County: Island

Grant No: SEANWS-2016-IsCoPH-00005

PROJECT TITLE: Island County Marine Resources Committee Operations and Projects

TASK NUMBER: 2 – Monitoring

DELIVERABLE: 2.6 – Eelgrass aggregated data and report on 2016 eelgrass monitoring

PERIOD COVERED: June-August 2016

DATE SUBMITTED: 9/29/2017

PUGET SOUND PARTNERSHIP

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2016 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 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 WADNR, that are of interest to ICMRC and WADNR and aligned with our project's goal, (2) to collect underwater video using methods developed by the Washington State Department of Natural Resources (WADNR), (3) to collect aerial photographs of vegetation at very low tides for entire shoreline in regions of interest, (4) to analyze the data and present the results using GIS techniques and (5) to communicate the results as a 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 eelgrass bed areas in Island County. Delivery of this report and the associated data in GIS format completes the project for 2016.

Over the years we have determined our capacity for underwater videography data collection is about ten sites during the summer months if all goes well. After consultation with the ICMRC and WADNR we chose Cornet Bay (flats29 - core), Monroe Landing (swh0888 - core), Coupeville (swh0898 - repeat), Mineral Springs (swh0900 - repeat), Greenbank (swh0920 - new), Freeland Park (swh0932 -core), Camano Island State Park (swh1567 and swh1568 - new), Dave Mackey Park (cps0761 - repeat) and the north shoreline of Useless Bay (cps0766-cps0772 – new area of interest). The rationale for each site will be described later (see 2016 Sites).

A new opportunity to investigate the utility of sonar mapping came our way in 2016. A new team member, Albert Foster, presented us with capability to 100% sonar survey entire eelgrass study sites using the latest generation of consumer grade digital fishfinder sonar and GPS chartplotter made by Navico Lowrance. This gave us a great opportunity to evaluate an alternative method to aerial and underwater video transect maps by being able to compare them directly to 100% sonar survey maps of the same sites at the same time.

Between June 8th and August 9th of 2016 we collected underwater video of all ten sites. Aerial photographs were taken for the entire coastline of Whidbey Island and Camano. Maps depicting both underwater video assessments and geo-referenced aerial photographs were prepared for all ten sites and bed area estimates were calculated from the underwater video analysis results. Albert produced sonar maps for all the same sites and bed area measurements were calculated from his maps for comparison.

Of the core sites, Monroe Landing (swh0888) and Freeland Park (swh0932) appear 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) we now have a six-year downward trend in eelgrass bed area measurements that has now reached a significant statistical certainty (R^2=0.98) and represents a 17% loss since 2011. By aerial inspection we still see local damage to eelgrass beds by boating activity, but cannot say if this contributes to decrease in the overall eelgrass bed loss as measured by underwater videography. We participated in a WADNR's project planning to relocate the docks and prevent some of this damage.

The two additional Penn Cove sites (swh0898 and swh0900) show no significant changes in the very small eelgrass beds at these sites.

We established a baseline to be used for comparison after construction at the Green Bank Boat Club (swh0920) and now have clearer pictures of the very small eelgrass beds at Camano State Park (swh1567 & swh1568). The eelgrass beds (probably surfgrass) at Dave Mackey Park may have increased over the last five years although the *Zostera japonica* beds appear smaller. We now better understand the distribution of eelgrass on the north shore of Usless Bay to be primarily at the dropoff of this large flats area and absent near Double Bluff.

Our preliminary investigation into the use of sonar mapping with Lowrance products suggests a good correlation with underwater videography, but with some caveats. Just as with aerial photos, the identity of the vegetation needs to be confirmed with visual methods. This comparison study will be extended in 2017.

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 (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:

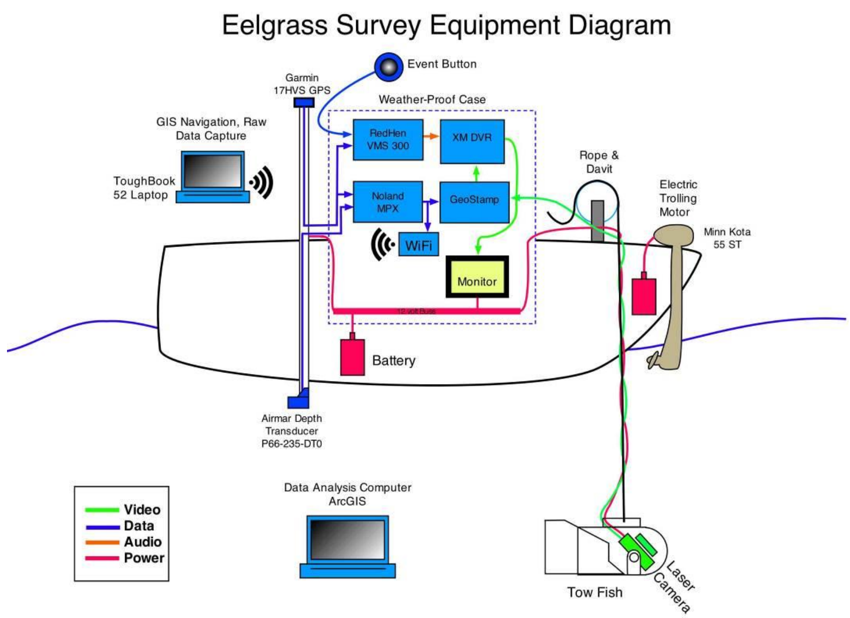


Figure 1. Equipment diagram for Beachwatcher's underwater video data collection.

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 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 base map (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 iPad program, “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

A new member of the eelgrass team in 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.cibiobase.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. x) and transom mounted Simrad GPS antenna. Hardware settings for sonar data collection in .sl2 file format per BioBase instructions (https://www.cibiobase.com/Home/EcoSoundFeatures)

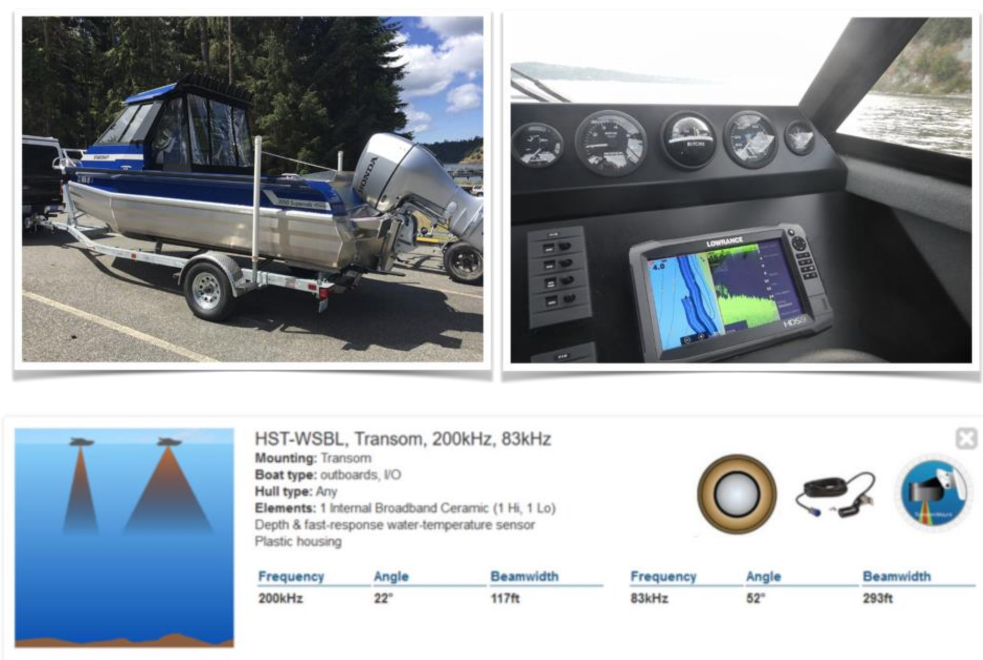


Figure 7. Albert Foster’s Boat and Lowrance sonar mapping system.

A brief (and woefully incomplete) 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).

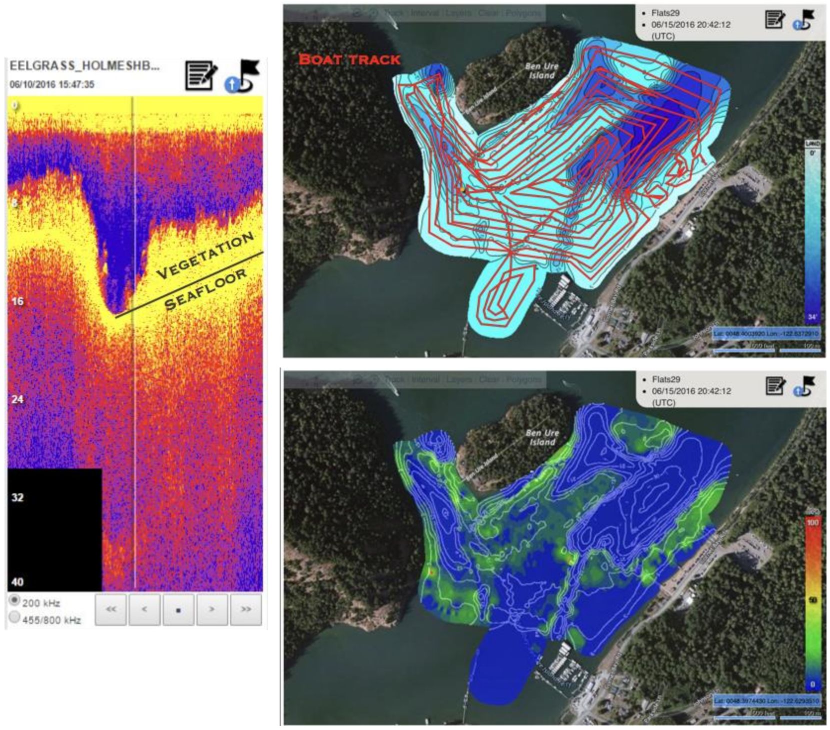


Figure 8. Raw sonar data (left), Boat track and seafloor contour map (upper right) and vegetation map with contour lines (lower right).

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. The underwater video assessment data 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 graphs show 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.

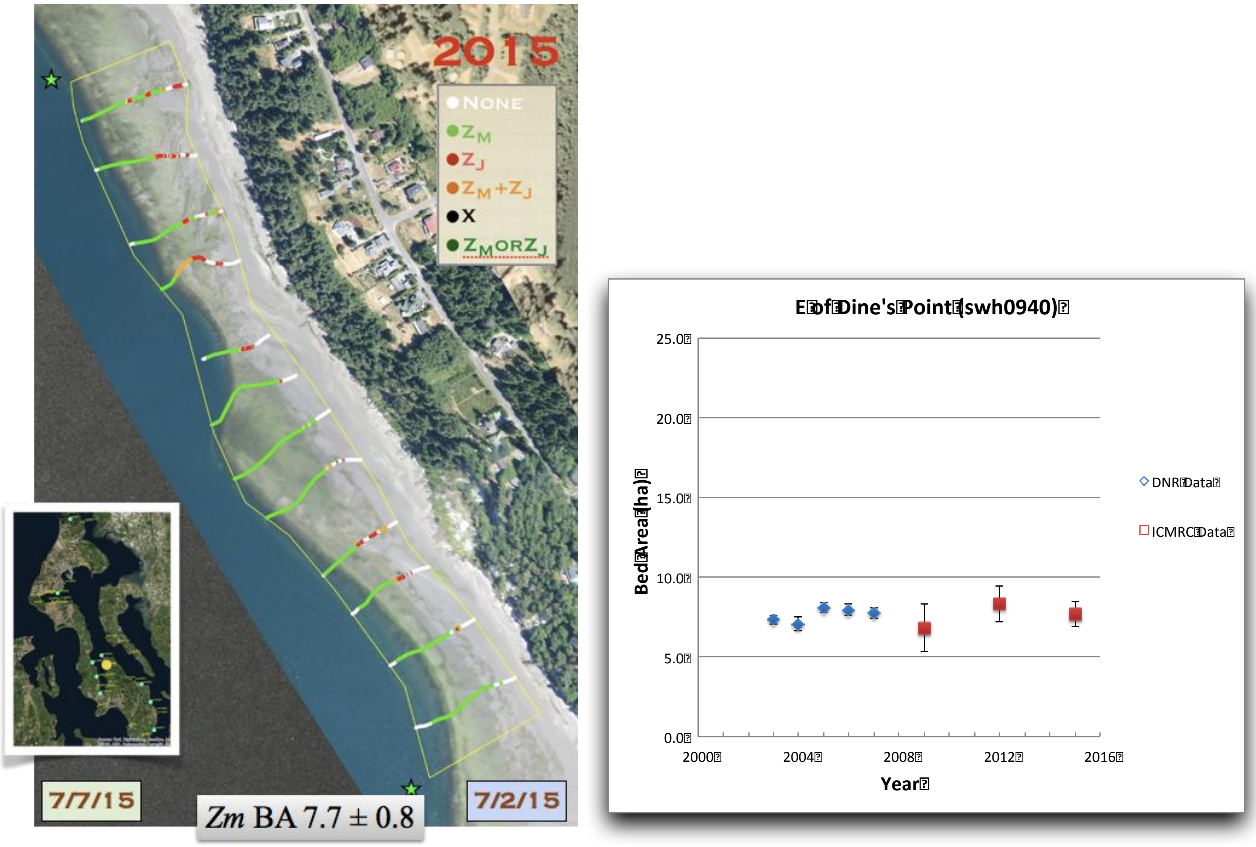


Figure 9. Example of geo-referenced aerial photograph, underwater videography and historic results of eelgrass bed areas.

An example of the sonar maps is shown in Figure 10. In order to 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.

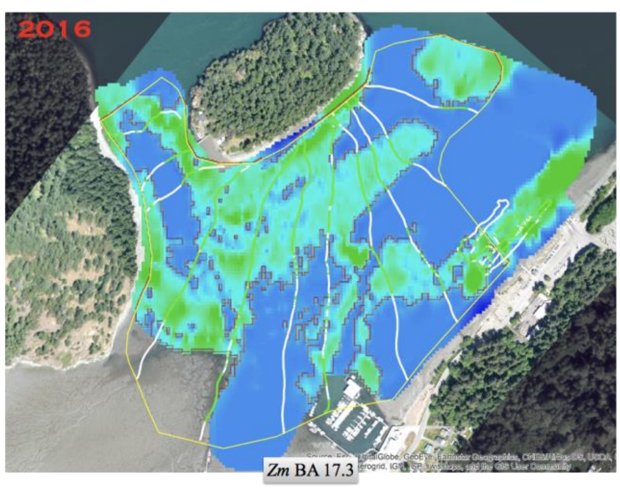


Figure 10. Sonar map of Cornet Bay overlaid with the underwater video analysis transect data, the sampling polygon (yellow line) and outline of vegetation boundaries (red lines)

2016 Sites

Our goal is ***not*** to randomly sample Whidbey and Camano islands to estimate overall eelgrass bed area for all of Island County. Due to under-sampling, this goal would be difficult to achieve to a precision needed to be meaningful. Our goal instead is to selectively sample sites with known human or environmental activity to understand related changes in their eelgrass bed areas over shorter periods of time (3-5 years).

Each year we consult with the IC MRC and WADNR before final selection. We also review our aerial photographs and results from previous years to develop the list of sites to study by underwater videography. We always welcome input from other interested parties. In 2016 we identified and were able to complete underwater videography for ten sites within Island County. Three of the selected sites were our core sites that have been sampled every year: Cornet Bay (flats29), Monroe Landing in Penn Cove (swh0888) and Freeland Park in Holmes Harbor (swh0932). We selected two additional sites in Penn Cove to repeat our assessment from 2013 (swh0898 and swh0900). Two sites were requested by the ICMRC for baseline data on Camano State Park (swh1567 and swh1568). One site at the Green Bank Boat Club (swh0920) was chosen to provide an assessment before starting a project to remove a tidegate, restore a wetland and improve access to the existing boat ramp (WICD Plan #2017081). This year we also turned our attention toward Useless Bay. Over the last ten years, littoral drift during winter storms has significantly remodeled the shoreline near Dave Mackey Park and the north shoreline of Useless Bay. We first measured this site in 2011 and returned this year to see what had changed. Also, anecdotal reports from north shore residents have told us there used to be much more eelgrass at the north end of Useless Bay. We thought this might be the year to take a look at the current conditions. Because there are seven sites along the northern shoreline (cps0766-cps0772), we decided to perform a reconnaissance run only to identify vegetation patterns, but not make quantitative measurements of eelgrass bed areas. Figure 11 is a map of our entire site list with those sampled by underwater videography in 2016 depicted in large blue dots.

Figure 11. Underwater videography sampling sites studied in 2016 (blue dots) are shown with other sites studied in previous years (small yellow dots)

Underwater Video Data Acquisition

A small document was created to record events and issues for each outing and to map the tracklog of the boat's path shortly after the event (see Appendices: "2016 Quick Report.doc"). In 2016 we encountered significant equipment issues with only minor weather restrictions.

The list of crew and sites for 2016 are shown in Table 1. All of our underwater video data collection was completed by August 9, 2016.

Crew Schedule for 2016 Eelgrass Monitoring				
Date	Site	Captain	Equipment	Camera
6/8/16	swh0932	Ken Urstad	Gregg,Bob,Neal Tom, Albert,Kes	Training/Testing
6/24/16	swh0900	Ken Urstad	Gregg	Albert
6/25/16	swh0898	Ken Urstad	Gregg	Albert
6/27/16	flats29	Ken Urstad	Gregg	Mark
6/28/16	swh0932	Ken Urstad	Gregg	Neal
7/9/16	swh0888	Ken Urstad	Neal	Albert
7/25/16	swh0920	Ken Urstad	Gregg	Neal
7/26/16	swh1567/8	Ken Urstad	Neal	Neal
8/8/16	Useless Bay	Ken Urstad	Gregg	Gregg
8/9/16	cps0761	Ken Urstad	Tom	Albert

Table 1. Crew Schedule for 2016 Underwater Videography outings (complete names of equipment/camera crew are: Gregg Ridder, Bob Gentz, Neal Clark, Tom Vos, Albert Foster, Kes Tautvidas, and Mark Kennedy).

Aerial Photography Data Acquisition

Five flights were sufficient to cover the entire coastline of Whidbey and Camano Islands and kelp beds in Jefferson County. The map below (Figure 12 left) shows the track of the flight used to gather aerial photographs of shorelines in 2016. One additional flight (Figure 12 right) was done to survey the eelgrass beds in the San Juan Islands. Figure 13 shows the location of geo-tagged photos. The total number of aerial photos collected for this project in 2016 was approximately 2900.

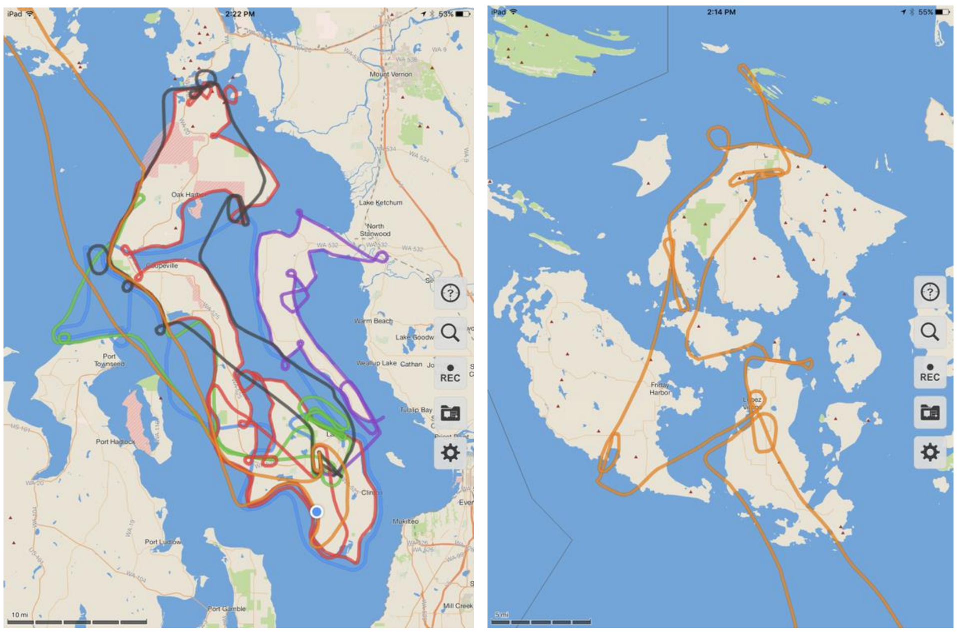


Figure 12. Galileo GPX tracks of some of the aerial eelgrass photography flights in 2016. The lines are randomly colored by flight date.

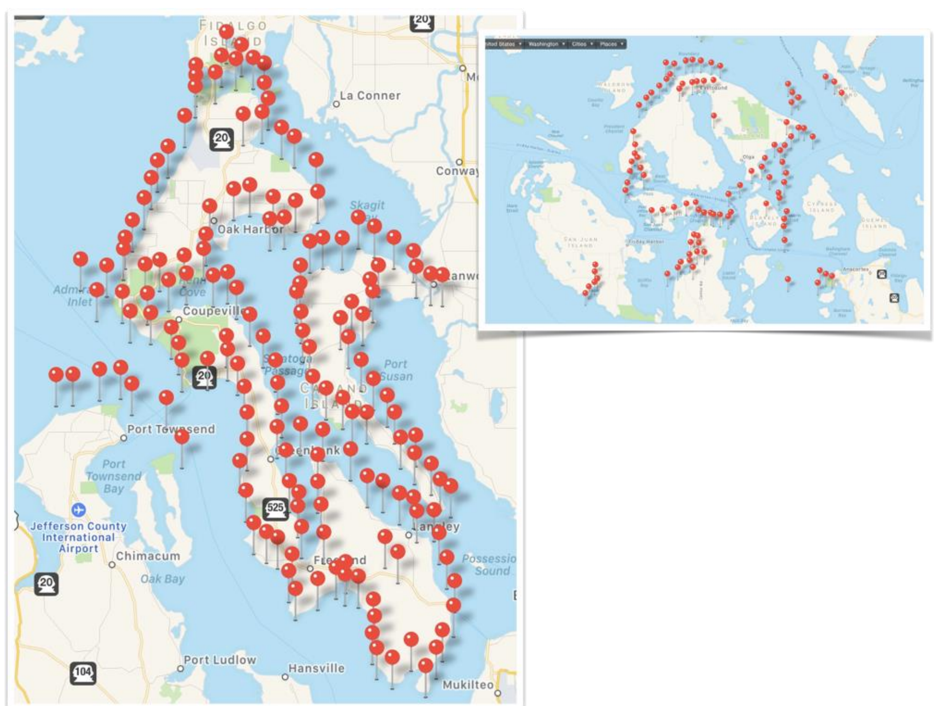


Figure 13. A small representative sampling of the geo-tagged photo positions identified by pins for multiple Counties in Puget Sound.

Data Preparation

By December 2016, all of the underwater video DVDs and accompanying spreadsheets were prepared and sent to volunteers for video analysis. By March of 2017 the aerial photographs had been geo-tagged, made into panorama images for each of the ten sampling sites and geo-referenced to a base map. The geo-referenced aerial images and available video-analysis of the transects were superimposed on a base map to allow comparison of the two data sets (underwater video and aerial photography) by April.

Video Analysis

The analysis of the underwater video for the presence/absence of eelgrass was completed by volunteers by March 1, 2016 using the video and spreadsheets produced in December 2015 and distributed by flash memory cards or dropbox downloads. The resulting Excel files containing the eelgrass scores for each site are attached (see Appendices: "2016 Video Analysis"). Scoring of the sites' videos was done by the volunteers as listed in Table 2.

Video Analysts for 2016					
Site	**Name**	**Date(s)**	**Transects**	**Size (Gb)**	**Analyst**
flats29	Cornet Bay	6/27/16	11	8.2	Mark Kennedy
swh0888	E. of Monroe Landing	7/9/16	12	4.5	Gregg Ridder
swh0898	Coupeville	6/25/16	10	2.8	Gregg Ridder
swh0900	Mineral Springs	6/24/16	11	2.1	Gregg Ridder
swh0920	S of Pratt's Bluff	7/25/16	13	1.7	Neal Clark
swh0932	Freeland Park	6/28/16	14	4.2	Gregg Ridder
swh1567/8	Camano Island SP	7/26/16	17	1.9	Neal Clark
cps0761	Dave Mackey Park	8/9/16	12	2.3	Gregg Ridder
	Usless Bay Recon	8/8/16		2.4	Gregg Ridder
Totals			100	30.1	
All data stored on LaCie/2016 and backed up on Gregg's Synology NAS Drive					

Table 2. Schedule of Video Analysis Volunteers

Eelgrass Bed Area Estimates

The Video Analysis Files for 2016 were reformatted to WADNR specifications by Neal and Connie Clark and submitted to Lisa Ferrier (WADNR). To date Lisa has now provided the estimates of eelgrass bed areas using our data from 2010 to 2014 with their latest analysis programs. For 2015 and 2016, we have done our own calculations of eelgrass bed areas by our own method (described and compared to WADNR in the 2012 final report). The results of all the eelgrass bed area estimates over the last eight years are presented in the Table 3. The results are grouped by site (colored by site to make comparisons over the years easier). The results for 2016 are highlighted in grey. Future reports will include WADNR calculations.

Results

A summary of *Zm* eelgrass bed area results (in hectares) is shown in Table 3.

Island County *Zostera marina* Bed Areas 2009 - 2016

Site Code	Site Name	Date	N	Zm Area (ha)		95% CI
cps0761	Dave Macke County Park, Maxwelton	23-Jun-11	12	4.0	±	0.8
cps0761	Dave Macke County Park, Maxwelton	9-Aug-16	12	5.7	±	0.7
cps0766-0772	Useless Bay: Deer Lagoon to Wahl Rd	8-Aug-16	2	Recon Only		
cps0776	Mutiny Bay Boat Ramp, SW Whidbey*	3-Aug-14	11	7.1	±	1.2
flats29	Cornet Bay, Whidbey*	27-Aug-09	7	20.6	±	5.3
flats29	Cornet Bay, Whidbey	3-Aug-10	10	16.2	±	3.8
flats29	Cornet Bay, Whidbey	9-Jun-11	8	22.5	±	4.4
flats29	Cornet Bay, Whidbey	11-Jul-12	9	21.7	±	3.8
flats29	Cornet Bay, Whidbey	15-Jun-13	8	21.0	±	3.1
flats29	Cornet Bay, Whidbey*	18-Jun-14	11	19.3	±	3.6
flats29	Cornet Bay, Whidbey*	22-Jun-15	12	18.2	±	3.2
flats29	Cornet Bay, Whidbey*	27-Jun-16	11	17.1	±	3.4
swh0851	Ala Spit Beach Access, Whidbey	19-Jun-14	1	Recon Only		
swh0875	Midway Blvd, Oak Harbor	29-Jun-13	12	6.0	±	2.4
swh0885	Blower's Bluff North, Whidbey	28-Jun-13	10	18.0	±	1.7
swh0885	Blower's Bluff North, Whidbey*	15-Aug-14	9	20.9	±	3.9
swh0888	E of Monroe Landing	17-Jul-10	12	8.0	±	1.6
swh0888	E of Monroe Landing	6-Jul-11	10	5.9	±	1.8
swh0888	E of Monroe Landing	21-Aug-12	10	5.4	±	2.2
swh0888	E of Monroe Landing	27-Jul-13	13	5.9	±	1.6
swh0888	E of Monroe Landing*	16-Jul-14	10	5.6	±	2.0
swh0888	E of Monroe Landing*	23-Jun-15	13	5.5	±	1.6
swh0888	E of Monroe Landing*	9-Jul-16	12	5.1	±	1.5
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	±	0.6
swh0898	W of Lovejoy Point, Coupeville	13-Jul-13	11	1.2	±	0.7
swh0898	W of Lovejoy Point, Coupeville	25-Jun-16	10	0.8	±	0.4
swh0899	Lovejoy Point, Coupeville*	28-Jul-13	10	1.3	±	0.7
swh0900	Mineral Spring, Coupeville*	26-Aug-09	14	1.4	±	1.0
swh0900	Mineral Spring, Coupeville	17-Jun-10	11	1.3	±	1.2
swh0900	Mineral Spring, Coupeville	10-Jun-11	14	0.9	±	0.9
swh0900	Mineral Spring, Coupeville	23-Jul-12	10	1.5	±	1.5
swh0900	Mineral Spring, Coupeville	12-Jul-13	13	1.2	±	1.1
swh0900	Mineral Spring, Coupeville	24-Jun-16	11	1.0	±	1.2
swh0920	S of Pratt's Bluff South, Whidbey	25-Jul-16	13	5.4	±	1.1
swh0923	N of Dines Pt North, Whidbey	9-Aug-12	10	3.6	±	0.8
swh0923	N of Dines Pt North, Whidbey*	8-Jul-15	11	2.6	±	0.7
swh0927	Honeymoon Bay, Whidbey*	17-Aug-09	14	10.9	±	1.0
swh0927	Honeymoon Bay, Whidbey	7-Jul-12	12	10.2	±	1.1
swh0927	Honeymoon Bay, Whidbey*	6-Jul-15	12	10.9	±	1.2
swh0930	S Harbor Hills Dr, Whidbey*	17-Jun-09	12	3.8	±	0.9
swh0930	S Harbor Hills Dr, Whidbey	26-Jun-12	11	3.8	±	0.8
swh0932	Freeland Park, Whidbey*	19-Jun-09	10	13.1	±	2.3
swh0932	Freeland Park, Whidbey	31-Jul-10	12	15.0	±	1.3
swh0932	Freeland Park, Whidbey	7-Jun-11	11	15.0	±	1.0
swh0932	Freeland Park, Whidbey	9-Jun-12	10	13.2	±	1.6
swh0932	Freeland Park, Whidbey	31-May-13	13	14.5	±	1.7
swh0932	Freeland Park, Whidbey*	3-Jul-14	11	14.9	±	1.5
swh0932	Freeland Park, Whidbey*	10-Jun-15	13	14.6	±	1.7
swh0932	Freeland Park, Whidbey*	28-Jun-16	14	14.9	±	1.6
swh0934	NW of Lone Lake, Whidbey*	18-Jun-09	18	4.9	±	0.5
swh0934	NW of Lone Lake, Whidbey	6-Aug-12	9	5.5	±	1.4
swh0937	East of Honeymoon Bay, Whidbey*	12-Aug-09	10	9.0	±	1.0
swh0937	East of Honeymoon Bay, Whidbey	7-Aug-12	12	9.1	±	0.6
swh0940	East of Dine's Point, Whidbey*	4-Jun-09	10	6.8	±	1.5
swh0940	East of Dine's Point, Whidbey	10-Aug-12	11	8.3	±	1.1
swh0940	East of Dine's Point, Whidbey*	7-Jul-15	12	7.7	±	0.8
swh0943	Baby Island, SE Whidbey*	19-Aug-09	13	17.7	±	2.0
swh0943	Baby Island, SE Whidbey	11-Aug-12	13	18.0	±	1.3
swh0943	Baby Island, SE Whidbey*	9-Jul-15	12	18.7	±	1.0
swh0954	N of Brooks Hill Rd, SE Whidbey*	31-Jul-14	10	20.6	±	1.8
swh0955	West Langley, SE Whidbey*	1-Aug-14	11	14.7	±	1.5
swh0957	Port of South Whidbey	20-Jun-11	10	9.1	±	1.5
swh0957	Port of South Whidbey*	2-Aug-14	12	11.0	±	1.4
swh0957	Port of South Whidbey*	20-Jul-15	12	11.2	±	1.2
swh0963	S Summerhill Drive, SE Whidbey*	21-Jul-15	9	14.6	±	0.7
swh0966	Clinton Ferry Terminal	21-Jun-11	11	7.5	±	1.2
swh0967	S of Clinton Ferry Terminal	22-Jun-11	13	2.7	±	1.0
swh0971	South Glendale, SE Whidbey*	9-Jun-15	11	6.8	±	2.4
swh0973	Possession, SE Whidbey	19-Jul-11	12	13.7	±	2.4
swh1565	Cama Beach, Camano Island	8-Aug-12	12	3.6	±	1.0
swh1567	Camano Island State Park	26-Jul-16	10	1.3	±	1.0
swh1568	Lowell Point, Camano Island	26-Jul-16	7	0.1	±	0.2
swh1570	Elger Bay, South Camano	26-Jul-13	11	18.2	±	2.1
swh1574	Camp Diana West, South Camano*	4-Aug-14	10	17.1	±	2.3

Table 3. Eelgrass Bed Areas by Site for the period from 2009 to 2016 (2009 , 2015 and 2016 results were calculated by method developed by G. Ridder; 2010 to 2014 were calculated by DNR from videography analysis data submitted by us to them. The 2016 data are highlighted in gray.

Results and Discussion by Site

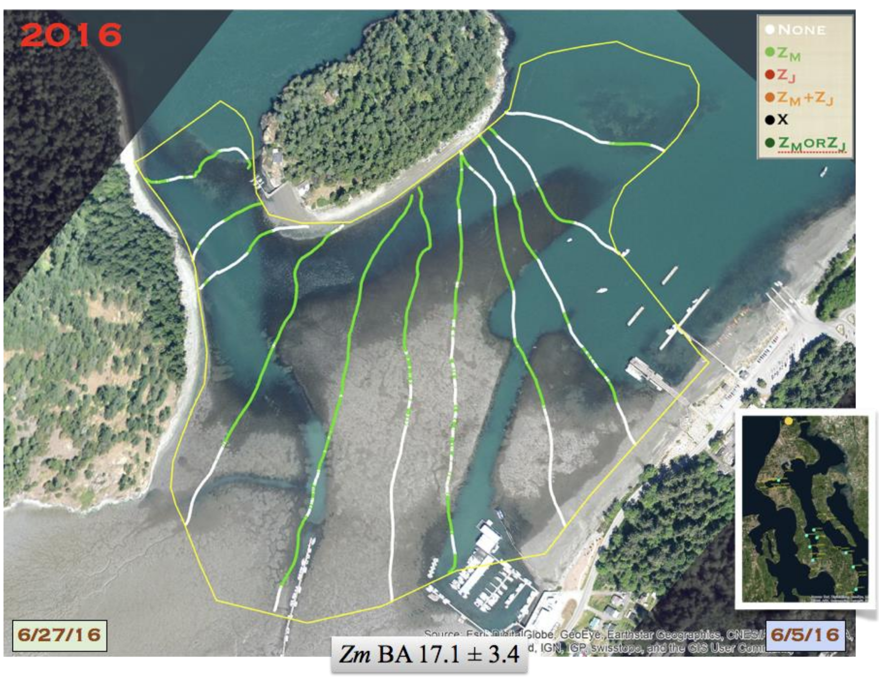
The following pages contain the maps and discussion of results for each site sampled by underwater videography in 2016 by the Island County MRC Eelgrass Project.

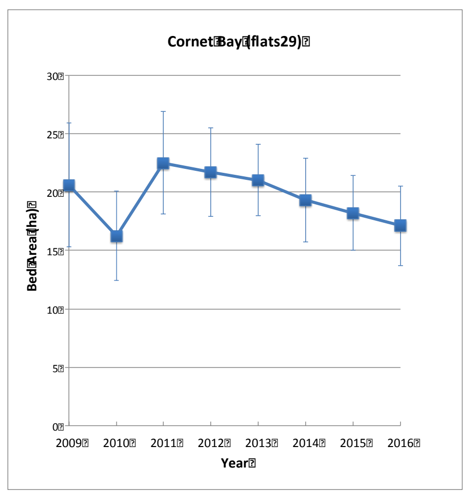
Cornet Bay (flats29)

Cornet Bay is one of our core sites and is therefore monitored each year. It contains one of the largest eelgrass beds of all the sites in Island County. The high level of interest for Cornet Bay is due to the extensive boating activity in the bay and inclusion of Deception Pass State Park where removal of creosote bulkheads and restructuring of the beach facilities was done in late 2012.

In addition, a new proposal has been submitted by WADNR and Island County Parks to change Cornet Bay moorage at the park perhaps as early as the summer-fall of 2017. The existing docks will be removed and replaced with new ones in deeper water to have less impact on the eelgrass beds than the existing docks. Also the project will replace creosote pilings with metal pilings and increase moorage space to reduce the anchorage of boats in the eelgrass beds. We were requested to survey the dock area with our methods as an adjunct to more detailed diving surveys in order to help validate the proposal's potential benefits to eelgrass and to have a more robust baseline before construction began.

The results of our 2016 monitoring show the entire eelgrass bed area for 2016 (17.1 ± 3.4 ha) is not statistically different than all the average of 19.6 ha for all the previous years (see Figure 14). However the graph has shown a clear downward trend in eelgrass bed area since 2011 ($R^2 = 0.98$; 17% loss), which is now difficult to explain simply by sampling variation. The error bars in Figure 14 are two standard errors based on the variance among the individual transects. These bars *really* represent the patchiness of the site rater than true errors of measurement.





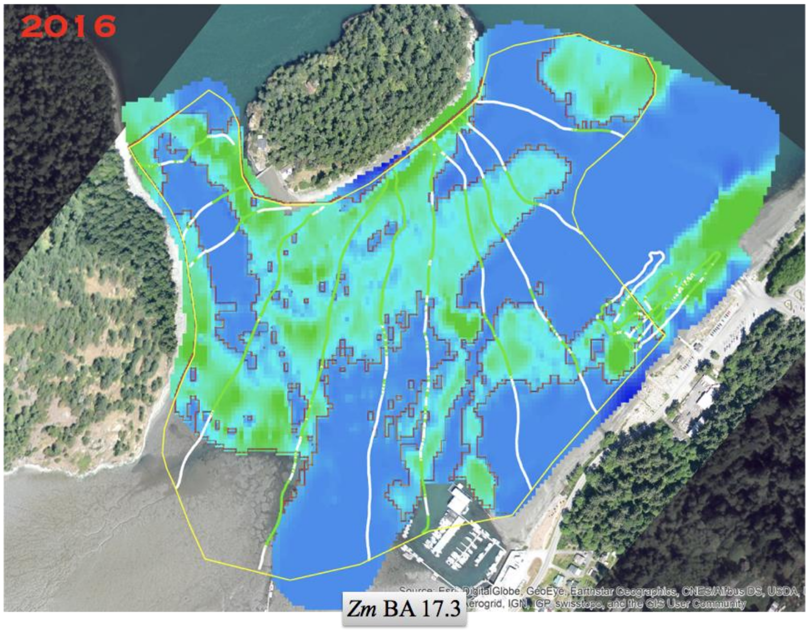


Figure 14. Aerial and Underwater Videography results for Cornet Bay (flats29) in 2016 and historic Bed Area values from 2009 (top images). Sonar map and bed area measurement based on area within sampling polygon (bottom image – red outline)

Examples of the suspected presence of propeller scars and anchor scouring are seen in the higher resolution 2016 aerial image as in all previous years (see Figure 15). No quantitative analysis of boat damage from aerial images has been done because determining which bare patches are due to recent boating activity would be too speculative.

Figure 15. 2016 Aerial photo of likely anchor scour and propeller scars (examples in purple boxes).

The dock area impacted by the WADNR proposal is shown in Figure 16. We performed a reconnaissance underwater video run and analyzed it for the presence of eelgrass (line) superimposed on the aerial image from 2016 (Figure 16 Top Left). This line was compared to a 2014 dive survey shown in the overlay provided by WADNR (Figure 16 Top Right - hatched area around existing docks). The agreement of the boundary is quite good in our opinion. In addition, Albert Foster performed sonar mapping of the same area that also shows fairly good agreement between the underwater video analysis and sonar data, but indicates more eelgrass under the docks than seen by the divers. There is some question in our mind about the effect of such structures on the sonar map.

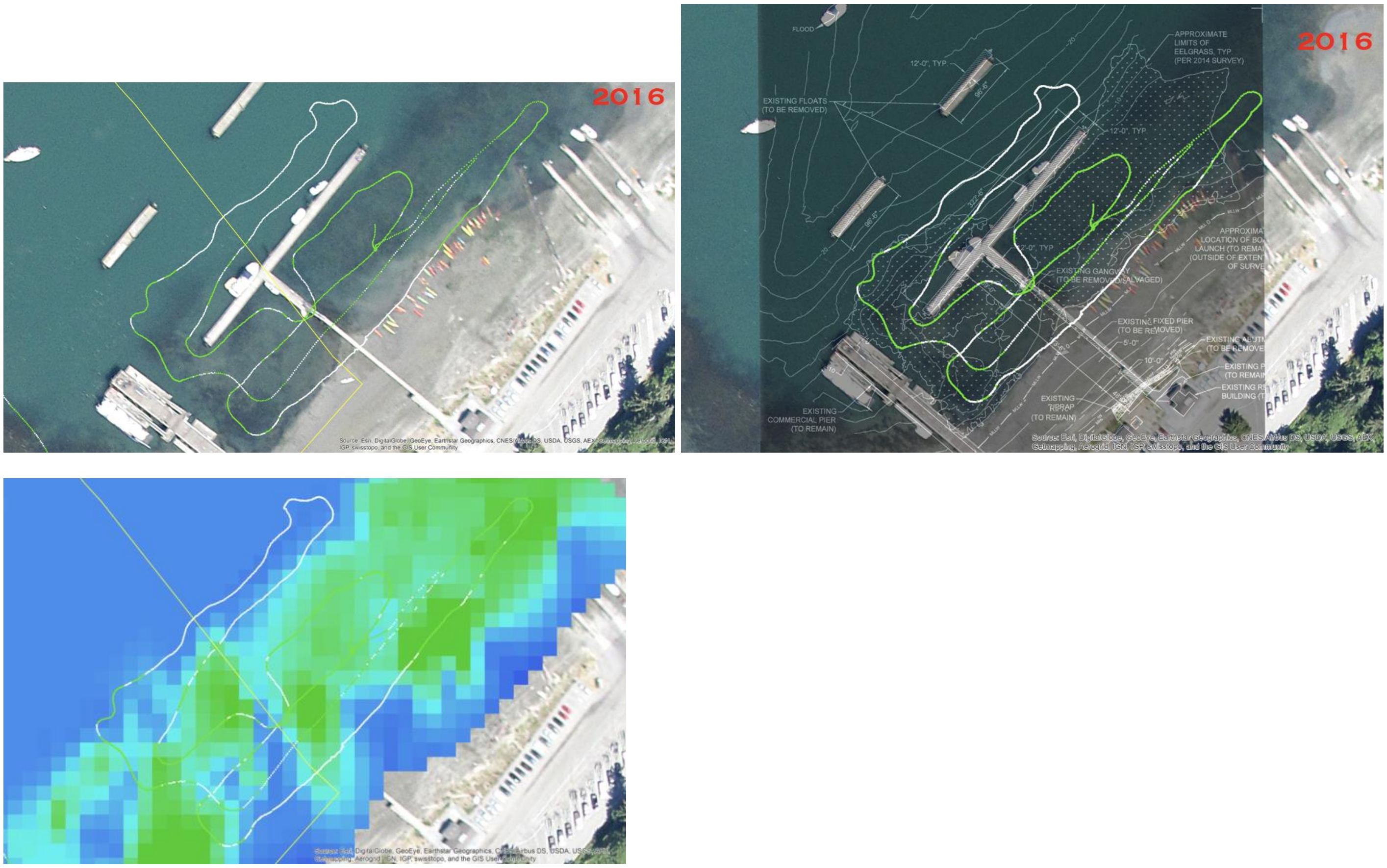


Figure 16. (Top Left) Dock area at Deception Pass State Park as seen by aerial photo and underwater video reconnaissance tracks, (Top Right) Same image as Top Left with overlay of 2014 diver's survey of eelgrass bed (hatched area) and (Bottom Left) Dock area as seen by sonar survey.

East of Monroe Landing, Penn Cove (swh0888)

The site East of Monroe Landing on Penn Cove (swh0888) is the largest bed area within Penn Cove. While eelgrass bed area differences between 2015 and 2016 are not statistically different, there appears to be further loss of eelgrass bed area on the east side of the site (right side of yellow sampling polygon in Figure 17). However, an increase in this same area compared to previous years was noted in 2014. These differences may simply represent normal variability within this site.

We also observed the appearance of green sea urchins and the loss of eelgrass that is reaffirmed in 2016. Whether there is causation by sea urchin grazing on eelgrass is not known, but there is some precedent in Alaska (NOAA Technical Memoradum NMFS-SFSC-240, P.M Harris). This is just speculation at this point.

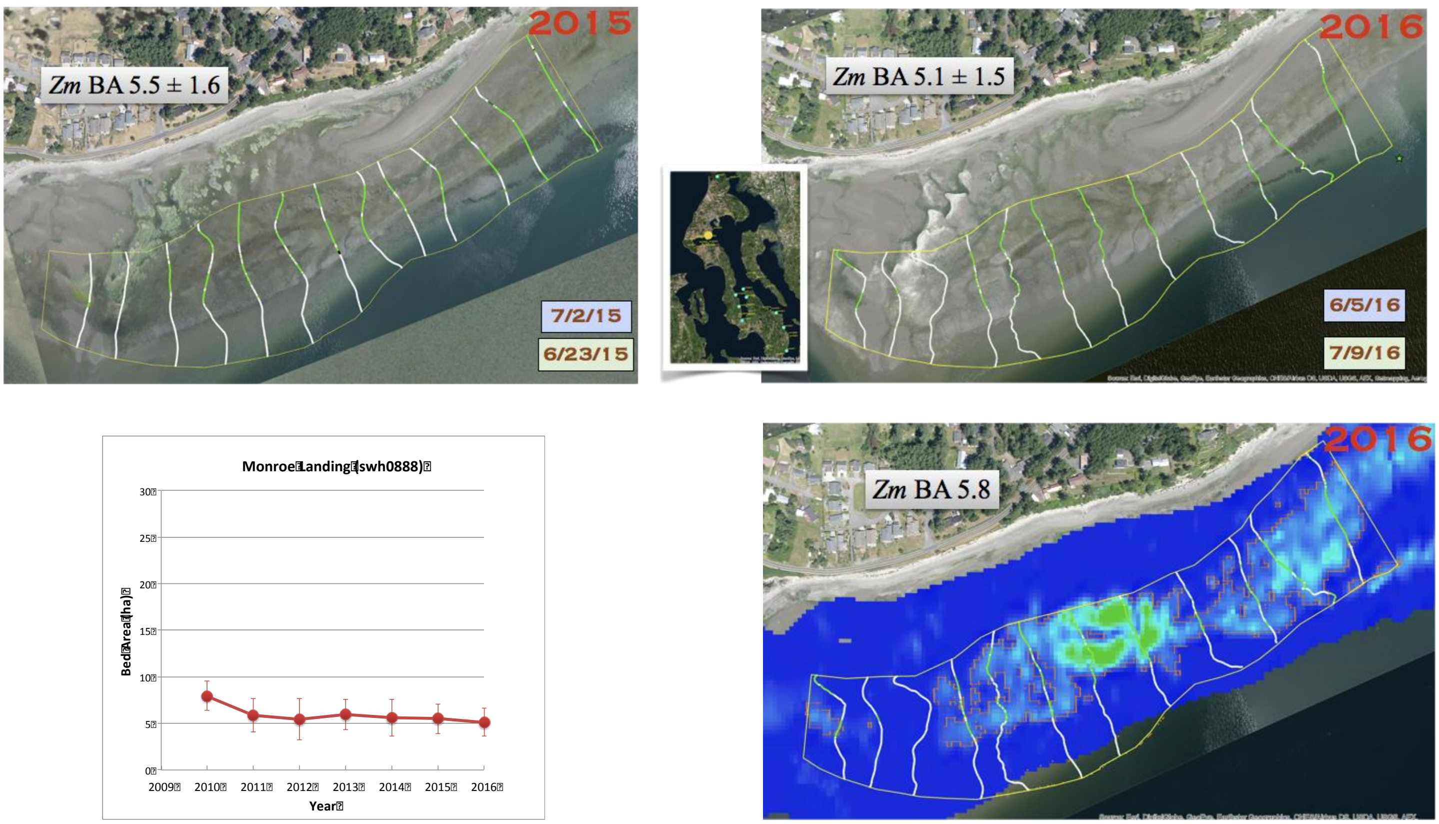


Figure 17. Aerial and Underwater Videography results for East of Monroe Landing (swh0888) in Penn Cove for 2015 and 2016 and historic Bed Area values from 2010.

West of Lovejoy Point, Coupeville (swh0898)

In the past, we measured the Coupeville eelgrass bed area in 2010 (1.0 ± 0.6 ha) and 2013 (1.2 ± 0.7 ha). Our 2016 results (0.8 ± 0.4 ha) were not statistically different from the previous results. Albert Foster also attempted to collect sonar data for this site, but was unsure of the boundaries. His partial map is also shown (see Figure 18). It is noted that the aerial photo from 2016 does not clearly show the eelgrass beds; the cause of this is unclear.

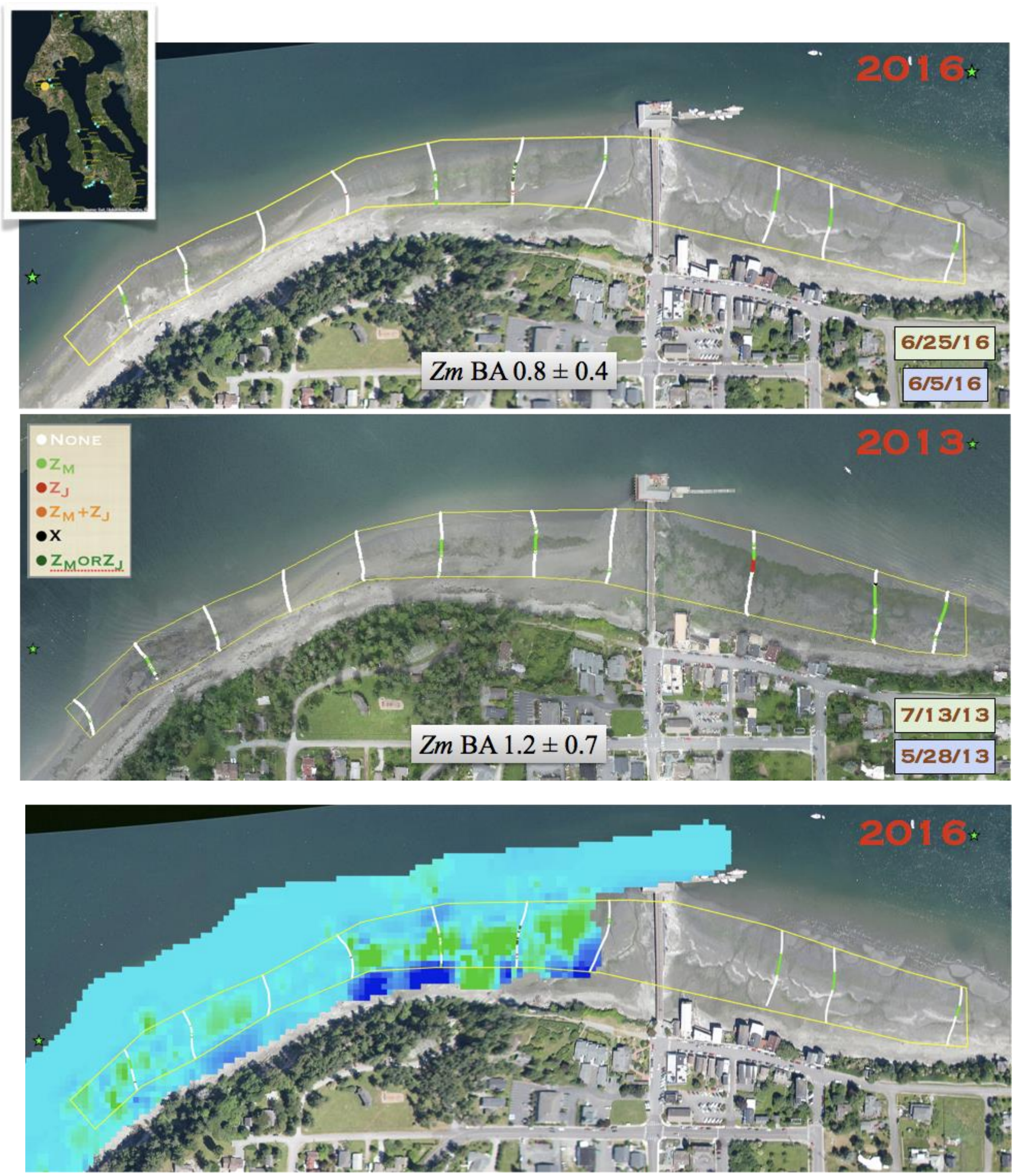


Figure 18. Aerial and Underwater Videography results for Coupeville (swh0898) in Penn Cove for 2016 and 2013.

While the eelgrass presence defined by the underwater video transect lines and the sonar data (green patches) do not disagree to any great extent, it clearly appears the total bed area in the sonar data (not quantified) is far greater than indicated by past and present underwater video assessment and aerial inspection. This is true especially in shallow areas outside of the sampling polygon (yellow line). This discrepancy requires further study.

Mineral Springs, Penn Cove (swh0900)

We have measured Mineral Springs multiple times (2009-2013) and consistently found a small eelgrass bed (1.2 ± 1.0 ha) near the western edge of the site (left in Figure 19). In 2016 an equal sized area suddenly appeared as green vegetation in aerial photos near the middle of the site. However the underwater video and sonar data agreed this was mostly sea lettuce and *not* eelgrass.

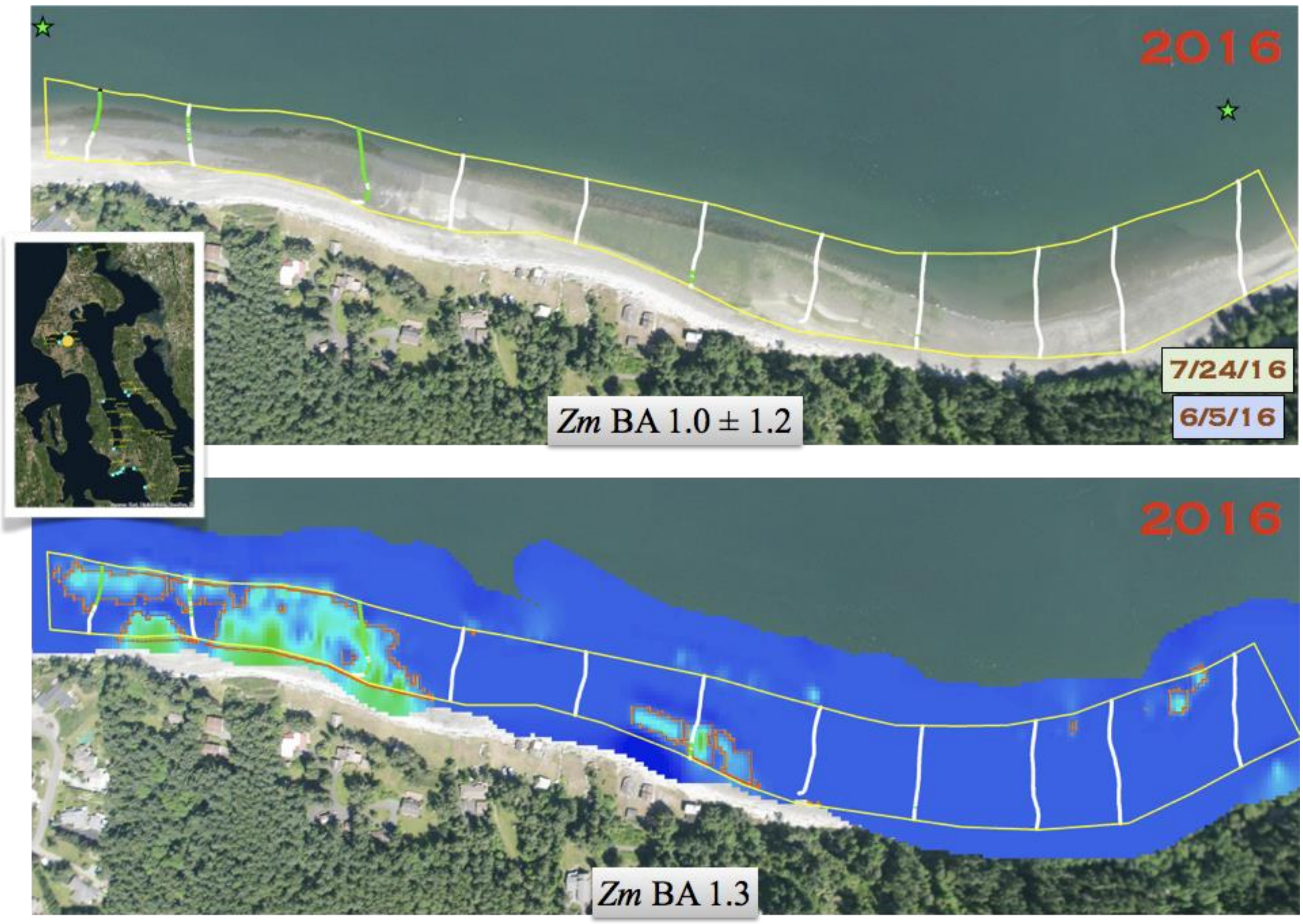


Figure 19. Aerial, Underwater Videography and Sonar results for Mineral Springs (swh0900) in Penn Cove for 2016.

South of Pratt's Bluff, Holmes Harbor (swh0920)

At the center of this site is a boat launch and wetland managed by the Green Bank Boat Club. There have been issues with the tidegate outfall and boat launch that have spawned the Whidbey Island Conservation District to propose opening the wetland by removing the tidegate and improving access to the boat launch. Our measurement of the eelgrass bed area here was intended to provide a baseline before construction to measure the impact of the changes at a future date. The sonar mapping of the site shows good agreement with the underwater video patterns, but resulted in a slightly higher estimate of bed area (see Figure 20).

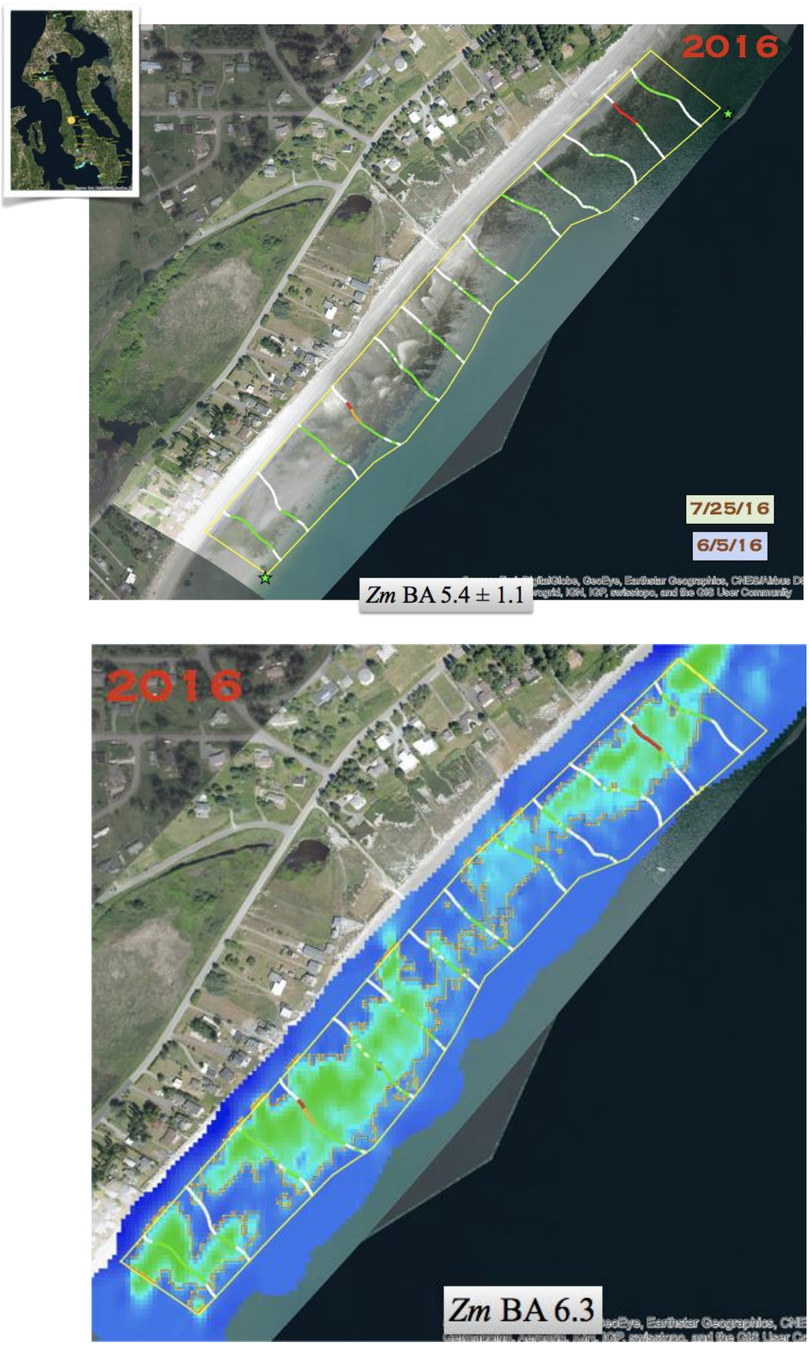
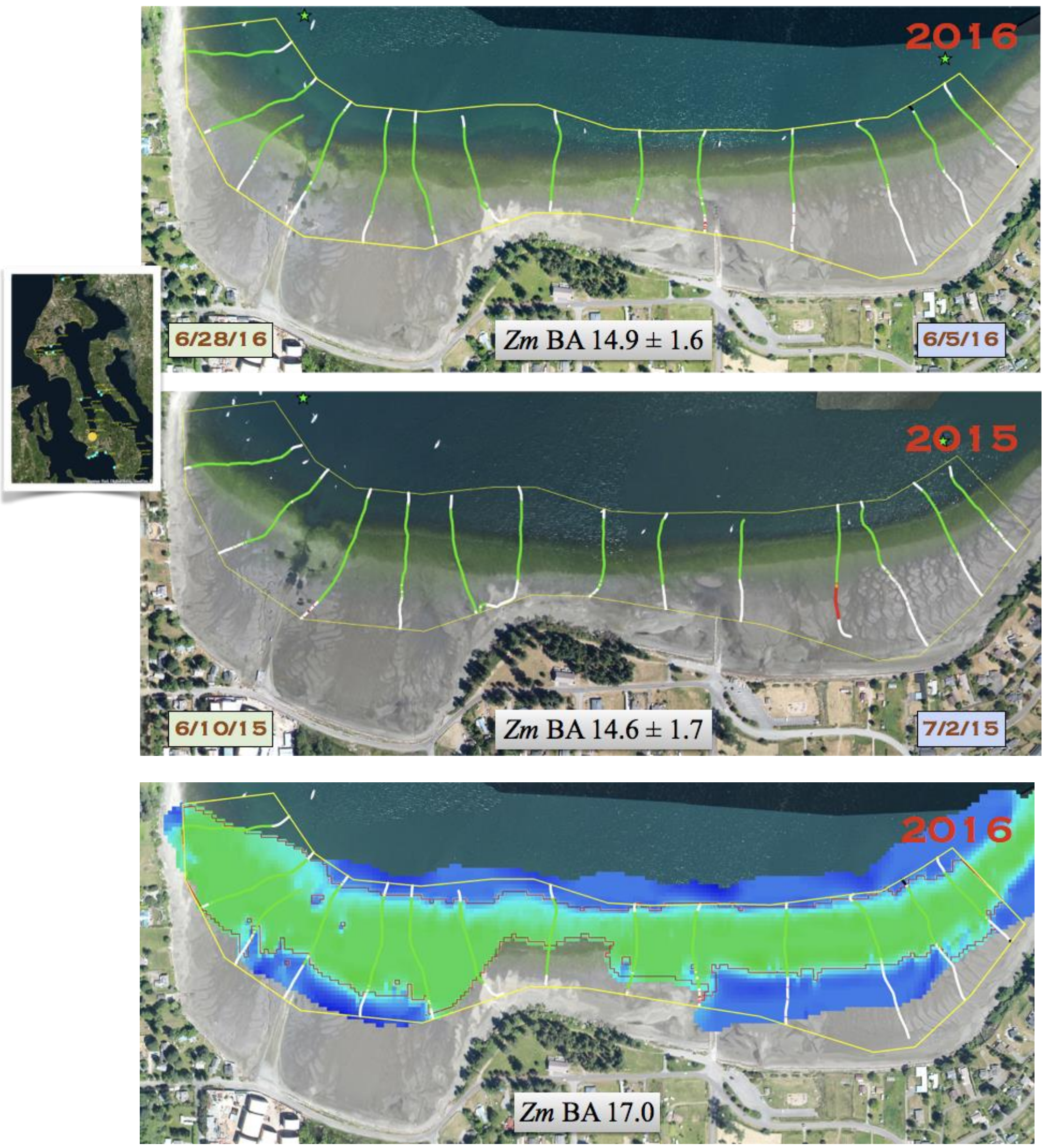


Figure 20. Eelgrass bed maps and area measurements by underwater video and sonar.

Freeland Park, Holmes Harbor (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 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).



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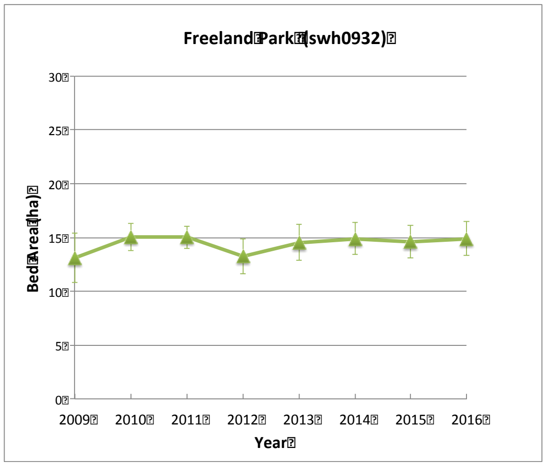

Figure 21. Aerial, Underwater Videography and Sonar results for Freeland Park (swh0932) in Holmes Harbor for 2015 and 2016 and historic Bed Area values from 2009.

No significant changes were seen from the underwater video analysis or aerial photo in the overall bed area or at the Nichols Bros. boatyard, where a difficult launch had taken place earlier in the year. The estimate of eelgrass bed area from the sonar data was somewhat higher than underwater video data estimates. This occurred even though some sonar data were missing in a shallow area (center of picture) where underwater video confirmed the presence of eelgrass. However there was close agreement between the sonar boundary (red line) and underwater video boundaries (green lines) for eelgrass presence.

Camano State Park and Lowell Point (swh1567 & 1568)

We were requested to measure the eelgrass bed area at Camano Island State Park (swh1567) and the site just south of it at Lowell Point (swh1568). Both of these sites are narrow fringes with a significant bull-kelp bed (determined by previous aerial photographs) on the southern edge of Lowell Point. Therefore we avoided creating transects at the south end of swh1568 and opted for an abbreviated reconnaissance there to confirm the kelp observations. By underwater videography and aerial photography (see Figure 22) we found only small eelgrass beds in swh1567 (1.3 ±1.0 ha) and almost none in swh1568 (0.1 ±0.2 ha).

Figure 22. Aerial and Underwater Videography results for Camano Island State Park and the adjacent site at Lowell Point.

The underwater video reconnaissance effort at the south end of Lowell Point confirmed an extensive bed consisting of bull-kelp as well as many other species of macroalgae.

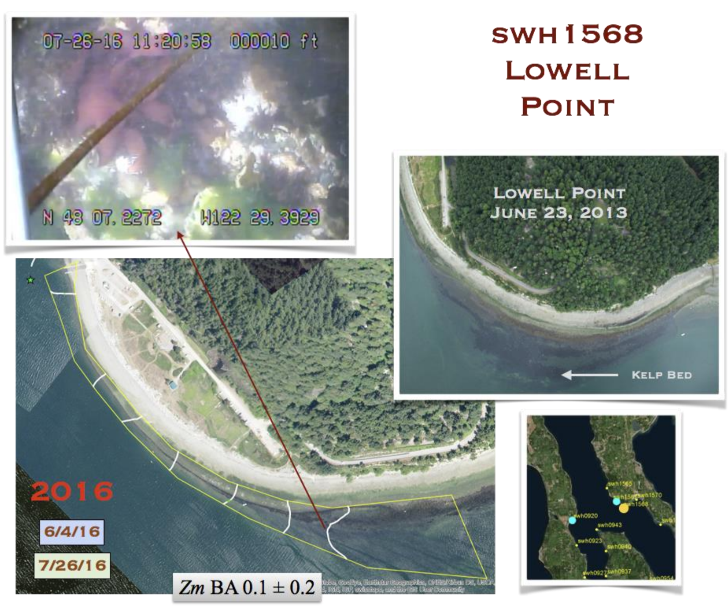

Figure 20. Aerial and Underwater Video showing kelp beds at the south end of Lowell Point

A sonar map was captured for Lowell Point (see Figure 22). The results of the map were a bit confusing as it showed a relatively high background in shallow waters (light blue) and more vegetation than expected for eelgrass compared with underwater videography. We made no attempt to quantify the eelgrass bed area from the sonar data as it would difficult to set a threshold and video inspection shows no eelgrass. The sonar signal is most likely picking up the extensive macroalgae on the seafloor. This site demonstrates the difficulty of using sonar data alone.

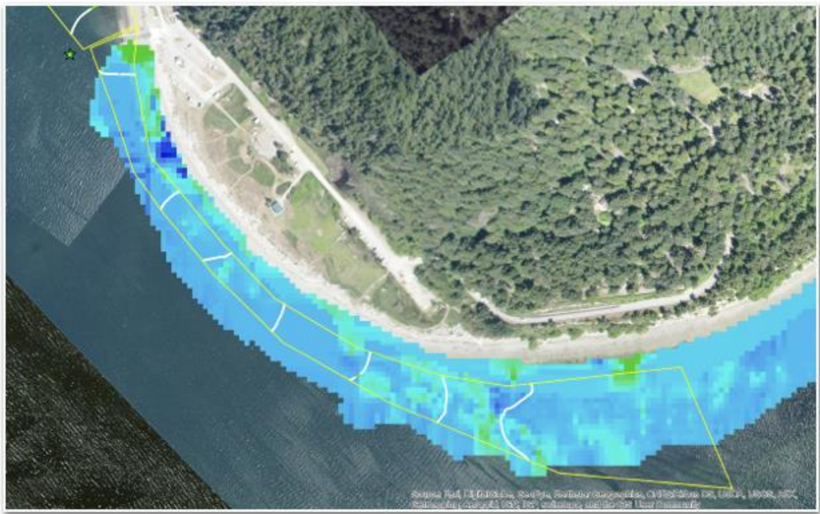

Figure 22. Sonar map of Lowell Point overlaid with underwater video transect lines.

Dave Mackey County Park, Maxwelton (cps0761)

The beach at Dave Mackey Park (see red outline in Figure 23) and beach area northward (right in picture) have undergone significant natural reconstruction due to the littoral drift of sand from the south (left) during storm events over the last seven years. Yearly aerial images from 2010 show clearly the steady progression (data not shown, but available on request). The "new" beach (white sand) formation has changed storm drain runoff, eroded beach front boundaries to the north of the park, altered the flow of fresh water from the tide gate (outfall is above the aerial date box). It also appears to have reduced the size of the *Zjaponica* bed area (large vegetative growth area in the shallow flats). This *Zjaponica* eelgrass bed is an important food source for overwintering Brandt's Geese each year (see panorama photo). Whether this beach remodeling has affected to the *Zmarina* bed area (dark area at the water's edge) was uncertain. The *Zmarina* eelgrass areas were originally measured in 2011 by underwater videography (4.0 ± 0.8 ha) and re-measured in 2016 (5.7 ± 0.7 ha). The aerial photos also appear to show an increase in the eelgrass bed area. Of course, there may be no cause and effect between the littoral drift in the shallow areas and the *Zmarina* in the steeper dropoff region. It is also very likely that this seagrass is actually surfgrass (*Phyllospadix*) and not *Zmarina.* Surfgrass and eelgrass are equivalent for our purposes.

Figure 23. Aerial photos of the Maxwelton Beach area from 2010 and 2016. Note the change in shoreline due to littoral drift from the south (left) and decrease in *Zjaponica* bed area to the north (right) of Dave

Mackey County Park (red outline in 2016). Brandt's Geese in the winter of 2016 are shown feeding on *Zjaponica*.

Sonar was also used in 2016 to measure the seagrasses at Dave Mackey Park (see Figure 24). The sonar map was measured and eelgrass bed area estimate of 5.1 ha. The sonar vegetation signal for this bed appeared much weaker than expected and missed the deeper regions of eelgrass. One reason could be that this is a fairly steep slope, presenting difficulty for sonar to discriminate plant height from a changing background and/or that strong currents reduced the plant height above the seafloor. Regardless, this site was challenging for sonar. However, the sonar vegetation signal from the much smaller *Zjaponica* plants in the shallow flats produced an impressive signal above background.

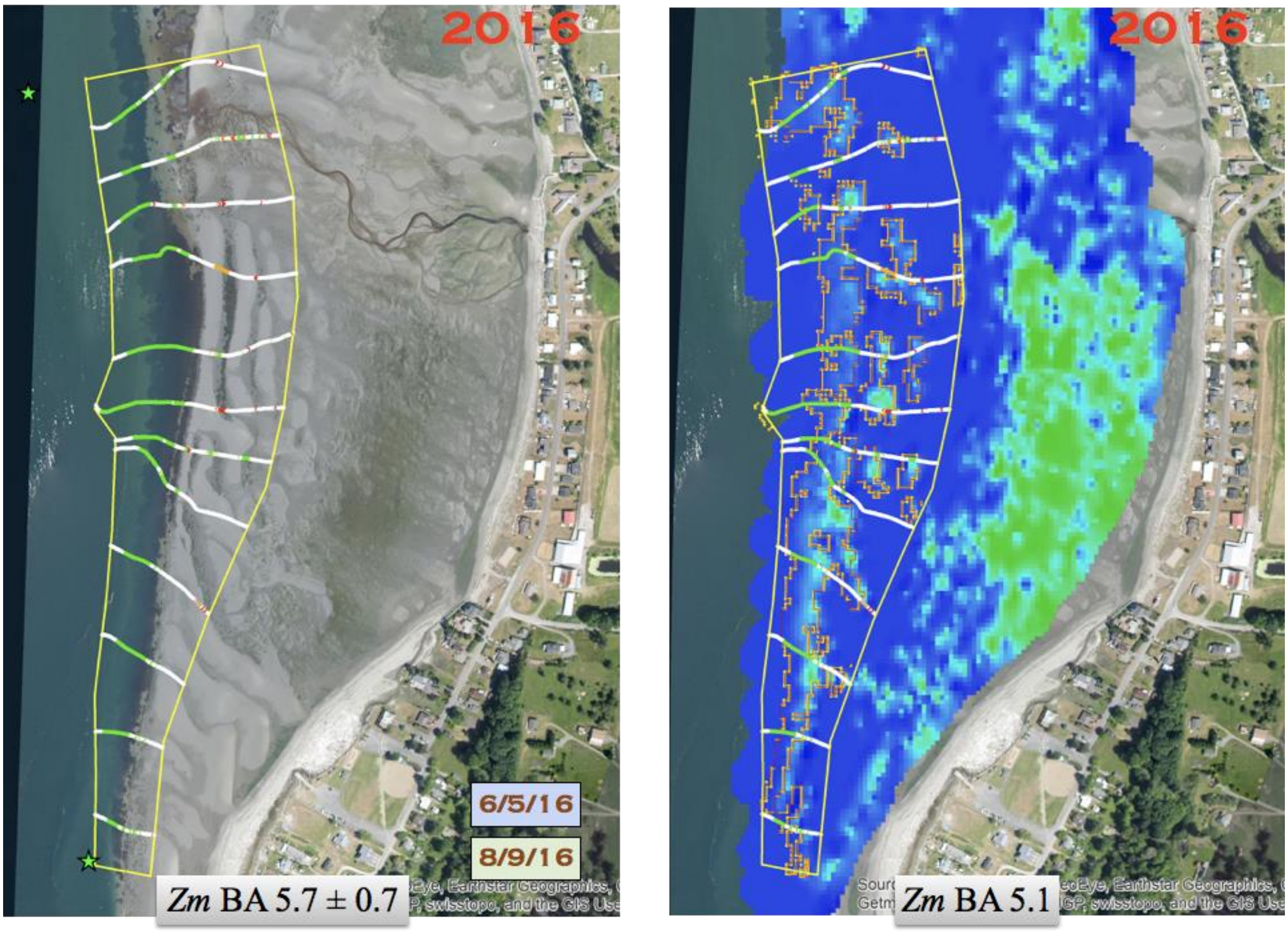

Figure 24. Aerial, underwater videography and sonar maps of Dave Mackey Park, Maxwelton (cps0761).

Useless Bay North - Reconnaissance.

The north shore of Useless Bay (see Figure 25) is quite long and spans seven WADNR sites (cps0766-cps0772). The shore varies from a large flats (cps0766 – right side of photo) to a narrow fringe (cps0772 – left side of photo). Just as with Dave Mackey Park, the seagrass (probably surfgrass) appears to follow the steep dropoff at the low tide edge. Because we have not surveyed this area before, we decided to do a zig-zag reconnaissance run to inspect, but not measure, the eelgrass distribution along the shoreline. Albert Foster is pictured near large clumps of seagrass at a low, low tide (yellow box #1 in Figure 25).

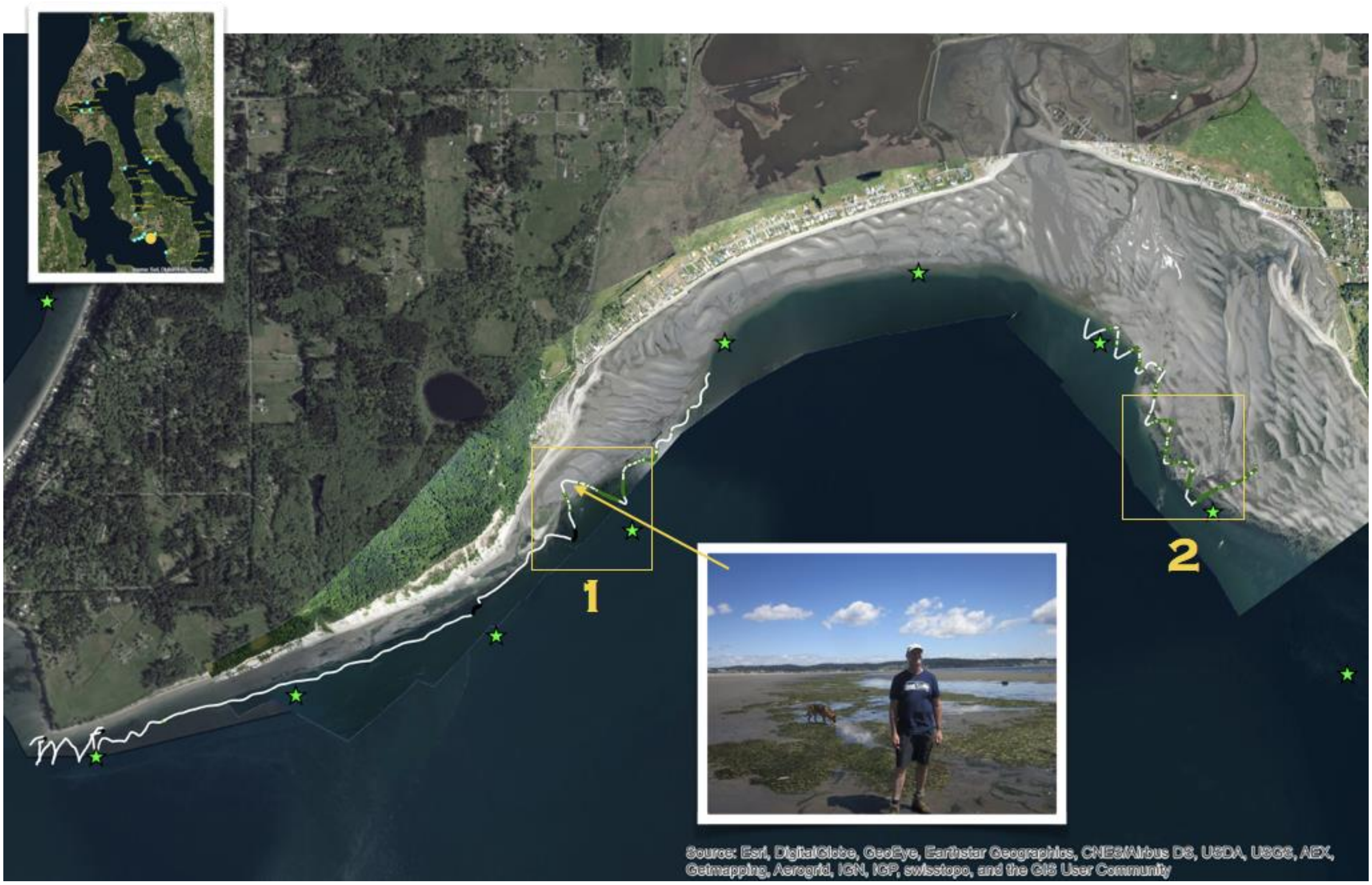

Figure 25. Aerial view of the north shore of Usless Bay with reconnaissance track of underwater video. Double Bluff shoreline (left two sites) appears to be devoid of seagrass. Areas containing seagrass (yellow boxes) are discussed below. Albert Foster inspecting seagrass at low, low tide – obviously his dog is doing all the work.

For this survey, the trip started on the western edge (left in Figure 25) of the shoreline and proceeded east in a slow zig-zag manner that quickly became a more of a straight line at a approximate depth of 10'. This was done to complete the survey of Double Bluff in a timely manner and because no eelgrass was seen during the zig-zag beginning. While there was nearly complete coverage of the seafloor with macroalgae of various species, we saw no eelgrass until we reached the area shown in the yellow box 1 in Figure 25. At that point we returned to a zig-zag pattern with results shown in Figure 26. The underwater video snap-shot of the position labeled "B" in Figure 26 shows the typical vegetation observed at that position and west (Double Bluff). It shows no eelgrass, but significant coverage of the seafloor with other vegetation. The underwater video snapshot of the position labeled "A" labeled shows the seagrass as encountered by Albert in Figure 25. Interestingly, the sonar map in Figure 26 does not detect vegetation occupying area above the seafloor at position "B", but does detect the seagrass column at position "A". We continued recording past this position to the east (right) until it was clear no vegetation was observed, then turned off the recording and increased our speed to get to the further most eastern spot (right of box "2"). At that point we started recording a zig-zag pattern from the east to the west through box "2" and beyond until the vegetation again disappeared. The results in box 2 are shown in Figure 27. Nearly all the vegetation observed at this depth was seagrass (snapshot "A") surrounded by bare sand (snapshot "B").

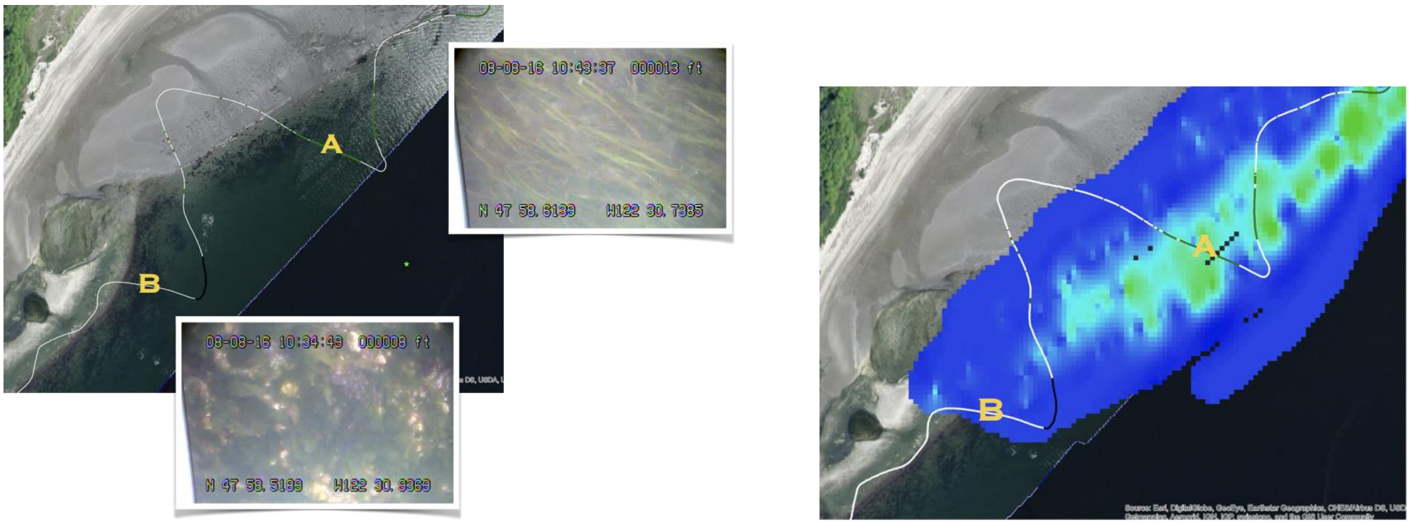

Figure 26. Recorded underwater video track and snapshots (left) taken in while surveying the area defined by the yellow box "1" in Figure 26 as well as sonar map of the same region (right)

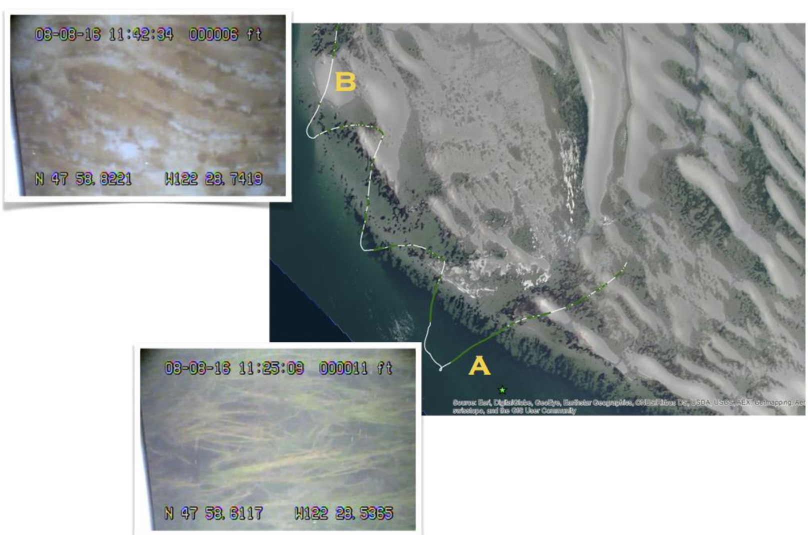

Figure 27. Recorded underwater video track and snapshots taken while surveying the area defined by the yellow box "2" in Figure 26. No sonar survey was done at this position.

Comparison of Underwater Video and Sonar Eelgrass Bed Area Estimates

For 2016 we were able to complete underwater video analysis and sonar mapping to estimate eelgrass bed areas at six sites: flats29, swh0888, swh0900, swh0920, swh0932 and cps0761. The correlation of bed area estimates between these methods is shown in Figure 28. We had incomplete mapping at swh0898 and very low signal to background at swh1568, so no estimates are available for those two sites. Both of these sites were between less than 1.0 ha by underwater videography estimates and appeared to identify more area by sonar.

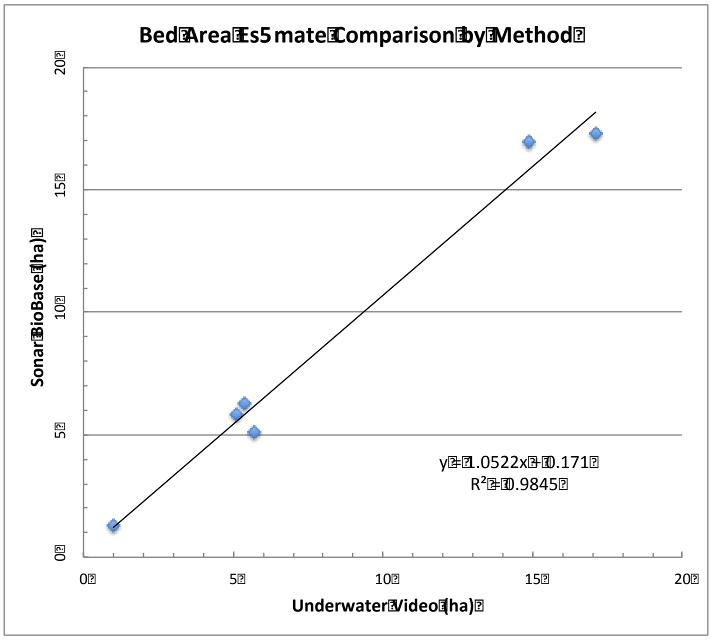

Figure 28. Comparison of Eelgrass Bed Area estimates by underwater video analysis versus sonar mapping in 2016.

The correlation of the data points we have to date is good and we are encouraged to continue this investigation. We recognize the limitation of sonar to identify the type of vegetation based only on the sonar signal and realize that some form of visual validation is required. There appear to be some issues with vegetation on steep slopes or in very shallow water or under structures such as docks. At this point it appears we have both false positives and false negatives to better understand. However, we greatly applaud the advantages of : (1) being able to get complete coverage of a site in less time that it takes to do ten underwater video transects, (2) having commercial equipment that is readily available and less expensive, (3) having commercial data processing services, (4) requiring only a single operator and (5) being able to use the equipment on small platforms (e.g. kayaks). Albert agreed to continue testing this approach with us in 2017 (as of this writing he has completed data collection) and determine what it would take to fully implement the method as a replacement for our aging underwater videography equipment (and operators!). There will be a much more thorough report next year when we have more data and experience.

Additional Aerial Photos

For 2016, a variety of sites outside of Island County were photographed for other projects. A map of where these photos were taken is shown in Figure 29. Some of these photos were taken in support of eelgrass wasting disease studies and some were in support of a kelp monitoring projects. No discussion of these projects will be offered here; we simply share that the aerial photos exist for other interested parties. Unfortunately, the airplane was out of service after July 4th until November due to a required wing repair identified during the annual inspection in July. All of the eelgrass aerial images were collected for 2016, but the prime kelp aerials (Aug-Sept) were not…bummer.

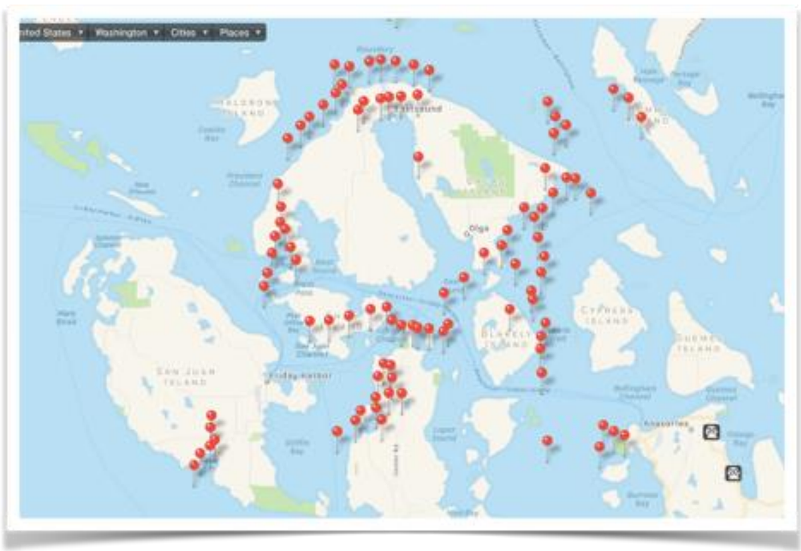

Figure 29. Map of aerial photographs taken in the San Juan Islands for 2016 before the plane broke.

Conclusions

We have completed the analysis of all the data (aerial, underwater videography and sonar) gathered in 2016. The results were presented to the Island County Marine Resource Committee on April 4th, 2017. This report fulfills our responsibilities for the 2016 contract period. From our experience we have reached a number of conclusions about our results and processes:

• Our core sites (flats29, swh0888 and swh0932) appear to be relative stable over the eight years we have measured them. There are issues within each site, but none of the eelgrass bed areas have changed at the 95% confidence limit. From the underwater videography data we have a trend of decreasing eelgrass bed areas at Cornet Bay (flats29) since 2011 that statistics tells us is very unlikely to be due to random sampling variations. The only clue we have from aerial photos is small, detrimental impacts on eelgrass beds from boating activity (channels, propeller strikes, anchor scour), but we cannot assign cause and effect. The data for Monroe Landing in Penn Cove (swh0888) suggests continuing shifts in eelgrass distribution with possible association of sea urchin grazing. The data for Freeland Park (swh0932) show recovery from a single (anecdotal) incident of eelgrass bed loss in 2008, but no apparent affect from boating activity or shipbuilding at this Holmes Harbor site. An interesting observation of potential sand dollar associated eelgrass loss at Freeland remains a very small issue and unchanged over the years.

• Our return to Penn Cove in 2016 resulted in measuring two additional sites (swh0898 and swh0900). Both of these sites have only small eelgrass beds that have not changed since they were measured in 2010 and 2013.

• At Greenbank (swh0920), we now have a baseline measurement to assess the impact of tidegate removal and boat launch modification in the future.

• It appears the shoreline of Camano Island State Park (swh1567 & swh1568) is better characterized by kelp beds rather than eelgrass beds. Very little eelgrass was found there.

• The entire shoreline of Usless Bay has undergone significant modification by littoral drift after winter storms in the past six years. Near the Dave Mackey County Park (cps0761) the *Zjaponica* beds in the flats appear smaller, but the seagrass beds (probably *Phyllospadix*) at the dropoff in deeper water appear to have increased in size. The north shore of Useless Bay (cps0766-cps0772) has the same profile of seagrass at the drop off which transitions into macroalgae across Double Bluff at the western edge.

• Over the last nine years we have measured eelgrass beds nearly eighty times at nearly forty different sites in Island County. We have collected aerial photos of the complete coastline of Whidbey in 2014, 2015 and 2016 and have partial coverage since 2009. We also have aerials of complete coastlines of Camano in 2009, 2015 and 2016 with partial coverage for other years. We now have sonar maps of eight sites.

• Underwater videography has been our primary tool to measure eelgrass bed area and has served us well. However, in 2016 we encountered troublesome equipment failures due to nearly ten years of use. Even our aerial photography was subject to issues of an aging plane. In the end we prevailed, but began thinking about how to retire the equipment (and the team). To date we have not found direct replacements for either the equipment or team. Fortunately, Albert Foster came along with a possible alternative method using inexpensive, commercially available equipment with many advantages. Our strategy for the next year is to continue one more year with the underwater videography, aerial and sonar to see if we can develop a strategy for going forward.

• Our results are presented in graphic form on SoundIQ thanks to the efforts of Suzanne Shull (NW Straits) - http://www.islandcountymrc.org/Projects/Education-Outreach/Sound-IQ-Data-System/SoundIQ.aspx

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 and 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

9/29/17