Giant Kelp *(Macrocystis pyrifera)* and Coastal Resilience: A New Long-term Monitoring Project in Sitka Sound, Alaska

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Introduction

Canopy-forming kelps serve an important role in coastal resilience by providing a key habitat for many marine species of commercial and conservation importance and by buffering coastal communities from the wave action of storms (Steneck et al. 2002, Smale et al. 2013). In northern latitudes, where climate change impacts are projected to be most pronounced (Serreze and Barry 2011), understanding factors that contribute to, or inhibit, kelp growth will be critical to the management and stewardship of coastal resources and to building resilient coastal communities in these regions.

In June 2015, the U.S. Coast Guard Academy and Sitka Sound Science Center initiated a long-term study to monitor the relationship between the spatial extent of giant kelp canopy cover and specific environmental variables in Sitka Sound, southeast Alaska.

The goal of this study is to determine whether giant kelp abundance and distribution in Sitka Sound is correlated with conditions associated with long-term climate change, specifically increased sea surface temperature, reduced salinity and pH.

Study Site

This study was conducted in Sitka Sound, Alaska, located off Baranof Island in Southeast Alaska.

Nearshore habitats in the region are characterized by rocky coasts with extensive kelp forests supporting a variety of cold-water finfish and shellfish species, including northern abalone. The area represents the extreme northern range of giant kelp, *Macrocystis pyrifera* (Graham et al. 2007)

Figure 1: Sitka Sound, Alaska.

Partnerships

This study is part of a larger, Sea Grant-funded collaborative project with the Sitka Sound Science Center (SSSC), United States Coast Guard Academy (USCGA), and the Alaska Department of Fish and Game (ADF&G). The institutions are working together to establish long-term ecological monitoring sites for both kelp forests and pinto abalone as proxies for coastal resilience (also see AMSS poster, *[A short history of] long-term monitoring of pinto abalone in Sitka Sound, Alaska*)

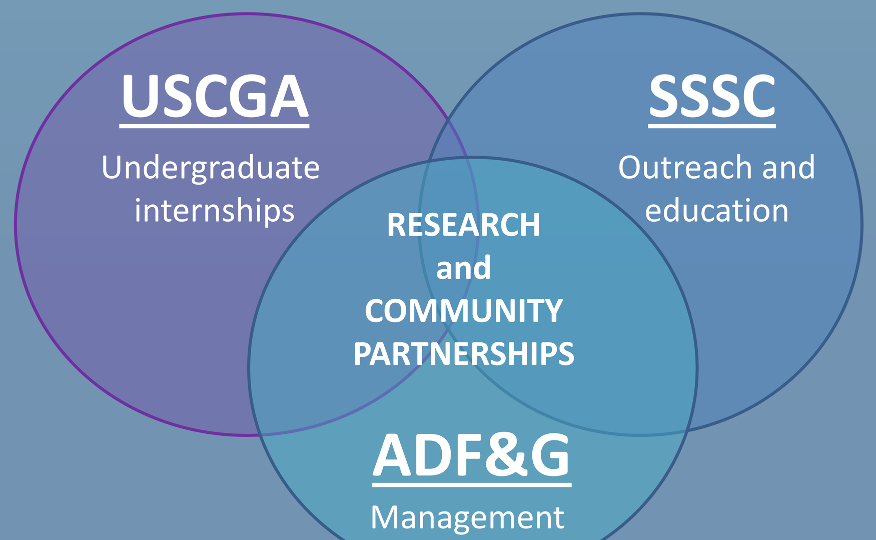

Figure 2: Summary of partner roles

Methods

Five permanent sites were established for long-term monitoring – three within existing kelp beds (Marker, Galankin, Ellsworth) and two in areas without kelp but near the other sites (Control 1, Control 2).

Kelp Canopy Extent - Kelp canopy cover was measured at the three kelp sites during the two lowest tides of June and July, 2015, when kelp growth rates reach a seasonal maximum. Global positioning system (GPS) devices were used to record the latitude and longitude of points along the perimeters of the surface canopy. Positions were uploaded into ArcGIS 10 software and kelp canopy cover was calculated from polygons created from those points.

Environmental Parameters - Sea temperature (°C) and conductivity were continuously monitored with a combination of HOBO TidbiTv2 (UTBI-001) and HOBO Salt Water Conductivity/Salinity data loggers (U24-002-C; Onset Computers Corp.) deployed at the surface and at the bottom of the water column at each sampling station. Data loggers were set to collect measurements at 15-minute intervals throughout a 24 cycle.

Figure 3: Map of sampling sites in Sitka Sound Alaska.

Water column profiles (temperature [°C], salinity [ppt], and pH) were taken with a conductivity-temperature-depth (CTD) meter (YSI 6500, YSI Inc.) twice a week during June-July, 2015. We also deployed a single current meter (S4 InterOcean Systems Inc.) at the Marker kelp site to test the resilience of the instrument for in field conditions in Sitka Sound and to collect preliminary data on current speed and direction at the study site. These data are available upon request; data from the HOBO data loggers are summarized below.

Results

Monitoring results from the three kelp stations and two control stations are shown in Figures 4-6. Overall, the spatial extent of kelp beds varied by 6-12% between June and July, 2015 (before corrections for exact sea level at the time of measurement) (Table 1). In addition, sea temperature and conductivity at kelp and control monitoring sites varied considerably over the sampling period and, over shorter time scales, with the tidal cycle (Figs. 4b, 4c, 5b, 6b , and 6c). Temperature was more variable over time at the surface than at the bottom of the water column at all five sampling sites but especially at Galankin and Ellsworth (Figs. 5b, 6b).

MARKER

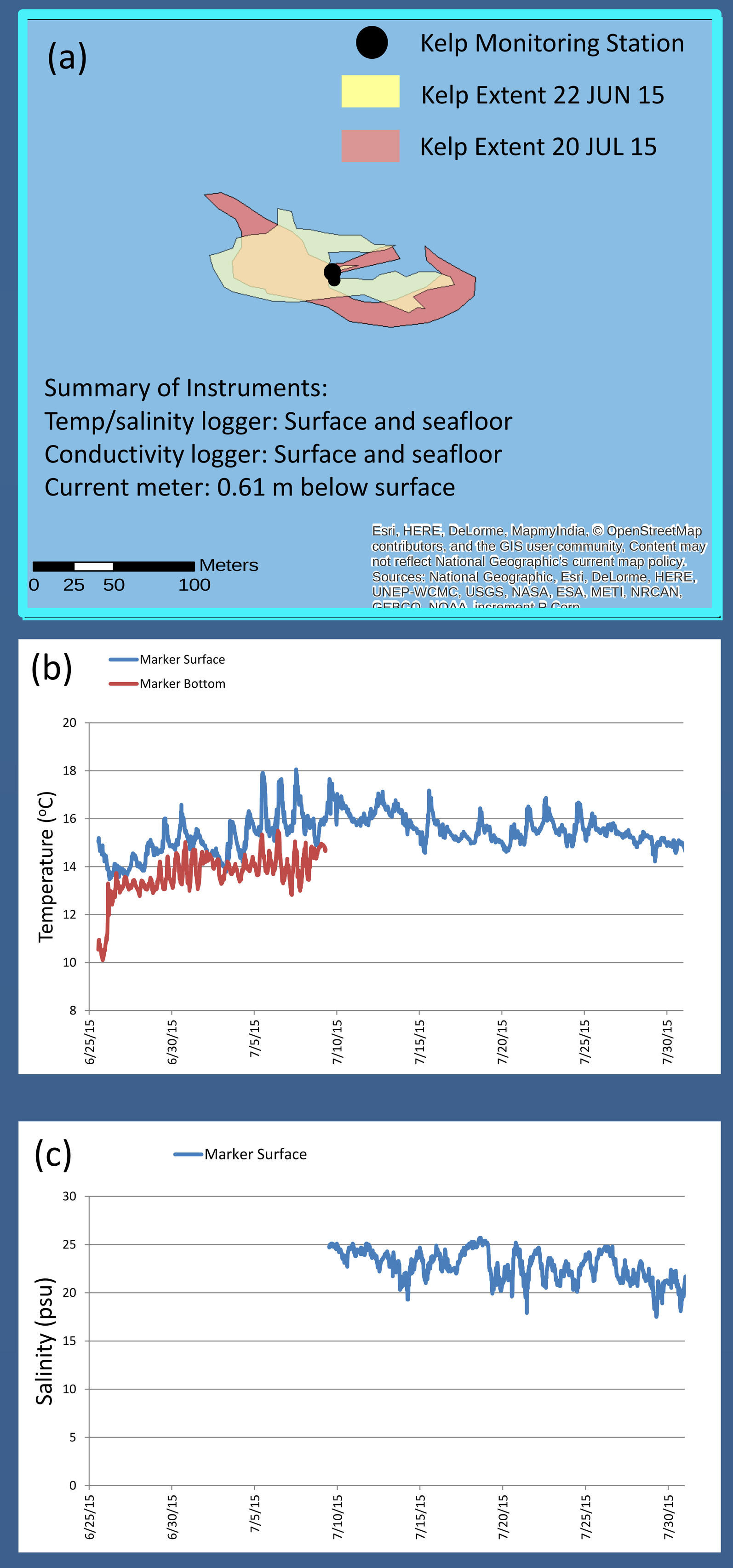

Figure 4: Marker monitoring station. (a) Spatial extent of kelp bed sites on 22 June 2015 (pink) and 20 July 2015 (yellow), (b) surface and bottom temperature , and (c) surface salinity.

GALANKIN

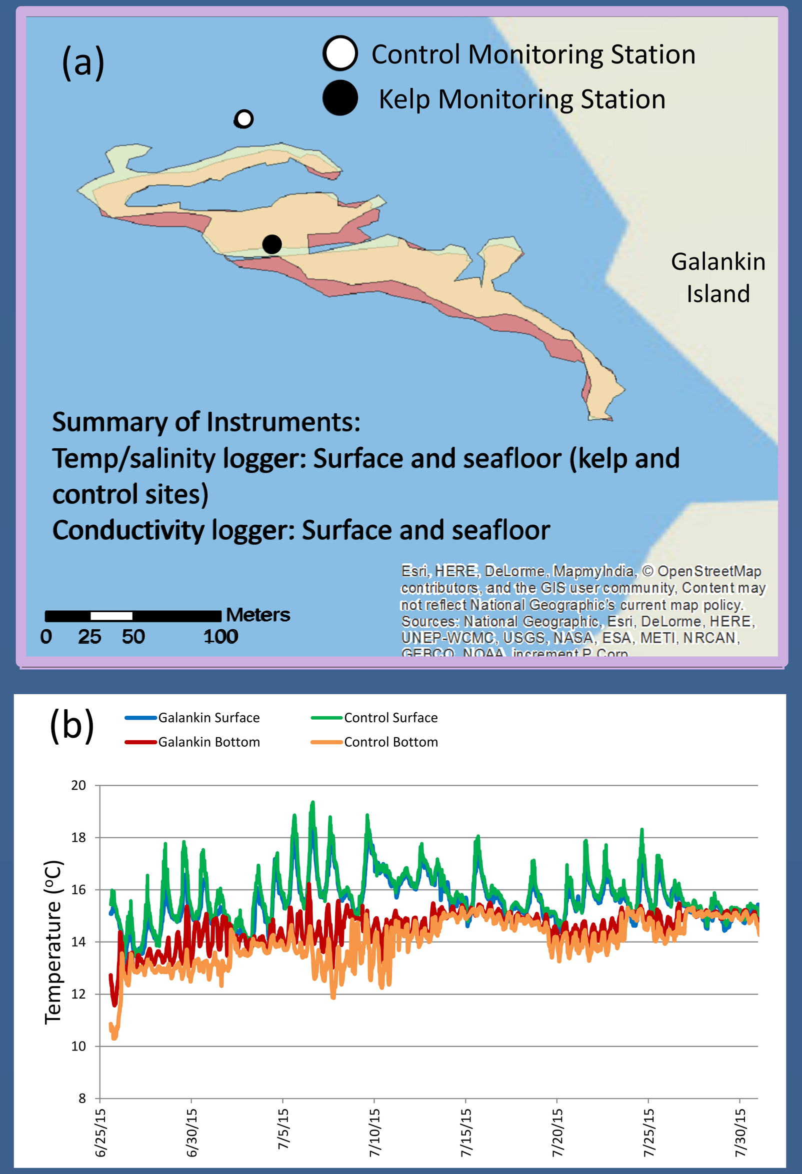

Figure 5: Galankin monitoring station. (a) Spatial extent of kelp bed sites on 22 June 2015 (pink) and 20 July 2015 (yellow), and (b) surface and bottom temperature at Galankin and Control 1 sites.

Table 1: Spatial extent of kelp beds measured during slack low tide on 22 June and 20 July 2015, which is peak growing season for kelp at the study site.

Date	Marker (m²)	Galankin (m²)	Ellsworth (m²)
22JUN15	2756	5654	3978
20JUL15	2573	5112	3492

ELLSWORTH

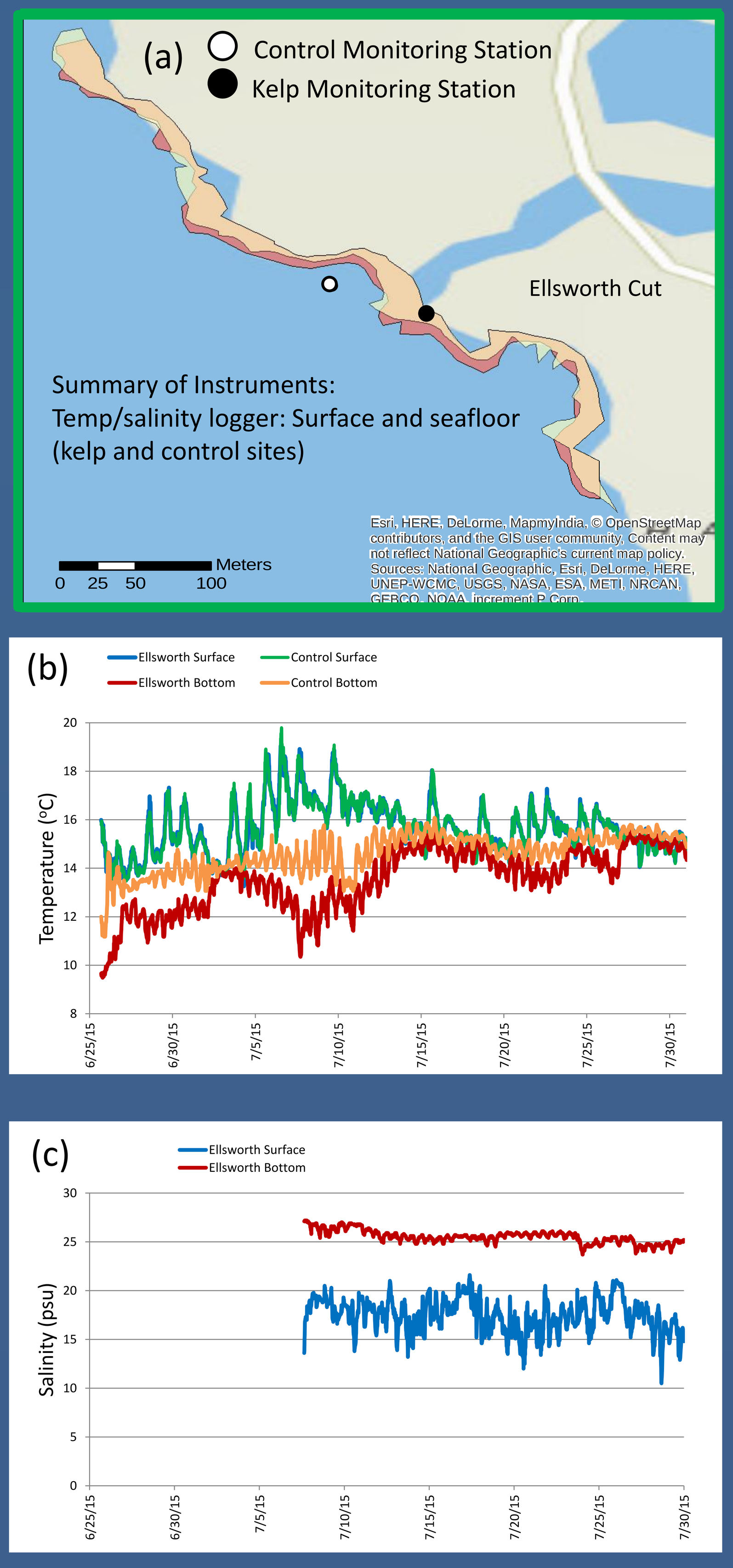

Figure 6: Ellsworth monitoring station. (a) Spatial extent of kelp bed sites on 22 June 2015 (pink) and 20 July 2015 (yellow), (b) surface and bottom temperature , and (c) surface and bottom salinity.

Discussion

An extended sampling period is required to understand long-term trends, but initial results demonstrate short-term (background) variation in water conditions and kelp canopy coverage. The fluctuations in kelp bed size at Marker, Galankin, and Ellsworth stations by approximately 6-12% (Table 1) are likely due to differences in the height of tide and thus the amount of kelp extending to the surface. In addition, sea temperature and conductivity at both kelp and control monitoring sites varied considerably with season and tides.

Temperature and conductivity were more variable over time at the surface than at the bottom of the water column, which is not surprising given that surface waters are more influenced by solar heating and freshwater inputs, e.g., precipitation and river runoff. We found little difference in surface temperature between kelp sites and control sites suggesting that kelp canopy cover has relatively little influence on surface conditions over such small spatial scales.

Next Steps

Future plans are to continue monitoring surface kelp extent during the growing season in the coming years, with existing data loggers also in place. In June 2016, monitoring efforts will be supplemented by a EMM68 data buoy and water quality sonde deployed in nearshore Sitka Sound. It will provide continuous measurements of surface temperature, salinity, chlorophyll concentration, and pH, accessible over a remote internet connection.

In addition, a new group of cadet interns will travel to Sitka during June-July 2016 to continue sampling of kelp bed extent and environmental parameters. Because the S4 current meter broke free from anchor in October 2015, interns will also be looking into a more effective way of securing it for future use.

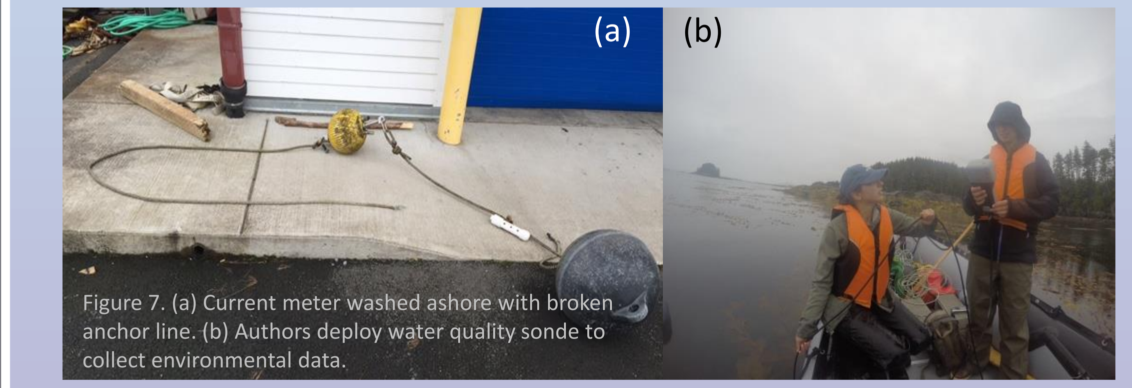

Figure 7. (a) Current meter washed ashore with broken anchor line. (b) Authors deploy water quality sonde to collect environmental data.

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