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2015 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 2015.

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. In 2015 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 four additional sites in Holmes Harbor to repeat our assessment from 2012 (swh0923, swh0927, swh0940 and swh0943). The remaining three sites were from south Whidbey and chosen because of recent dock construction at Langley Marina (swh0957), future bulkhead removal at the Waterman property on Summerhill Drive (swh0963) and future dock construction at Glendale (swh0971).

Aerial photographs were taken for the entire coastline of Whidbey Island and selected areas of Camano. Maps depicting both underwater video assessments and geo-referenced aerial photographs were prepared for all ten sites. Additional features were noted in the aerial photographs for other sites in Island County.

Results this year show the three core sites, the four additional Holmes Harbor sites and Langley Marina (swh0957) appear to have stable eelgrass bed areas compared to previous years. Cornet Bay again demonstrated local damage to eelgrass beds by boating activity and no changes from recent bulkhead removal. We have established a baseline for two South Whidbey sites for comparison after future construction.

Methods

Underwater Videography

A complete description of our underwater videography method has been defined in the attached document: "Underwater Videography Manual v1_4.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:

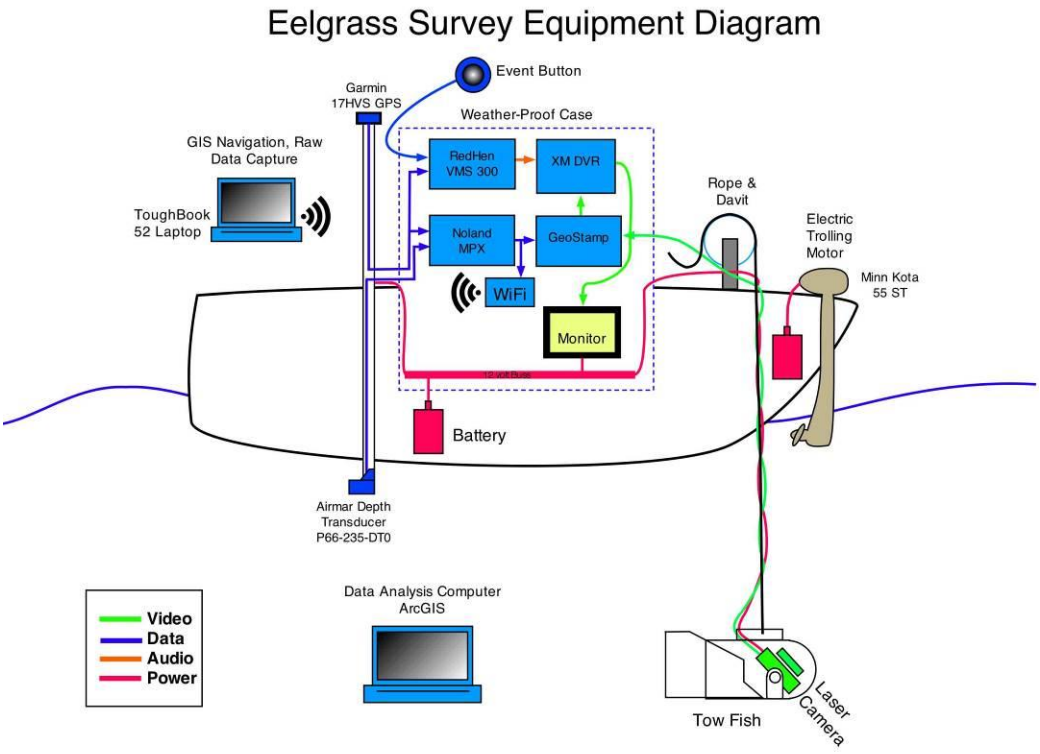


Figure 1. Equipment diagram for Beachwatcher's underwater video data collection.

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 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. 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 naip_1-1_1n_s_wa029_2006_1.sid) 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.

Mapping of Aerial and Underwater Videography Results

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 key below). 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.

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 (e.g., 2011 and 2013 in Figure 7 graph).

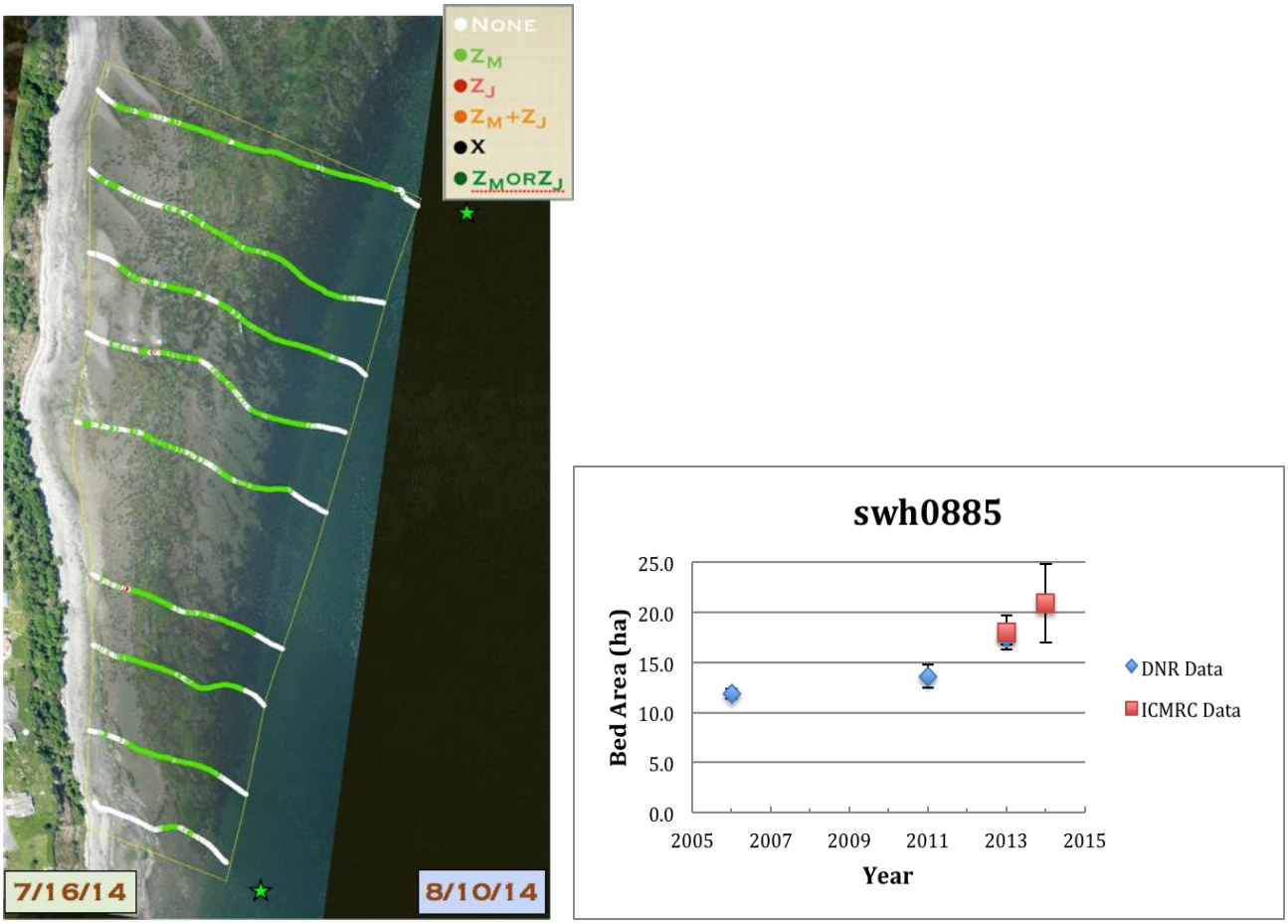


Figure 7. Example of geo-referenced aerial photograph, underwater videography and historic results of eelgrass bed areas.

2015 Data Acquisition

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 activity to understand related changes in selected eelgrass bed areas over shorter periods of time (3-5 years).

Three sites, Cornet Bay (flats29), Monroe Landing (swh0888) and Freeland Park (swh0932) are measured and analyzed every year to study year-to-year changes in areas of significant human activity. Cornet Bay has shown continuing damage to eelgrass beds from boating activity and is an interesting study of bulkhead removal at the park. Monroe landing (swh0888), at the mouth of Penn Cove, is being studied because it is the boundary between good eelgrass growth outside the cove and nearly absent eelgrass growth inside Penn Cove. Freeland Park (swh0932) in Holmes Harbor was the site of damage to eelgrass beds by Nichols Brothers at the boat launch ramp, significant loss of eelgrass beds by a large storm event and frequent boat launches at the park.

On a three-year cycle time we repeat other sites in Holmes Harbor, Penn Cove and South Whidbey. We also sample individual sites associated with past or planned disruptions to the shoreline. In 2015 we chose Langley Marina (swh0957), the Waterman property on Summerhill Drive (swh0963) and Glendale (swh0971). No sites of interest on Camano were identified for 2015.

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. Figure 8 is a map of our entire site list with those sampled by underwater videography in 2015 depicted in large blue dots.

Figure 8. Underwater videography sampling sites studied in 2015 (blue dots) are shown with other sites studied in previous years (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: "2015 Quick Report.doc"). In 2015 the data collection outing went smoothly with only minor weather or equipment issues.

The list of crew and sites for 2015 are shown in Table 1. All of our underwater video data collection was completed by July 21, 2015.

Crew Schedule for 2015 Eelgrass Monitoring				
Date	**Site**	**Captain**	**Equipment**	**Camera *****
6/8/15	swh0932	Ken Urstad	Gregg,Bob,Neal Tom,Mark,Anna	Training/Testing
6/9/15	swh0971	Ken Urstad	Neal	Neal
6/10/15	swh0932	Ken Urstad	Gregg	Gregg
6/22/15	flats29	Ken Urstad	Mark, Bob	Bob, Mark
6/23/15	swh0888	Ken Urstad	Mark	Mark
7/6/15	swh0927	Ken Urstad	Gregg	Gregg
7/7/15	swh0940	Ken Urstad	Bob	Bob
7/8/15	swh0923	Ken Urstad	Tom	Tom
7/9/15	swh0943	Ken Urstad	Bob, Tom	Tom,Bob
7/20/15	swh0957	Ken Urstad	Gregg	Anna
7/21/15	swh0963	Ken Urstad	Bob	Finn

Table 1. Crew Schedule for 2015 Underwater Videography outings (complete names of equipment/camera crew are: Gregg Ridder, Bob Gentz, Neal Clark, Tom Vos, Mark Kennedy, Anna Toledo).

Aerial Photography Data Acquisition

Five flights were sufficient to cover the entire coastline of Whidbey Island, selected areas of Camano Island, kelp beds in Jefferson and Snohomish Counties, and Fidalgo Bay. The map below (Figure 9 left) shows the track of the flight used to gather aerial photographs of shorelines in 2015. Two additional flights (Figure 8 right) were done to survey the eelgrass and kelp beds in the San Juan Islands. Figure 10 shows the location of geo-tagged photos. The total number of aerial photos collected for this project in 2015 was approximately 5,800.

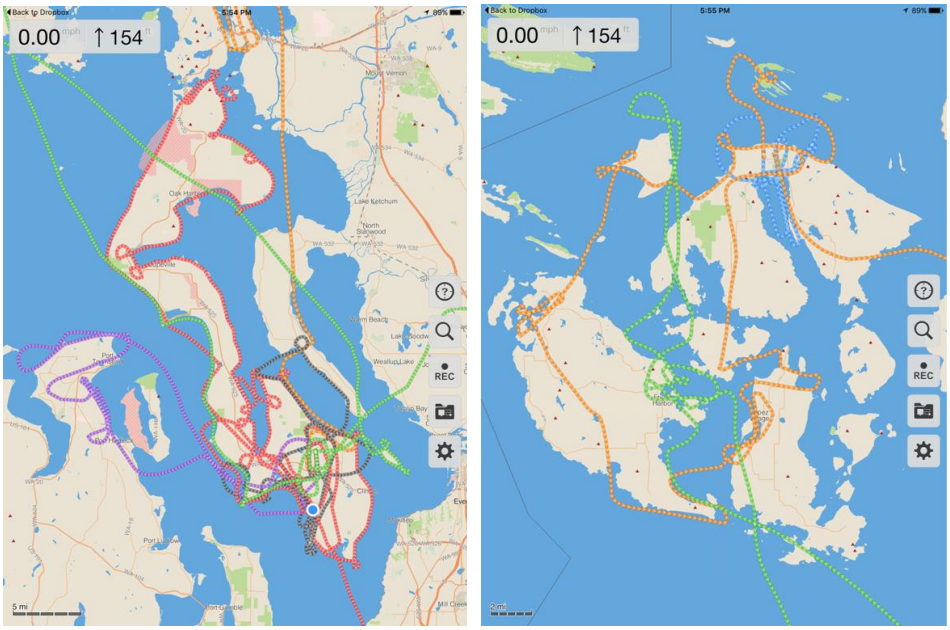


Figure 9. Galileo GPX tracks of some of the aerial eelgrass photography flights in 2015. The lines are randomly colored by flight date.

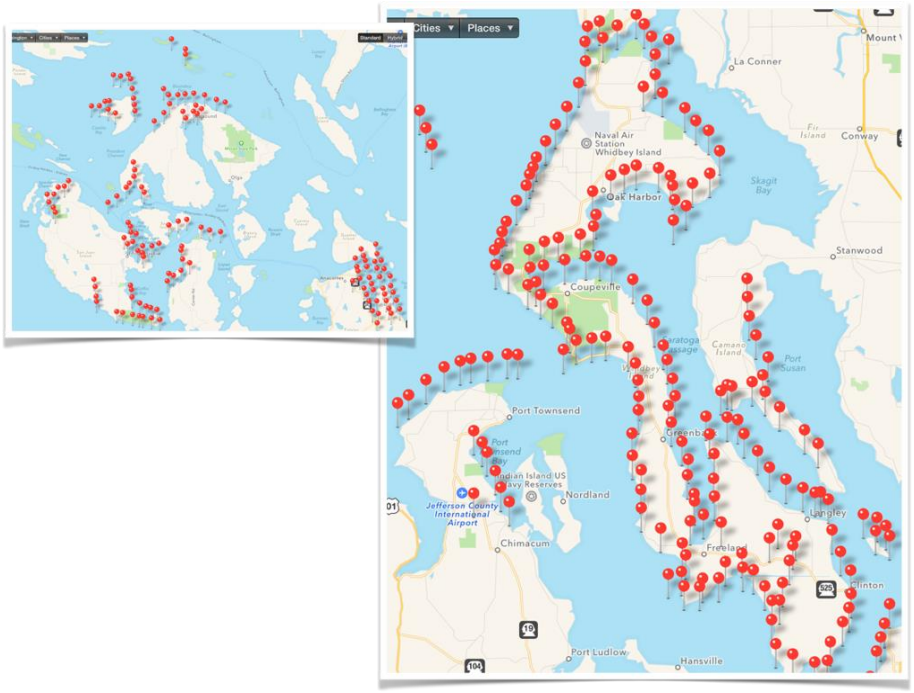


Figure 10. A small representative sampling of the geo-tagged photo positions identified by pins for multiple Counties in Puget Sound.

Data Preparation

By December 8, 2015, all of the underwater video DVDs and accompanying spreadsheets were prepared and sent to volunteers for video analysis. By March of 2015 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 of eelgrass was completed by volunteers by March 1, 2016 using the video DVDs and spreadsheets produced in December 2015. The resulting Excel files containing the eelgrass scores for each site are attached (see Appendices: "2015 Video Analysis"). Scoring of the sites' videos was done by the volunteers as listed in Table 2.

Video Analysts for 2015					
Site	**Name**	**Date(s)**	**Transects**	**Size (Gb)**	**Analyst**
swh0971	South Glendale	060915	11	4.2	Gregg Ridder
swh0932	Freeland Park	061015	13	6.0	Gregg Ridder
flats29	Cornet Bay	062215	12	7.8	Mark Kennedy
swh0888	Monroe Landing	062315	13	7.0	Mark Kennedy
swh0927	Honeymoon Bay	070615	12	4.1	Gregg Ridder
swh0940	Holmes View	070715	12	3.3	Gregg Ridder
swh0923	N of Dine's Point	070815	11	1.8	Gregg Ridder
swh0943	Baby Island	070915	12	5.1	Gregg Ridder
swh0957	Langley Marina	072015	12	3.5	Neal Clark
swh0963	Summerhill Dr.	072115	9	3.4	Neal Clark
Totals			117	46.2	
All data stored on LaCie/2015 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 2014 and 2015 were reformatted to DNR specifications by Neal and Connie Clark and submitted to Lisa Ferrier (DNR). 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, we have done our own calculations of eelgrass bed areas by our own method (described and compared to DNR in the 2012 final report). The results of all the eelgrass bed area estimates over the last five 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 2015 are highlighted in grey.

Results

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

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
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	20.3	±	4.7
flats29	Cornet Bay, Whidbey*	22-Jun-15	12	18.2	±	3.2
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	20.4	±	3.1
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	6.0	±	1.8
swh0888	E of Monroe Landing*	23-Jun-15	13	5.5	±	1.6
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
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
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

Site Code	Site Name	Date	N	Zm Area (ha)		95% CI
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	15.2	±	1.7
swh0932	Freeland Park, Whidbey*	10-Jun-15	13	14.6	±	1.7
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	21.5	±	1.9
swh0955	West Langley, SE Whidbey	1-Aug-14	11	14.9	±	1.4
swh0957	Port of South Whidbey	20-Jun-11	10	9.1	±	1.5
swh0957	Port of South Whidbey	2-Aug-14	12	11.4	±	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
swh1570	Elger Bay, South Camano	26-Jul-13	11	18.2	±	2.1
swh1574	Camp Diana West, South Camano	4-Aug-14	10	17.2	±	1.5

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

In order to facilitate a long term view of eelgrass bed area measurements, past results from WADNR were compiled along with our results for sites we have both sampled by underwater videography over the years (see Table 4).

		DNR		Team	
Year	Site	Bed Area	95%CI	Bed Area	95%CI
2006	swh0885	11.9	0.5		
2011	swh0885	13.6	1.1		
2013	swh0885	17.5	0.7	18.0	1.7
2014	swh0885			20.4	3.1
2003	swh0940	7.3	0.3		
2004	swh0940	7.1	0.4		
2005	swh0940	8.1	0.3		
2006	swh0940	7.9	0.4		
2007	swh0940	7.8	0.3		
2009	swh0940			6.8	1.5
2012	swh0940			8.3	1.1
2015	swh0940			7.7	0.8
2001	swh0943	18.5	0.8		
2002	swh0943	18.2	0.6		
2003	swh0943	17.8	0.3		
2004	swh0943	18.4	0.5		
2005	swh0943	19.2	0.4		
2009	swh0943			17.7	2.0
2012	swh0943			18.0	1.3
2015	swh0943			18.7	1.0
2005	swh0955	6.1	0.3		
2006	swh0955	7.4	0.2		
2007	swh0955	7.7	0.2		
2008	swh0955	8.2	0.4		
2009	swh0955	9.6	0.4		
2011	swh0955	12.7	0.5		
2014	swh0955			14.9	1.4
2006	swh0973	14.4	1.1		
2007	swh0973	12.4	0.9		
2008	swh0973	13.4	1.5		
2009	swh0973	12.6	1.2		
2010	swh0973	14.5	1.0		
2011	swh0973			13.7	2.4
2012	swh1574	15.7	1.6		
2013	swh1574	16.9	0.6		
2014	swh1574			17.2	1.5

Calculated by ICMRC Team

Table 4. Eelgrass Bed Areas for sites where both WADNR and the ICMRC eelgrass team have measured over multiple years.

Results and Discussion by Site

The following pages contain the maps and discussion of results for each site sampled by underwater videography in 2015 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.

The overall eelgrass bed area for 2015 (18.2 ± 3.2 ha) remained consistent with previous years at around 20 ha (see Figure 11). While the graph shows a downward trend in eelgrass bed area since 2011, it has not reached statistical significance and could possibly be explained by sampling variation. The overall pattern of eelgrass bed coverage remained consistent with previous years. The presence of propeller scars and anchor scouring are seen in the higher resolution 2015 aerial image as in all previous years (see Figure 12).

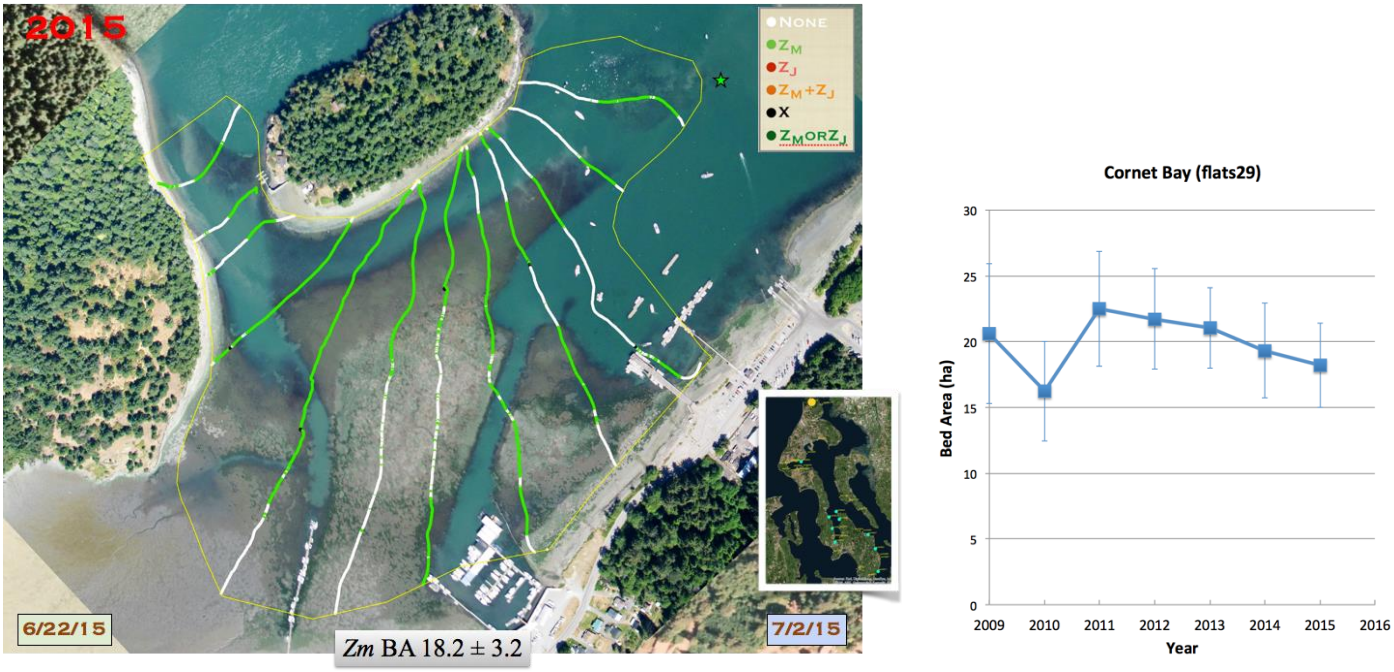


Figure 11. Aerial and Underwater Videography results for Cornet Bay (flats29) in 2015 and historic Bed Area values from 2009.

Figure 12. 2015 Aerial photo of anchor scour and propeller scars (examples - red arrows).

Comparison of aerial photos and underwater video taken in 2015 and 2014 near the bulkhead removal and construction area (see Figure 13) appear consistent. The color difference of the eelgrass areas in the photos may be due to differences in tide levels (-2.5'↑ and -2.2'↓ respectively).

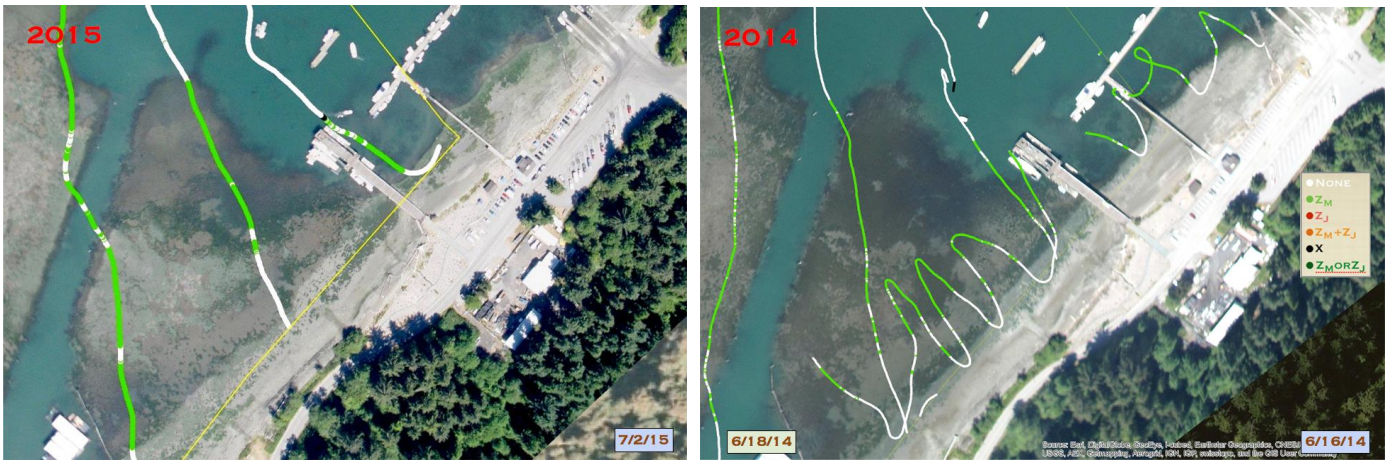


Figure 13. A closer look at the construction site at Cornet Bay in 2014 and 2015 after bulkhead removal in 2012.

At this time, the construction appears to have had little effect on the eelgrass beds in Cornet Bay. However, every year we have documented the detrimental effects (anchor scour and propeller scars) of boating activity in the bay. Perhaps the approach of the "Voluntary Anchor-Out Project" in Port Townsend might be suitable to reduce the damage (personal communication with Caroline Gibson, NW Straits).

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 2014 are not statistically different, there appears to be a loss of eelgrass bed area on the east side (right side of yellow sampling polygon) of the site. However, an increase in this same area compared to previous years was noted for 2014. These differences may simply represent normal variability within this site.

A loss of eelgrass on the west (left) side has been noted between previous years and 2010 (see previous reports and chart in Figure 14). This loss persists in 2015. We have also observed a correlation between the appearance of green sea urchins and the loss of eelgrass that is reaffirmed in 2015. 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.

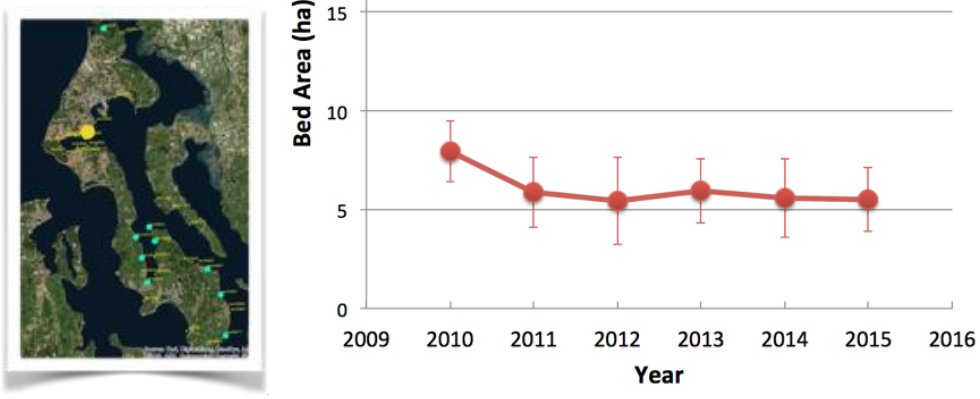


Figure 14. Aerial and Underwater Videography results for East of Monroe Landing (swh0888) in Penn Cove for 2015 and 2014 and historic Bed Area values from 2010.

North of Dine's Point, Holmes Harbor (swh0923)

The site North of Dine's Point at the northwest entrance of Holmes Harbor (swh0923) is a narrow fringe of eelgrass for which we have only two measurements. There is no statistical difference between the eelgrass bed areas between 2015 and 2012 and no obvious differences from the aerial photos (see Figure 15). The small difference in *Zjaponica* (red line) probably represents variation in scoring.

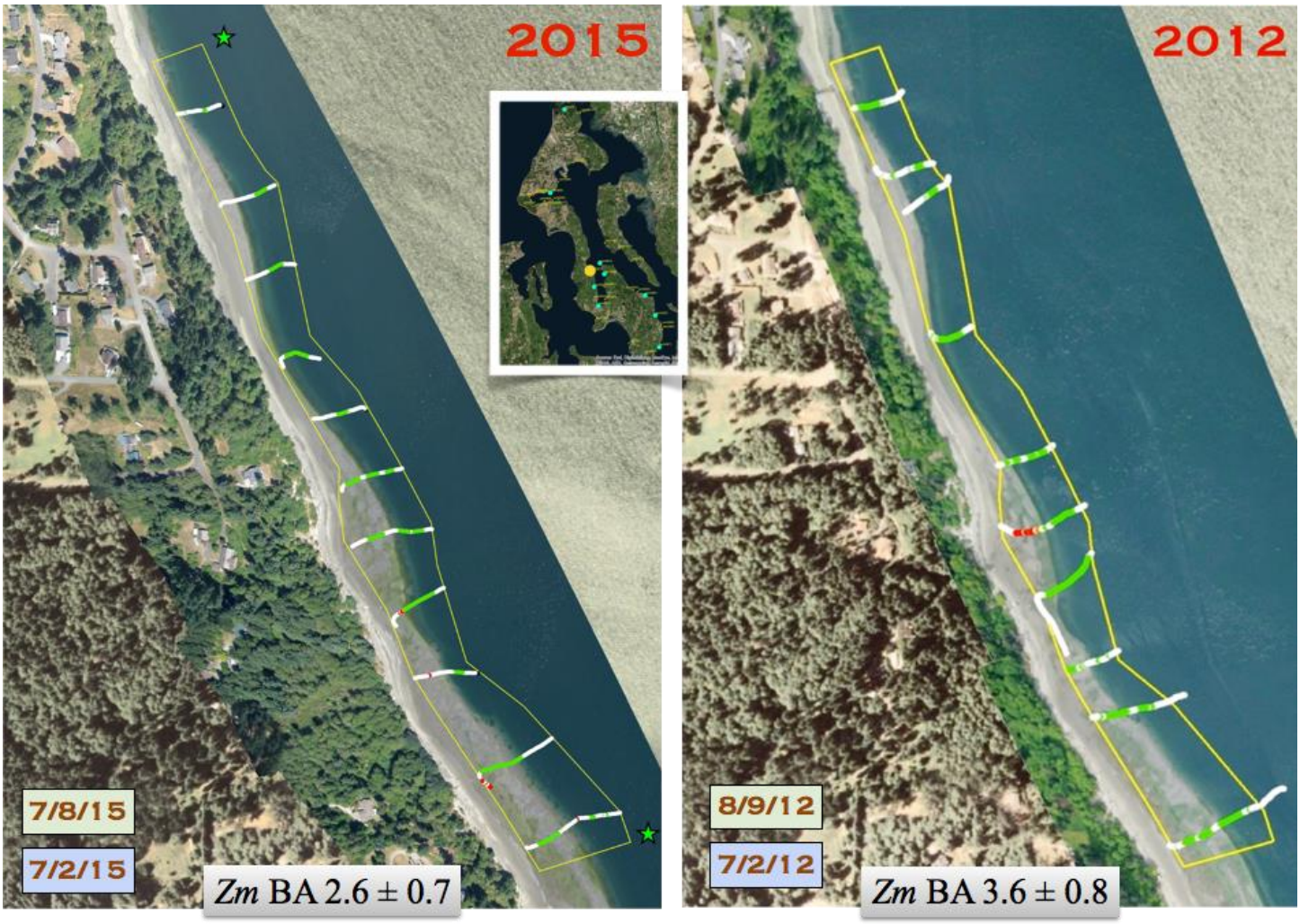


Figure 15. Aerial and Underwater Videography results for East of Dines' Point (swh0923) in Holmes Harbor for 2015 and 2012.

Honeymoon Bay, Holmes Harbor (swh0937)

This is the third time we have measured the eelgrass bed at Honeymoon Bay (see graph in Figure 16). While the bed area for the entire site appears stable, one feature has been apparent in all the aerial photographs each year since 2009. There has been an unusual bare spot (see red circle in Figure 15 and red arrows in Figure 17) that has remained nearly constant at approximately 0.13 ha (0.33 acres) which seems associated with a large oyster bed near the dock to the left. This year it appears to have nearly filled in for whatever reason.

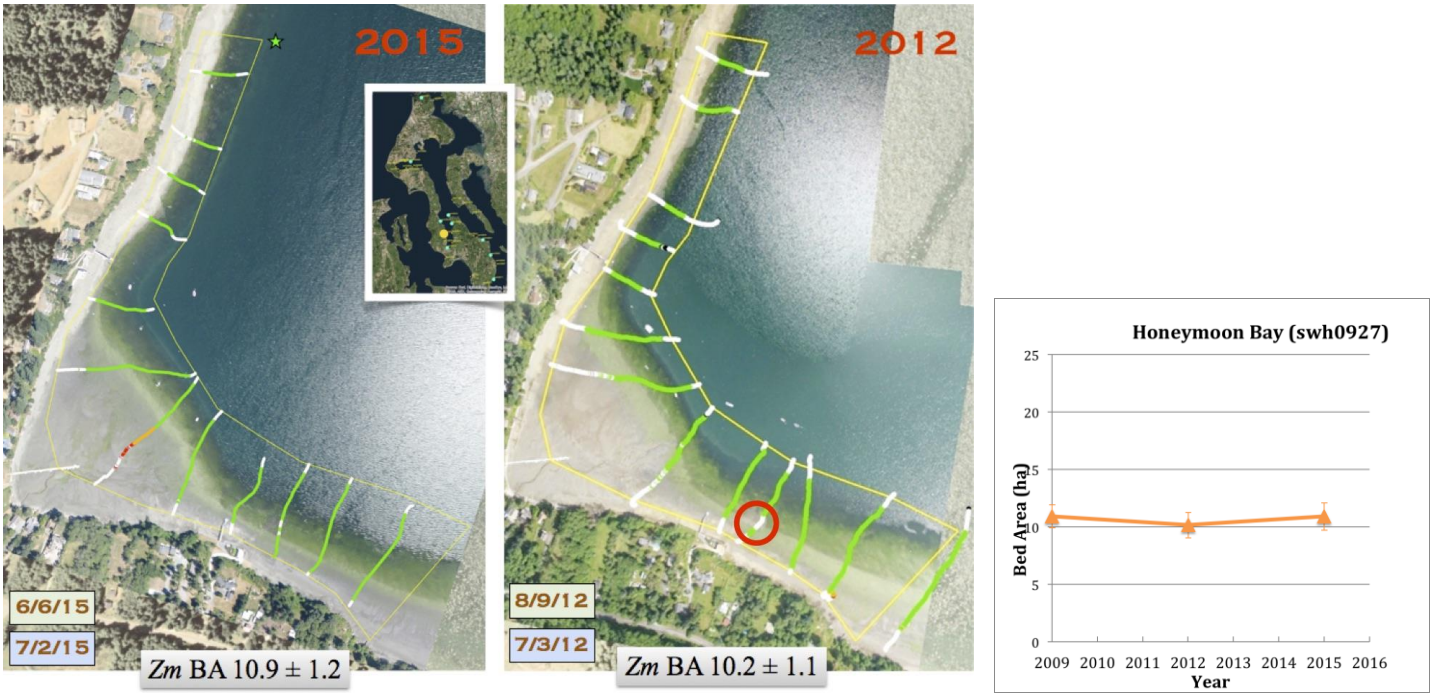
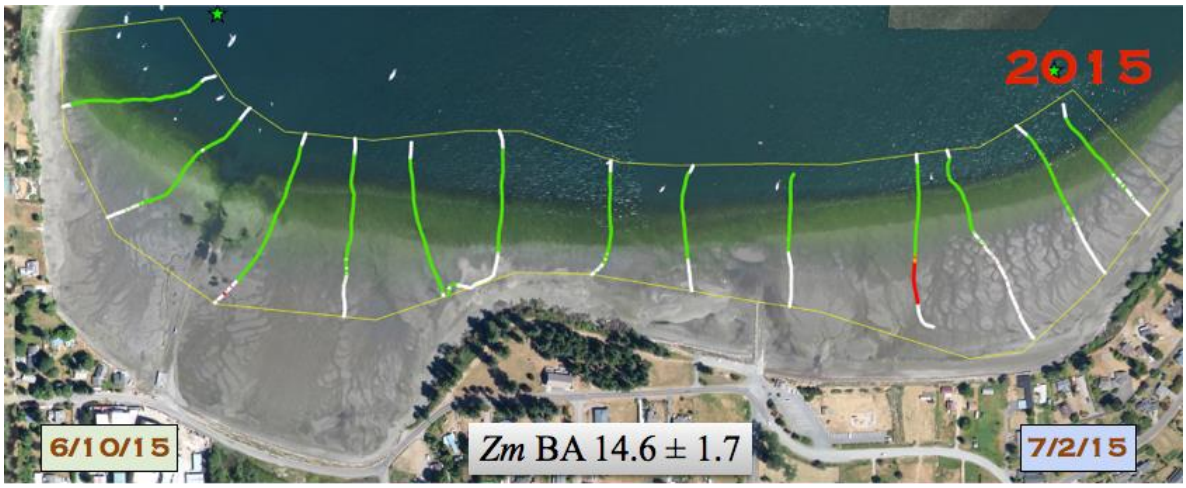


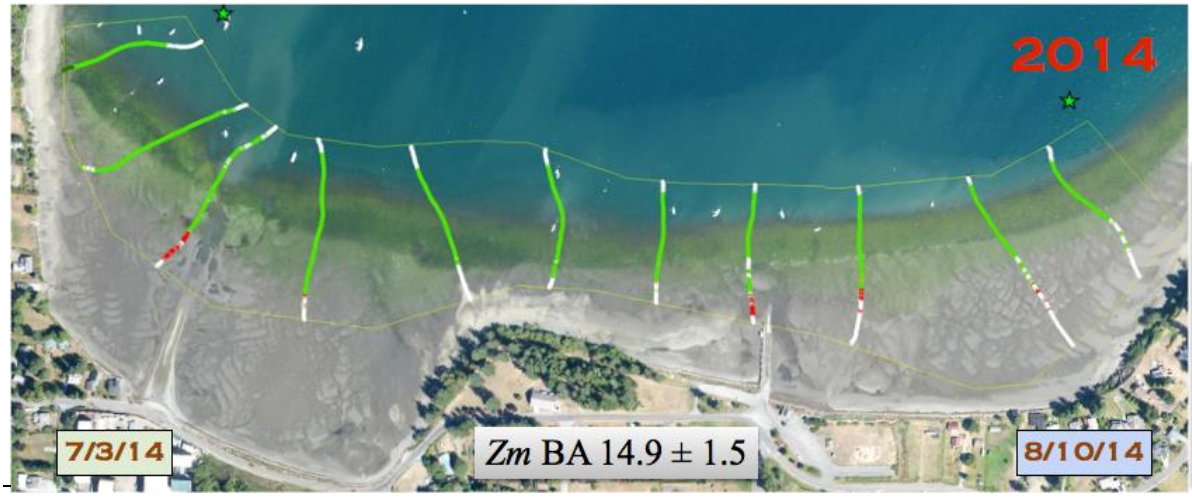
Figure 16. Aerial and Underwater Videography results for Honeymoon Bay (swh0927) in Holmes Harbor for 2015 and 2012 and historic Bed Area values from 2009.

Figure 17. Reduction of bare patch (see red arrows) at Honeymoon Bay in 2015.

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 14 hectares with small patches on Zostera japonica in the shallows and a sea urchin bed near the east end (right side of photos – see 2014 report for more detail).





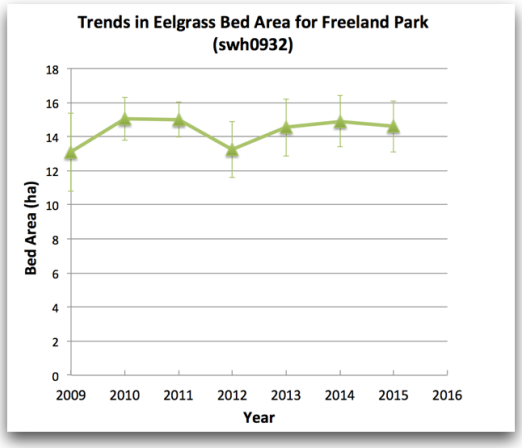


Figure 18. Aerial and Underwater Videography results for Freeland Park (swh0932) in Holmes Harbor for 2015 and 2014 and historic Bed Area values from 2009.

East of Dine's Point (swh0940)

The site "East of Dine's Point" (swh0940) probably should have been named "Holmes View" since that is the name of the closest road and community. We have measure this site three times since 2009 and DNR has measured it five times from 2003 to 2007 (see graph in Figure 19.) The eelgrass bed area has held remarkably steady around 7.5 hectares.

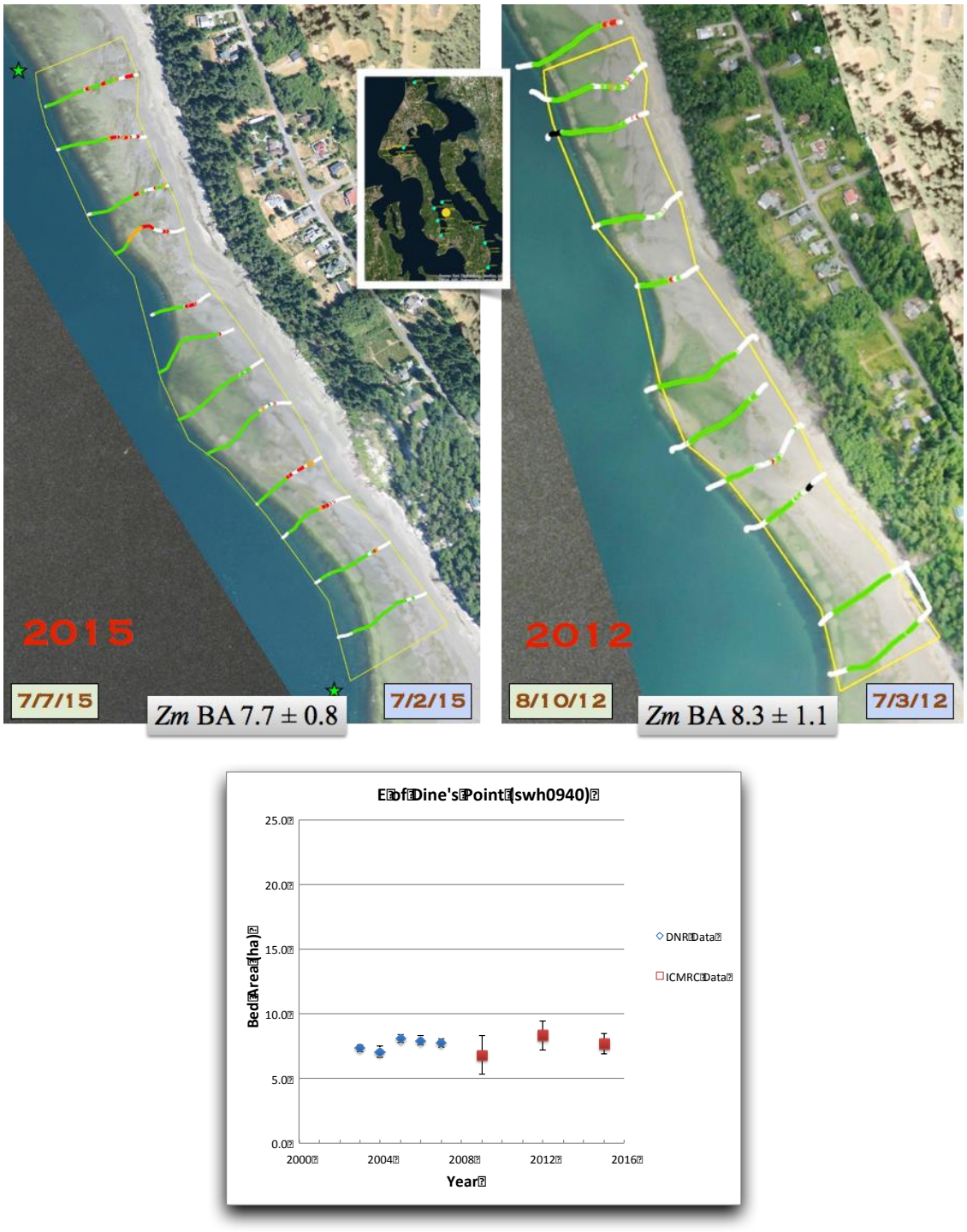


Figure 19. Aerial and Underwater Videography results for East of Dine's Point (swh0940) in Holmes Harbor for 2015 and 2012 and historic Bed Area values from 2003 (includes DNR data).

Baby Island, Holmes Harbor (swh0943)

Baby Island has a very large eelgrass bed for which the swh0943 site boundary is defined by an unusual and somewhat arbitrary sampling polygon (yellow line). It has remained around 18 hectares since 2001 as measured by DNR and by us (see graph in Figure 20). The island gets significant boating and foot traffic during the summer and is habitat for a large variety of wildlife.

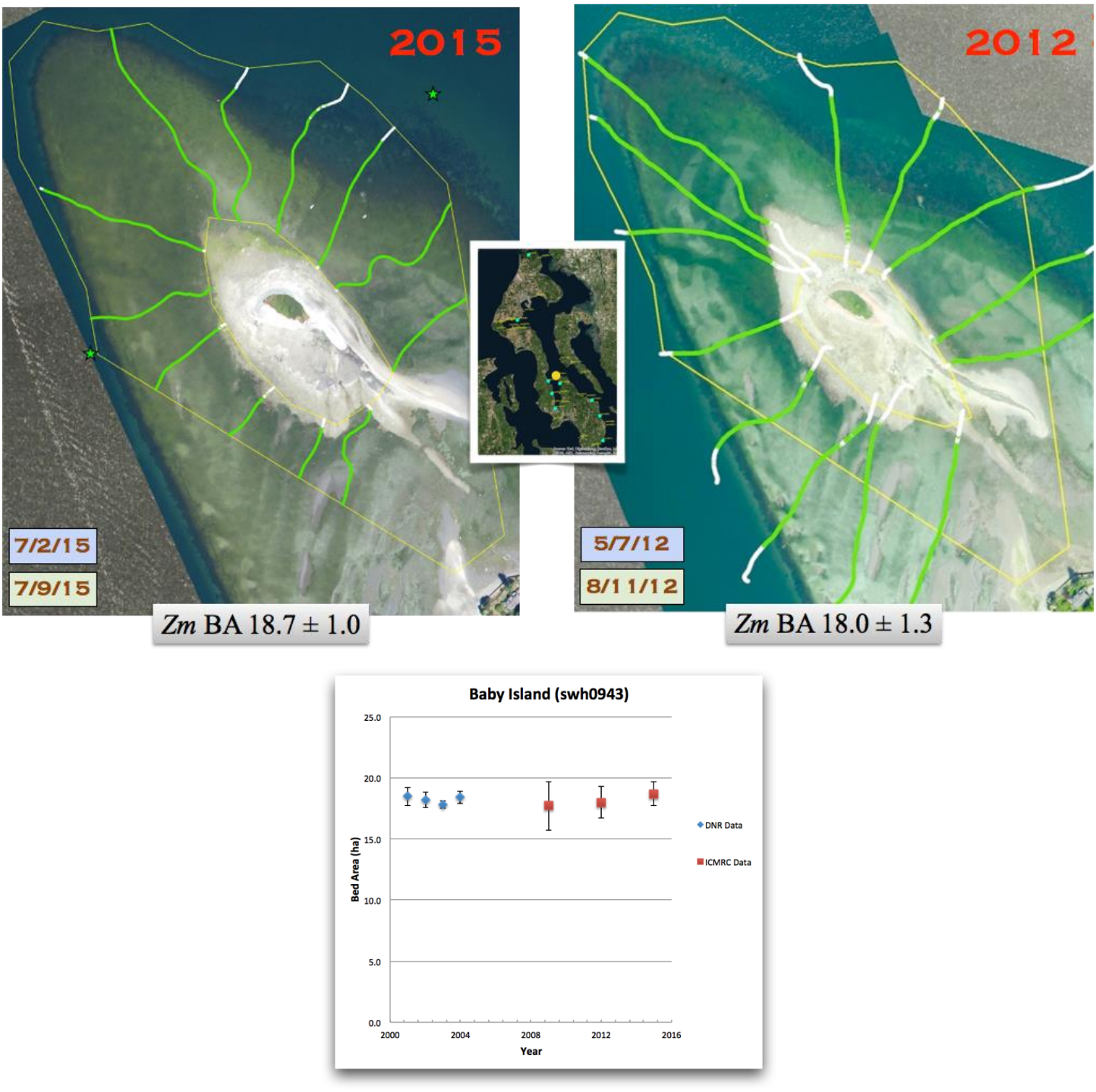


Figure 20. Aerial and Underwater Videography results for Baby Island (swh0943) in Holmes Harbor for 2015 and 2012 and historic Bed Area values from 2001.

Port of South Whidbey, Langley Marina (swh0957)

Langley Marina has undergone a significant amount of dock reconstruction in the last few years. Our first measurement of the eelgrass bed area at this site was in 2011 where we found 9.1±1.5 hectares. In 2014 and 2015 we returned to find the *Zmarina* bed area measure over 11 (see Figure 21). The eelgrass beds continue to the very edge of the sampling polygon, but not beyond, so the measurements should be valid.

Since the 2015 and 2014 Bed Area results appear to have increased compare to the 2011 result with nearly 95% confidence, the underwater videography tracks from 2015 and 2011 were superimposed to look for differences (bottom photo in Figure 21). It appears the difference between 2015 and 2011 results (11.2 vs 9.1 respectively) are more likely due to sampling differences rather than significant changes in eelgrass growth.

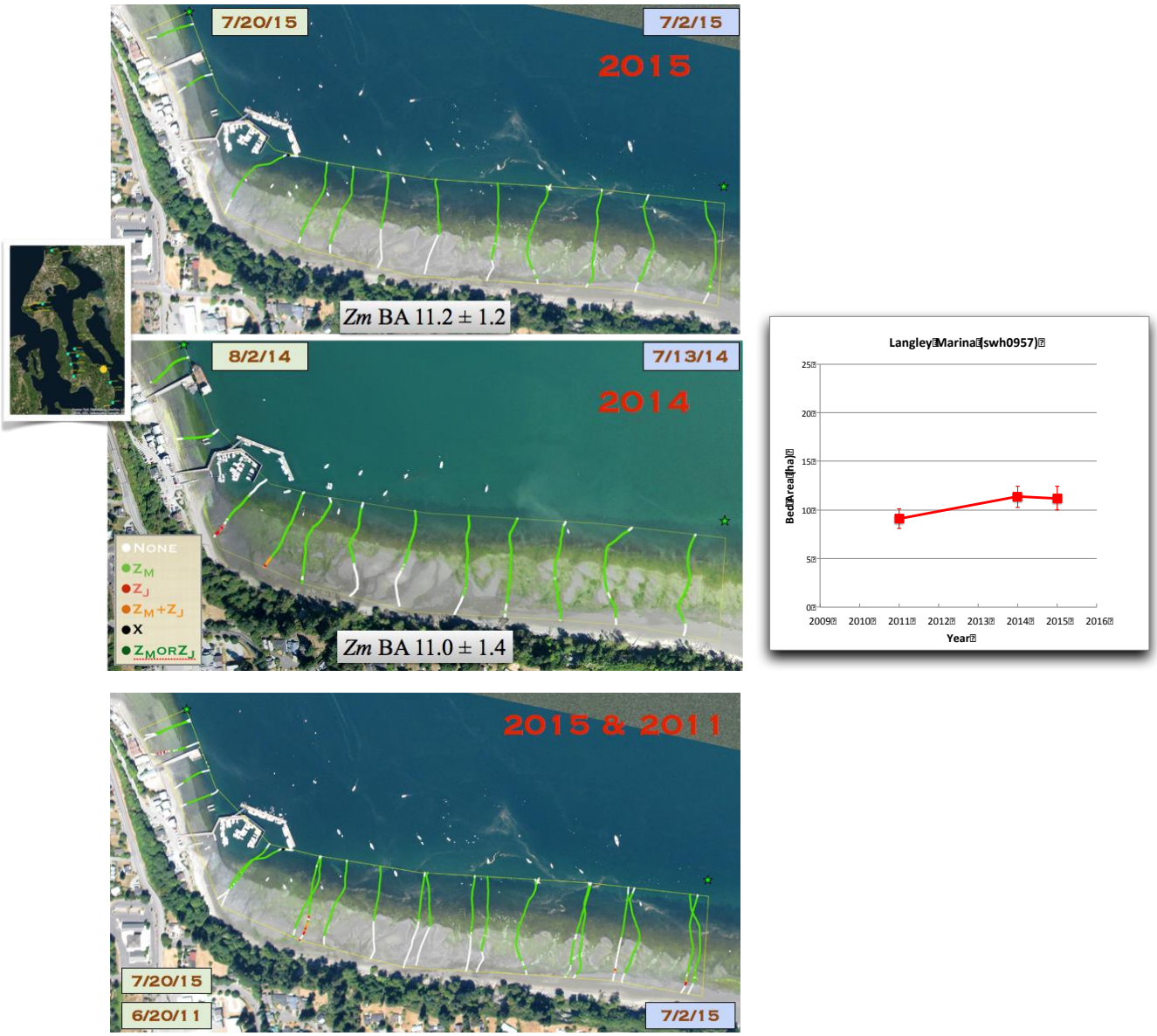


Figure 21. Results for Langley Marina (swh0957) from 2015 and 2014 and historic Bed Area values from 2011. Bottom image is an overlay of 2015 and 2011 transects on the 2015 aerial photograph.

Summerhill Drive - Waterman Property (swh0963)

The Waterman Property on Summerhill Drive encompasses a large part of site swh0963. We measured the eelgrass bed area for swh0963 this year in anticipation of a bulkhead removal in 2016 or 2017 at the Waterman property. There is an expectation that the bulkhead removal may result in changes in the shoreline and possibly eelgrass beds. We now have a baseline against which we can compare future results.

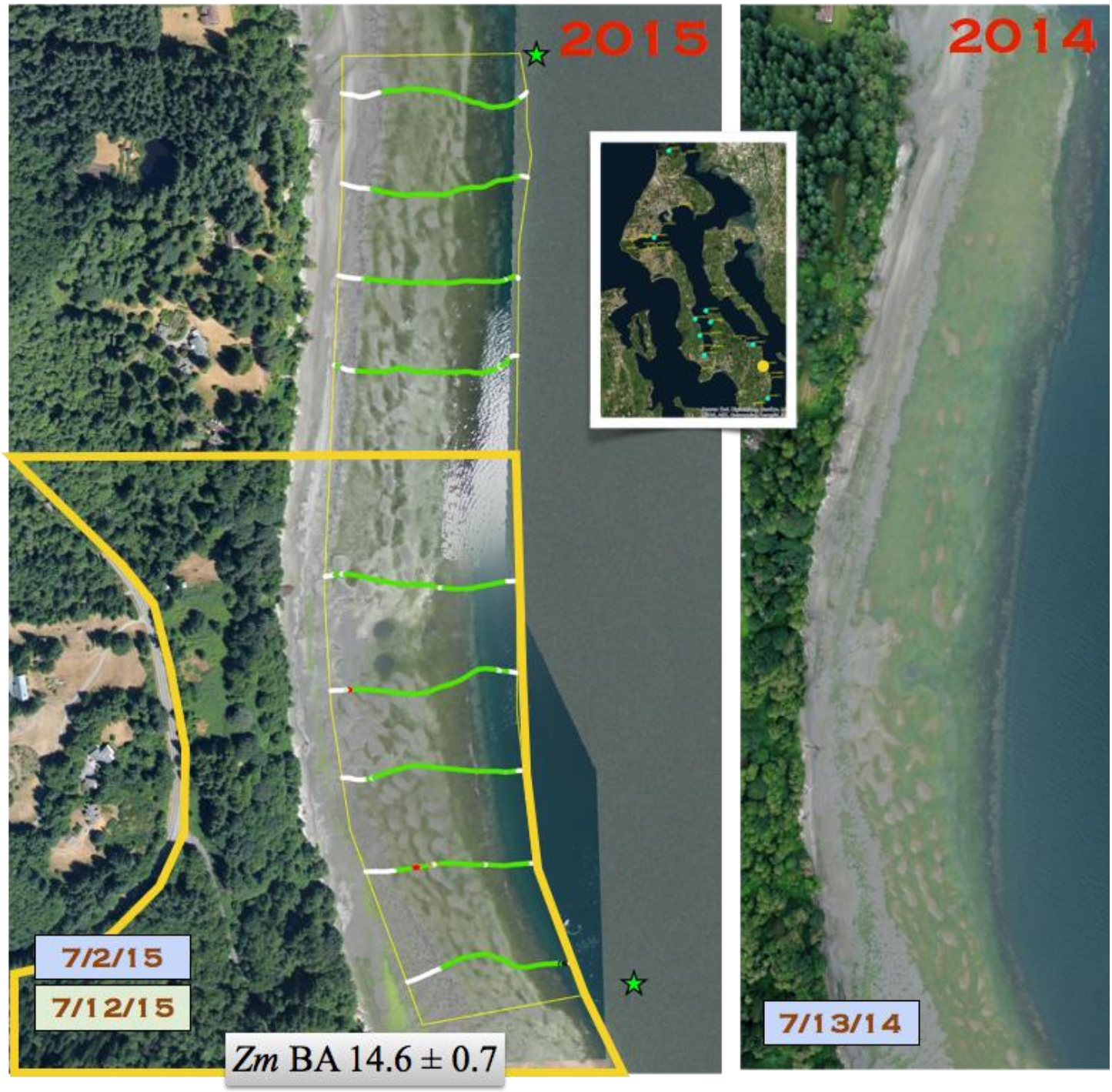


Figure 22. Aerial and Underwater Videography results for Summerhill Drive (swh0963) in 2015 (yellow outline is Waterman Property)

Glendale (swh0971)

This site was measured in 2015 in order to have a baseline in anticipation of future dock construction at Glendale. The results show very no eelgrass near the dock (red arrow in Figure 23) such that any construction will result in little or no loss of eelgrass. To the south (bottom of Figure 23), however, lies a substantial eelgrass bed. This site will be measured again after construction has finished, but the expectation is that work on the dock will not change the eelgrass bed area for this site.

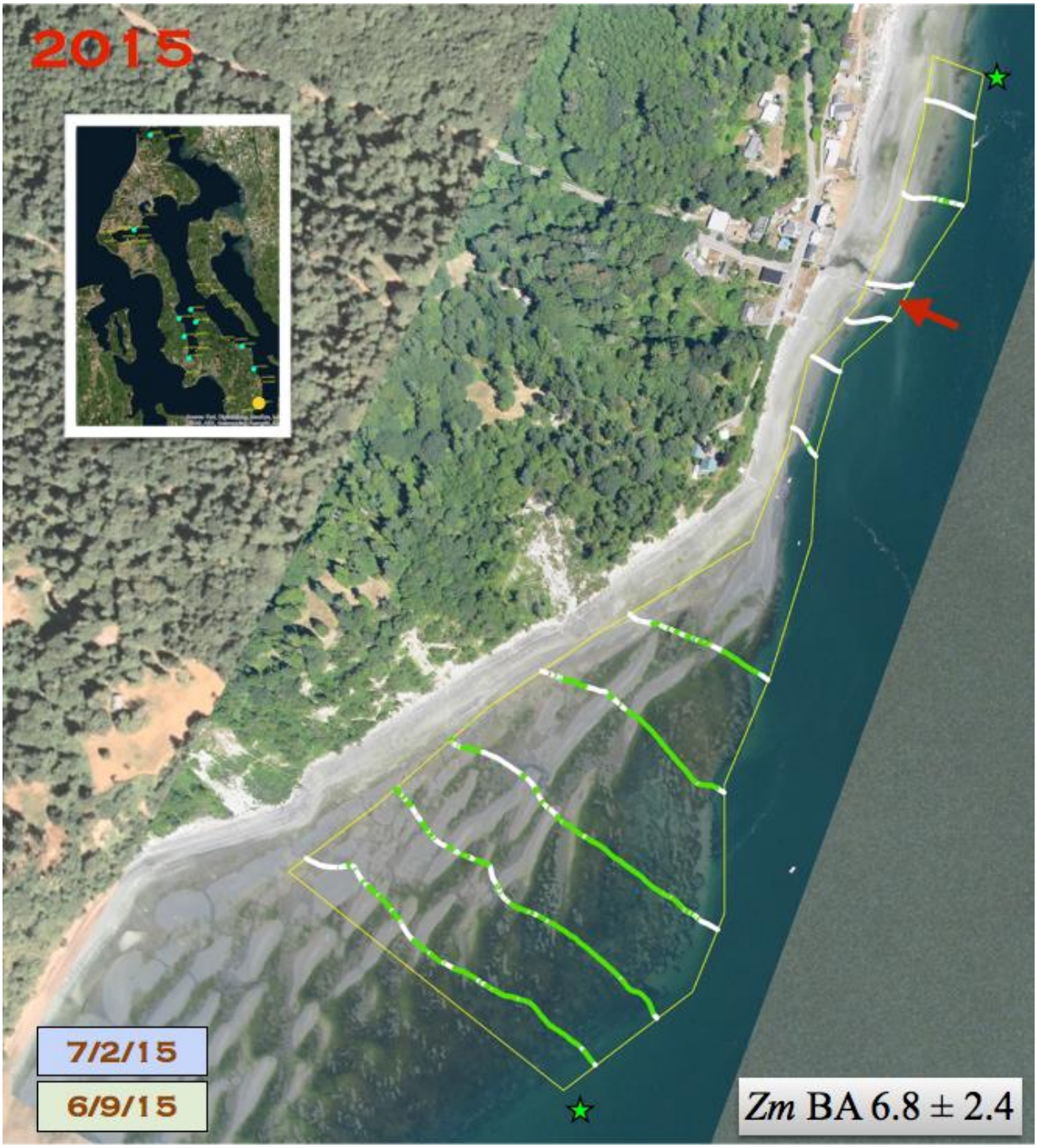


Figure 23. The 2015 results from Glendale (swh0971) on the south east side of Whidbey Island.

Aerial Surveys of Other Island County Sites:

Dave Mackey Park, Maxwelton (cps0761)

The beach at Dave Mackey Park (see red outline in Figure 24)and northward has undergone significant natural reconstruction due to the littoral drift of sand from the south (left) during storm events over the last ten years. 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 date box) and perhaps 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. What this beach remodeling has done to the *Zmarina* bed area (dark area at the water's edge) is uncertain. Both seagrass areas were measured in 2011 and will be re-measured in 2016.

Figure 24. Photos of Maxwelton Beach Area (South is left; North is right) from 2010 and 2015. The site cps0761 starts to the left of the boat ramp and extends slightly beyond the right side of the photo.

Ala Spit Beach Access (swh0851)

The beach access area of Ala Spit has undergone construction funded by the State Salmon Recovery Funding Board to remove a bulkhead and rock jetty to provide better habitat for fish and submerged aquatic vegetation. We attempted to measure the eelgrass bed area in 2014, but strong currents only allowed us to make a reconnaissance run. We identified the eelgrass bed area (see dark area by red arrow in Figure 25), but were unable to navigate along transect lines.

Figure 25. Aerial photo of Ala Spit during construction in the fall of 2015.

Kelp Beds

A team of citizen scientists lead by Linda Rhodes has interest in measuring bull-kelp beds using kayaks and a method established in Island County by intern Emily Bishop. Aerial photographs of entire coastlines were acquired at a low tide and geo-referenced to a base map to test the value of the photos to help select sites for kayak studies. A series of images taken of the West Beach area gives an impression of the variability of these kelp beds over time.

Kelp on West Beach, Whidbey Island, Island County

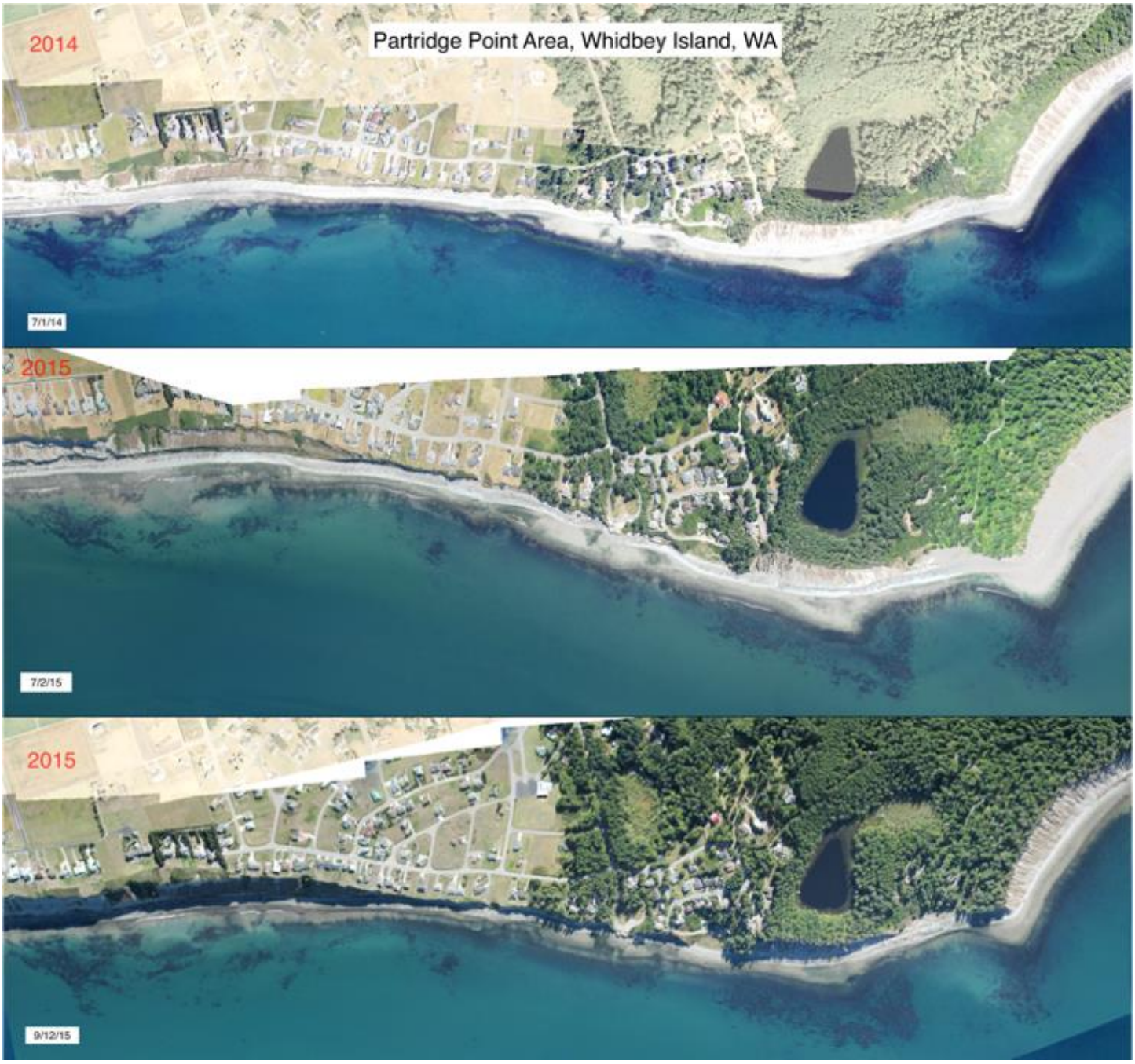


Figure 26. Aerial photographs of a selected area of West Beach kelp beds taken on 7/1/14, 7/2/15 and 9/12/15 near zero tide.

Kelp in Saratoga Passage

Oblique aerial photos were taken of kelp beds in Saratoga passage. Five areas were identified that contained significant amounts of bull-kelp for further study in 2016 (see Figure27).

Figure 27. Aerial photo (7/14/15) of kelp bed around Lowell Point near Oak Harbor (photo) and sites identified with bull-kelp in Saratoga Passage. (see orange dots on map)

Infrared Aerial Photography of Bull-Kelp

John Githens has been investigating the use of drones and infrared photography for measuring kelp bed densities in Island County. To test his camera, we mounted it on our plane in place of our color camera and flew near Washington Park in Anacortes, WA in search of kelp on February, 27, 2016. Since water absorbs IR radiation and the chlorophyll in kelp reflects IR, kelp shows up as bright objects in the water (see Figure 28). In a separate effort, Vern Brisley also is investigating IR photography for kelp studies and we will take photos for Island County in 2016 using his equipment.

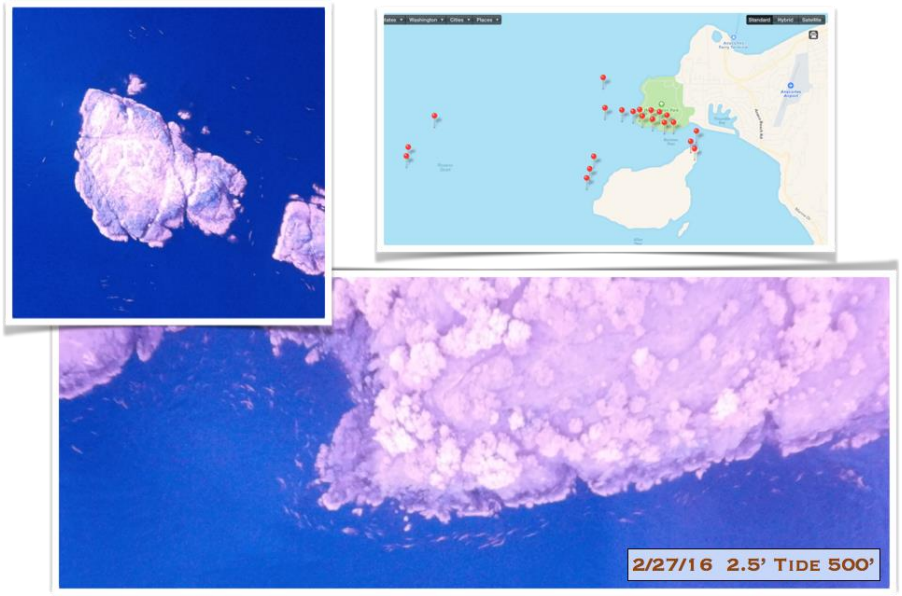


Figure 28. False color IR images of kelp beds near Washington Park. Kelp is identified as light (pink) objects in dark (blue) water.

Aerial Photos on the San Juan Islands and Fidalgo Bay

For 2015, a variety of sites outside of Island County were photographed for several projects. A map of where these photos were taken is shown in Figure 29.

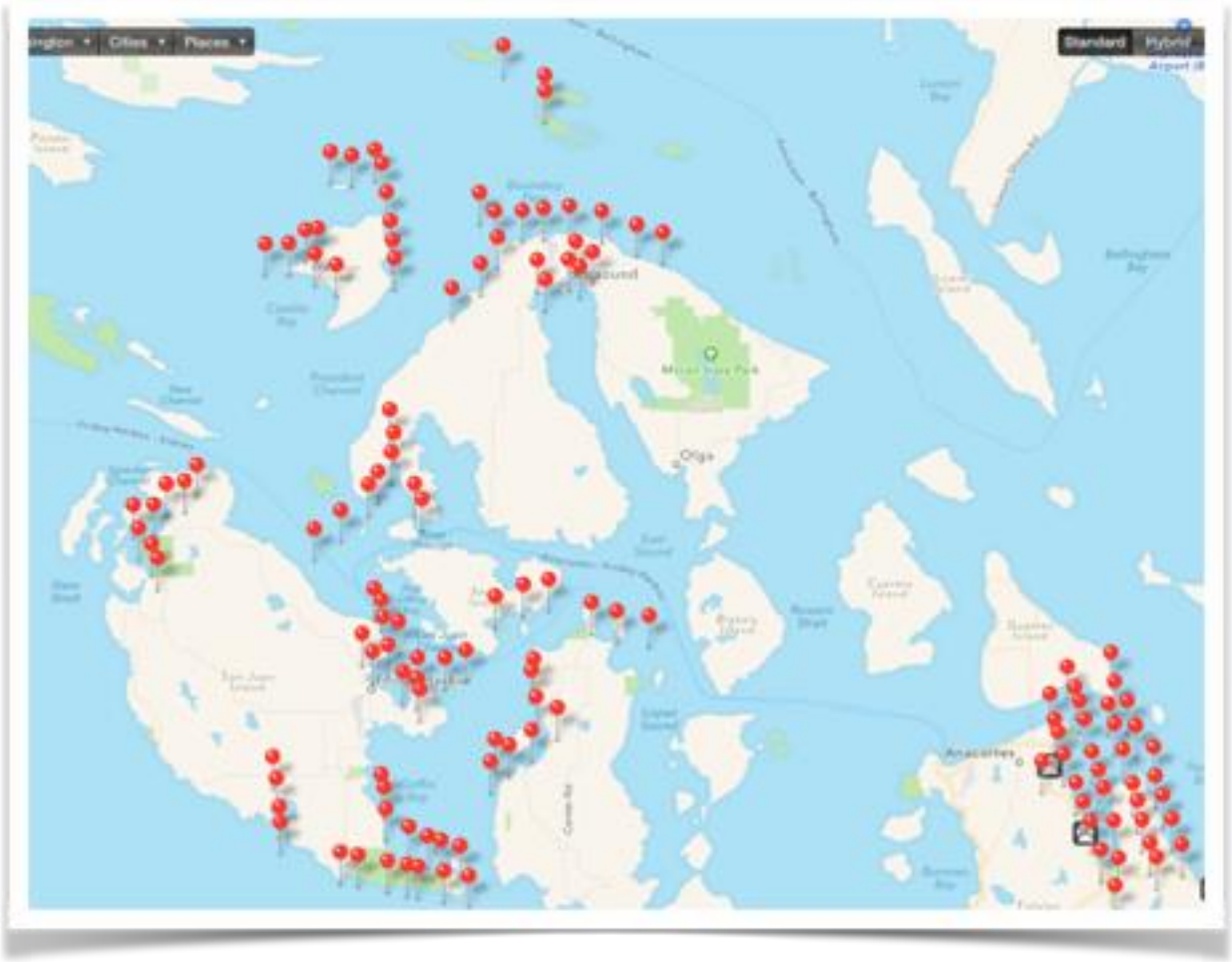


Figure 29. Map of aerial photographs taken in the San Juan Islands for 2015.

Eelgrass disease in San Juan County

For several years eelgrass-associated aerial photographs have been collected in the San Juan Archipelago in collaboration with Sandy Wyllie-Echeverria (Friday Harbor Labs). A major issue being studied in this region is an eelgrass wasting disease caused by the slime-mold organism, *Labyrinthula zostera* (see map in Figure 30 for list of sites being studied and visit the website http://depts.washington.edu/seagrass/disease-analysis-in-san-juan-archipelago/ for more detail). In 2014 the images of Fisherman's Bay (see Figure 30) showed the odd, brown appearance of "diseased" eelgrass beds inside the bay (see Figure 30 insert photo) while eelgrass beds just outside the bay appear normal.

In 2015 the same areas appeared greener and perhaps healthier (see Figure 31). However, only ground studies of the plants can determine the status of plant health. We are looking for such changes in Island County as an indicator for the disease in our eelgrass bed areas; so far none have been seen. It is thought that the disease is limited to bays that have reduced tidal flushing.

Genetic Structure and Diversity of Zostera marina (Eelgrass) in the San Juan Archipelago, Washington, USA
Estuaries and Coasts, 04 Dec, 2009
Sandy Wyllie-Echeverria & Sandra Looman Talbot & Jolene Rae Rearick

Figure 30. Sites within San Jan County that are being studied for eelgrass wasting disease.

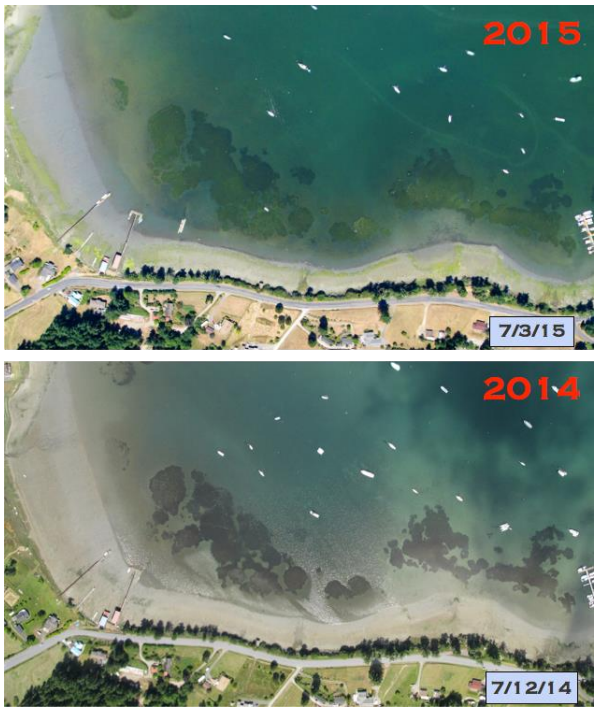


Figure 31. Comparison of diseased area of Fisherman's Bay between 2014 and 2015.

Sand Dollar Study on Orcas Island, WA

Amy Henry has been studying the relationship between sand dollars and eelgrass growth for her PhD thesis at the University of Chicago. For several years I have been sending her aerial photographs of her site at Crescent Beach, East Sound on Orcas Island (see Figure 32 left photo insert and red star on map). Amy's site is shown in the insert demarked by six white buckets and a transect line (look very closely!). Her study is defining the competition between eelgrass and sand dollars for the seabed.

For 2015, aerial photographs were taken of her study area twice, just after low tide (10:36 am) and two hours later (12:36 pm). The 2015 photos (see Figure 32 right images – red boxes show same area for comparison) show a disappearing dark color caused by exposed sea urchins burying themselves in the sand over the two-hour interval.

Figure 32. Study of the relationship between sand dollars and eelgrass growth by Amy Henry at Crescent Beach, Orcas Island WA.

Fidalgo Bay

The Samish Indian Nation DNR (Erin Lincata and Sam Barr) is mapping eelgrass in their tidelands in Fidalgo Bay. An aerial photographic image of the area of interest in the bay was produced to help prepare for the underwater videography of Sandy Wyllie-Echeverria (Friday Harbor Labs) and aerial mapping by UAV (drones) with H. Gary Greene and Norman Maher. This UAV sampling will give us a one-to-one comparison of our aerial photography with drone technology and underwater videography data from Friday Harbor Labs.

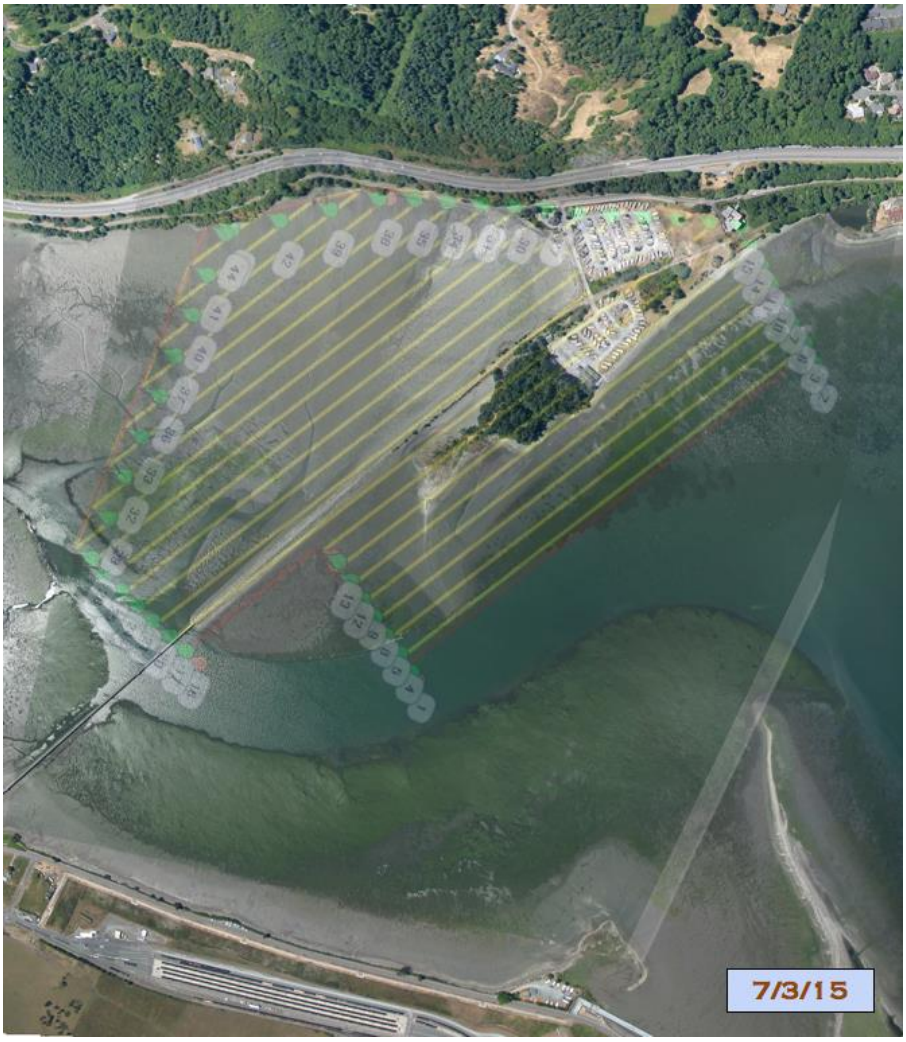


Figure 33. Geo-referenced image of Fidalgo Bay, Anacortes, WA with ovelay of drone flight plan.

Conclusions

We have completed the analysis of all the data (aerial and underwater videography) gathered in 2015. The results were presented to the Island County Marine Resource Committee on April 5, 2016. This report fulfills our responsibilities for the 2015 contract period. From our experience we have reached a number of conclusions about our process and results:

• Our core sites (flats29, swh0888 and swh0932) appear to be relative stable over the seven 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. The data for Cornet Bay (flats29) suggest the largest detrimental impact on eelgrass beds is still boating activity (channels, propeller strikes, anchor scour). The data for Monroe Landing in Penn Cove (swh0888) suggests shifting patterns in eelgrass distribution with possible involvement of sea urchin grazing. The data for Freeland Park (swh0932) show recovery from a single incident of damage at Nichols Bros boat launch in 2008, but no apparent damage from boating activity at Freeland Park. An interesting observation of potential sand dollar associated eelgrass loss at Freeland appears to be only a very small issue at this point. Perhaps we will see a similar issue if the green crab invades our waters.

• Our focus on Holmes Harbor in 2015 resulted in measuring four sites (swh0923, swh0927, swh0940 and swh0943) we have measured in previous years (2009 and 2012). All of these sites appear to have stable eelgrass bed areas. The small bare patch observed by aerial photography at Honeymoon Bay appears to be filling in.

• On South Whidbey, the Langley Marina (swh0957) eelgrass bed appears stable since 2011 and we now have baseline data for two new sites (swh0963 and swh0971) where shoreline construction is planned.

• To date we know of only two sites that have shown statistically significant changes in eelgrass bed area over time: Blower's Bluff (swh0885) and West Langley (swh0955). We only know these sites have changed due to previous measurements by DNR as far back as 2005. For one other nearby site, Brooks Hill (swh0954) we have aerial photographs that suggest similar increases but no historical eelgrass bed area measurements (see 2014 Report).

• We have now monitored over 37 different sites in Island County and collected site data nearly 80 times including our recently completed 2016 data collection.

• We have collected aerial photos of the complete coastline of Whidbey in 2014 and 2015 and have partial coverage since 2009. We also have complete coastlines of Camano in 2009 and 2015 with partial coverage for other years. The 2015 aerial photos are made available for viewing on the new ICMRC dropbox.

• Underwater videography remains our primary tool to measure eelgrass bed area. Aerial photography is a complementary tool allowing us to gather data on more of the shoreline, but is not specific enough to quantify eelgrass beds alone. Upcoming UAV (drone) technology may become useful for eelgrass bed assessment in the future; we are participating in testing the possibilities. One of our new team members has been using multi-beam sonar to measure submerged vegetation in 2016. Infrared photography appears very useful for bull-kelp measurements, but probably limited value for eelgrass.

• 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

We'd like to thank our volunteers Anna Toledo and Finn Gatewood for helping us gather data in 2015. Our core group (Tom Vos, Ken Urstad, Gregg Ridder, Mark Kennedy, Bob Gentz and Neal Clark) is very appreciative for the help and guidance by a variety of experts in this field, especially Jeff Gaeckle and Lisa Ferrier (WADNR), Sandy Wyllie-Echeverria (Friday Harbor Labs) and H. Gary Greene (Tombolo, Orcas Island). Finally, 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

9/15/16