Island County

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MRC Action and Administration

Eelgrass Monitoring – aerial and video-based

Task 3.2

6/17/2011

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2010 Aerial and Underwater Videography Assessments of Eelgrass in Island County

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Overview

The objective of the eelgrass project is to monitor the health of eelgrass (*Zostera marina*, Zm) beds in Island County. The goal of the aerial and underwater videography segments of the project is to measure the area of our largest eelgrass beds in regions sensitive to damage from human or environmental threat. The primary regions of interest include Holmes Harbor, Penn Cove and Cornet Bay. Our strategies are: (1) to collect underwater video using sites and methods developed by the Washington State Department of Natural Resources (DNR) in selected regions of Island County and (2) to collect aerial photographs of submerged vegetation at very low tides for entire shoreline of the regions of interest. Our measures of success for this project are the completion of data collection and the analysis of the data such that we detect and communicate biologically significant changes in eelgrass bed areas.

This year nine DNR sites within Island County were selected with a particular emphasis on Penn Cove. The DNR provided the random transect point coordinates within each site that were used to navigate during our underwater video data collection. All of our data collection was completed by August, 2009 and our post-processing of all the data was completed in January 2011. Data collected from both aerial and underwater videography were combined in GIS maps to provide a more complete view of the site the results. This report contains completed assessments for the Freeland Park site at the south end of Holmes Harbor (swh0932), seven sites in Penn Cove (swh0888, swh0890, swh0892, swh0894, swh0896, swh0898 and swh0900) and Cornet Bay (flats29). For the first time we submitted our underwater video assessment data to DNR who was able to calculate quantitative estimates of eelgrass bed areas for each site. Our key findings this year by using the combination of aerial and underwater videography are: (1) Penn Cove contained much less eelgrass bed coverage than either Holmes Harbor or Cornet Bay, (2) both Holmes Harbor and Cornet Bay had similar eelgrass bed coverage between 2009 and 2010, and (3) one site in Holmes Harbor (swh0927) showed a focal spot of eelgrass loss that increased in size between 2009 and 2010 and appears to be linked to shellfish farming practices.

Methods

Aerial Photography

For a more detailed description of the tasks required to complete the aerial photography segment of this project see Appendix 1: "Aerial Photography Manual v1_1.doc". Briefly, overlapping vertical photographs of the shorelines of interest were taken from a small airplane using a wing-mounted camera controlled remotely from the cabin. The images were geo-tagged with the GPS data from the navigation system of the plane to identify the position of each photograph and markers were placed on a map for each photograph. Since sites require more than one image to cover the entire area, overlapping photographs were stitched together into a collective site image. The images for each site were then geo-referenced using ArcGIS 10 to a county map to allow comparison with other GIS data (underwater videography data primarily) and make accurate measurements of the size of features of interest.

Figure 1. Wing mounted Camera

Figure 2. View from 2500' over Useless Bay

Figure 3. Resolution of single photo over Holmes Harbor

Figure 4. Geo-referenced low-tide image of Holmes Harbor site swh0932.

Changes in the process from 2009 include: (a) some photographs were stored as RAW file format and converted to JPEG when needed, (b) no movies were created, but the equivalent view was produced by rapidly scrolling through photograph icon sequences in Mac OS X Finder Cover Flow folder display option.

Underwater Videography

For a more complete description of our underwater videography method, see Appendix 2: "Underwater Videography Manual by Task.doc". Briefly, our method is modeled after techniques developed by WDNR (Jeff Gaeckle) to collect underwater video of shoreline vegetation at depths from approximately 3 feet to about 25 feet below the surface of the water at medium tide levels. Data is collected by recording underwater video and GPS & depth finder information while navigating a small boat slowly (0.5 knots) along transect lines that are perpendicular to the median line of the transect points defined by DNR. Data for ten to fifteen transect lines are collected for each site. Our equipment diagram is shown below:

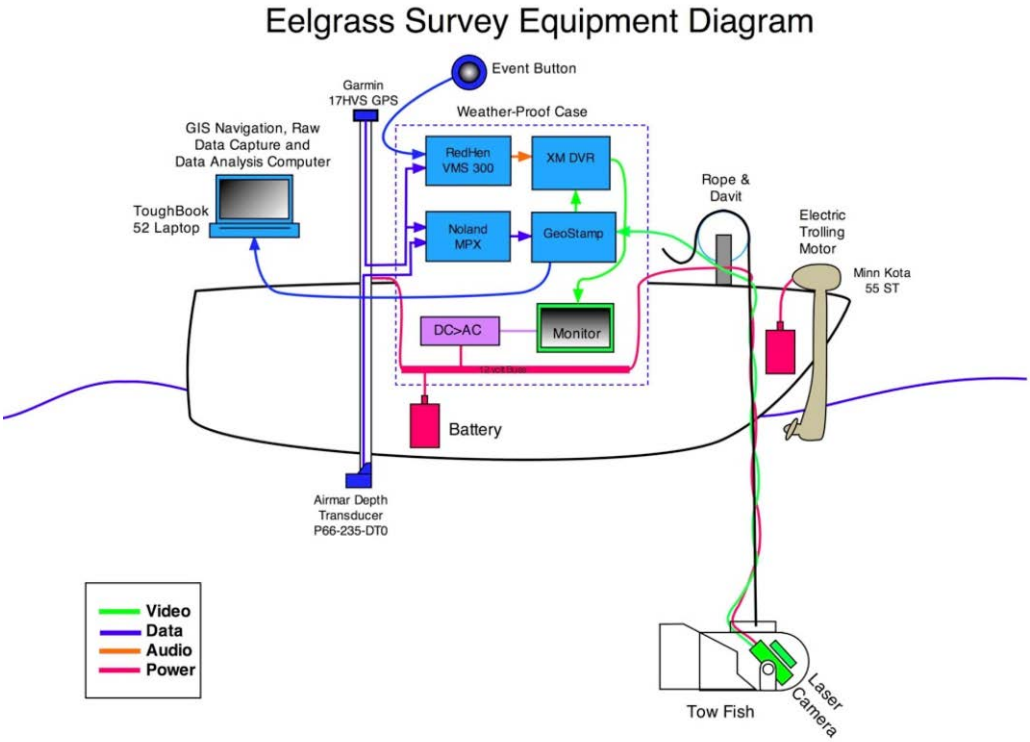


Figure 4. Equipment diagram for Beachwatcher's underwater video data collection.

Figure 5. Boat used for Beachwatcher's underwater video data collection.

Once the video, GPS and depth data have been collected into a tracklog file, the file is processed into spreadsheets that can be displayed as XY data on GIS maps. To determine the area of eelgrass coverage, volunteers review the video and record their scores for the presence or absence of eelgrass in the spreadsheets. An assessment of video quality is also recorded to indicate places where eelgrass identity could not be determined due to poor positioning of the camera above the seabed by the camera operator or poor underwater visibility. The scores of the reviewers are then displayed in GIS maps and the resulting spreadsheets and sampling polygons are analyzed by DNR to estimate eelgrass bed areas. Complete results of DNR calculations are returned to us in spreadsheet form.

Changes to the process from 2009 include: (a) video data collection was started at the beginning of a transect line and stopped at the end. This process created a separate file for each transect line and eliminated the need to create video clips for each transect line in Mediamapper. Video processing in Mediamapper had proven to degrade video quality and was very time consuming, (b) Spreadsheets were generated by extracting transect data from tracklog data files using start and stop times from overlay displays on the video files rather than using Mediamapper's geo-tagged video information.

Experimental Design

In 2009 we focussed our data collection by performing underwater video studies in 8 sites in Holmes Harbor and one site only in Cornet Bay and Penn Cove. In 2010 we shifted our focus by collecting data in 7 sites in Penn Cove and one site each in Cornet Bay and Holmes Harbor. Both years aerial photographs were taken for the entire shorelines of all three regions. Below are maps of the DNR's underwater video transect points within the sites studied for 2010.

Figure 6. Underwater videography sampling sites in Penn Cove for 2010

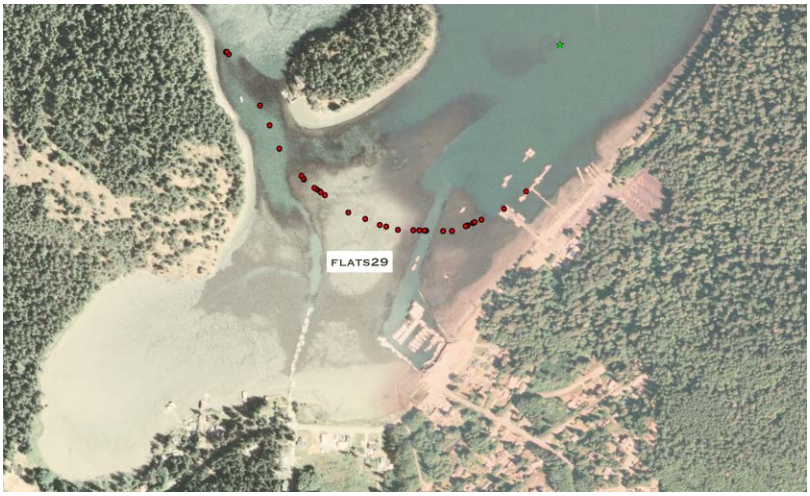


Figure 7. Cornet Bay site

Figure 8. Holmes Harbor site swh0932

The map of Holmes Harbor (Figure 8) shows the one site (red, swh0932) for which underwater videography was performed in 2010 and additional sites that were studied in 2009 (green). By inspection of aerial images between 2009 and 2010, the Honeymoon Bay (swh0927) became a site of interest (See results).

Results

The following table summarizes our progress from June, 2010 to the present against all the tasks (see Method attachments) identified for the program:

Progress for 2010 Aerial and Underwater Videography Eelgrass Project

		Transects for 2010									
Task	Appendix	swh0888	swh0890	swh0892	swh0894	swh0896	swh0898	swh0900	swh0932	flats29	Where data is stored; Notes
Aerial											
Taking Photos	A1	✓	✓	✓	✓	✓	✓	✓	✓	✓	Iomega,ED mini)\2010\Aerials.2010\6-12 & 7-24\IMG_0XXX
Geo-tagging Photos	A2	✓	✓	✓	✓	✓	✓	✓	✓	✓	9Gb of images
Stitching Photos	A3	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Georeferencing Images	A4	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Making Movies	A5										Not done this year; but can be displayed as sequence in Finder
Analyzing	A6										Only swh0927 was analyzed for eelgrass bed damage
Videography											
Import DNR TP	V1	✓	✓	✓	✓	✓	✓	✓	✓	✓	SVMP 2010/DNR Files/RTP
Draw T. Lines	V2	✓	✓	✓	✓	✓	✓	✓	✓	✓	MediaMapper
Equipment Setup	V3	✓	✓	✓	✓	✓	✓	✓	✓	✓	Equip. issues: DVD>DVR
Collect Data	V4	7/16,17	7/16	7/30	7/19,30	7/19	7/2	6/17	7/31	8/3	Collection Date(s) (m/d)
Store Video	V5	6.6Gb	2.9Gb	2.5Gb	4.4Gb	3.1Gb	3.2Gb	2.8Gb	5.7Gb	6.8Gb	Iomega,ED mini)\2010\mmddyy\(MPEG2/DVD)
Store Tracklog	V6	✓	✓	✓	✓	✓	✓	✓	✓	✓	SVMP.2010\mmddyy\mmddyy.txt to external drive
Import Data to MM	V7	✓	✓	✓	✓	✓	✓	✓	✓	✓	Doc&Set\Eelgrass\My Documents\Map Library\2010\
Record Notes/Report	V8	✓	✓	✓	✓	✓	✓	✓	✓	✓	QuickReport.2010.doc
Make Transect Clips	V9	Not require this year due to change in recording procedure to create one file for each transect									
Export Transect SHP	V10	✓	✓	✓	✓	✓	✓	✓	✓	✓	SVMP.2010/SHP2010/transect_namedbf/*.dbf
ArcMap	V11	✓	✓	✓	✓	✓	✓	✓	✓	✓	SVMP.2010/(Comet Bay, Penn CoveN, Penn CoveS, Holmes HarborS).mxd
Translate Tracklog	V12	✓	✓	✓	✓	✓	✓	✓	✓	✓	SVMP.2010/Site/transect name_mmddyy.csv
Create Spreadsheet	V13	✓	✓	✓	✓	✓	✓	✓	✓	✓	SVMP 2010/transect name_mmddyy.xls
Video Analysis	V14	✓	✓	✓	✓	✓	✓	✓	✓	✓	SVMP 2010/Site/transect name_mmddyy_8.xls
Map Results	V17	✓	✓	✓	✓	✓	✓	✓	✓	✓	SVMP.2010/(Comet Bay, Penn CoveN, Penn CoveS, Holmes HarborS).mxd
Measurements	V15	✓	✓	✓	✓	✓	✓	✓	✓	✓	Data submitted to DNR in specific format
Calc. Eelgrass Area	V16	✓	✓	✓	✓	✓	✓	✓	✓	✓	Results received from DNR
Reports											
Semi-Annual	✓					MRC/NWS/NOAA					January 12, 2011
Presentation	✓					Sound Waters					February 5, 2011
Presentation	✓					MRC					May 5, 2011
Final Report	✓					MRC/NWS/NOAA					June 18, 2011

Table 1. Progress Chart showing completion of 2010 Tasks

Data Acquisition Report

A document was created to log each outing and map the tracklog of the boat's path and video acquisition shortly after the event and before any data analysis had begun (see Appendix 3: "QuickReport.2010.doc"). This was done to provide a quick inspection and report of the data collection event.

Video Analysis

Analyses of the underwater video for the presence of eelgrass were completed in early November, 2010 using DVD's and spreadsheets produced in late October. The resulting Excel files containing the eelgrass scores for each site are attached (see Appendix 4: "Video Analysis Files"). Scoring of the sites was done according to the list below:

Site ID	Volunteer
flats29	Bob Gentz
swh0932	Jan Holmes
swh0888	Gregg Ridder
swh0890	John Johnson
swh0892	Lili Yocum
swh0894	Lili Yocum
swh0896	Neal Clark
swh0898	Gregg Ridder
swh0900	Neal Clark

Table 3. Schedule of Video Analysis Volunteers

Data Analysis by DNR

The Video Analysis Files were reformatted to DNR specifications and submitted to Jeff Gaeckle (DNR) for analysis of eelgrass bed areas and depth limits using their validated analysis programs. The results were reported to us in spreadsheets contained in the Appendix 5: "SWH_Beachwatchers_Zm_results.xlsx".

A brief summary of selected parameters from the DNR report is shown below:

AREA

Site Information			Number of Transects		Area (10^6 ft^2)		
Name	ID	Date	n	n Zm+	Sample	Zm	95% ci
Cornet Bay	flats29	08/03/10	10	10	4.03	1.927	0.405
Penn Cove Park	swh0888	07/17/10	12	12	1.55	0.757	0.174
W. Fossil Bay	swh0890	07/16/10	12	1	0.69	0.000	0.001
Penn Cove Shellfish	swh0892	07/30/10	9	1	0.71	0.004	0.008
Twin Lagoon	swh0894	07/30/10	12	2	0.89	0.002	0.004
Penn Cove Shellfish S.	swh0896	07/19/10	11	0	0	0	
Coupeville	swh0898	07/02/10	12	8	0.86	0.107	0.065
NE Moore Pl, Penn Cove	swh0900	06/17/10	11	6	0.76	0.139	0.121
Freeland County Park	swh0932	07/31/10	12	12	2.40	1.618	0.133

Table 4. Areas of Eelgrass Beds by Site (Calculated by DNR from submitted videography data)

Depth

Site Information			Number of Transects		Zm Depth (ft)			
Name	ID	Date	n	n Zm+	Mean Deep	Deepest	Mean Shallow	Shallowest
Cornet Bay	flats29	08/03/10	10	10	17.9	21.3	5.0	0.0
Penn Cove Park	swh0888	07/17/10	12	12	12.7	19.9	2.4	0.0
W. Fossil Bay	swh0890	07/16/10	12	1	10.0	10.0	10.0	10.0
Penn Cove Shellfish	swh0892	07/30/10	9	1	7.7	7.7	6.1	6.1
Twin Lagoon	swh0894	07/30/10	12	2	14.3	16.4	13.4	12.2
Penn Cove Shellfish S.	swh0896	07/19/10	11	0				
Coupeville	swh0898	07/02/10	12	8	7.7	8.7	3.7	0.0
NE Moore Pl, Penn Cove	swh0900	06/17/10	11	6	11.4	13.4	5.7	4.4
Freeland County Park	swh0932	07/31/10	12	12	18.8	22.0	0.0	0.0

Table 5. Depth Limits of Eelgrass Beds by Site (DNR calculations from submitted videography data)

The results for the Mean Shallow and Shallowest Zm Depth for Freeland County Park are incorrect due to an error yet to be identified.

Mapping of Results

The Video Analysis Files were imported into ArcGIS 10 and mapped onto aerial images that were geo-referenced to each site map. The data were displayed as: (a) yellow lines are sampling polygons, (b) green lines represent the presence of Zm, and (c) white lines represent the absence of Zm. The resulting maps are shown for each site below:

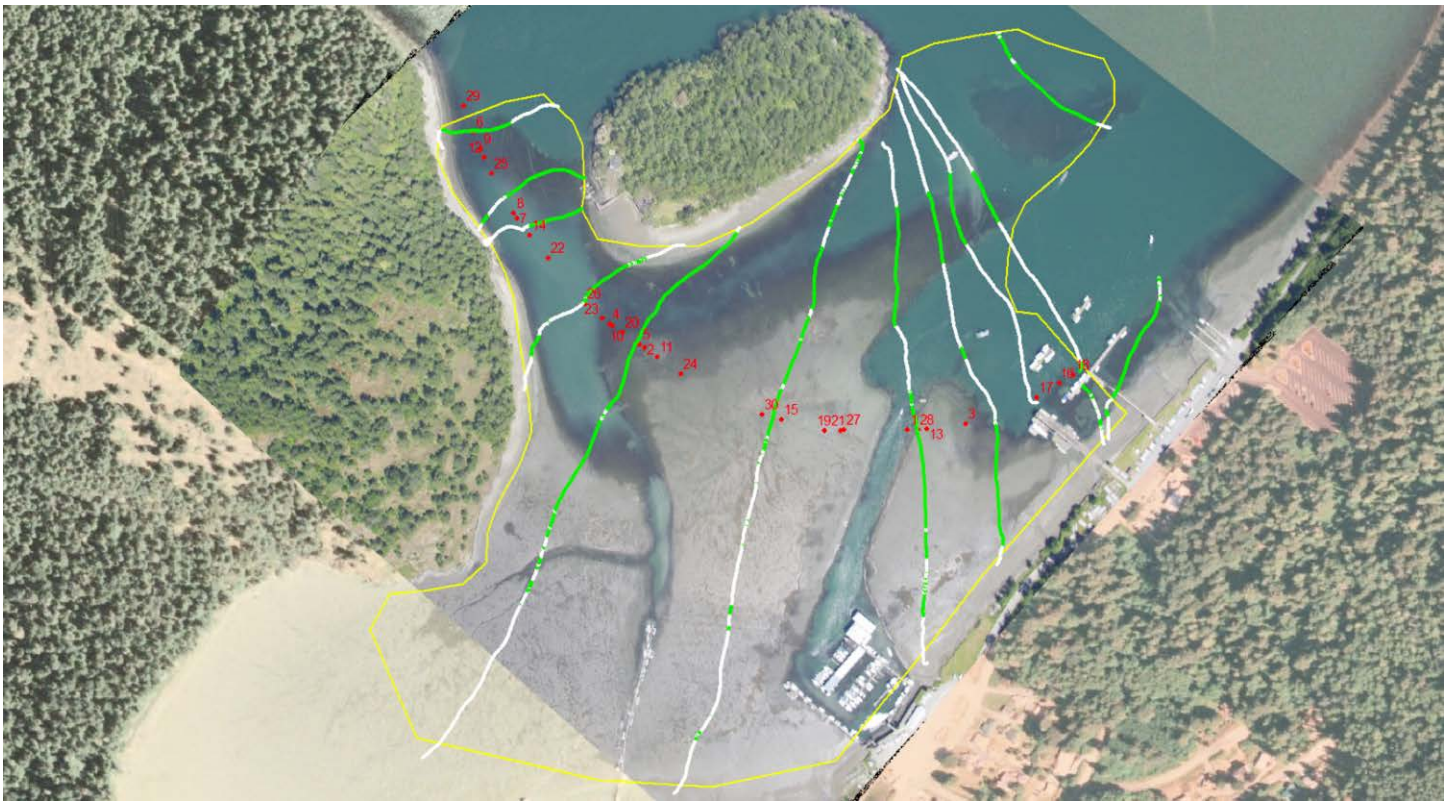


Figure 9. Flats29 (Cornet Bay)

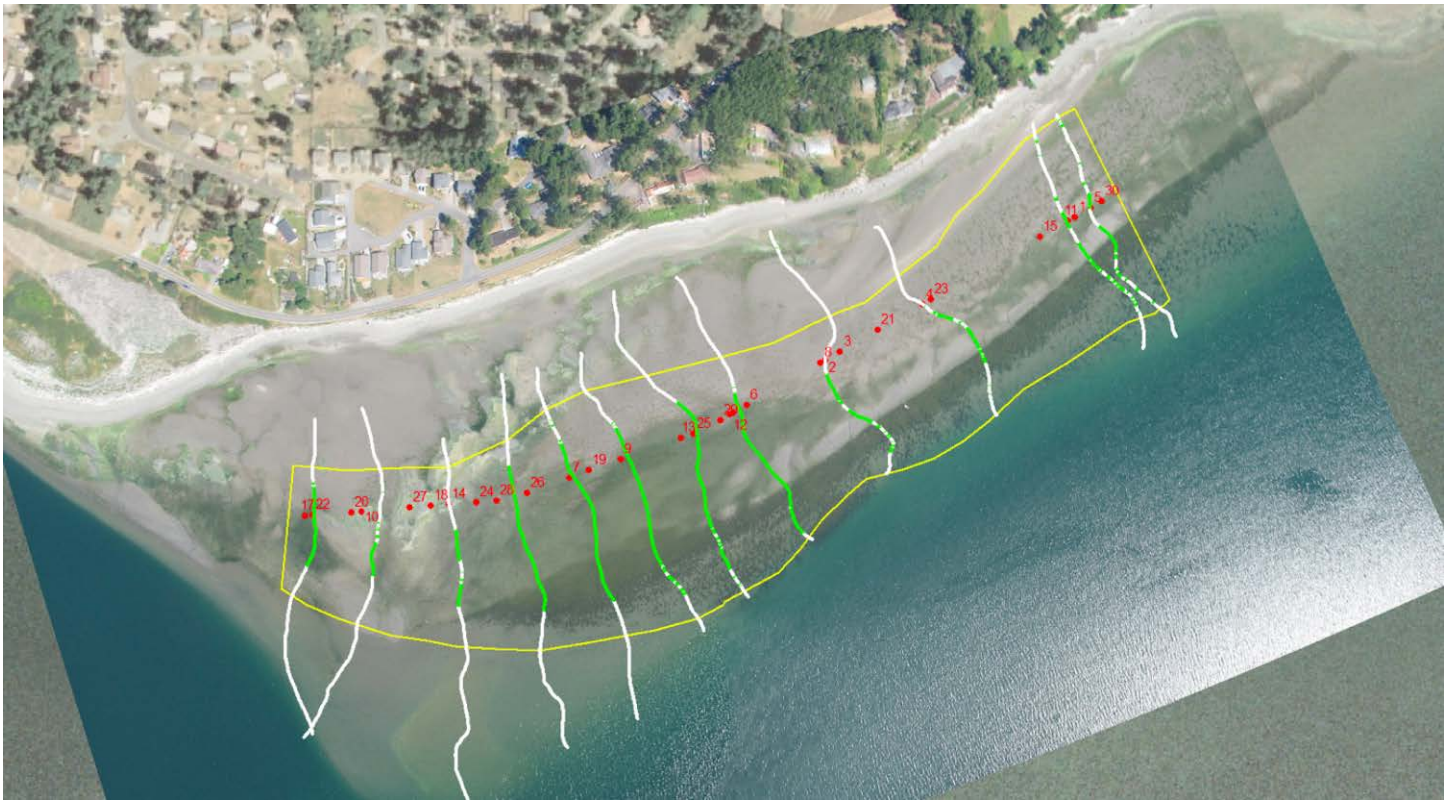


Figure 10. swh0888 (Penn Cove - Penn Cove Park)

Figure 11. swh0890 (Penn Cove – West Fossil Bay)

Figure 12. swh0892 (Penn Cove – Penn Cove Shell Fish)

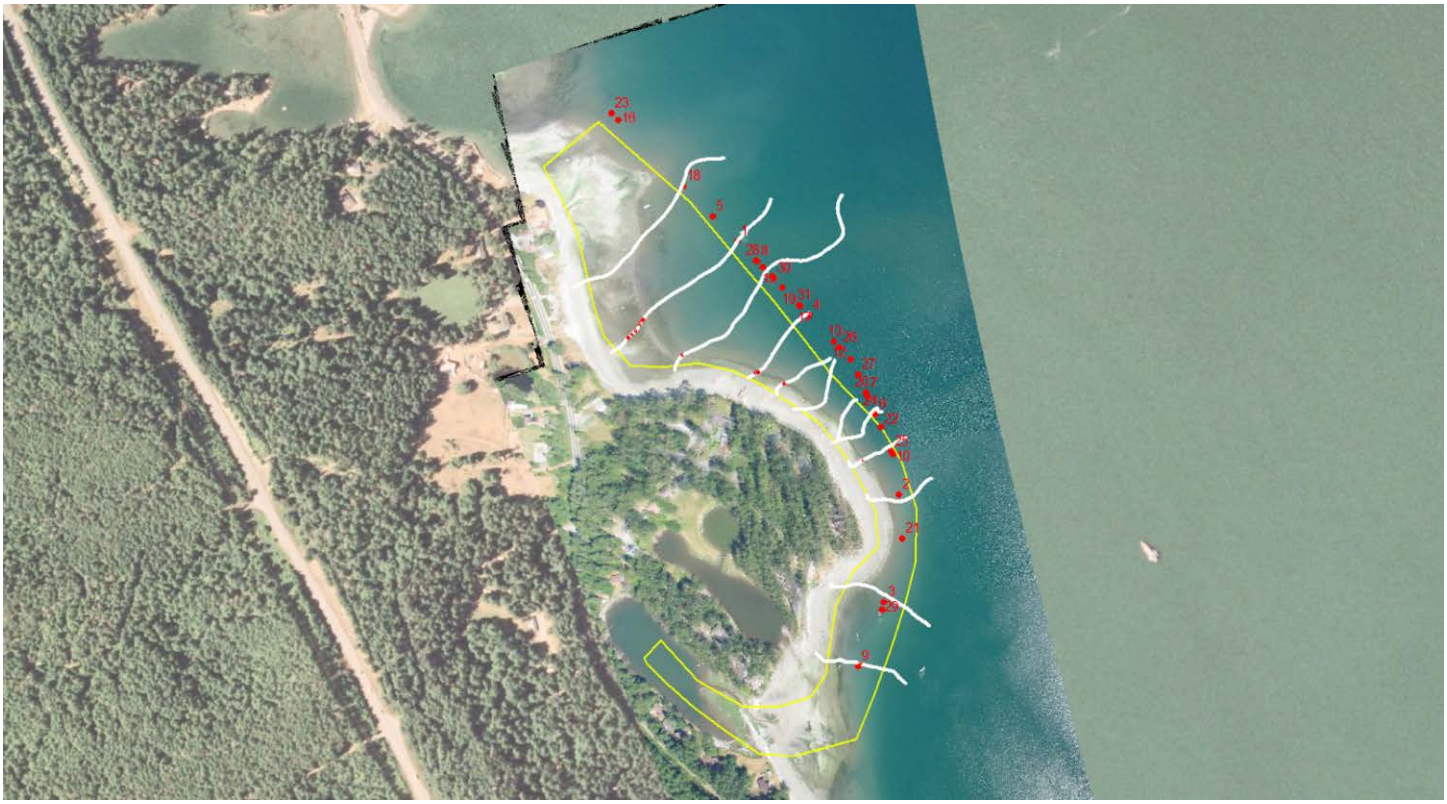


Figure 13. swh0894 (Penn Cove – Twin Lagoon)

Figure 14. swh0896 (Penn Cove – Penn Cove Shellfish South)

Figure 15. swh0898 (Penn Cove – Coupeville)

Figure 16. swh0900 (Penn Cove - NE Moore Pl)

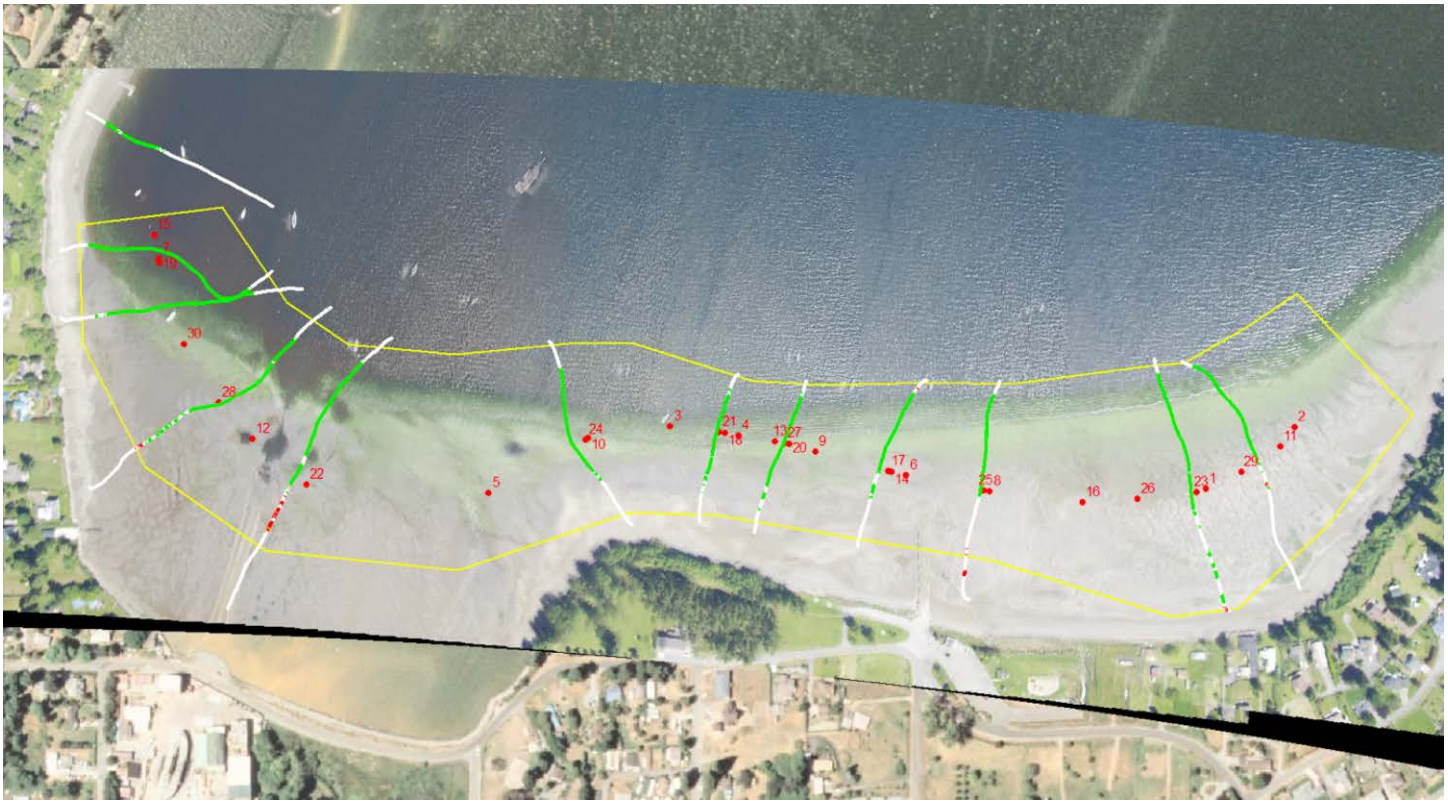


Figure 17. swh0932 (Holmes Harbor – Freeland Count Park)

Cornet Bay Observations

Several issues become apparent when looking at the aerial photographs of Cornet Bay (Figure 10) at higher resolution (see Figures 18-22). First, there are several long, thin streaks through the eelgrass that look like propeller scars of boats motoring through it and second, there are small patches of eelgrass damage that look like anchor scour (Figure 18, personal communication from both Sandy Wyllie-Echeverria and Jeff Gaeckle).

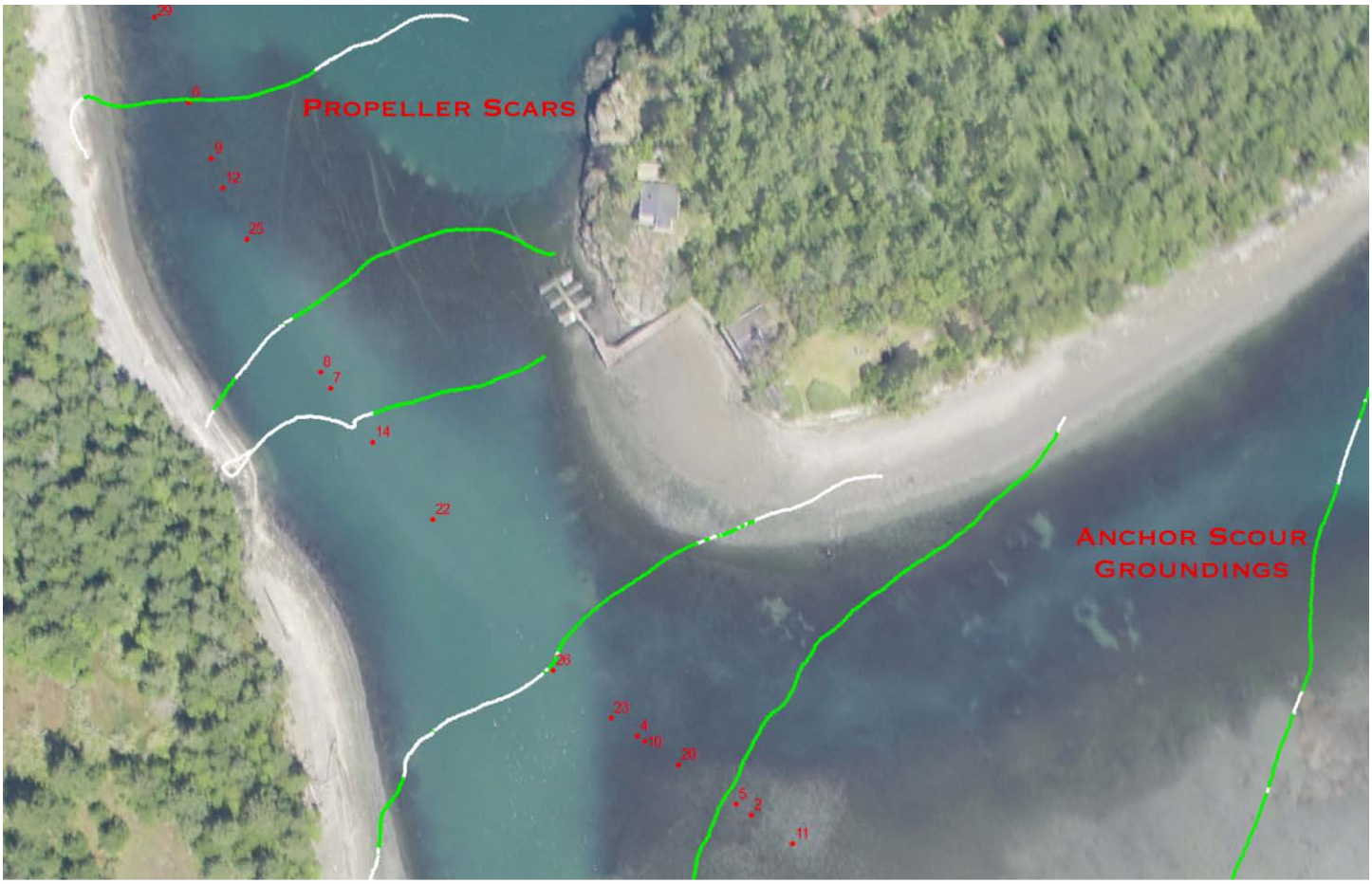


Figure 18. Higher resolution image of Figure 10 showing examples of eelgrass damage

Underwater videos of transect line (green/white line 2nd from the top in Figure 18) show the camera crossing propeller scars (e.g. at 12:52:07,12:52.15, and 12:53:10). These scars are too narrow to be scored as breaks in eelgrass beds by underwater videography.

(Play Movie "flats29_080310_ClipABC.mpg" in the Support Files folder)

Since aerial photographs were taken of Cornet Bay in 2009 and 2010, a comparison of two geo-referenced images shows the persistence of assumed damage already done by 2009 and new damage done since 2009 (examples in red circles).

Figures 19 (top) and 20 (bottom) show persistence of damage below island and new damage (red circles)

The dock area at Cornet Bay also shows persistent areas of suspected damage from boating activity.

Figures 21 (top) and 22 (bottom) Possible damage from boat activity near dock

Penn Cove Observations

Our primary observation of eelgrass beds in Penn Cove is "Where are they?" Only a one site has an eelgrass bed that compares with beds found in Holmes Harbor and Cornet Bay (swh0888), two have only very small beds (swh0898 and swh0900) and most have basically no eelgrass at all (swh0890, swh0892, swh0894 and swh0896). Comparison of aerial images of the Penn Cove shoreline at low tide show no obvious differences between 2009 and 2010.

We did observe an unusually large number of green sea urchins in videos where eelgrass was sparse.

(play movie "swh0896_071910_6_ClipA.mpg" in the Support Files folder)

Holmes Harbor Observations

Comparing both aerial and underwater video data from 2009 and 2010 for the Freeland Park site (swh0932) shows no obvious differences. Overlaying the transect data from the two years shows no significant trends.

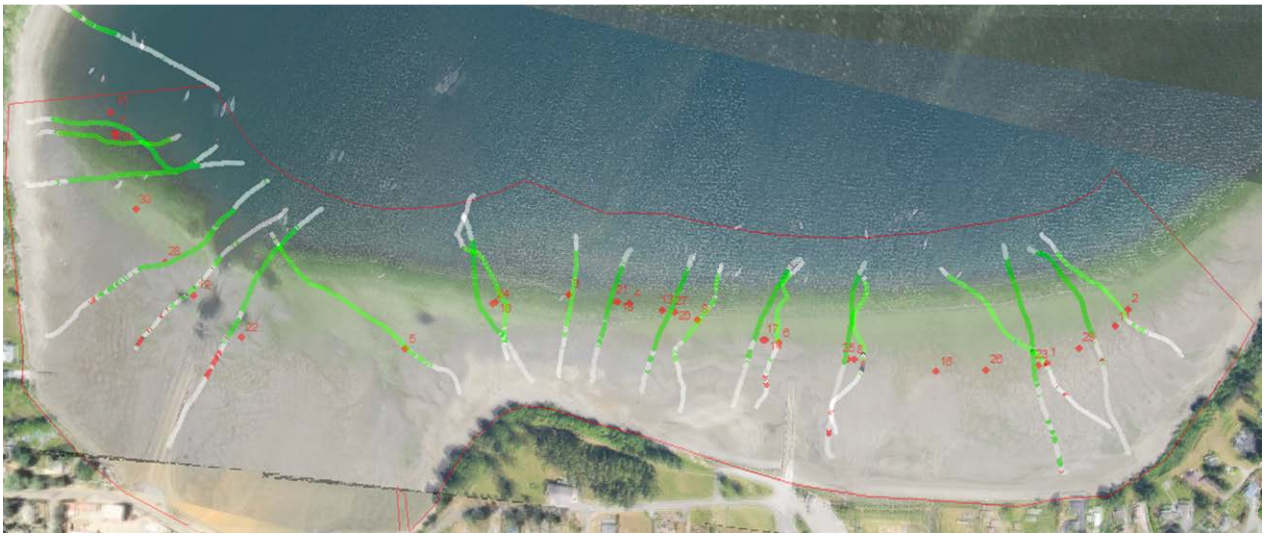
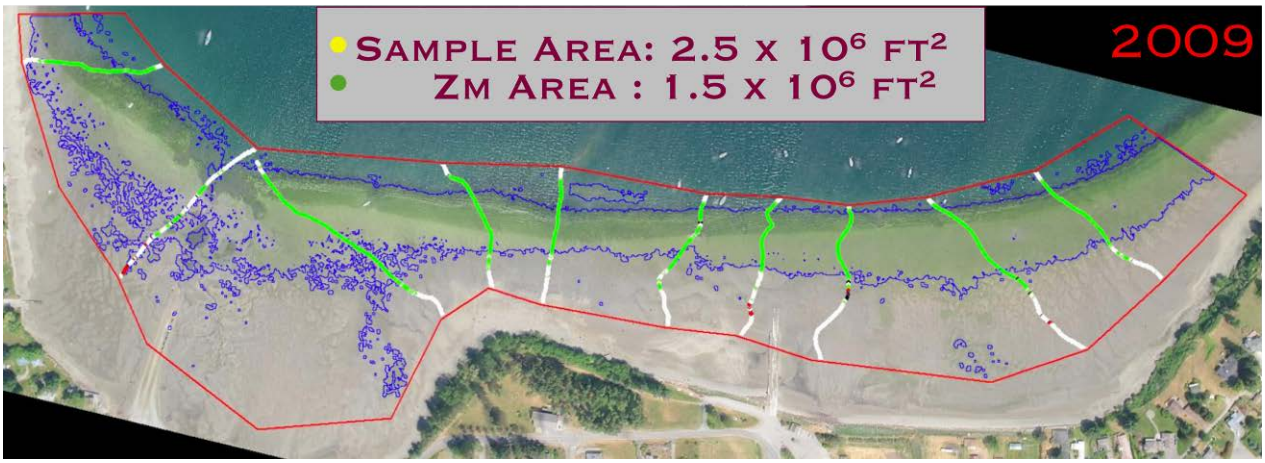
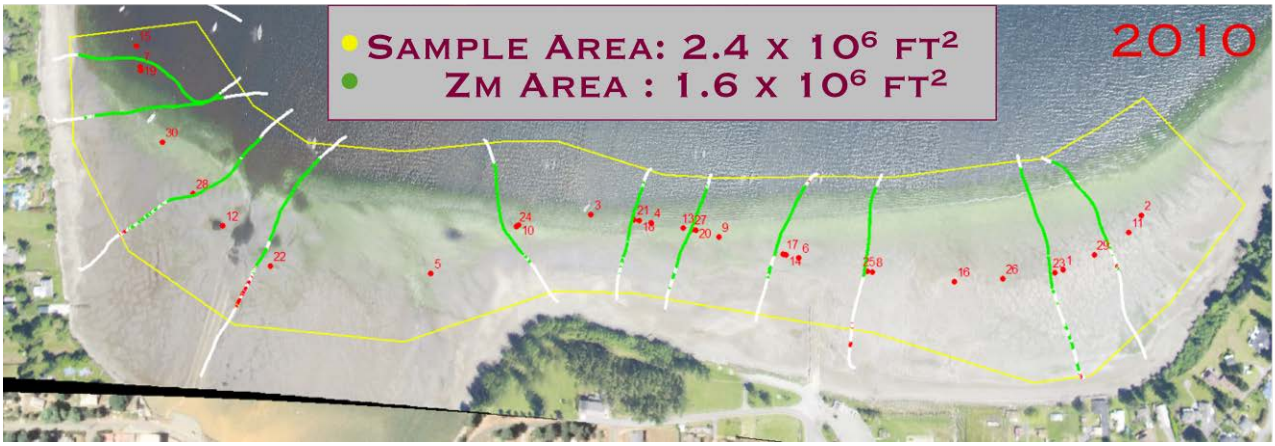


Figure 23. Overlaid eelgrass beds transect line analyses for 2009 and 2010





Figures 24 (top) and 25 (bottom). Quantitative assessment of Zm eelgrass bed areas by our estimation (2009) and by DNR's estimation (2010) show no differences between the years.

Aerial photographs of the complete shoreline of Holmes Harbor are remarkably similar between 2009 and 2010 with one exception. Near Honeymoon Bay (swh0927) there appears to be a significant loss of eelgrass that is larger in 2010 than in 2009. Geo-referenced images of the 2009 and 2010 photographs were made and the area of damage was traced and measured in ArcMap (see Figure 26).

Figure 26 (top) and 27 (bottom). Images show growth of eelgrass damaged area from 2009 to 2010.

Underwater video from 2009 transects (green line) across the white rectangles to the right of the dock show these are shellfish beds. The blank areas of the third transect to the right of the dock show a bottom littered with empty shells. Unfortunately the outlined area in question was not observed in the 2009 underwater video.

Conclusions

We completed the analysis of all the data (aerial and underwater videography) gathered in 2010. From the results we have reached a number of conclusions:

• Cornet Bay has extensive eelgrass beds and damage from boating activity is suspected. Jack Hartt (Park Manager, Deception Pass State Park) is using the data presented here to as a tool to educate boaters.

• Penn Cove has relatively few eelgrass beds and an unusual number of green sea urchins. These finding are consistent with an earlier report from 2001 ("Videographic Eelgrass Survey of Island County Selected Areas Final Report", Norris JG and Wyllie-Echeverria S, 2001). The roles of sea urchins, human activity and habitat condition related to the few eelgrass beds are unknown.

• The Freeland Park site (and Holmes Harbor in general) has extensive eelgrass beds. With only one exception, no difference between 2009 and 2010 in Holmes Harbor is observed.

• The Honeymoon Bay site in Holmes Harbor appears to have a growing focal spot of eelgrass loss presumably related to shellfish farming.

• This was the first year we have generated validated, quantitative estimates of eelgrass bed areas and depth limits with the help of DNR. We hope to make this a permanent part of our process.

• We will continue to improve: (1) underwater video data collection and analysis processes to be more efficient and (2) aerial photography by eliminating sun glare and transmitting photographs from the camera to the cockpit during flight.

• In 2011 our focus will be to sampling new areas based on discussions with ICMRC and DNR while monitoring one site each in Cornet Bay (flats29), Penn Cove (swh0888) and Holmes Harbor (swh0932). These areas include Dugualla Bay, Utsalady Bay, Langley Marina, Clinton Ferry Dock, Maxwelton Beach and Possession Shores.

Acknowledgements

We'd like to thank all our volunteers who have helped us gather so much high quality data. Our core group (Ken Urstad, Jan Holmes, Neal Clark and Gregg Ridder) is very appreciative for the help and guidance by a variety of experts in this field, especially Jeff Gaeckle (DNR) and Sandy Wyllie-Echeverria (Friday Harbor Labs). We also thank DNR for providing us with geographic coordinates and diagrams that allowed us to collect data. We especially want to thank Jeff Gaeckle for providing quantitative estimates of eelgrass bed areas and depth limits from our data this year. We also acknowledge the staff support of WSU Beachwatchers, especially Lynette Goodell , for helping us acquire needed materials and equipment. Finally, we thank the Island County Marine Resource Council and Rex Porter for their enthusiastic support for the project. The project , of course, would not have been possible without the funding support provided by the Northwest Straits and NOAA; thank you!

Gregg Ridder

6/13/11