Site Characterization and Monitoring at PacWave – Focus on Benthos

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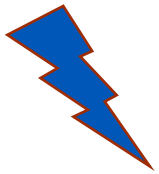
PacWave Environmental Studies

1. Site Characterization

- Characterize spatial and temporal variability in habitat characteristics (physical/acoustic) and species distributions in the project areas
- Identify species potentially unknown to the area
- Inform the design and implementation of future pre-installation and post-installation surveys

2. Pre- and Post-installation Monitoring

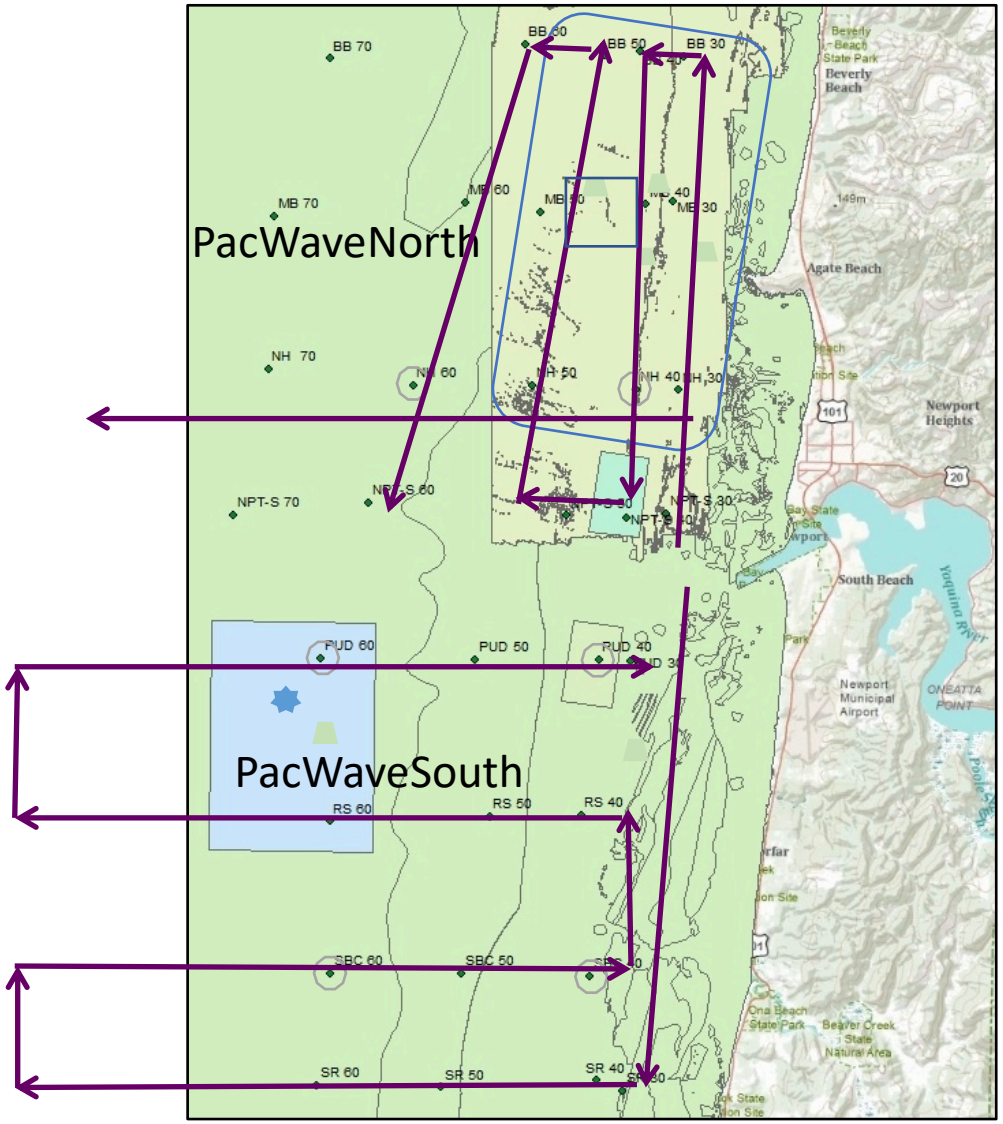


- Per license requirements

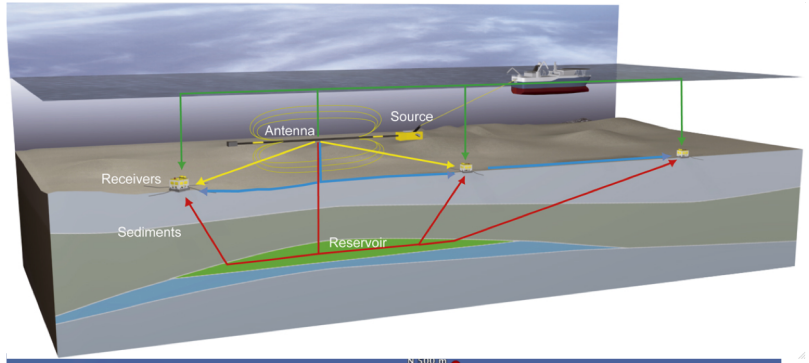
3. Opportunities for Research

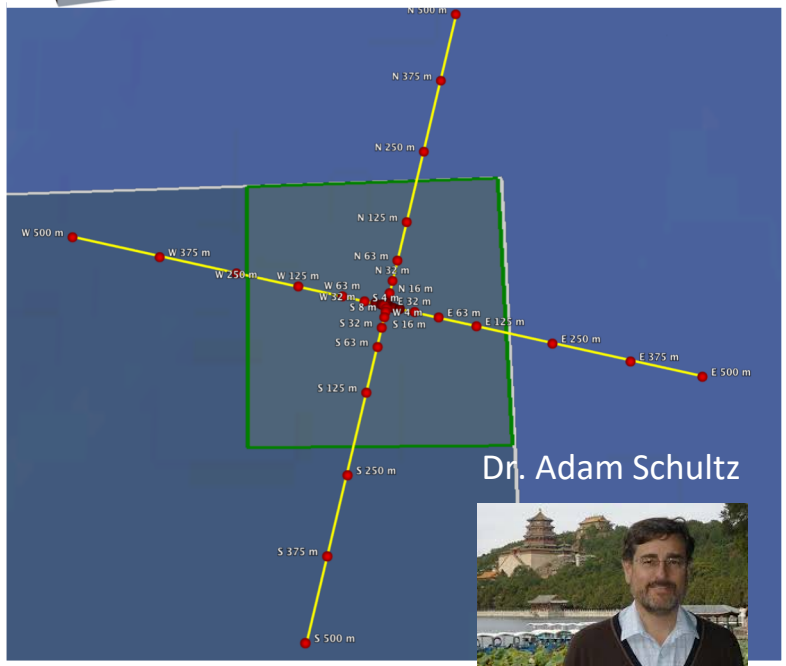
PacWave Environmental Surveys

- Benthic Invertebrate and Sediment grabs
  - 2010-16, 2020-2021 @ PacWave North
  - 2013-15, 2019, 2021-2025 @ PacWave South
- Flatfish trawls
  - 2010-15 @ PWN
- Seafloor Videos
  - 2012 & 2024 @PWN, 2022 – 2025 @ PWS
- Dungeness Crab pots
  - 2013-15 @ PWS
- Marine Bird and Mammal ship-based observations
  - 2013-15 @ PWN & PWS
- Acoustics (hydrophones deployed)
  - 2011-13 @ PWN
  - 2015, 2022-2025 @ PWS
- Electromagnetic Field mapping (also lab studies)



EMF Mapping at PacWave





Dr. Adam Schultz

Skate and Crab response to EMF in lab

Dr. Kyle Newton

Dr. Taylor Chapple

Dr. Sarah Henkel

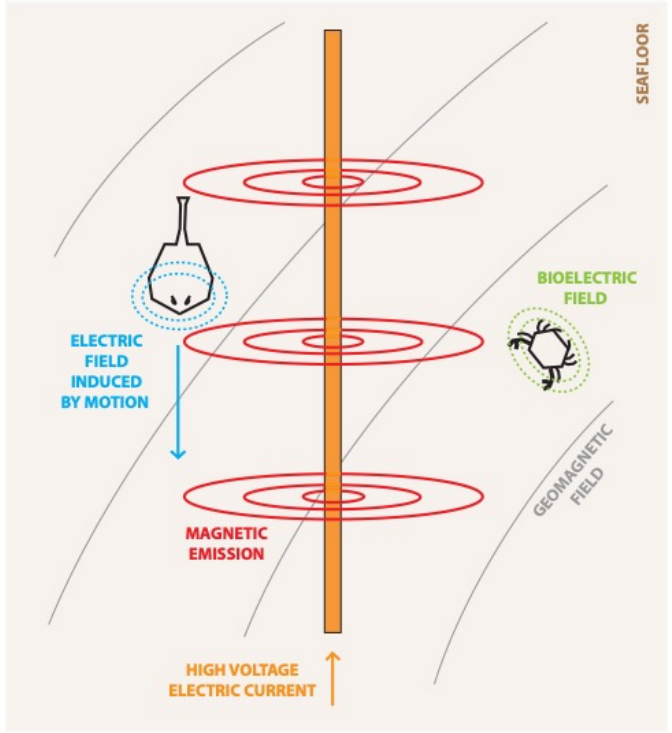
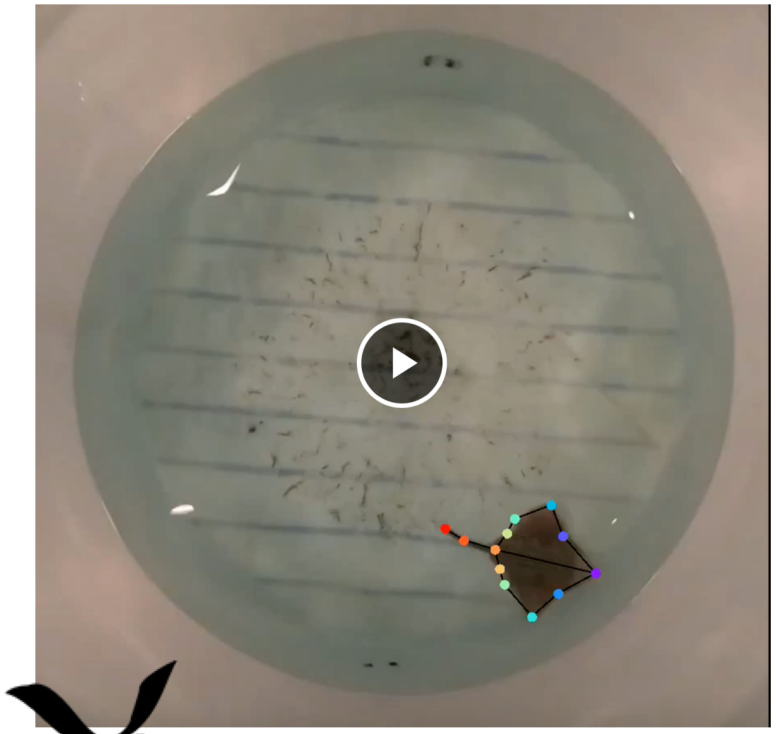


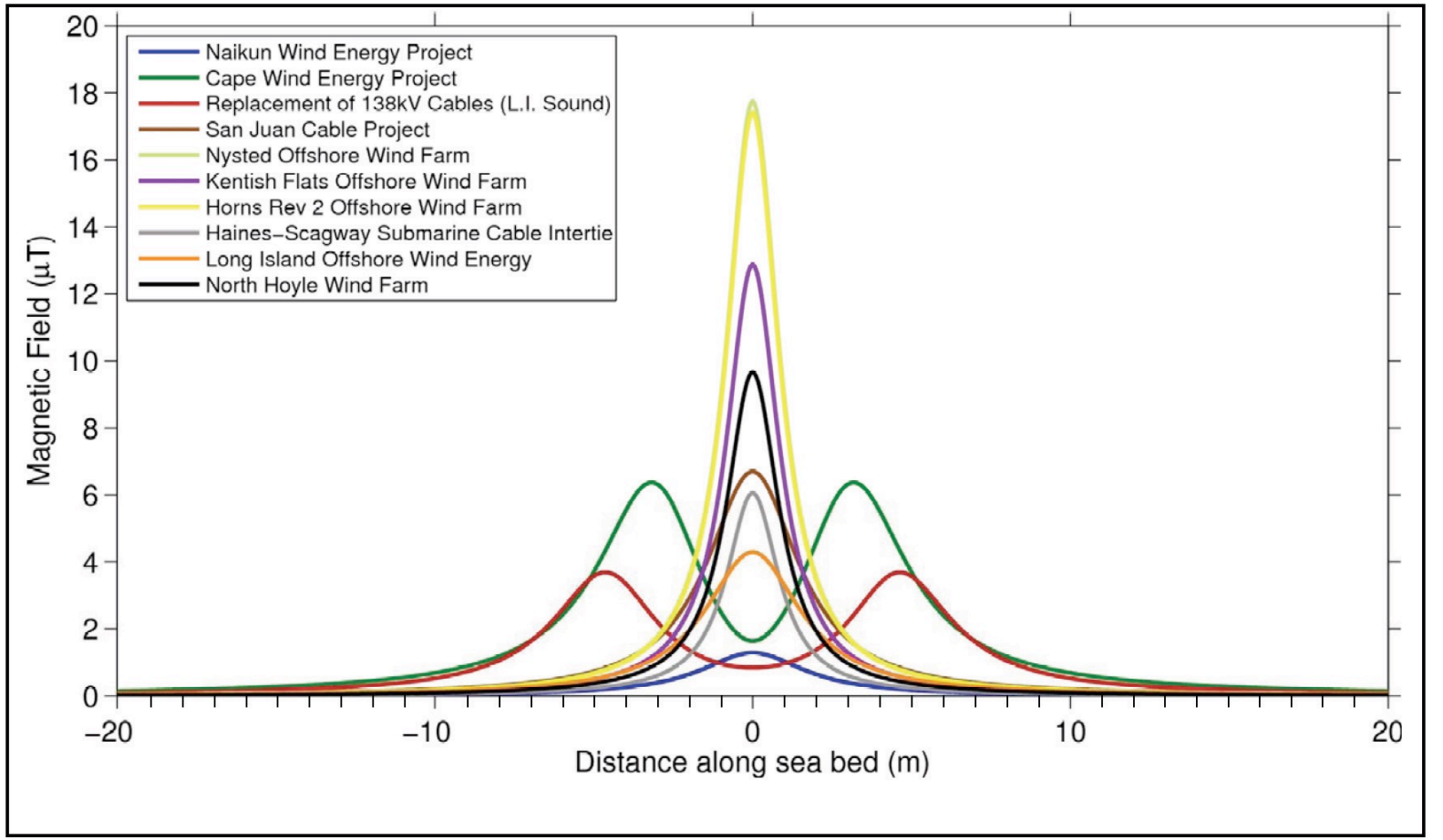
Figure 1. EMF noise emitted by subsea cables could mask the bioelectric signals of prey during foraging or geomagnetic field during navigation



Sea Grant Oregon

PacWave

EMF Modelling/Monitoring



EMF Modelling/Monitoring

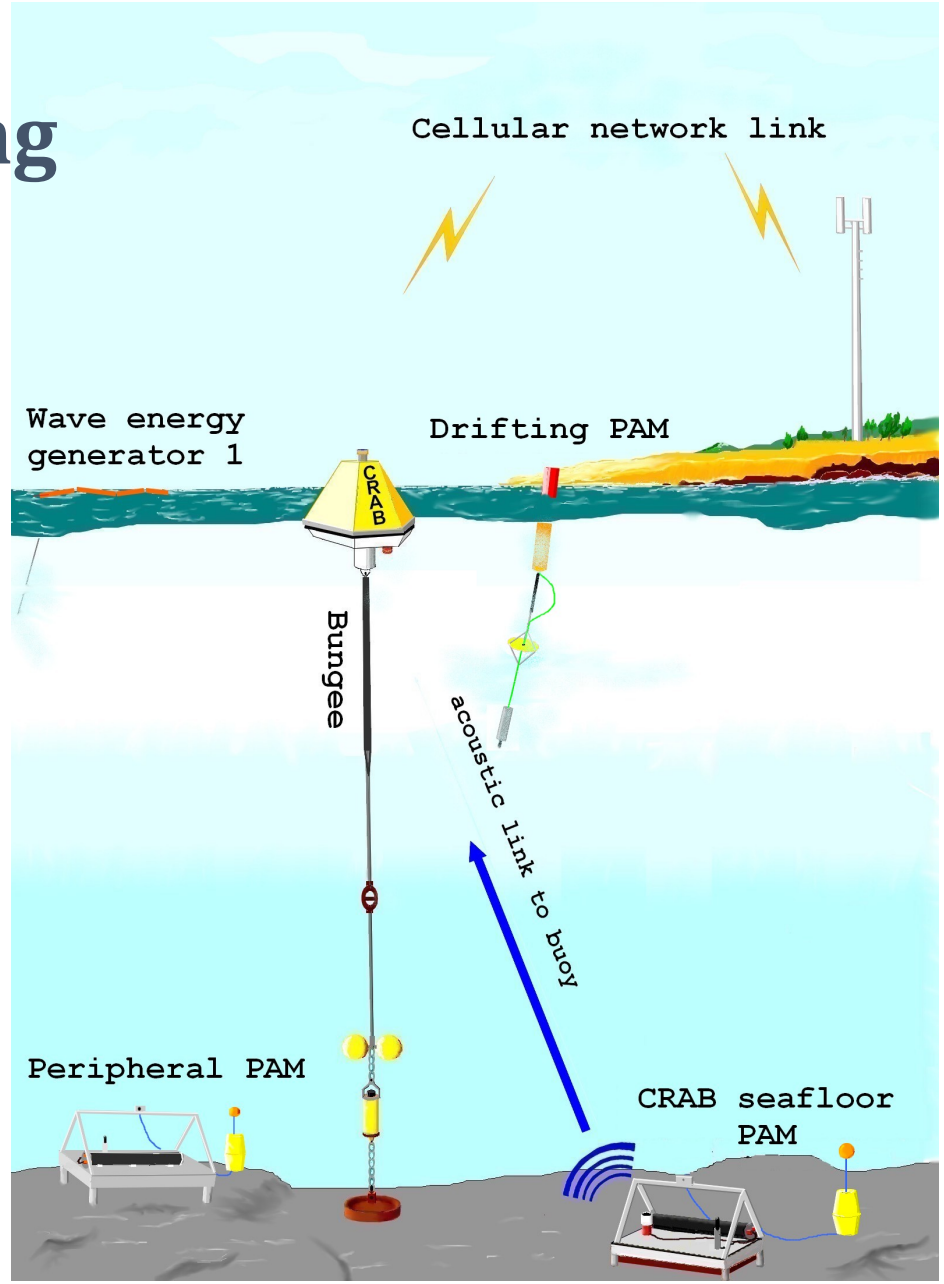
- Once specific WEC device(s) are committed to be deployed we will run models to estimated the anticipated EMF output associated with the WEC to determine if EMF from the WEC is likely to exceed ambient levels at a distance of 20 meters from WEC.
- Within 45 days after the first WEC(s) become operational we will conduct a field survey to measure EMF at the WEC(s) while they are in an energized state to provide field data to validate the models.
- If field monitoring from the first 8 WEC tests indicate that EMF does not exceed ambient levels, modeled at a distance of 20 meters from WECs, then field monitoring will only be conducted when the licensee plans to deploy WECs with a rated capacity that is 30% greater than previously studied or plans to operate more WECs per berth than previously studied.

Noise Monitoring

1. Peripheral PAM (passive acoustic monitoring) systems: deployed on the 4 corners of the permitted area of PacWave South in July 2024 scheduled recovery in fall 2024. To be re-deployed in spring/summer 2025 for continuous presence at PWS.

2. Coastal Real-time Acoustic Buoy (CRAB) - A low power (PAM) system capable of measuring and *reporting* project noise levels in near real-time in any active WEC berth – deployed for testing in fall 2024. To be deployed subsequent to any deployed WEC.

3. Drifting PAM system – rapid assessment of range-dependent project noise levels when a WEC is deployed or CRAB system alerts an underwater noise issue – tested in fall/winter 2024-2025. To be deployed subsequent to any deployed WEC.



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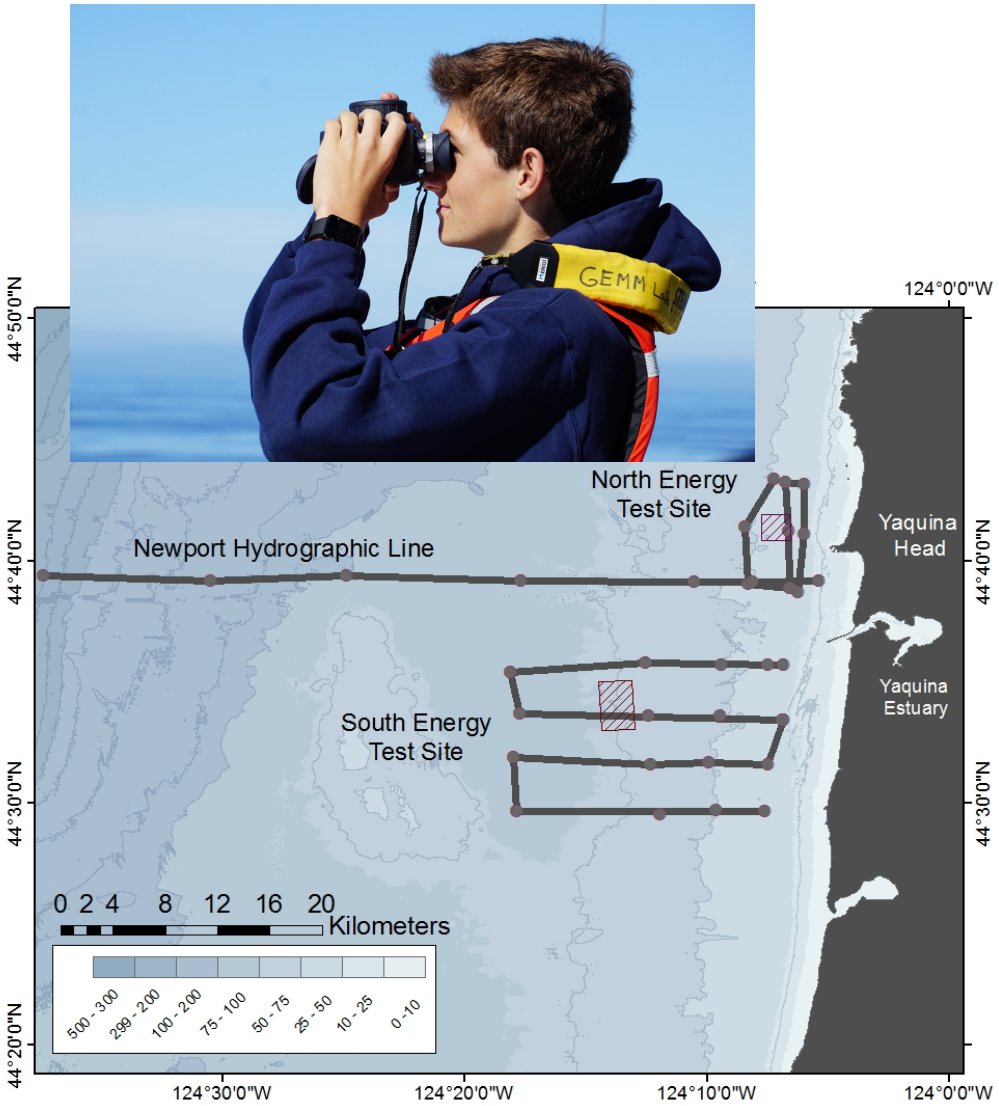
PMEL

Pacific Northwest NATIONAL LABORATORY

PacWave

Bird/Marine Mammal Surveys



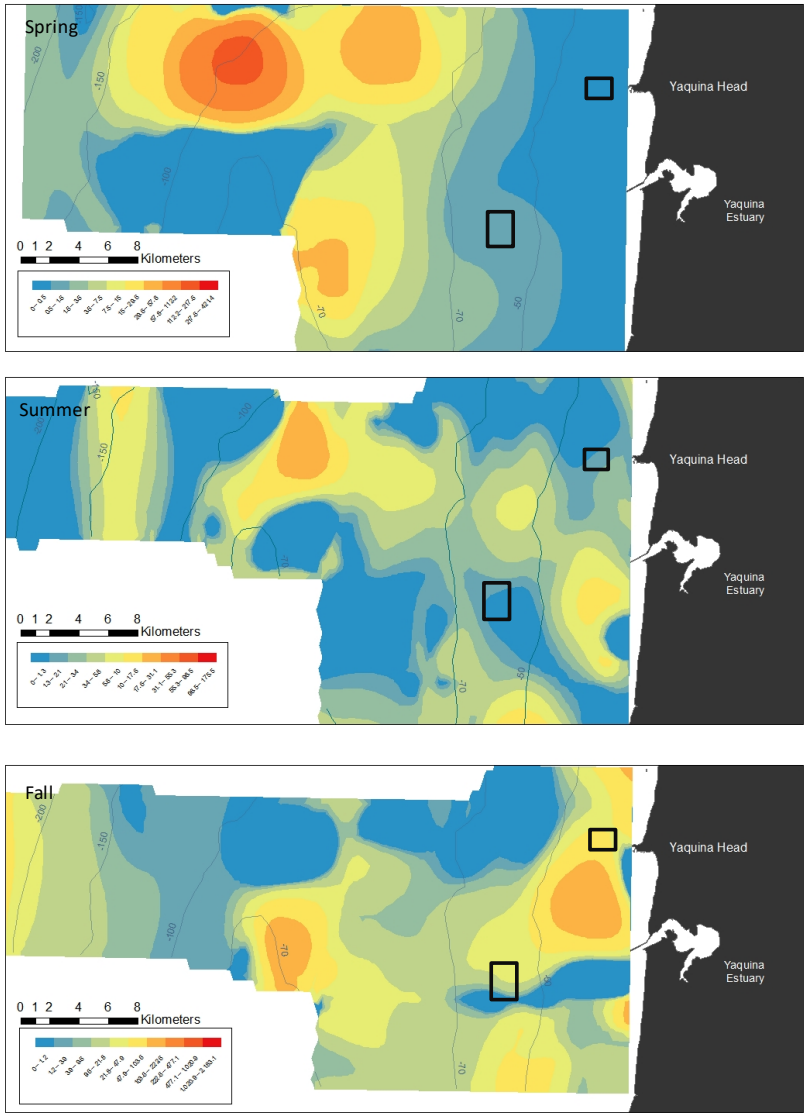
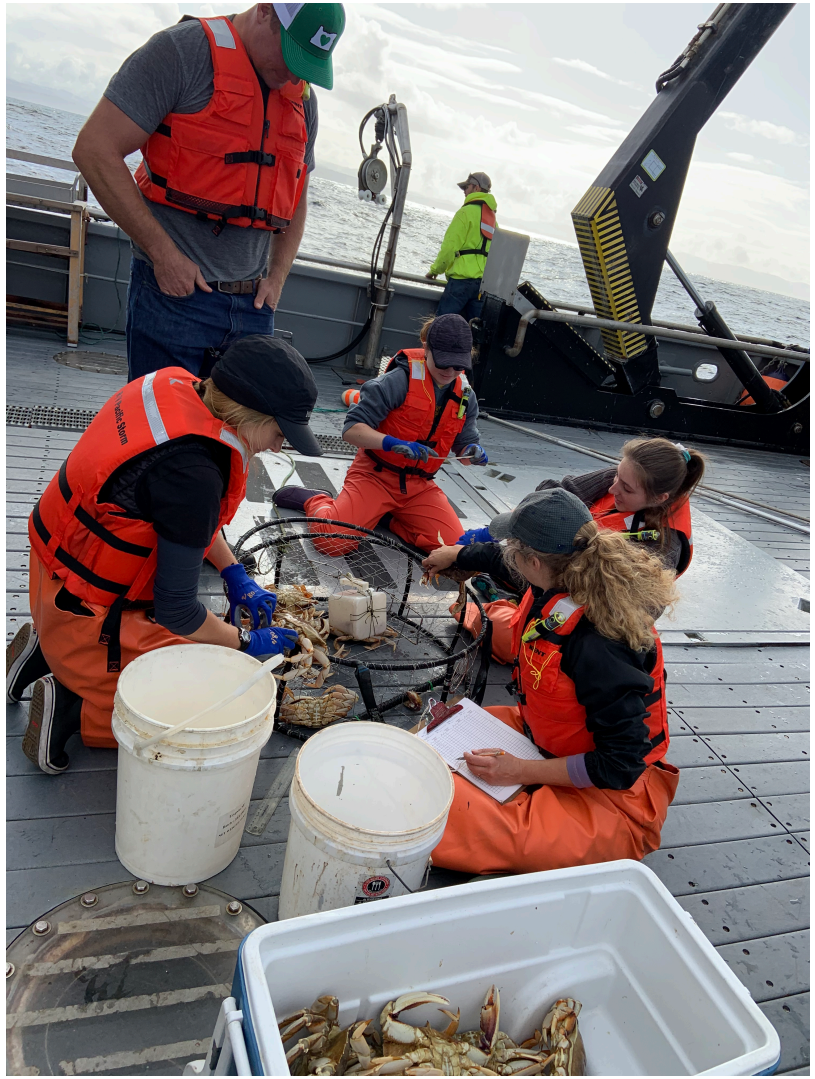


Figure 5. Seasonal sooty shearwater density across the three study sites. Kernel density estimates produced in ArcMap 10.2 with constant kernel function and prediction output. A power of 1 and ridge of 50 was applied to all 3 maps. The black boxes denote the NETS and SETS. Note that the maximum fall density predictions are an order of magnitude greater than spring and summer.

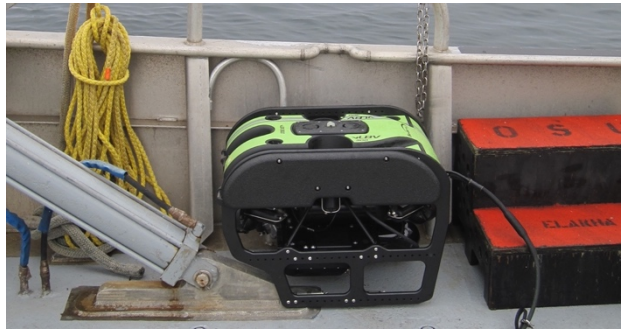
Crab Sampling

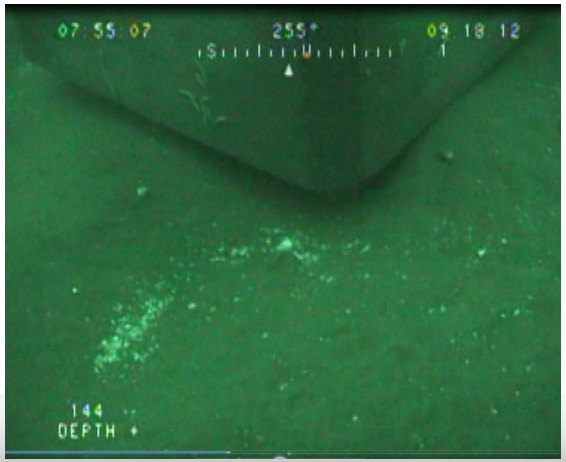


		NH	PUD	SBC	Total Average per Pot per Month
September 2013	40 m	16.3	10.3	14.0	12.7
	60 m	14.7	7.7	13.0	
December 2013	40 m	11.7	12.7	8.3	11.9
	60 m	13.0	11.7	14.3	
April 2014	40 m	7.0	7.7	8.7	5.4
	60 m	3.7	2.0	3.3	
June 2014	40 m	16.7	11.5	14.3	12.3
	60 m	6.3	6.0	13.0	
September 2014	40 m	6.0	12.0	15.7	9.4
	60 m	11.0	7.3	4.7	
January 2015	40 m	12.7	11.3	12.0	9.3
	60 m	9.7	3.0	7.0	
April/May 2015	40 m	15.7	16.7	12.5	15.3 (high b/c no 60 m)
	60 m	-	-	-	
June 2015	40 m	9.3	15.7	16.7	11.9
	60 m	11.0	9.0	9.7	
Total Average per Pot per Line		10.73	8.6	10.69	

PacWave

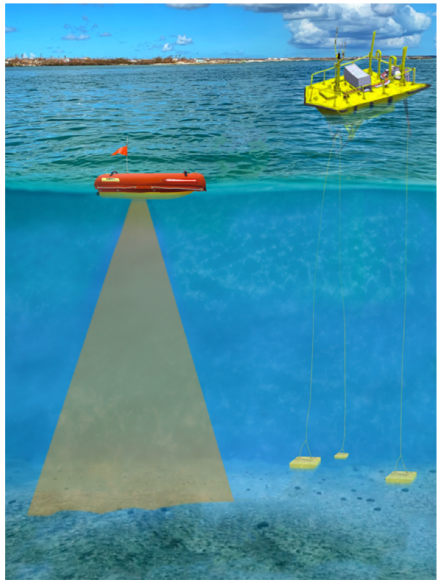
Organism Interactions/Artificial Reef Effect

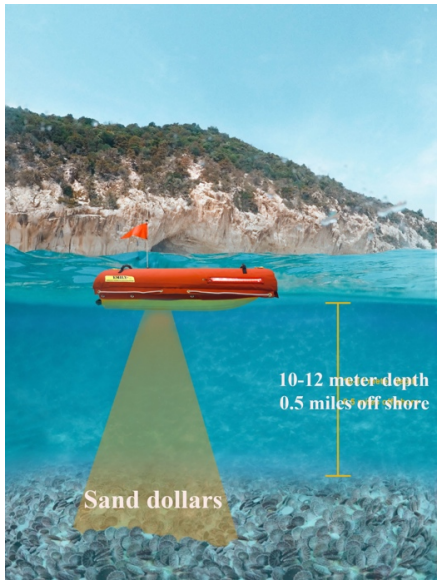




HYDRONALIX

SEARCHER:
Sea Remote Controlled
Hydrographic Explorer and Recorder

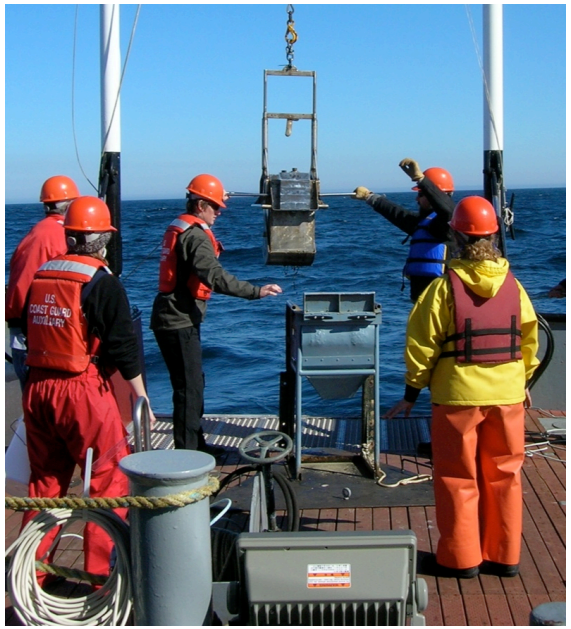




PacWave

Sediment and Benthic Invertebrate Visualization and Collection

0.1 m^2 box core

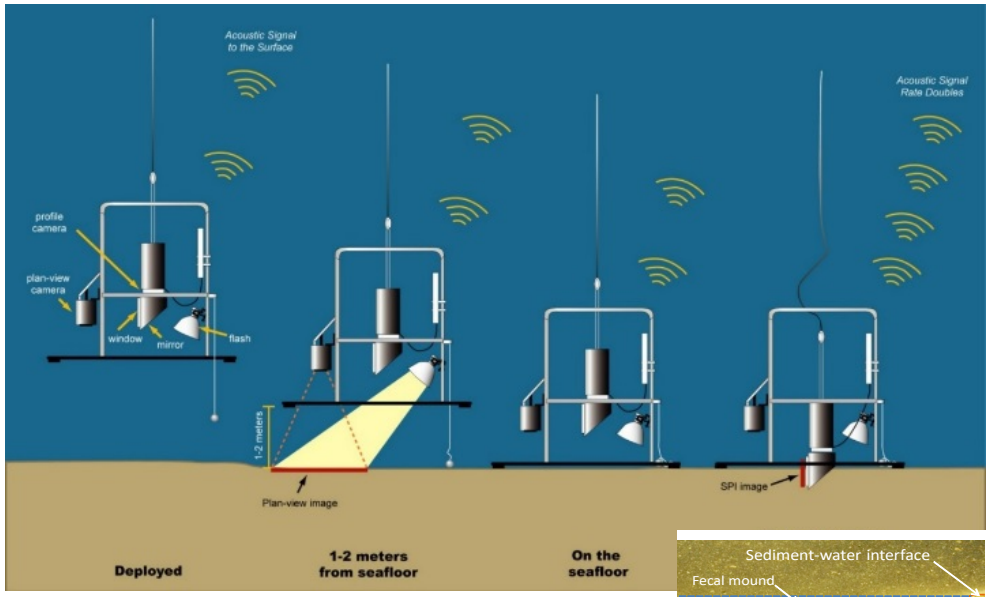


Analyze sediment for grain size, total organic carbon

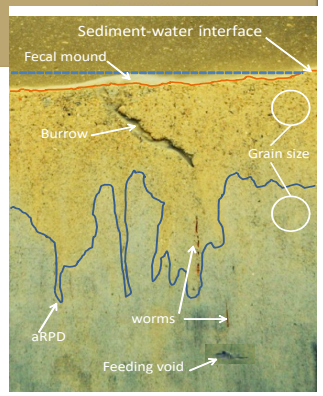
Sieve collection

Identify fauna in the lab

Plan view and sediment profile imaging (SPI) cameras

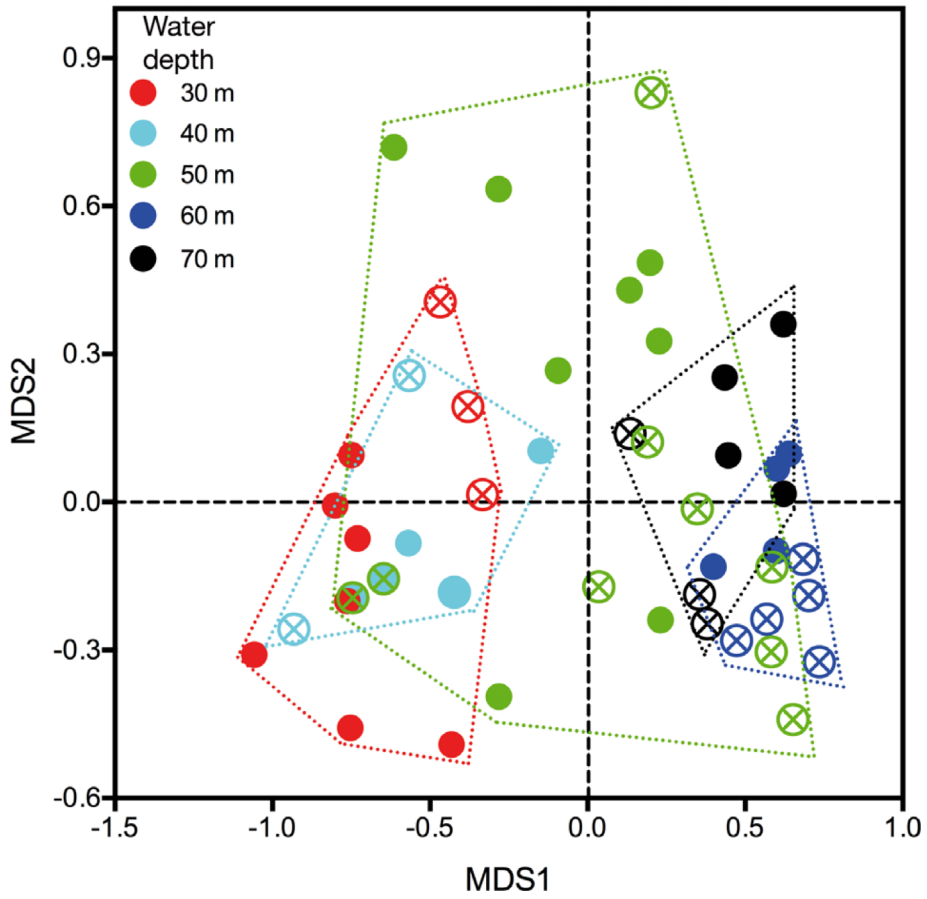


Sediment profile image with features highlighted.

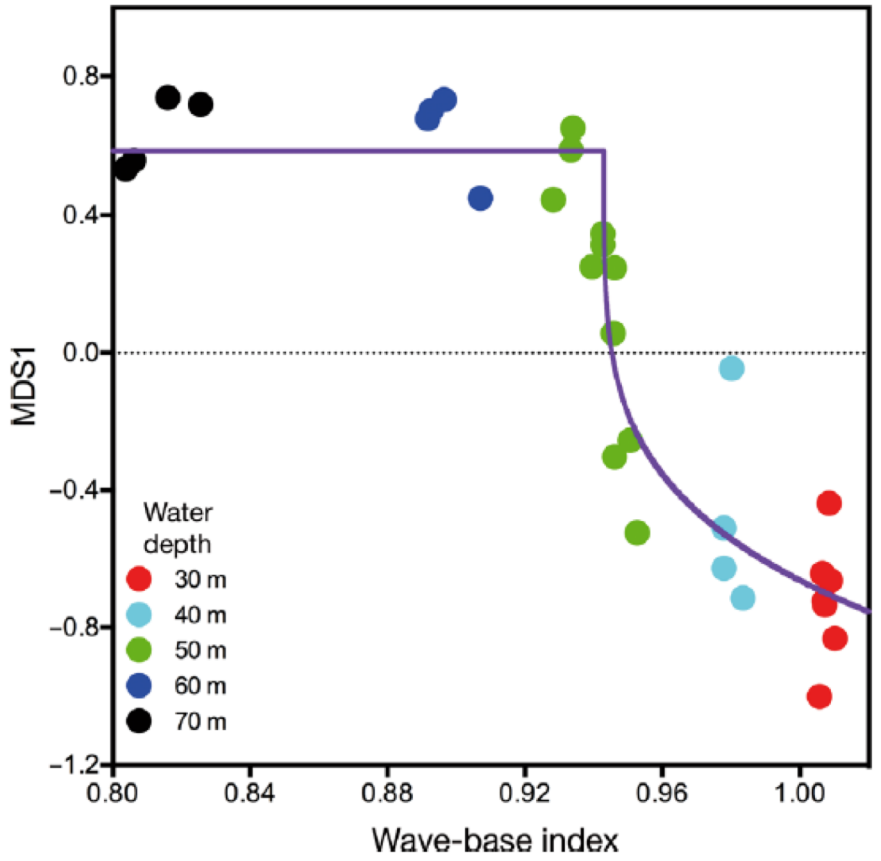


Development of automated interpretation software.

PacWave North Pre-Installation Patterns



The benthic community at 50 m has always been a “transition” community, particularly for bivalves plotted here

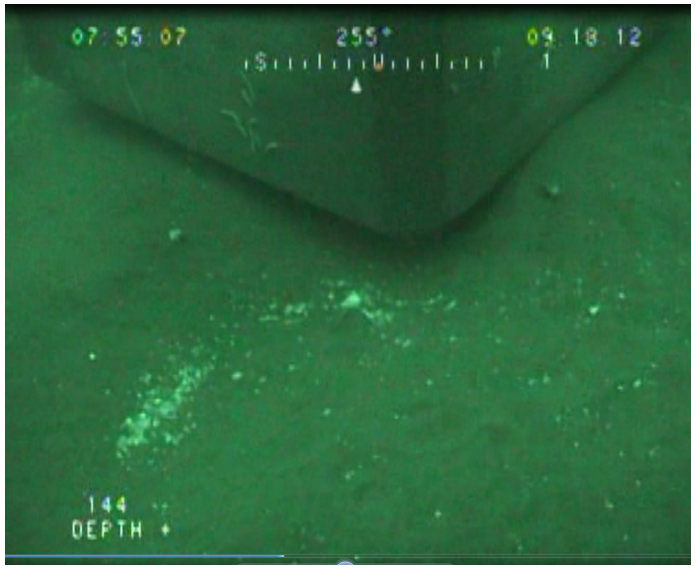


This seems to be related to the wave energy at the site
(Spearman rank correlation = -0.919)

Voorhies et al. 2018 MEPS

PacWave

PacWave North (45 m) Post-Installation Observations



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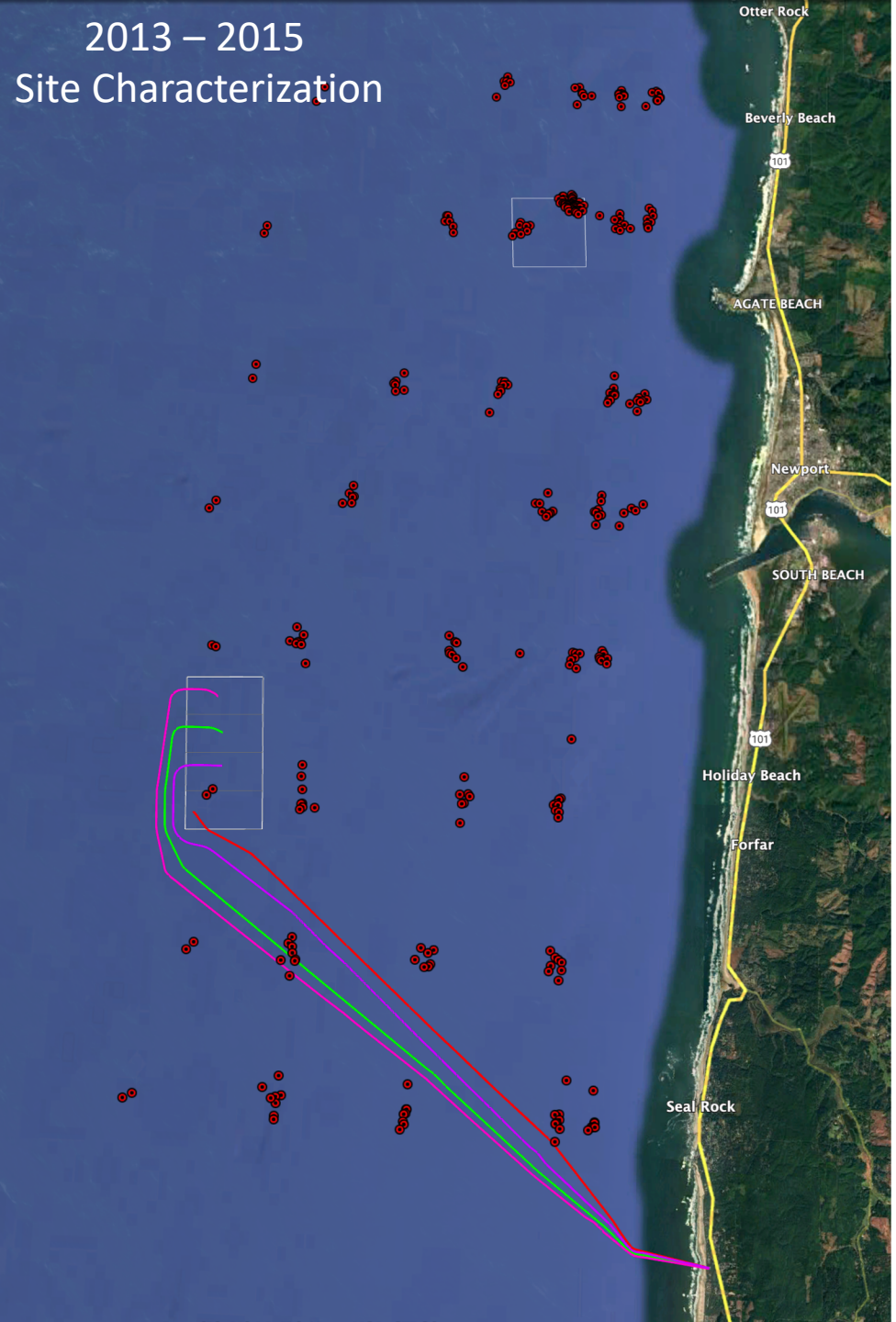
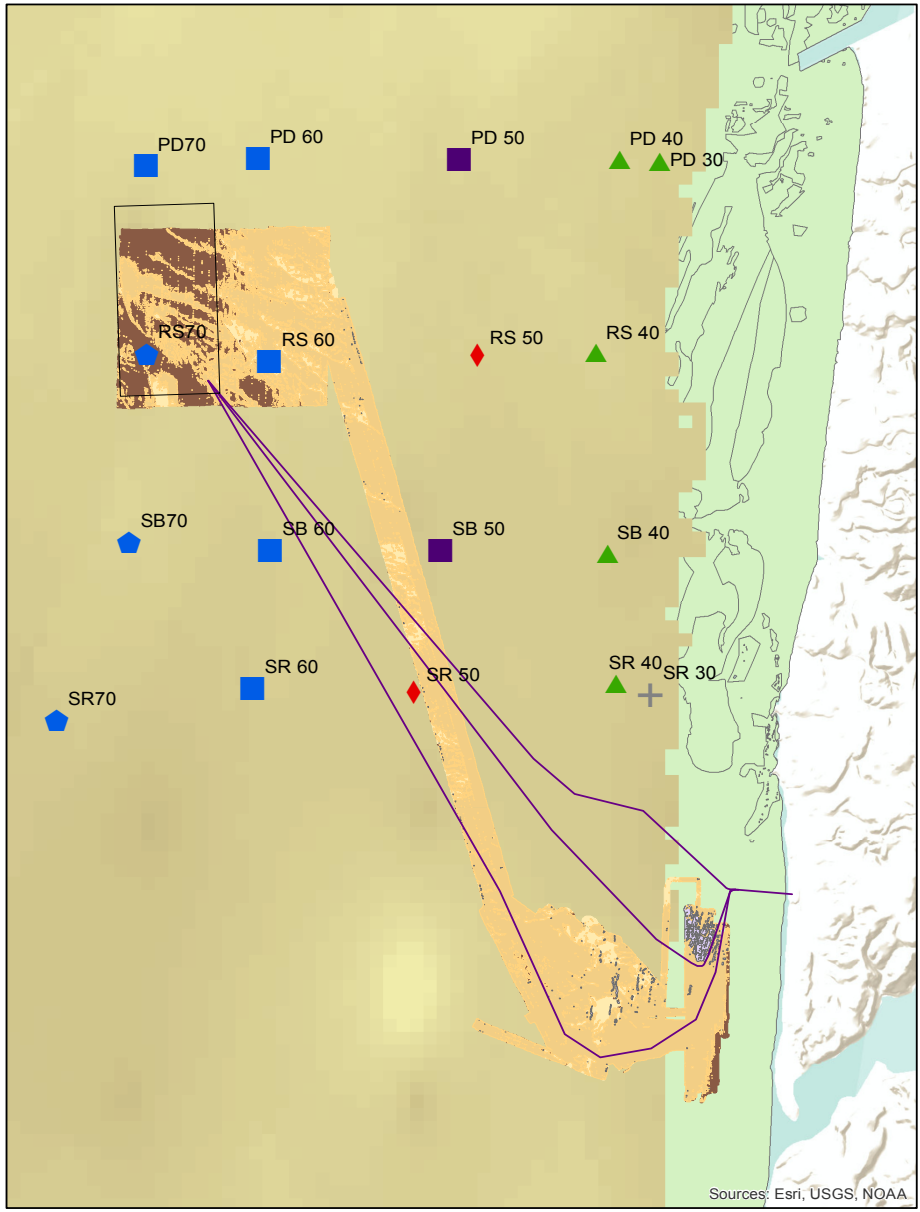
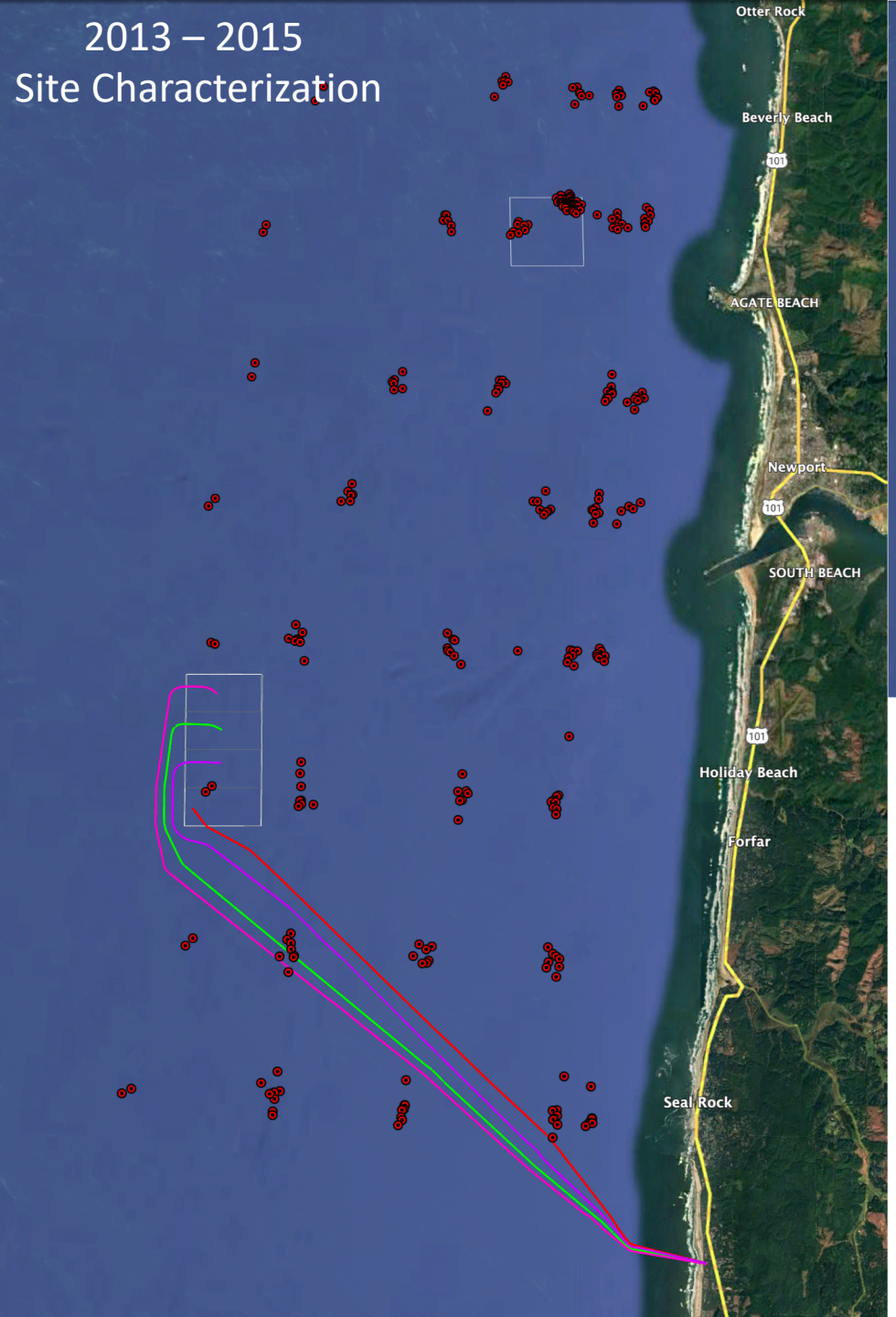


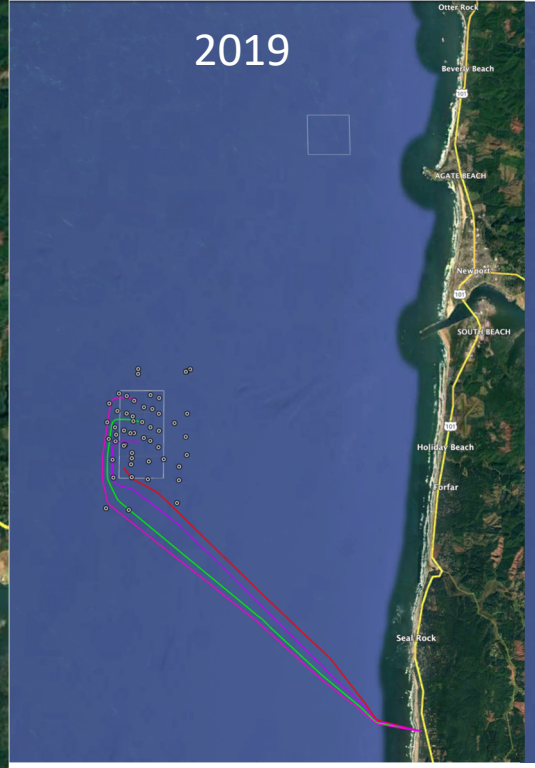
Sediment and Benthic Invertebrate Box Core Collections

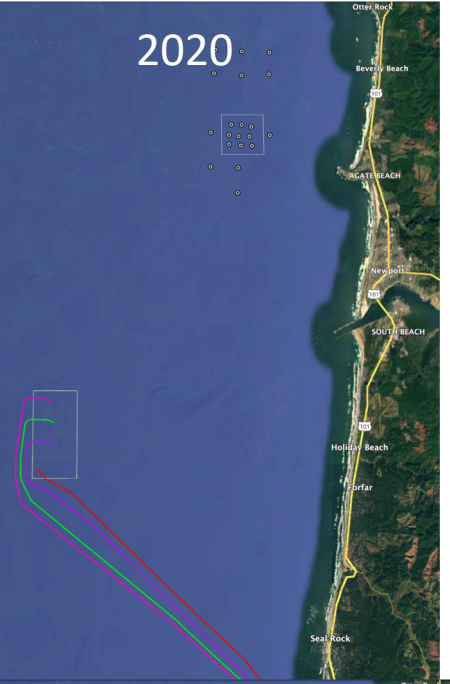
Site characterization with repeated sampling (April, June, August, October 2013-15) at "fixed" stations to look at overall spatial and temporal variability in the area.

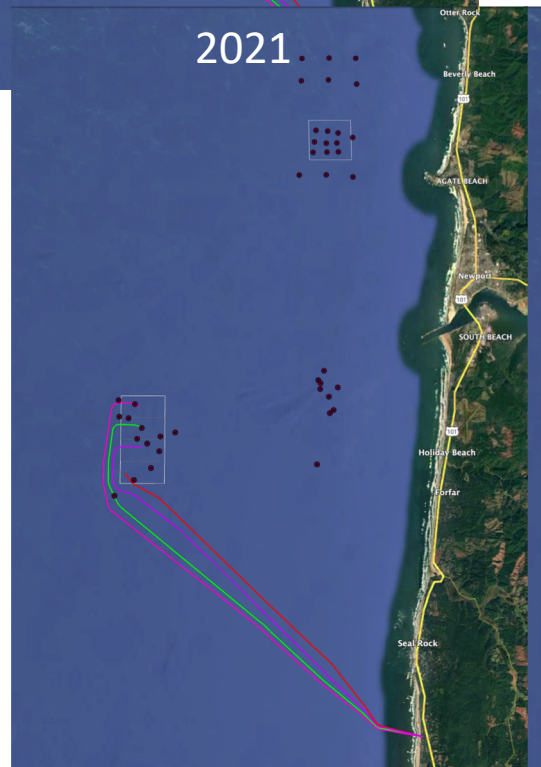
-50 m stations unique (as observed at PWN)
-60 & 70 m stations similar, but some north-south differences.
Report included in license application.

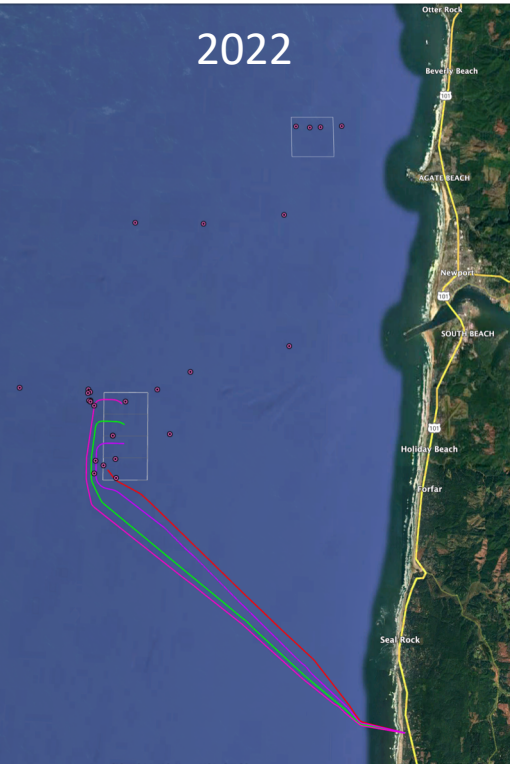




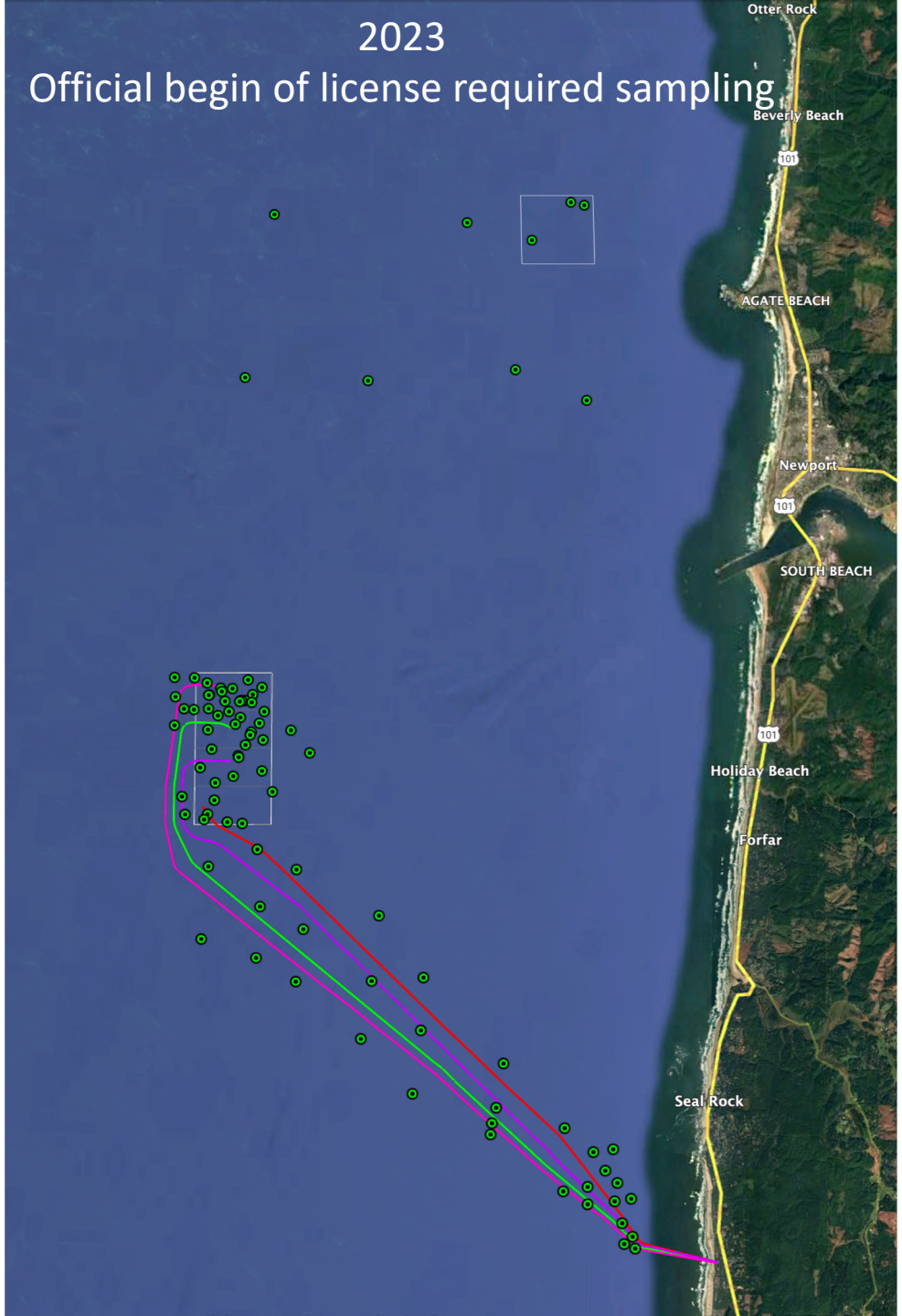


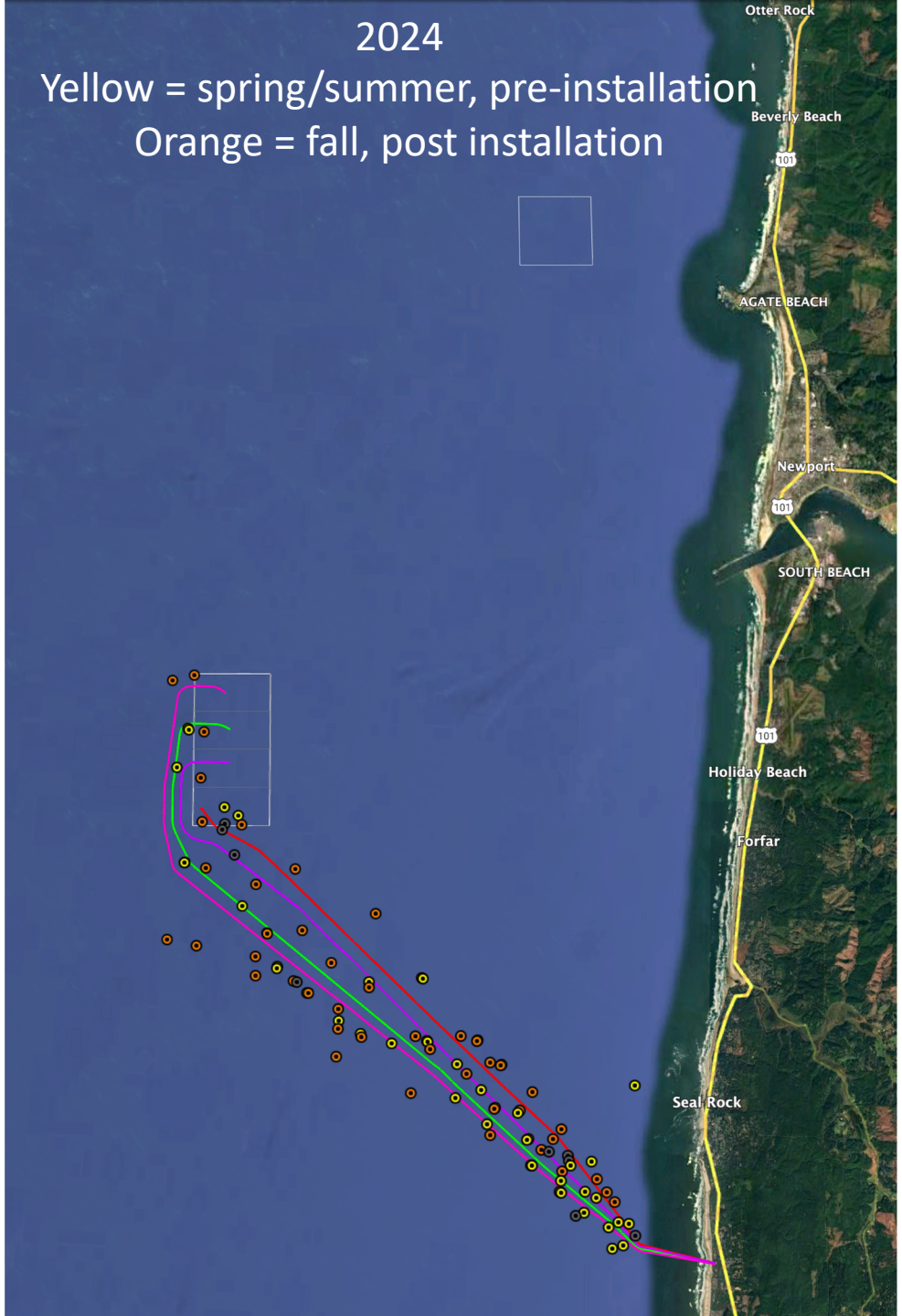






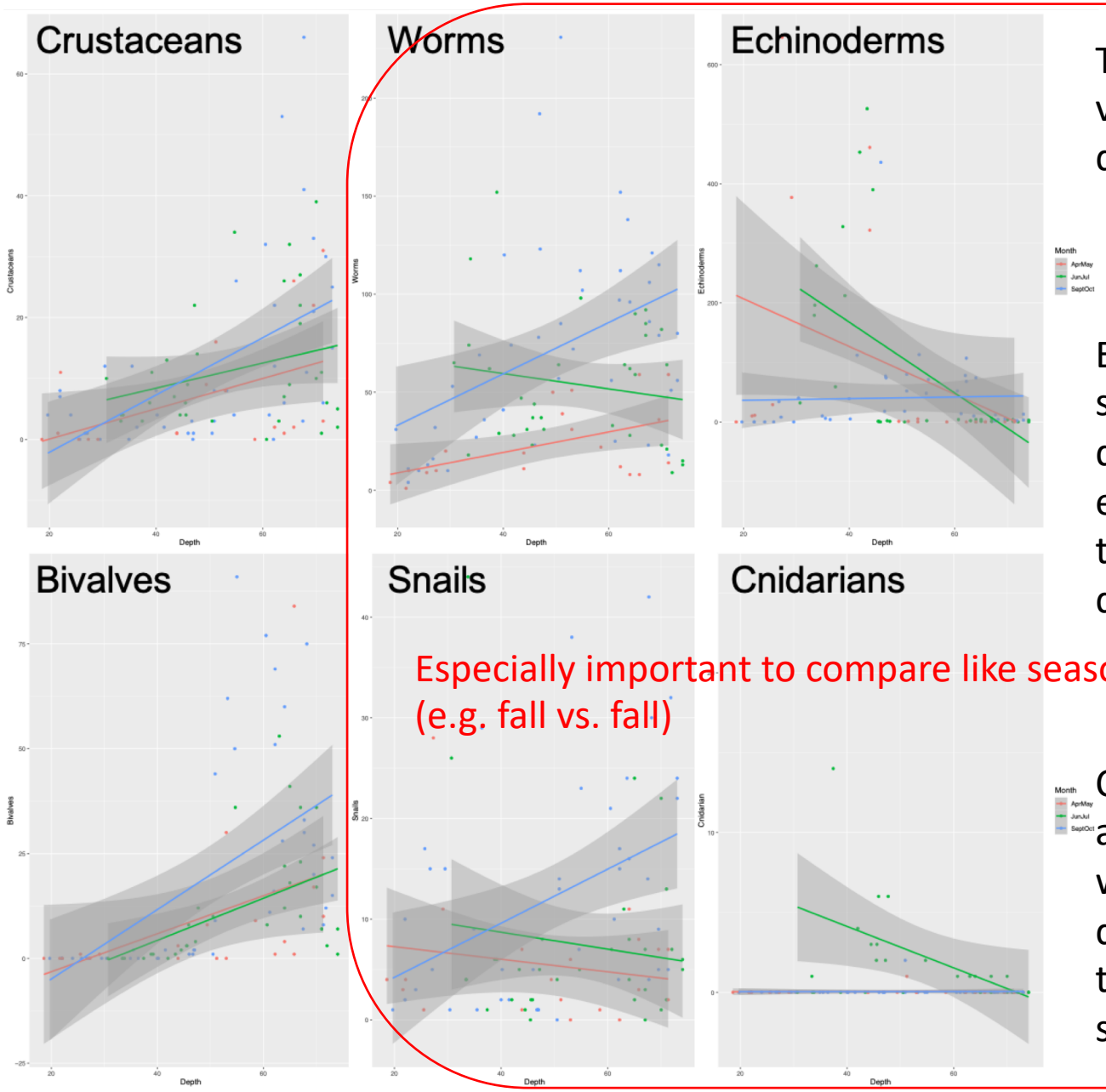
Additional opportunistic sampling 2019 to 2022 to keep time series going and track long term trends prior to project kick-off.


2023
Official begin of license required sampling
Otter Rock
Beverly Beach
101
AGATE BEACH
Newport
101
SOUTH BEACH
101
Holiday Beach
Forfar
Seal Rock


2024
Yellow = spring/summer, pre-installation
Orange = fall, post installation
Otter Rock
Beverly Beach
101
AGATE BEACH
Newport
101
SOUTH BEACH
101
Holiday Beach
Forfar
Seal Rock

Pre-installation Benthic Invertebrate Patterns

Crustaceans (e.g. amphipods, various shrimp) and bivalves (e.g. small clams) increased in abundance with depth with little variability among seasons, although both were in slightly higher abundance overall in fall.



The worms and snails varied in response to depth among seasons.

Echinoderms (mostly sand dollars) generally decreased with depth except in the fall, when they were in lower densities overall.

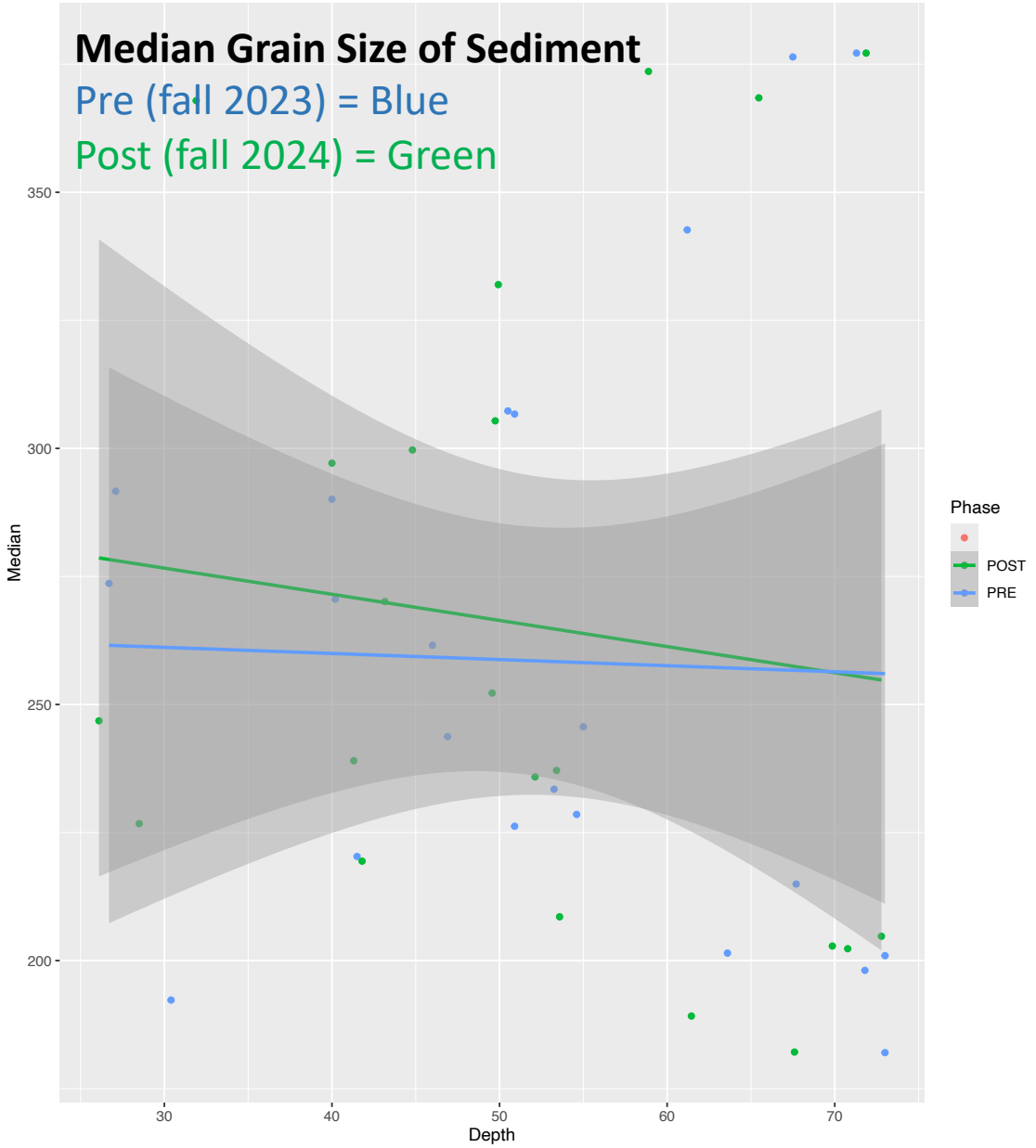
Especially important to compare like seasons (e.g. fall vs. fall)

Cnidarians (e.g. sea anemones) decreased with depth but only during the summer as they were absent in spring and fall.

Pre- versus Post-Cable Installation Benthic Patterns

Paired t-test of the fall 2024 stations that match those sampled in fall 2023:

- No statistically detectable difference in median grain size.
- Organism analysis underway



Thank you!

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PacWave
TESTING WAVE ENERGY FOR THE FUTURE