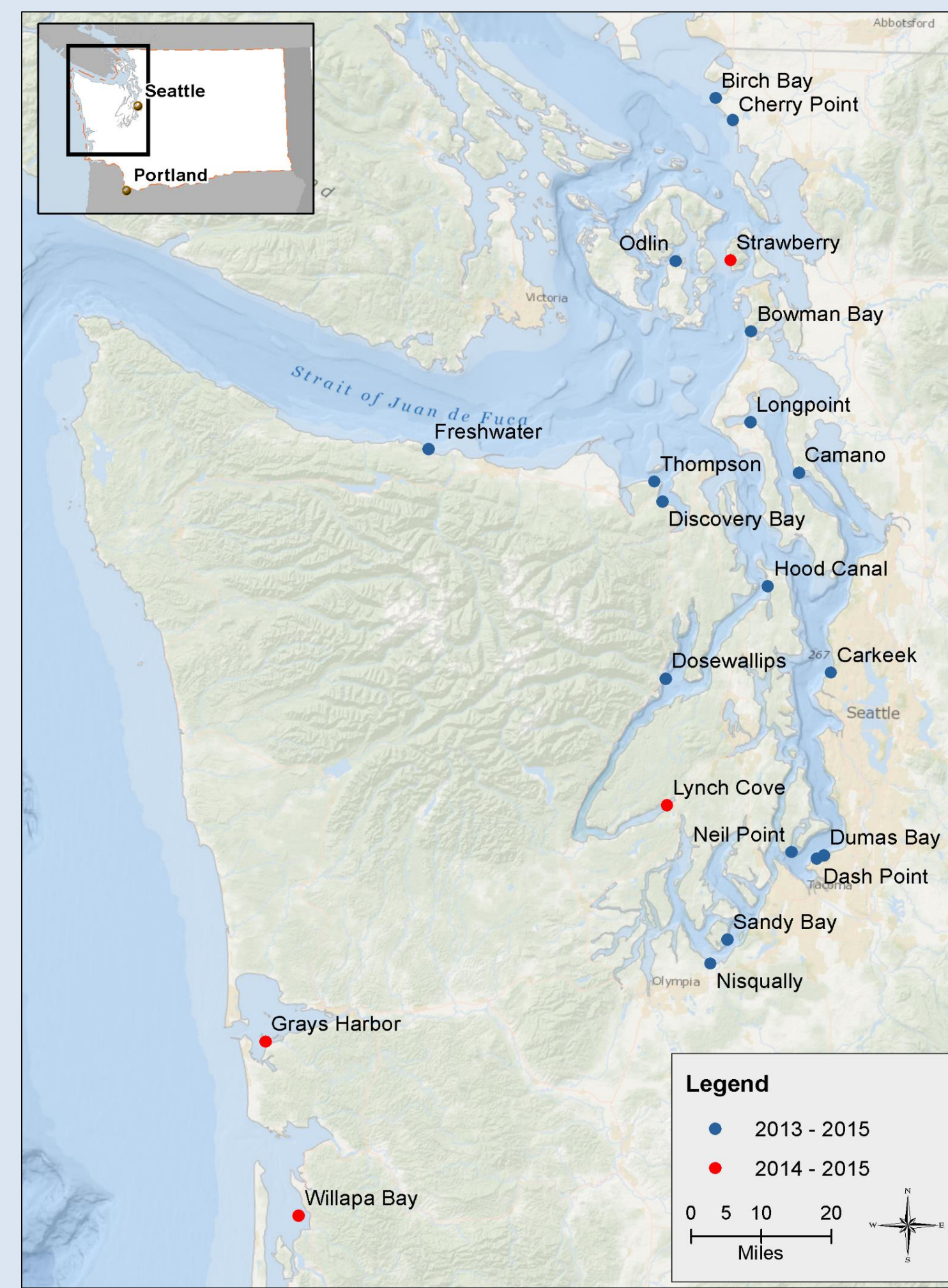


Monitoring eelgrass bed dynamics and lower edge movement: applications for resource management in Washington State

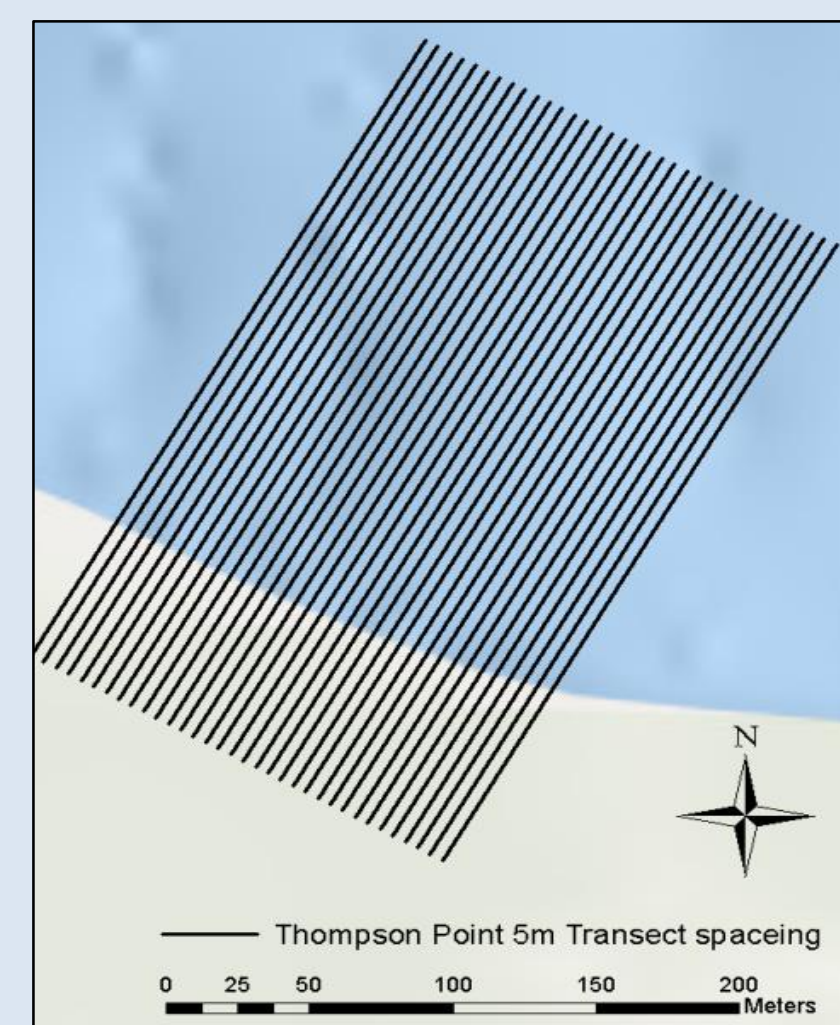
Introduction

As the marine land manager for the state of Washington, the Department of Natural Resources (DNR) is responsible for sustainable stewardship of state-owned aquatic lands, while providing economic and public access opportunities for the state's residents. Eelgrass (*Zostera marina*), a state protected species, provides important ecological function to nearshore habitats. The DNR Aquatic Assessment Monitoring Team (AAMT) is developing protocols to map eelgrass distributions and monitor eelgrass bed and physical site characteristics. The project goals are to accurately and efficiently provide quantifiable data to support and assess DNR restoration efforts, leasing activities, and policy requirements.



Study Objectives

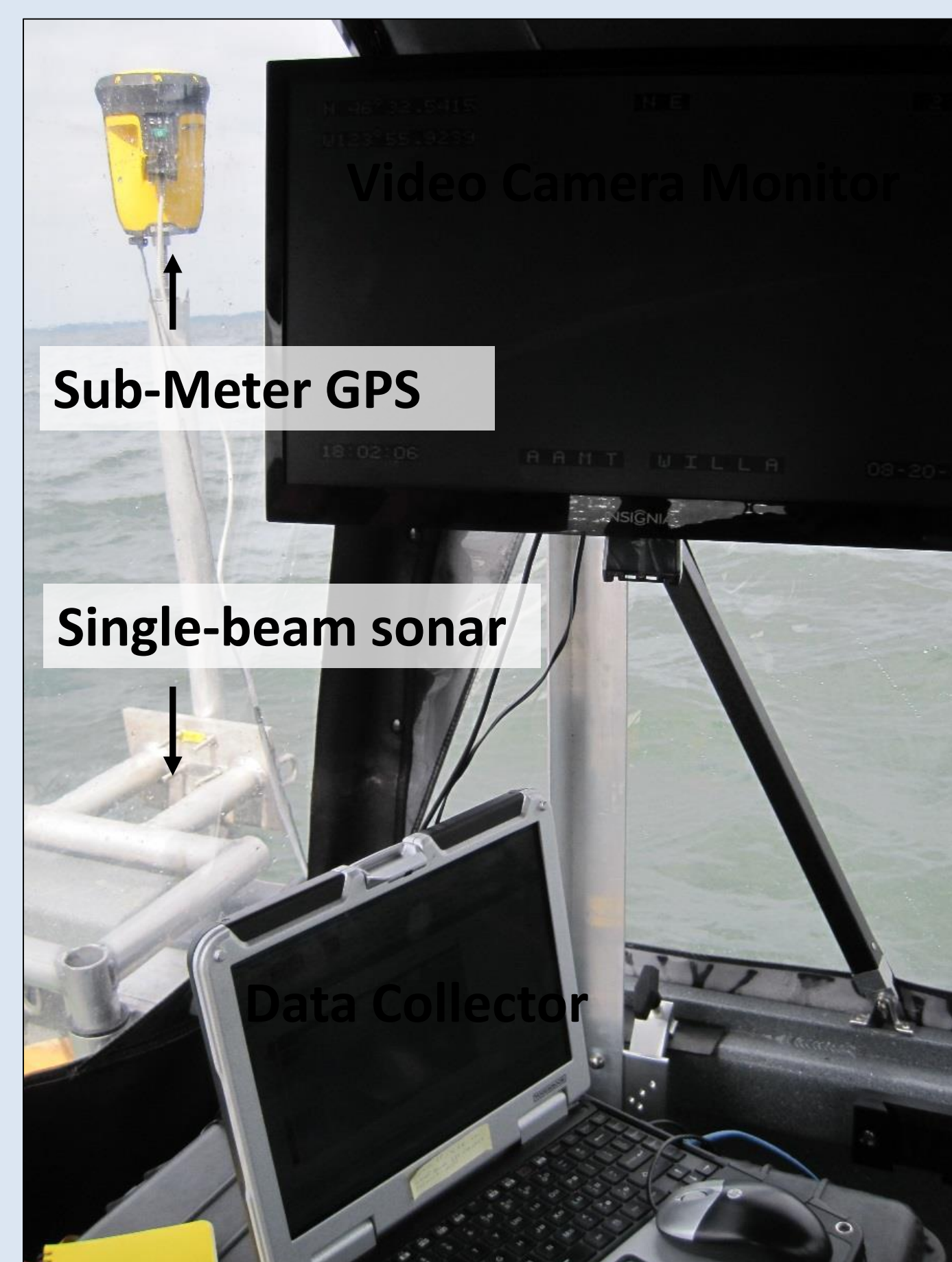
- Develop protocols to monitor eelgrass (*Z. marina*, *Z. japonica*) distributions
- Monitor undisturbed eelgrass beds across the Puget Sound
- Determine annual variability in bed characteristics
- Associate changes to bed and site characteristics



Survey transects

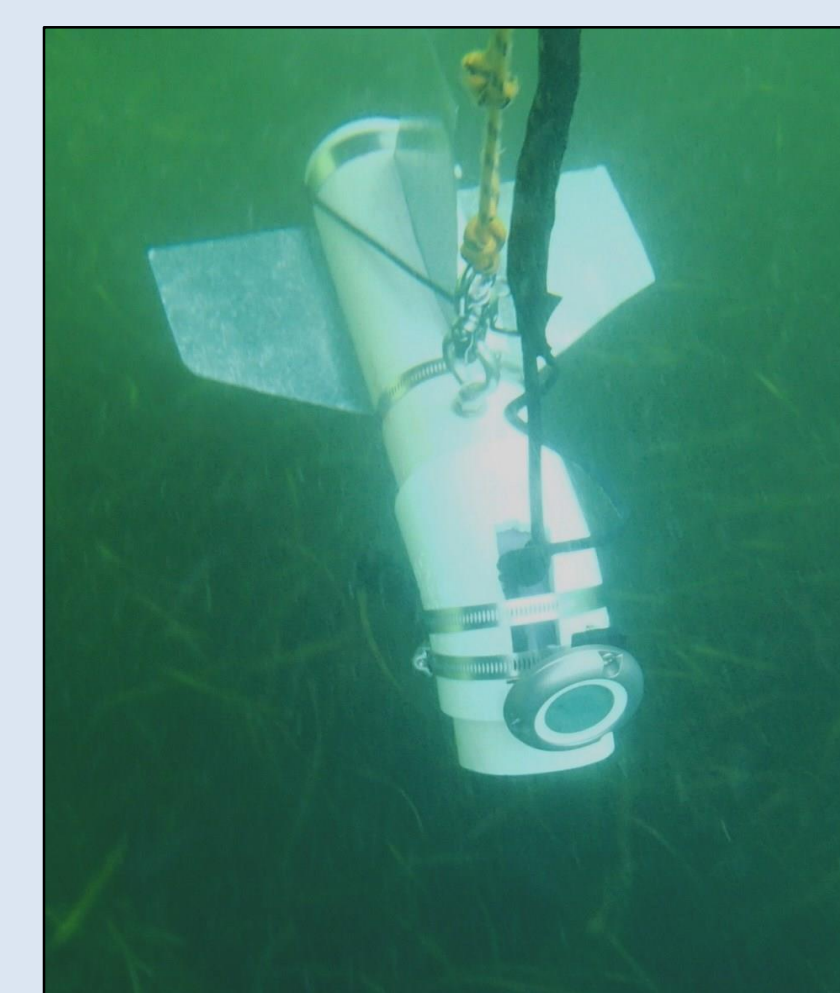
Survey Design/Data Collection

Data is collected annually from 22 sites across the Puget Sound. Survey sites are 150 m across shore. Survey transects are oriented shore-perpendicular and driven at an average boat speed of 4 knots. A BioSonics 420 KHz single-beam sonar is used to collect eelgrass presence and bathymetry data. GPS navigation is used to maintain on-track positioning. Video data is collected on every 4th transect with the camera held at 3 feet above the benthos.



Equipment layout during data collection.

Video camera above eelgrass meadow.



Survey Vessel

Data Processing

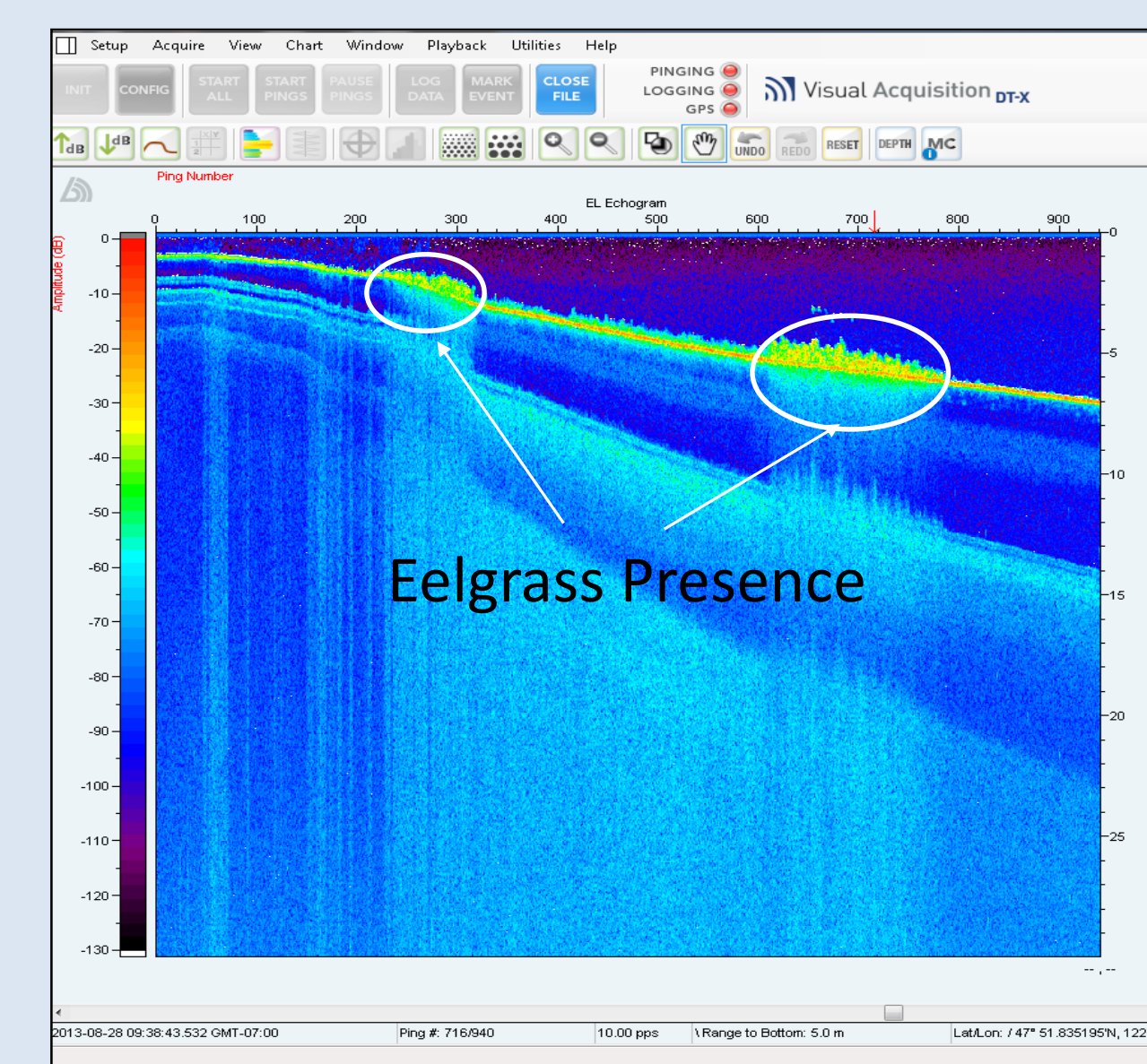


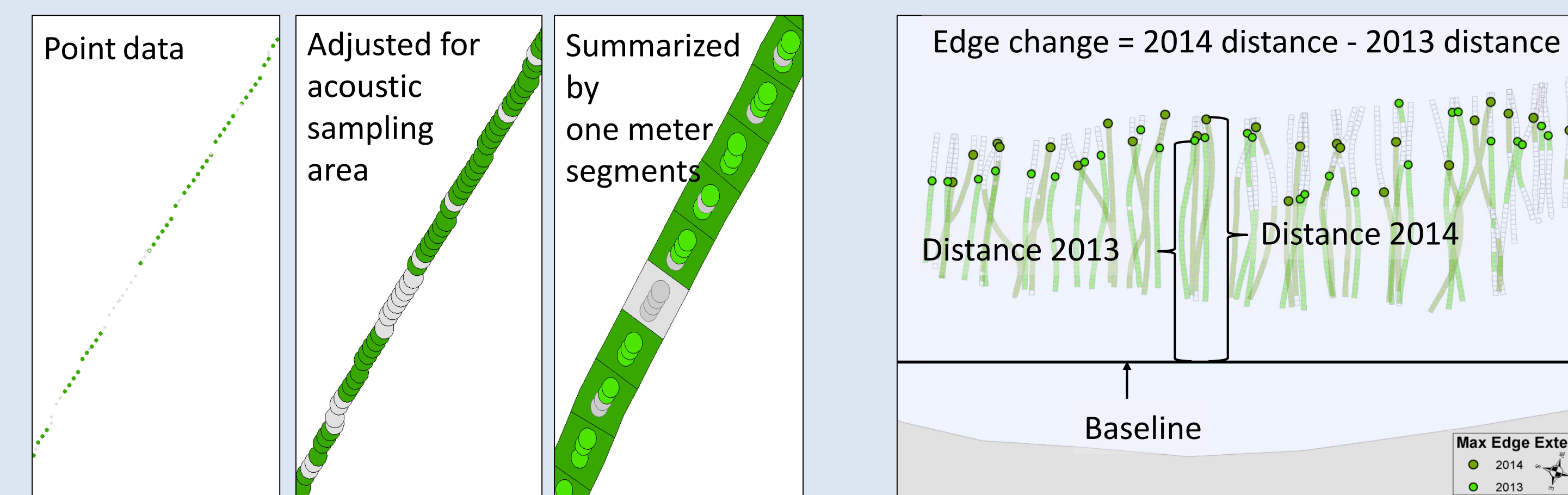
Figure 6: Echosounder data processing software



Figure 8: Video used for data validation

Eelgrass presence and seafloor bathymetry are delineated using BioSonics Visual Habitat Software. Depth data is corrected for equipment offsets and transformed to Mean Lower Low Water (MLLW). GPS position is differentially corrected using the nearest NOAA reference station. Video data are reviewed in one-second segments to determine eelgrass presence. Percent agreement between acoustic and video data is calculated using a confusion matrix.

Data Summaries



Eelgrass data point 1 m² spatially summation

Offshore edge change calculation

Point data are summarized spatially, by one meter segments, to account for changes in boat speed, sample size variance of the acoustic cone, and spatial overlap of data points. Eelgrass edge is delineated as the furthest offshore meter grid with eelgrass. Eelgrass presence data are summarized for each site by spatial extent, depth distribution, percent cover, bed slope, and plant height.

Error Estimate

Survey year	Video comparison	Horizontal accuracy	Vertical accuracy
2013	92.0%	99.20%	10 to 20 cm
2014	93.8%	98.24%	10 to 20 cm

- Video comparison: Estimate calculated using confusion matrices. Agreement = (total bare agreement + total presence agreement)/total number of data points.
- Horizontal accuracies: Percentage of points that fall within 0-15 cm. Estimated using Trimble GPS Pathfinder software.
- Vertical accuracy: Based on equipment tolerances, processing errors, and tidal correction model inaccuracies

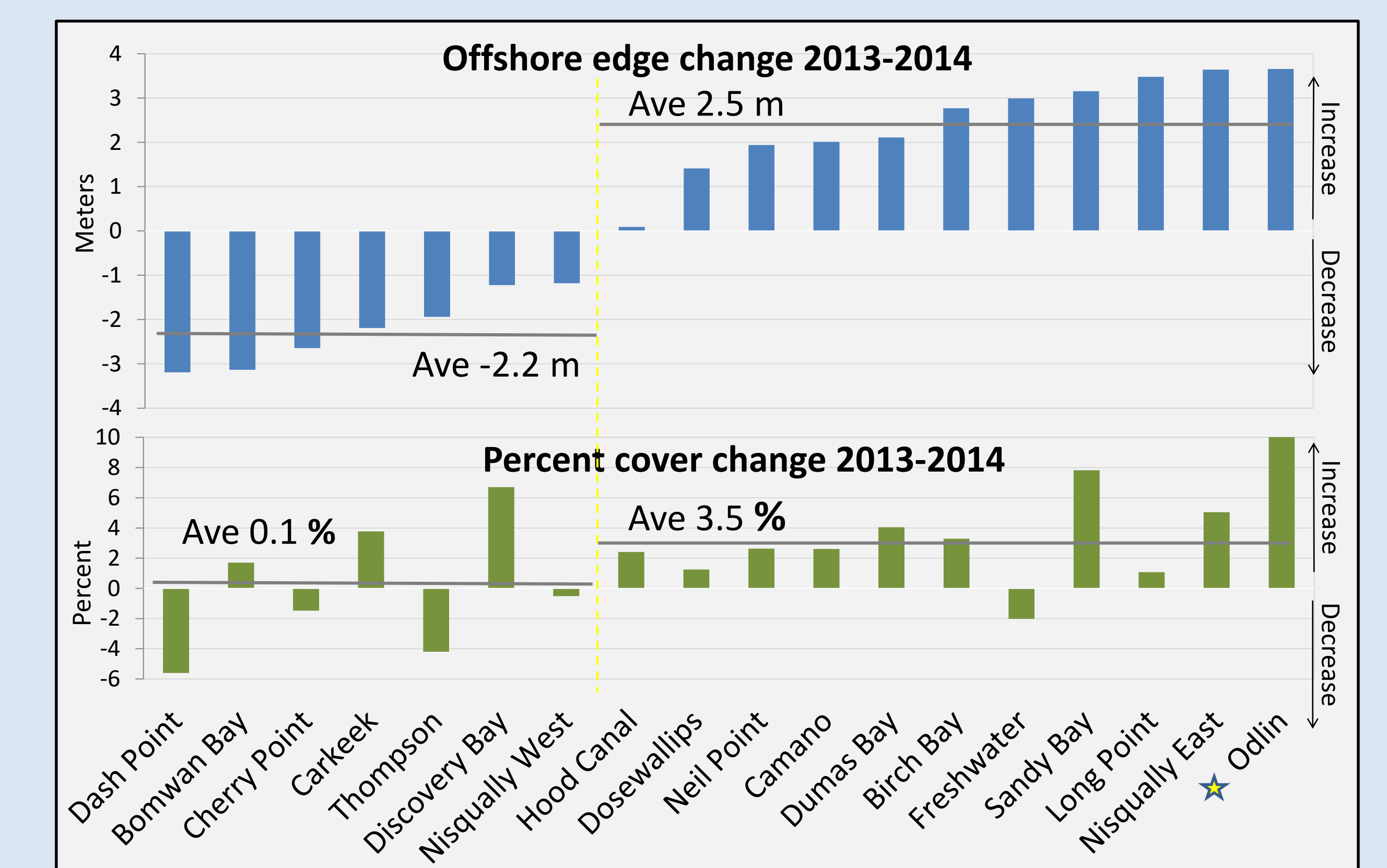
Results

Offshore edge

Edge movement average 2.4m in both seaward and shoreward directions. Seaward migration was seen in 10 sites, 7 study showed shoreward migration. The greatest average increase was 3.6 m at Odlin Park, greatest decrease was -3.2 m at Dash Point.

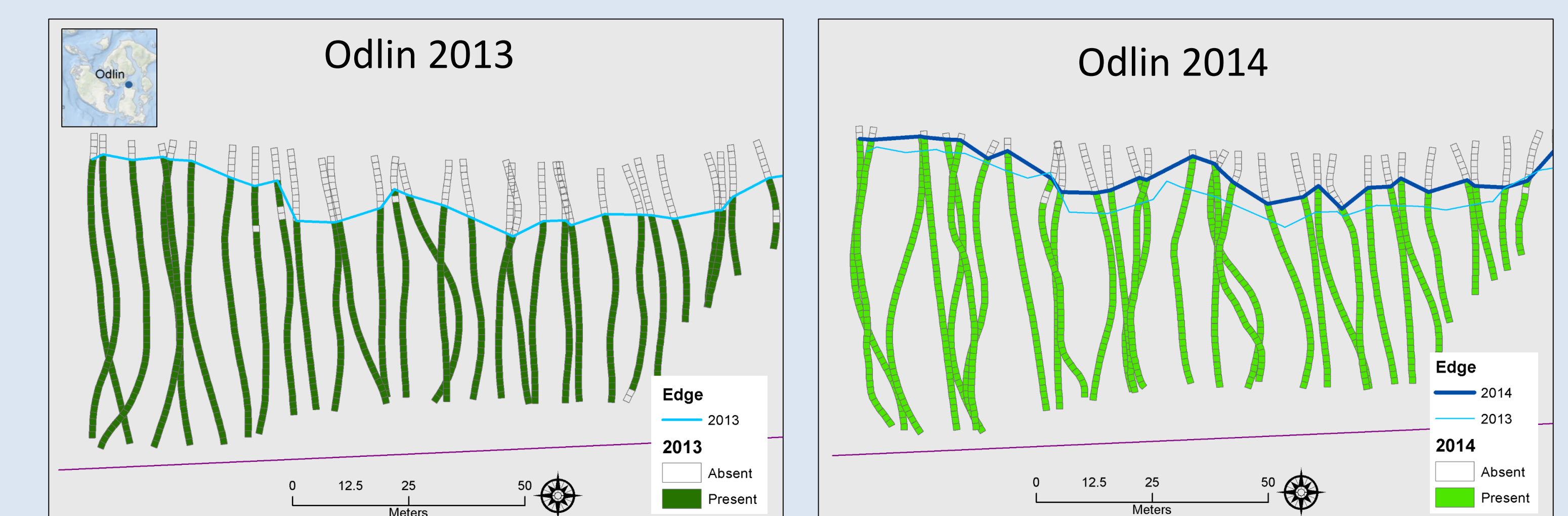
Percent Cover

Average percent cover and annual change in cover significantly correlated with edge movement (Spearman correlation $p < 0.05$). Percent cover increased at each of the sites where edge increased, with the exception of Freshwater. Percent cover decreased in 4 of the 7 sites where edge decreased. Bowman Bay, Carkeek, and Discovery Bay increased coverage while offshore extent decreased.



Odlin Park

Increased in both offshore edge extent and percent cover between 2013-2014. (pooled variance t-test $p < 0.05$). Offshore extent increased by an average of 3.6 m, percent cover increased by 10%.



Discussion

Survey techniques efficiently and accurately delineate eelgrass presence, map horizontal position, and determine vertical depth. Annual monitoring of eelgrass beds can describe changes in bed extent and correlate changes with site parameters. These surveys can be used to determine pre-site conditions and monitor changes in eelgrass distribution and bathymetry. Our methods can provide quantifiable data for restoration efforts, leasing activities, and policy decisions

Next steps

- Incorporate 2015 data
- Determine 2013-2015 trends
- Assess variances in site characteristics with Ordination analysis