conditions at sites previously selected for physical monitoring of beach nourishment. Bull kelp monitoring is included to determine the location of any bull kelp beds present within immediate vicinity of the monitored beach nourishment sites.

This document describes the methods used to collect information, and the data analysis performed to identify the existing biological conditions at selected sites that will be altered by beach nourishment. The major challenge in achieving this objective is to separate the natural temporal variation of biological communities from those changes resulting in substrate changes produced by beach nourishment.

The strategy for achieving this objective is an treatment vs. reference approach. In this approach the treatment locations are the selected beach nourishment sites. At these beach nourishment locations physical changes will occur as a result of placement of the new substrate on the existing beach. The monitoring will be conducted again for two years following placement of the beach nourishment material to document changes in the macrophyte communities at these sites. The reference stations are located adjacent to the beach nourishment sites with similar substrate, slope, and energy exposure. The major challenge of this approach is that no true reference sites are known to exist. All potential reference sites have both obvious and obtuse differences from the treatment sites that will complicate interpretation of changes to the physical and biological conditions over time at the sites.

ASSUMPTIONS

The potential biological effects produced by beach nourishment are most likely to occur to the biological community of the intertidal and very shallow subtidal zones. These are the tidal elevations where both substrate grain size and surface elevation will change with beach nourishment.

Macroalgae commonly occur in Puget Sound at the lower intertidal elevations within the beach nourishment range. Beach nourishment material is likely to move from higher to lower tidal elevations as it is moved by wind wave and boat wake action along the beaches. Thus, macroalgae within the lower intertidal elevations are likely to be within the zone of active substrate movement at beach nourishment sites.

MONITORING SITES

Macrophyte monitoring is being conducted at two previously identified beach nourishment locations where changes to the site's fauna and flora can be expected, and at adjacent reference locations.

BEACH NOURISHMENT LOCATIONS

Evaluation of the macrophyte communities is being conducted at each of the two proposed beach nourishment locations (Figure 1):

- Point White East (north side Rich Passage)
- Glover Point (south side Rich Passage)

Figure 1. Macrophyte monitoring sites for beach nourishment action.

The Point White East location is located at the upstream edge of a southwest to northeast drift sector. The reference site for this location is toward the downstream (northeast) end of the drift sector prior to a major change in substrate type.

The direction of drift is uncertain at the Point Glover site. A reference location was selected adjacent to the beach nourishment site where appropriate slope and substrate are present in the apparent down-drift direction.

REFERENCE LOCATIONS

A reference location was established near each of the two beach nourishment sites. Each of these reference locations is a sufficient distance from the treatment site that movement of the proposed beach nourishment materials from the treatment location to the reference location is not anticipated in the first two years following treatment. The Point White reference location is to the about 500 ft to the northeast of the beach nourishment location within the general area shown in Figure 1. The Point Glover reference location is about 125 ft to the southwest of the beach nourishment location and is separated from the beach nourishment site by a groin that extends across the beach.

MONITORING METHODS

The following subsections describe methods used to monitor the macroalgae and bull kelp communities present at the two proposed beach nourishment sites. This information is being gathered to evaluate the potential biological effects of beach nourishment on the macrophyte community of the lower intertidal portion of the nourishment sites in the Rich Passage area.

Macroalgae are prevalent throughout the lower intertidal and shallow subtidal elevations of much of the Rich Passage area. The marine algae tend to occur wherever sufficiently large and stable substrate particles are present at the lower intertidal and shallow subtidal elevations to give the algae the opportunity to remain in place. Bull kelp beds are both rare and transitory at various patchy locations in the Rich Passage area. Our previous observations indicate the transitory nature of bull kelp beds may be related to grazing by the abundant population of kelp crabs (*Pugettia producta*).

MACROALGAE

Macro algae are challenging to characterize quantitatively. Identifying the species present and characterizing their frequency of occurrence in a substantial number of quadrat (plot) samples provides general coverage or abundance information. However, the flexible nature of the plants, together with variability in size and structure makes quantitative characterization challenging.

The macroalgae growing on the substrate at each of the proposed beach nourishment sites and adjacent reference sites were surveyed at the Pt. White site on July 31 and the Pt. Glover site on August 1, 2008. Transects parallel with the shoreline were established at intertidal elevations of 0 to -1 ft MLLW. Transect lengths ranged from about 180 to 250 ft long. Tide elevations at the sites were based on predictions from local tide tables[1]. Transect markers were set at 0 ft and -1 ft MLLW at the beginning and end of both reference and treatment transects at each site. Fifty circular quadrats (0.25 m^2) were placed approximately every 0.5 m, at approximately the -0.5 ft MLLW level along each transect. The macrophyte species present within each quadrat was then recorded.

Digital photographs were taken of each quadrat examined.

The percent frequency was later calculated for each taxon (species) identified as the number of quadrats in which the taxon was identified divided by 50. Taxon richness for each location (treatment or reference) was summarized as the total number of taxa encountered at the location and also as the mean number of taxa found in each quadrat.

Several taxa were not identified to species (e.g. *Porphyra, Ceramium, Ulva/Enteromorpha, Mazzella*, Ralfsiod crusts, Coralline crusts) because the species included in these groups are difficult to distinguish in the field. Several finely branched red algae may have been lumped within the species *Microcladia borealis*. These species may have included small specimens of *Odonthallia floccosa, Gracilaria* sp., or *Polysiphonia* sp. In some cases, *Enteromorpha linza* was clearly identifiable among the green algae in a quadrat, but this species may also have been

[1] Tides and Currents, v. 2.5k, Nautical Software Inc., Copyright 1993-1997. Station #1059 - Clam Bay, Rich Passage (Lat.- 47 deg. 34.50 min. N, Long.- 122 deg. 32.60 min. W); reference station for station #1059 is station #1049 - Seattle (Madison St.), Elliot Bay (Lat.- 47 deg. 36.20 min. N, Long.- 122 deg. 20.20 min. W).

included in the *Ulva/Enteromorpha* group. The finely branching green algae *Acrosiphonia coalita* may also have included *Polysiphonia* spp.

BULL KELP

The general areas of both beach nourishment sites were surveyed from a boat for the presence of bull kelp visible on the water surface. The surveys were conduced during higher tide portions of the dates on which the macrophyte surveys were conducted (July 31, August 1). Since no bull kelp beds were identified, no boundaries could be recorded using GPS measurements.

RESULTS

MACROALGAE

Transect length ranged from approximately 150 ft to 250 ft at the different locations (Table 1). Though elevation was the same for each transect at each reference and treatment location, and the treatment and reference locations were near each other for each site, the substrate and exposure is obviously not identical. Thus, the observed species composition, species richness, and total area cover varied among the reference and treatment locations for each site as well as between the two sites.

Table 1. Transect state plane coordinates (ft) and length for each site.

Site	Location	Transect Length (ft)	GPS Coordinates	
			Northing	Easting
Pt. Glover	Reference east	164	1,214,932	219,648
	Reference west		1,214,843	219,511
	Treatment east	156	1,215,148	219,832
	Treatment west		1,215,026	219,725
Pt. White	Reference east	206	1,213,538	220,931
	Reference west		1,213,419	220,816
	Treatment east	222	1,213,033	220,508
	Treatment west		1,213,858	220,383

A total of 19 taxon groups (species or species groups) were observed at the two sites; with 16 taxa at Point White and 17 taxa at Point Glover (Table 2). Between 10 and 13 taxon groups were observed along the four monitoring transects. Within a site, the macroalgal communities present at the reference and treatment locations appeared substantially different. At both sites, species richness and total cover tended to be lower at the reference location than at the treatment location. In addition, total cover tended to be lower at the reference locations than at the treatment locations.

Table 2. Qualitative total cover estimate and species richness at each site.

Site	Location	% Cover	Species Richness			
			Mean	Minimum	Maximum	Site Total
Pt. Glover	Reference	<50%	3.3	1	5	10
	Treatment	>50%	3.9	1	7	13
Pt. White	Reference	<50%	2.8	1	7	10
	Treatment	>50%	4.6	2	8	11

At Point White, the difference in percent cover between the treatment and reference locations was likely due to the larger, less mobile cobbles present on the surface at the treatment location apparently due to a higher energy environment (Figure 2). At Point Glover, the reference location appeared to be effectively "higher" in elevation because the substrate had fewer small crevices and topographic low points that held water at higher tides (Figure 3).

Figure 2. Top photo: Pt. White Treatment, large substrate and high algal cover. Bottom photo: Point White Reference, small substrate and low algal cover.

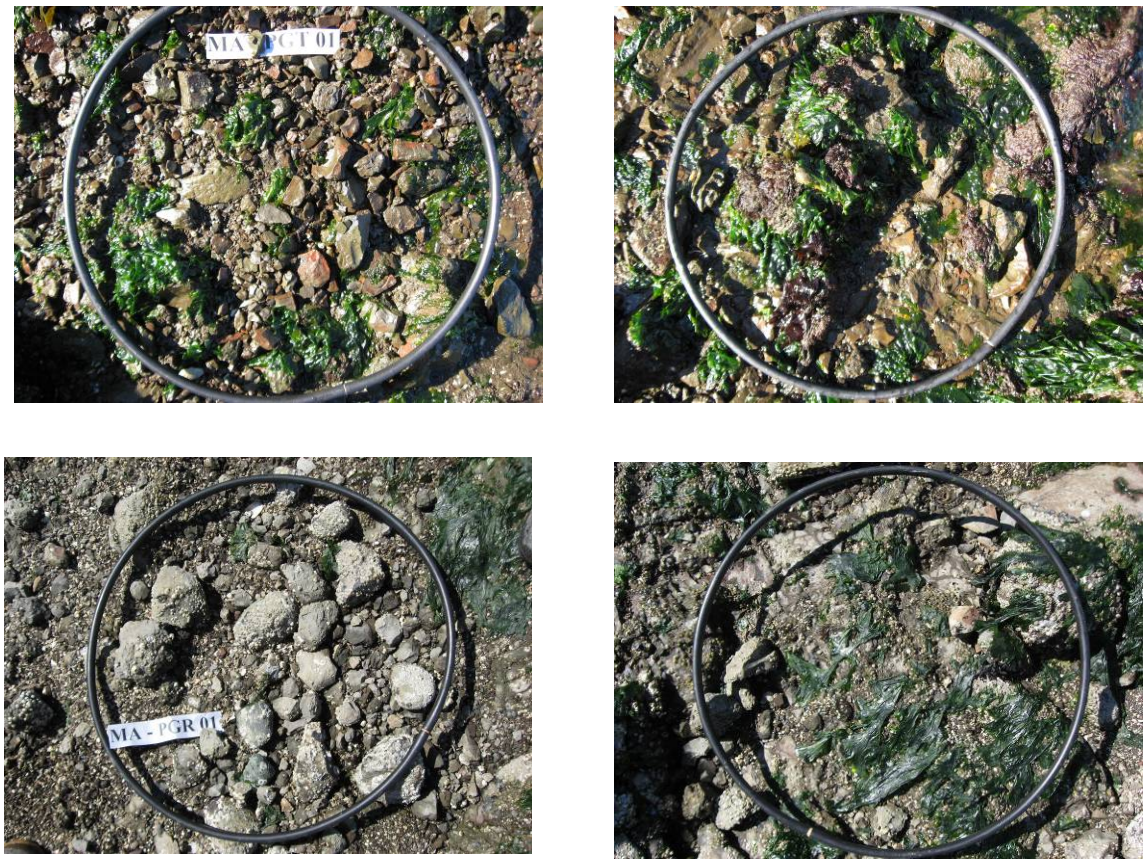

Figure 3. Top photos: Pt Glover treatment, hard clay substrate with embedded cobbles and more attached algae. Bottom photos: Pt. Glover reference, lose cobbles with less algae.

At least a small amount of sea lettuce, *Ulva* sp., was present in every quadrat sampled. All other taxa tended to vary among the sites. *Microcladia borealis* and *Lomentaria hakodatensis*[2] were observed only at Point White, while *Endocladia muricata*, *Scitosphon lomentaria*, and Ralphsiod crusts were observed only at Point Glover (Table 3).

[2] This species was identified from a photograph after the sampling with the help of Terrie Klinger, University of Washington.

Table 3. Percent frequency of macrophyte taxa observed in quadrats by relative frequency.

Type	Taxon	Pt. Glover		Pt. White	
		Reference	Treatment	Reference	Treatment
Green	*Ulva/Enteromorpha*	100%	100%	100%	100%
Red	*Mastocarpus papillatus* (blade phase)	44%	44%	18%	96%
Red	*Porphyra sp.*	12%	8%	50%	64%
Green	*Acrosiphonia coalita*	2%	2%	52%	56%
Brown	*Fucus gardneri*	32%	70%	0%	46%
Red	*Mastocarpus papillatus* (crust phase)	20%	6%	0%	32%
Red	*Ceramium* sp.	12%	28%	18%	26%
Red	*Mazzella* sp.	0%	6%	0%	18%
Red	*Cryptosiphonia woodii*	22%	10%	6%	10%
Green	*Enteromorpha linza*	6%	0%	2%	4%
Red	*Microcladia borealis*	0%	0%	16%	4%
Brown	*Sargassum muticum*	4%	0%	0%	2%
Red	*Lomentaria hakodatensis*	0%	0%	2%	2%
Red	*Gigartina exasperata*	0%	10%	10%	0%
Brown	*Laminaria saccharina*	2%	8%	6%	0%
Brown	*Leathesia difformis*	0%	2%	4%	0%
Red	*Endocladia muricata*	66%	66%	0%	0%
Brown	*Ralfsiod* crust	2%	16%	0%	0%
Brown	*Scitosiphon lomentaria*	2%	14%	0%	0%

Table 4 identifies the algal species that were observed at only the reference or treatment locations within a site. In most cases, the species present at only one location within a site were relatively rare (e.g., *Sargassum muticum* at the Point Glover reference and Point White treatment locations or *Laminaria saccharina* at the Point White reference and Point Glover treatment locations).

Table 4. Taxa present at only one of the two locations within a site.

Pt. Glover		Pt. White	
Reference	**Treatment**	**Reference**	**Treatment**
Enteromorpha linza	*Gigartina exasperata*	*Gigartina exasperata*	*Fucus gardneri*
Sargassum muticum	*Leathesia difformis*	*Leathesia difformis*	*Mazzella* sp.
	Mazzaella sp	*Laminaria saccharina*	*Mastocarpus papapillatus (crust phase)*
	.		*Sargassum muticum*

Figure 4 graphically portrays the relative frequency of occurrence of the various taxa at each treatment and reference location. Several species that were present at only one location were relatively abundant at these locations. For example, at Point White *Mazzella* sp. was present only at the treatment location but was abundant there (18% frequency). *Fucus gardneri* was also present only at the Point White treatment location and occurred in 46% of the quadrat samples.

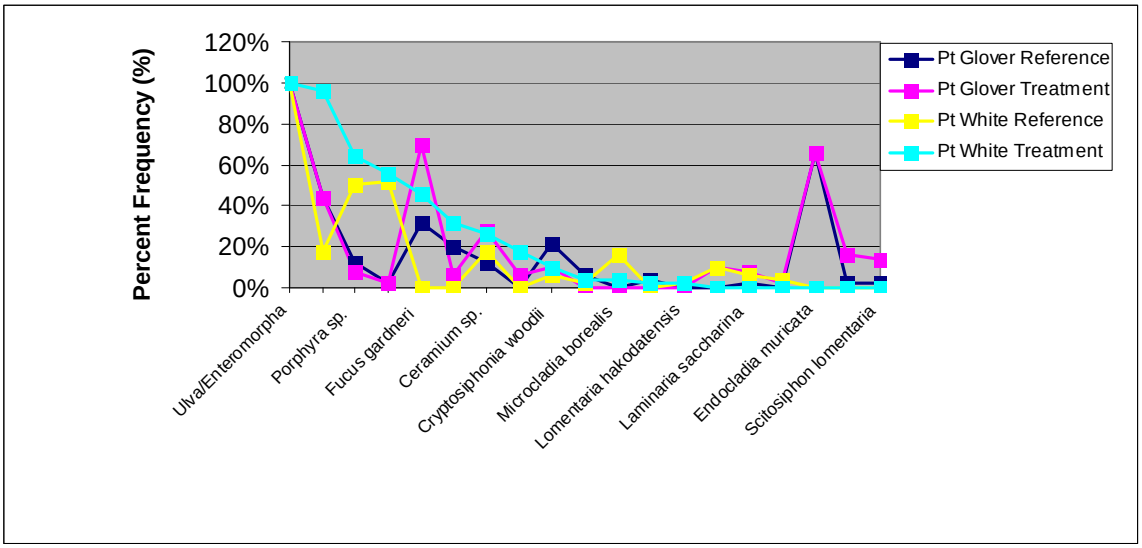

Figure 4. Percent frequency of macrophyte taxa observed in quadrats at Pt. Glover and Pt. White.

BULL KELP

No bull kelp beds were observed along the shorelines in the vicinity of Pt. Glover or Pt. White. Several individual plants were observed drifting in the vicinity.

Prior to this investigation, an established bed of bull kelp was observed along the east side of Pt. Glover in depths of about -5 to -10 ft MLLW. This bull kelp bed has appeared and disappeared previously. Parametrix scientist's previous diving observations indicated that each bull kelp's holdfasts spread over multiple cobbles or small boulders providing a stable attachment. The holdfasts and stipes previously remained in place when the bull kelp's fronds disappeared. The loss of fronds was apparently the result of kelp crab grazing, with one or more kelp crabs observed near the top of each bull kelp plant.

DISCUSSION

This report provides a baseline evaluation of the macroalgal species present and the general coverage of algae prior to the proposed beach nourishment actions in Rich Passage. General coverage of each algal species within the treatment and reference locations has been assessed by determining the frequency of occurrence of each species within 50 quadrat (plot) samples at each location.

Each of the treatment and reference locations at each site does presently support substantial macroalgal communities as documented by these results. However, the treatment and reference locations at each site differ somewhat in their exposure and therefore in the substrate present and in the relative abundances of many species. At both the Point White and Point Glover sites the reference locations currently have fewer species and less total cover than the treatment locations. This appears to be due a higher energy environment as evidenced by larger-more stable substrate on the surface at the treatment locations. The reference locations appear to have more of the smaller, less-stable substrate that provides less favorable attachment sites for macroalgae than the treatment locations. This is why the treatment locations were chosen for beach nourishment that would add the smaller, less-stable substrate.