Effects of glacial discharge on recruitment and succession in kelp bed communities

Sarah B. Traiger (sbtraiger@alaska.edu), Brenda Konar
School of Fisheries and Ocean Sciences, University of Alaska Fairbanks

Introduction

- Glacial melt water, which is cold, fresh, silty, and low in nutrients influences nearshore marine organisms through the changes it causes to water conditions. (Wiencke et al. 2007).
- Recent climatic change has led to increased glacial melting in Alaska (Neal et al. 2010).
- Glacial discharge typically peaks in the fall, but timing may change with future climate change.
- Kelp and kelp associated benthic invertebrate recruitment and succession are sensitive to glacial melt.
  - Many marine organisms are stressed by lowered salinity.
  - High sedimentation can prevent kelp and invertebrate settlement or can bury small organisms.
  - Suspended sediment can decrease light, inhibiting macroalgal recruitment and growth.

Research Questions:

- How does recruitment and succession vary across Kachemak Bay?
- Are recruitment and succession influenced by glacially-influenced environmental factors?

Methods

- Study sites in Kachemak Bay were sampled along the 10 m depth contour in April and biweekly from May – September in 2013 and 2014 (Fig. 1).
- Water currents flow along the southern shore toward the head of the bay, then exit along the north side of the bay. Glacial melt water discharges into the head the bay. The Homer Spit divides Kachemak Bay into inner and outer bay regions.

Figure 1. Study sites in Kachemak Bay. White arrows show general current directions. Red box on the inset map shows location of Kachemak Bay within Alaska.

***Recruitment & Succession*:** Sets of six replicate rocks were cleared and tagged and placed at each site in March 2013. Percent cover of sessile organisms was estimated and individual kelp were counted on each tagged rock at each visit .

***Glacially-influenced Factors*:** Environmental factors related to glacial discharge were measured as follows: organic and inorganic sedimentation rate (sediment traps), salinity (2013 YSI, 2014 HOBO loggers), irradiance and temperature (HOBO loggers). River discharge, cloud cover, precipitation, and daylight hours were non-glacial variables.

Results

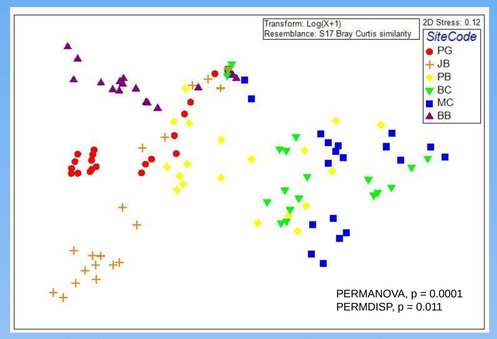

Figure 2. nMDS plot of percent cover data from April 2013 to September 2014. Each point represents percent cover data averaged for the six replicate rocks at each sampling event.

- **Sessile communities** that recruited onto rocks were significantly different among sites (Fig. 2).

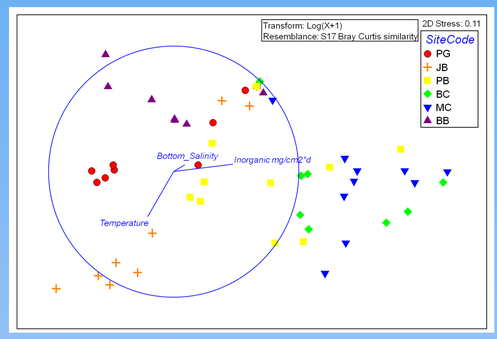

Figure 3. nMDS plot of percent cover data from rocks deployed in March 2013, with salinity, inorganic sedimentation rate, and temperature vectors overlaid. There are fewer points in this nMDS than in Figure 2 because sedimentation rate was sampled monthly.

- **Environmental factors** that explained 29% of the variability in the percent cover data on rocks included inorganic sedimentation rate, temperature, and salinity (Fig. 3).

- **Barnacles** were important early recruits to the three inner bay sites (PB, BC, MC) and contributed to similarity within these sites (SIMPER). In contrast, there was little to no barnacle recruitment at the three outer bay sites (PG, JB, BB).
- There was high temporal variability in barnacle cover as they died and were replaced by additional barnacle recruitment (Fig. 4).
- In 2014, there no barnacle recruitment to PB until the end of August (Fig. 4a).

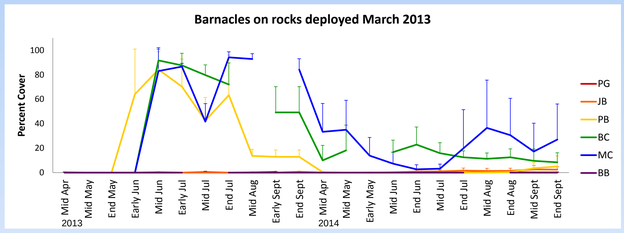

Figure 4. Percent cover of barnacles on rocks deployed in March 2013.

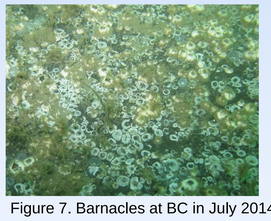

Figure 7. Barnacles at BC in July 2014.

- **Kelp recruitment** was limited on rocks deployed in March 2013.
- In spring and summer of 2014, recruitment occurred at all sites (Fig. 6).
- Kelp was most abundant and diverse at outer, southern shore sites (PG and JB).
- Very few kelp recruits appeared at MC and none of these grew large enough to be identified to species.
- At BB, only a single *Agarum clathratum* was observed.

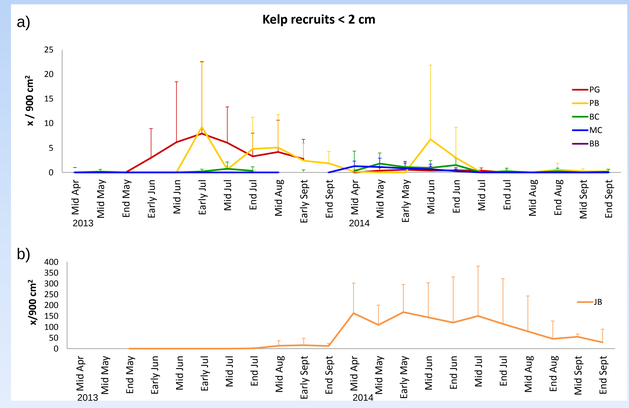

Figure 6. a) Density of kelp recruits (< 2 cm tall) on rocks deployed in March 2013, b) Density of kelp recruits on rocks deployed at JB in March 2013 shown separately because kelp recruitment was much higher than at other sites.

Figure 8. Kelp recruits at PB in August 2013.

Summary & Conclusions

- There were distinct patterns of recruitment and succession that differed according to position within the bay and were correlated to glacially influenced environmental factors.
  - Barnacle abundance in the inner bay may be explained by circulation patterns pooling larvae in the inner bay. Barnacles appeared to be robust against sedimentation, as they survived at highly sedimented sites (Fig. 7).
  - Since kelp recruitment was so low at inner bay sites, kelp beds at these sites could be vulnerable to disturbance (Fig. 8).
  - The identity of the major recruiting taxa at each site did not change greatly over time.
  - Recruitment may be limited by lack of propagule supply or early mortality of new recruits.
- Inorganic sedimentation rate was the most important driver of recruitment and succession.
  - Inorganic sedimentation rate could be an important factor to monitor in light of future changes in glacial discharge dynamics.

Literature Cited:

Field & Walker (2003) Kachemak Bay Research Reserve site profile

Neal et al. (2010) Geophysical Research Letters 37: L06404

Wiencke et al. (2007) Life in Extreme Environments 213 - 244

Acknowledgements: This research was supported in part by Alaska Sea Grant and by a UAF Center for Global Change Student Research Grant with funds from the Cooperative Institute for Alaska Research. Thanks to the staff at the Kasitsna Bay Laboratory for lab and boating support. Thanks to volunteers Alex Ravelo, Lander Ver Hoef, Kim Powell, Nathan Green, Ira Hardy, Shae Bowman Eric Wood, Alyssa Lind, Elizaveta Ershova, Alexandra Ravelo, Richard Doering, Anne Benolkin , and Martin Schuster.