

**Environmental Studies at  
PMEC:  
Addressing Information Needs  
for Permitting/Testing  
&  
Future Environmental  
Research Campaign**

# National Marine Renewable Energy Centers



## Northwest National Marine Renewable Energy Center (NNMREC)

- University of Washington (tidal)
- Oregon State University (wave)

## Hawaii National Marine Renewable Energy Center (HINMREC)

- University of Hawaii
- Wave, OTEC

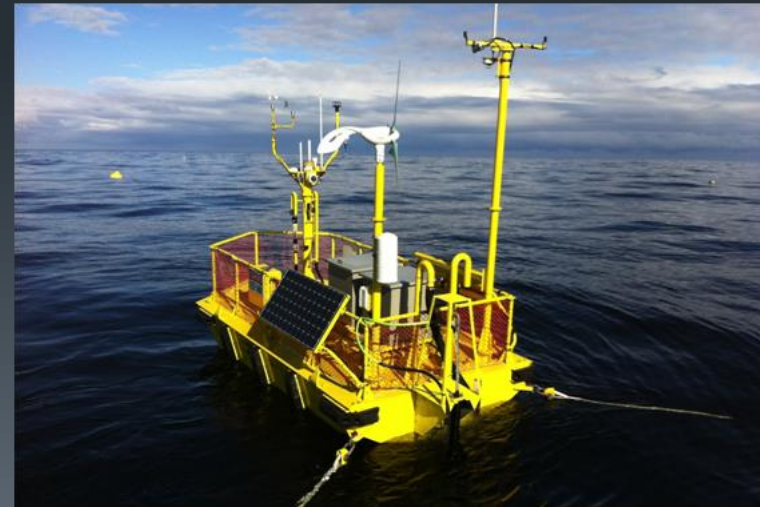
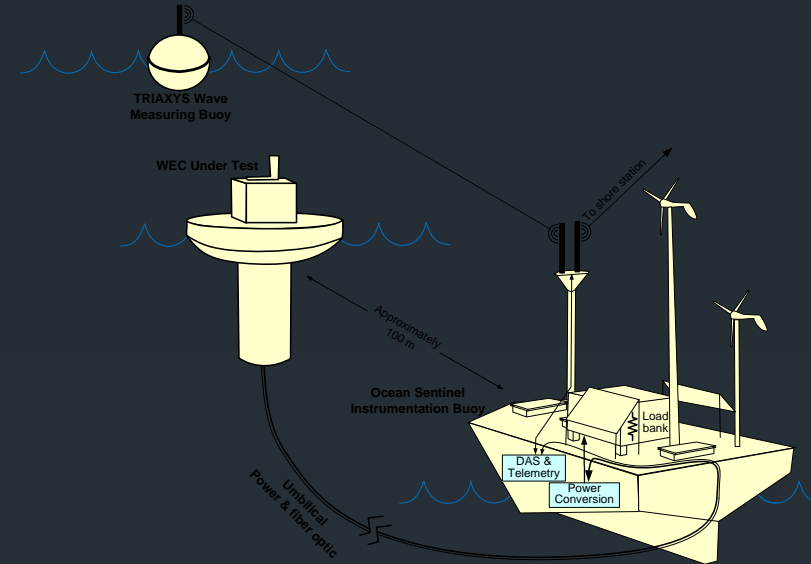
## Southeast National Marine Renewable Energy Center (SNMREC)

- Florida Atlantic University
- Ocean Current
- OTEC

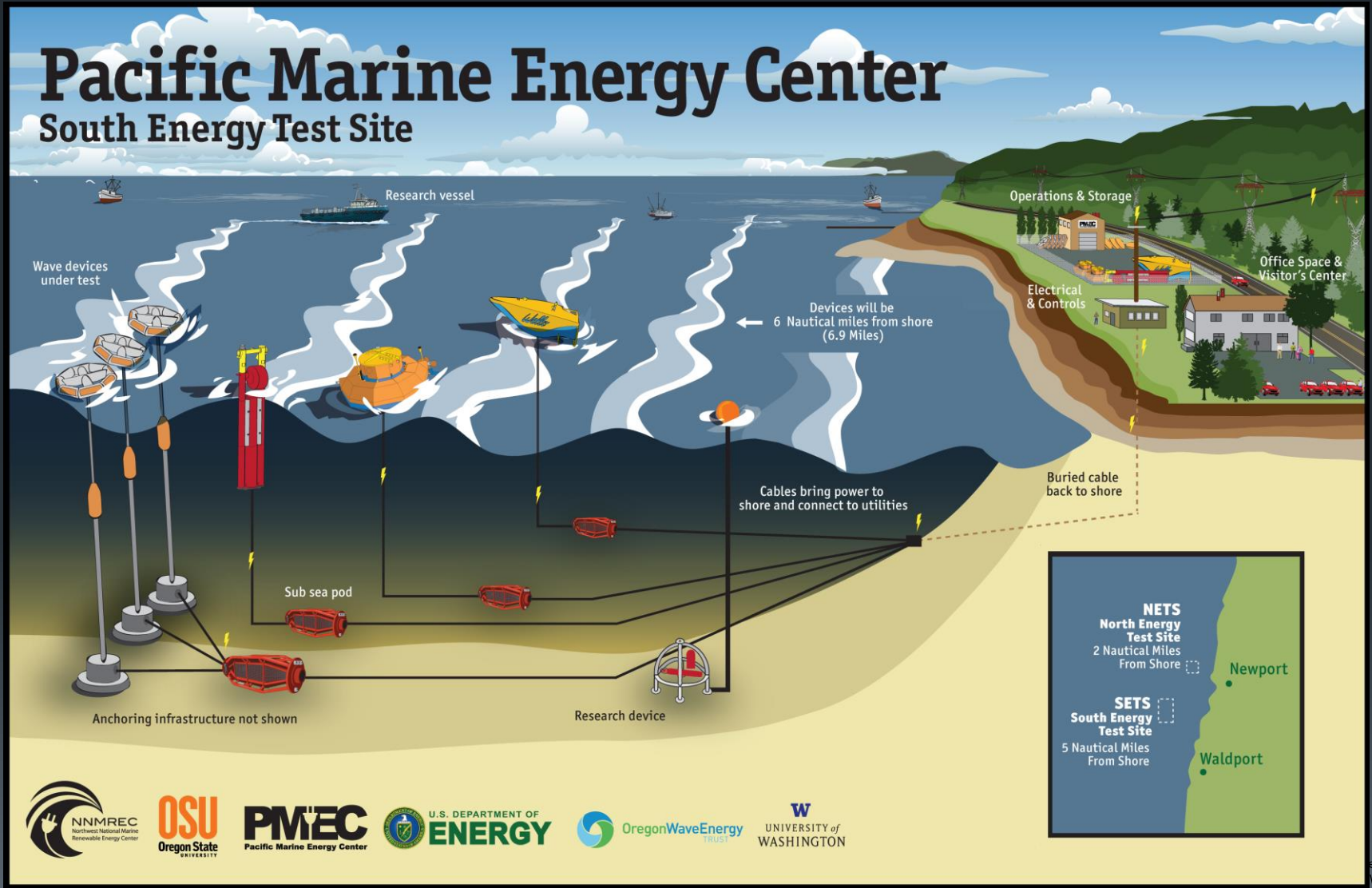
# Pacific Marine Energy Center North Energy Test Site

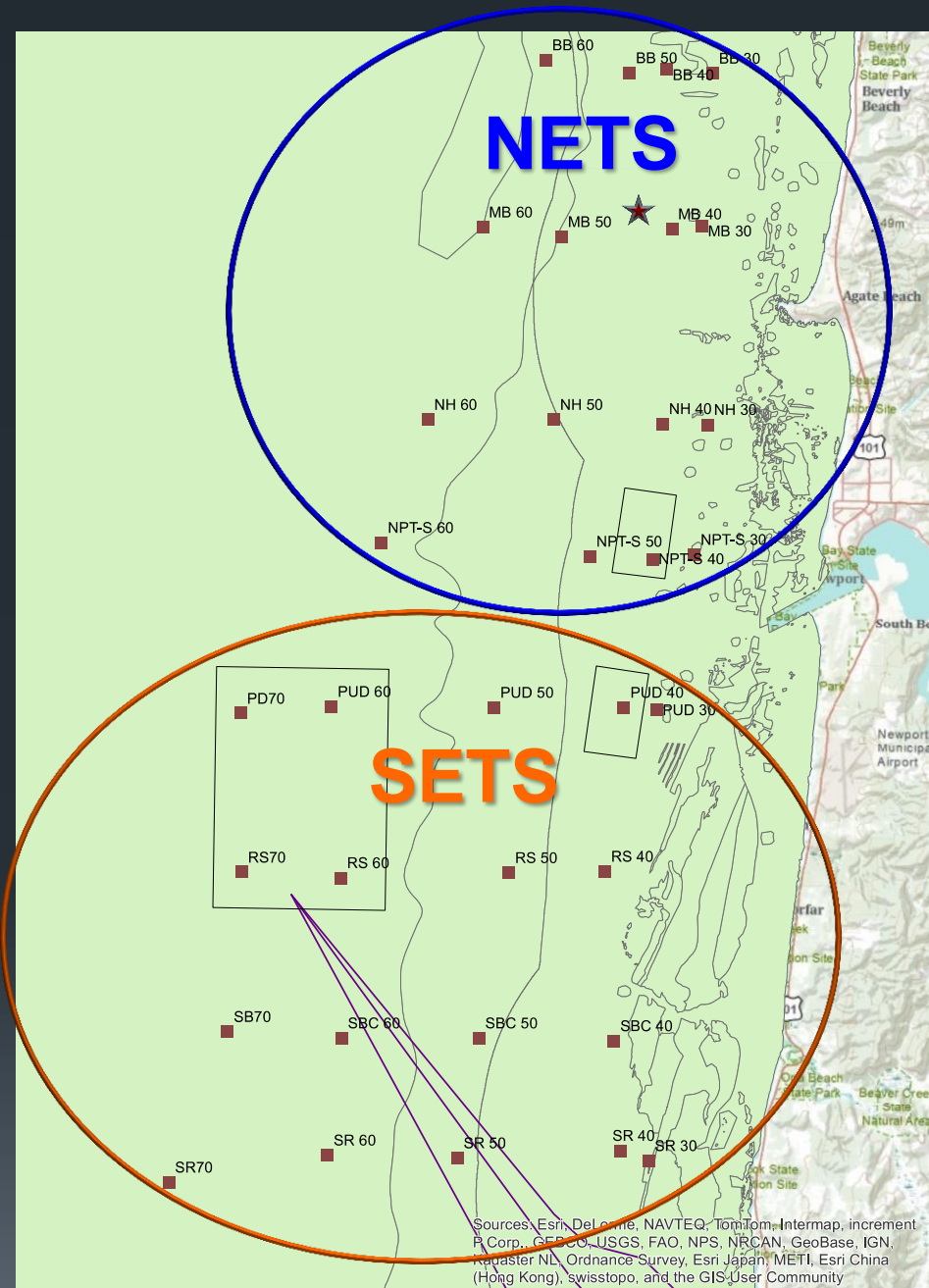
## Ocean Sentinel

- Provide stand-alone electrical loading and power conversion for test WEC
- Measure and record WEC power output
- Collect and store data transmitted from the WEC under test and nearby wave-measuring instrument
- Transmit collected data to shore via wireless telemetry system



# PMEC - South Energy Test Site





# PMEC Survey Areas



# Talk Structure



- 1. Site Characterization / Baseline Studies**
- 2. Monitoring Deployed Devices / Structure**
- 3. Future Environmental Research Campaign**

# Purpose of Site Characterization /Baseline

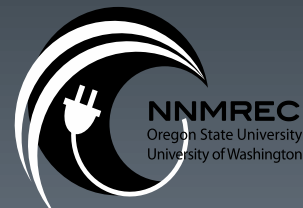
- **Characterize spatial and temporal variability in habitat characteristics and species distributions in the project areas**
- **Identify species potentially unknown to the area**
- **Inform the design and implementation of future pre-installation and post-installation surveys**
- **Collect data to inform future monitoring results and adaptive management actions**



# Habitat Characteristics and Species Surveyed

- *Sediment & Macrofaunal Invertebrates*
- *Fish & Epibenthic Crustaceans\**
- *Dungeness Crabs\*\**
- *SeaBirds & Marine Mammals*
- *Ambient Ocean Noise*
- *Wave/Current Conditions*

\*NETS Only, \*\*SETS only





# PMEC-NETS Surveys

	2010			2011					2012			2013					2014						2015				
	Jun	Aug	Oct	Feb	Apr/ May	Jun	Aug	Oct	Dec	Jun	Aug/ Sept	Oct/ Nov	Apr	Jun	Aug/ Sept	Oct	Dec	Feb	April/ May	Jun	Aug/ Sept	Oct	Dec	Feb	Apr/ May	Jun	
Cores	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓
Beam Trawl	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bird Obs															✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Marine Mammal Obs											✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Acoustics (Lander)	March 2010 – April 2011																										
Acoustics (Surface)											✓				✓												
TRIAXYS (surface wave)											11 weeks				10 weeks												
AWAC (bottom wave)															8 weeks												

- ✓ Ocean Sentinel + WetNZ: 6 concrete anchors
- ✓ Ocean Sentinel: 3 concrete anchors
- ✓ 3 concrete anchors only



# PMEC-SETS Surveys

	2013					2014								2015			
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Apr	June	July	Aug	Sept	Oct	Dec	Feb	Apr	Jun
Sediment & Macrofauna	✓		✓					✓	✓		✓		✓	✓	✓	✓	✓
Crab Pots		✓			✓			✓	✓			✓		✓		✓	✓
Bird Surveys	✓	✓	✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓
Marine Mammal Obs			✓	✓		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓
DMON/CPO DS								Five 1-week deployments May - Oct									
Acoustics (Lander)								Two deployed in April. One recovered with damage, one lost.									✓
Acoustics (Drifting)		✓					✓		✓								
TRIAXYS (surface wave)													10 week deployment				
AWAC (bottom wave)													6 month deployment				



# Sediment and Macrofaunal Sampling

0.1 m<sup>2</sup> Grey-O'Hare box core  
Sieve collection through 1.0 mm mesh



Analyze sediment for grain size, total organic carbon

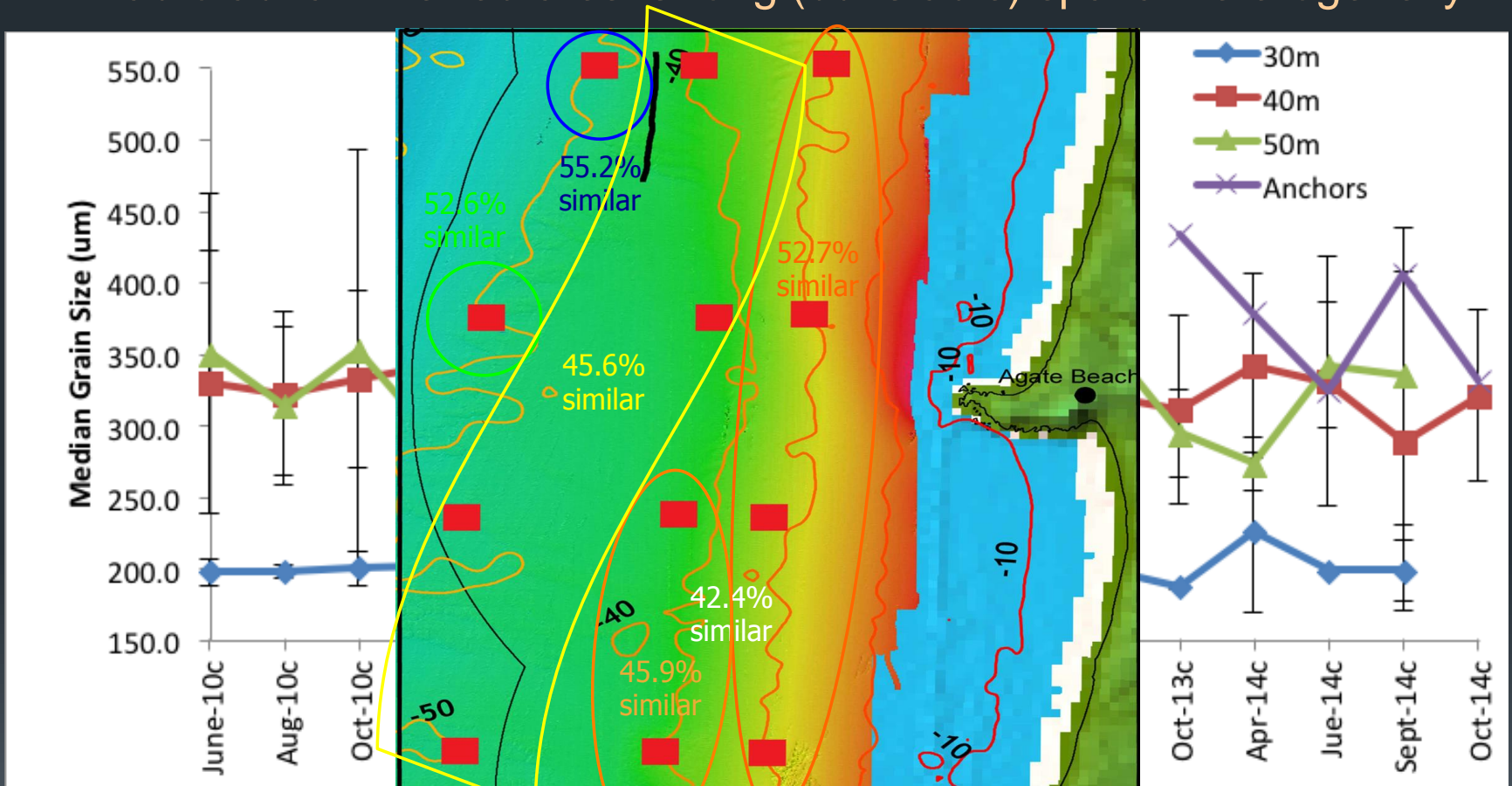


Identify macrofauna in the lab



# Macrofauna and Sediment Vary Spatially but not Temporally

Macrofaunal invertebrates: strong (but stable) spatial heterogeneity



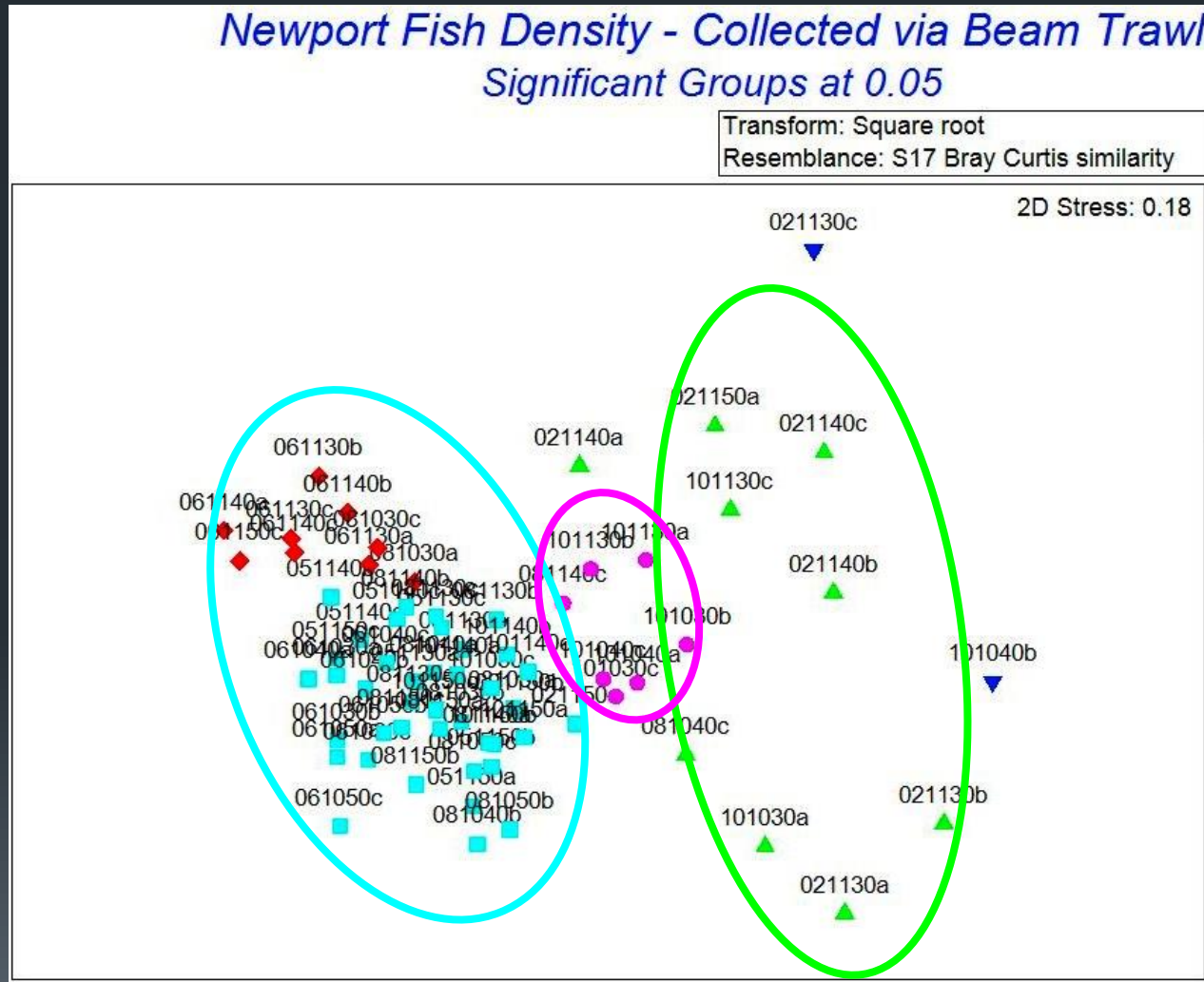


# Epifauna/Fish Sampling

2 m Wide Beam Trawl (3 mm mesh liner)



# Fish Species Vary across Seasons but not Depth



Summer  
Fall  
Winter



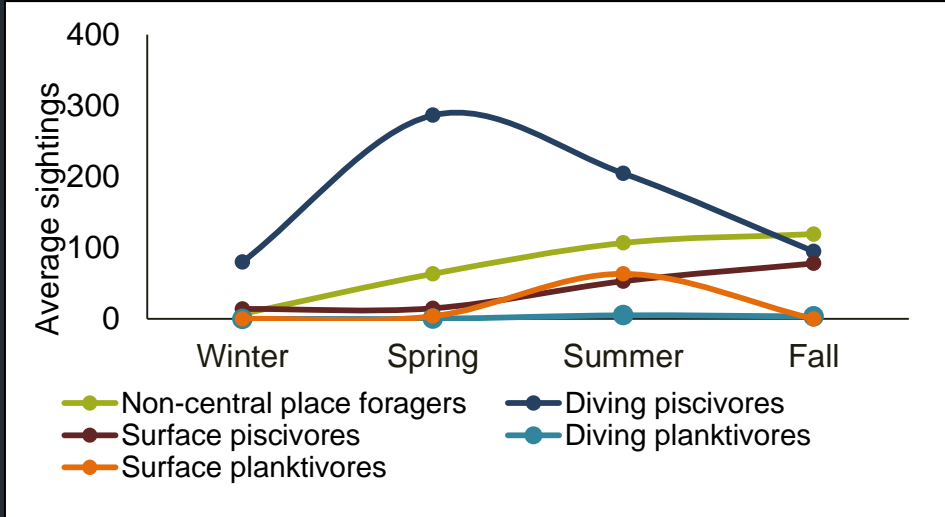
# Dungeness Crab Distributions

CPUE varies by depth by not transect



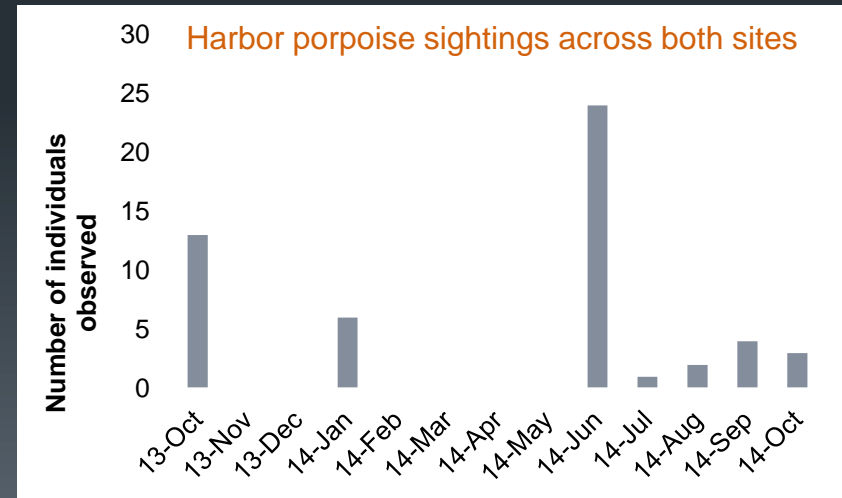


# Seabird and Marine Mammal Observations



Species	Individuals observed
Harbor porpoise	53
Gray whale	20
Humpback whale	20
Steller sea lion	15
California sea lion	9
Unidentified whale	7
Dalls porpoise	6
Pacific white sided dolphin	6
Unidentified porpoise	3
Unidentified sea lion	3
Orca	2
Harbor seal	1
<b>Total:</b>	<b>145</b>

Foraging group	Species
<b>Diving piscivores (dpis)</b>	Common murre ( <i>Uria aalge</i> ), cormorant spp., pigeon guillemot ( <i>C. columba</i> ), murrelet spp., rhinoceros auklet ( <i>C. monocerata</i> )
<b>Diving planktivores (dplank)</b>	Cassin's auklet ( <i>Ptychoramphus aleuticus</i> )
<b>Surface piscivores (spis)</b>	Tern spp., gull spp., kittiwake spp.
<b>Surface planktivores (splank)</b>	Phalarope spp., storm petrel spp.
<b>Non-central place foragers (ncpf)</b>	Northern Fulmar ( <i>F. glacialis</i> ), albatross spp., jaeger spp., shearwater spp., phalarope spp.

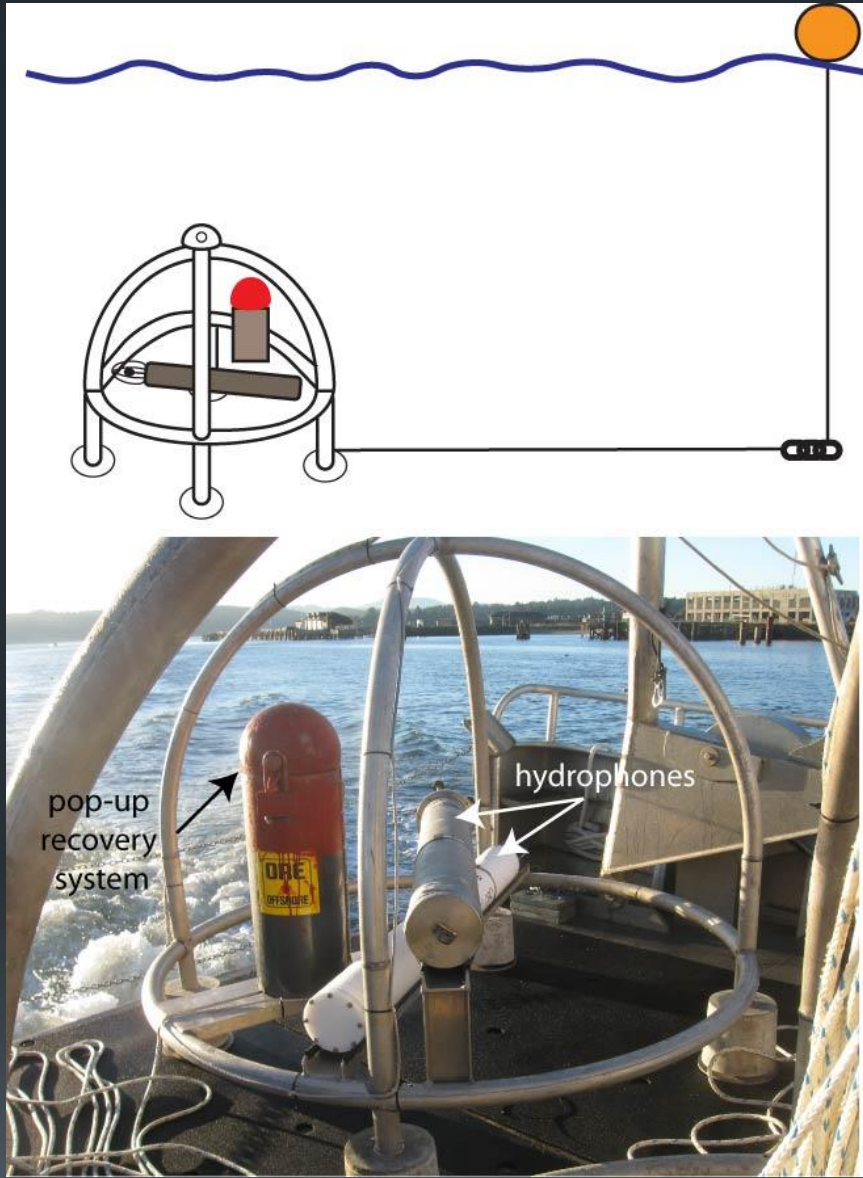


# Passive Acoustic Lander Mooring

PIs: Haxel, Matsumoto, Dziak

Oregon State University: Cooperative Institute for Marine Resources Studies

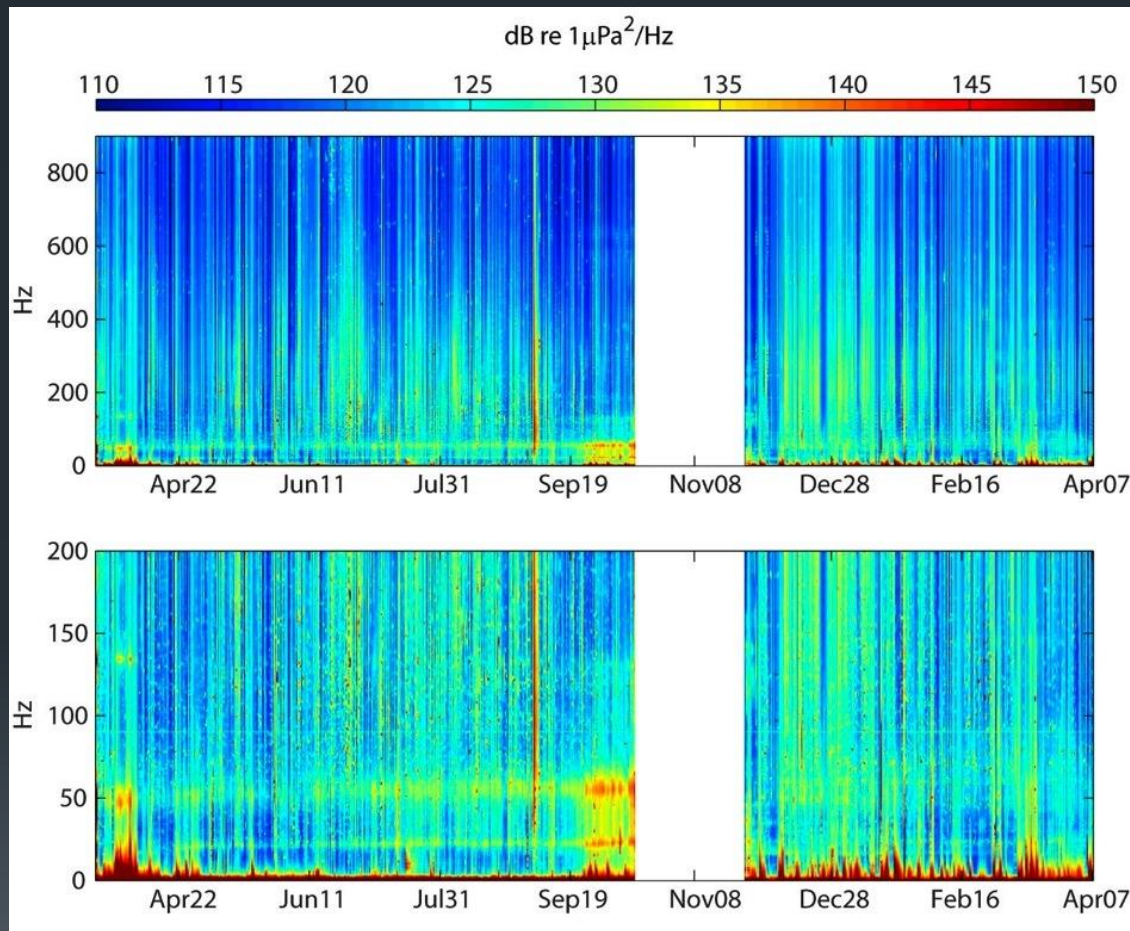
NOAA: Pacific Marine Environmental Laboratory



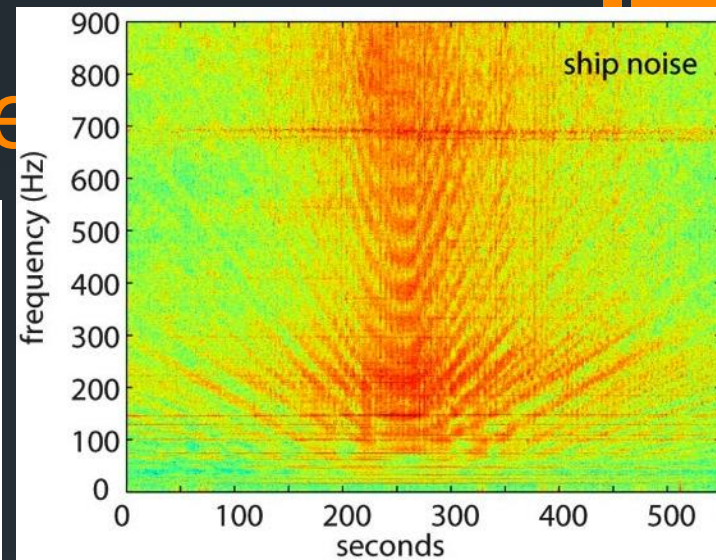
- Lowered to the seafloor  
Hydrophones record continuously or on duty cycle (1 Hz – 20 kHz)
- Collect continuous passive acoustic data
- Characterize the amplitude and frequency distribution through time of the ambient noise field
- ID sound sources



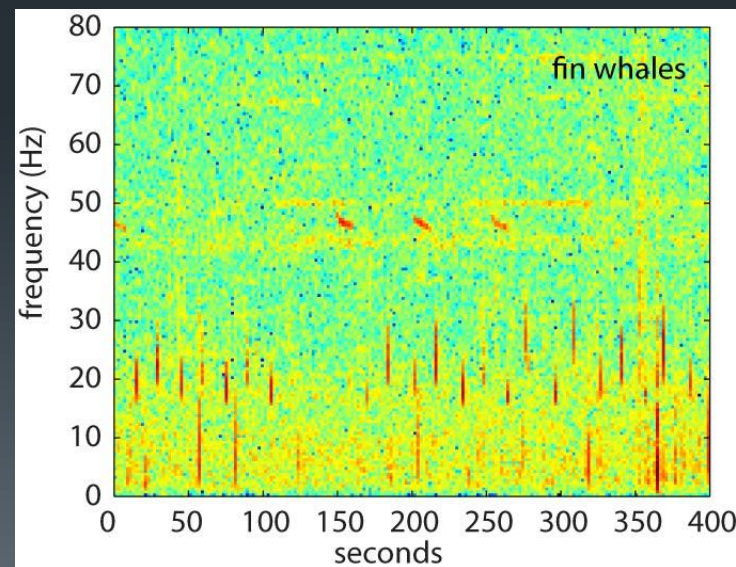
# Dominant Sounds are wind/waves and ship noise



## SHIP NOISE



## FIN WHALES





# Part 2: Detecting Device Effects



# Acoustic Effects?

## 2012: WetNZ & Ocean Sentinel

- Acoustic recordings indicated sound energy transmitted by the devices appeared to oscillate with wave period, primarily in frequencies below 1 kHz, but the cabled hydrophone was approach severely limited in the lower frequency range (< 300 Hz) by system noise contamination.
- $SPL_{rms}$  recorded at 10 m and 85 m from the WET-NZ and Ocean Sentinel remained below NMFS threshold criteria (120 dB).

## 2013: Ocean Sentinel only

- The spectral signature of sounds generated by the motion of mooring hardware (chain noise) was detected and identified as a set of five localized spectral peaks (4.6 - 5.0 kHz, 5.2 - 5.5 kHz, 9.0 - 9.4 kHz, 10.0 - 10.6 kHz, and 12.1 - 13 kHz).
- Despite the contribution of these sound sources to ambient levels,  $SPL_{rms}$  integrated across the 60Hz – 13 kHz frequency range remained below NMFS threshold criteria (120 dB).



# Seafloor Effects?



## 2012 ROV Survey of Wet-NZ test

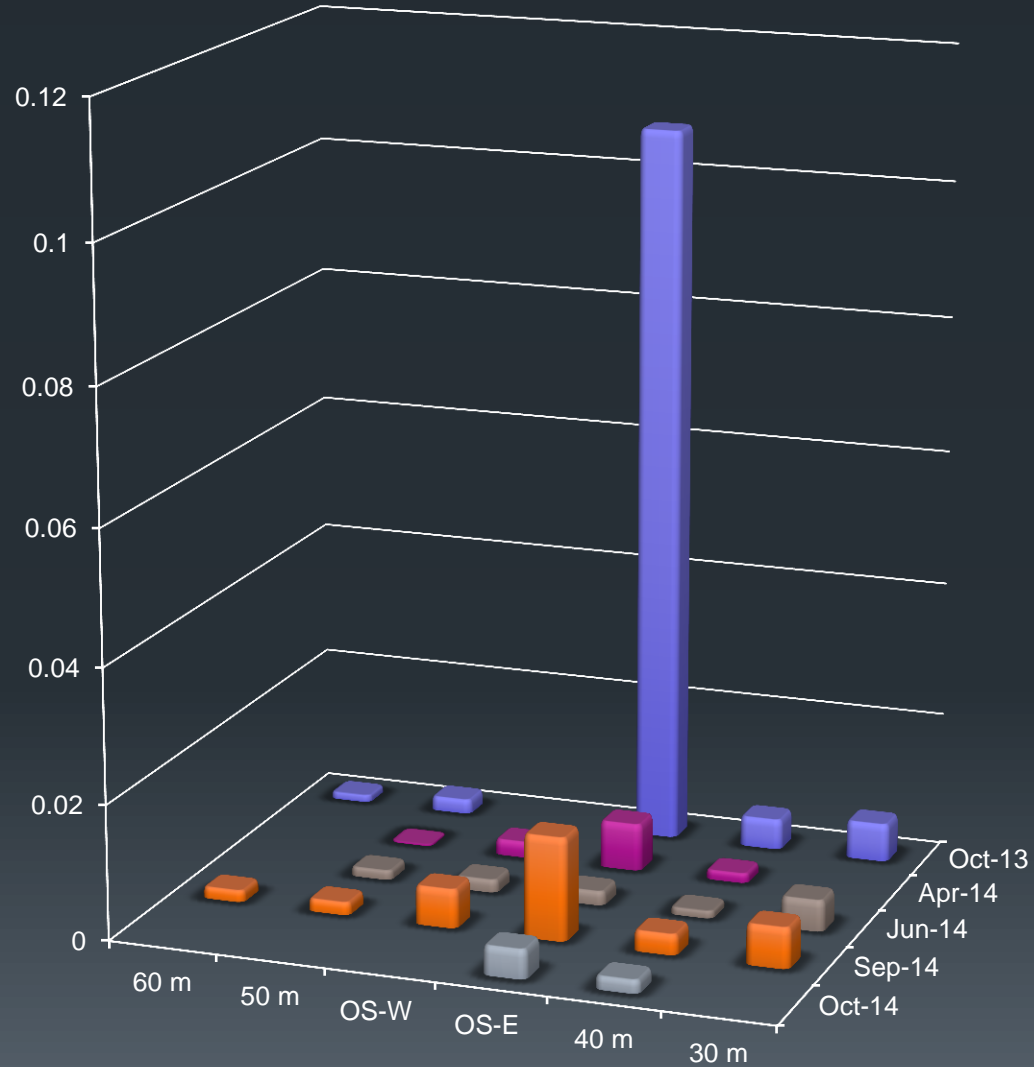


# Starting in 2013: Anchor Grabs

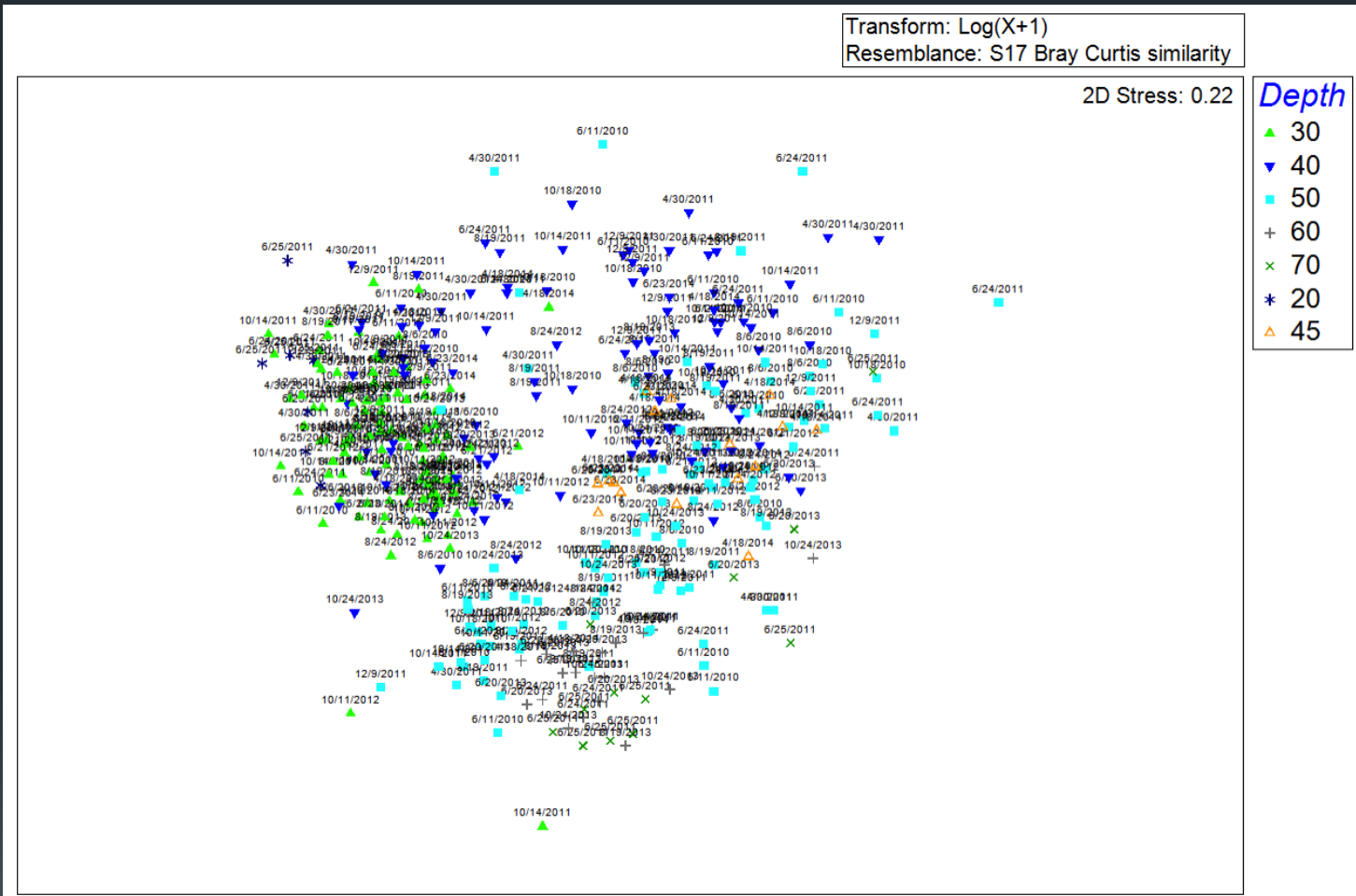




# Shell Hash Proportion

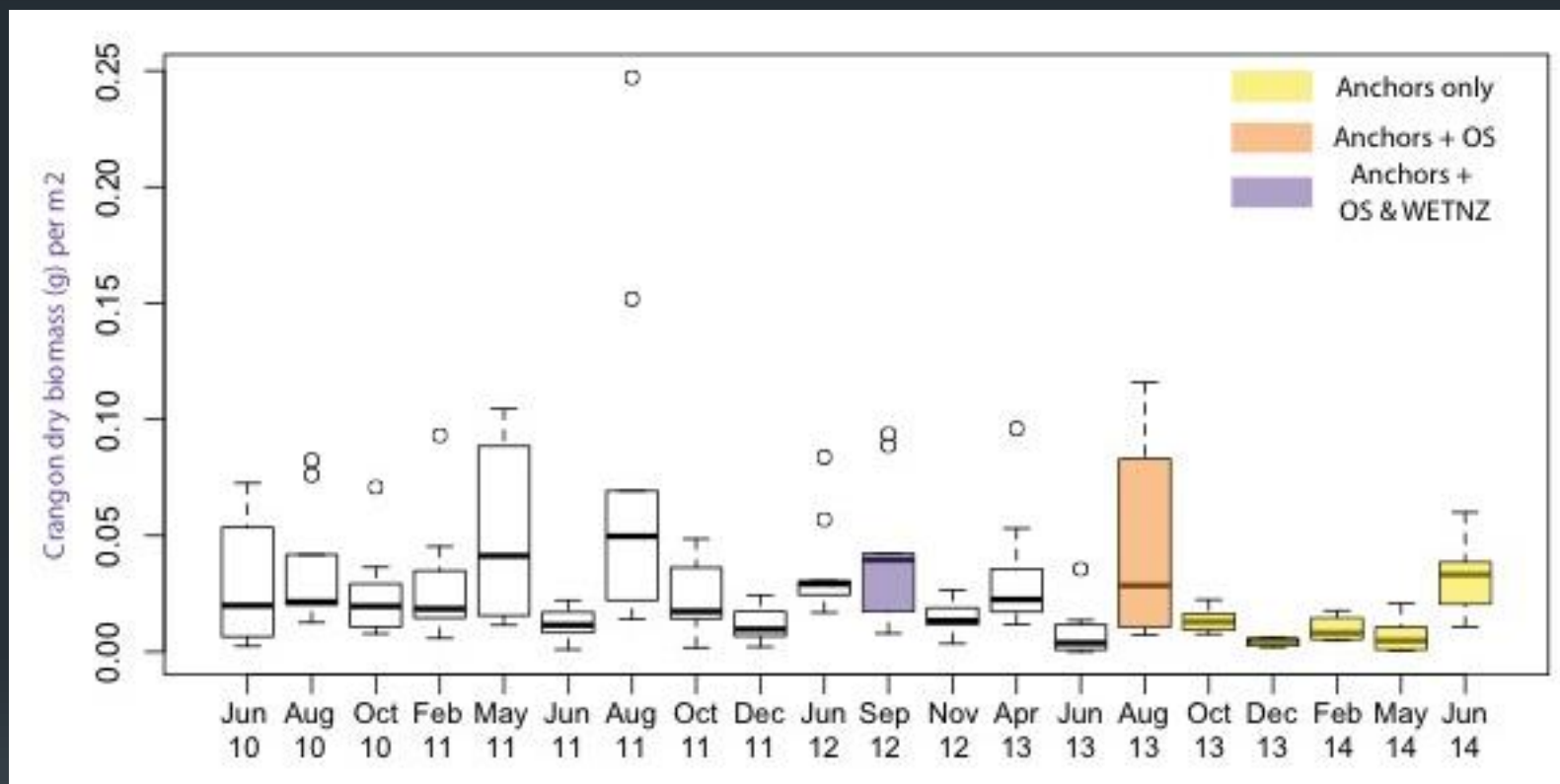


# Effects on Organisms?



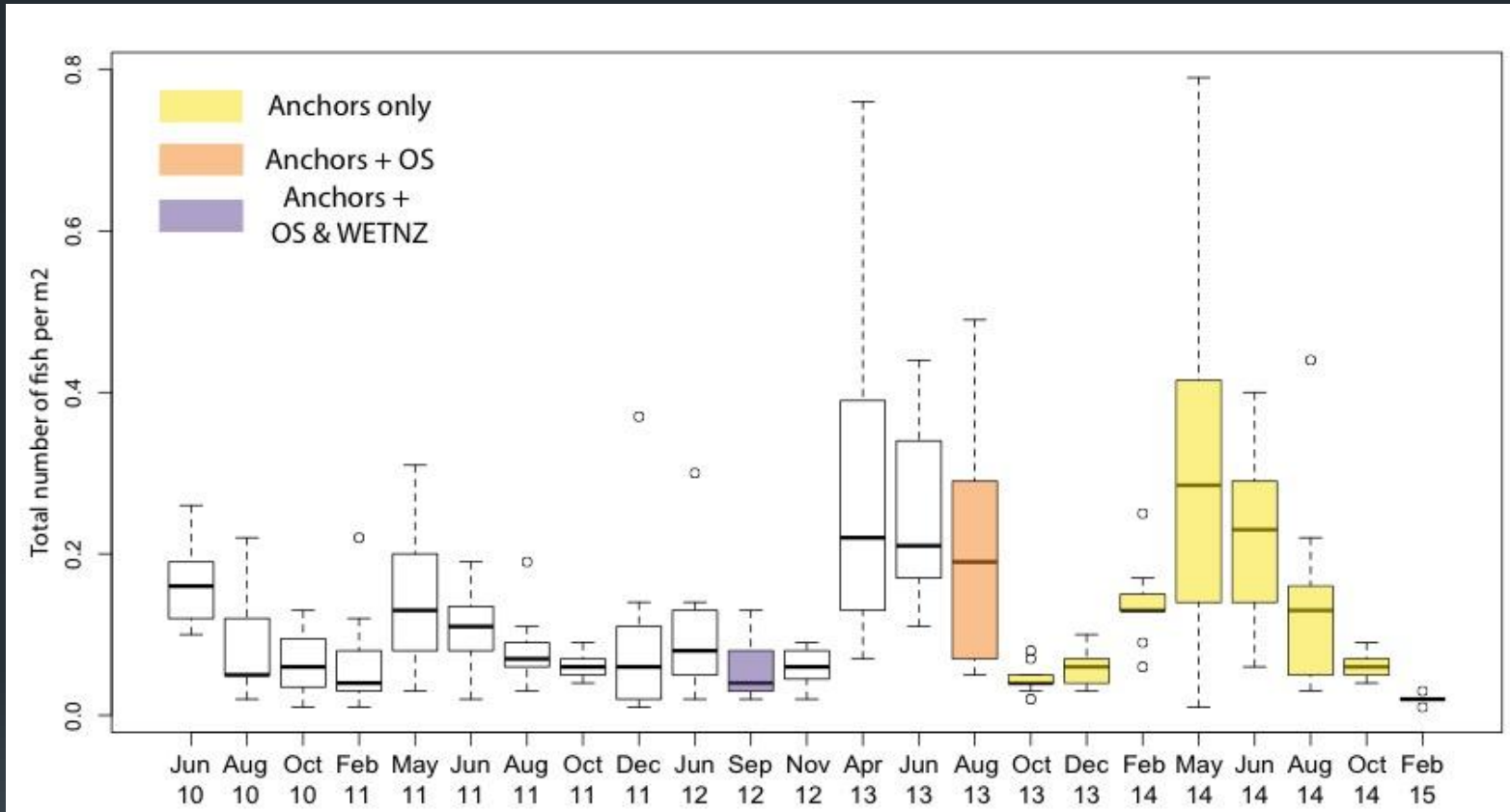
Macrofaunal assemblages at anchor stations indistinguishable from 40 m and 50 m

# Effects on Organisms?



No difference in biomass of *Crangon* shrimp over time

# Effects on Organisms?



**No changes in benthic fish density during WetNZ deployment. Recent increases started before OS installation (El Niño)**

# Future Environmental Research Campaign

- Work with resource agencies to determine the most interesting and important environmental research questions that can be addressed at P MEC in order to develop a prioritized research agenda for NNMREC
- Coordinate with outside scientists interested in conducting research at P MEC to ensure their activities align with NNMREC priority issues
- Communicate with DOE and/or other funding streams priority research questions for future funding calls
- Evaluate periodically to see what goals are being met / what is not longer a priority due to other studies / what new topics should be added to the research agenda