U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

PNNL-15678-5

Fifth Annual Report: 2008 Pre-Construction Eelgrass Monitoring and Propagation for King County Outfall Mitigation

D. L. Woodruff
C. Judd
R. M. Thom
N. K. Sather
R. Kaufmann

Marine Sciences Laboratory
Sequim, Washington 98382

January 2010

Prepared for
King County Department of Natural Resources and Parks
Wastewater Treatment Division, Brightwater Project
Under a Related Services Agreement
With the U.S. Department of Energy
Contract DE-AC05-76RL01830

Pacific Northwest
NATIONAL LABORATORY

PACIFIC NORTHWEST NATIONAL LABORATORY
operated by
BATTELLE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC05-76RL01830

Printed in the United States of America

Available to DOE and DOE contractors from the
Office of Scientific and Technical Information,
P.O. Box 62, Oak Ridge, TN 37831-0062;
ph: (865) 576-8401
fax: (865) 576-5728
email: reports@adonis.osti.gov

Available to the public from the National Technical Information Service,
U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161
ph: (800) 553-6847
fax: (703) 605-6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/ordering.htm

This document was printed on recycled paper.

(9/2003)

PNNL-15678-5

Fifth Annual Report:

2008 Pre-Construction Eelgrass

Monitoring and Propagation

for King County Outfall Mitigation

D. L. Woodruff
N.K. Sather
C. Judd
R. Kaufmann
R. M. Thom

Marine Sciences Laboratory
Sequim, Washington

January 2010

Prepared for
King County Department of Natural Resources and Parks
Wastewater Treatment Division, Brightwater Project
under a Related Services Agreement
with the U.S. Department of Energy
Contract DE-AC05-76RL01830

Pacific Northwest National Laboratory
Richland, Washington 99352

Executive Summary

This is the fifth and final report in a series documenting progress of the pre-construction eelgrass restoration and mitigation activities for the proposed King County Brightwater marine outfall, discharging to Puget Sound near Point Wells, Washington. King County began implementing a multiyear eelgrass monitoring and restoration program in 2004, with the primary goal of returning intertidal and shallow subtidal habitat and eelgrass to pre-construction conditions, after construction of the outfall. Major eelgrass mitigation program elements include: a) pre-construction monitoring, i.e., documenting initial eelgrass conditions and degree of fluctuation over a 5 year period prior to construction, b) eelgrass transplanting, including harvesting, offsite propagation and stockpiling of local plants for post-construction planting, and c) post-construction planting and subsequent monitoring, occurring in 2009 and beyond. The overall program is detailed in the *Eelgrass Restoration and Biological Resources Implementation Workplan* (King County 2008).

This report documents pre-construction eelgrass activities during calendar year 2008 and 2009 by Pacific Northwest National Laboratory for King County up to the point of post-construction transplanting of eelgrass. Activities during this time included 1) a side scan sonar and underwater video mapping survey to document the location of eelgrass in the survey area and evaluate any change that may have occurred between 2004 and 2008, 2) harvesting of additional eelgrass from the corridor just prior to trenching and construction in the outfall corridor, 3) continued propagation of eelgrass at the PNNL Marine Sciences laboratory in Sequim, Washington, and 4) harvesting of eelgrass from the propagation tanks for transplanting back to the outfall corridor, post-construction in 2009.

The side scan sonar and underwater video survey was conducted during the spring of 2008 to document the location and extent of eelgrass in the Outfall Study and Reference Areas prior to outfall construction. There was a 27% increase of eelgrass meadow area documented in the overall study area in 2008 (8,486 m^2) compared to 2004 (6,701 m^2), which included a 127% increase in the Outfall Corridor proper, and a 29% increase in the Reference Corridor. Increases were shown for eelgrass shoot density conducted by Grette Associates during the same time periods in the Outfall and Reference Corridors.

During May of 2008, just prior to trenching of the outfall corridor, over 12,000 eelgrass shoots were harvested from the corridor, transported to PNNL and added to their propagation tanks containing close to 2,000 shoots harvested from the corridor in prior years. All shoots were then held and propagated for approximately one year. In May of 2009, approximately 16,000 shoots were harvested from the propagation tanks and prepared for return to the Outfall Corridor for transplanting by Grette Associates. A portion of the eelgrass shoots currently remain at PNNL, and will be held in reserve as contingency until the success of the transplant operation has been confirmed.

Contents

Figures

Tables

1.0 Introduction

In late 2008, King County's Wastewater Treatment Division completed construction of the Brightwater sewer outfall, which will discharge highly treated effluent into Puget Sound near the King-Snohomish County line just south of Point Wells, Washington. The site was selected in part because of its narrow nearshore zone and the presence of fewer biological resources such as eelgrass that could be detrimentally affected by construction activities. Native eelgrass (*Zostera marina* L.) is present along the proposed outfall alignment, but is less abundant there than at other proposed sites. King County is implementing a mitigation program to monitor and restore those eelgrass beds that will be unavoidably disturbed by construction.

This report is the fifth and final in a series of annual reports on pre-construction activities conducted by the Pacific Northwest National Laboratory (PNNL) for the King County Brightwater outfall eelgrass and biological resource mitigation program. Work related to this program is described in an *Eelgrass Restoration and Biological Resources Implementation Workplan* (King County 2008). PNNL tasks included the pre-construction mapping that was completed in 2004 (Woodruff et al. 2006a), subsequent monitoring of eelgrass beds in the outfall survey area, and eelgrass stockpiling and propagation for post-construction restoration during 2005 (Woodruff et al. 2006b), 2006 (Woodruff et al. 2007a), and 2007 (Woodruff et al. 2007b). This report includes a final year of pre-construction mapping that occurred in the summer of 2008, as well as eelgrass propagation activities that have occurred through the summer of 2009.

The Brightwater outfall survey area encompasses the Outfall (Eelgrass) Study Area, Marine Outfall Corridor, Eelgrass Reference Area, and the Eelgrass Reference Corridor (Figure 1). An Eelgrass Donor Site has been identified as a contingency in the event the harvest and propagation effort described below fails to provide sufficient eelgrass for transplanting. The Outfall Study Area extends 210 feet both north and south of the outfall pipeline alignment centerline, between 0 ft mean lower low water (MLLW) and -25 ft MLLW, a zone in which eelgrass and associated macroalgae grow. Within the Outfall Study Area is the Marine Outfall Corridor, a narrow zone (20 ft wide) centered on the outfall pipeline alignment that includes 4 ft on either side of the 12-ft-wide sheeted trench.

In April 2008, Grette Associates, LLC (2008) conducted a diver-based survey of eelgrass density in the Marine Outfall Corridor and Reference Area Corridor. Shortly after that in May 2008, PNNL conducted a side-scan sonar and underwater video survey of the Marine Outfall and Reference Corridor areas to document the location of eelgrass and nearshore habitat condition. The eelgrass mapping activities, including a comparison to maps created during the 2004 survey are documented in Section 2.0 of this report.

In accordance with the restoration and monitoring plan, PNNL harvested just over 300 eelgrass shoots from the Marine Outfall Corridor in 2004 to begin offsite propagation of plants for post-construction restoration (Woodruff et al. 2006a). This approach to restoration eliminates the need to remove plants from eelgrass meadows that would otherwise be undisturbed, while ensuring that the resident population is restored at the site. Propagation activities continued into 2009, when approximately 16,000 shoots were harvested and transplanted from the PNNL Marine Sciences Lab outdoor propagation tanks to the Marine Outfall Corridor in May 2009. Section 3.0 of this report documents the eelgrass propagation history and propagation monitoring activities during 2008 and 2009.

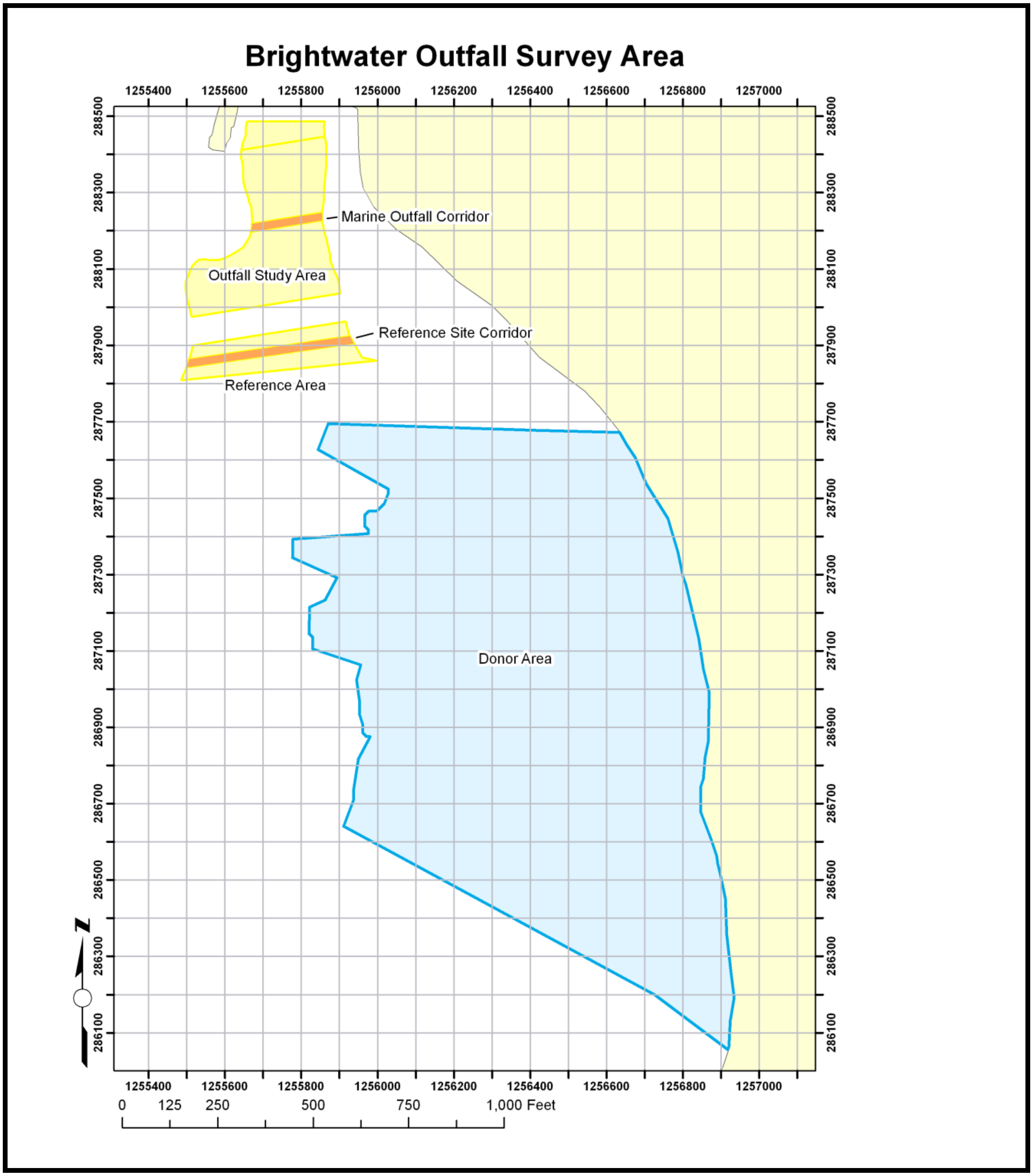

Figure 1. **Location of Brightwater Outfall Survey Area Including Outfall Study Area, Reference Area, and Donor Area**

2.0 Eelgrass Mapping Using Side-Scan Sonar and U/W Video

On April 29th and 30th, 2008 PNNL conducted a side-scan sonar and underwater video survey of the Brightwater Outfall Survey area including the Outfall Study Area and the Reference Area (Figure 1). These areas, including the Donor Area, were also surveyed in 2004, however at that time only the Outfall Study Area and Reference Area were processed. The eelgrass and subsequent maps produced in 2008, the maps produced in 2004, as well as quantitative eelgrass shoot counts from diver surveys (Grette Associates, 2006; 2008) will provide a robust baseline dataset for evaluating transplant success as part of post-construction monitoring.

2.1 Eelgrass Mapping Methods

2.1.1 Sonar and Underwater Video Field Collections

The side-scan sonar and underwater video data were collected in the Outfall Study Area and the Reference Area (Figure 1), from approximately 65 m (213 ft) north of the Marine Outfall Corridor, to approximately 10 m (33 ft) south of the Eelgrass Reference Area, and offshore to a depth of at least -25 ft MLLW. The methods used are described in greater detail in the Implementation Workplan (King County 2008). A GeoAcoustics Ltd. side scan sonar system was towed by boat in overlapping swaths at high tide to include all areas where eelgrass was present. Data were collected along transects (tracklines) parallel to shore, and spaced approximately 60 m apart to provide the best resolution of data with an approximate 50% overlap of swaths. Each transect provided a unique "view angle" (upslope or downslope) of the eelgrass. An on-board differential global positioning system (dGPS) and computer imaging system provided real-time output of sonar images on a computer monitor. Each pass of the sonar was examined for signatures of eelgrass edges and patches; the information from the passes with the strongest eelgrass signal returns were merged, creating the final mosaic (Figure 2) used to delineate the eelgrass polygons.

Underwater video transects were collected in the area of the Outfall Study Area and Reference Area: five transects were collected parallel to shore approximately 10-20 m apart, several transects were collected perpendicular to shore in the corridor areas, and several transects were collected diagonally in an onshore to offshore "zig zag" pattern encompassing the entire survey area. Additional transects were collected at the north end of the survey area inside the Paramount Petroleum pier to provide additional coverage (Figure 3). Video data was collected at a high tide to ensure the fullest possible coverage close to shore. Copies of all video data have been provided to King County.

The underwater video survey was conducted immediately after the sonar survey. The towed system consists of a custom-built aluminum tow-sled with a vertical stabilizer and bottom skids to protect the camera. The camera, a compact Sony Super Circuits low-light color system mounted in a pressure housing with a Plexiglas lens, was towed behind the vessel approximately 1 m off the bottom at an oblique looking angle toward the bottom. The camera and tow-sled were linked to a dGPS and Sony digital video recording system and monitor. The dGPS position and time were recorded and stored in a computer database and also encoded onto the video image as a permanent record. This information was updated and recorded every one second.

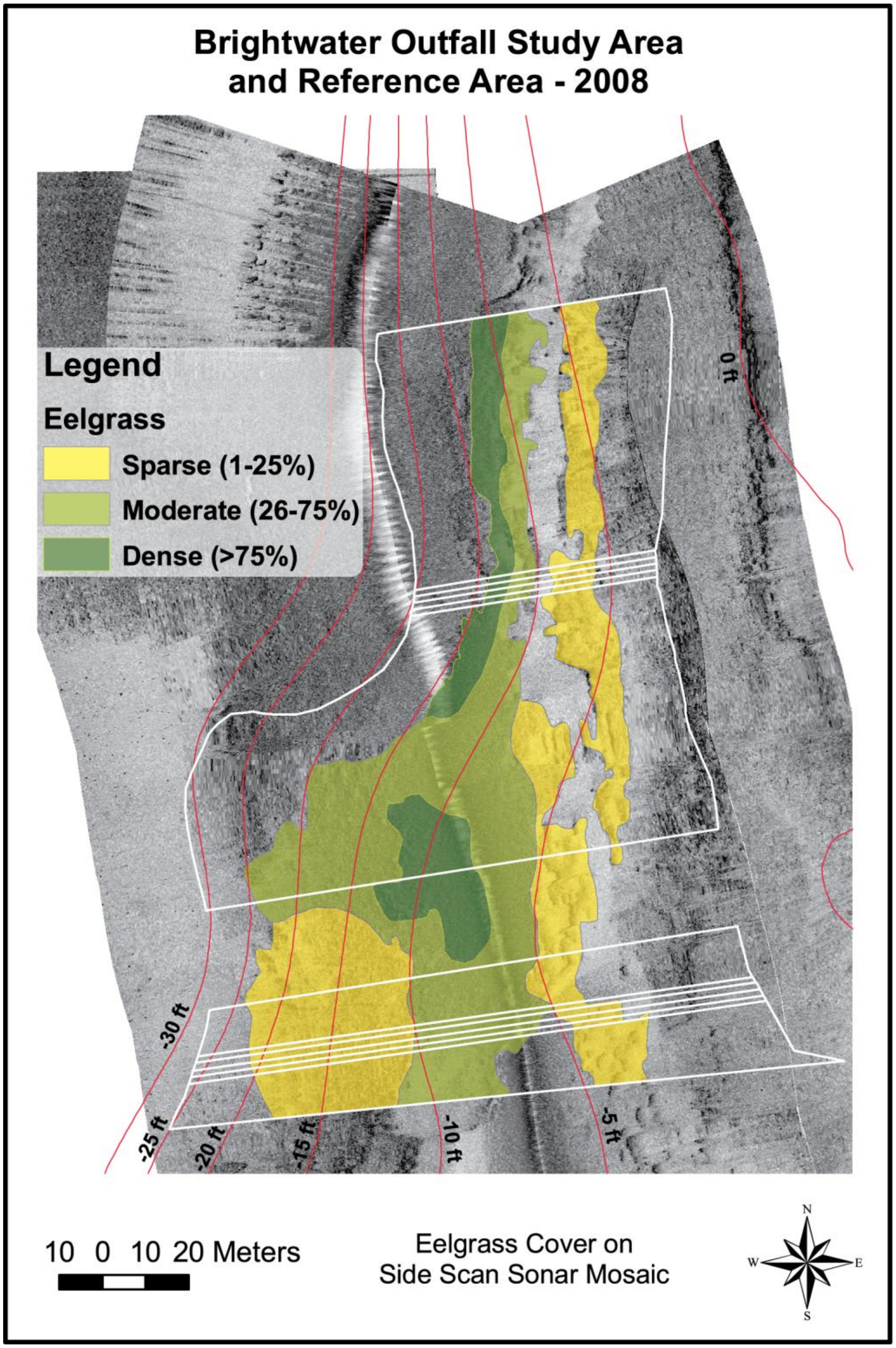

Figure 2. **Final Side Scan Sonar Mosaic Used to Delineate Eelgrass Cover**

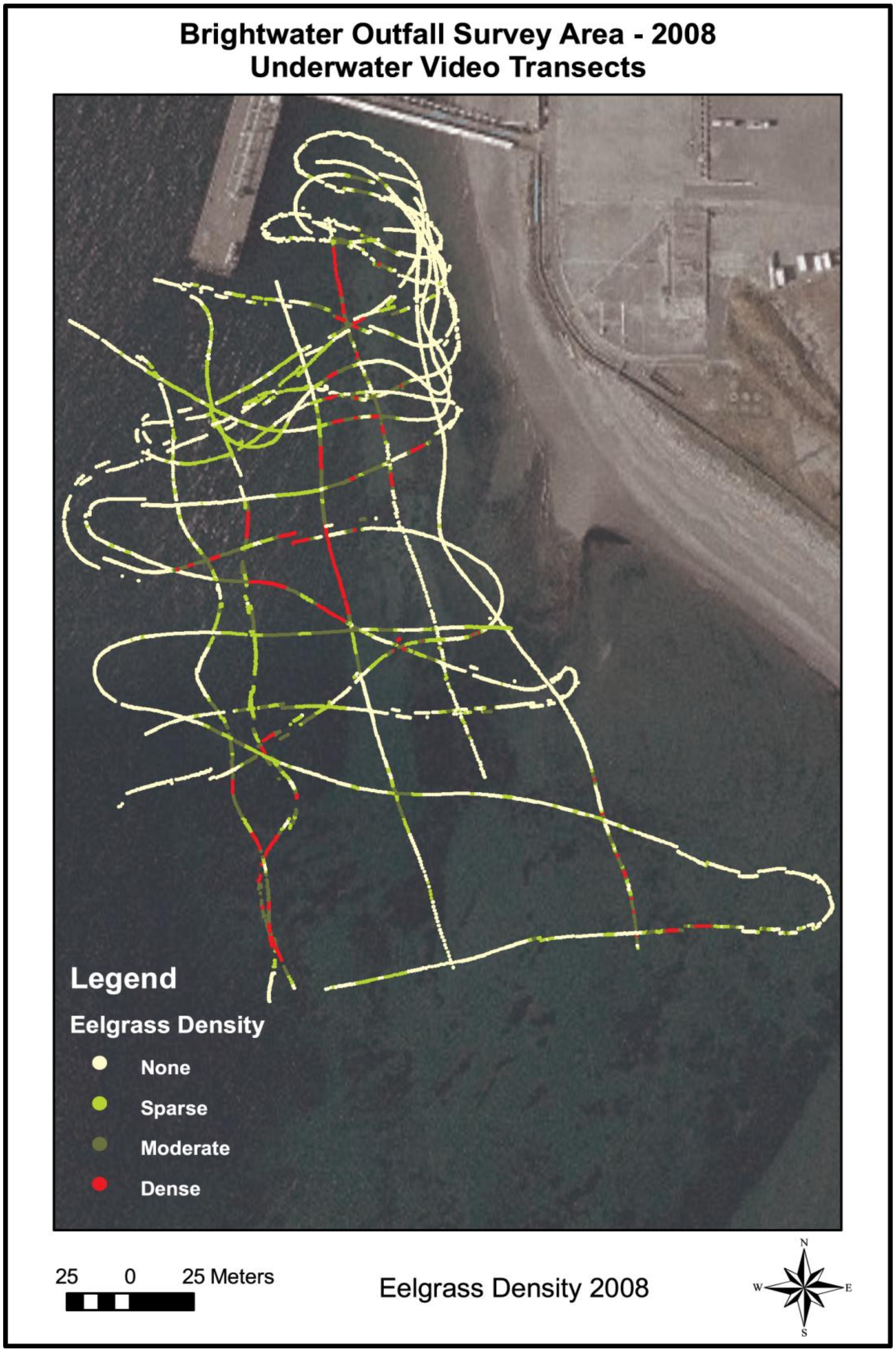

Figure 3. **Georeferenced Underwater Video Transects and Eelgrass Cover Class Located in the outfall Study Area and Reference Area.**

2.1.2 Underwater Video Analysis

Video analysis was accomplished using PNNL-developed software. The software allows an operator to link a digital video stream to a GPS log file and associate observed video features with a specific spatial position based on the coordinated universal time (UTC) from the GPS that is imprinted on each video frame. The analyst has full control of video playback, including forward/reverse at any rate specified, and incremental frame stepping. Changes in eelgrass density, eelgrass cover type, and substrate type were recorded and assigned to each GPS point (logged once per second). A quality assurance check of the data was conducted by a second video analyst to verify the classification accuracy of the data. As an additional independent check, all data points were checked where transects line crossed each other to confirm that the same and appropriate classification was used.

The video post-processing cover class designations were as follows:

- *None* – no eelgrass showing
- *Sparse* – 25% or less of the viewing area contained eelgrass
- *Moderate* – between 25% and 75% of the viewing area contained eelgrass
- *Dense* – >75% of the viewing area contained eelgrass

Additional video post-processing was done to determine the dominant substrate type (either sand or gravel), and whether the eelgrass cover was continuous or patchy within the viewing screen.

2.1.3 Data Analysis and Map Production

Side-scan sonar and underwater video imagery were formatted in ArcView 9.3 to create preliminary data layers for further delineation of eelgrass distribution. Eelgrass cover was delineated in the Outfall Study Area, the Marine Outfall Corridor, the Reference Area, Reference Site Corridor and the areas between the Outfall and Reference Study areas. In the Corridor Areas (Outfall and Reference), Grette Associates (2008) dive-survey information was also incorporated into the final delineation, providing higher resolution of eelgrass distribution within the Outfall and Reference corridors. The overall process involved an initial evaluation of the side-scan sonar data to determine the spatial extent of the eelgrass (boundaries), then overlaying the underwater video data to verify spatial cover and patchiness, and determination of final cover classes, shown in Figure 4 as an overlay on side scan sonar imagery.

The data from each sonar swath was evaluated separately to determine the location of larger eelgrass patches or bed edges. The discernible edge of the eelgrass beds within each swath varied depending on the angle of the sonar pass (upslope or downslope), the density of the eelgrass, and the wave and current speed impacting the eelgrass beds, hence each swath was evaluated independently. A final sonar mosaic was created utilizing the information from all sonar swaths and was used as a base layer for adding the video information.

The underwater video data was used as an overlay on the mosaic of the side-scan sonar image. Additional polygons were delineated or refined based on the information from the underwater video data. Finally, the survey data from Grette Associates (2008) was reviewed for the Corridors and final polygon determinations made based on all available data. Each polygon was assigned a cover class as shown in Table 1.

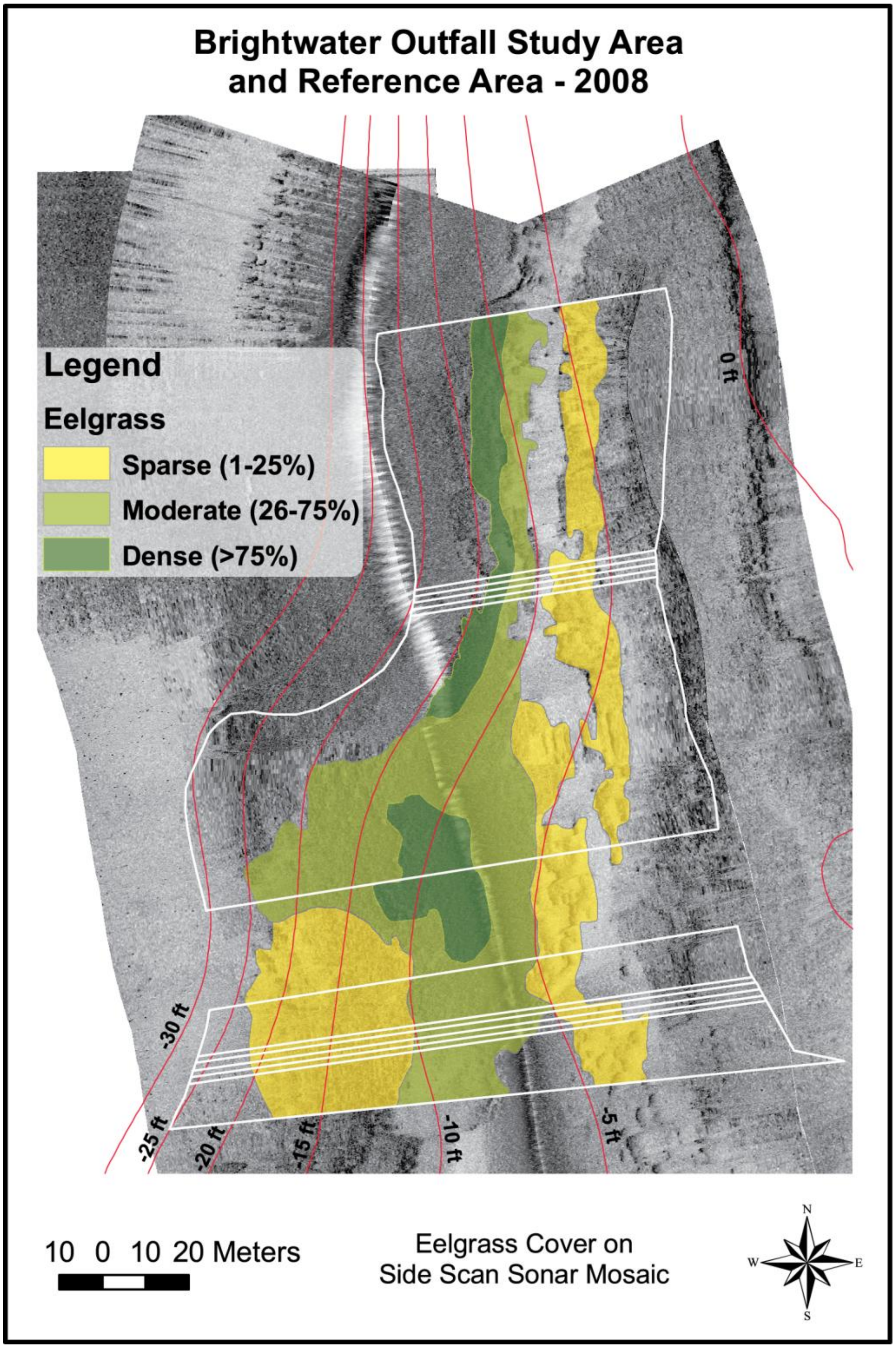

Figure 4. **Eelgrass Cover Classes as an Overlay on Side Scan Sonar Mosaic in the Brightwater study Area.**

Table 1 **Eelgrass (*Zostera marina*) Polygon Cover Classes**

Cover Class	*Z. marina* Coverage	Description
0	0%	None
1	1-25%	Sparse or patchy cover
2	26-75%	Moderate cover
3	76 – 100%	Dense cover

Final polygon delineation was based on a set of decision rules to guide the interpretation of the data. An eelgrass bed was considered a separate polygon if its dimension on any one side, based on a combination of the sonar and video data, was at least 3 m across. Eelgrass beds that did not meet the 3-m criterion but contained eelgrass noted in the sonar or video or video data were coded as sparse or patchy cover (Cover Class 1). Cover Class 0 (none) may have also contained single isolated eelgrass plants that were not captured by the sonar swath or were not within the video track-line field of view.

The spatial accuracy of this mapping method is determined by the equipment and the techniques used to collect the data. In this type of application, the spatial location is considered accurate within ±2 meters when the independent collections of side-scan sonar and underwater video data are combined. The location of the camera relative to the boat and GPS unit varied depending on the depth and the speed of the boat. Every attempt was made to account for and minimize the effects of these factors. When the video data were analyzed, each transect was evaluated separately to determine the direction of the boat and the position of the camera relative to the recorded GPS point. The resulting eelgrass polygons were delineated accordingly. In areas where there were limited data, such as areas between video track-lines with sparse eelgrass, or areas of sonar swaths with sparse eelgrass and limited video coverage, best professional judgment was used to delineate the polygons.

2.2 Eelgrass Mapping Results

The distribution of eelgrass, *Z. marina*, in the Brightwater outfall study area is shown as polygon overlays on aerial imagery in Figure 5. On a broad scale, the location and pattern of eelgrass presence in the study area is similar to that mapped in 2004, shown in Figure 6. However there has been an increase in overall coverage and density between 2004 and 2008, noted in Figures 5 and 6, and Table 2. The overall area of coverage of eelgrass in the general area of study was 8486 m^2 in 2008, compare to 6701 m^2 in 2004. A similar trend was also observed by Grette Associates (2008) in diver surveys of the corridors. Table 2 shows the eelgrass cover class distribution (m^2) for each density classification and area for 2004 and 2008. The eelgrass cover increase in the Marine Outfall Corridor between 2004 and 2008 was 127 percent, (63 to 143 m^2) compared to a 29% increase in the Reference Corridor (412 to 533 m^2). A similar trend was shown in the corridors by Grette Associates based on the average eelgrass shoot density. The average shoot density in the Marine Outfall Corridor increased from 23 shoots/m^2 in 2004 to 80 shoots/m^2 in 2008, and 30 shoots/m^2 in 2004 to 38 shoots/m^2 in 2008 in the Reference Area Corridor.

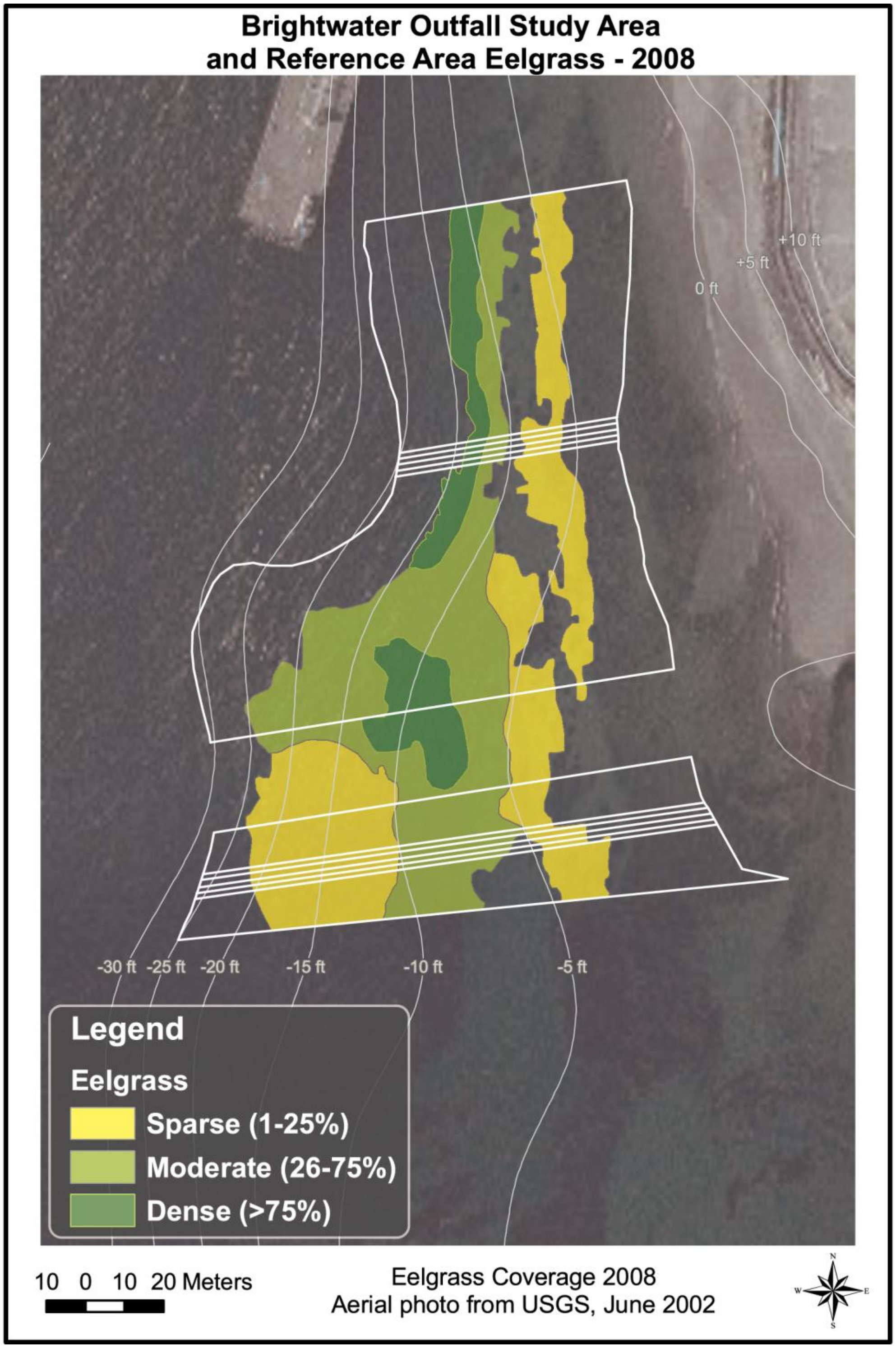

Figure 5. **Eelgrass Cover Classes and Area (m^2) Determined in 2008 in Brightwater Survey Area.**

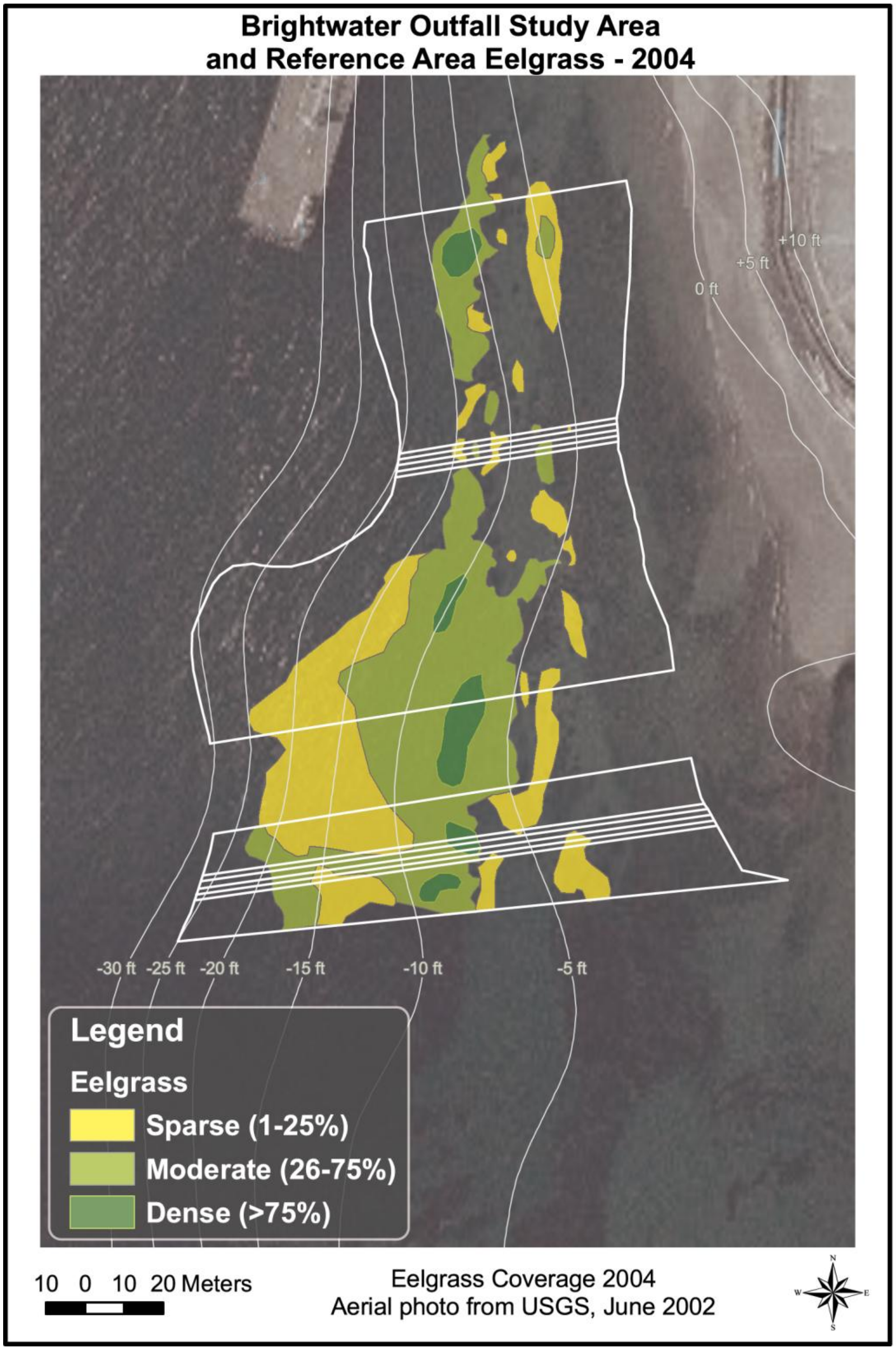

Figure 6. **Eelgrass Cover Classes and Area (m^2) Determined in 2004 for the Outfall Study and Reference Areas.**

Table 2. **Eelgrass (*Z. marina*) area coverage (m^2) in the Brightwater Outfall Survey Area estimated for 2004 and 2008.**

2004

Survey Area (m^2)	**Sparse**	**Moderate**	**Dense**	**Total**
Outfall Study Area w/o Corridor	1210	2023	201	3434
Marine Outfall Corridor	38	25	--	63
Eelgrass Ref. Area w/o Corridor	779	648	71	1498
Eelgrass Reference Corridor	77	304	31	412
Area Between Study & Ref.	622	536	136	1294
Total	**2726**	**3536**	**439**	**6701**

2008

Survey Area (m^2)	**Sparse**	**Moderate**	**Dense**	**Total**
Outfall Study Area w/o Corridor	1324	2147	852	4323
Marine Outfall Corridor	69	39	35	143
Eelgrass Ref. Area w/o Corridor	1091	605	--	1696
Eelgrass Reference Corridor	339	194	--	533
Area Between Study & Ref.	868	576	347	1791
Total	**3691**	**3561**	**1234**	**8486**

3.0 Eelgrass Stockpile, Propagation and Transplant

For the past five years, a process of periodically harvesting eelgrass shoots from the Marine Outfall Corridor has occurred following guidelines established in the *Implementation Workplan* (King County, 2008). Propagation of plants taken from the Outfall Corridor eliminates the need to disturb an undisturbed natural eelgrass bed for the purpose of transplanting to another location; it also ensures that the same genetic population is restored to the site. A "bare-root method" was used where divers gently vibrate the roots by hand to loosen the substrate from around the rhizome and extract the rhizome with roots and blades attached. This method created minimum disturbance to surrounding plants and substrate. The harvested shoots were transported to the PNNL Marine Sciences Laboratory (MSL) in Sequim, Washington, where they were planted in outdoor tanks containing medium-grained sand similar to substrate at the project site and supplied with continuously flowing ambient, unfiltered seawater. Several techniques were used to increase the eelgrass population in the tanks to ensure an ample supply of plants for post-construction restoration planting. The number of shoots increased in the tanks over the years by 1) harvesting from the Outfall Corridor in 2004, 2006, 2007 and 2008, 2) vegetative reproduction through natural growth of the rhizome and root system, and 3) deposition of seeds by natural flowering of the plants. In May of 2009 a portion of the plants were transplanted back to the corridor after removal from the tanks. A description of the transplanting activities for the past five years is provided below.

3.1 Eelgrass Propagation: 2004-2008

A summary of the propagation and transplant activities is provided in Table 3. During early October of 2004, 305 shoots were harvested from the Marine Outfall Corridor by PNNL's scientific dive team and transplanted to the outdoor tanks at MSL. The shoots were counted one month later and at that time had declined 36%. This loss shortly after transplanting to a new area is not unusual. One year later, the plants had rebounded and 397 shoots were counted. No additional shoots were harvested that year. Approximately one year later in August of 2006, the shoot counts had increased significantly to 3,232, a 960% increase from the initial 2004 planting. The increase was primarily a result of vegetative reproduction in the propagation tanks and the spread of underground rhizomes and roots throughout the tank. An additional 1,500 shoots were harvested from the Outfall Corridor during August of 2006, bringing the total to 4,732 shoots. At that time all plants were moved to a larger diameter tank to better accommodate the expected growth and reproduction. The shoot count decreased dramatically the following year to only 974 shoots present during July 2007, with the probable cause of shoot loss due to transplant shock. An additional 490 shoots were collected from the Outfall Corridor at that time, bringing the total to 1,464 shoots. There was a 27 % increase during the next year with 1,856 shoots counted in May of 2008. Just prior to construction in the Marine Outfall Corridor, a majority of the plants (12,240) in the corridor were removed and transported to the MSL during the same month. Plants were bundled in groups of 10 shoots and transplanted by hand into the propagation tanks (Figure 6). The plants were held in the propagation tanks for approximately 1 year, when a large proportion of the plants were returned to the Outfall Corridor for transplanting and restoration.

Table 3 **Summary of Shoot Counts in Propagation Tanks, 2004-2009**

Assessment Date	**Number of Shoots Harvested and Planted**	**Number of Shoots and (change from previous count)**	**Comments** **(reason for increase or decrease)**
Oct 2004	305		Initial harvest and transplant to tank
Nov 2004		195 (-210)	Transplant shock and subsequent loss
Sept 2005		397 (+202)	Natural propagation
Aug 2006		3232 (+835)	Natural propagation
Aug 2006	1500	4732 (+1500)	Additional harvest and transplant to tank
July 2007		974 (-3748)	Transplant shock and subsequent loss
July 2007	490	1464 (+490)	Additional harvest and transplant to tank
May 2008		1856 (+392)	Natural propagation
May 2008	12,240	14,096 (+12,240)	Harvest of Marine Outfall Corridor
early May 2009		~18,000 (+3904)	Estimated natural propagation
May 18, 2009	~16,000 to outfall corridor	~2,000 remain in tank	Transplanted back to Outfall Corridor

Figure 7. **Transplanting eelgrass into MSL propagation tanks in May 2008 (left), and bundled eelgrass shoots ready for transplanting (right).**

3.2 Post-Construction Transplanting and Future Activities

Between July 2008 and mid-October 2008, construction activities below mean high water in the Marine Outfall Corridor, included the following components; shoring, trenching, placing the outfall pipes, backfilling the trenched area, and removal of shoring. To replicate pre-construction habitat conditions as closely as possible, the uppermost layer of substrate in the corridor was stockpiled separately during construction and returned after construction to the site. Eelgrass plants were returned to the site approximately seven months after construction early in the growing season to allow establishment of a healthy root system and to store energy for the following winter. On May 18th, 2009, approximately 16,000 eelgrass shoots were harvested using the bare-root method described above from the MSL propagation tanks. The leaves were trimmed to approximately 30 cm to facilitate handling and planting (Figure 8). Shoots were packed in coolers filled with seawater and transported to the outfall site where they were transplanted by Grette Associates divers. A portion of the shoots will remain at the MSL in reserve during the first year, and used as needed to fulfill the restoration guidelines outlined in the *Implementation Plan* (King County, 2008).

Figure 8. **Eelgrass ready for transplant at Marine Outfall Corridor, May 2009 (left), and recently transplanted in the Outfall Corridor, June 2009 (right).**

4.0 References

Grette Associates. 2006. *Eelgrass Program: 2006 Dive Survey Report*. Prepared for King County, Department of Natural Resources and Parks, Wastewater Treatment Division, Seattle, Washington.

Grette Associates. 2008. *Eelgrass Program: 2008 Eelgrass Dive Survey Report*. Prepared for King County, Department of Natural Resources and Parks, Wastewater Treatment Division, Seattle, Washington.

King County. 2008. *Eelgrass Restoration and Biological Resources Implementation Workplan* (revised April 2008). Prepared by Grette Associates, Battelle Marine Sciences Laboratory, and King County Department of Natural Resources and Parks. Seattle, Washington.

Woodruff, DL, AB Borde, JA Southard, NP Kohn, NR Evans, and RM Thom. 2006a. *First Annual Report: 2004 Pre-Construction Eelgrass Monitoring and Propagation for King County Outfall Mitigation*. PNNL-15678-1. Prepared by Pacific Northwest National Laboratory, Marine Sciences Laboratory, Sequim, Washington, for King County Department of Natural Resources and Parks Wastewater Treatment Division, Seattle, Washington.

Woodruff, DL, NP Kohn, SL Southard, MG Anderson, VI Cullinan, J Vavrinec. 2007a. *Third Annual Report: 2006 Pre-Construction Eelgrass Monitoring and Propagation for King County Outfall Mitigation*. PNNL-15678-3. Prepared by Pacific Northwest National Laboratory, Marine Sciences Laboratory, Sequim, Washington, for King County Department of Natural Resources and Parks Wastewater Treatment Division, Seattle, Washington.

Woodruff, DL, SL Southard, and JA Southard. 2006b. *2005 Pre-Construction Eelgrass Monitoring and Propagation for King County Outfall Mitigation.* PNNL-15678-2. Prepared by Pacific Northwest National Laboratory, Marine Sciences Laboratory, Sequim, Washington, for King County Department of Natural Resources and Parks Wastewater Treatment Division, Seattle, Washington.

Woodruff, DL, NP Kohn, VI Cullinan, SL Southard, J Vavrinec. 2007b. *Fourth Annual Report: 2007 Pre-construction Eelgrass Monitoring and Propagation for King county Outfall Mitigation*. Prepared by Pacific Northwest National Laboratory, Marine Sciences Laboratory, Sequim Washington, for King County Department of Natural Resources and Parks Wastewater Treatment Division, Seattle, Washington.

Distribution

No. of Copies		No. of Copies		
OFFSITE		**ONSITE**		
6	Kim Stark King County Department of Natural Resources and Parks Wastewater Treatment Division, Brightwater Project 201 South Jackson Street, Suite 503 Seattle, WA 98104-3855	6	Pacific Northwest National Laboratory	
			D.L. Woodruff	SEQUIM
			Information Release	K1-06

Pacific Northwest
NATIONAL LABORATORY

U.S. DEPARTMENT OF
ENERGY

902 Battelle Boulevard
P.O. Box 999
Richland, WA 99352
1-888-375-PNNL (7665)
www.pnl.gov