FROM BAY FLOOR TO OCEAN FLOOR: A SHRIMP TALE

Dr. Sarah Henkel

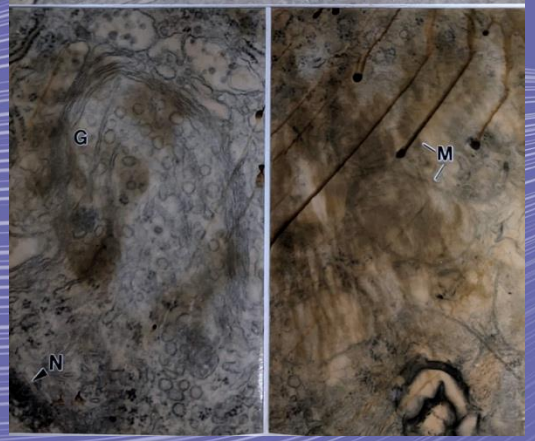
Associate Professor
Department of Integrative Biology
College of Science

Associate Director
Pacific Marine Energy Center

Environmental Monitoring
PacWave

Hatfield Marine Science Center

Charismatic Megaflora - Seaweeds!



2000

WILLIAM & MARY
CHARTERED 1693

2008 UCSB
UNIVERSITY OF CALIFORNIA
SANTA BARBARA

CALIFORNIA STATE UNIVERSITY
FULLERTON
1957

2003

If animals…

No bones are best

Cartilage is ok

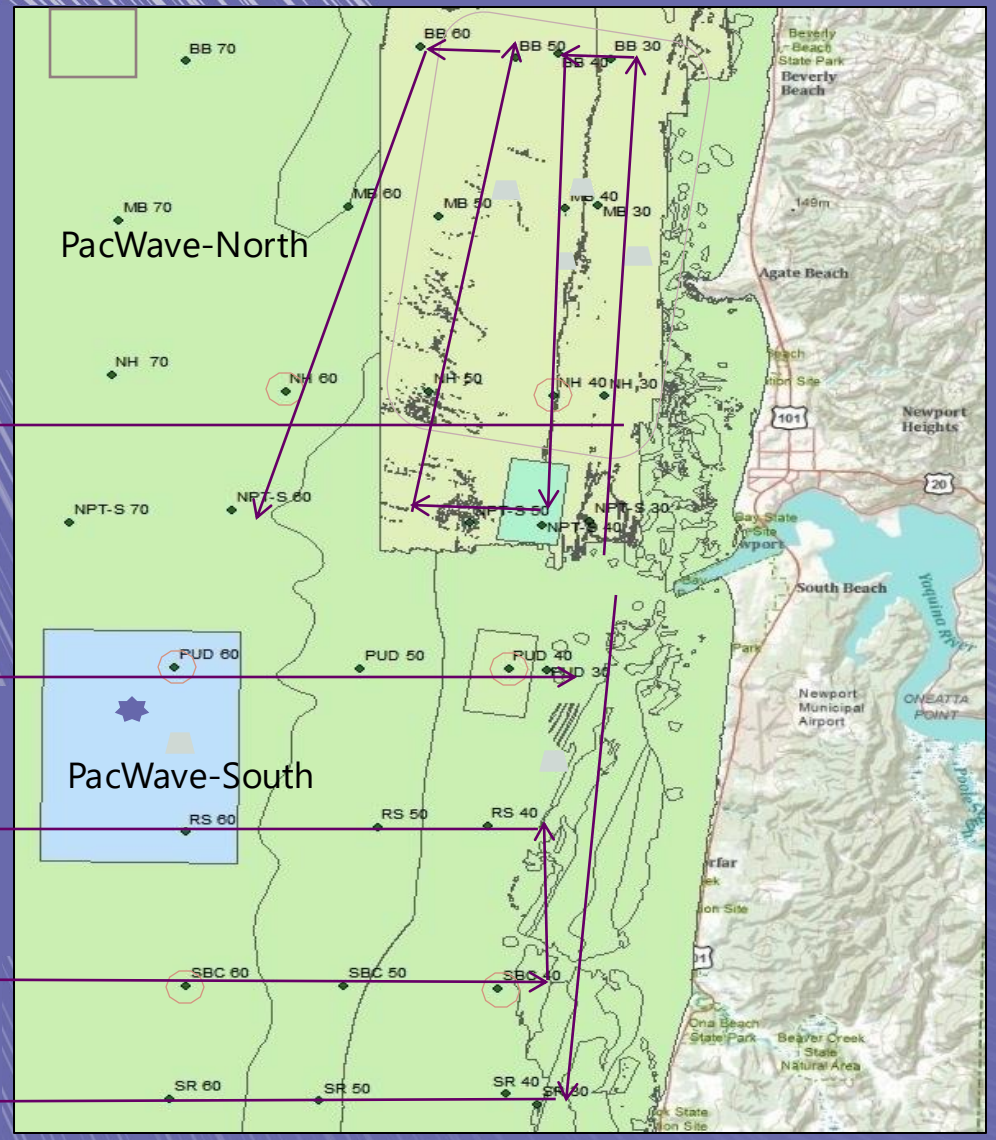
When I'm not sciencing

Oregon State University

Assistant Prof, Sr. Res. 2009-2018	Associate Prof, Sr. Res. 2018-2020	Associate Prof, TT (pre tenure) 2020-2025	Associate Prof, Tenured 2025!
Member, NNMREC 2009-2013	Director of Env Res, NNMREC 2013-2018	Associate Director, PMEC 2018-present	Acting Director, PMEC AY 24-25
BI450: Cons. & Policy 2010-present	BI370: Ecology 2015-present	BI450: Algae BI353:Coastal 2018-present	BI364: Ocean Justice Co-developing

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
- Electromagnetic Field mapping (also lab studies)
- Acoustics (hydrophones deployed)
  - 2011-13 @ PWN
  - 2015, 2022-2025 @ PWS



THE STAR OF THE TODAY'S SHOW: GHOST SHRIMP

Ecosystem Engineers

- burrow into sediments
- increase depth of oxygen penetration
- disrupt benthic macrofaunal assemblages?
- excluded by eelgrass
- considered a pest in oyster aquaculture

Neotrypaea sp.
Male (left) and female (right)

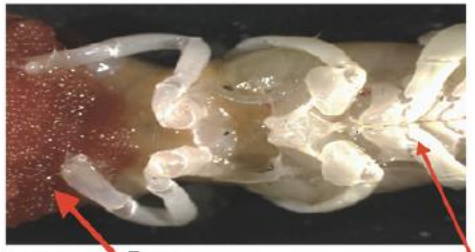
HOW TO SEX GHOST SHRIMP
(*Neotrypaea californiensis*)

FEMALES

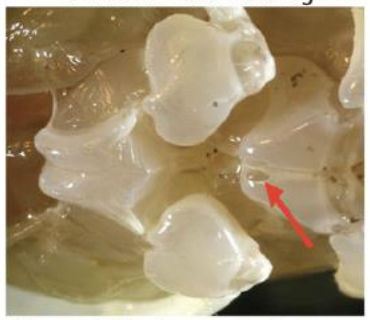
The two claws are about the same size

Eggs may be visable two red stripes down the back (if not yet released by the female)

Eggs may be visable on the ventral anterior first three abdominal segments



Ovapores appear as small oval or tear drop shaped openings as the base of the third leg



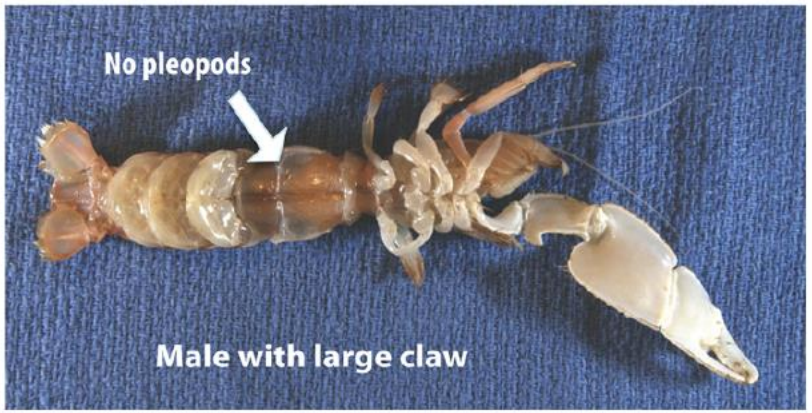
Pleopods (the legs on the first abdominal segment) are much longer in the female then the male

MALES

One claw is much larger then the other

Sperm may be visable as two yellowish stripes on the dorsal side of the abdomen

Ovapores are not apparent & Pleopods, if visible will be short and stubby



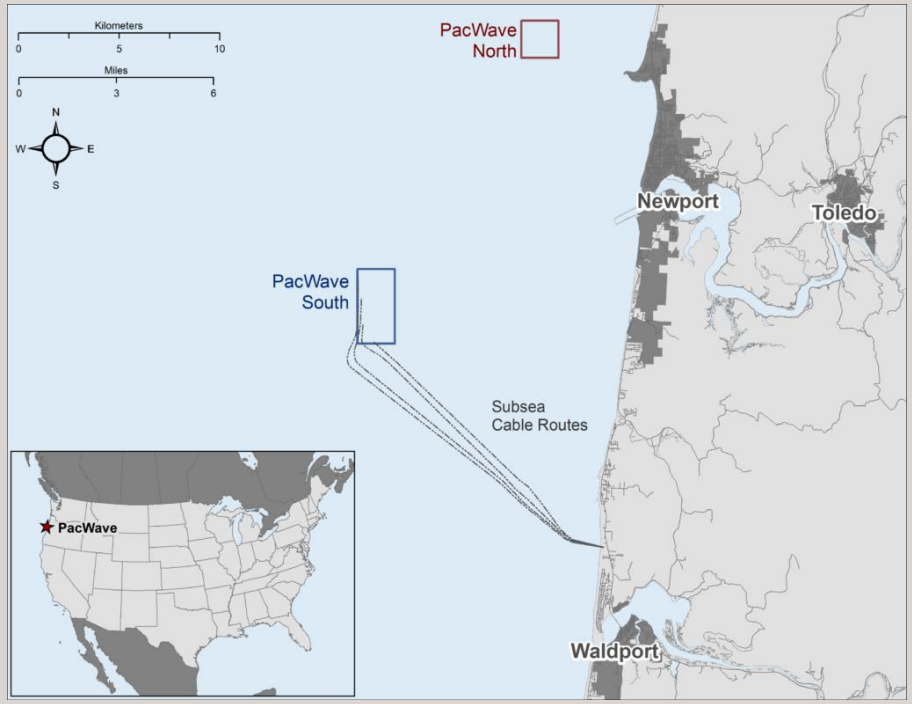
N. californiensis

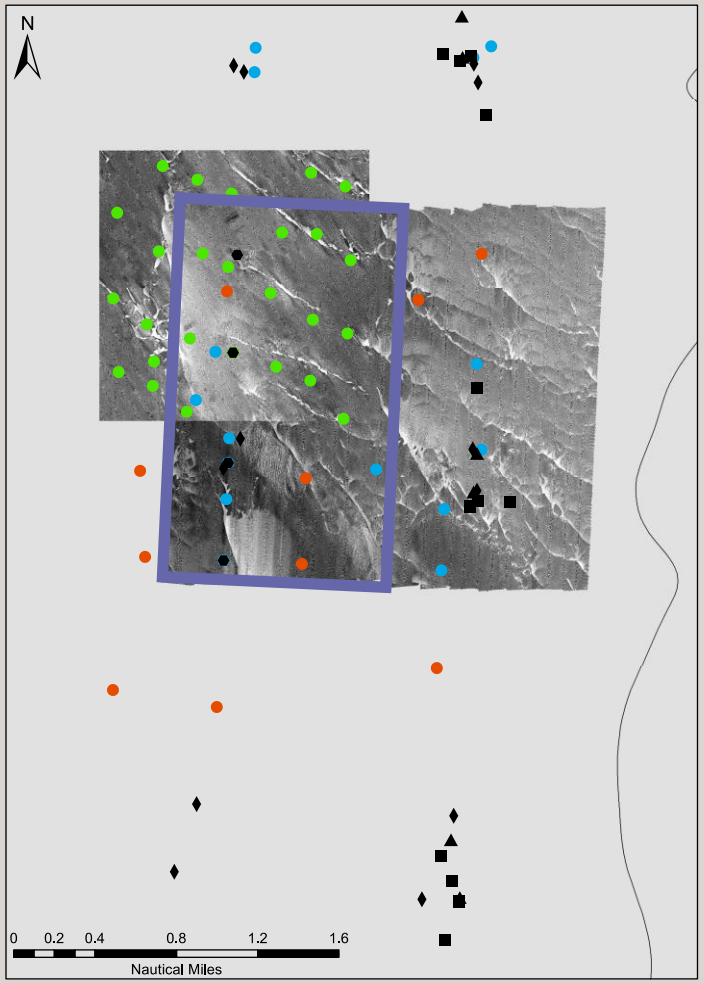
- Dominant in estuaries
- Pink hue
- Sandy, upper intertidal substrate
- Y-shaped burrow (30.8 cm mean depth)
- Recorded up to 26 meters deep offshore

N. gigas

- Less common in estuaries
- Brown/beige in color
- Muddy, lower and mid-intertidal substrate
- Shallow, branching burrows (17.3 cm mean depth)
- Recorded up to 88 m deep offshore

PacWave Site Monitoring: Benthic Inverts & Sediment

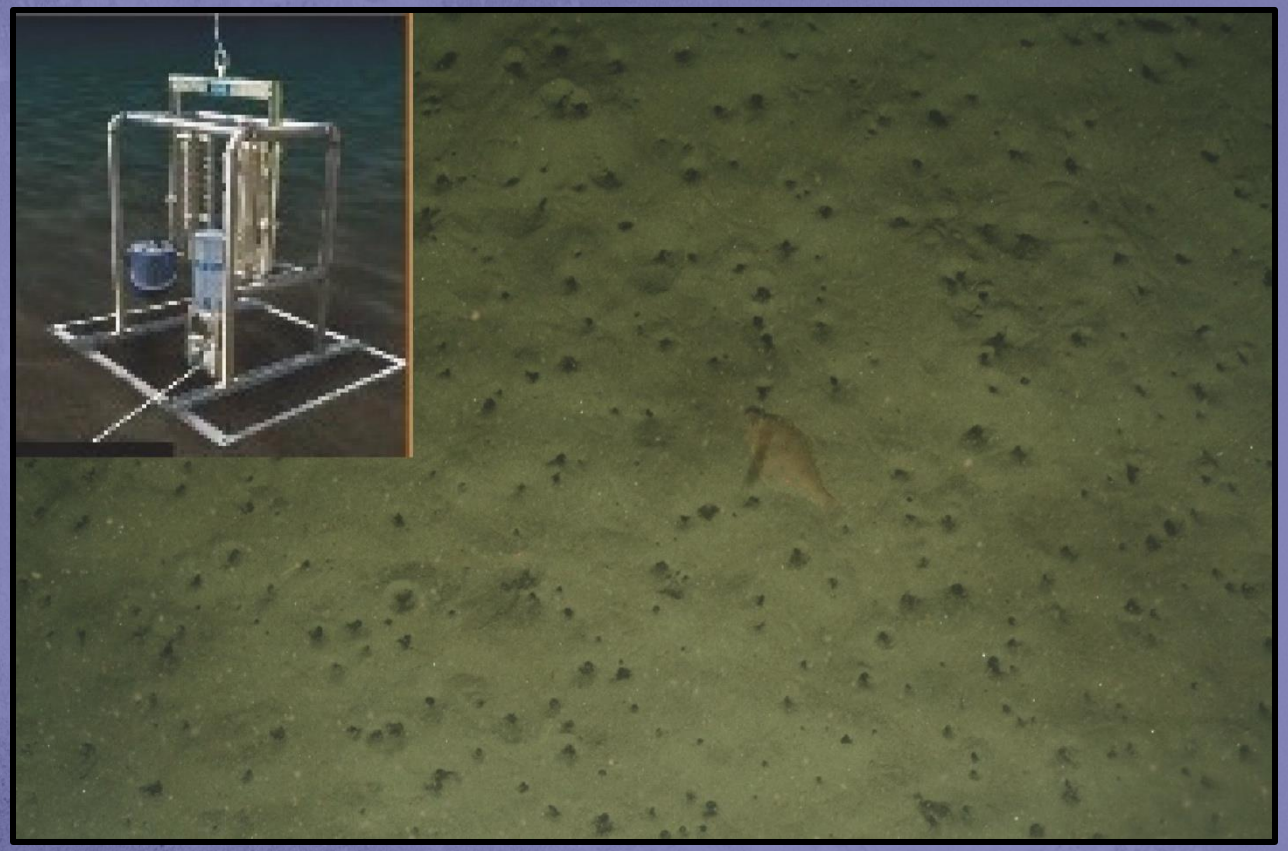




- 2013 – 2015 sparse "site characterization" sampling (black):
  - Found in 14 of 117 box cores, 1-2 shrimp per core always little
- July 2019 intense "pre-installation" sampling (green)
  - Found ghost shrimp in 16 of 26 box cores. As many as 26 shrimp in a 0.1 m^2 core!
- Found in 12 of 16 grabs in September (blue) and 8 of 10 grabs in October (orange)

Offshore Population of *Neotrypaea*?

WHAT???

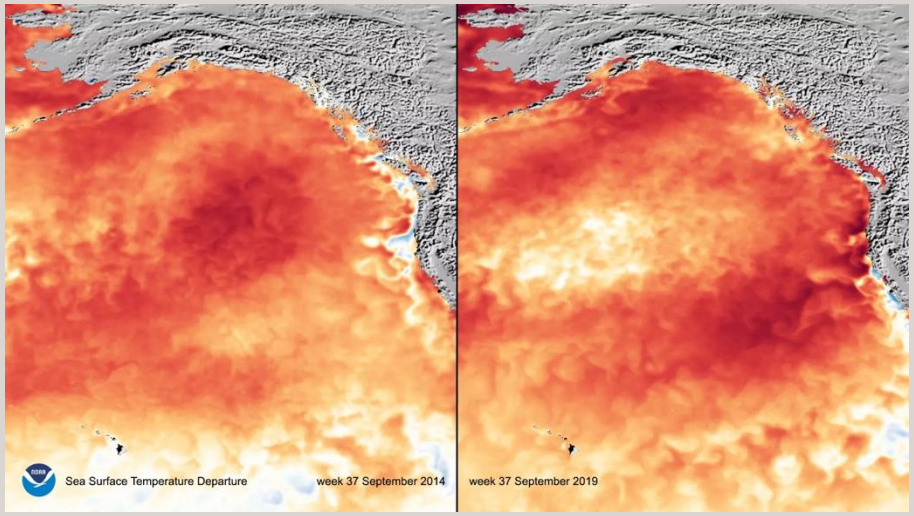


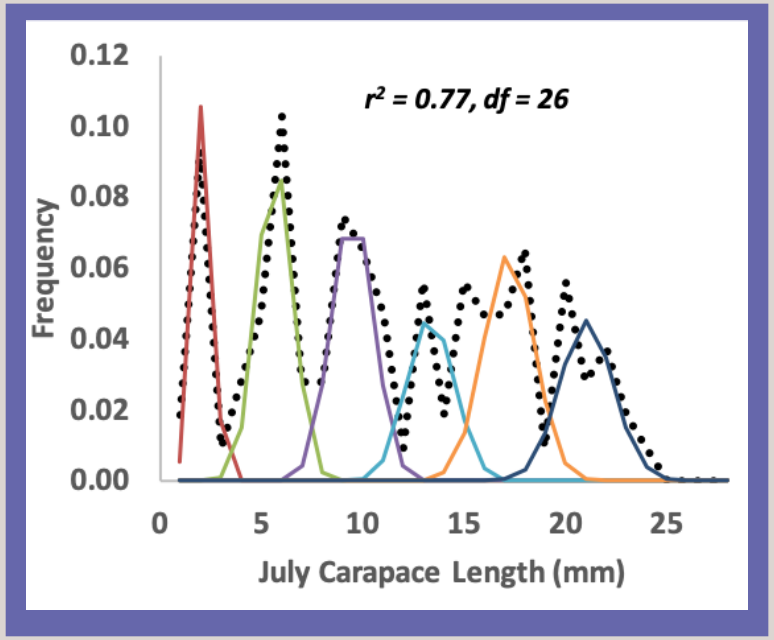
Plan view camera image of *Neotrypaea* sp. burrows.

Up to 400 burrow openings/m^2

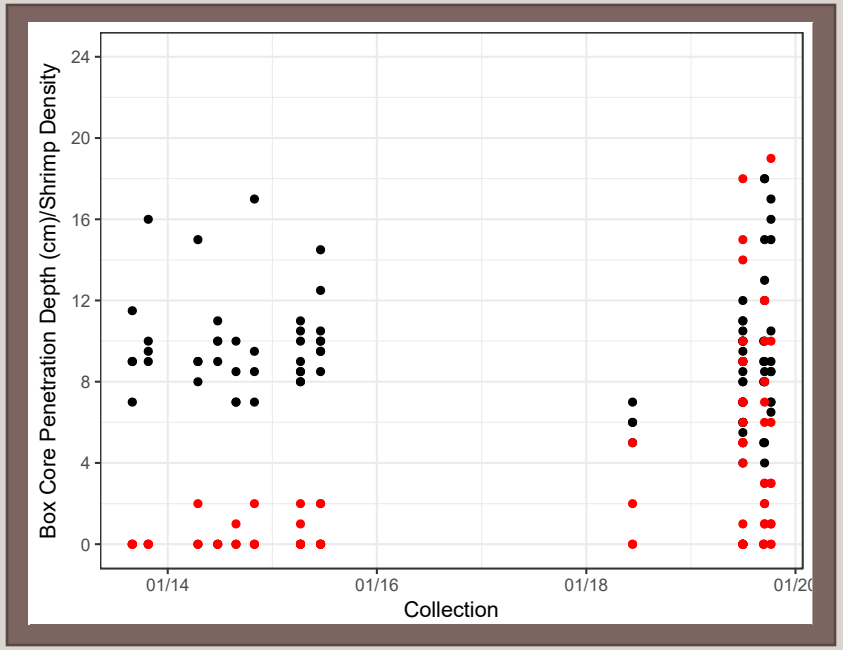
WHEN DID THEY GET THERE?

What else happened in 2014-2015?





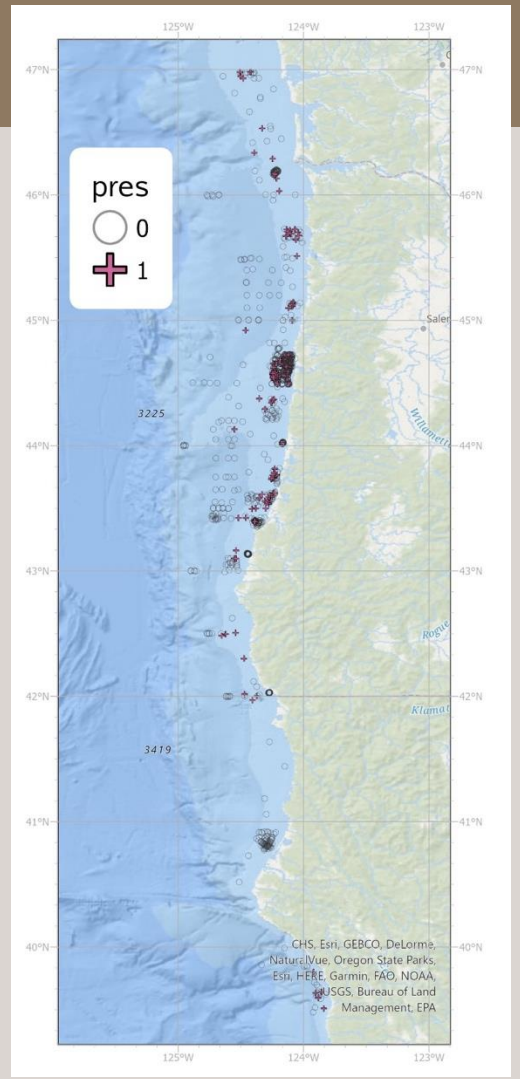
2014-2015

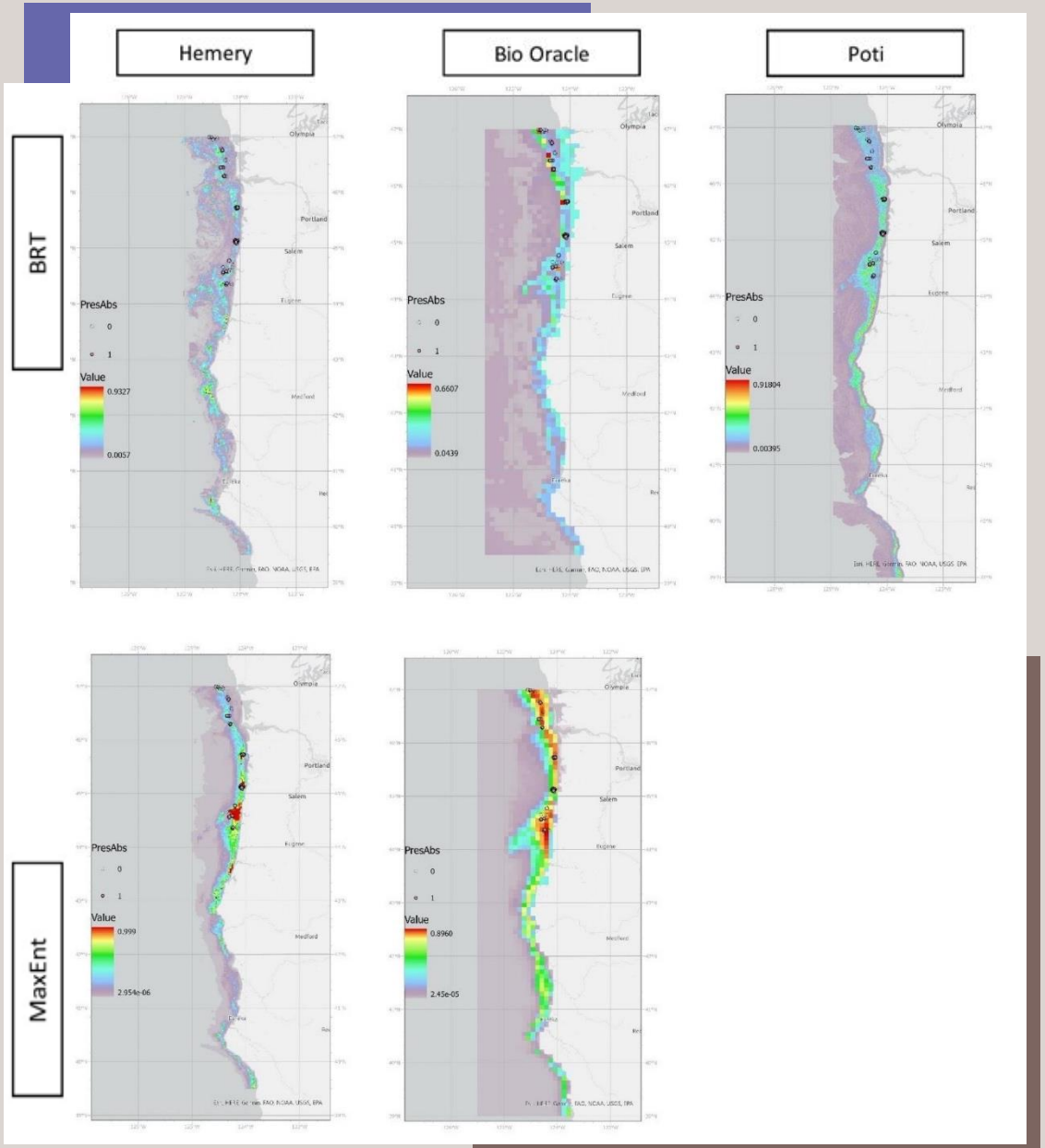


DID THEY SETTLE ELSEWHERE?

Habitat Suitability Modeling

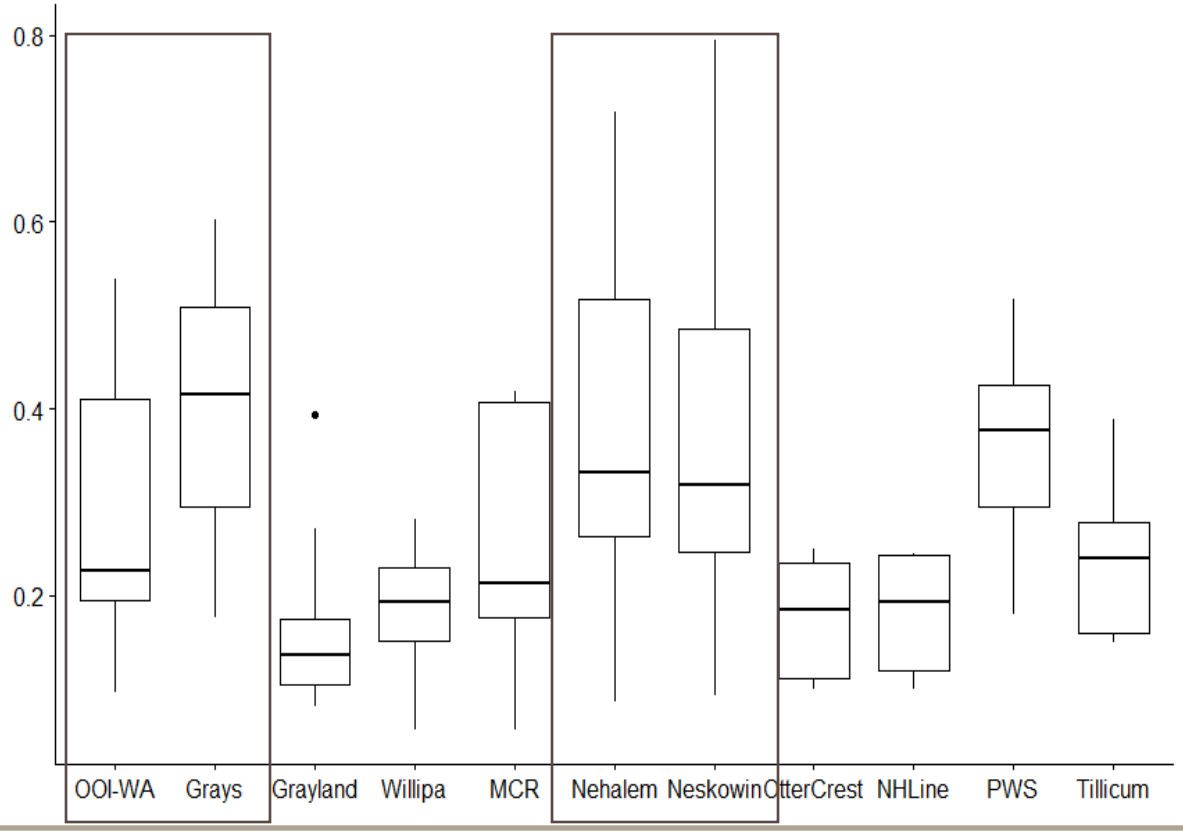
Sarah Hardisty

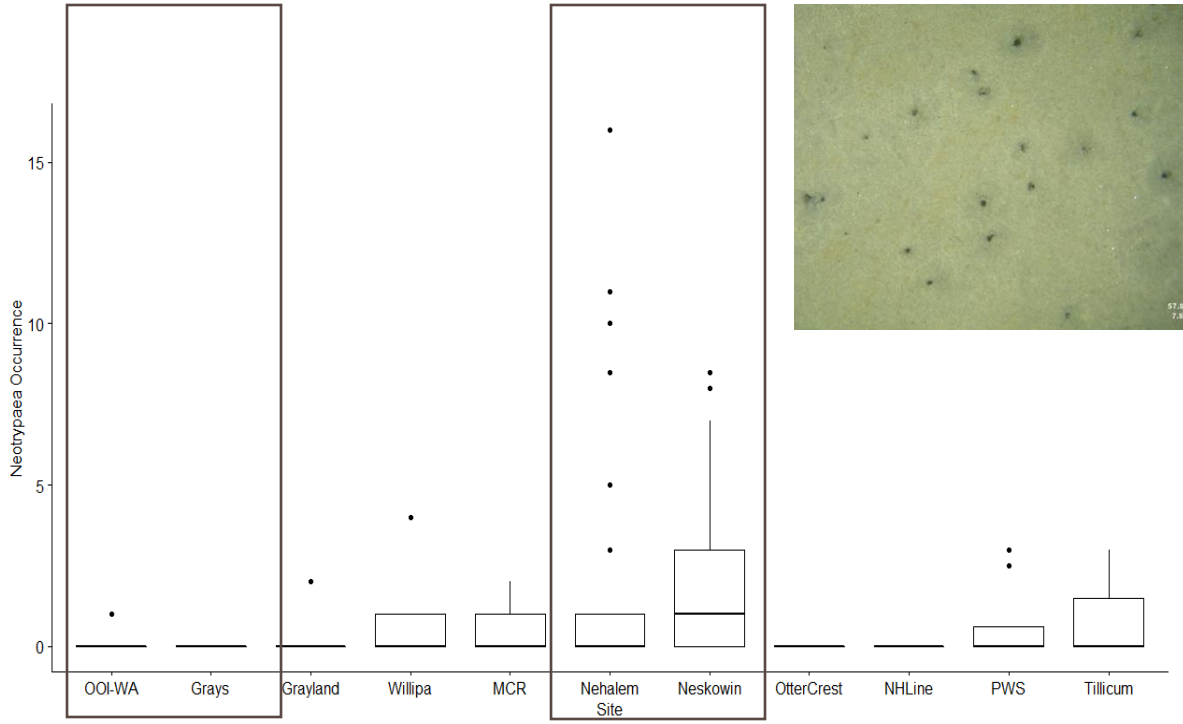




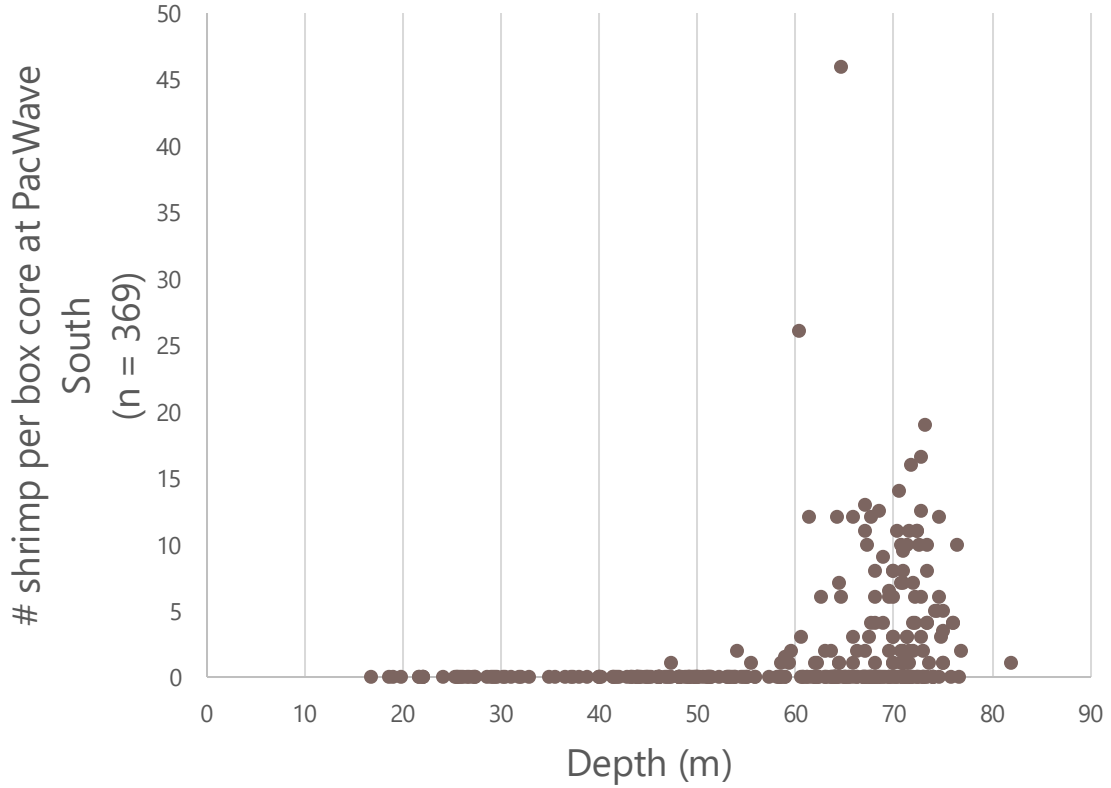
YES!
(But not everywhere predicted)

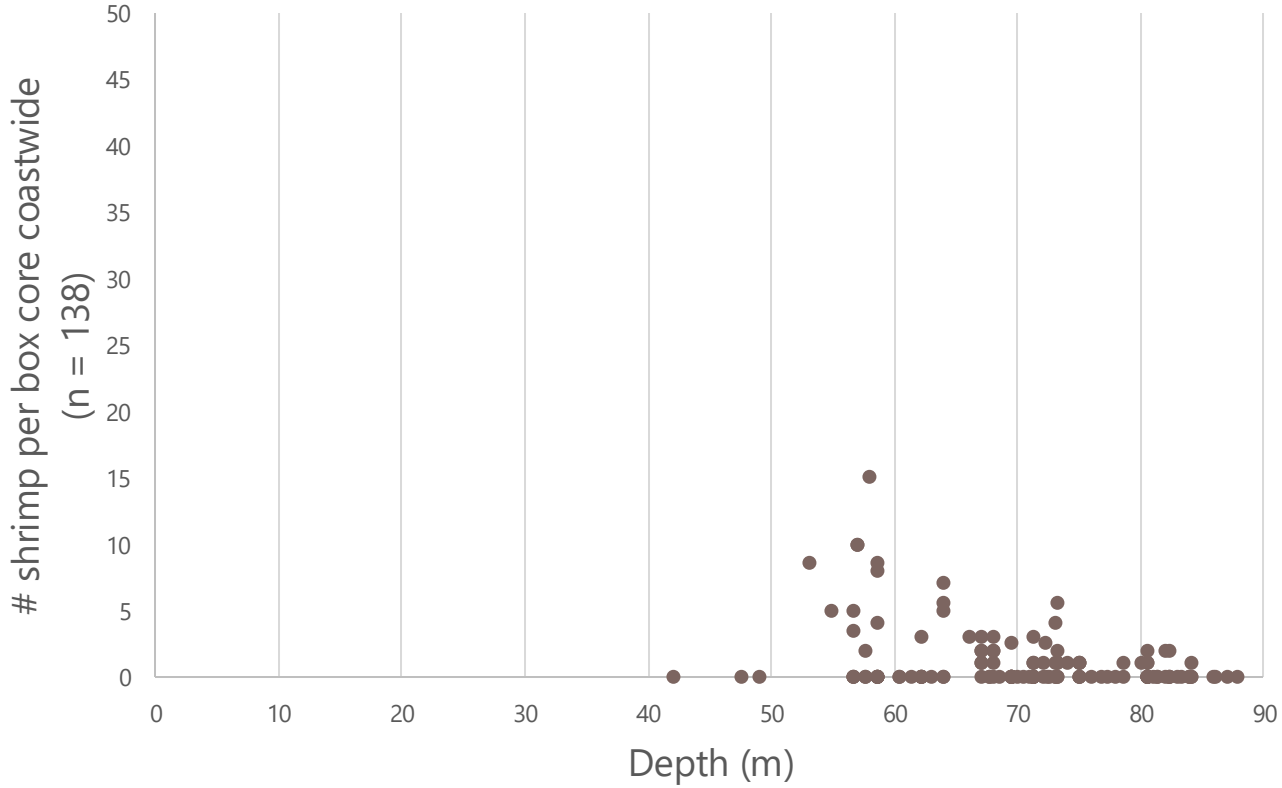
Sites in Oregon that had high suitability had shrimp. Suitable sites in WA did not.





YES!
(But > 50 m)


shrimp per box core at PacWave South (n = 369)
Depth (m)
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
70
80
90

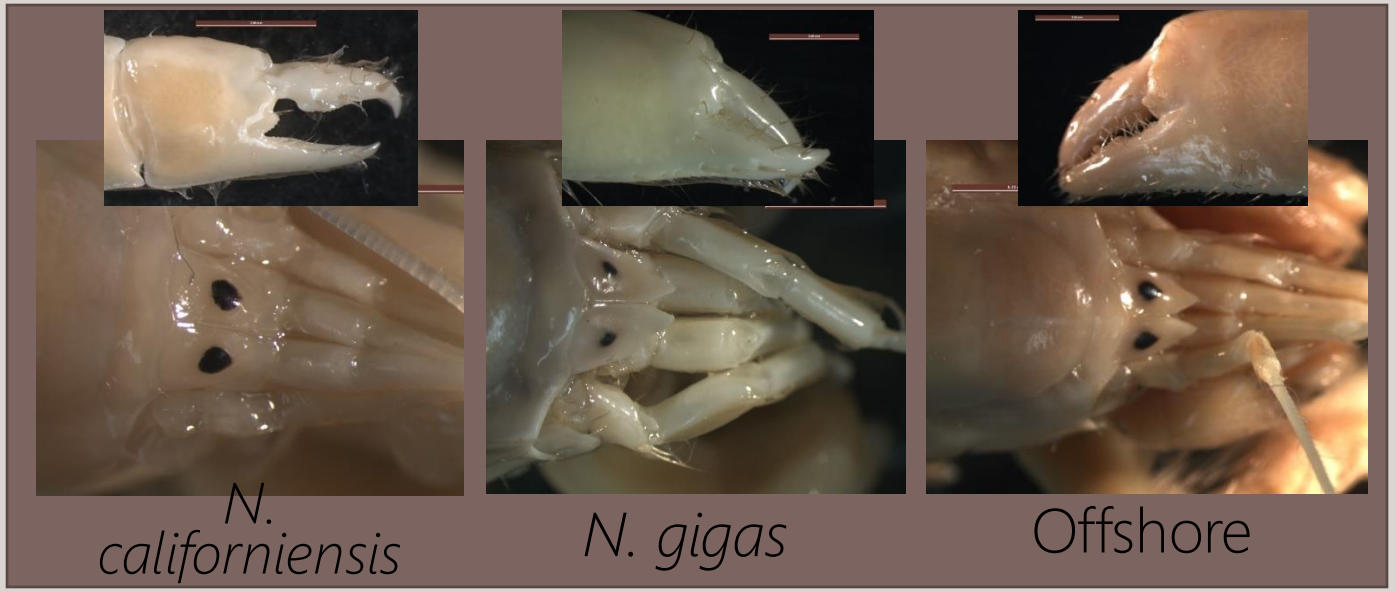

shrimp per box core coastwide (n = 138)
Depth (m)
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
70
80
90

WHO ARE THEY?

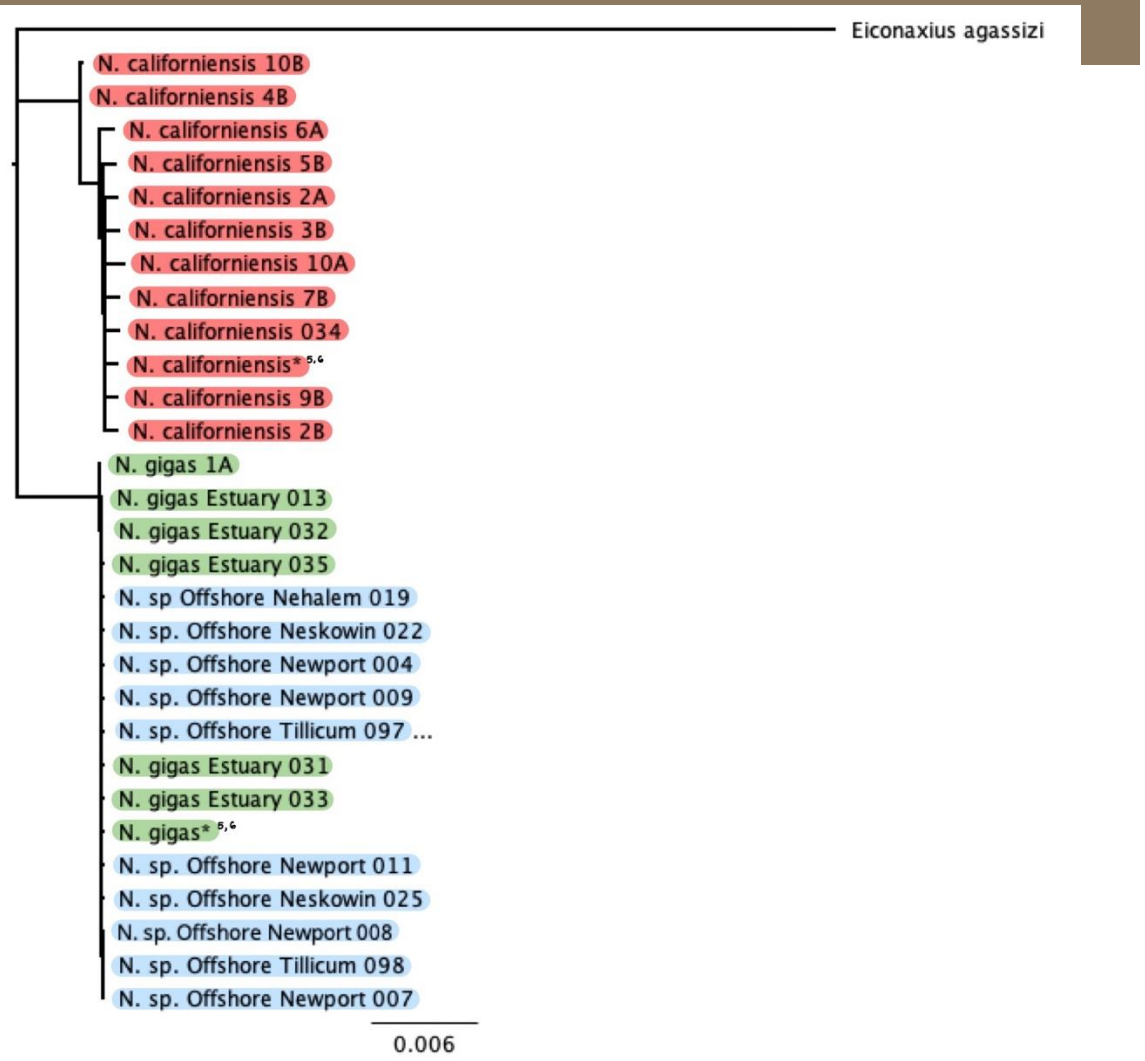
(My students) measured 33 morphological characters:

- **Eye stalks/corneas**
- **Male major claw**
- Minor claw
- Walking leg 1
- Walking leg 2

"Cornea" and minor claw differed between estuary *N. gigas* and Offshore shrimp



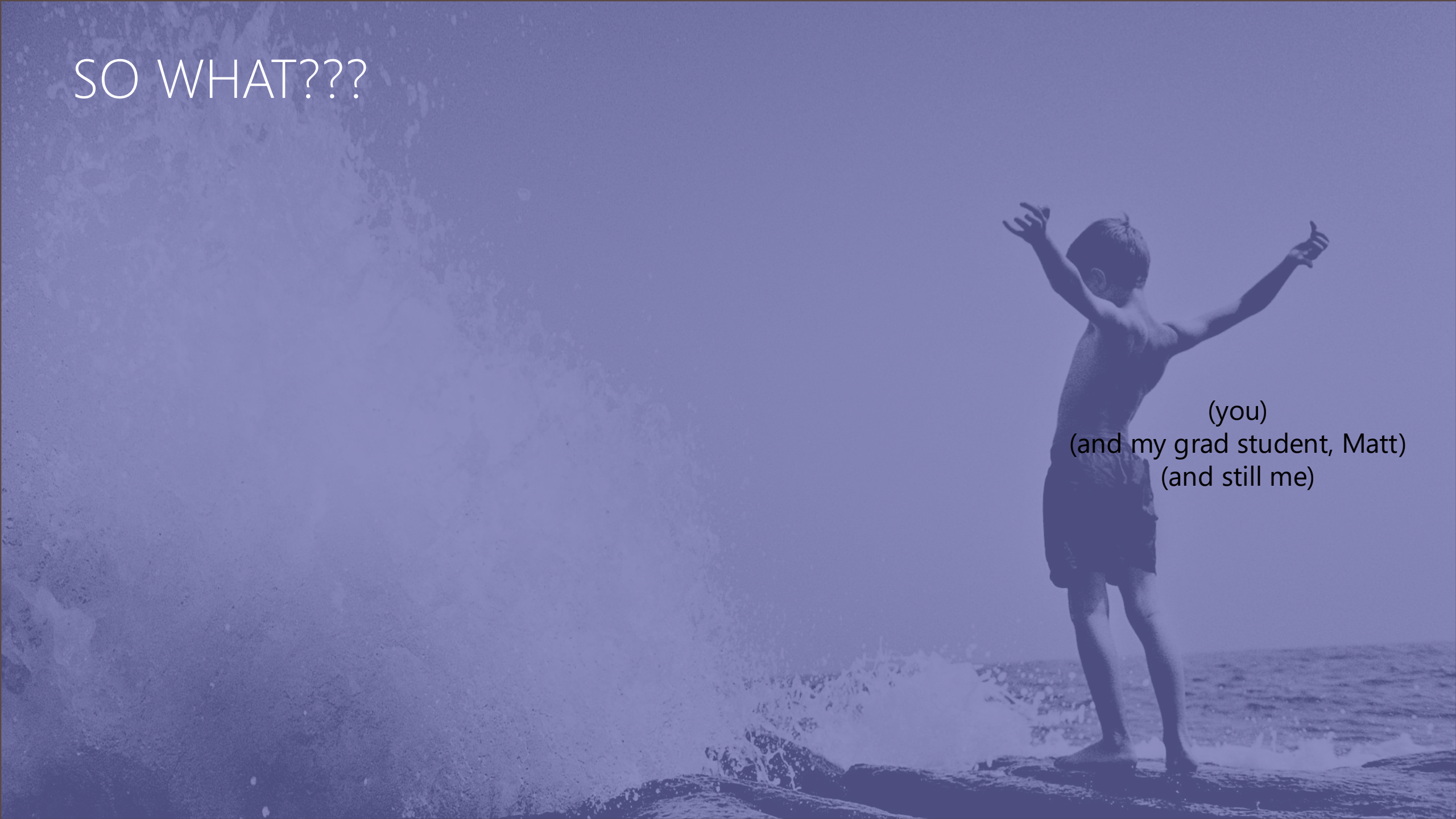
WHO ARE THEY?



The 18S gene showed differences between the two known species of ghost shrimp.

There were no differences between *N. gigas* and offshore shrimp using the 18S marker.

SO WHAT???



(you)
(and my grad student, Matt)
(and still me)

WHAT ARE THEIR PHYSICAL IMPACTS?

Mesocosm tanks to get “natural” burrow morphology.

Nearly all literature on *Neotrypaea* is of *N. californiensis* in the estuary. Do the offshore shrimp have similar burrow construction and behavior?

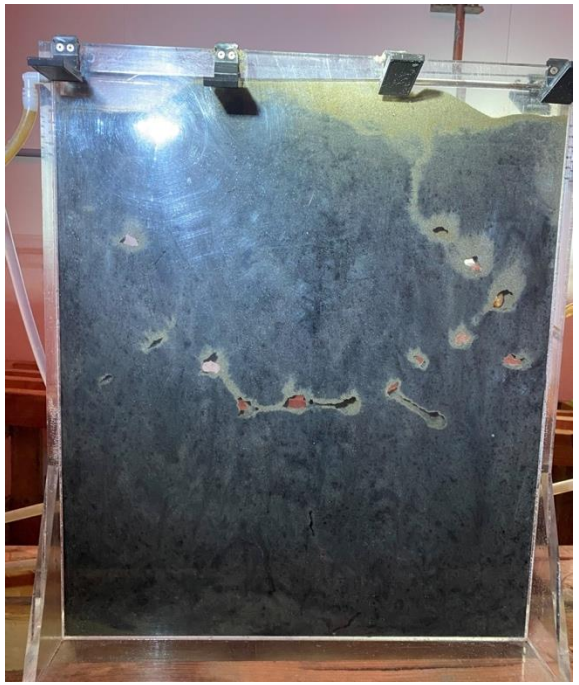
Matt Vaughan

Resin casts of a burrow made by *N. californiensis* from Yaquina Bay (right) and offshore shrimp (left) in sediment from their respective habitats.

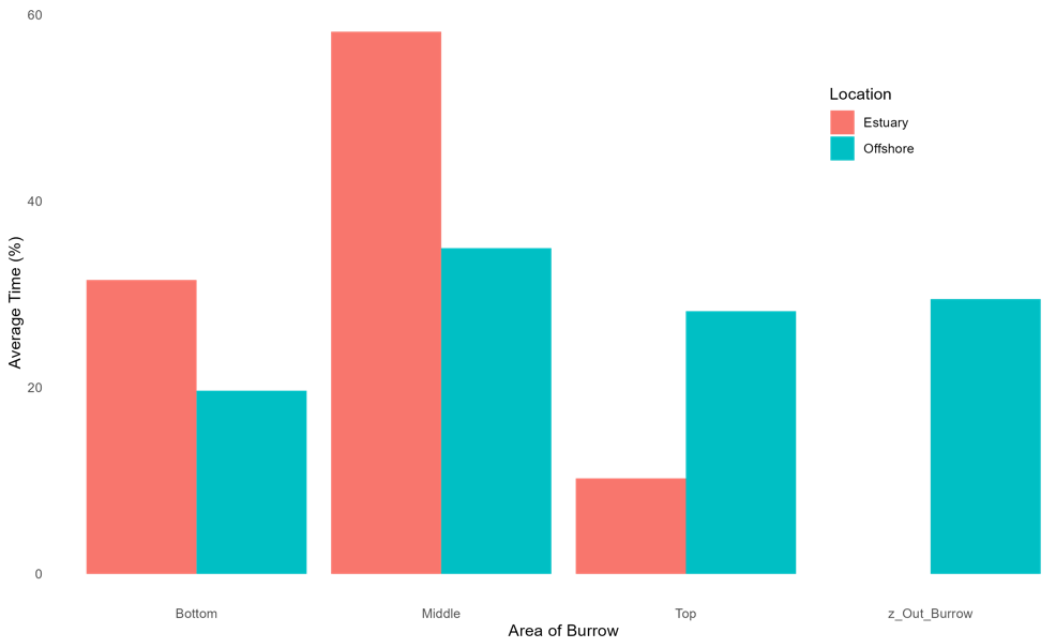
Vaughan & Henkel *in prep.*

WHAT ARE THEIR PHYSICAL IMPACTS?

"Ant farm" tanks to monitor behavior and estimate area of oxygenation.



Nearly all literature on *Neotrypaea* is of *N. californiensis* in the estuary. Do the offshore shrimp have similar burrow construction and behavior?



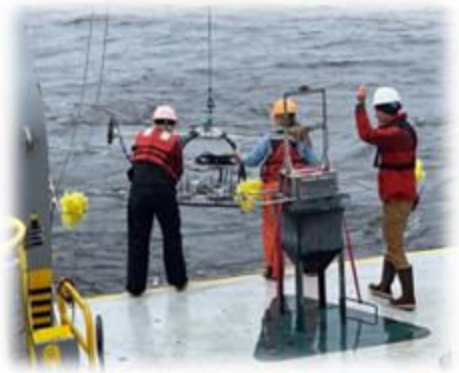
Vaughan & Henkel *in prep.*

WHAT ARE THEIR CHEMICAL IMPACTS?

EC deployment	EC oxygen flux (mmol m^{-2} d^{-1})	# Neotrypaea
NH80 (2018)	-3.7±2.9	0
PWS2	-4.9±2.3	0.92
NKW1	-23.0±11.2	3.71
NEH2	-13.2±6.9 -13.3±9.3	0.29
WLP1	-4.7±2.6	1.43

Core incubations showed highest O_2 and NO_3^- uptake rates at sites where shrimp burrows were abundant.

EC lander with fiber optic O_2 sensors



We caught a shrimp!

Slow corer to collect cores for incubation.

Reimers et al. *in rev.*

WHAT ARE THE COMMUNITY IMPACTS?

Species	Avg. Abund Neo Absent	Avg. Abund Neo Present
Kurtiella tumida	1.16	22.81
Acila castrensis	5.48	3.28
Axinopsida serricata	4.17	2.32

https://www.flickr.com/photos/ecologywa/30843212505/

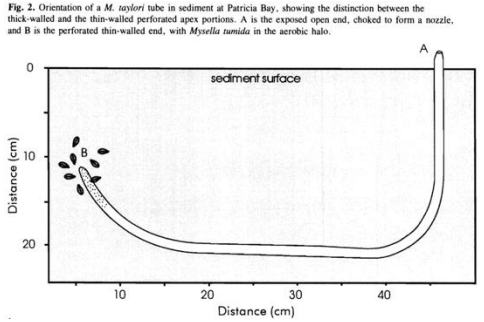
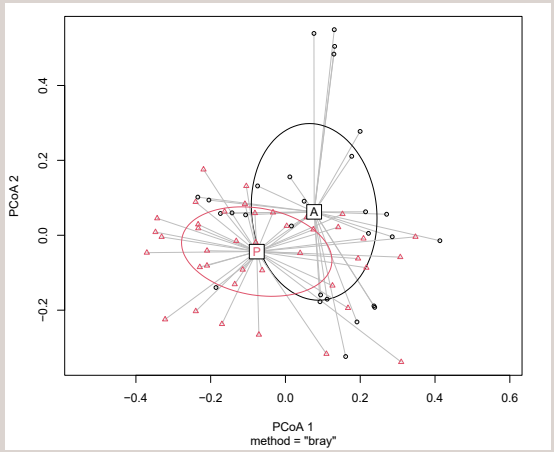


Fig. 2. Orientation of a *M. taylori* tube in sediment at Patricia Bay, showing the distinction between the thick-walled and the thin-walled perforated apex portions. A is the exposed open end, choked to form a nozzle, and B is the perforated thin-walled end, with *Mysella tumida* in the aerobic halo.

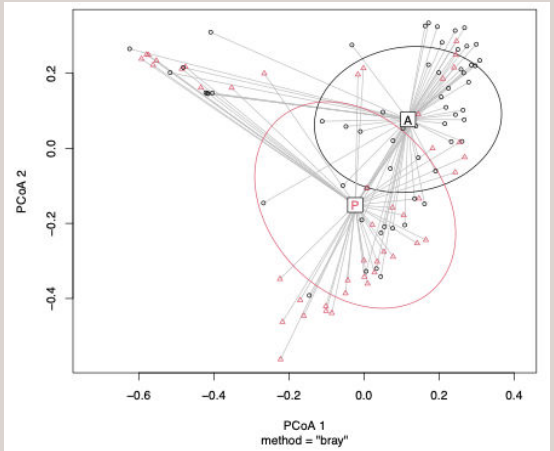
Sendall, KA, Fontain, AR, O'Foighil, D. 1995. Can. J. Zool. 73: 509-517.

K. tumida has a positive association with an "aerobic halo" generated by the tube-forming polychaete *Mesochaetopterus taylori*.

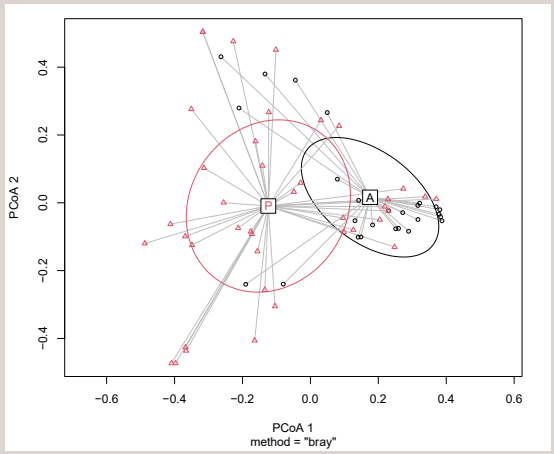
Worms



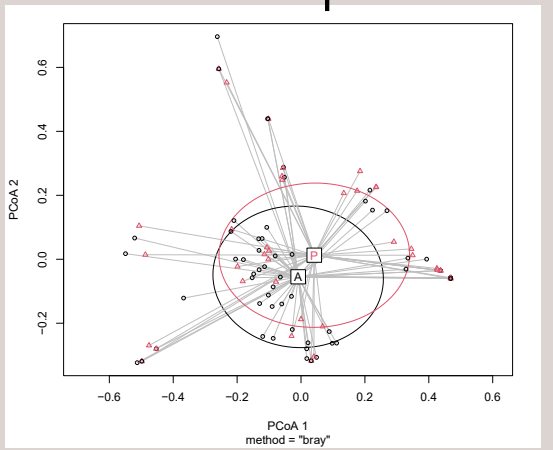
Bivalves



Crustaceans



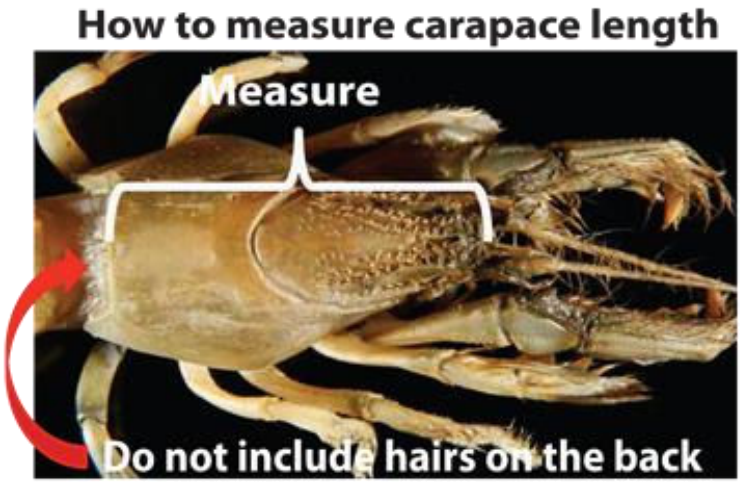
Gastropods



Bivalve, polychaete, and crustacean abundances generally increased while gastropods (snails) declined.

WHAT CAN YOU DO?????

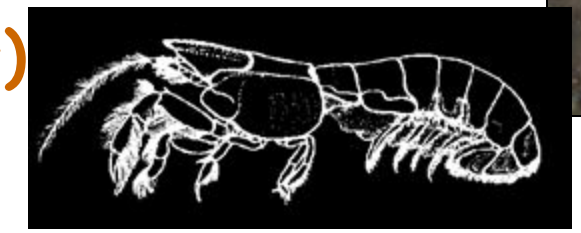
COLLECT YOUR OWN DATA

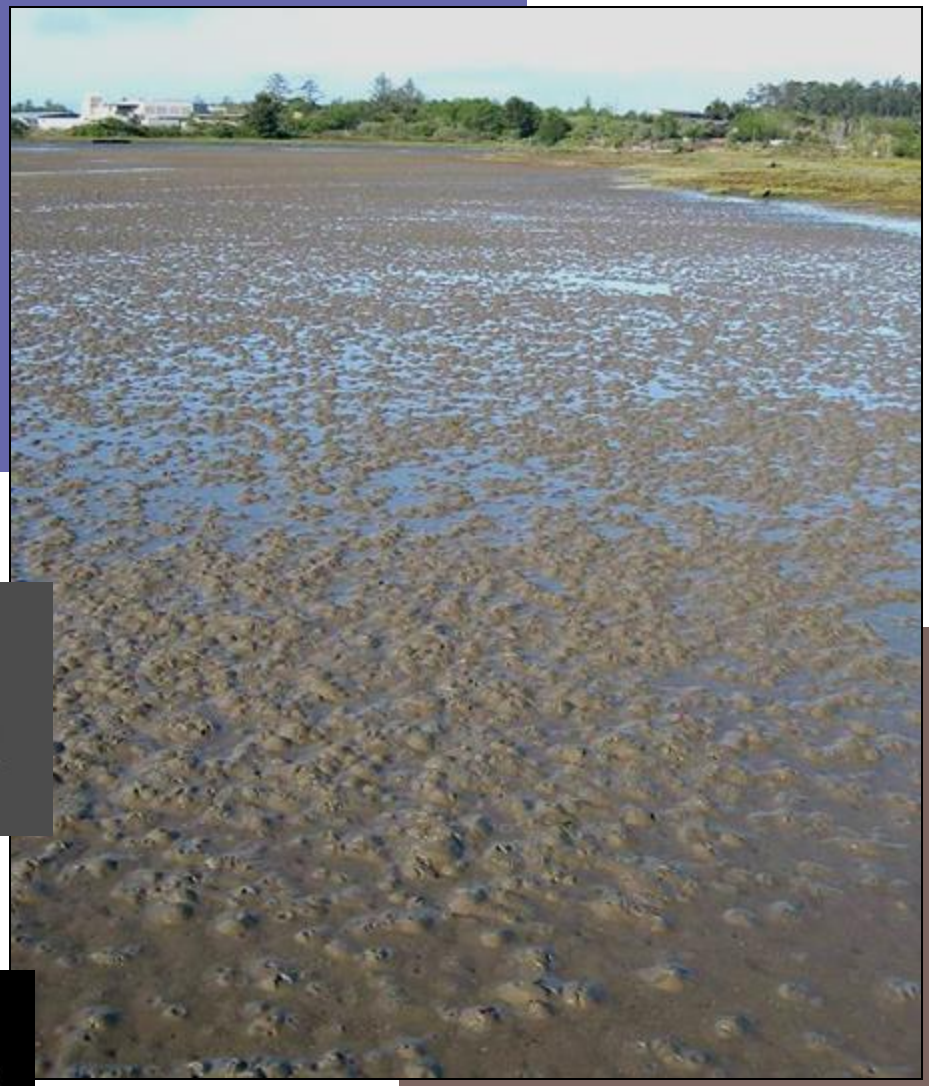


Measure in mm

Ghost Shrimp = N (*Neotrypaea*)

Mud Shrimp = U (*Upogebia*)





COLLECT YOUR OWN DATA

Sea Grant OREGON | Oregon State University

HMSC Estuary Sampling Form

_____ Time _____ Tide _____

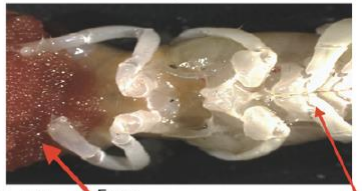
_____ Location _____

Species or Mud Shrimp)	Carapace Length (mm)	Sex (M, F, U)	Para Iso (Y

HOW TO SEX GHOST SHRIMP
(*Neotrypaea californiensis*)

FEMALES
The two claws are about the same size
Eggs may be visable two red stripes down the back (if not yet released by the female)

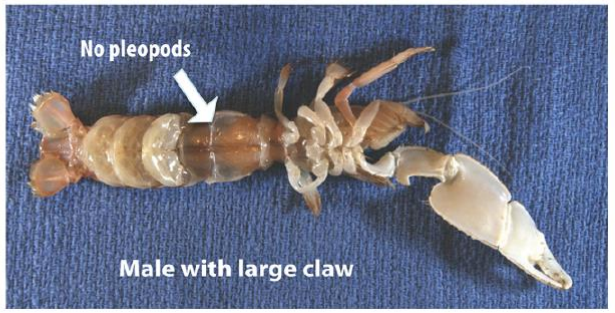
Eggs may be visable on the ventral anterior first three abdominal segments



MALES
One claw is much larger then the other
Sperm may be visable as two yellowish stripes on the dorsal side of the abdomen
Ovapores are not apparent & Pleopods, if visible will be short and stubby

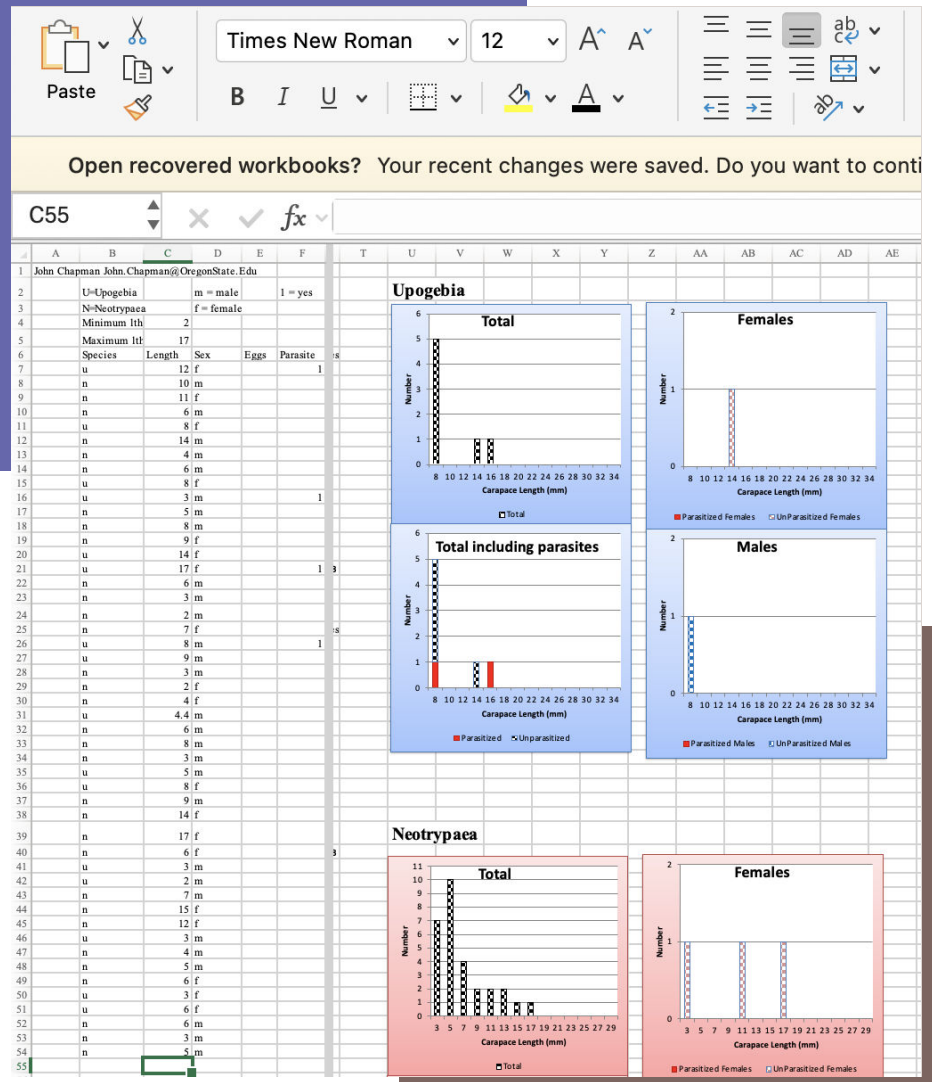
Ovapores appear as small oval or tear drop shaped openings as the base of the third leg

Pleopods (the legs on the first abdominal segment) are much longer in the female then the male



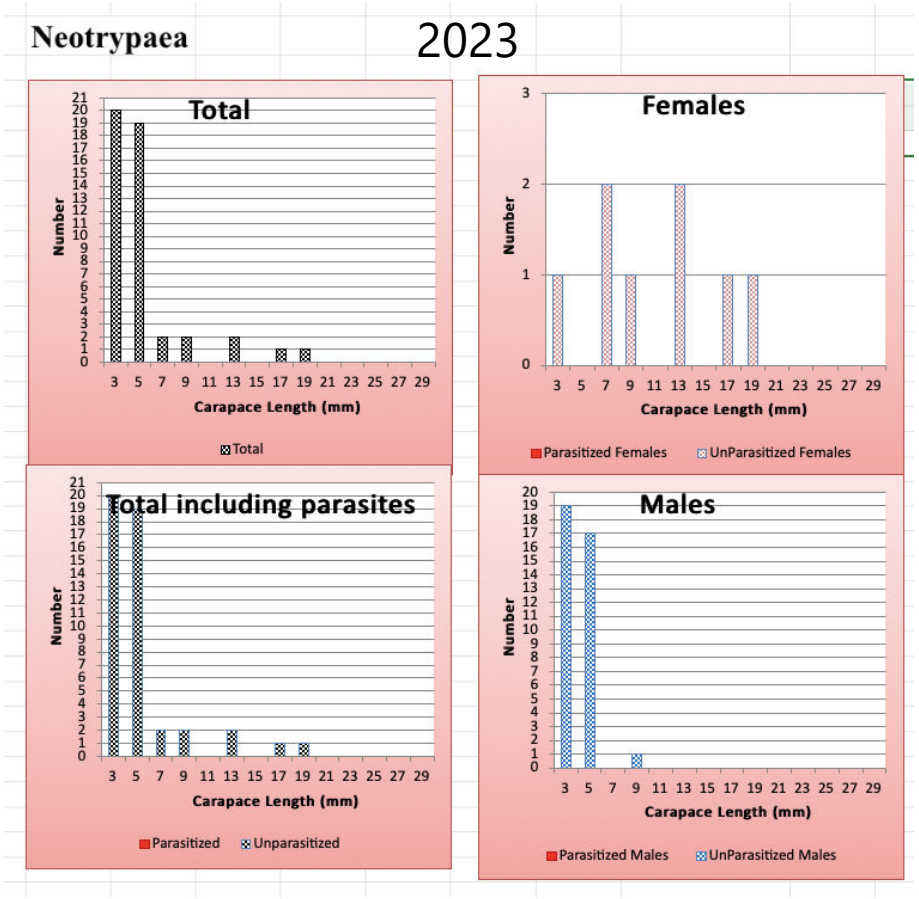
COLLECT YOUR OWN DATA

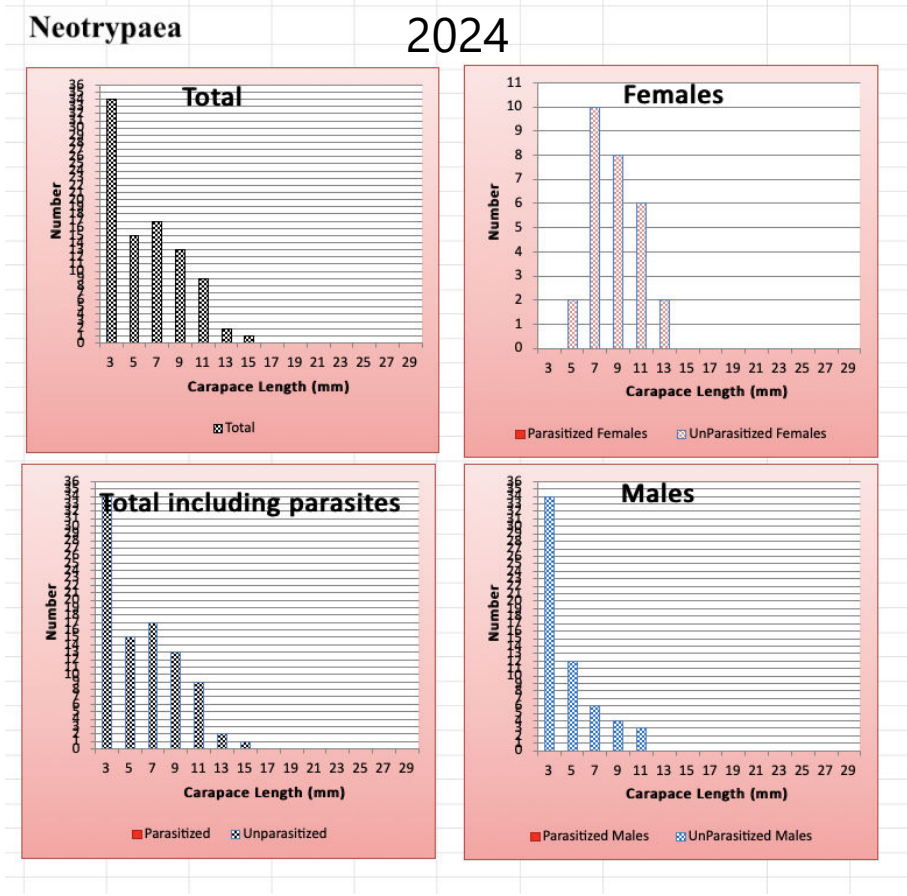
Enter field data into a provided spreadsheet to make histograms. This can help show age classes.



ANALYZE OFFSHORE SHRIMP DATA

Compare 2023 vs. 2024
Compare Males vs. Females
Compare Months
Compare to *N. californiensis* in estuary





Let’s go get some shrimp!

@thehenkellab

Oregon State University

PacWave
TESTING WAVE ENERGY FOR THE FUTURE

Sea Grant
Oregon