Linking Habitat and Benthic Invertebrate Species Distributions in Areas of Potential Renewable Energy Development

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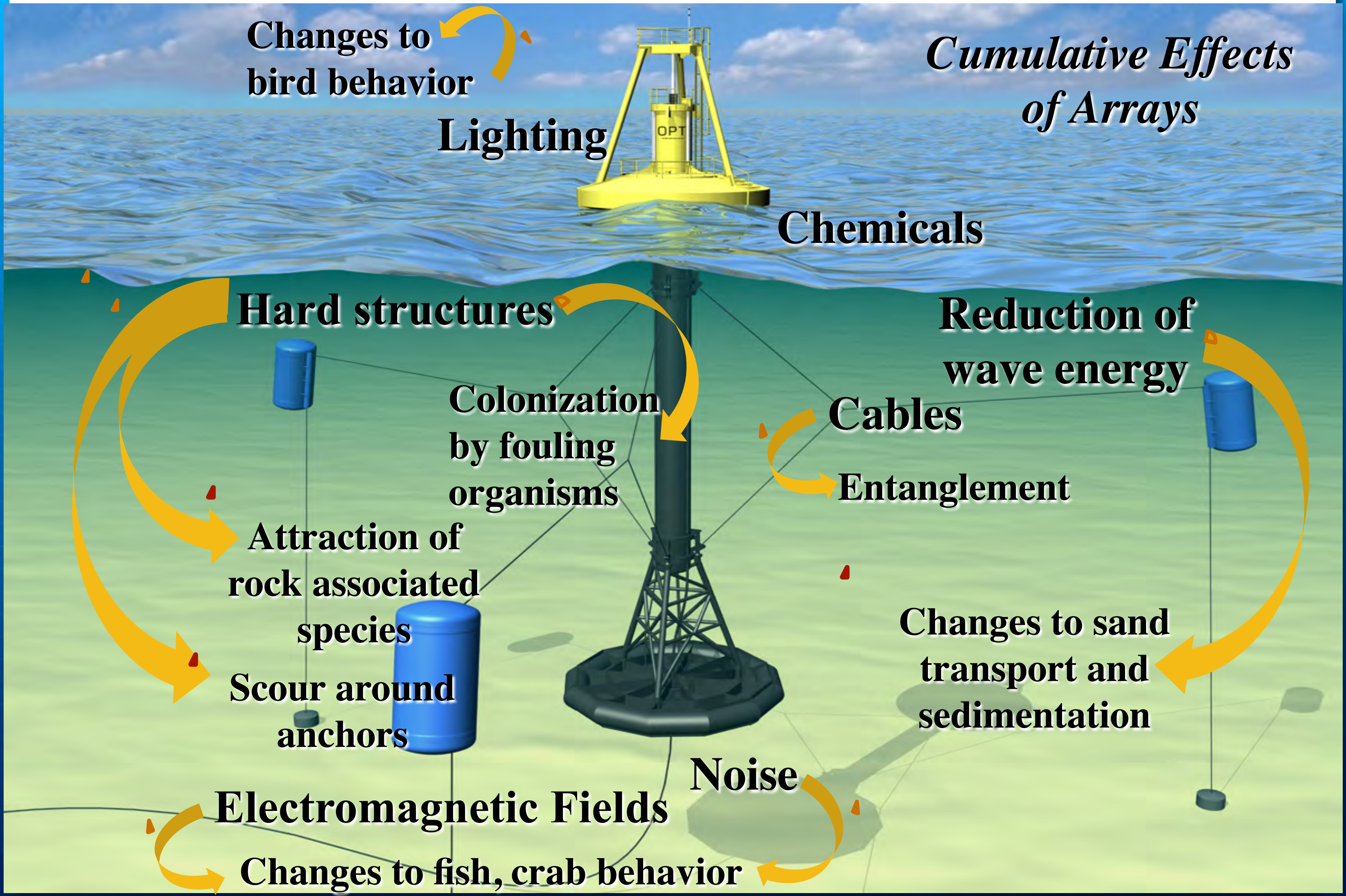
Potential Environmental Effects



Objectives for Baseline Benthic Research

1. Describe the benthic habitats and communities of organisms in areas of potential marine renewable energy development in the Pacific Northwest
2. Develop an understanding of species-habitat relationships
3. Determine variation in habitat characteristics and benthic species **across space** in the region
4. Determine variation in benthic species **over time**

Spatial (and quasi-Temporal) Study

❖ **Infaunal invertebrates in sedimentary habitats and macro-inverts in rocky habitats**

- ✧ 2010 - 2012
- ✧ Northern California to central Washington
- ✧ Federal waters only
- ✧ Depth range of ~40 to 130 m
- ✧ All sites approximately the same area sampled
- ✧ Sampling intensity represents depth proportion

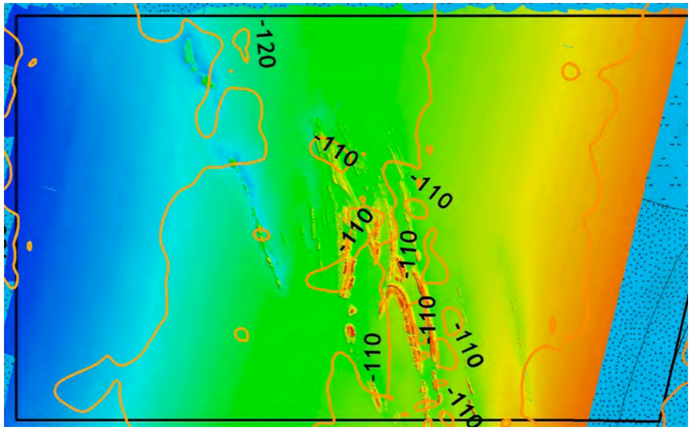
❖ **Compare infaunal data to 2003 EPA survey**

❖ **Compare reef data to 1990s *Delta* surveys**

High Resolution Mapping

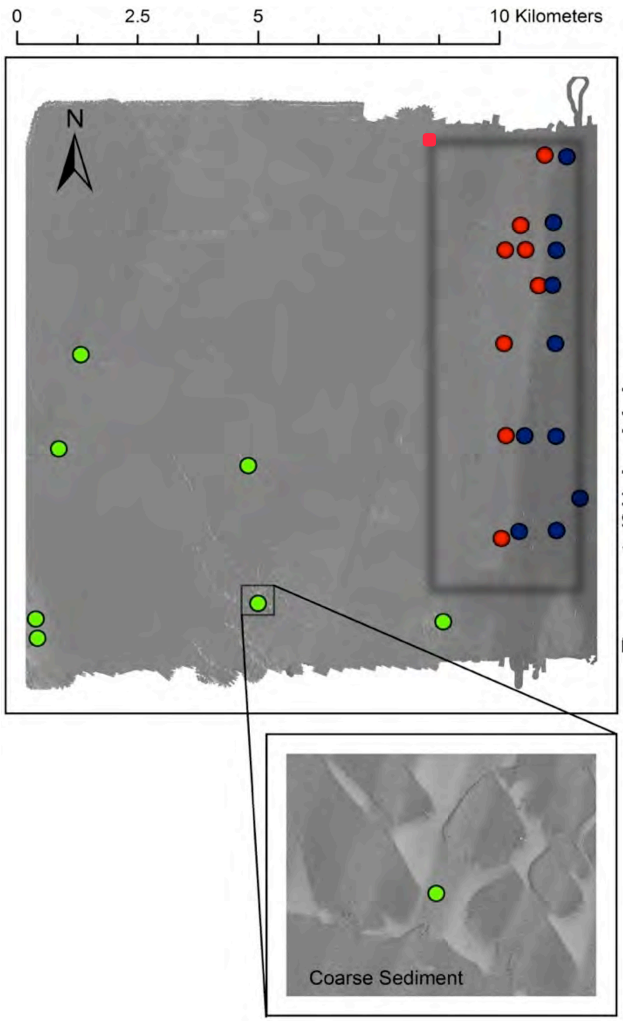
Conducted by C. Goldfinger lab (CEOAS)

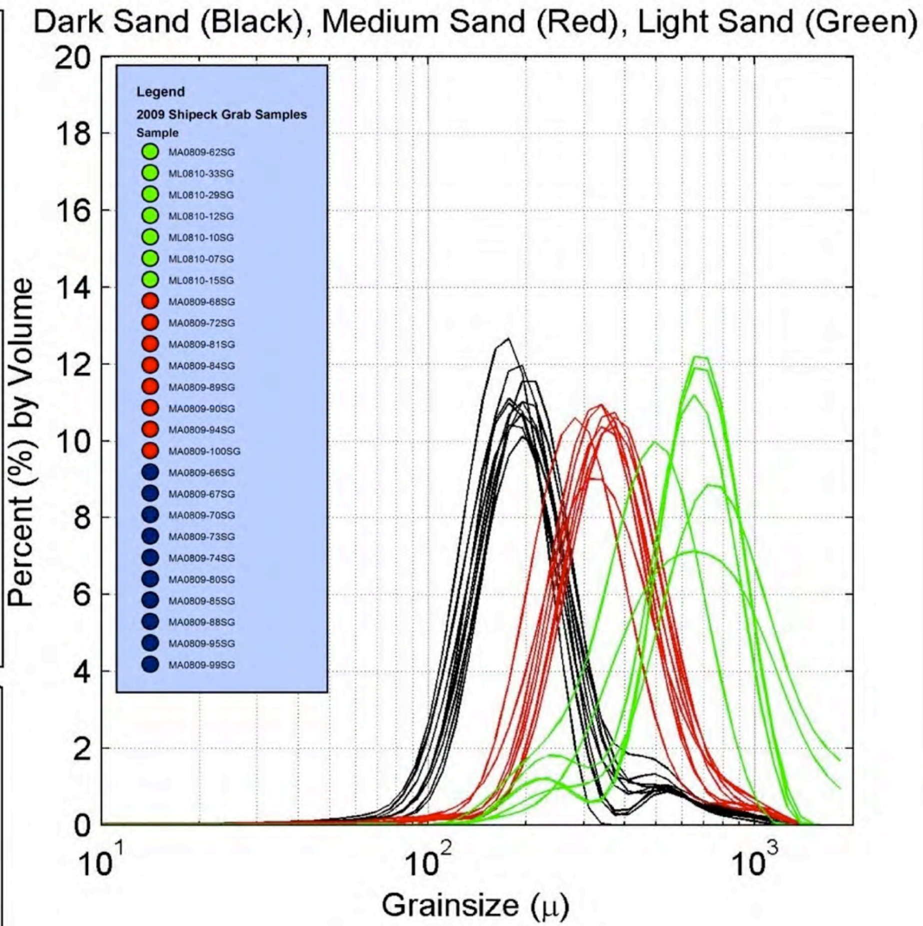
Multi-beam sonar mapping (bathymetry)



Acoustic backscatter (substrate type)

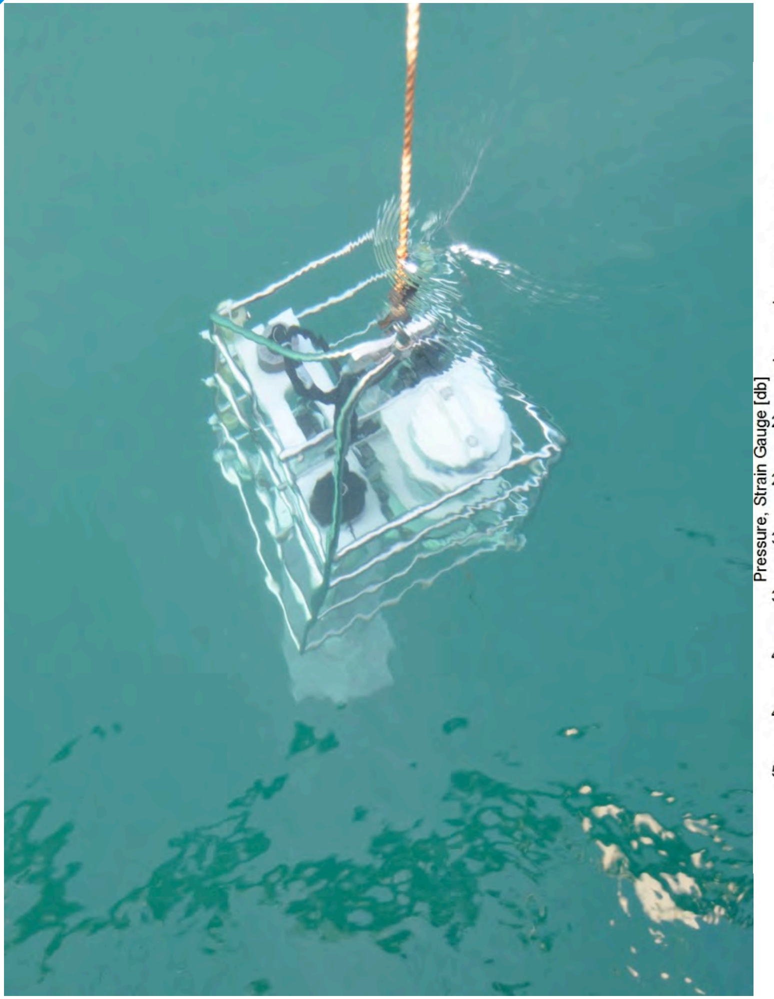
Groundtruth with Grab Samples

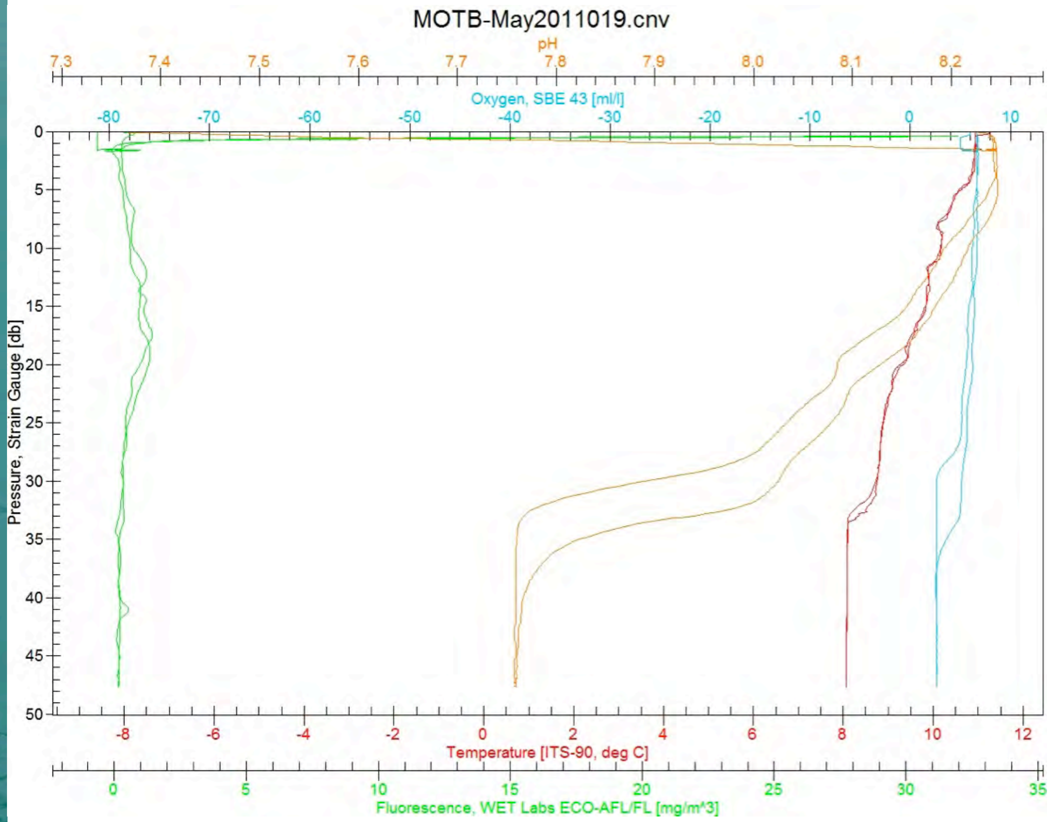




Water Column Sampling

CTD cast at each station measures depth, temperature, salinity, dissolved oxygen, chl fluorescence, pH





Infauna and Sediment Sampling

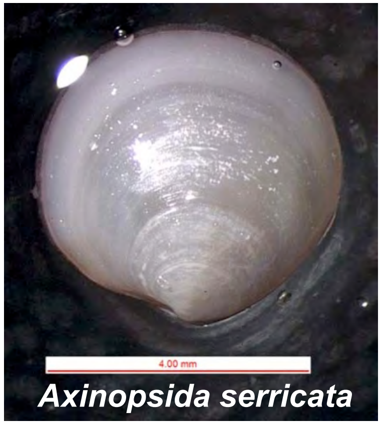
0.1 m^2 Grey-O'Hare box core (versus van Veen in 2003)

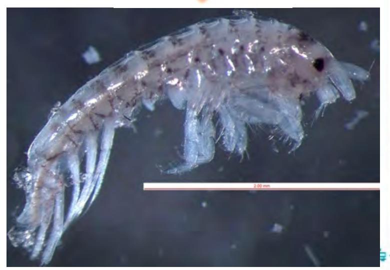
Analyze sediment for grain size, total organic carbon

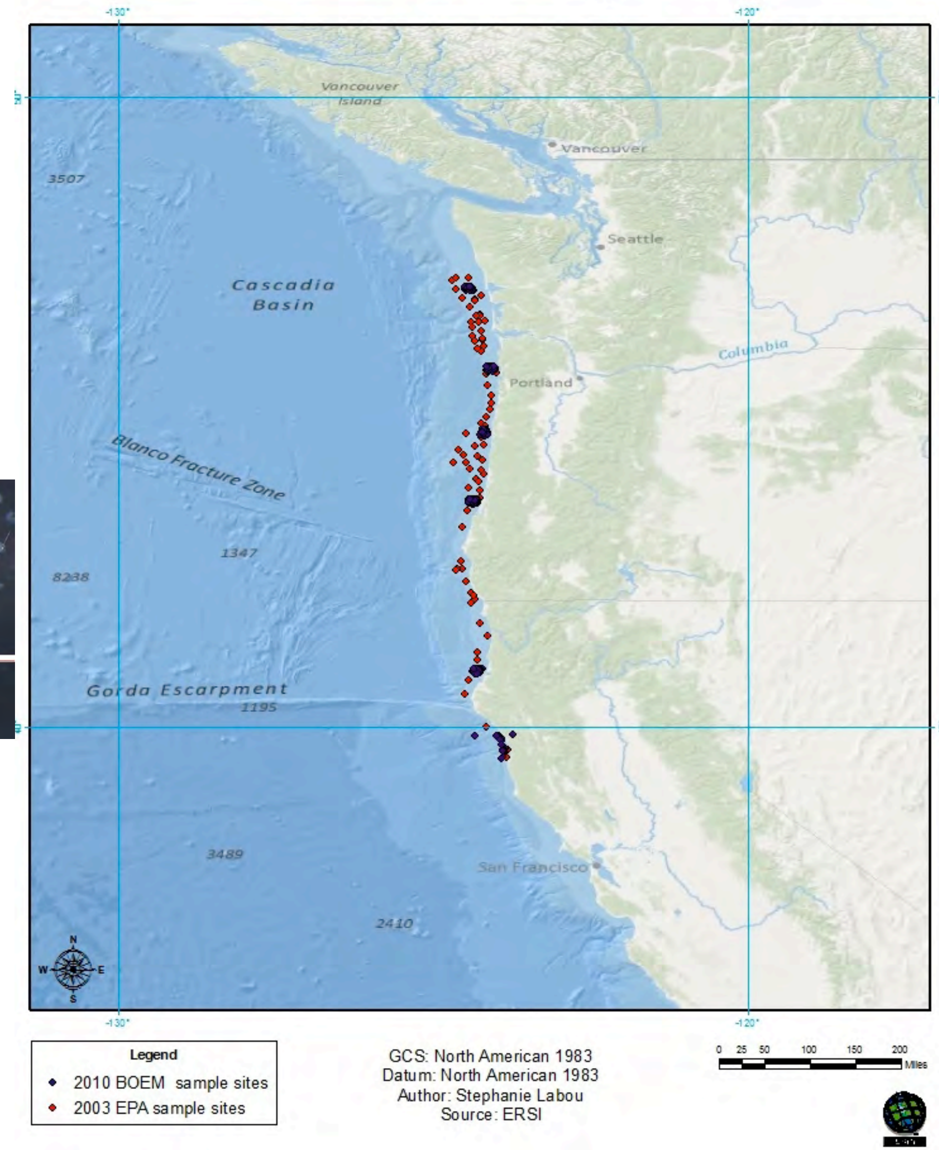
Sieve through 1.0 mm mesh

Identify infauna in the lab

Infauna and Sediment Results

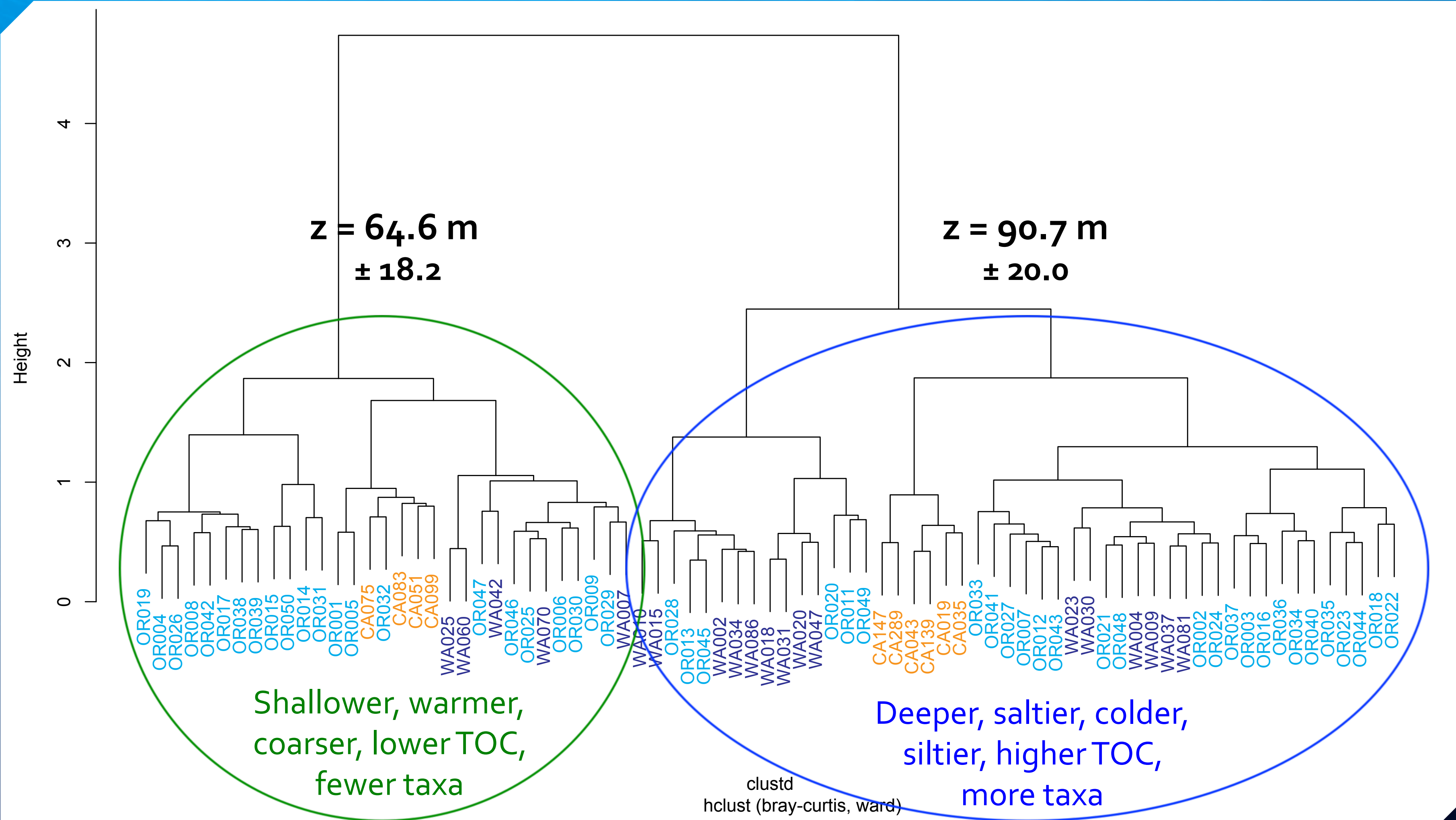




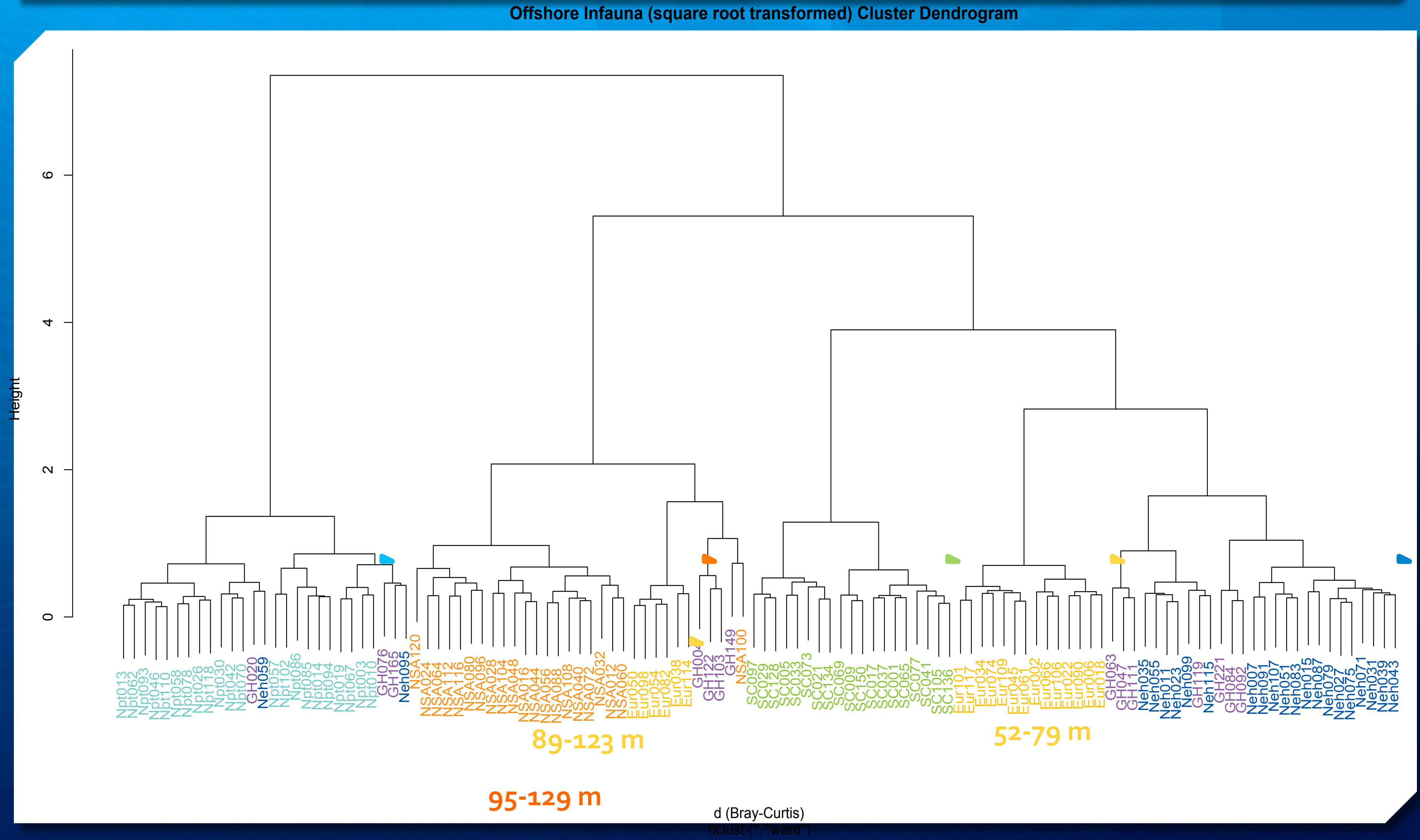


2003 EPA-NCA stations

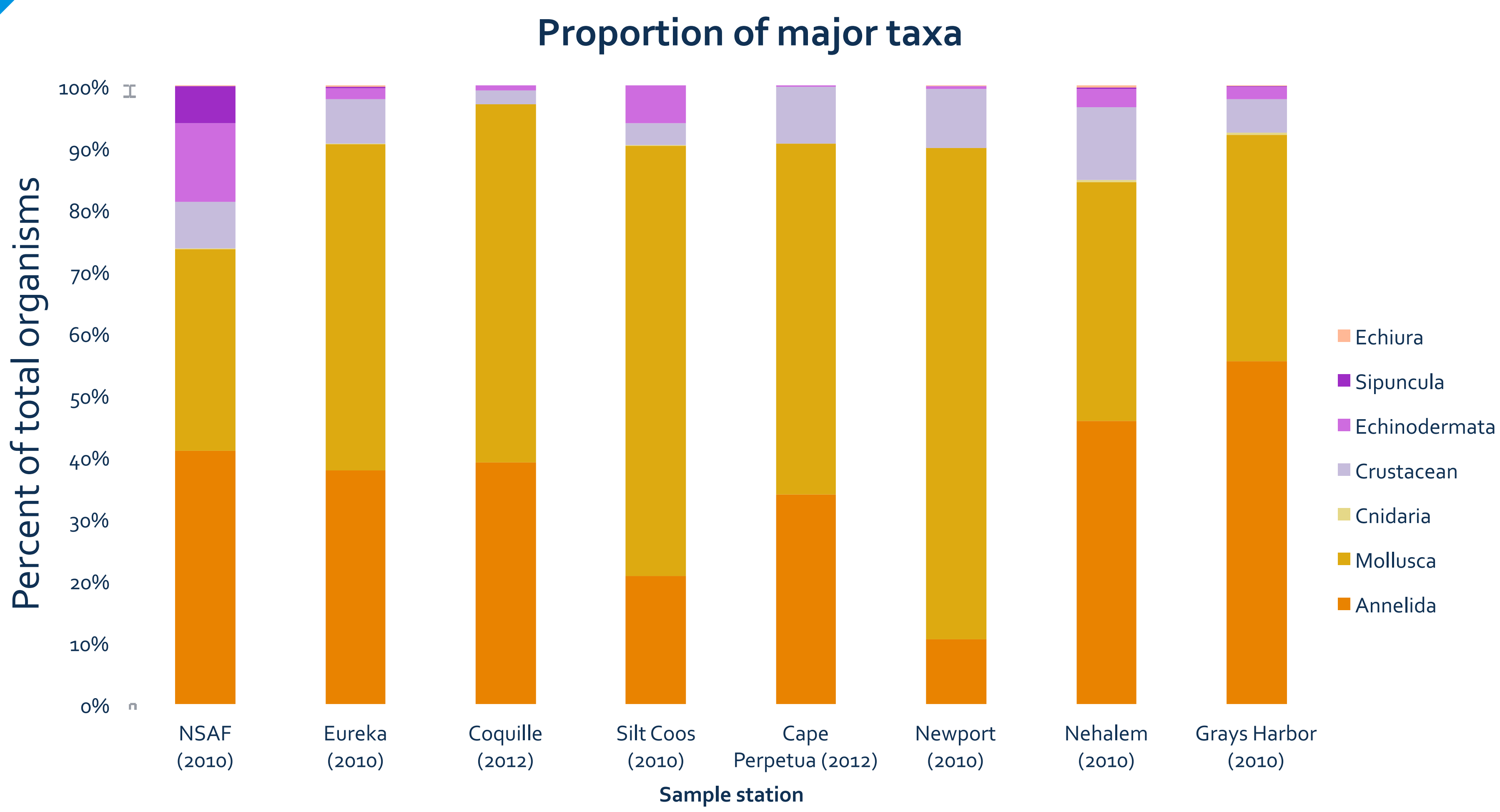
Cluster Dendrogram of 2003 EPA-NCA Samples from Northern California to Washington (outside the NMS)



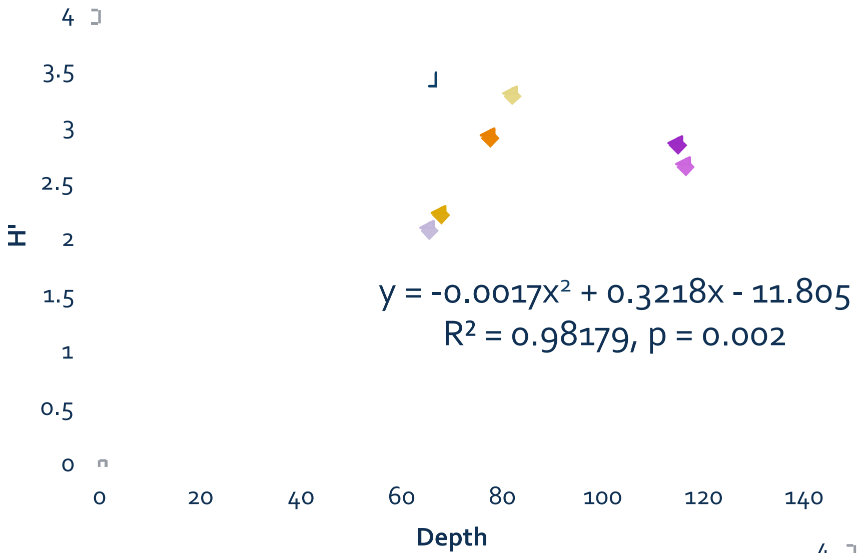
2010 BOEM Benthic Stations



What makes Newport so different? Mollusca (Bivalves)!

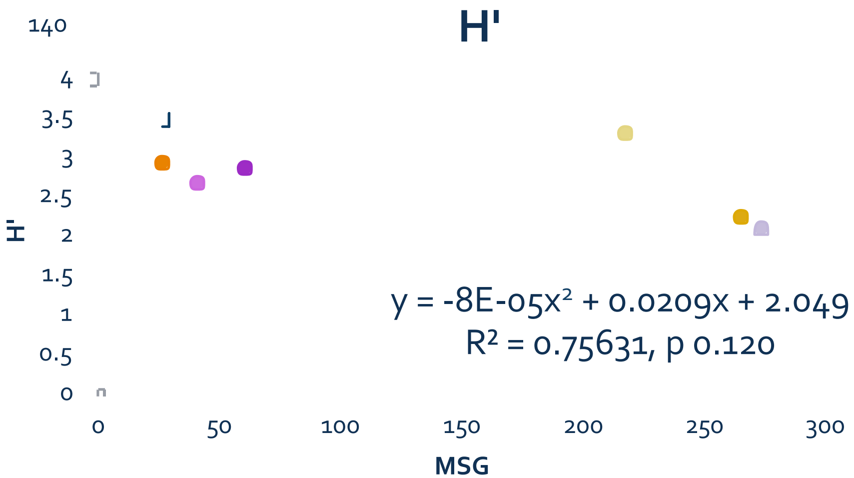


H’ Diversity of Infaunal Samples (BOEM)



Shannon Diversity $_{\log(e)}$ had a 2nd degree polynomial relationship with both depth and median grain size.

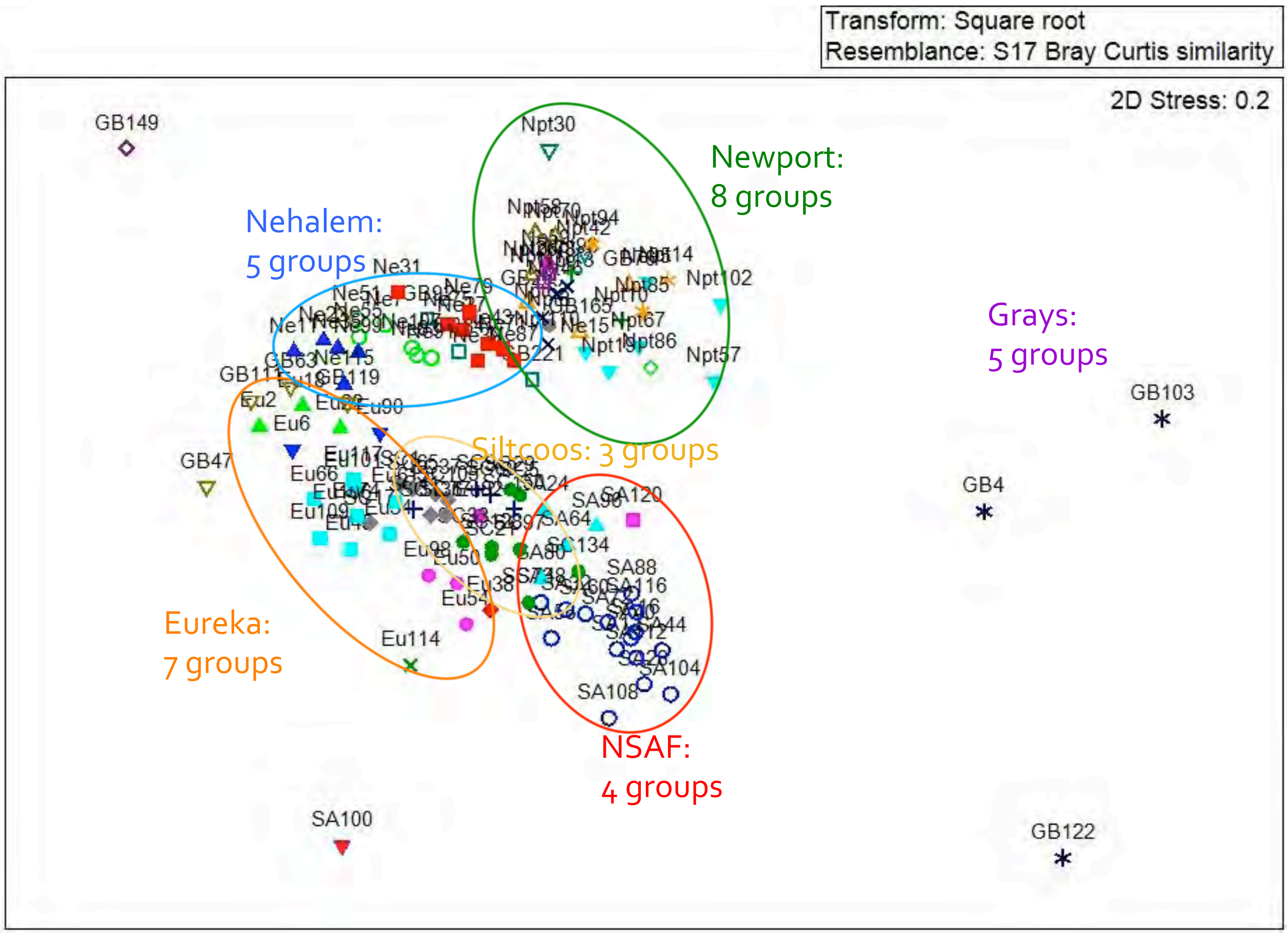
The relationship with depth was stronger than with MGS.



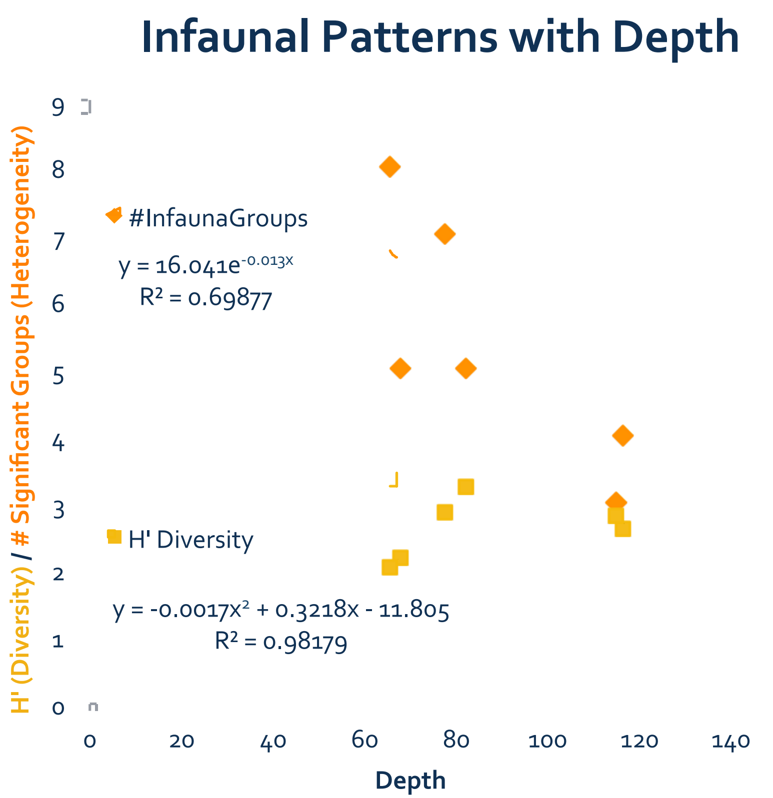
Maximum Diversity $_{\log(e)}$ should be found at ~ 95 m and 120 µm median grain size.

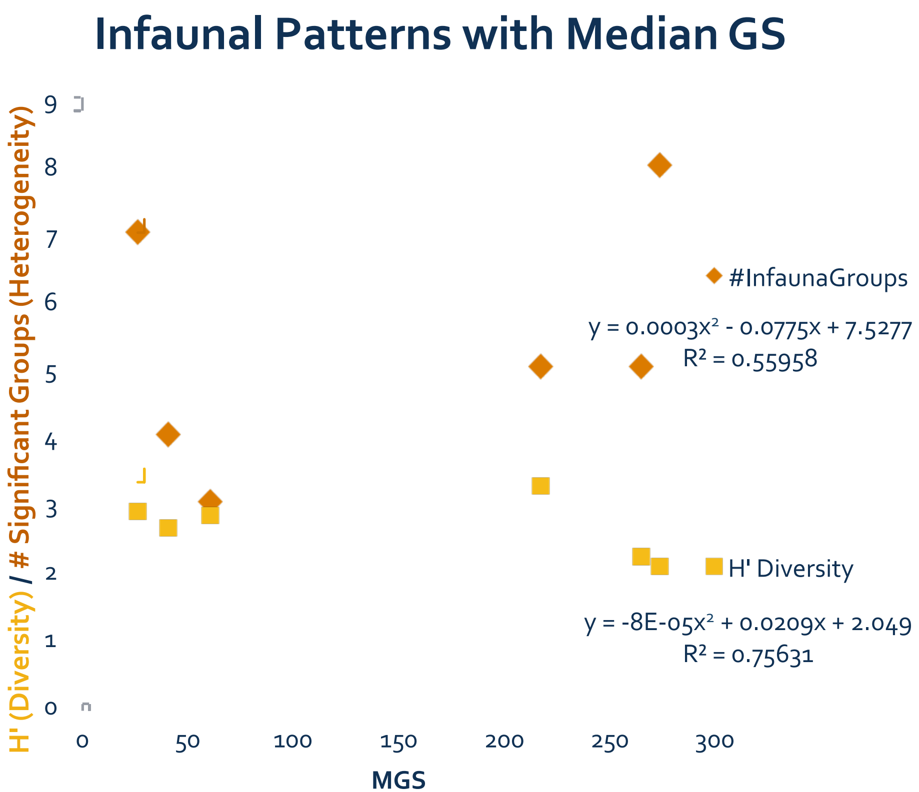
Community Analysis (SIMPER)

BEST Bio-Env = 0.702: lon, z, % sand, % gravel, mgs

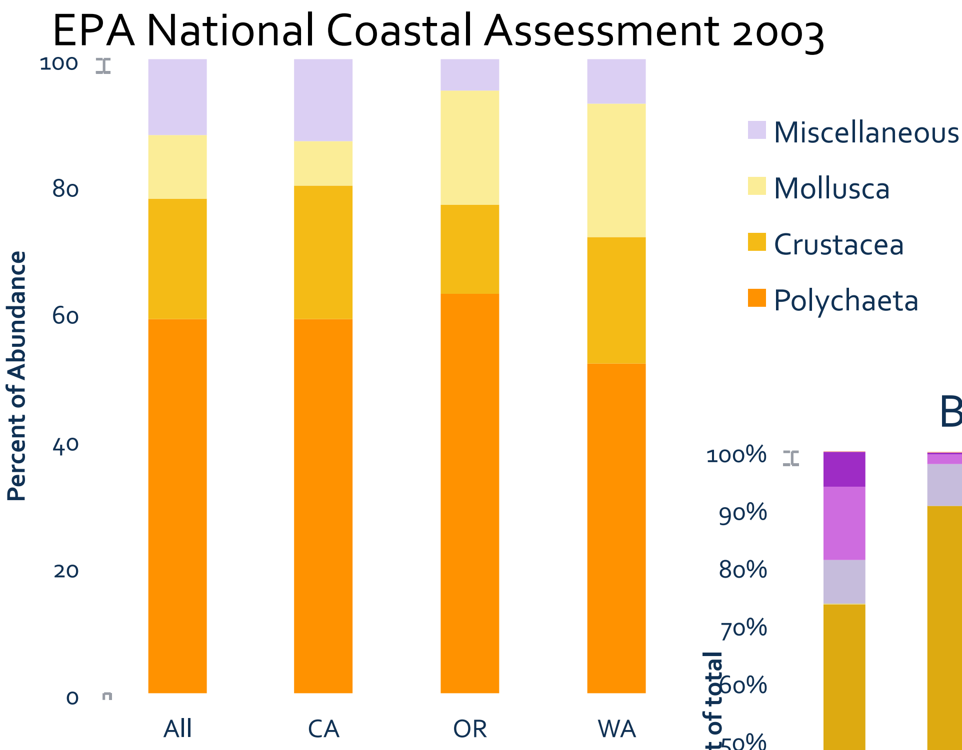


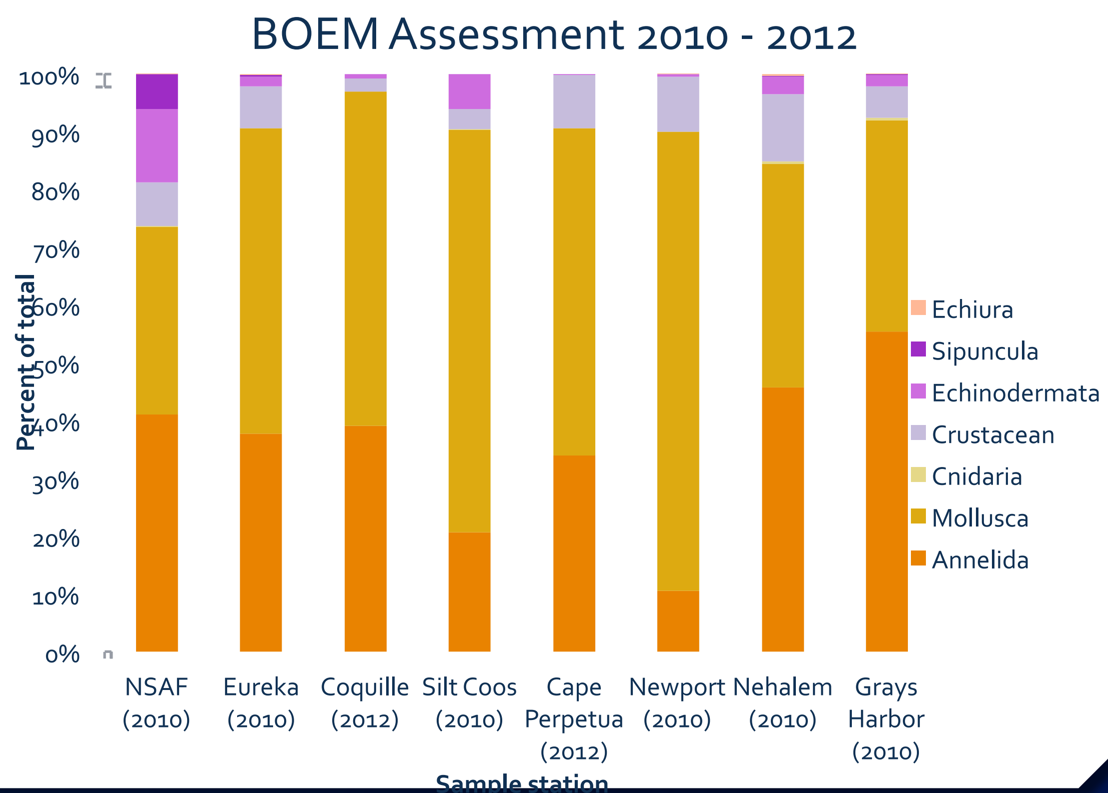
Community Trends





Shelf Infaunal Densities over Time

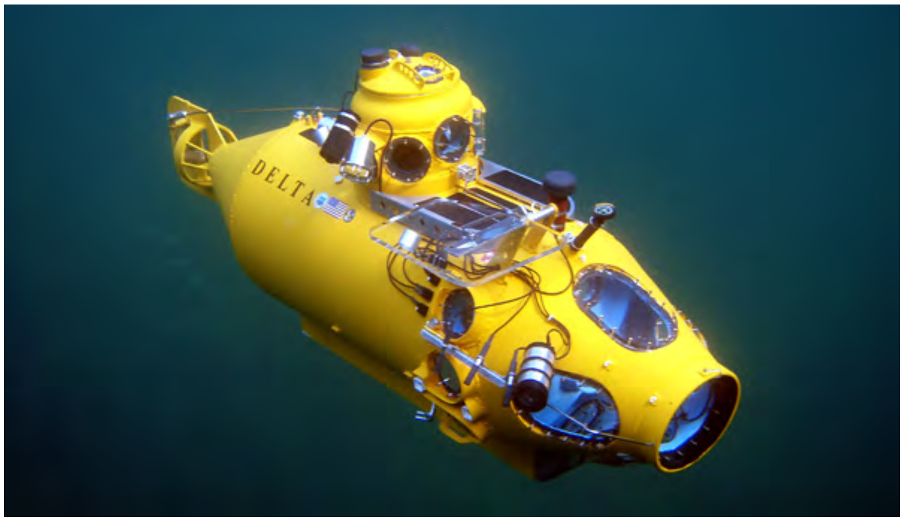




Infaunal Invertebrate Summary

- **Unique invertebrate** assemblages were found at each site in the PNW
- There appears to be a break in the infaunal community at 70–80 m depth
- Species diversity peaked at ~95 m depth and ~120 µm median grain size
- Local spatial heterogeneity was higher at shallower sites (usually with larger grain size)
- One site cannot necessarily serve as a proxy for distant sites (or nearby sites in different depth range)
- If the depth and grain size of a site are measured, one may be able to make good predictions of the species assemblage likely to be found there, within a region
- *In central Oregon state waters, **infaunal invertebrate** assemblages have not varied across seasons (but may have longer term variability)*
- *Baseline/monitoring sampling may be conducted 1x/year*

Epifaunal Sampling – *Reef Surveys*



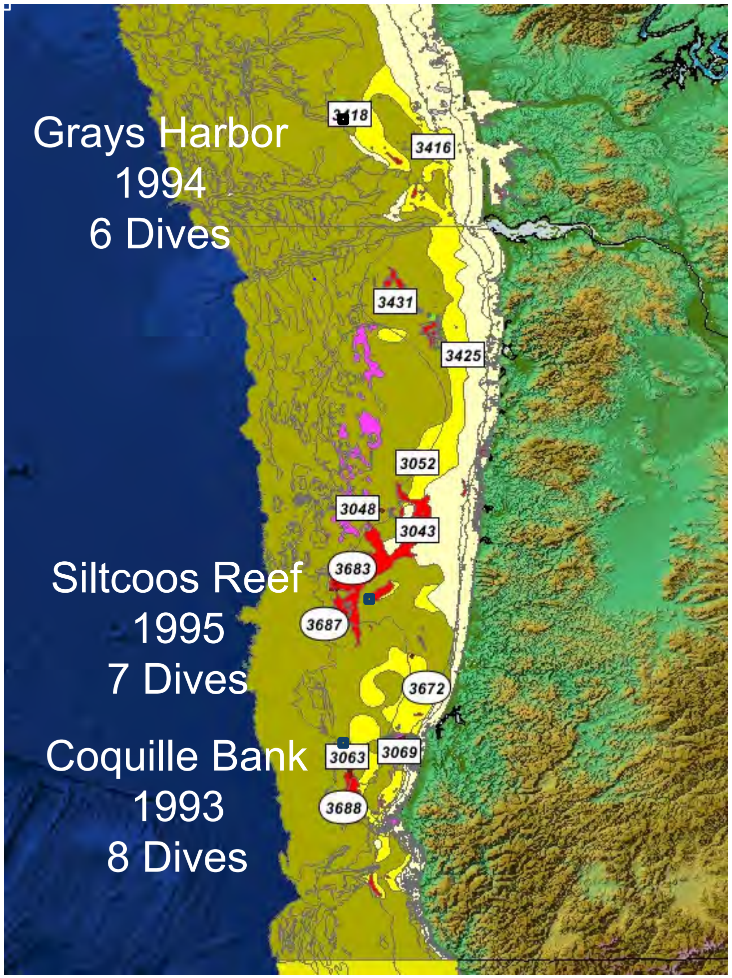
Submersible *Delta*

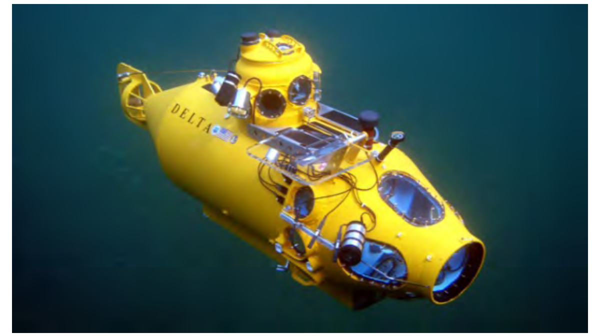
- Used for historic dives of the 1990s
- Camera attached on starboard
- Camera equipped with two 20 cm-apart sizing lasers
- Equipped with sensor that measured temperature & depth every second

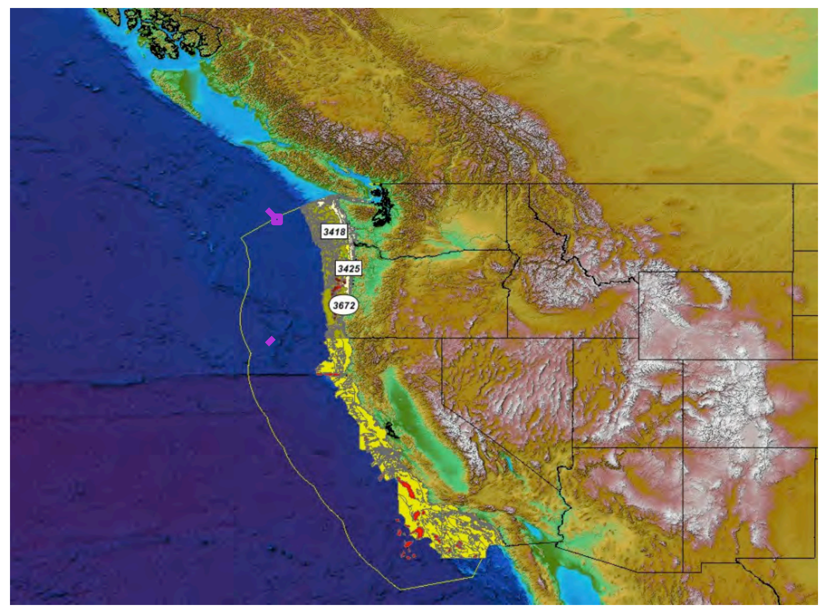
Remotely operated vehicle (ROV) *Hammerhead*

- Used for dives in 2011
- Two cameras: forward & downward
- Sizing lasers
- Equipped with CTD
- Equipped with navigator beam

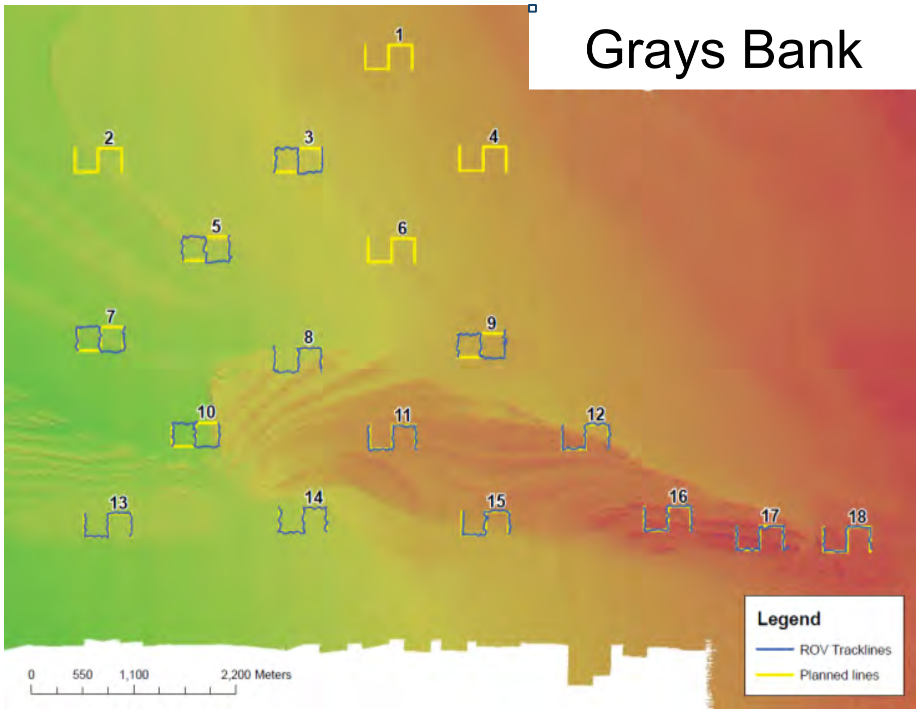
Epifaunal Sampling - *Delta*

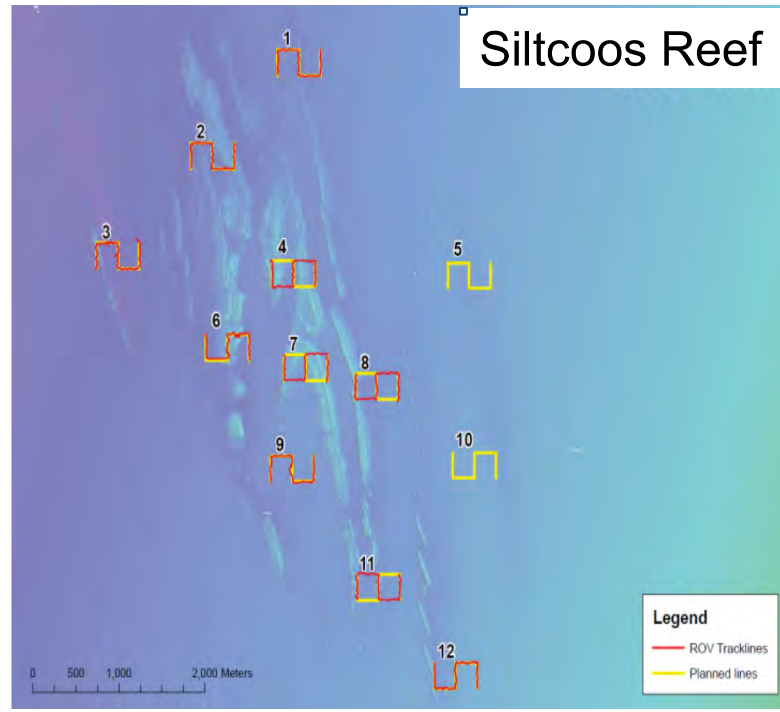






Epifaunal Sampling - *Hammerhead*





- Grays Bank – 14 stations, Siltcoos Reef – 10 stations
- Each station was composed of three transects, approximately 250 meters long and distributed in parallel fashion, 250 meters apart

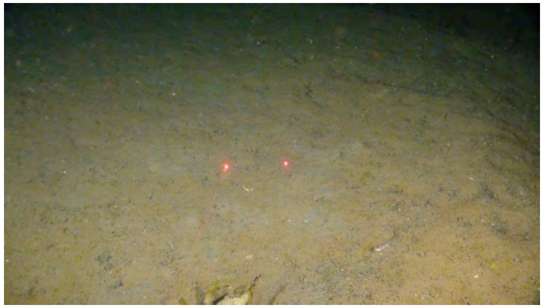
Video Analysis

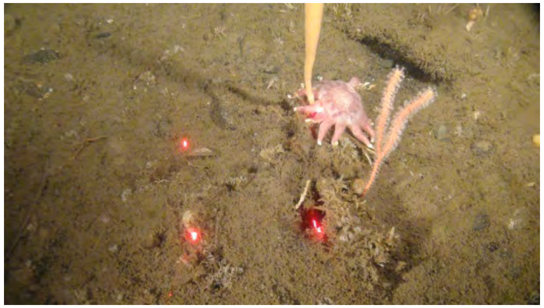
- Each *Delta* dive was watched three times:

1. Substratum Identification based on grain size class and relief

   Each patch was coded with two letters – first letter indicating primary (50 – 80% of cover) and second letter indicating secondary (20 – 50% of cover)

2. Sessile Invertebrate Identification and Count
3. Motile Invertebrate Identification and Count





- Each ROV *Hammerhead* video was watched twice (steps 2 and 3 were combined for these videos)

- All invertebrates ≥ 5 cm were counted and identified to lowest possible taxonomic classification

Epifaunal Invertebrate Summary

- Two major substratum groups held different macroinvertebrate assemblages: moderate to high relief rocky habitats and low-relief fine sediment habitats
  - The majority of macroinvertebrate taxa (highest diversity) was associated with high-relief rocks
  - These taxa were further differentiated between flat versus ridge rocks
- Low-relief fine sediment habitat was most often associated with motile invertebrates
  - Within this habitat it appeared that fine-sediment substrata mixed with mud, boulders, or gravel each yield unique macro-invertebrate associations versus those found on uniformly mud or sand substrata.
- Latitude/temperature also were correlated with variation in assemblages, indicating regionally distinct macroinvertebrate communities along the continental shelf

Acknowledgements

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OSU Test Platform