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2018 & 2019 Aerial and Underwater Videography Assessments of Eelgrass in Island County

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Overview

The objective of this eelgrass project is to monitor the health of eelgrass (*Zostera marina*, *Zm*) beds in Island County. The goal of the project is to measure the area of our largest eelgrass beds in regions sensitive to damage from human activity or environmental stress. Our strategies are: (1) to select sites within Island County, as defined by the Washington State Department of Natural Resources (WADNR), that are of interest to Island County Marine Committee (ICMRC) and WADNR (2) to collect underwater video using methods developed by WADNR, (3) to collect aerial photographs of vegetation at extreme low tides for entire shoreline in regions of interest, (4) to analyze the data and present the results using GIS mapping techniques and (5) to communicate the results as an oral presentation to the ICMRC and as a written report to the NW Straits Commission. Our measure of success for this project is communication of the current status and biologically significant changes in the area of eelgrass beds in Island County. Delivery of this report and the associated data in GIS format completes the project for 2018 and 2019.

We began our underwater videography effort in 2008 with establishing our methods and started surveying multiple sites in 2009. Since then we have conducted 89 surveys including 40 different sites. However, after eleven years our team has decided to discontinue underwater videography due to the age of the equipment and members. The ICMRC may want to establish a new underwater videography team in the future, but at present there is no plan to do so. The results presented here are our last underwater video surveys of our core sites - Cornet Bay (flats29), Monroe Landing (swh0888) and Holmes Harbor (swh0932) in 2018 and of Cornet Bay alone in 2019.

The aerial survey of the entire Island County shoreline was completed for both 2018 and 2019 will be done for a few more years. The aerial surveys in 2019 were all flown at 4500' for the first time (instead of the usual 2500') to accommodate the increased military jet traffic from NAS Whidbey. The effect on the aerial photo resolution was surprisingly slight. With discontinuing the underwater video data collection, a new method for identifying eelgrass needs to be established since it cannot be differentiated from other vegetation in our aerial photos. Either walking surveys at low-low tides, spot-checking with an underwater camera from a new boat or perhaps higher resolution drone photos may be required.

Maps depicting both underwater video assessments and geo-referenced aerial photographs were prepared for all four sites, and bed area estimates were calculated from the underwater video analysis results. Of the core sites, Monroe Landing (swh0888) and Freeland Park (swh0932) continue to have stable bed areas. Monroe Landing shows some redistribution of eelgrass within the site as in previous years, but the overall area is basically unchanged.

For Cornet Bay (flats29) the measurements were similar in both 2018 and 2019 to our last measurement in 2017. This confirmed the end of a seven-year downward trend from 2011 to 2016 in eelgrass bed area measurements. By aerial inspection we continue to see local damage to eelgrass beds by boating activity, but do not believe this is a significant factor in the overall eelgrass bed area loss as measured by underwater videography.

We were again fortunate to have the opportunity to investigate sonar mapping in 2018. Albert Foster acquired data for all three sites in late June. He provided the sonar map of Cornet Bay to evaluate the utility of the method. Unfortunately that map identified a new (to us anyway) issue that decreased our confidence in obtaining reproducible results.

Methods

Underwater Videography

A complete description of our underwater videography method has been defined in the attached document: "Underwater Videography Manual v1_5.doc". Briefly, our method is modeled after techniques developed by WADNR 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:

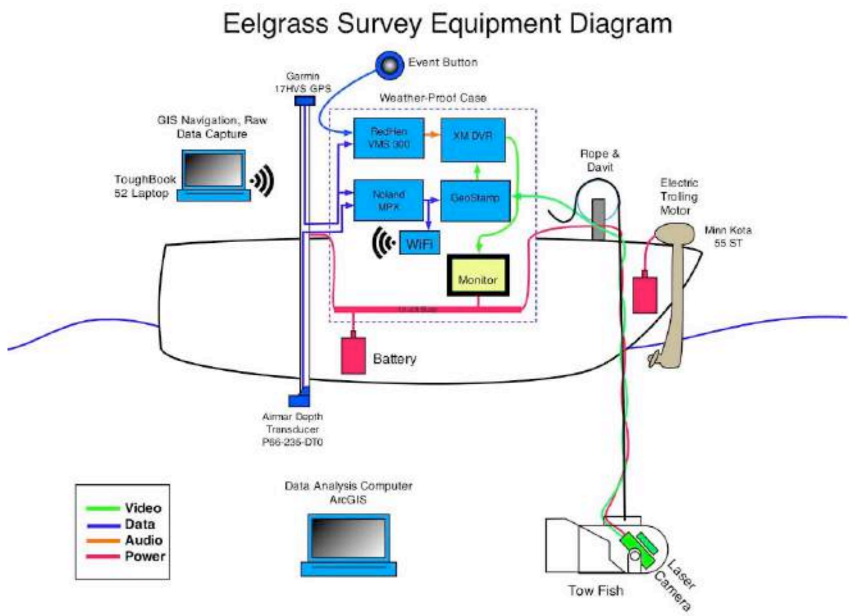

Figure 1. Equipment diagram for Beachwatcher's underwater video data collection.

Figure 2. Boat used for ICMRC team's underwater video data collection.

Once the GPS and depth data have been collected into a tracklog file, the file is processed into spreadsheets (.CSV format) that can be displayed as XY data on GIS maps. To determine the area of eelgrass coverage, volunteers review the video files and record their scores for the presence or absence of eelgrass into the corresponding Video Analysis 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 used by WADNR (Lisa Ferrier) to estimate eelgrass bed areas. Complete results of DNR calculations are returned to us in spreadsheet form. Alternatively, we have developed a method (described in previous years) to calculate the eelgrass bed areas ourselves.

Aerial Photography

A detailed description of the tasks required to complete the aerial photography segment of this project have been defined previously in the attached document: "Aerial Photography Manual v1_1.doc". Briefly, overlapping orthogonal 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 to a base map using ArcGIS 10 (usually ESRI Satellite maps) to allow comparison with other GIS data (underwater videography data primarily) and to make accurate measurements of the size of features of interest.

Figure 3. Wing mounted Camera

Figure 4. View from 2500' over Useless Bay

Figure 5. Resolution of single photo over Holmes Harbor

Figure 6. Geo-referenced low-tide site image of Holmes Harbor site swh0932.

The iPhone program, "Guru Maps" (formerly "Galileo"), was used along with an external GPS (Dual XGPS170) to navigate the airplane along the shoreline. This provided navigation and a tracklog in GPX format to more easily geotag all the photographs after the flights.

Sonar Mapping

As a member of the eelgrass team since 2016, Albert Foster, provided us with a new method for measuring underwater vegetation using consumer grade sonar products from Navico Lowrance (now a CMAP company). Our intention was to investigate the feasibility of this method by comparing sonar maps to maps from aerial and underwater video at the same sites. Albert provided the boat, hardware and $2,500 annual subscription to the BioBase sonar data processing service (https://www.biobasemaps.com/) as well as his donated time and expenses to single handedly collect and process the data (see Figure 7). The hardware consisted of the Lowrance HDS-9 GEN 3 chartplotter with transom mounted Lowrance HST-WSBL/HST-WSU 200/83kHz sonar transducer (see Fig. 7 lower diagram) and transom mounted Simrad GPS antenna. Hardware settings for sonar data collection in .sl2 file format per BioBase instructions.

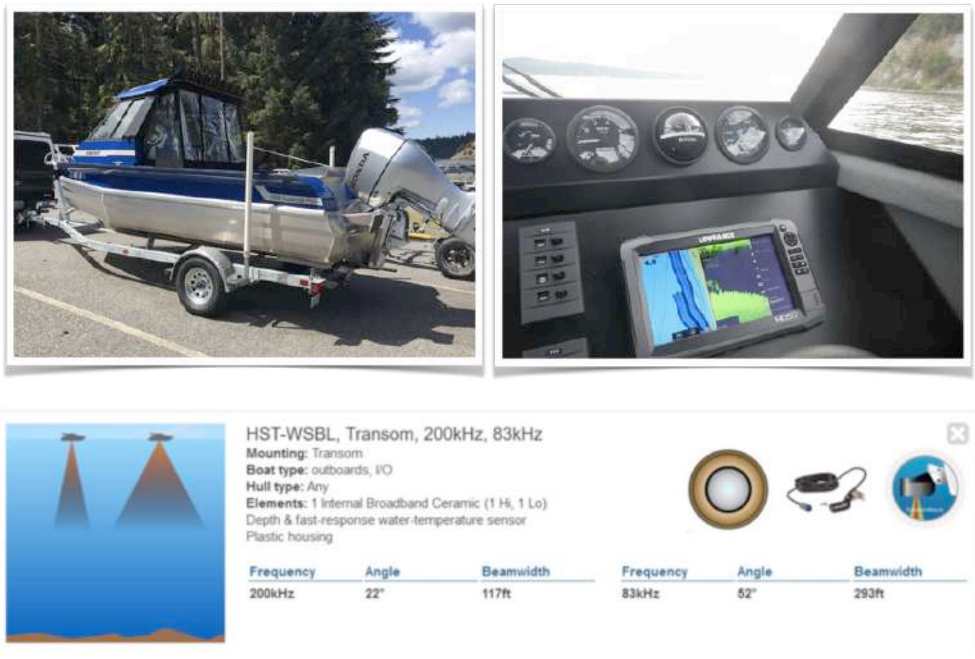

Figure 7. Albert Foster's Boat and Lowrance sonar mapping system.

A brief description of the method is provided. At one second intervals a scanned line of data points were collected containing measurements of latitude, longitude, depth of the seafloor and % of that depth occupied by vegetation. The line of data points were perpendicular to the boat transom and roughly 25 feet either side of the sonar transducer (see left diagram in Figure 8). Albert navigated his boat at approximately 5 knots such that the data lines overlapped, akin to mowing a lawn (see red lines in upper right diagram in Figure 8). From all the overlapping data points, the offline BioBase data service later calculated maps of the seafloor contour (see blue map in upper right diagram in Figure 8) and of the vegetation (see lower right diagram in Figure 8).

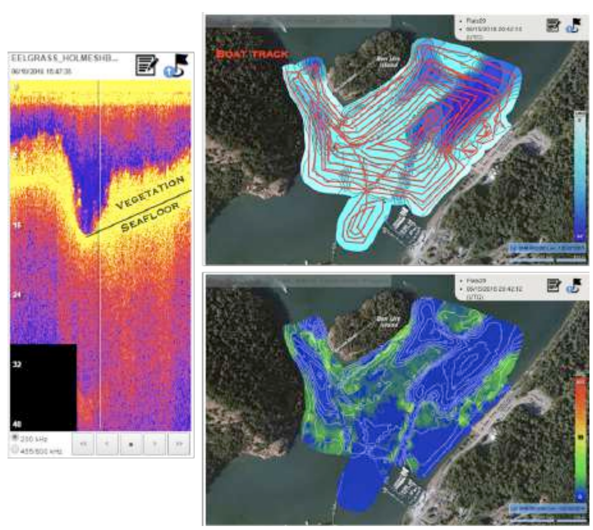

Figure 8. Raw sonar data (left), Boat track and seafloor contour map (upper right) and vegetation map with contour lines (lower right).

Data Presentation

The Video Analysis spreadsheet files were imported into ArcGIS 10 and mapped onto aerial images that were geo-referenced to each site's basemap (Google). The underwater video assessment data (see Figure 9 left image) are displayed as: (a) white lines represent the absence of all eelgrass, (b) green lines represent the presence of Z*marina*, (c) red line represent the presence of Z*japonica* , (d) orange lines represent the presence of both *Zmarina* and *Zjaponica* and (e) black represent unusable video, and (f) dark green represents areas where *Zmarina* or *Zjaponica* eelgrass was present, but the identity of which was not possible to determine from the video (see Figure 9). A yellow line represents the sampling polygon used to calculate eelgrass bed areas. Only data within the yellow polygon are used for eelgrass bed area calculations. In a few of the older diagrams the data outside the yellow polygon have not been clipped, but those data points did not contribute to the calculations.

The green stars identify the boundaries of the sites as described by WADNR. All maps with underwater video data are oriented with North being toward the top. Photographs without underwater video data are oriented with the long axis along convenient for display purposes. Dates shown with blue background are for aerial flights and dates with green background are for underwater video outings. A small map shows the location of the site with a yellow dot; blue dots represent all the sites (e.g. 2015 in the example shown here). The *Zmarina* Bed Area measurement in hectares is shown at the bottom.

The accompanying graph shows historic values for eelgrass bed areas in hectares (1 hectare = 2.47 acres). The blue data points are values calculated by DNR from their underwater videography data and the red are values calculated by DNR from our data (ICMRC). The error bars represent ±2 standard errors. Only values with no overlap in error bars are statistically different from each other at the 95% confidence level.

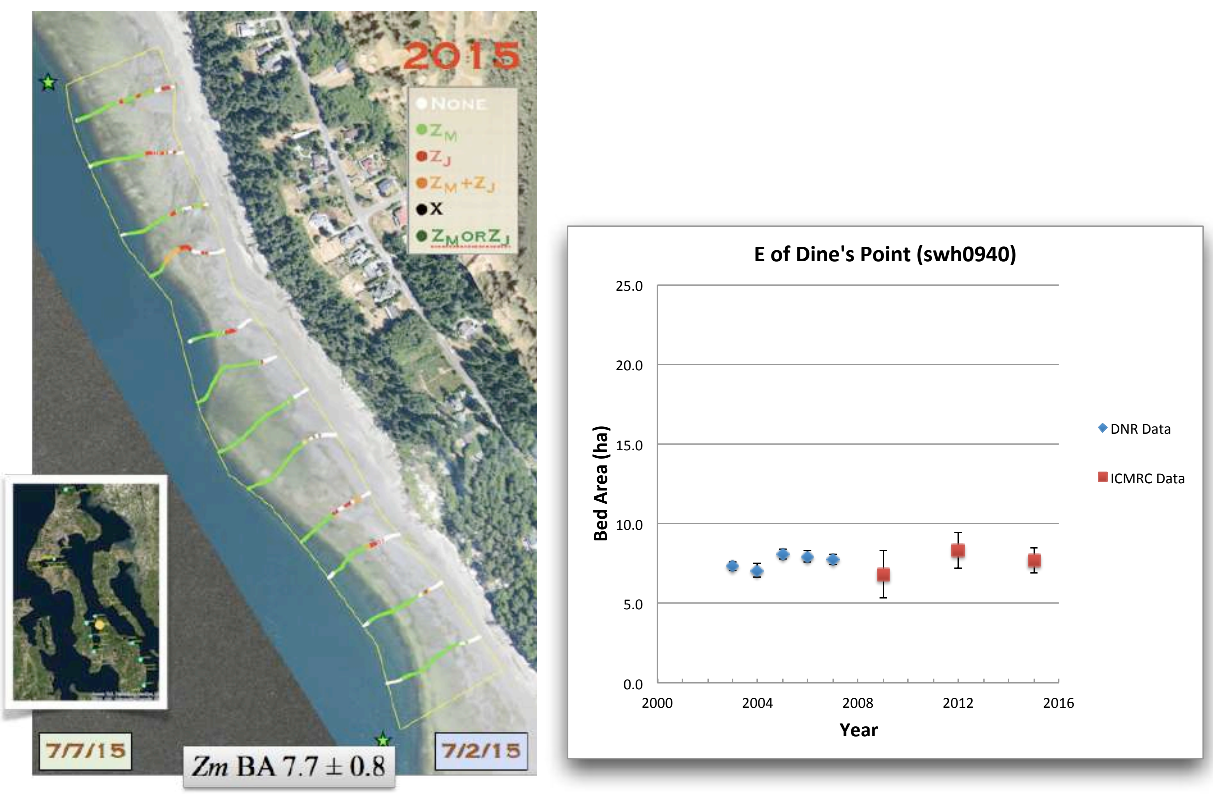

Figure 9. Example of geo-referenced aerial photograph, underwater videography transects and historic results of eelgrass bed areas.

An example of the sonar maps is shown in Figure 10. In order to combine bed area measurements from the underwater videography with sonar data, the contour of the vegetation map was determined using image analysis techniques and constrained to the sampling polygon (see red boundary in Figure 10) and enumerated in ArcGIS.

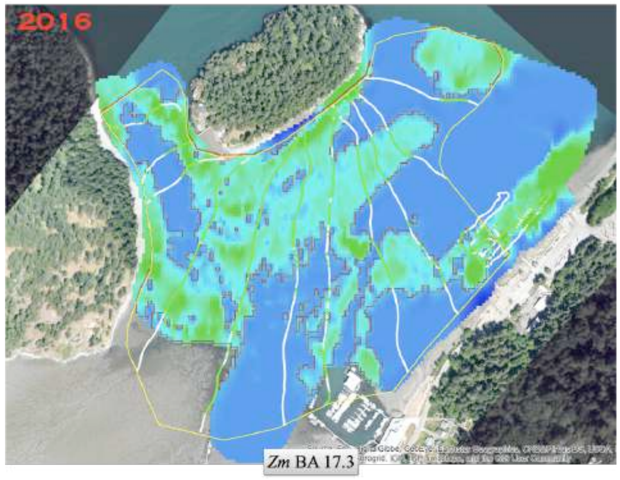

Figure 10. An example of sonar mapping of Cornet Bay overlaid with the underwater video analysis transect data, the sampling polygon (yellow line) and outline of vegetation boundaries (red lines)

2018-9 Sites

A map of the sites where eelgrass bed areas have been measured by underwater videography in Island County is shown below (Figure 11). The large blue dots indicate the three sites we measured in 2018 (Cornet Bay – top, Monroe Landing – middle, and Freeland Park – bottom). In 2019 we measured only Cornet Bay. This map also shows our previous sites (red dots) as well as those measured since 2000 by WADNR (green dots). There were five sites measured by both our team and DNR (yellow dots) with only one done in the same year. The WADNR results are available at:

https://www.dnr.wa.gov/programs-and-services/aquatics/aquatic-science/puget-sound-eelgrass-monitoring-data-viewer

Figure 11. Underwater videography sampling sites studied in 2018-9 (large blue dots). Sites measured previously by our team (red dots) and WADNR (green dots) or both (yellow dots) are also shown.

Underwater Video Data Acquisition

A small document was created to record events and issues for each outing in 2018 and to map the tracklog of the boat's path shortly after each event (see Appendices: "2018 Quick Report.doc"). The list of crew and sites for 2018 and 2019 are shown in Table 1.

Crew Schedule for 2018-9 Eelgrass Monitoring				
Date	Site	Captain	Equipment	Camera
6/18/18	swh0932	Ken Urstad	Gregg,Tom,Kes Neal, Bob	Training - No data
7/16/18	swh0932	Ken Urstad	Gregg	Kes
7/17/18	flats29	Ken Urstad	Gregg	Tom
7/19/18	swh0888	Ken Urstad	Gregg	Gregg
6/21/19	flats29	Ken Urstad	Gregg	Gregg

Table 1. Crew Schedule for 2018 and 2019 Underwater Videography outings (complete names of equipment/camera crew are: Gregg Ridder, Tom Vos, Kes Tautvidas, Neal Clark and Bob Gentz).

Aerial Photography Data Acquisition

Below are flight paths (recorded as GPX files) of the aerial photography in 2018 and 2019 for Island County. The date of each flight is indicated in the same color as the path. In 2018 the flight altitude was 2500' and in 2019 the altitude was changed to 4500' to avoid increased military jet traffic at NAS Whidbey. While following the shoreline, photographs were taken every four seconds with the wings held level. Usually the photos in June were used for primarily for eelgrass surveys and the photos in August used for kelp surveys. The later surveys included and IR camera (Vern Brisley) to detect bull kelp.

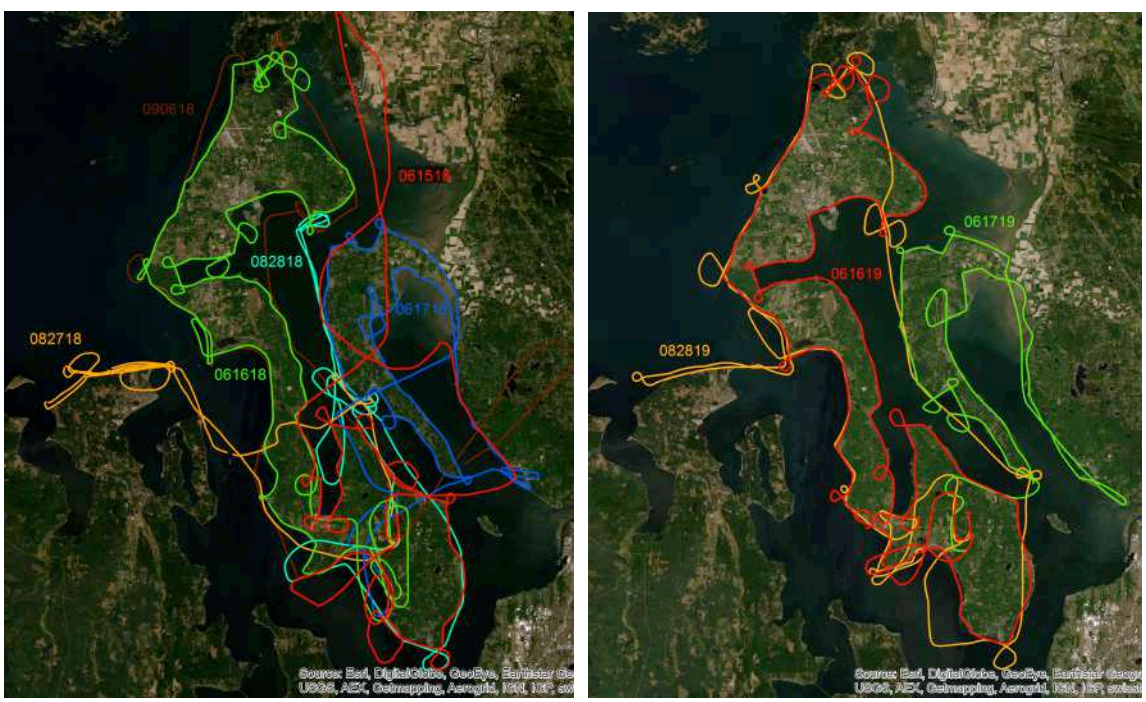

Figure 12. GPX tracks of aerial photography flights in 2018 and 2019 in Island County.

Additional eelgrass flights were performed in the San Juan Islands for Friday Harbor Labs and at Fidalgo Bay for Sarah Wheatley (Samish Tribe). The flights in Whatcom County were for the benefit of their kelp survey.

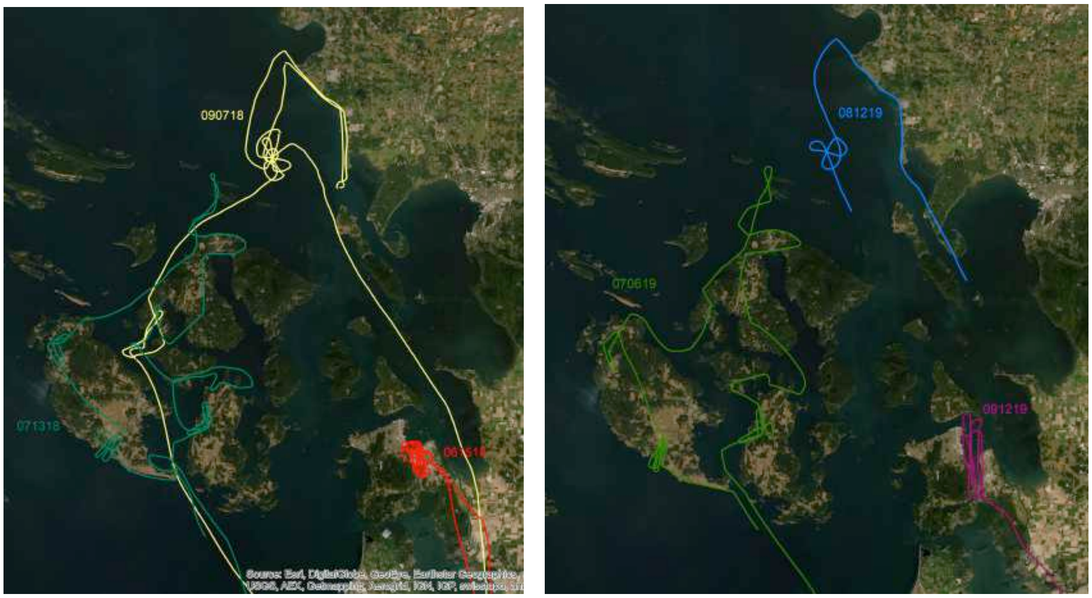

Figure 13. GPX tracks of aerial photography flights in 2018 and 2019 in San Juan County, Whatcom County and Fidalgo Bay.

Additionally, the Washington Department of Ecology has a shoreline photo viewer to find great historic oblique pictures of the entire Washington shoreline at:

https://fortress.wa.gov/ecy/shorephotoviewer/

Sonar Surveys

Albert Foster completed the data acquisition for all three sites in late June of 2018. No sonar data were acquired in 2019. One map was produced for Cornet Bay (flats29) in 2018.

Data Preparation

By June 30, 2019, all of the underwater video files and accompanying spreadsheets for 2018 and 2019 underwater video data were prepared. Also, the aerial photographs were geo-tagged, made into panoramic images for each of the sampling sites and geo-referenced to a base map. The geo-referenced aerial images and available video-analysis of transects were superimposed on a base map to allow comparison of the two data sets (underwater video and aerial photography.

Video Analysis

The 2018 and 2019 underwater video was scored for the presence/absence of eelgrass by Gregg Ridder on July 15, 2019 using the video and spreadsheets produced in June.

Eelgrass Bed Area Estimates

The eelgrass bed area estimates were calculated by our own method (described and compared to WADNR in the 2012 final report) from the scored transect tracks for 2018 and 2019. The results of all the eelgrass bed area estimates over the last eleven years are presented in Table 2. The results are grouped by site (randomly colored by site to make comparisons over the years easier).

Sonar Results

No eelgrass bed area estimate was calculated for Cornet Bay since the map showed obvious inaccuracies compared to underwater video data.

Results

A summary of *Zm* eelgrass bed area estimations (in hectares) is shown in Table 2.

Site Code	Site Name	Date	N	Zm Area (ha)		SE
cps0761	Dave Macke County Park, Maxwelton	23-Jun-11	12	4.1	±	0.4
cps0761	Dave Macke County Park, Maxwelton	9-Aug-16	12	5.8	±	0.4
cps0766-0772	North Useless Bay	8-Aug-16	2	Recon Only		
cps0776	Mutiny Bay Boat Ramp, SW Whidbey	3-Aug-14	11	7.4	±	0.6
flats29	Cornet Bay, Whidbey*	27-Aug-09	7	20.6	±	2.7
flats29	Cornet Bay, Whidbey	3-Aug-10	10	16.8	±	2.0
flats29	Cornet Bay, Whidbey	9-Jun-11	8	22.8	±	2.1
flats29	Cornet Bay, Whidbey	11-Jul-12	9	21.4	±	1.9
flats29	Cornet Bay, Whidbey	15-Jun-13	8	20.5	±	1.6
flats29	Cornet Bay, Whidbey	18-Jun-14	11	20.1	±	2.3
flats29	Cornet Bay, Whidbey	22-Jun-15	12	18.8	±	1.8
flats29	Cornet Bay, Whidbey	27-Jun-16	11	17.2	±	2.0
flats29	Cornet Bay, Whidbey	28-Jun-17	11	16.9	±	1.5
flats29	Cornet Bay, Whidbey*	16-Jul-18	12	17.4	±	1.9
flats29	Cornet Bay, Whidbey*	21-Jun-19	11	17.5	±	1.1
swh0851	Ala Spit Beach Access, Whidbey	19-Jun-14	1	Recon Only		
swh0875	Midway Blvd, Oak Harbor	29-Jun-13	12	6.0	±	1.2
swh0884	Oak Harbor SW	13-Jul-17	9	5.7	±	3.0
swh0885	Blower's Bluff North, Whidbey	28-Jun-13	10	18.0	±	0.7
swh0885	Blower's Bluff North, Whidbey	15-Aug-14	9	20.3	±	1.3
swh0888	E of Monroe Landing	17-Jul-10	12	7.9	±	0.8
swh0888	E of Monroe Landing	6-Jul-11	10	6.2	±	0.7
swh0888	E of Monroe Landing	21-Aug-12	10	5.8	±	1.0
swh0888	E of Monroe Landing	27-Jul-13	13	5.8	±	0.8
swh0888	E of Monroe Landing	16-Jul-14	10	5.9	±	0.9
swh0888	E of Monroe Landing	23-Jun-15	13	5.8	±	0.7
swh0888	E of Monroe Landing	9-Jul-16	12	5.4	±	0.6
swh0888	E of Monroe Landing	11-Aug-17	12	5.9	±	0.9
swh0888	E of Monroe Landing*	19-Jul-18	13	5.7		0.9
swh0890	W of Monroe Landing	16-Jul-10	12	0.0	±	0.0
swh0892	San de Fuca, Whidbey	30-Jul-10	9	0.0	±	0.1
swh0893	Kennedy's Lagoon, Whidbey	29-Jul-13	12	0.0	±	0.0
swh0894	Mueller Park, Whidbey	30-Jul-10	12	0.0	±	0.0
swh0896	Carriage Heights Ln	19-Jul-10	0	0.0	±	0.0
swh0898	W of Lovejoy Point, Coupeville	2-Jul-10	12	1.0	±	0.3
swh0898	W of Lovejoy Point, Coupeville	13-Jul-13	11	1.2	±	0.4
swh0898	W of Lovejoy Point, Coupeville	25-Jun-16	10	0.8	±	0.2
swh0899	Lovejoy Point, Coupeville	28-Jul-13	10	1.1	±	0.3
swh0900	Mineral Spring, Coupeville*	26-Aug-09	14	1.4	±	0.5
swh0900	Mineral Spring, Coupeville	17-Jun-10	11	1.3	±	0.6
swh0900	Mineral Spring, Coupeville	10-Jun-11	14	0.9	±	0.5
swh0900	Mineral Spring, Coupeville	23-Jul-12	10	1.5	±	0.7
swh0900	Mineral Spring, Coupeville	12-Jul-13	13	1.2	±	0.5
swh0900	Mineral Spring, Coupeville	24-Jun-16	11	1.0	±	0.6
swh0920	S of Pratt's Bluff South, Whidbey	25-Jul-16	13	5.5	±	0.6
swh0923	N of Dines Pt North, Whidbey	9-Aug-12	10	3.6	±	0.3
swh0923	N of Dines Pt North, Whidbey	8-Jul-15	11	2.6	±	0.3

Site Code	Site Name	Date	N	Zm Area (ha)		SE
swh0927	Honeymoon Bay, Whidbey*	17-Aug-09	14	10.9	±	0.5
swh0927	Honeymoon Bay, Whidbey	7-Jul-12	12	10.2	±	0.6
swh0927	Honeymoon Bay, Whidbey	6-Jul-15	12	11.0	±	0.6
swh0930	S Harbor Hills Dr, Whidbey*	17-Jun-09	12	3.8	±	0.5
swh0930	S Harbor Hills Dr, Whidbey	26-Jun-12	11	3.8	±	0.4
swh0932	Freeland Park, Whidbey*	19-Jun-09	10	13.1	±	1.2
swh0932	Freeland Park, Whidbey	31-Jul-10	12	14.7	±	0.6
swh0932	Freeland Park, Whidbey	7-Jun-11	11	14.0	±	0.5
swh0932	Freeland Park, Whidbey	9-Jun-12	10	13.4	±	0.7
swh0932	Freeland Park, Whidbey	31-May-13	13	14.7	±	0.5
swh0932	Freeland Park, Whidbey	3-Jul-14	11	14.6	±	0.7
swh0932	Freeland Park, Whidbey	10-Jun-15	13	14.3	±	0.7
swh0932	Freeland Park, Whidbey	28-Jun-16	14	14.7	±	0.6
swh0932	Freeland Park, Whidbey	14-Jun-17	12	14.0	±	1.1
swh0932	Freeland Park, Whidbey*	16-Jul-18	12	12.8	±	0.9
swh0934	NW of Lone Lake, Whidbey*	18-Jun-09	18	4.9	±	0.3
swh0934	NW of Lone Lake, Whidbey	6-Aug-12	9	5.4	±	0.7
swh0937	East of Honeymoon Bay, Whidbey*	12-Aug-09	10	9.0	±	0.5
swh0937	East of Honeymoon Bay, Whidbey	7-Aug-12	12	9.1	±	0.3
swh0940	East of Dine's Point, Whidbey*	4-Jun-09	10	6.8	±	0.8
swh0940	East of Dine's Point, Whidbey	10-Aug-12	11	8.4	±	0.6
swh0940	East of Dine's Point, Whidbey	7-Jul-15	12	8.2	±	0.4
swh0943	Baby Island, SE Whidbey*	19-Aug-09	13	17.7	±	1.0
swh0943	Baby Island, SE Whidbey	11-Aug-12	13	18.3	±	0.6
swh0943	Baby Island, SE Whidbey	9-Jul-15	12	18.8	±	0.7
swh0954	N of Brooks Hill Rd, SE Whidbey	31-Jul-14	10	21.8	±	0.9
swh0955	West Langley, SE Whidbey	1-Aug-14	11	15.0	±	0.7
swh0957	Port of South Whidbey	20-Jun-11	10	9.1	±	0.8
swh0957	Port of South Whidbey	2-Aug-14	12	11.4	±	0.7
swh0957	Port of South Whidbey	20-Jul-15	12	11.4	±	0.6
swh0963	S Summerhill Drive, SE Whidbey	21-Jul-15	9	15.2	±	0.3
swh0963	S Summerhill Drive, SE Whidbey	27-Jul-17	11	14.5	±	0.4
swh0966	Clinton Ferry Terminal	21-Jun-11	11	7.5	±	0.6
swh0967	S of Clinton Ferry Terminal	22-Jun-11	13	2.7	±	0.5
swh0971	South Glendale, SE Whidbey	9-Jun-15	11	7.0	±	0.6
swh0973	Possession, SE Whidbey	19-Jul-11	12	13.7	±	1.2
swh0973	Possession, SE Whidbey	28-Jul-17	11	14.4	±	1.5
swh1565	Cama Beach, Camano Island	8-Aug-12	12	3.6	±	0.5
swh1567	Camano State Park	26-Jul-16	10	1.3	±	0.4
swh1568	Lowell Point, Camano Island	26-Jul-16	7	0.1	±	0.1
swh1570	Elger Bay, South Camano	26-Jul-13	11	18.3	±	1.0
swh1574	Camp Diana West, South Camano	4-Aug-14	10	17.3	±	0.8

Table 2. Eelgrass Bed Areas by Site for the period from 2009 to 2019. The 2009 & 2018 -2019 results were calculated by method developed by G. Ridder and marked (*). The 2010 - 2017 were calculated by DNR from our videography analysis data.

Results and Discussion by Site
The following pages contain the maps and discussion of results for each site sampled by underwater videography in 2018 and 2019 by the Island County MRC Eelgrass Project.

Cornet Bay (flats29)

The results of our 2018 and 2019 underwater video analysis show the eelgrass bed areas are 17.4 ± 1.9 hectares and 17.5 ± 1.1 hectares respectively. The images below (Figure 14) show similar appearances between the years and the graph demonstrates no significant trend since 2016. We have speculated in the past that the significant downward trend between 2011 and 2016 was due to loss of sparse eelgrass areas in the intertidal region possibly associated with increasing air or water temperatures. For now, it appears that trend has stopped.

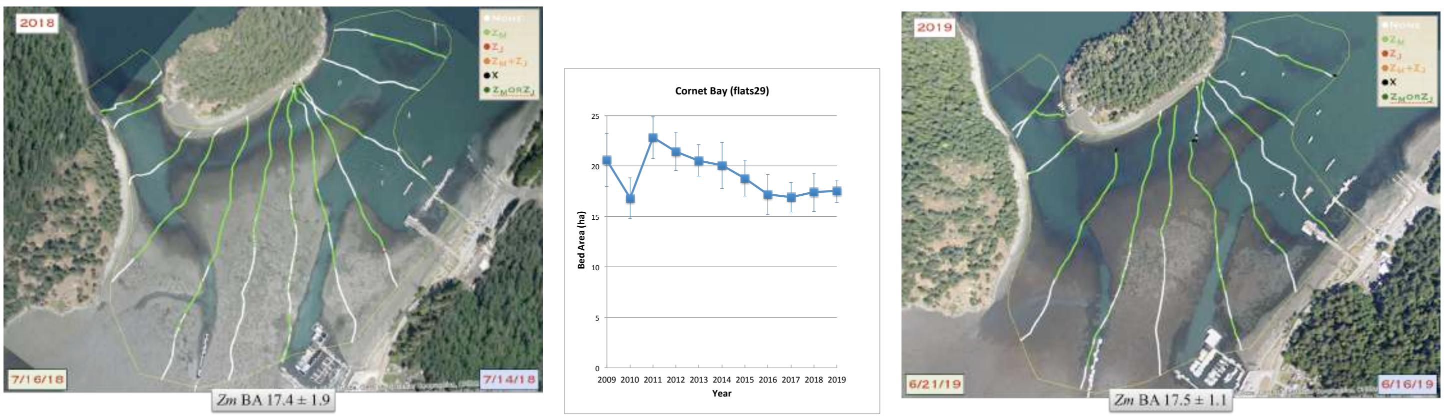

Figure 14. Eelgrass images and bed area estimates for 2018 and 2019 along with historic trends.

A photograph by WADNR from May of 1993 (Figure 15 left) shows nearly complete coverage of the intertidal area with vegetation (Figure 15 left). We have never witnessed any such vegetation by underwater videography in the past eleven years and suspect it was eelgrass based on the sampling polygon (Figure 14 yellow line) drawn by WADNR to incorporate the eelgrass boundaries at the time it was created (sometime after 2000 but before 2008).

Of interest is a recent aerial photograph from 8/28/19 (Figure 15 right) that shows the presence of significant new vegetation in the intertidal region. Whether this new vegetation is eelgrass has not been determined, but it's persistence and identity will be evaluated next summer.

Figure 15. 1993 WADNR photo of vegetation in shallow areas of Cornet Bay (left) and recent aerial photo of Cornet Bay (8/28/2019) showing increased vegetation in shallow area.

Sonar (flats29)

Albert Foster scanned for eelgrass in Cornet Bay by sonar on June 28, 2018. In 2016 and 2017 the sonar maps closely resembled the underwater video tracks and aerial photographs. The 2018 map (Figure 16 right) did not show any vegetation in areas known to have eelgrass, especially around Ben Ure Island.

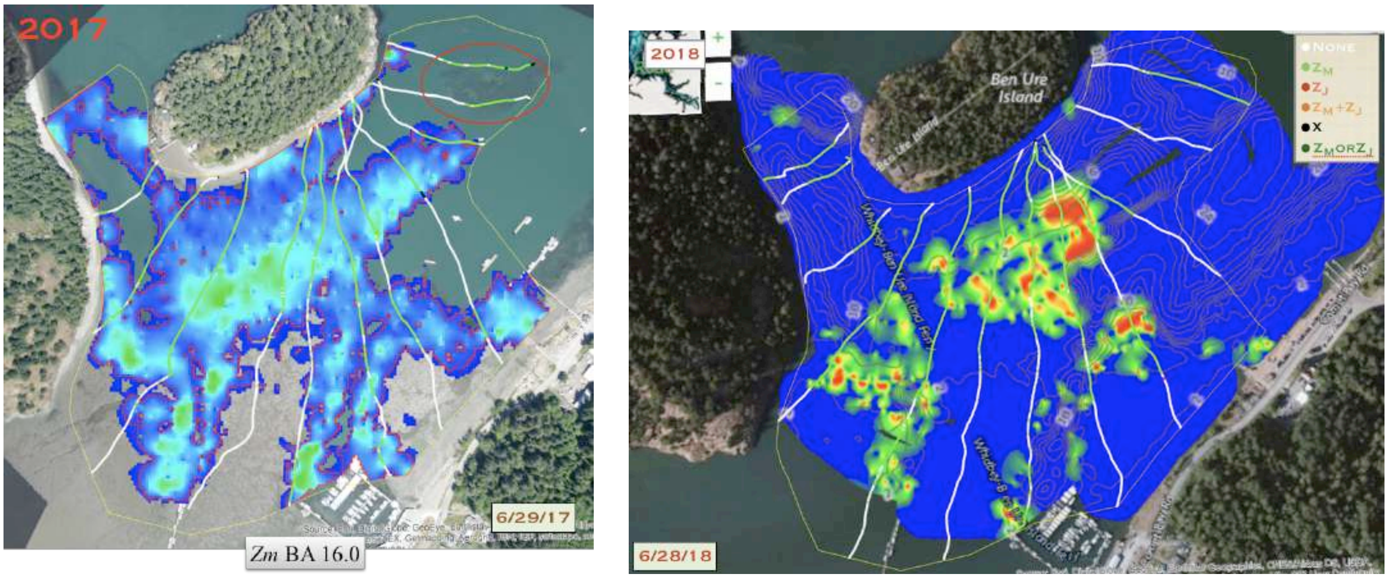

Figure 16. The 2017 Sonar map (left panel) and bed area measurement based on area within sampling polygon (green = high biovolume, blue = low biovolume). Red outline represents threshold of eelgrass boundary area. The red oval (upper right) represents missed sampling of the sonar data collection. The 2018 sonar map (right panel) does not show vegetation where underwater video has confirmed its presence especially around Ben Ure Island.

Two theories were suggested to explain this inaccuracy: either high plant density or the effect of current. If the plant density were extremely high, then it is possible the sonar never penetrated the canopy and the sea floor was not detected. Likewise if the currents were high enough to lay over the eelgrass on the seafloor (as we have seen in underwater video at Cornet Bay), no eelgrass would be detected in the water column. Our experience from both the underwater videography and past sonar measurements is that the eelgrass density in the suspected areas is not especially high. Another piece of data is the current flows were 4-6 knots at the time of data collection (see green box in Figure 17). Whatever the cause, this error was significant enough along with other know issues (plant identity, steep slopes, shallow/deep water, wave effect on boat, expensive/black box data processing) to keep us from adopting this version of sonar as our primary method.

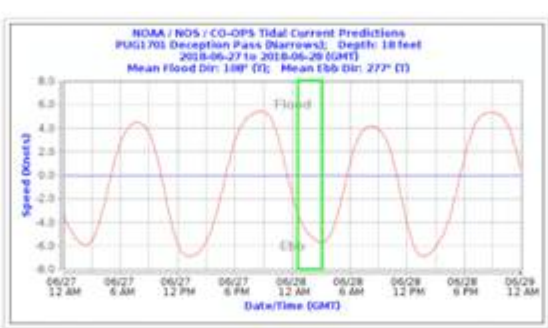

Figure 17. Current flow at Deception Pass (adjacent to Cornet Bay) at the time of sonar data collection (green box).

East of Monroe Landing, Penn Cove (swh0888)

The site East of Monroe Landing (swh0888) is the largest eelgrass bed area within Penn Cove. Penn Cove is fairly unique in that almost all of its fourteen sites each have less than 1 ha of eelgrass; most have none in our surveys. Whether this is due to natural conditions of he substrate or water quality due to human activity is not known. We suspect sediment deposition plays a role (see page 20).

The eelgrass bed area estimates over the last eight years are very consistent (Figure 18). The aerial photographs over the same time period show some shifting of eelgrass beds within the site. The underwater video have also shown the presence of green sea urchins in some areas devoid of eelgrass (see 2017 Report).

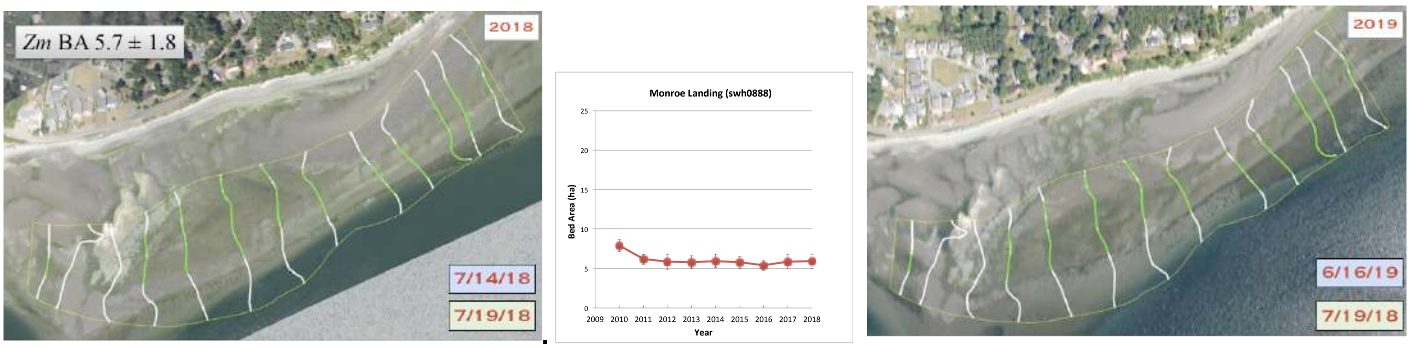

Figure 18. Aerial and Underwater Videography results for East of Monroe Landing (swh0888) in Penn Cove for 2018 (left) and 2019 aerial image overlaid with 2018 underwater video transects (right). Historic estimates of eelgrass bed areas (center). There is no bed area estimate for 2019 since underwater videography was not done in 2019.

Freeland Park (swh0932)

Freeland Park is a core site in Holmes Harbor for which we have collected aerial and underwater videography data every year since 2009. The overall bed area remains about 15 hectares (see Figure 19) with small patches on *Zjaponica* in the shallows and a sea urchin bed near the east end (right side of photos – see 2014 report for more detail). Sonar results have agreed well with underwater videography.

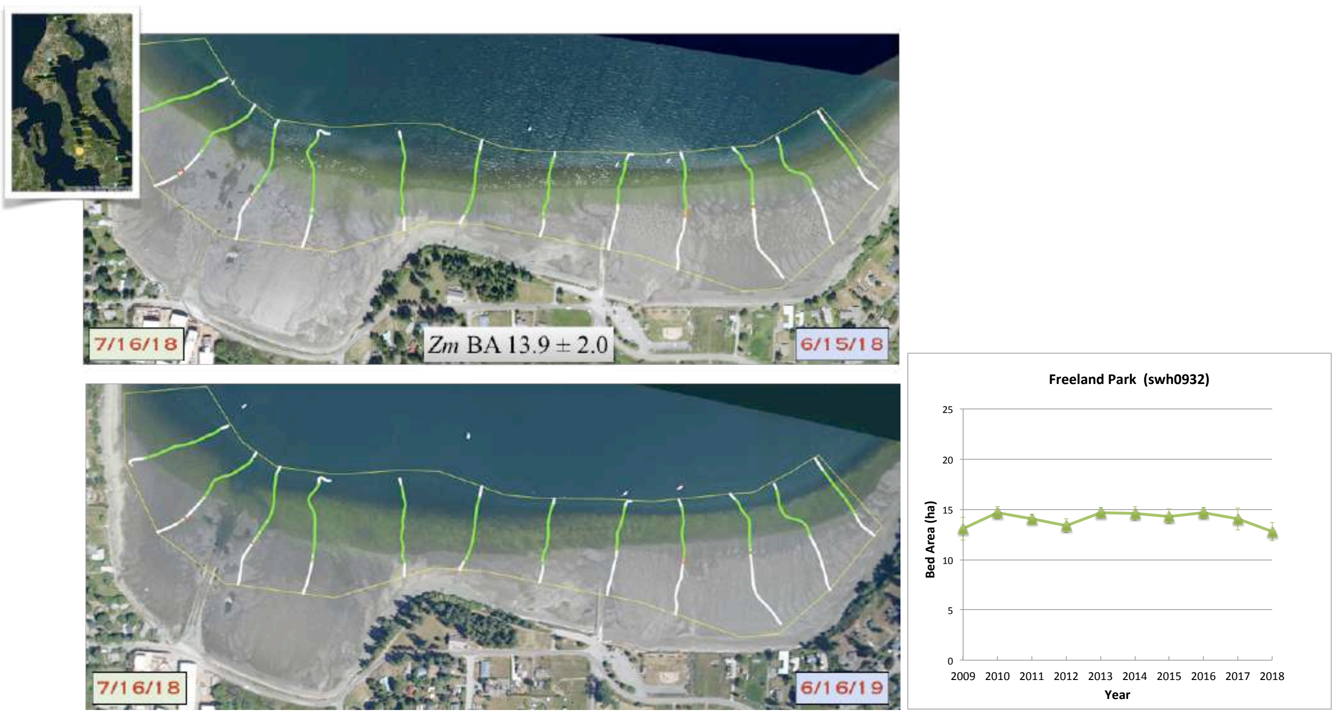

Figure 19. Aerial, Underwater Videography and Sonar results for Freeland Park (swh0932) in Holmes Harbor for 2018 and 2019 (overlaid with 2018 underwater video transects) and historic Bed Area values since 2009. There is no bed area estimate for 2019.

This site has remained extremely stable over the years we have monitored. The original interest was due to the loss of eelgrass noted in a request to Beach Watchers (now Sound Water Stewards) in a blog by Nancy Bartlett on August 25, 2007 (Figure 20 top). Listed as possible stressors to the eelgrass were water quality, boat launches from Nichols Brothers shipyard and weather events. While water quality and increased temperature often result in algae blooms in Holmes Harbor (Figure 20 bottom left), the eelgrass bed areas appears stable. Likewise, after many boat launches from Nichol's Brothers (Figure 20 bottom center), the eelgrass bed area hasn't changed. Most likely a very significant storm event on December 13, 2006 (Figure 20 bottom right) was responsible for disrupting the eelgrass plants. The roots, however, must have been left intact in that the plant growth in 2009 was back to average and there were rhizome nodes from years before the storm (Figure 21).

August 25,2007

I live on Holmes Harbor, on Whidbey Island. In recent years the algal blooms here have become all but toxic to humans. Now the toxicity to eel grass is absolutely clear. Where 10 years ago the bottom of the Harbor was not visible, only undulating fields of eelgrass, now we can see nothing but sand.

……

I'd like to start a BW project to deal with this disturbing trend but all I have is anecdotal evidence. I need to get my hands on some data. Would you be able to point me in a direction to get something helpful?

NANCY BARTLETT

Figure 20. Blog by Nancy Bartlett in 2007 (top), Algae bloom on 5/25/13 (lower left), boat launch at Nichols Brothers on 6/4/17 (bottom center) and wind event on December 13, 2007 (bottom right).

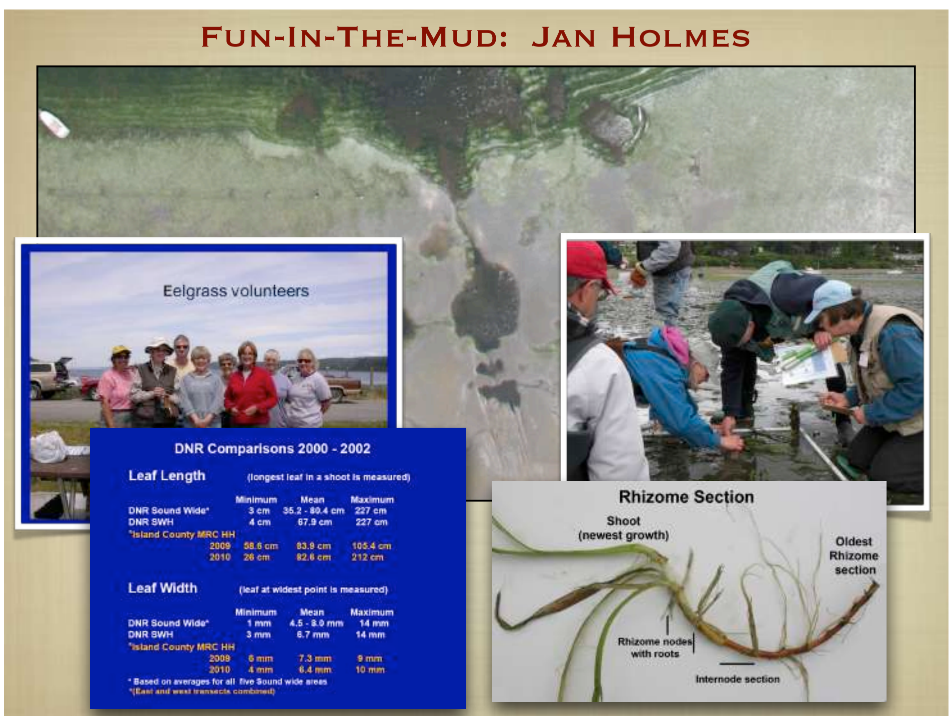

Figure 21. Jan Holmes and Sandy Wyllie-Echeverria assessment of plant growth characteristics for 2009 and 2010 showing normal plant growth compared with DNR results.

Aerial Observations

For years we have collected aerial images of the shoreline around Whidbey and Camano Islands. When questions arise we can review these photos and or look for trends over time. A few of these more recent observations are below.

Sediment Flow in Saratoga Passage from the Skagit River

A recent review of the aerial photos for the entirety of Whidbey Island yielded a realization that there is a lot of sediment in the waters of Penn Cove and north to Ala Spit (see Figure 22 top panel). The sediment appears to be coming from the Skagit River (multiple observations by Ken Urstad while boating in the region). The appearance of the eelgrass is much more brown in both our underwater video and in anecdotal observations from the Sound Water Stewards monitoring the beach at Dugualla Bay. Images of the large eelgrass bed just North of Ala Spit shows typical amounts of sediment in the water (Figure 22, bottom left) and an extreme deposition on the eelgrass (Figure 22, bottom center). Underwater video collected at Ala Spit from 2014 demonstrates the brown, slimy material deposited on the eelgrass (Figure 22, bottom right). Our eelgrass bed area measurements in Penn Cove show very little growth of eelgrass and a persistent cloud of sediment in the nearshore. Perhaps this sediment from the Skagit is the issue.

Figure 22. Proximity of the Skagit River to the north end of Whidbey Island (top), large eelgrass bed north of Ala Spit on Sept 6, 2018 (bottom left), large sediment deposit on eelgrass bed on August 20, 2017 (bottom center) and underwater video frame in Ala Spit on June 19, 2014.

Green Bank Boat Club

The Green Bank Boat Club (GBBC) is evaluating proposed improvements to the dike and outfall pipe and a new boat ramp. We were asked to give perspective to the effect of a new boat ramp on the eelgrass beds. We had measured the eelgrass bed area in 2016 at the site (DNR swh0920; Figure 23 top). Aerial images were available for 2015 to 2019. The new boat ramp was established after the 2015 (Figure 23 bottom left) and before the 2016 aerial photos. By 2019 (Figure 23 bottom right) it appears changes in the beach dynamics have changed and the eelgrass bed is beginning to be impacted. The hydrodynamics of the site are complicated and hopefully the images and data will help the hydrologists evaluate the plan.

Figure 23. Aerial images of the GBBC (swh0920) from 2015 (lower left), our 2016 eelgrass bed area measurement (top) and an aerial photo from 2019 (bottom right)

Seahorse Siesta Barge Removal (swh0955)

Plans have been made for the removal of the Seahorse Siesta barge from the shoreline near Langley, WA. We were recently asked by Lisa Kaufmann (NW Straits) for information about the eelgrass beds. We had measure this site (swh0955) in 2014 (Figure 24 top), but more recent information was required. An aerial photo was taken on July 6th, 2019 (Figure 24 center) and a ground photo of the site was taken on July 7th, 2019 (Figure 24 bottom) to verify the identity of the vegetation as eelgrass. Hopefully when the barge is removed it will not negatively impact the large eelgrass bed.

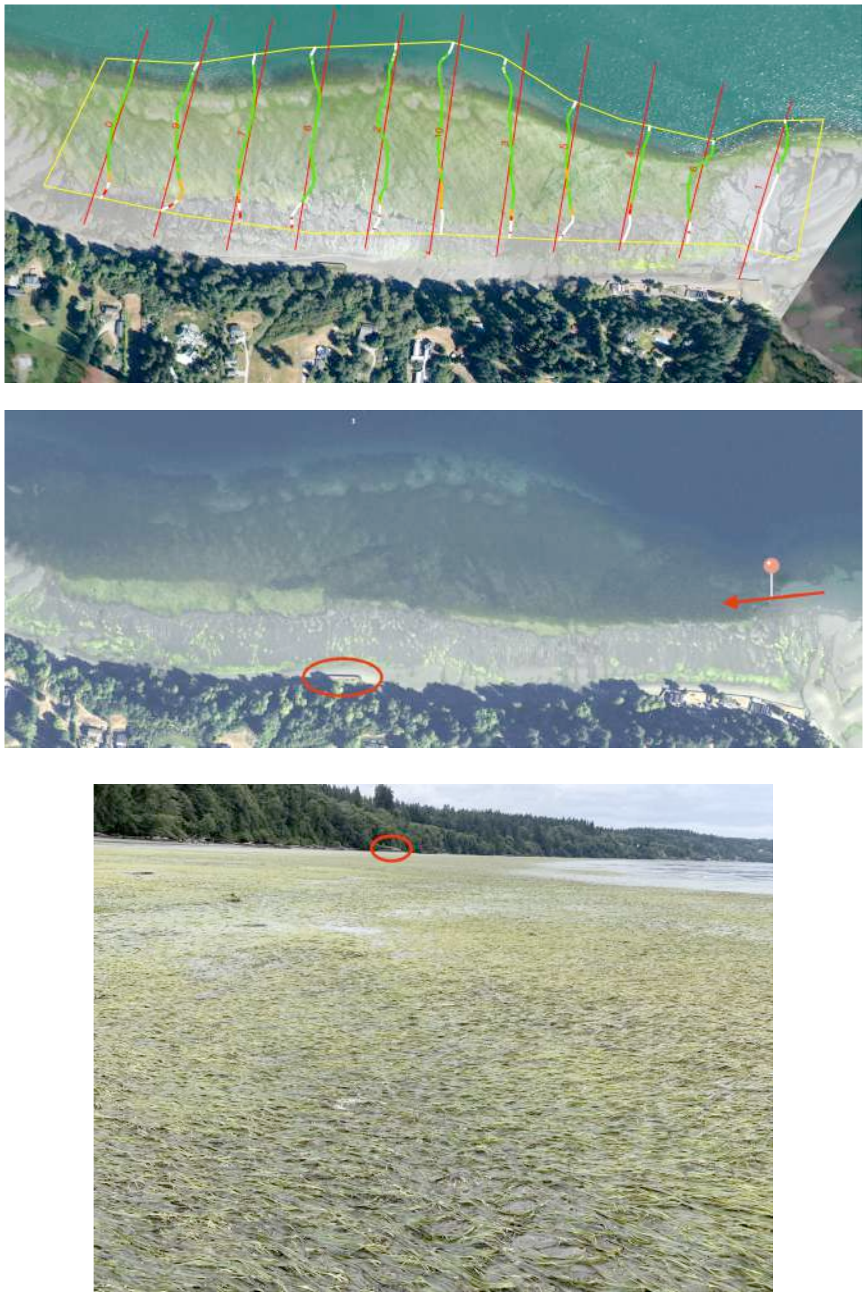

Figure 24 Eelgrass bed analysis of swh0955 by underwater video and aerial photo from 2014 (top), aerial photo of same site from July 6, 2019 (center, color difference from top due to tide and cloudy day) shows the position of the barge (red oval) and the location (pin) and direction (arrow) for the ground photo taken on July 7, 2019.

Loss of Eelgrass from Mutiny Bay

In 2014 we measured the eelgrass beds at the boat ramp near Robinson Road (Figure 25 top). A local resident suggested that she had noticed some loss of eelgrass in this area in the last few years. Inspection of recent aerial photos showed that sometime between 2017 and 2018, there was a loss of vegetation identified as eelgrass in 2014 from the shoreline near Robinson Road. Perhaps this was the result of a storm event during the winter of 2017 and it will recover with time. Inspection of all the rest of the shoreline aerials for Mutiny Bay did not reveal any other changes like this.

We will monitor the site to see if the vegetation returns. This example shows the importance of local resident observations and the difficulty of identifying small changes over time from aerial photos of 300 miles of shoreline.

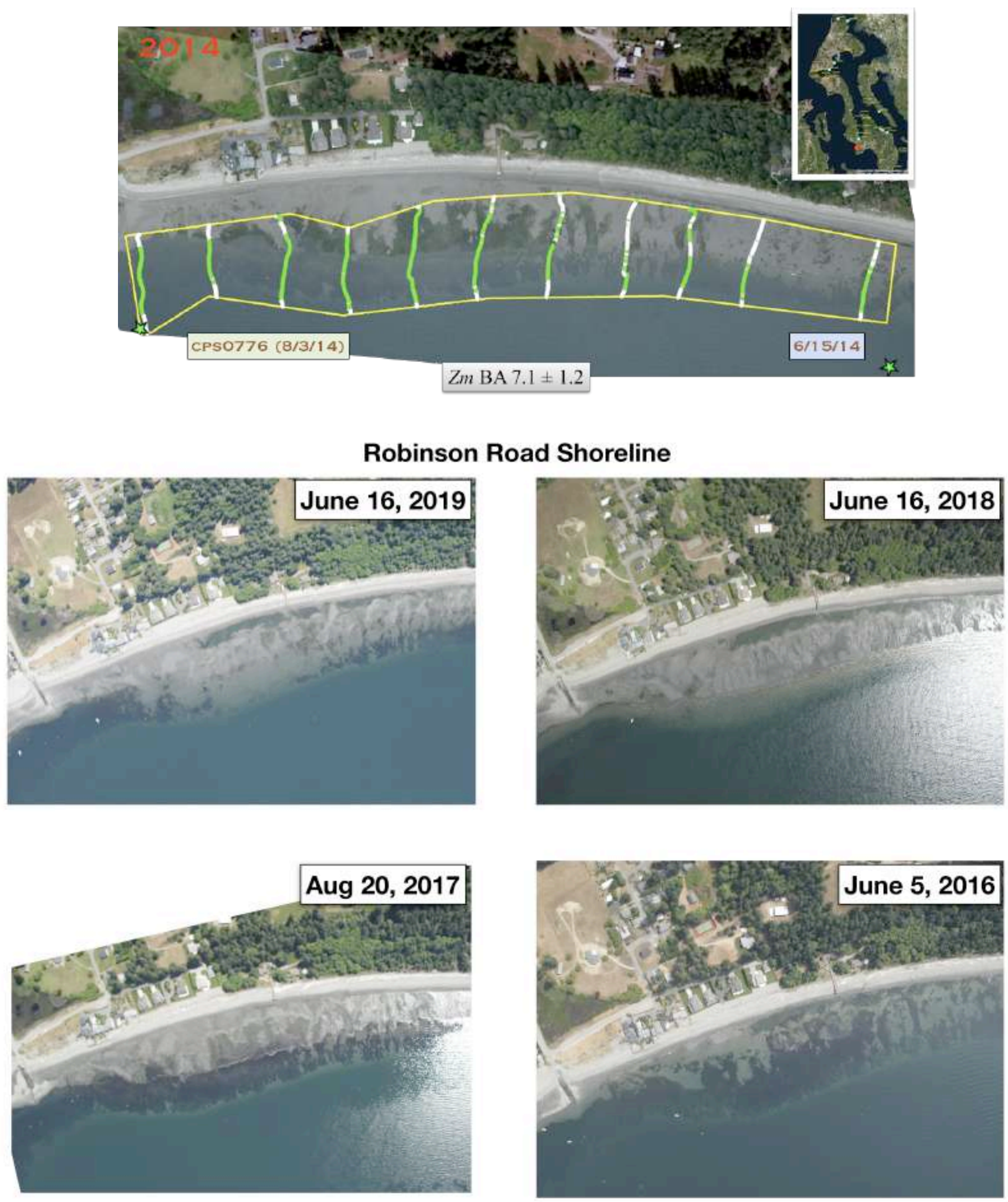

Figure 25. Results from the 2014 measurement of eelgrass bed area at the Mutiny Bay boat ramp (cps0776 - top). Aerial photographs of same region from 2016 to 2019 demonstrating loss of eelgrass between 2017 and 2018.

Conclusions

We have completed the analysis of all the data (aerial, underwater videography and sonar) gathered in 2018 and 2019. The results were presented to the Island County Marine Resource Committee on July 2nd, 2019. This report fulfills our responsibilities for this contract period. From our experience we have reached a number of conclusions about our results and processes:

• We now have a very significant database of eelgrass bed area measurements in Island County (see Figure 11). But, our team has lost the ability to continue due to the age and health of our equipment and members. In particular, we are saddened by the recent incapacity of our tireless, dedicated boat captain, Ken Urstad. However, the WADNR will continue to survey sites in Island County, the Island County Marine Resource Committee may want to reconstitute another team and the aerial surveys will continue.

• The loss of eelgrass bed area at Cornet Bay appears to have stopped. We will look for visible changes in future aerial photographs, develop a method to identify the vegetation and determine if quantitative measures are again needed.

• It appears that our other two core sites, Monroe Landing and Freeland Park, remain stable. Our conclusion is that a storm event is the most likely cause of the observed loss of eelgrass at Freeland Park in 2007.

• Sediment flowing from the Skagit River toward north Whidbey Island may be a stressor to healthy eelgrass growth

• Anecdotal observations by landowners can be good clues to changes in our shorelines. We need to facilitate better communication.

• It is not necessary to collect aerial photographs at just the low, low tides or fly at a 2500' altitude. In fact, there is better contrast between sand and eelgrass when it is wet and it opens up more opportunities to collect data. Also, flying at 4500' gives a larger field of view without sacrificing too much resolution. It also greatly reduces conflicts in airspace usage with NAS Whidbey.

• Sonar has great potential and capacity, but also has limitations in precision and accuracy. Data processing by C-Map is expensive ($2,500/year) and proprietary (black box). We have decided not to pursue further development. Thanks to Albert Foster for this gift and some great work!!

Acknowledgements

Our team (Tom Vos, Ken Urstad, Gregg Ridder, Mark Kennedy, Bob Gentz, Albert Foster and Neal Clark) is very appreciative for the help and guidance by Jeff Gaeckle , Lisa Ferrier (WADNR) and Suzanne Shull (NW Straits). We thank the Island County Marine Resource Committee, Kestutis Tautvydas (Project Lead, ICMRC) and Anna Toledo (Progam Manager, ICMRC) 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; Thank You!

Gregg Ridder

9/30/19