Abundance and Depth of *Zostera marina* in Quartermaster Harbor, King County

January 2005

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Submitted to:

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1 Introduction

The Nearshore Habitat Program in the Washington State Department of Natural Resources (WADNR) began collecting data in 2000 on the status and trends of *Zostera marina* in Puget Sound as part of the Submerged Vegetation Monitoring Project (SVMP). The SVMP is one component of the Puget Sound Ambient Monitoring Program (PSAMP), a multi-agency effort to monitor key aspects of the Puget Sound environment to support resource management.

In 2004, the King County Department of Natural Resources and Parks, Water and Land Resources Division (King County) contracted the WADNR to collect baseline *Z. marina* abundance and depth data at four SVMP delineated sample sites within Quartermaster Harbor using line intercept sampling, towed underwater videography, and statistical extrapolation. These baseline data will augment the 2004 Puget Sound SVMP data set by providing greater sampling intensity within a smaller focus area for future comparison, and provide King County scientific staff an opportunity to assess the effectiveness and practicality of the SVMP sampling methodology. King County is considering monitoring eelgrass as a biological indicator of water and habitat quality in the future.

This report summarizes the Quartermaster Harbor *Z. marina* sampling methods and results. It fulfills all specified deliverables in IAA #04-251 between King County and WADNR.

2 Methods

2.1 Study Area Description

Quartermaster Harbor is located between Vashon and Maury Islands in south Puget Sound. The harbor has a surface area of 1,135 hectares and is sheltered from the wind and waves associated with open water (Bulman, 1975). There are two public parks located within the harbor area--Dockton and Burton Acres. Dockton Park, operated by King County Parks, has facilities for swimming, picnicking, hiking trails, a boat launch, and boat moorage. It is located on the western side of Maury Island and consists of 9.3 hectares. Burton Acres Park is located on the tip of land extending into Quartermaster Harbor from Vashon Island and has facilities for swimming, picnicking, walking, horseback riding trails, watercraft rentals, and a boat launch. The Burton Acres Park consists of 28 hectares and is operated by the Vashon Park District (www.vashonparksdistrict.org).

Judd Creek, located in the northwestern portion of the inner harbor, is the only stream that flows year-round, however, there are other smaller streams that flow during the winter months.

In the outer harbor area south of Burton, water depths are approximately 11-46 meters with rapid flushing action and tidal currents. However, in the inner harbor the deepest depth is only about 5 meters and there is relatively little current and tidal flushing. The shore around the inner harbor is developed with houses, roads, a marina, yacht club, and considerable shoreline armoring.

In this study we measured *Z. marina* area and depth at four SVMP delineated sample sites within Quartermaster Harbor. The sites were hand-picked from sampling frames used by the SVMP for sampling over the entire Puget Sound in two main strata. The flats stratum includes embayments and the fringe stratum includes all remaining shoreline in Puget Sound where fringing beds of *Z. marina* may occur.

The location of the four study sample sites (labeled Flats33, cps1181, cps1182, cps1186) within the Quartermaster Harbor area is shown in Appendix A. We also show the historical distribution of *Z. marina* at these sites from the Puget Sound Environmental Atlas and the Washington State ShoreZone Inventory. These data depict conditions in 1979-80 and 1996-2000 respectively (Needham and Lanzer 1993, Nearshore Habitat Program 2001).

2.2 Field Sampling

The SVMP sampling methods and statistical framework are described in detail in Berry et al. 2003. They are summarized briefly in the following two sections.

We conducted all field sampling within Quartermaster Harbor September 21 and 22, 2004 from the *Shawnie II*, a 32-ft research vessel operated (under contract with WDNR) by a skipper and technician from Marine Resources Consultants (MRC). A scientist from WADNR coordinated all field sampling onboard. King County personnel (Kim Stark and Randy Shuman) accompanied the crew for part of the first day of sampling as observers.

Our sampling approach involved essentially two steps at all sites. We first delineated the sample area or sampling polygon within site boundaries through a series of underwater video transects oriented either perpendicular or parallel to shore or meandering throughout the site. The sample polygons were defined conservatively to include all observed *Z. marina* patches and any potential habitat where we could not rule out *Z. marina* presence. The area within the site boundaries yet outside the sampling polygon was assumed to contain no *Z. marina*. We then randomly selected and sampled 11 or more transects within the sample polygon (available sample time ultimately dictated the number at each site). All randomly selected transects were orientated perpendicular to shore or along the greatest axis of *Z. marina* variation, depth.

Along all transects we collected *Z. marina* presence/absence data with an underwater video camera mounted in a “downward-looking” orientation on a heavy towfish. Parallel lasers mounted 10 cm apart created two red dots in the video images as a scaling reference. The towfish was deployed directly off the stern of the vessel using the cargo boom and boom winch. We acquired time and position data using a differential global

positioning system (DGPS) processor with the antenna located at the tip of the cargo boom used to deploy the camera. The weight of the towfish kept the camera positioned directly beneath the DGPS antenna, ensuring that the position data accurately reflected the geographic location of the camera. We received differential corrections from the United States Coast Guard public DGPS network using the WSG 84 datum. A transducer mounted on the starboard side of the transom collected depth and bottom discrimination data. Table 1 shows the major equipment components we used to conduct this sampling.

Table 1. Equipment used to collect underwater video data in 2004

Item	Manufacturer/Model
Differential GPS	Trimble AgGPS 132 Leica MX200 GPS Navigator
Echosounder	Biosonics DT Series Echosounder (or DE) 420 KHz 6º single-beam transducer
Underwater Camera	Deep Sea Power & Light SeaCam 2000
Lasers	Deep Sea Power & Light
Underwater Light	Deep Sea Power & Light RiteLite (250 watt)
Video Overlay Controller	Discovery Bay Software
Image Recording	Sony DVC310 Digital8 Camcorder
(master and backup)	Sony RDR-GX7 DVD

2.3 Data Processing and Analysis

In the office, we classified all underwater video for *Z. marina* presence/absence within one-second intervals. We defined *Z. marina* presence as one or more rooted plants visible in one of the video frames stamped with a specific time/position that fell within the given one second interval. We recorded *Z. marina* presence information with corresponding spatial information.

We corrected all measured depths to the MLLW datum by adding the transducer offset, subtracting the predicted tidal height for the site and adding the tide prediction error (calculated using measured tide data from the National Oceanic and Atmospheric Administration website http://co-ops.nos.noaa.gov/data_res.html). These final corrected depth data were then merged with *Z. marina* presence/absence data and spatial information into a site database (comma delimited spreadsheet) so each *Z. marina* observation had an associated date/time, position and depth measurement corrected to MLLW datum.

We calculated *Z. marina* area at each site using Auto-Cad software and the site database file in the following sequential steps:

1. Calculated the area within the Sample Polygon;
2. Calculated the fraction of *Z. marina* along each random line transect;
3. Calculated the mean fraction and associated variance;

4. Estimated the overall *Z. marina* area and variance at the site by extrapolating the mean fraction along random transects over the Sample Polygon area.

Every random underwater video transect that intersected *Z. marina* had a minimum and maximum depth observation. We summarized minimum and maximum *Z. marina* depth characteristics for each site using descriptive statistics (i.e. means and ranges).

3 Results

3.1 Quantitative Summary

We show the *Z. marina* area and depth summaries for the four study sites in Table 2 and Table 3 respectively. Final site maps showing transect locations and *Z. marina* observations for all sites are found in Appendix A.

Table 2. *Z. marina* area summary for 2004 Quartermaster Harbor sample sites.

Site	Number of Transects	Mean Fraction Along Transects	Eelgrass Area at Site (hectares)	Variance	Coefficient of Variation	Estimated Eelgrass Coverage Confidence Interval (hectares) 80% Lower Limit	80% Upper Limit
Flats33	11	0.2822	0.95	0.032	0.19	0.72	1.18
cps1181	11	0.6235	1.33	0.012	0.08	1.19	1.47
cps1182	11	0.7393	4.60	0.046	0.05	4.32	4.87
cps1186	11	0.6783	0.47	0.001	0.06	0.43	0.5

Table 3. *Z. marina* depth (MLLW) summary for 2004 Quartermaster Harbor sample sites.

	Minimum Eelgrass Depth						Maximum Eelgrass Depth					
Site	n	Absolute Depth (m)	Mean Depth (m)	Standard Error	95% Lower Limit (m)	95% Upper Limit (m)	n	Absolute Depth (m)	Mean Depth (m)	Standard Error	95% Lower Limit (m)	95% Upper Limit (m)
Flats33	9	-0.1	-0.4	0.3	-0.6	-0.2	9	-2.0	-1.2	0.5	-1.6	-0.8
cps1181	10	-0.3	-0.6	0.1	-0.7	-0.5	10	-2.6	-2.0	0.4	-2.3	-1.8
cps1182	11	-2.1	-2.1	0.2	-0.7	-0.5	11	-3.4	-2.5	0.5	-2.9	-2.2
cps1186	11	-2.1	-2.1	0.2	-1.1	-0.9	11	-2.9	-2.5	0.5	-2.8	-2.1

3.2 Qualitative Summary

3.2.1 Flats33

Within the Flats33 site boundaries we observed a relatively small fragmented bed of *Z. marina* located in the northeast corner of the site. Other submerged vegetation noted but not quantified included the introduced seagrass *Z. japonica* (transects 40-43), *Gracilaria/Gracilariopsis* spp. (transects 13-14) and *Ulva* spp. (all). There were also *Dendraster excentricus* present at the start of most transects.

3.2.2 cps1181

This site had a fringing *Z. marina* bed along the northern ½ of the site. We described the *Z. marina* as relatively short with some epiphytes. We also observed *Z. japonica* in a narrow band shallower than the *Z. marina* with a distinct gap between the two species. These *Z. japonica* plants were observed at the beginning of transects 5 through 20. No other vegetation was noted.

3.2.3 cps1182

This site had a *Z. marina* bed from site boundary to site boundary (all transects). The deeper *Z. marina* plants appeared to have more epiphytes than the shallower plants. We also observed an extensive *Z. japonica* bed, distinctly separated higher in the intertidal zone from the *Z. marina*. *Z. japonica* was observed at the beginning of all transects and extended throughout the site. We observed extensive *Ulva* spp. on transects 3 and 10-14.

3.2.4 cps1186

The only *Z. marina* we observed was in the southern ¼ of the site. Within that area, *Z. marina* generally began at the deep edge of the *Ulva* spp. Also, there was an extensive *Z. japonica* bed shallower than the *Z. marina* with a distinct separation between the two species. The *Z. japonica* bed extended further to the north than the *Z. marina* bed.

3.3 Supporting Data

Appendix B contains six DVD's with underwater video footage collected at all four sites. Each DVD is labeled by site and transects numbers.

Appendix C contains a CD with all post-processed electronic data for all four sites. The post-processed electronic data for each site consists of the following three files:

1. Site data base (Excel)
2. *Z. marina* area transects summary (Excel)
3. *Z. marina* depth transects summary (Excel)

4 Conclusion and Recommendation

We measured *Z. marina* area and depth at four sites within Quartermaster Harbor using the SVMP sampling methods and statistical framework. These results provide a baseline or benchmark to which future *Z. marina* studies within these site boundaries can be compared. Although it is beyond the scope of this project, these results could also be compared to historical records of *Z. marina* within this region. One potential source for historical comparison is the Washington Department of Fisheries/Fish and Wildlife Herring Spawning Ground Logs from 1983 and 1997. These Logs contain information on *Z. marina* distribution as well as the distribution of other submerged vegetation.

The strength of the SVMP sampling design is to evaluate *Z. marina* abundance and depth trends using a statistically valid protocol, not to make maps depicting distribution. Therefore, we strongly recommend that King County sample these sites again in three to five years to test for significant change in the resource condition. Additionally, we are going to conduct more intense sampling on a five-year rotation within the Central Puget Sound Region in the future. Perhaps, there will be an opportunity to partner with King County on this effort. One potential approach would be to use randomly selected sites so that a measure of total *Z. marina* area in Central Puget Sound could be estimated and tracked with statistically robust measures of uncertainty and of change between sampling occasions.

5 References

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Appendix A. Maps

A1. Quartermaster Harbor Map

A2. Flats33 2004 Sample Map

A3. cps1181 2004 Sample Map

A4. cps1182 2004 Sample Map

A5. cps1186 2004 Sample Map

Appendix B. Underwater Video

Appendix C. Electronic data