



**BRIGHTWATER CONVEYANCE FINAL DESIGN**

# **Eelgrass Program: 2008 Eelgrass Dive Survey Report**

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**Task 200 – Permitting**

**Subtask 202- Outfall Support Services**

**July 2008**

*Rev 1*

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# Chapter 1

## Introduction

As part of the new Brightwater Treatment System, King County (County) is planning to build a new sewer outfall immediately south of Point Wells, Washington (Figure 1), scheduled for construction in 2008. Although the outfall was sited at Point Wells to minimize effects on nearshore marine areas, specifically eelgrass (*Zostera marina*) beds, there will be unavoidable impacts to eelgrass during the construction phase of this project (King County 2003a, b). The County has prepared an *Eelgrass Restoration and Biological Resources Implementation Work Plan* (Work Plan) that describes a multi-year eelgrass monitoring program for the Brightwater outfall project (King County 2005). The eelgrass monitoring component of the Work Plan includes both dive-based density surveys and a combination of sonar and underwater video-based coverage surveys. The construction schedule calls for pre-construction monitoring surveys to be conducted in 2004, 2006, and 2008. This report provides methods and results for the third dive survey conducted during the April 21 and 22, 2008 monitoring activities.

### 1.1 Previous Eelgrass Surveys

A dive-based eelgrass survey was completed in 2003 at the outfall site as part of the outfall siting process (King County 2003b). The survey included a series of 13 transects 420 feet (ft) in length (from Mean Higher High Water [MHHW] to at least -25 ft Mean Lower Low Water [MLLW]), centered on the proposed outfall alignment at a coarse resolution scale. The seven central transects were spaced at 10-ft intervals, while the outer six transects were at 25-ft intervals, encompassing a total distance of 210 ft (105 ft on either side of the outfall centerline). Eelgrass within the outfall corridor determined by the WDFW triplicate method (see Section 2.2), ranged from 4 to 113 shoots/meter<sup>2</sup> (m<sup>2</sup>), and an average density of 31 shoots/m<sup>2</sup>. Based on these data, the dive-based eelgrass monitoring program was designed to include only those elevations expected to include eelgrass, 0 to -25 ft MLLW. In 2004, a pre-construction dive survey was conducted at the site using the methods described in detail in Chapter 2. In brief, these methods utilize transects spaced at 5-foot intervals with measurements (triplicate counts) conducted every 10 feet in the outfall area and 20 feet at the reference location. Also, in 2004, 2005, and again in 2008, the eelgrass within the entire Study Area (defined below) was mapped using Side-Scan sonar and roughly quantified using underwater videography (PNNL 2006). The results of those efforts are presented under separate cover.

During 2006 diver surveys in the Marine Outfall Corridor, eelgrass was observed above -15 ft MLLW and within 28 of 100 sample quadrats (28%). Density of eelgrass within the Outfall Corridor ranged from 8 to 101 shoots/m<sup>2</sup>, with an average density of 55 shoots/m<sup>2</sup> where present. Within all sample quadrats including those where eelgrass was absent, eelgrass density in the outfall corridor averaged 16 shoots/m<sup>2</sup>. Eelgrass shoot density at all elevations was greater in 2006 when compared to both 2004 and 2003 survey data (King County 2006).

## 1.2 Survey Areas

For pre-construction monitoring, the Work Plan defines three specific monitoring areas at Point Wells: the Eelgrass Study Area (sonar and underwater video only), the Marine Outfall Corridor, and the Eelgrass Reference Area. Based on 2003 eelgrass distributions at this site (King County 2003b), all monitoring areas include elevations between approximately 0 ft MLLW and -25 ft MLLW. The diver surveys in 2004, 2006, and described in this report were conducted only in the Marine Outfall Corridor and the Reference Area. For clarification purposes, a description of the Eelgrass Study Area is also included.

The Eelgrass Study Area surrounds the proposed outfall alignment and is bounded from east to west by the upper and lower range of potential eelgrass habitat and from north to south by the area in which anticipated impacts from construction, boats, and barges will be confined.

The Marine Outfall Corridor is within the greater Eelgrass Study Area. It is a 23-ft wide area centered along the outfall pipeline alignment, including allowances for the 12-ft wide sheeted trench area with an additional 5.5-ft wide area on either side of the sheeted trench to account for potential localized effects of construction (i.e., driving sheet pile walls, excavating material with a clamshell dredge, backfilling, etc...).

The Eelgrass Reference Area is approximately 332 ft SSE of the Marine Outfall Corridor, well outside of the area in which construction impacts are anticipated (Figure 2).

## 1.3 Dive Survey Monitoring Schedule

Dive surveys on the transects at the Marine Outfall Corridor and Eelgrass Reference Area conducted in 2004 and 2006 were the first in a series of pre- and post-construction monitoring efforts planned for the site as presented in the Work Plan (Table 1). Assuming outfall construction occurs as scheduled (summer 2008), the 2008 monitoring effort is Project Year 0 for construction and Project Year -1 in terms of eelgrass post-transplant monitoring. This is in response to changes initiated by the County following both the 2006 and 2004 surveys, and this information is presented in Table 1 to avoid confusion with past reports.

In addition to the dive surveys described above, the Work Plan also calls for sonar and video surveys and results of these surveys will be reported under a separate cover.

**Table 1. Dive Survey Monitoring Schedule.**

<b>Calendar Year*, Season</b>	<b>Monitoring Year</b>	<b>Eelgrass Post-Transplant Monitoring Year</b>	<b>Survey Areas</b>	<b>Survey Purpose</b>
2004, Summer	Year -4	Year -5	Marine Outfall Corridor, Reference Area	Establish baseline and variation
2006, Summer	Year -2	Year -3	Marine Outfall Corridor, Reference Area	Establish variation
2008, Spring/Summer	Year 0	Year -1	Marine Outfall Corridor, Reference Area	Establish variation
<b>OUTFALL CONSTRUCTION</b>				
2009, Spring/Summer	Year 1	Year 0***	Marine Outfall Corridor**, Reference Area	Transplant monitoring
2010, Spring/Summer	Year 2	Year 1	Marine Outfall Corridor**, Reference Area	Transplant monitoring
2011, Spring/Summer	Year 3	Year 2	Marine Outfall Corridor**, Reference Area	Transplant monitoring
2012, Spring/Summer	Year 4	Year 3	Marine Outfall Corridor**, Reference Area	Transplant monitoring
2014, Spring/Summer	Year 6	Year 5	Marine Outfall Corridor**, Reference Area	Transplant monitoring

\* Calendar year has been adjusted from the 2006 schedule based on anticipated construction in 2008.

\*\* Marine outfall corridor monitoring may be expanded to include the greater Eelgrass Study Area if transplanting beyond the corridor is required.

\*\*\*Year 0 indicates the transplanting of eelgrass

# Chapter 2

## Methods

In 2004, 2006 and 2008, eelgrass density monitoring occurred in two areas: the Marine Outfall Corridor and the Eelgrass Reference Area. Five transects were defined ahead of time in each area, and end point coordinates were identified on base maps. Transects 1, 3, and 5 at the Marine Outfall Corridor were defined using the shallow endpoints for the three center transects from the previous eelgrass diver survey in 2003 (King County 2003b). For both survey areas, transects were spaced at 5-ft intervals (Figures 3 and 5).

### 2.1 Identification of Survey Areas

Survey areas were first identified and marked using rebar stakes during 2004 surveys. Coordinates for shallow (0 ft MLLW) and deep (-25 ft MLLW) end points for transects 1 and 5 were uploaded into the dGPS system and located in the field (Table 2). For deep endpoints, weighted buoys were deployed to temporarily mark transects 1 and 5. Because transect length in the reference area (400 ft) is greater than 300 ft (standard survey tape length), coordinates for additional reference points 200 ft waterward of MLLW also were determined and temporarily marked with weighted buoys (Table 2).

Distance between the Transect 1 and 5 end points and additional reference points for both survey areas as identified using dGPS were confirmed at 20 ft. Transect end points for the remaining three transects were spaced at 5-ft intervals from each other, and all end and reference points were marked with permanent markers. A fiberglass survey tape was placed between end points (or an end point and midpoint at the reference area) of each transect to place additional markers. At the Marine Outfall Corridor, the transect end points at -25 ft MLLW are 190 ft from MLLW, and additional markers were placed at 50 ft, 100 ft and 150 ft along the transect. Markers were placed at 40 ft intervals at the Eelgrass Reference Area, ending 400 ft from MLLW. Following sampling, markers at elevations subject to tidal exposure were driven to no more than 2 inches above the substrate in order to make them less noticeable to beach walkers. Subtidal markers were driven into the substrate leaving 4 inches exposed at the surface.

During the 2008 survey, a dGPS was used to relocate shallow end points marked by rebar stakes at both the Marine Outfall Corridor and the Eelgrass Reference Area. Transects were deployed from these markers and extended to the deep end point markers. In several instances along the survey transects, a rebar stake was not located. In this situation, a compass bearing was used to find the next rebar (20 ft beyond the missing stake) and the transect line continued.

**Table 2. Transect End and Reference Point Coordinates (NAD 83).**

<b>Area, Transect, Point</b>	<b>Northing</b>	<b>Easting</b>
WDNR Survey Monument 1	287663.56	1256628.75
WDNR Survey Monument 2	287662.59	1256670.75
Marine Outfall, 1, onshore	288247.63	1255853.58
Marine Outfall, 5, onshore	288227.55	1255854.88
Marine Outfall, 1, offshore	288218.42	1255671.01
Marine Outfall, 5, offshore	288197.56	1255667.62
Eelgrass Reference, 1, onshore	287924.36	1255927.13
Eelgrass Reference, 5, onshore	287905.71	1255937.91
Eelgrass Reference, 1, 200-ft midpoint	287863.86	1255505.96
Eelgrass Reference, 5, 200-ft midpoint	287842.75	1255498.97
Eelgrass Reference, 1, offshore	287863.86	1255729.16
Eelgrass Reference, 5, offshore	287877.26	1255739.94

## 2.2 Survey Methods

Survey methods established during the 2004 eelgrass surveys were repeated in 2008. Eelgrass survey methods are based on Washington Department of Fish and Wildlife (WDFW) Eelgrass/Macroalgae Habitat Survey Guidelines. At each sample location, divers recorded triplicate shoot counts within a 0.25-m<sup>2</sup> quadrat rotated around the sample location to the 2, 6, and 10 o'clock positions (relative to waterward orientation on the survey tape). The inside corner of the quadrats pivot around the same center point to ensure repeatability. This center point is the appropriate distance measured on a fiberglass survey tape stretched between permanent markers, in sample intervals specific to each survey area.

Divers stretched a fiberglass survey tape along each transect, based on endpoint rebar stakes and stakes spaced at 20 ft intervals. Triplicate shoot counts were recorded at 10-ft intervals in the Marine Outfall Corridor and at 20-ft intervals in the Eelgrass Reference Area. Qualitative observations of macroalga species presence and distribution as well as qualitative notes on substrate type were recorded within each sample quadrat. In addition, divers noted eelgrass patch edges along each transect (e.g., begin at 25 ft, end at 32 ft; begin at 54 ft, end at 67 ft) for 4 out of 10 transects. At the Marine Outfall Corridor, a total of 21 sample locations were recorded along each transect, for a total of 105. At the Eelgrass Reference Area, a total of 24 sample locations were recorded along each transect, for a total of 120.

## 2.3 Density Calculations

Eelgrass shoot density for each sample, reported as the number of eelgrass shoots per square meter, is calculated from the mean of the triplicate shoot count at the sample location multiplied by four (as the quadrats are 0.25 m<sup>2</sup>). The WDFW method for density calculations requires that samples that were taken where eelgrass is present are included in density calculations for either survey area (i.e., a sample where all three triplicates have a shoot count of zero is not included).

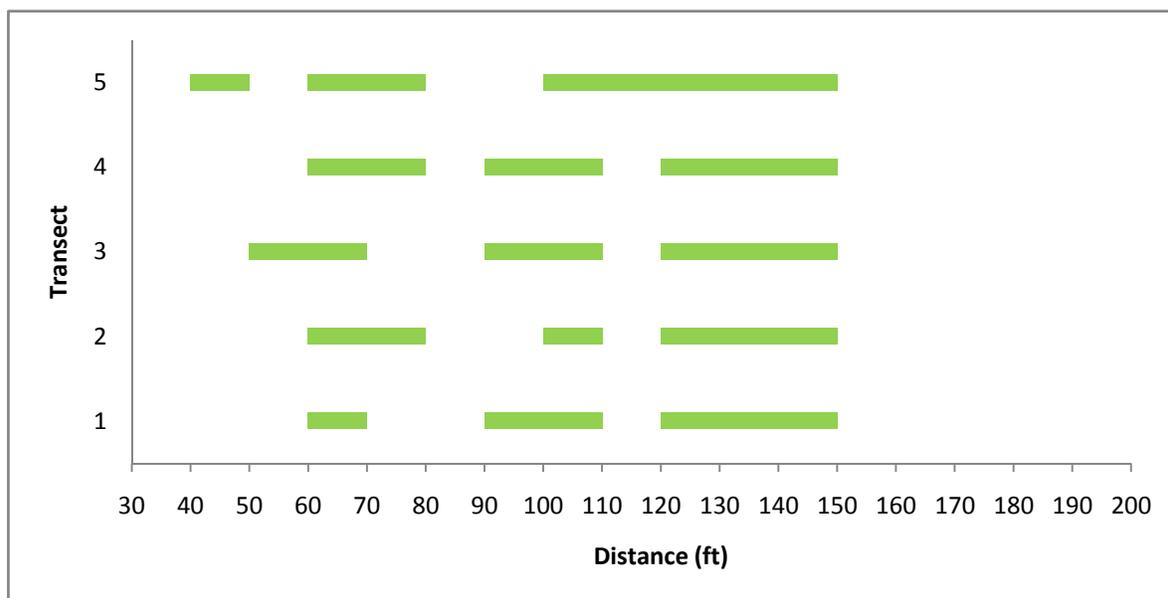
# Chapter 3

## Survey Results

### 3.1 Marine Outfall Corridor

In the Marine Outfall Corridor, 34 of the 105 samples (32%) included eelgrass. Where present, average eelgrass density in this area was 80 shoots/m<sup>2</sup>. Individual density measurements ranged from 1 to 227 shoots/m<sup>2</sup> (Figure 3). Across all sample points, including those where eelgrass was not present, eelgrass density in the outfall corridor was 26 shoots/m<sup>2</sup>. Eelgrass was present above -15 ft MLLW. Eelgrass patches were observed along most transects from 55-145 ft, with generally patchy or sparse distribution. The greatest eelgrass density by elevation was 108 shoots/m<sup>2</sup> between -5 and -10 ft MLLW; greatest coverage (80% of sampled locations) also occurred between -5 and -10 ft MLLW (Table 3). No rooted eelgrass was observed in the debris mat at the toe of the slope in the Marine Outfall Corridor.

Patterns of substrate composition and alga coverage were similar on all five survey transects (Appendix A). Substrate was generally coarse (cobble and gravel) from MLLW to between 70 and 80 ft along the survey transects (above -5 ft MLLW) and sandy for the remainder of the survey area. The greatest diversity of macroalgae coverage (primarily *Ulva* sp.) correlated to coarser substrates and shallower elevations, although there were also areas of macroalgae cover in deeper, sandy substrates. Macroalgae presence in the Marine Outfall Corridor is presented in Table 4.

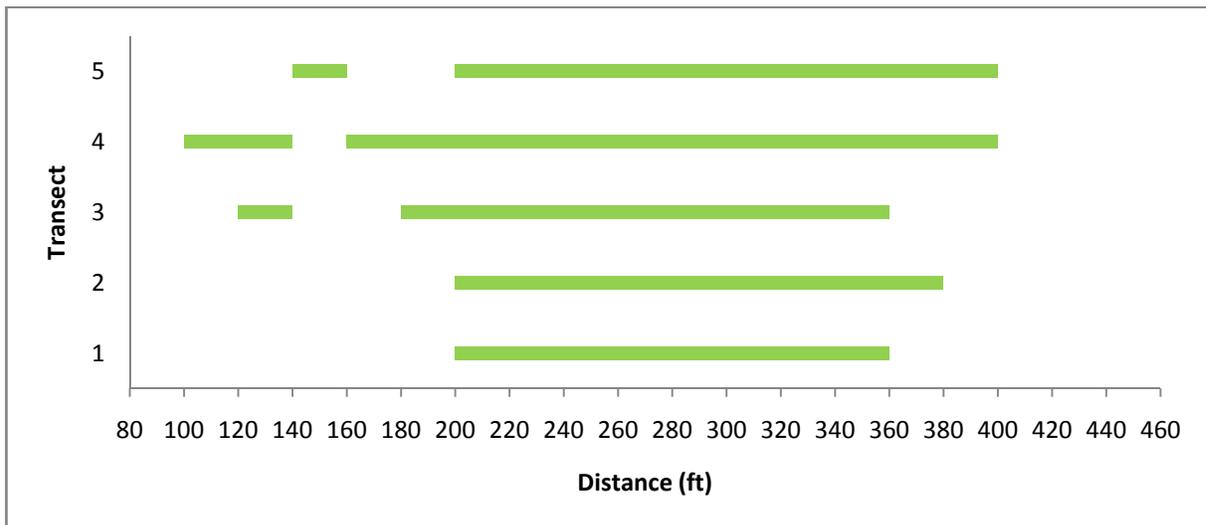


**Figure 4. Eelgrass Edge Locations in the Outfall Corridor. Consecutive quadrats along each transect in which eelgrass was observed are represented as a continuous band. Resolution is to 10 feet (since quadrats were spaced every 10 feet for the length of the transects).**

## 3.2 Eelgrass Reference Area

In the Eelgrass Reference Area, 55 of the 120 samples (46%) included eelgrass (Figure 5). Where present, average eelgrass density in this Reference Area was 38 shoots/m<sup>2</sup> (Figure 5). Across all sample points, including those where eelgrass was not present, eelgrass density in the outfall corridor was 17 shoots/m<sup>2</sup>. Individual density measurements ranged from 1 to 240 shoot/m<sup>2</sup>. Eelgrass was present between 100ft (~2ft MLLW) and 380 ft (<20 ft MLLW). Greatest eelgrass density by elevation was 84 shoots/m<sup>2</sup> between 0 and -5 ft MLLW; greatest coverage (100% of sampled locations) occurred between -10 and -15 ft MLLW (Table 3). While some eelgrass was present along the first 200 ft of the survey transects, most was part of a continuous band between approximately 200 and 380 ft (Figure 6). Eelgrass density tended to decrease between 240 and 300 ft along the transects, in correlation with increased macroalgae coverage. This is also an area where bathymetry changes quickly between -10 and -15 MLLW, before flattening out between -15 and -20 MLLW. The eelgrass patch ends between 380 and 400 ft along the survey transects, above -20 ft MLLW.

As with the Marine Outfall Corridor, substrate was generally coarser above -5 ft MLLW and similar along all five transects, starting with cobble and gravel substrates at the shallow end and transitioning to mostly sandy substrate beyond 80 ft, with some coarser substrate as far as 120 ft along transect 5 (Appendix A).



**Figure 6. Eelgrass Edge Locations in the Reference Area.** Consecutive quadrats along each transect in which eelgrass was observed are represented as a continuous band. Resolution is to 20 feet (since quadrats were spaced every 20 feet for the length of the transects).

Macroalgae species were most likely to be observed in areas of coarse substrate in the shallow end of the survey area as well as on the slope or its toe between -10 and -15 ft MLLW (Table 4.). Macroalga composition in this area included large *Saccharina latissima* (formerly *Laminaria* spp.) blades and a diverse assemblage of smaller species. Other species observed at all 5 depth bins within the Marine Outfall Corridor include *Ulva* spp., *Porphyra* spp. and

*Desmerestia ligulata*. Beyond approximately 380 ft along the survey transects (just above -20 ft MLLW), macroalgae cover consisted of sparse single *S. latissima* blades with occasional other small taxa (Appendix A).

**Table 3. 2008 Eelgrass observations by elevation at each survey area.**

Elevation (ft below MLLW)	Marine Outfall Corridor				Eelgrass Reference Area			
	Average shoots/m <sup>2</sup> eelgrass*	n*	Average shoots/m <sup>2</sup> entire sample**	Samples**	Average shoots/m <sup>2</sup> eelgrass*	n*	Average shoots/m <sup>2</sup> entire sample**	Samples**
0 – 5	73	12	17	50	84	3	7	35
5 – 10	108	16	86	20	68	14	38	25
10 – 15	24	5	12	10	25	14	25	14
15 – 20	0	0	0	6	22	24	17	31
20 – 25	0	0	0	19	0	0	0	5
>25	--	--	--	--	0	0	0	10
All	80	33	26	105	38	55	17	120

\* Based on observations with eelgrass (each observation is a density based on triplicate shoot counts)

\*\* Based on all observations made at each elevation

**Table 4. 2008 Macroalgae observed at each survey area.**

Elevation (ft below MLLW)	<u>Marine Outfall Corridor</u>			<u>Eelgrass Reference Area</u>		
	Species	n*	Samples**	Species	n*	Samples**
0 – 5	<i>Ulva</i> spp.	39	50	<i>Ulva</i> spp.	19	35
	<i>Porphyra</i> spp.	22		branched brown	13	
	<i>Scytosiphon simplicissimus</i>	21		<i>Saccharina latissima</i> <sup>††</sup>	11	
	<i>Mazzaella</i> spp.	9		<i>Porphyra</i> spp.	9	
	<i>Saccharina latissima</i> <sup>††</sup>	4		<i>Scytosiphon simplicissimus</i>	5	
	<i>Desmarestia ligulata</i>	4		<i>Mazzaella</i> spp.	2	
	branched brown	3		<i>Desmarestia ligulata</i>	1	
	<i>Chondracanthus</i> spp.	3				
	feathery brown	1				
<i>Smithora naiadium</i> <sup>†</sup>	1					
5 – 10	<i>Porphyra</i> spp.	11	20	<i>Porphyra</i> spp.	13	25
	<i>Ulva</i> spp.	9		<i>Saccharina latissima</i> <sup>††</sup>	11	
	<i>Desmarestia ligulata</i>	2		<i>Ulva</i> spp.	10	
	<i>Saccharina latissima</i> <sup>††</sup>	2		branched brown	2	
	<i>Prionitis</i> spp.	1		<i>Smithora naiadium</i> <sup>†</sup>	2	
				<i>Desmarestia ligulata</i>	2	
10 – 15	<i>Ulva</i> spp.	3	10	<i>Porphyra</i> spp.	10	14
	<i>Porphyra</i> spp.	2		<i>Saccharina latissima</i> <sup>††</sup>	7	
	<i>Desmarestia ligulata</i>	1		<i>Ulva</i> spp.	6	
	<i>Saccharina latissima</i> <sup>††</sup>	1		<i>Desmarestia ligulata</i>	1	
	<i>Mazzaella</i> spp.	1		<i>Mazzaella</i> spp.	1	
15 – 20	No macroalgae present		6	<i>Porphyra</i> spp.	16	31
				<i>Saccharina latissima</i>	14	
				<i>Desmarestia ligulata</i>	8	
				<i>Ulva</i> spp.	7	
				<i>Smithora naiadium</i> <sup>†</sup>	2	
20 – 25	<i>Ulva</i> spp.	2	19	<i>Saccharina latissima</i> <sup>††</sup>	2	5
	<i>Saccharina latissima</i> <sup>††</sup>	1		<i>Desmarestia ligulata</i>	1	
	<i>Porphyra</i> spp.	1				
>25	not sampled			<i>Saccharina latissima</i> <sup>††</sup>	2	10
All		62	105		92	120

<sup>†</sup> Observed on eelgrass or *Ulva* spp.

<sup>††</sup> Formerly *Laminaria* spp.

\* Number of sampling locations where macroalgae species were observed

\*\* Total number of observations made at each elevation

## Chapter 4

# Discussion

In 2008, shoot density of eelgrass observed in the Corridor from 0 to -10 ft MLLW was greater than that recorded in 2006 dive surveys, although density remained similar to past years between -10 and -15 ft MLLW. The largest increase in shoot density was observed at the -5 to -10 ft MLLW depth, where density almost doubled from 2006 to 2008. Between 2004 and 2006 surveys, eelgrass density also doubled in this portion of the transects (Table 5).

Density of eelgrass shoots in the Reference Area did not increase at the same magnitude as that in the Corridor (Table 5). A slight increase was noted at the 0 to -5 ft MLLW depth, and a slight decrease in shoot density was observed from -5 to -20 ft MLLW.

The elevation range at which eelgrass was observed in 2008 remained similar to that observed in 2004 and 2006 (Table 5). As in 2006, no plants were observed at depths greater than -15 ft MLLW in the Outfall Corridor during 2008 surveys, though the 2004 survey had noted some eelgrass at this depth.

In Puget Sound, eelgrass typically becomes light limited at around -7 m relative to Mean Sea Level (MSL) (Thom et al. 1999), which is approximately -13.5 ft based on 9.47 ft MSL at Edmonds. A number of other factors, including substrate and current as well as water quality and light transmission, can contribute to the lower extent of eelgrass. These may affect local differences in eelgrass plant density like those observed between the Outfall Corridor and Reference Area, as well as differences observed at sites throughout Puget Sound. Inter-annual variation in site conditions, including light availability, also may have resulted in growing conditions favorable to eelgrass and influenced the increased densities observed at shallow elevations at both the outfall corridor and reference area compared to 2004.

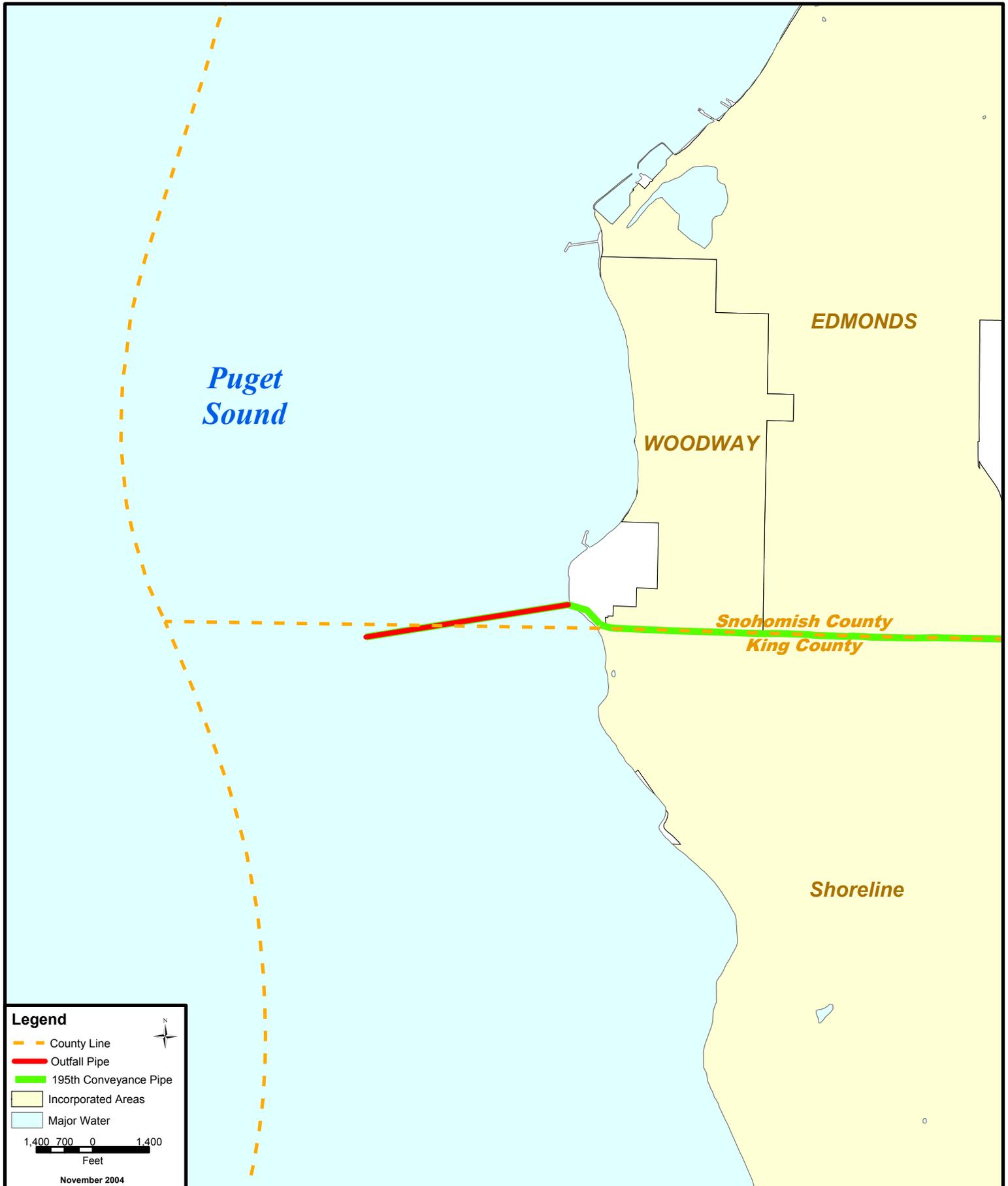
**Table 5. 2004, 2006, and 2008 Eelgrass observations by elevation at each survey area.**

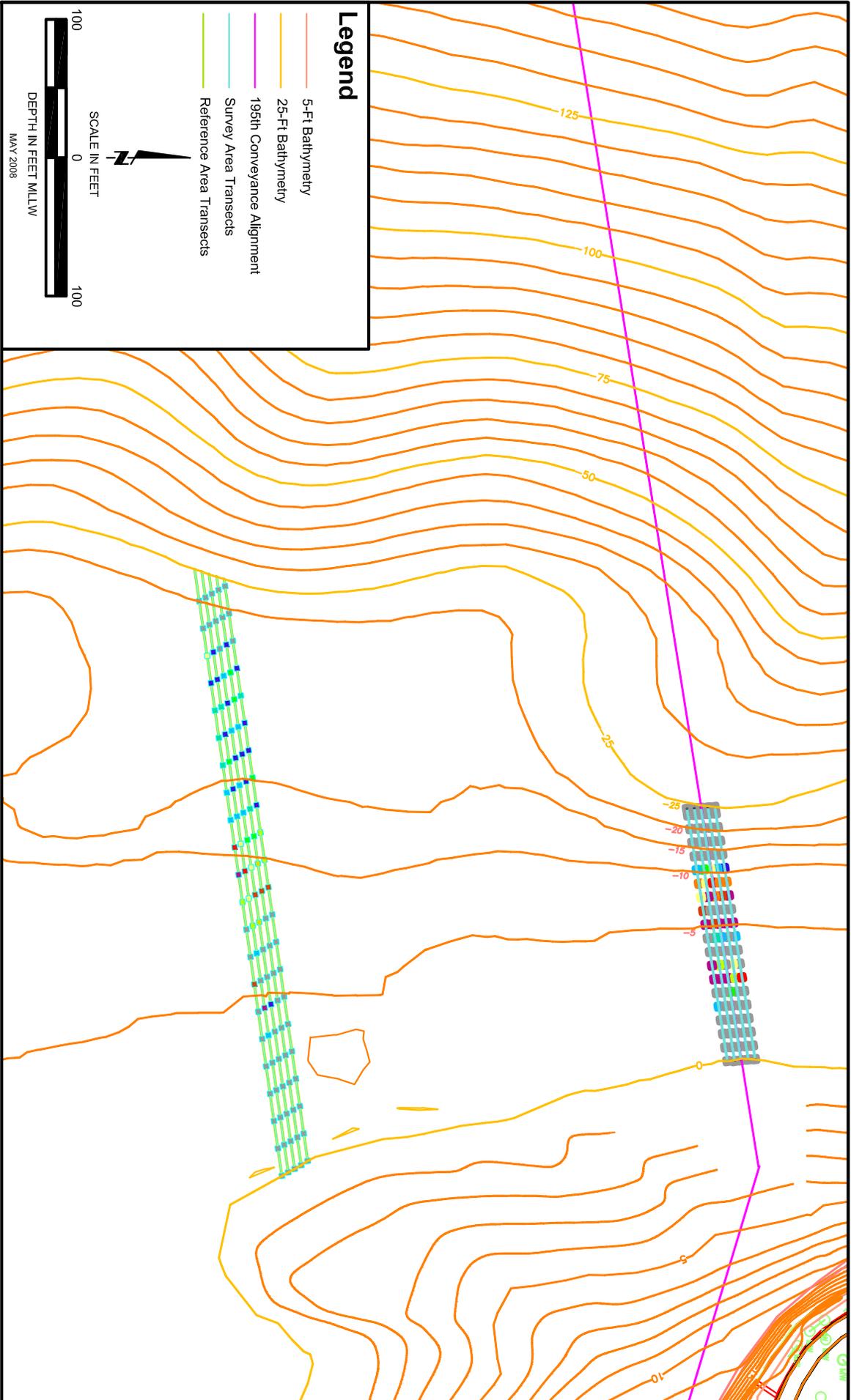
Elevation (ft below MLLW)	<u>Marine Outfall Corridor</u>		<u>Eelgrass Reference Area</u>	
	Average shoots/m <sup>2</sup>	n*	Average shoots/m <sup>2</sup>	n*
<b>2004</b>				
0 – 5	26	9	18	3
5 – 10	29	10	52	11
10 – 15	20	4	29	12
15 – 20	3	1	23	24
20 – 25	7	4	0	0
All	23	28	30	50
<b>2006</b>				
0 – 5	63	9	62	4
5 – 10	59	14	91	11
10 – 15	33	5	35	12
15 – 20	0	0	35	24
20 – 25	0	0	0	0
>25	--	--	0	0
All	55	28	30	50
<b>2008</b>				
0 – 5	73	12	84	3
5 – 10	108	16	68	14
10 – 15	24	5	25	14
15 – 20	0	0	22	24
20 – 25	0	0	0	0
>25	--	--	0	0
All	80	33	38	55

\* Number of observations with eelgrass (each observation is a density based on triplicate shoot counts)

# References Cited

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**King County**  
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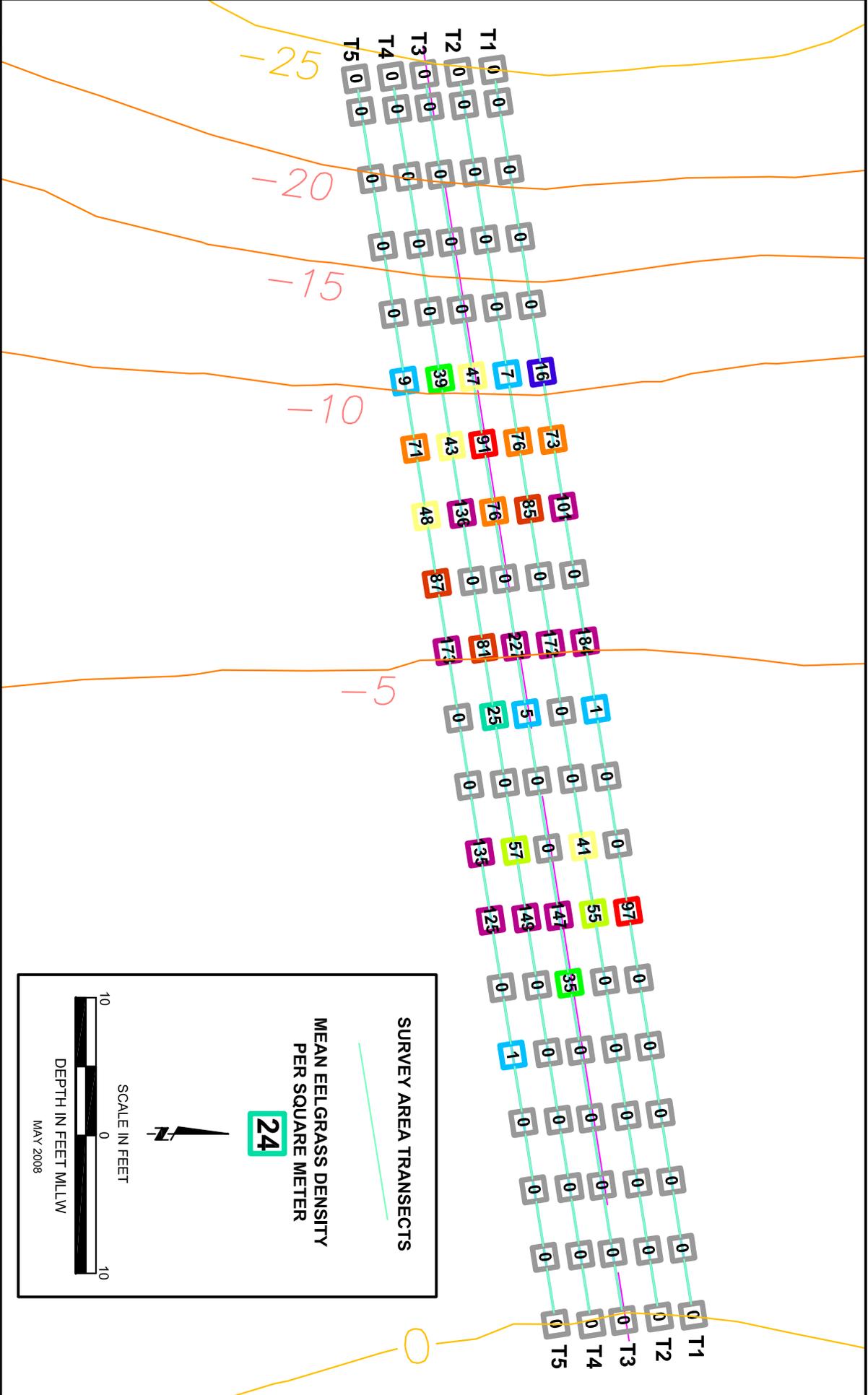
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**FIGURE 2**  
**Marine Outfall Site**  
**Survey and Reference Areas**



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 Division**



**SURVEY AREA TRANSECTS**

**MEAN EELGRASS DENSITY  
 PER SQUARE METER**

**24**

SCALE IN FEET

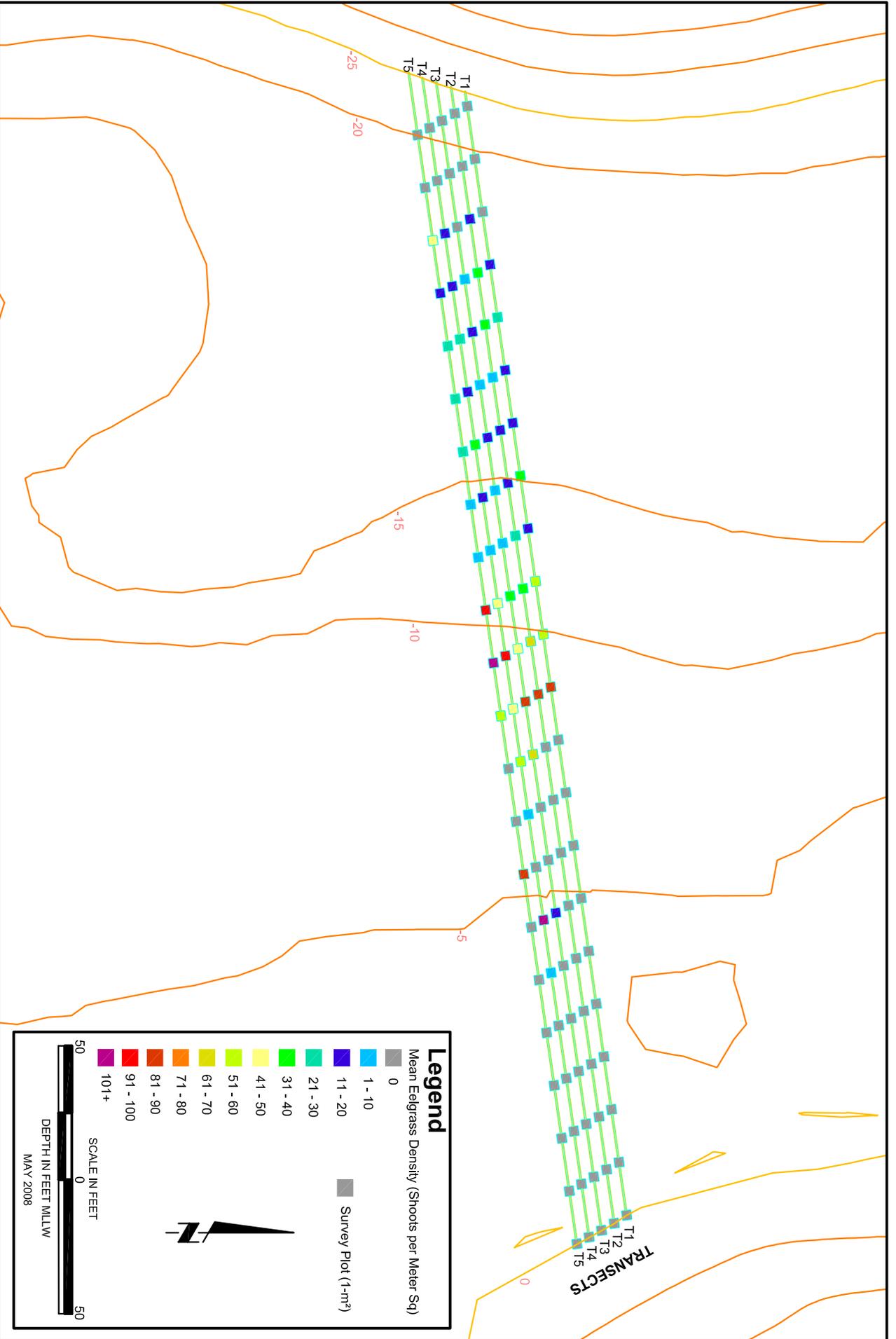
DEPTH IN FEET MLW

MAY 2008

**FIGURE 3**  
**MARINE OUTFALL CORRIDOR EELGRASS DENSITY**

The information included in this map has been compiled from a variety of sources and is subject to change without notice. King County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. King County shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. Any sale of this map or information on this map is prohibited except by written permission of King County.

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 Wastewater Treatment  
 Division

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File Name: 312001100-4  
 Prepared By: Gettie Associates, LLC

**FIGURE 5**

**REFERENCE AREA EELGRASS DENSITY**

**Legend**

Mean Eelgrass Density (Shoots per Meter Sq)

0	Survey Plot (1-m <sup>2</sup> )
1 - 10	
11 - 20	
21 - 30	
31 - 40	
41 - 50	
51 - 60	
61 - 70	
71 - 80	
81 - 90	
91 - 100	
101+	

SCALE IN FEET  
 0 50  
 DEPTH IN FEET MILLIWATER  
 MAY 2008

# Appendix A

Brightwater Eelgrass Survey Data Table

2008

## Table Legend

### Transect:

SA, Study Area\*  
RA, Reference Area

### Depth Bin:

1, 0 to -5 ft MLLW  
2, -5 to -10 ft MLLW  
3, -10 to -15 ft MLLW  
4, -15 to -20 ft MLLW  
5, -20 to -25 ft MLLW

### Substrate (qualitative):

ro, rock  
co, cobble  
gr, gravel  
sa, sand

Eelgrass edge: b/e, begin/end

### Macroalgae Taxa:

br, branched brown  
ch, *Chondracanthus* sp.  
de, *Desmarestia ligulata*  
fb, feathery brown  
la, *Saccharina latissima*\*  
ma, *Mazzaella* sp.  
po, *Porphyra* sp.  
pr, *Prionitis* sp.  
sc, *Scytosiphon simplicissimus*  
sm, *Smithora naiadum*  
ul, *Ulva* spp.

\* formerly *Laminaria saccharina*)

Year	Transect	Distance (ft)	Depth Bin	shoots/0.25 m <sup>2</sup>			Density (m <sup>2</sup> )	Eelgrass Edge	Substrate	Macro Taxa	Notes
				2	6	10					
2008	SA-1	0	1	0	0	0	0	no data	cb	ul	
2008	SA-1	10	1	0	0	0	0	no data	cb	ul	
2008	SA-1	20	1	0	0	0	0	no data	cb	ul, sc, ma	
2008	SA-1	30	1	0	0	0	0	no data	cb	ul, sc	
2008	SA-1	40	1	0	0	0	0	no data	cb	ul, sc, ma	
2008	SA-1	50	1	0	0	0	0	no data	cb	ul, sc, ma	
2008	SA-1	60	1	24	21	28	97.33333333	no data	cb	ul, sc, ma	
2008	SA-1	70	1	0	0	0	0	no data	sa, cb	ul, la	
2008	SA-1	80	1	0	0	0	0	no data	sa		
2008	SA-1	90	1	1	0	0	1.333333333	no data	sa		
2008	SA-1	100	2	41	56	41	184	no data	sa	ul	
2008	SA-1	110	2	0	0	0	0	no data	sa		
2008	SA-1	120	2	29	22	25	101.3333333	no data	sa	po	
2008	SA-1	130	2	22	16	17	73.33333333	no data	sa	ul, po	
2008	SA-1	140	3	10	2	0	16	no data	sa	ul	
2008	SA-1	150	3	0	0	0	0	no data	sa		
2008	SA-1	160	4	0	0	0	0	no data	sa		
2008	SA-1	170	5	0	0	0	0	no data	sa		
2008	SA-1	180	5	0	0	0	0	no data	sa		
2008	SA-1	190	5	0	0	0	0	no data	sa		
2008	SA-1	200	5	0	0	0	0	no data	sa		
2008	SA-2	0	1	0	0	0	0	no data	sa/gr	ul, po, bb	
2008	SA-2	10	1	0	0	0	0	no data	sa/gr	ul, sc, bb	
2008	SA-2	20	1	0	0	0	0	no data	sa/gr	ul, po, sc	
2008	SA-2	30	1	0	0	0	0	no data	sa/gr	ul, ma	
2008	SA-2	40	1	0	0	0	0	no data	sa/gr	ul, sc	
2008	SA-2	50	1	0	0	0	0	no data	sa/gr	ul, de, ma, ch	
2008	SA-2	60	1	5	21	15	54.66666667	no data	sa/gr	ul, de, po, ch	
2008	SA-2	70	1	8	7	16	41.33333333	no data	sa/gr	ul, la, de, ch	
2008	SA-2	80	1	0	0	0	0	no data	sa	ul	
2008	SA-2	90	1	0	0	0	0	no data	sa		
2008	SA-2	100	2	48	42	39	172	no data	sa		
2008	SA-2	110	2	0	0	0	0	no data	sa		
2008	SA-2	120	2	19	21	24	85.33333333	no data	sa	ul, po	
2008	SA-2	130	2	8	17	32	76	no data	sa	ul, po, la	
2008	SA-2	140	3	0	5	0	6.666666667	no data	sa	ul	
2008	SA-2	150	3	0	0	0	0	no data	sa		
2008	SA-2	160	4	0	0	0	0	no data	sa		

Year	Transect	Distance (ft)	Depth Bin	shoots/0.25 m <sup>2</sup>			Density (m <sup>2</sup> )	Eelgrass Edge	Substrate	Macro Taxa	Notes
				2	6	10					
2008	SA-2	170	5	0	0	0	0	no data	sa	ul	
2008	SA-2	180	5	0	0	0	0	no data	sa		
2008	SA-2	190	5	0	0	0	0	no data	sa		
2008	SA-2	200	5	0	0	0	0	no data	sa		
2008	SA-3	0	1	0	0	0	0		sa/gr/cb	ul, sc, po, bb	
2008	SA-3	10	1	0	0	0	0		sa/gr/cb	ul, sc, po	
2008	SA-3	20	1	0	0	0	0		sa/gr/cb	ul, sc	
2008	SA-3	30	1	0	0	0	0		sa/gr/cb	ul, sc	
2008	SA-3	40	1	0	0	0	0		sa/gr/cb	ul, sc, po	
2008	SA-3	50	1	0	0	26	34.66666667	b 50 e 69	sa/gr/cb	ul, sc, po	
2008	SA-3	60	1	32	22	56	146.6666667		sa/gr/cb	ul, po	
2008	SA-3	70	1	0	0	0	0		sa/gr/cb	ul, po, la	
2008	SA-3	80	1	0	0	0	0		sa		
2008	SA-3	90	1	0	0	4	5.333333333	b 91 e 105	sa		
2008	SA-3	100	2	61	43	66	226.6666667		sa	ul, po	
2008	SA-3	110	2	0	0	0	0	b 117 e 134	sa		
2008	SA-3	120	2	15	25	17	76		sa	ul, po	
2008	SA-3	130	2	20	30	18	90.66666667	b 139 e 145	sa	ul, la, de, pr	
2008	SA-3	140	3	13	11	11	46.66666667		sa	ul, la, ma	
2008	SA-3	150	3	0	0	0	0		sa		
2008	SA-3	160	4	0	0	0	0		sa		
2008	SA-3	170	5	0	0	0	0		sa	la	
2008	SA-3	180	5	0	0	0	0		sa		
2008	SA-3	190	5	0	0	0	0		sa		
2008	SA-3	200	5	0	0	0	0		sa		
2008	SA-4	0	1	0	0	0	0	no data	cb	po, sc, ul	
2008	SA-4	10	1	0	0	0	0	no data	cb	ul	
2008	SA-4	20	1	0	0	0	0	no data	cb	po, sc, ul	
2008	SA-4	30	1	0	0	0	0	no data	sa/cb	po, sc, ul	
2008	SA-4	40	1	0	0	0	0	no data	sa/cb	po, sc, ul, ma	
2008	SA-4	50	1	0	0	0	0	no data	sa/cb	ul, po	
2008	SA-4	60	1	38	42	32	149.3333333	no data	cb	ul, de, ma, po	
2008	SA-4	70	1	6	20	17	57.33333333	no data	sa/cb	ul, po, la, fb	
2008	SA-4	80	1	0	0	0	0	no data	sa		
2008	SA-4	90	1	13	0	6	25.33333333	no data	sa	po, sm	
2008	SA-4	100	2	22	39	0	81.33333333	no data	sa	po	
2008	SA-4	110	2	0	0	0	0	no data	sa		
2008	SA-4	120	2	31	30	41	136	no data	sa	po	

Year	Transect	Distance (ft)	Depth Bin	shoots/0.25 m <sup>2</sup>			Density (m <sup>2</sup> )	Eelgrass Edge	Substrate	Macro Taxa	Notes
				2	6	10					
2008	SA-4	130	2	0	32	0	42.66666667	no data	sa	po, de	
2008	SA-4	140	3	17	8	4	38.66666667	no data	sa	po, de	
2008	SA-4	150	3	0	0	0	0	no data	sa	po	
2008	SA-4	160	4	0	0	0	0	no data	sa		
2008	SA-4	170	5	0	0	0	0	no data	sa	ul, po	
2008	SA-4	180	5	0	0	0	0	no data	sa		
2008	SA-4	190	5	0	0	0	0	no data	sa		
2008	SA-4	200	5	0	0	0	0	no data	sa		
2008	SA-5	0	1	0	0	0	0	no data	sa/gr/cb	ul, sc, po	
2008	SA-5	10	1	0	0	0	0	no data	sa/gr/cb	ul, po	
2008	SA-5	20	1	0	0	0	0	no data	sa/gr/cb	ul, sc, po	
2008	SA-5	30	1	0	0	0	0	no data	sa/gr/cb	ul, po	
2008	SA-5	40	1	0	0	1	1.333333333	no data	sa/gr/cb	ul, sc, po, ma	
2008	SA-5	50	1	0	0	0	0	no data	sa		
2008	SA-5	60	1	38	27	29	125.3333333	no data	sa		
2008	SA-5	70	1	44	36	21	134.6666667	no data	sa	ul	
2008	SA-5	80	1	0	0	0	0	no data	sa		
2008	SA-5	90	1	0	0	0	0	no data	sa		
2008	SA-5	100	2	53	52	25	173.3333333	no data	sa		Zostera japonica at 100 ft
2008	SA-5	110	2	34	18	13	86.66666667	no data	sa	ul	
2008	SA-5	120	2	10	11	15	48	no data	sa	po	
2008	SA-5	130	2	26	20	7	70.66666667	no data	sa	ul, po	
2008	SA-5	140	3	7	0	0	9.333333333	no data	sa		
2008	SA-5	150	3	0	0	0	0	no data	sa		
2008	SA-5	160	4	0	0	0	0	no data	sa		
2008	SA-5	170	4	0	0	0	0	no data	sa		
2008	SA-5	180	5	0	0	0	0	no data	sa		
2008	SA-5	190	5	0	0	0	0	no data	sa		
2008	SA-5	200	5	0	0	0	0	no data	sa		
2008	RA-1	0	1	0	0	0	0		sa/gr/cb	ul, bb	
2008	RA-1	20	1	0	0	0	0		sa/gr/cb	ul	
2008	RA-1	40	1	0	0	0	0		sa/gr/cb	ul, bb	
2008	RA-1	60	1	0	0	0	0		sa/gr/cb	ul, bb	
2008	RA-1	80	1	0	0	0	0		sa/gr/cb	ul, la	
2008	RA-1	100	1	0	0	0	0		sa		
2008	RA-1	120	1	0	0	0	0		sa		
2008	RA-1	140	2	0	0	0	0		sa	ul, la	
2008	RA-1	160	2	0	0	0	0		sa		

Year	Transect	Distance (ft)	Depth Bin	shoots/0.25 m <sup>2</sup>			Density (m <sup>2</sup> )	Eelgrass Edge	Substrate	Macro Taxa	Notes
				2	6	10					
2008	RA-1	180	2	0	0	0	0	b 182 e 187	sa		
2008	RA-1	200	2	26	15	22	84	b 192 e 378	sa	po	
2008	RA-1	220	2	14	14	16	58.66666667		sa	po, la, ul	
2008	RA-1	240	3	17	11	14	56		sa	po, ul	
2008	RA-1	260	3	8	1	1	13.33333333		sa	po, la, ul	
2008	RA-1	280	4	2	12	10	32		sa	po, la	
2008	RA-1	300	4	7	3	4	18.66666667		sa	po, la, ul	
2008	RA-1	320	4	0	6	4	13.33333333		sa	po, la, ul	
2008	RA-1	340	4	10	9	3	29.33333333		sa	po, la, ul	
2008	RA-1	360	4	3	4	2	12		sa	po, ul	
2008	RA-1	380	4	0	0	0	0		sa		
2008	RA-1	400	4	0	0	0	0		sa	de	
2008	RA-1	420	5	0	0	0	0		sa	la	
2008	RA-1	440	6	0	0	0	0		sa		
2008	RA-1	460	6	0	0	0	0		sa		
2008	RA-2	0	1	0	0	0	0		sa/gr	ul	
2008	RA-2	20	1	0	0	0	0		sa/gr/cb	bb	
2008	RA-2	40	1	0	0	0	0		sa/gr/cb	ul, bb	
2008	RA-2	60	1	0	0	0	0		sa/gr/cb	ul	
2008	RA-2	80	1	0	0	0	0		sa/gr/cb	ul, la	
2008	RA-2	100	1	0	0	0	0	b 103 e 115	sa		
2008	RA-2	120	1	0	0	0	0		sa		
2008	RA-2	140	2	0	0	0	0		sa	ul, po	
2008	RA-2	160	2	0	0	0	0	b 165 e 174	sa		
2008	RA-2	180	2	0	0	0	0		sa	po	
2008	RA-2	200	2	21	19	26	88	b 192 e 380-400	sa	po, la	
2008	RA-2	220	2	16	17	17	66.66666667		sa	po, la	
2008	RA-2	240	3	7	15	5	36		sa	po, la, ul	
2008	RA-2	260	3	8	2	8	24		sa	pr, po, la	
2008	RA-2	280	3	5	3	6	18.66666667		sa	po, la	
2008	RA-2	300	4	2	5	6	17.33333333		sa	po, la	
2008	RA-2	320	4	0	4	2	8		sa	pr, po	
2008	RA-2	340	4	6	8	11	33.33333333		sa	po, la	
2008	RA-2	360	4	8	9	12	38.66666667		sa	po, la	
2008	RA-2	380	4	1	2	7	13.33333333		sa	po, la, ul	
2008	RA-2	400	4	0	0	0	0		sa	la, de	
2008	RA-2	420	5	0	0	0	0		sa	la, de	
2008	RA-2	440	6	0	0	0	0		sa		

Year	Transect	Distance (ft)	Depth Bin	shoots/0.25 m <sup>2</sup>			Density (m <sup>2</sup> )	Eelgrass Edge	Substrate	Macro Taxa	Notes
				2	6	10					
2008	RA-2	460	6	0	0	0	0		sa		
2008	RA-3	0	1	0	0	0	0	no data	sa/gr/cb	bb	
2008	RA-3	20	1	0	0	0	0	no data	sa/gr/cb	ul	
2008	RA-3	40	1	0	0	0	0	no data	sa/gr/cb	ul, la	
2008	RA-3	60	1	0	0	0	0	no data	sa/gr/cb	ul, la, po	
2008	RA-3	80	1	0	0	0	0	no data	sa/gr/cb	ul, la	
2008	RA-3	100	1	0	0	0	0	no data	sa/gr/cb	ul, la	
2008	RA-3	120	1	2	0	6	10.66666667	no data	sa	ul, la	
2008	RA-3	140	2	0	0	0	0	no data	sa	ul, la	
2008	RA-3	160	2	0	0	0	0	no data	sa	ul, la	
2008	RA-3	180	2	17	9	23	65.33333333	no data	sa		
2008	RA-3	200	2	22	25	19	88	no data	sa	ul	
2008	RA-3	220	2	16	8	11	46.66666667	no data	sa	ul, la	
2008	RA-3	240	3	9	13	4	34.66666667	no data	sa	ul	
2008	RA-3	260	3	0	0	4	5.333333333	no data	sa	la	
2008	RA-3	280	3	0	3	1	5.333333333	no data	sa	la	
2008	RA-3	300	4	4	3	7	18.66666667	no data	sa	ul, po	
2008	RA-3	320	4	0	3	0	4	no data	sa	la	
2008	RA-3	340	4	6	7	2	20	no data	sa	de	
2008	RA-3	360	4	0	0	7	9.333333333	no data	sa		
2008	RA-3	380	4	0	0	0	0	no data	sa		
2008	RA-3	400	4	0	0	0	0	no data	sa		
2008	RA-3	420	5	0	0	0	0	no data	sa		
2008	RA-3	440	6	0	0	0	0	no data	sa		
2008	RA-3	460	6	0	0	0	0	no data	sa		
2008	RA-4	0	1	0	0	0	0		sa/cb	bb	
2008	RA-4	20	1	0	0	0	0		sa/cb	ul, po	
2008	RA-4	40	1	0	0	0	0		sa/cb	ul, po, bb	
2008	RA-4	60	1	0	0	0	0		sa/cb	ul, ma, sc	
2008	RA-4	80	1	0	0	0	0		sa/gr	la, ul, po	
2008	RA-4	100	1	2	0	0	2.666666667	b 101 e 131	sa		
2008	RA-4	120	1	62	55	63	240		sa	la, ma	
2008	RA-4	140	2	0	0	0	0		sa	la, ul, po	
2008	RA-4	160	2	1	0	0	1.333333333	b 170 e 179	sa	la, ul	
2008	RA-4	180	2	0	33	9	56		sa	po	
2008	RA-4	200	2	27	0	8	46.66666667	b 199 e 258	sa	po, ma	
2008	RA-4	220	2	20	30	20	93.33333333		sa	po	
2008	RA-4	240	3	14	10	8	42.66666667		sa	po, la	

Year	Transect	Distance (ft)	Depth Bin	shoots/0.25 m <sup>2</sup>			Density (m <sup>2</sup> )	Eelgrass Edge	Substrate	Macro Taxa	Notes
				2	6	10					
2008	RA-4	260	3	2	0	0	2.666666667		sa	po, ma	
2008	RA-4	280	3	3	6	2	14.666666667		sa	ul, de	
2008	RA-4	300	4	7	10	13	40		sa	la, de	
2008	RA-4	320	4	1	6	4	14.666666667		sa	la, de	
2008	RA-4	340	4	9	4	9	29.333333333		sa	la, de	
2008	RA-4	360	4	0	8	3	14.666666667		sa	de	
2008	RA-4	380	4	7	3	4	18.666666667		sa	ul, la	
2008	RA-4	400	4	0	0	0	0		sa		
2008	RA-4	420	5	0	0	0	0		sa		
2008	RA-4	440	6	0	0	0	0		sa		
2008	RA-4	460	6	0	0	0	0		sa	la	
2008	RA-5	0	1	0	0	0	0	no data	co	bb, sc, po	
2008	RA-5	20	1	0	0	0	0	no data	co	bb, sc, po	
2008	RA-5	40	1	0	0	0	0	no data	co	bb, sc, po	
2008	RA-5	60	1	0	0	0	0	no data	co	bb, sc, po	
2008	RA-5	80	1	0	0	0	0	no data	sa, co	la, de, po, bb	
2008	RA-5	100	1	0	0	0	0	no data	sa		
2008	RA-5	120	1	0	0	0	0	no data	sa	la	
2008	RA-5	140	2	4	49	13	88	no data	sa	la, de, bb	
2008	RA-5	160	2	0	0	0	0	no data	sa	la, ul, po, bb	
2008	RA-5	180	2	0	0	0	0	no data	sa		
2008	RA-5	200	2	0	41	0	54.666666667	no data	sa	de, po	
2008	RA-5	220	2	22	26	35	110.666666667	no data	sa	po	
2008	RA-5	240	3	13	26	29	90.666666667	no data	sa	po	
2008	RA-5	260	3	0	5	1	8	no data	sa	ul, po	
2008	RA-5	280	3	2	0	0	2.666666667	no data	sa	po	
2008	RA-5	300	4	5	9	8	29.333333333	no data	sa	po	
2008	RA-5	320	4	4	9	6	25.333333333	no data	sa	po	
2008	RA-5	340	4	9	4	9	29.333333333	no data	sa	po, sm	
2008	RA-5	360	4	8	5	0	17.333333333	no data	sa	de, po, sm	
2008	RA-5	380	4	15	13	7	46.666666667	no data	sa	po	
2008	RA-5	400	4	0	0	0	0	no data	sa		
2008	RA-5	420	5	0	0	0	0	no data	sa		
2008	RA-5	440	6	0	0	0	0	no data	sa		
2008	RA-5	460	6	0	0	0	0	no data	sa	la	