From Nurseries to Reefs: Spiny Lobsters as Lenses of Habitat Degradation in the Florida Keys

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Degradation





The Problem – Coral Reef Degradation



Coral reef degradation

- <2% live coral cover

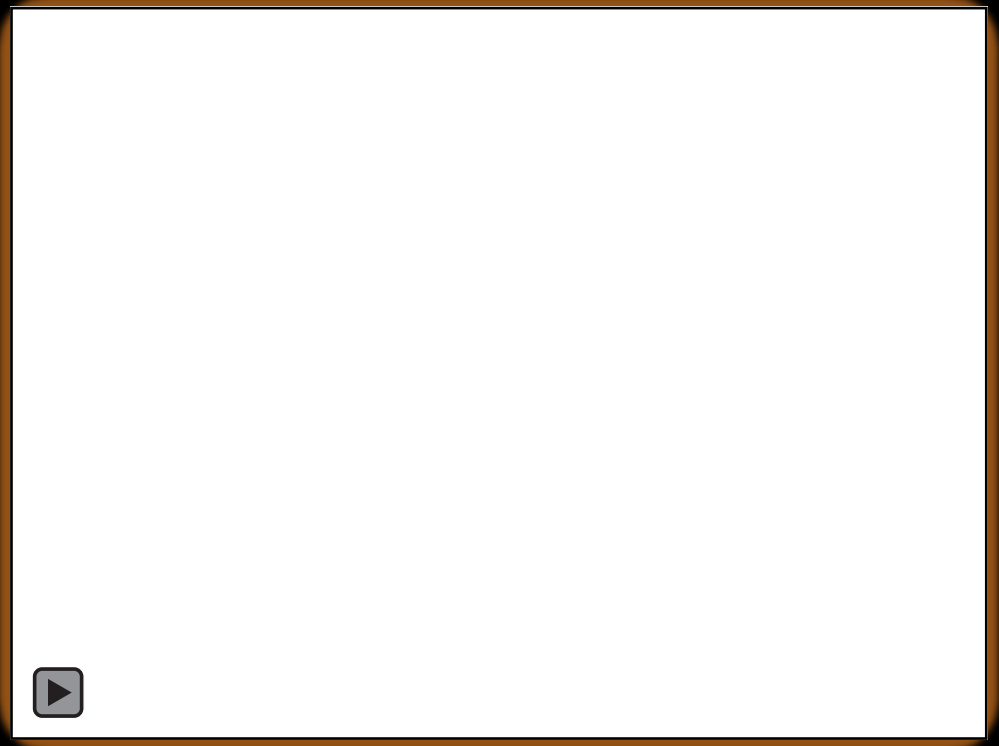
Loss of biological complexity

- at genetic, species, and functional levels

Loss of functional processes

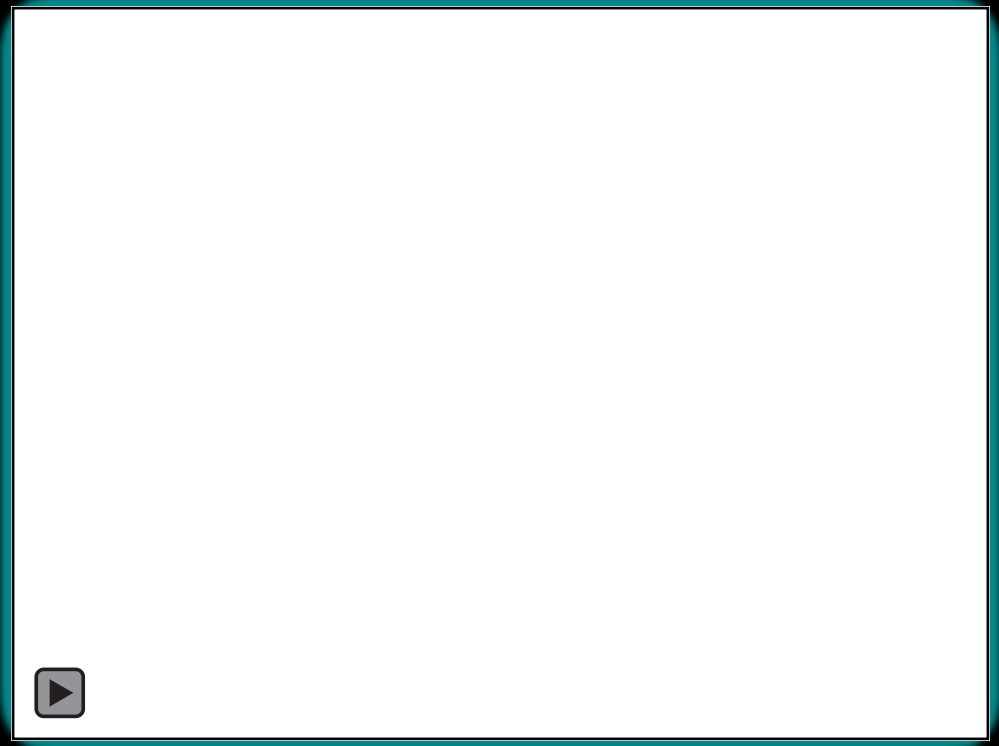
- trophodynamics

A *Tail* of Two Lobsters as Lenses



Caribbean spiny lobster,
Panulirus argus

- Lives on reefs during part of its life
- Generalist feeder



Spotted spiny lobster,
Panulirus guttatus

- Reef obligate
- Generalist feeder, but usually has higher trophic position

Lobster and Habitat Surveys

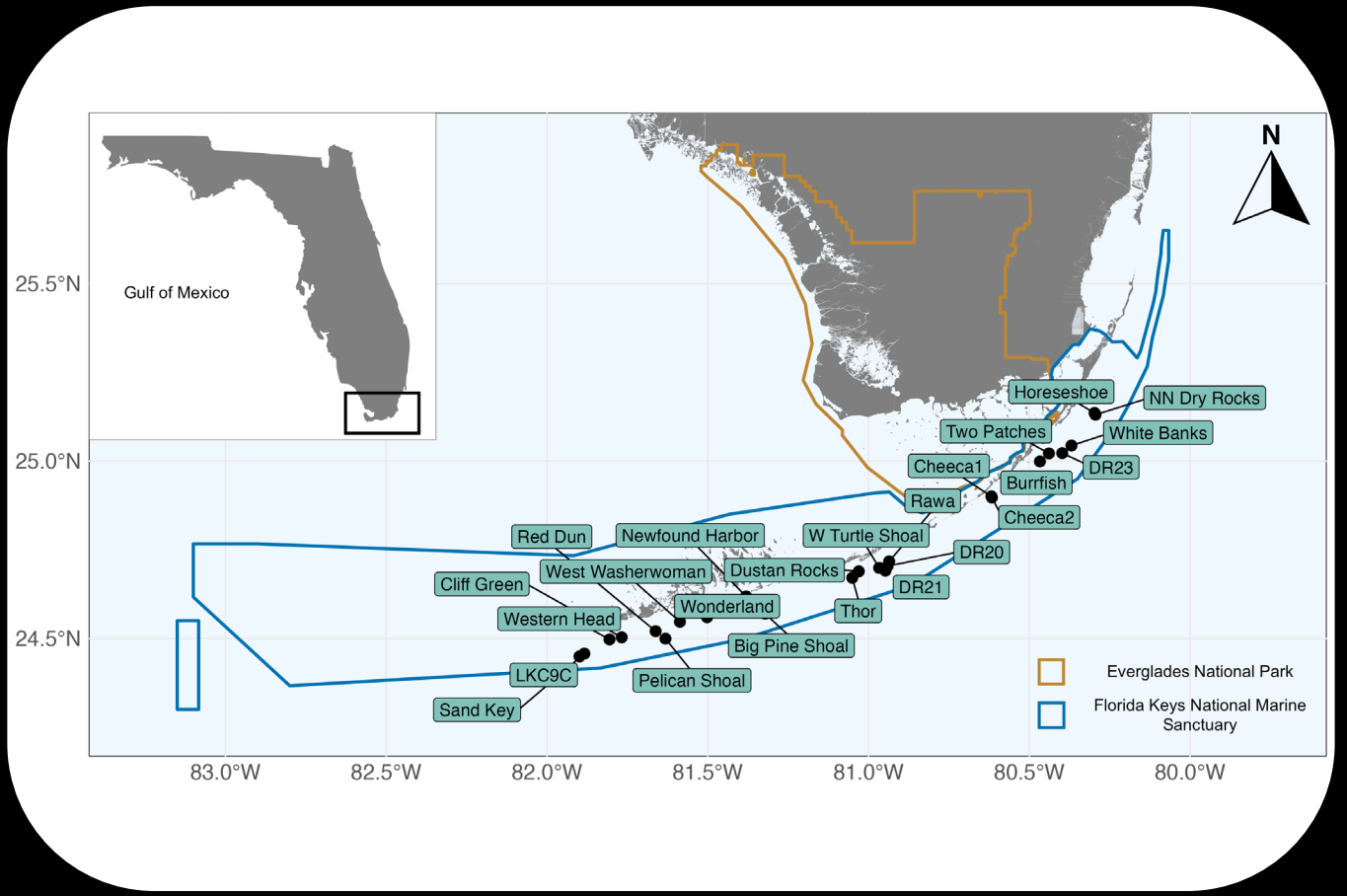


Lobsters

- Counts/Population dynamics
- nutritional condition
- Gut contents
- stable isotopes (CSIA ^{13}C, ^{15}N)

Benthos

- Photoquadrats/Coral Point Count
- Percent cover of benthos, Rugosity
- PCA
- K-means clustering into 3 site condition groupings
- Will also try using a continuous framework for habitat condition



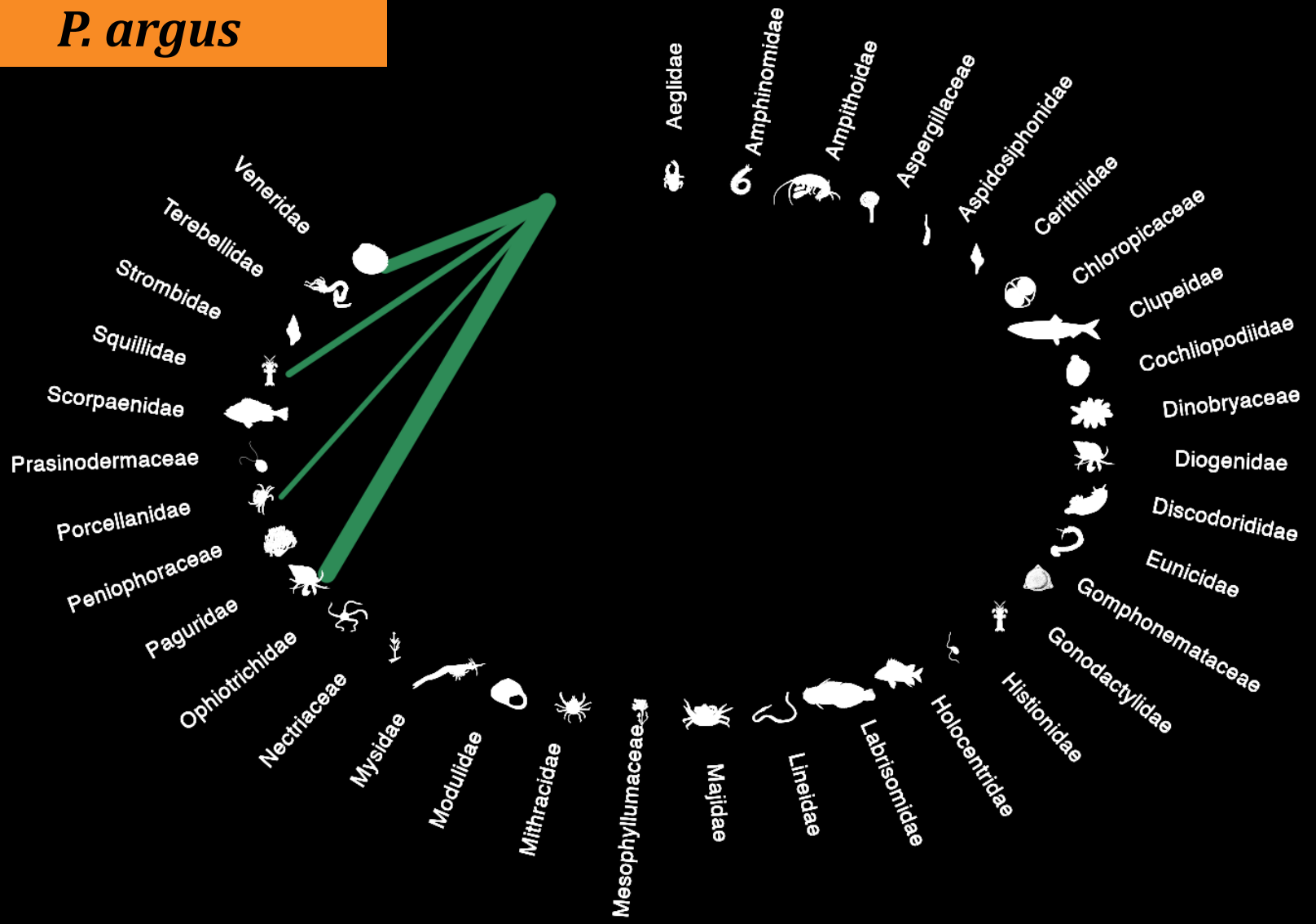
P. argus



- 123 *P. argus*,
  124 *P. guttatus* guts
- combined by site and species
  → 27 *P. argus*, 20 *P. guttatus*

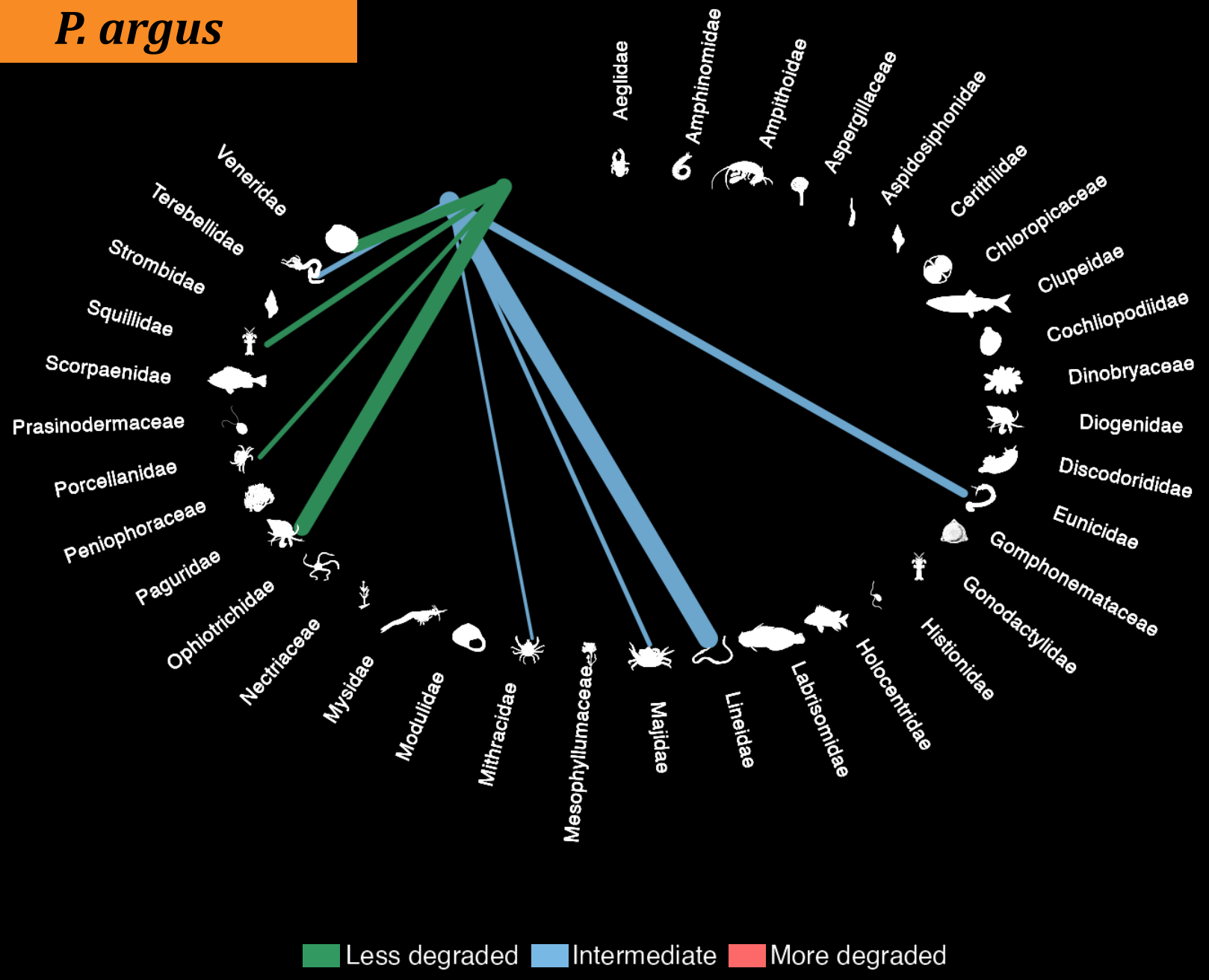
Less degraded | Intermediate | More degraded

P. argus

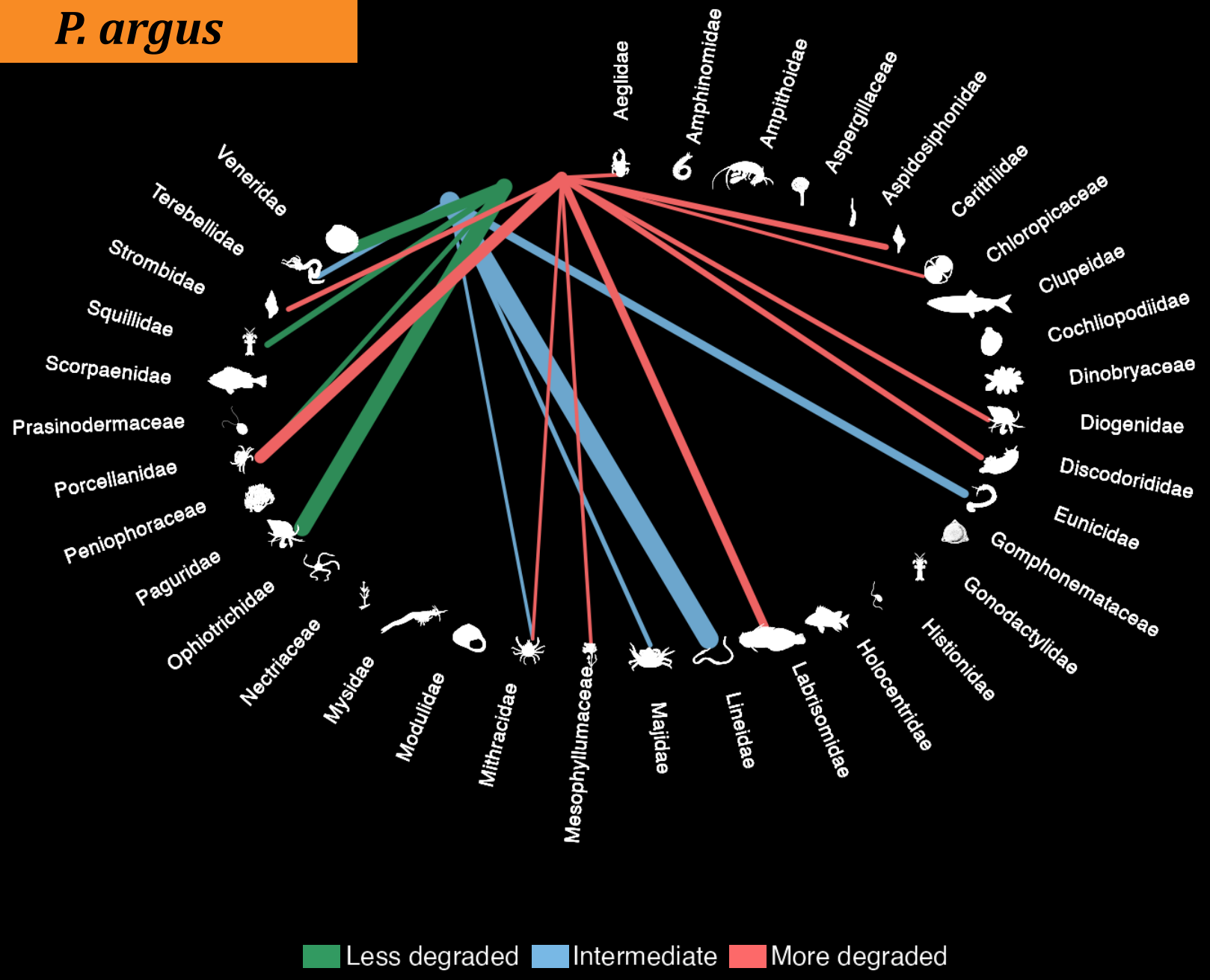


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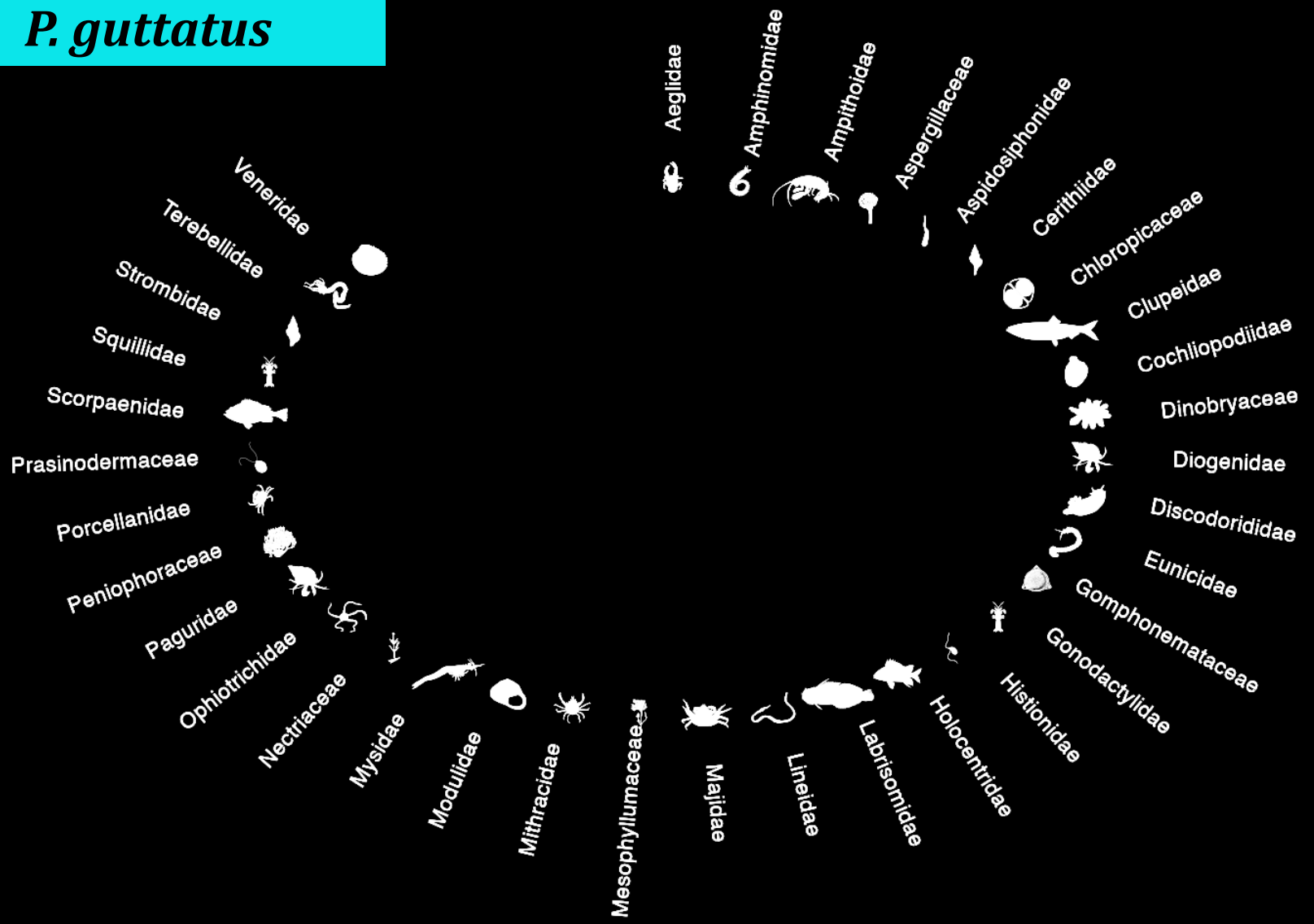
P. argus


Veneridae
Terebellidae
Strombidae
Squillidae
Scorpaenidae
Prasinodermaceae
Porcellanidae
Peniophoraceae
Paguridae
Ophiotrichidae
Nectriaceae
Mysidae
Modulidae
Mithracidae
Mesophyllumaceae
Majidae
Lineidae
Labrisomidae
Holocentridae
Histionidae
Gonodactylidae
Gomphonemataceae
Eunicidae
Discodorididae
Diogenidae
Dinobryaceae
Cochliopodiidae
Clupeidae
Chloropicaceae
Cerithiidae
Aspidosiphonidae
Aspergillaceae
Ampithoidae
Amphinomidae
Aeglidae
Less degraded
Intermediate
More degraded

P. argus

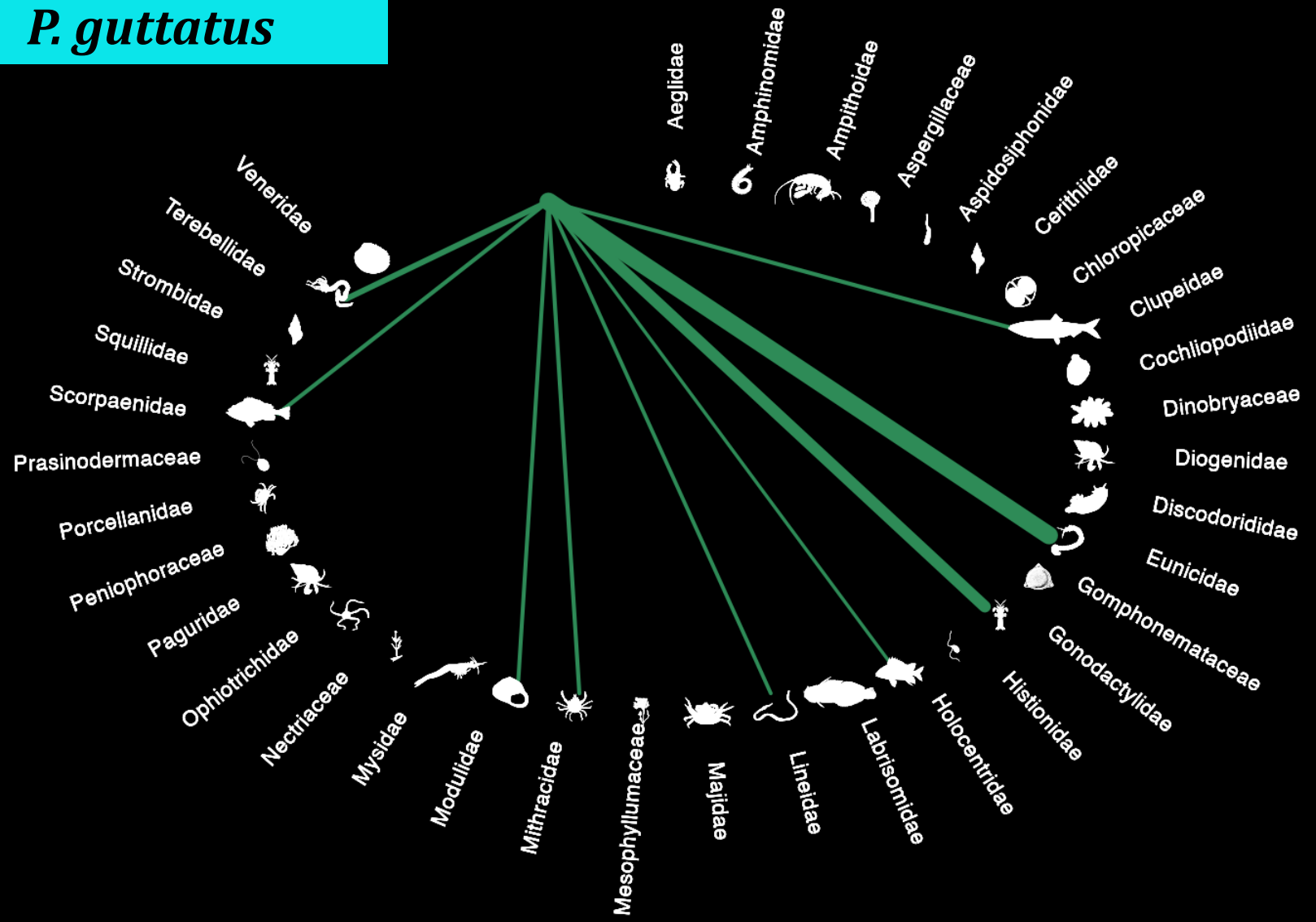

Aeglidae
Amphinomidae
Ampithoidae
Aspergillaceae
Aspidosiphonidae
Cerithiidae
Chloropicaceae
Clupeidae
Cochliopodiidae
Dinobryaceae
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Less degraded
Intermediate
More degraded

P. guttatus

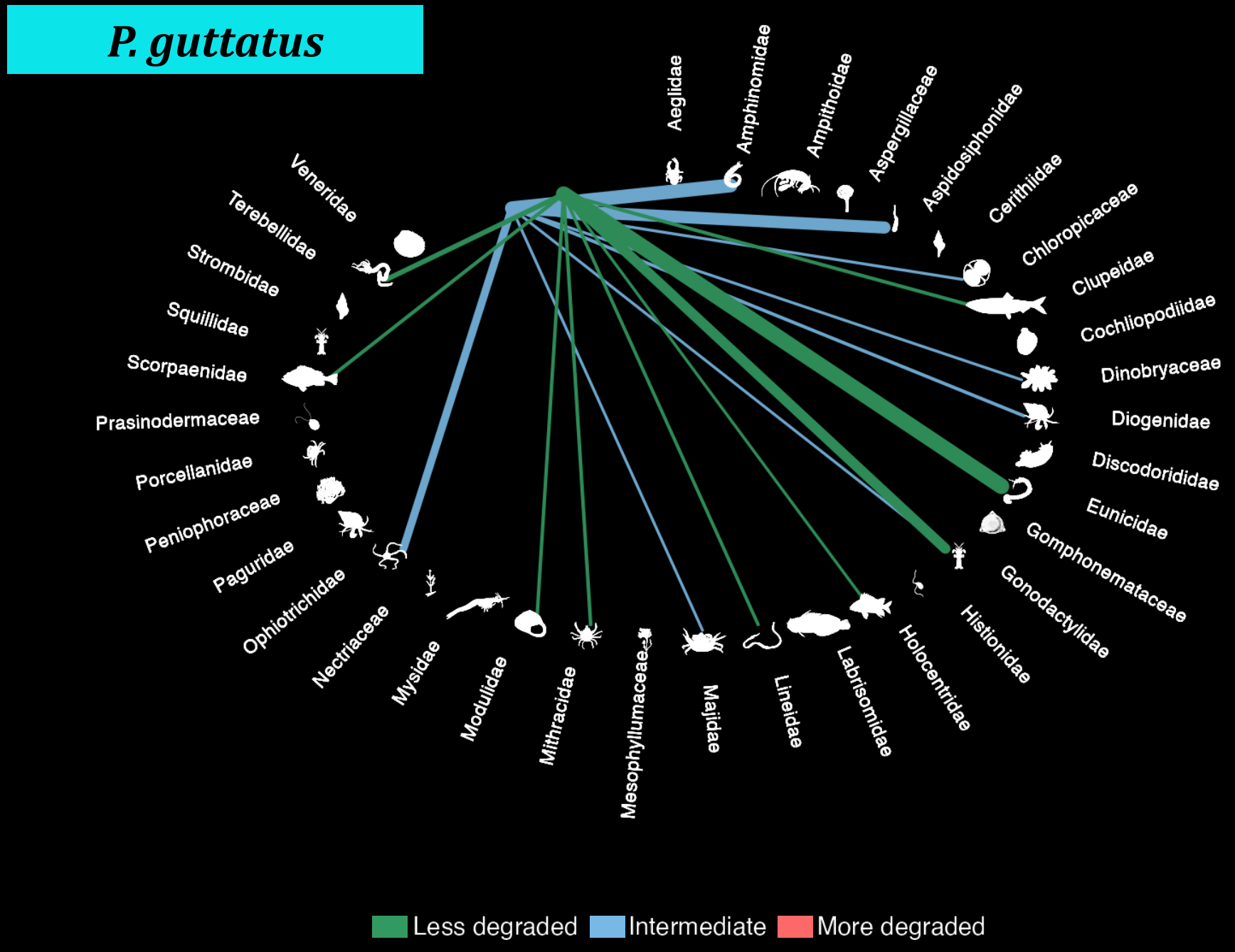


Less degraded Intermediate More degraded

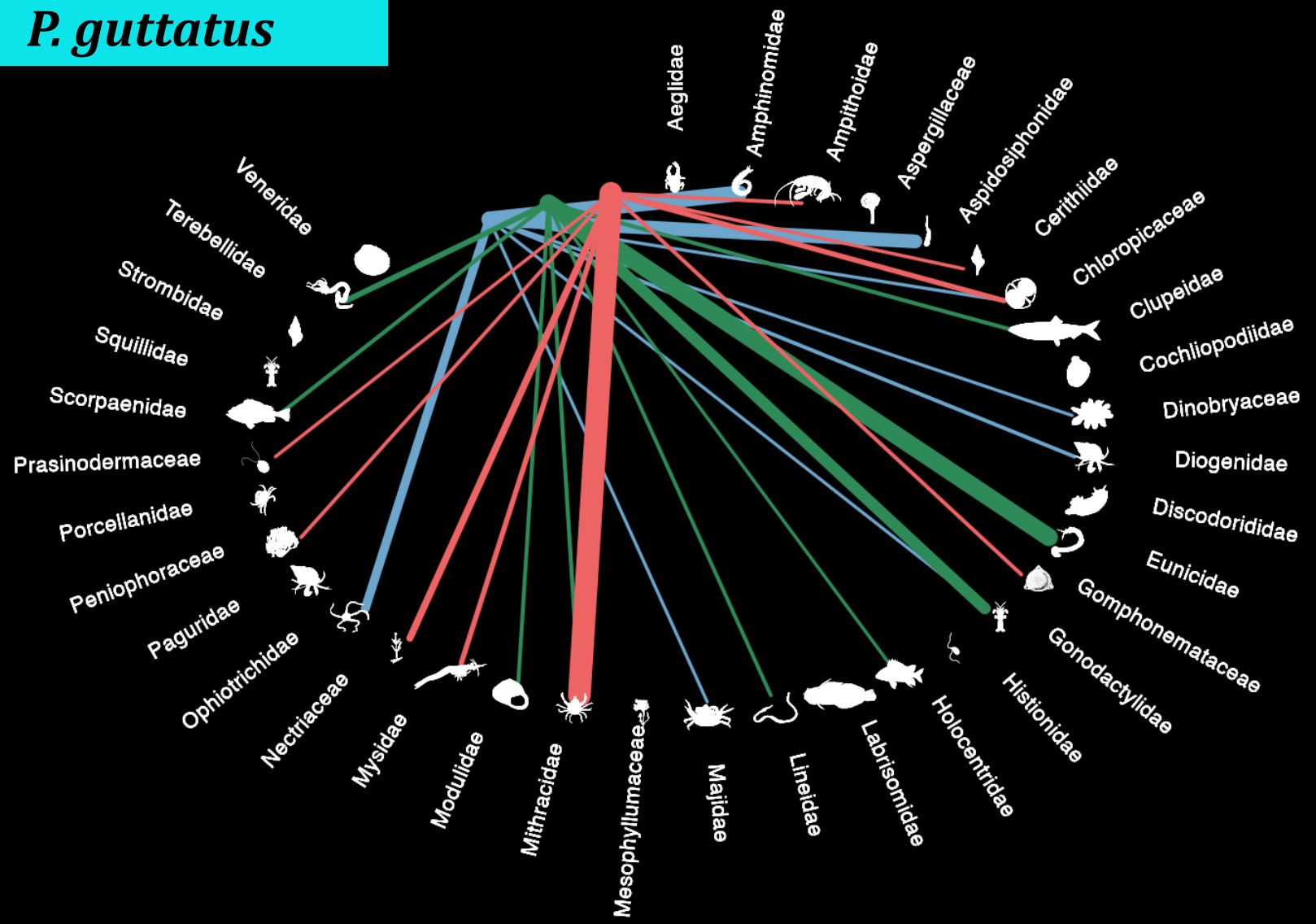
P. guttatus



Less degraded | Intermediate | More degraded

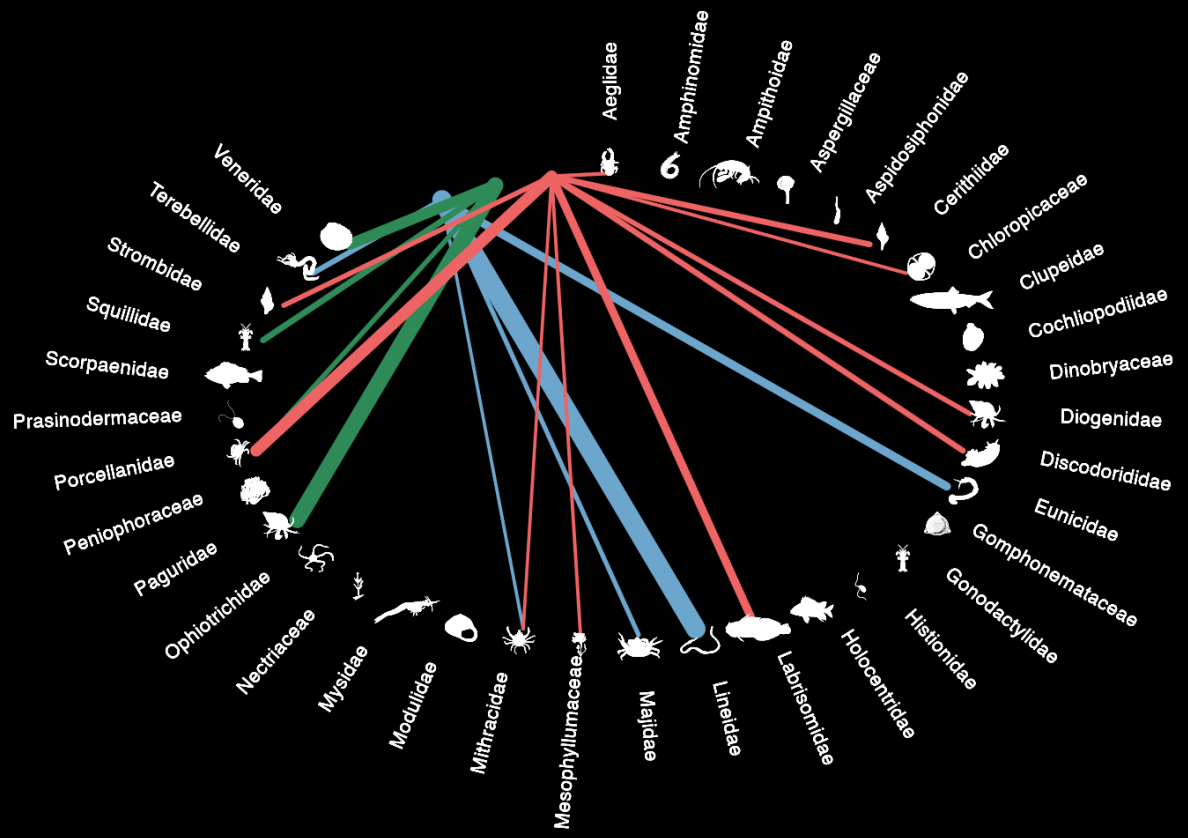

P. guttatus
Aeglidae
Amphinomidae
Ampithoidae
Aspergillaceae
Aspidosiphonidae
Cerithiidae
Chloropicaceae
Clupeidae
Cochliopodiidae
Dinobryaceae
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Squillidae
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Less degraded
Intermediate
More degraded

P. guttatus

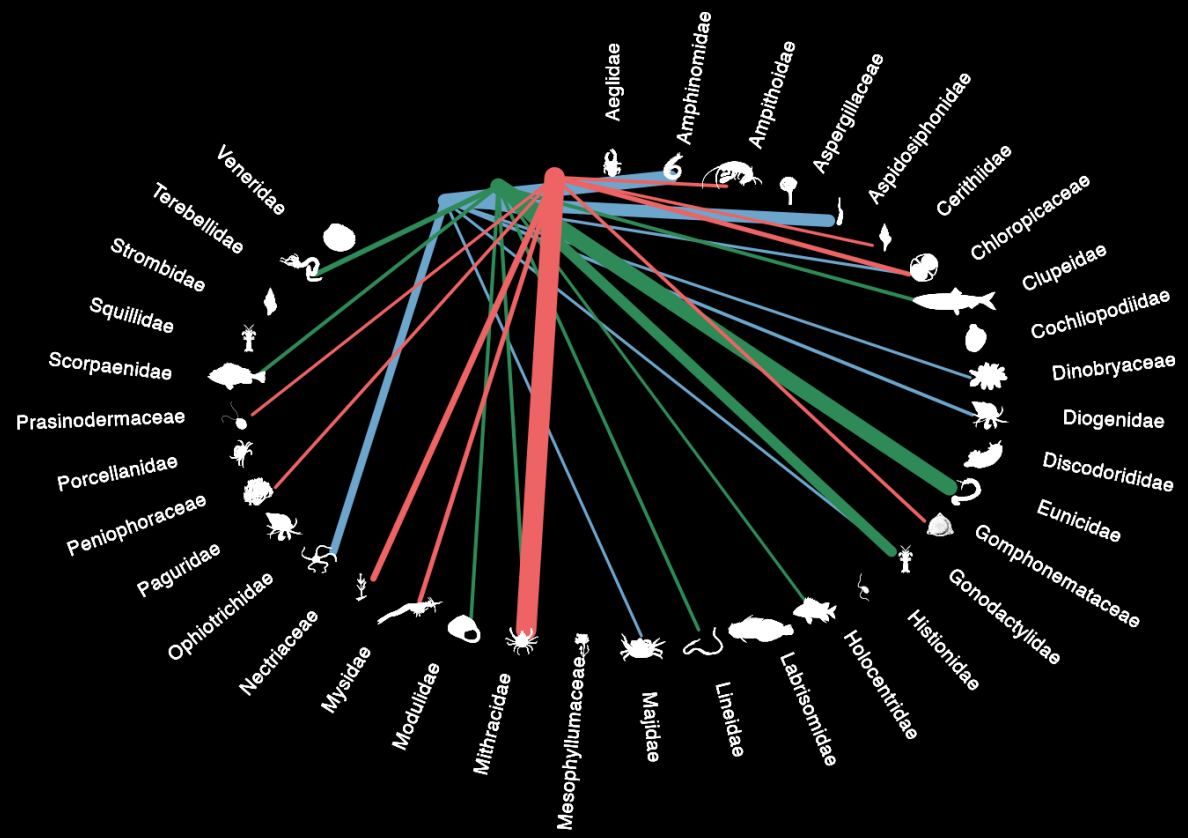


Less degraded — Intermediate — More degraded

P. argus



P. guttatus



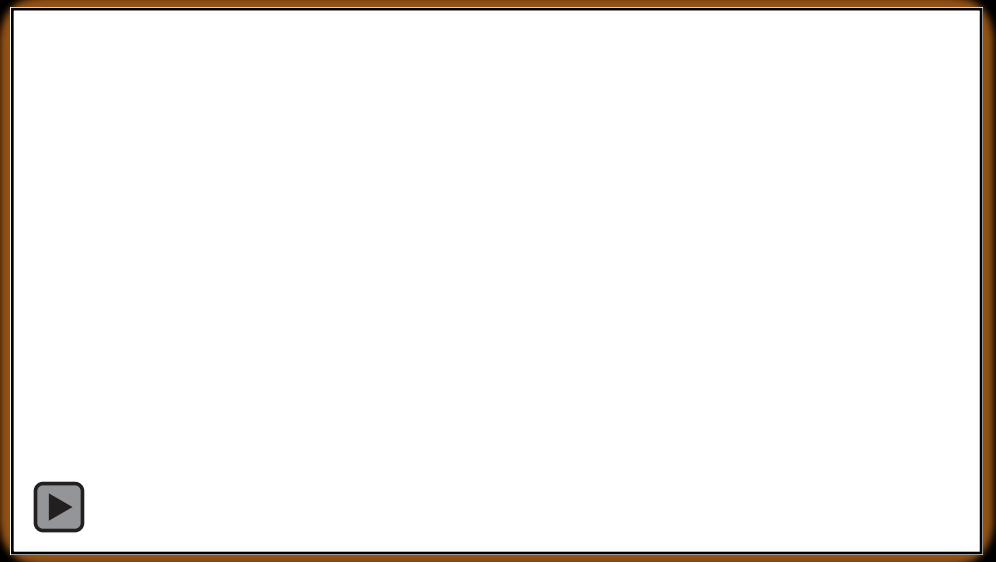
Less degraded | Intermediate | More degraded

- Niche differences degrade with habitat degradation

Lobster Lenses of Coral Reef Degradation

- We can start to understand shifts in coral reef food webs and diversity
  - Shift in tropho-dynamics for BOTH lobster species reflecting changes in coral reef food web with reef degradation
- Next, we will use lobsters in a similar way at their hardbottom nursery habitats





Nearshore Hardbottom



- Complex structures – sponges, solution holes
- Nursery habitat
- Essential fish habitat

Hardbottom Habitat in Decline

- Algal blooms
- Hurricanes
- Marine heat waves
- Sponge and gorgonian die-off



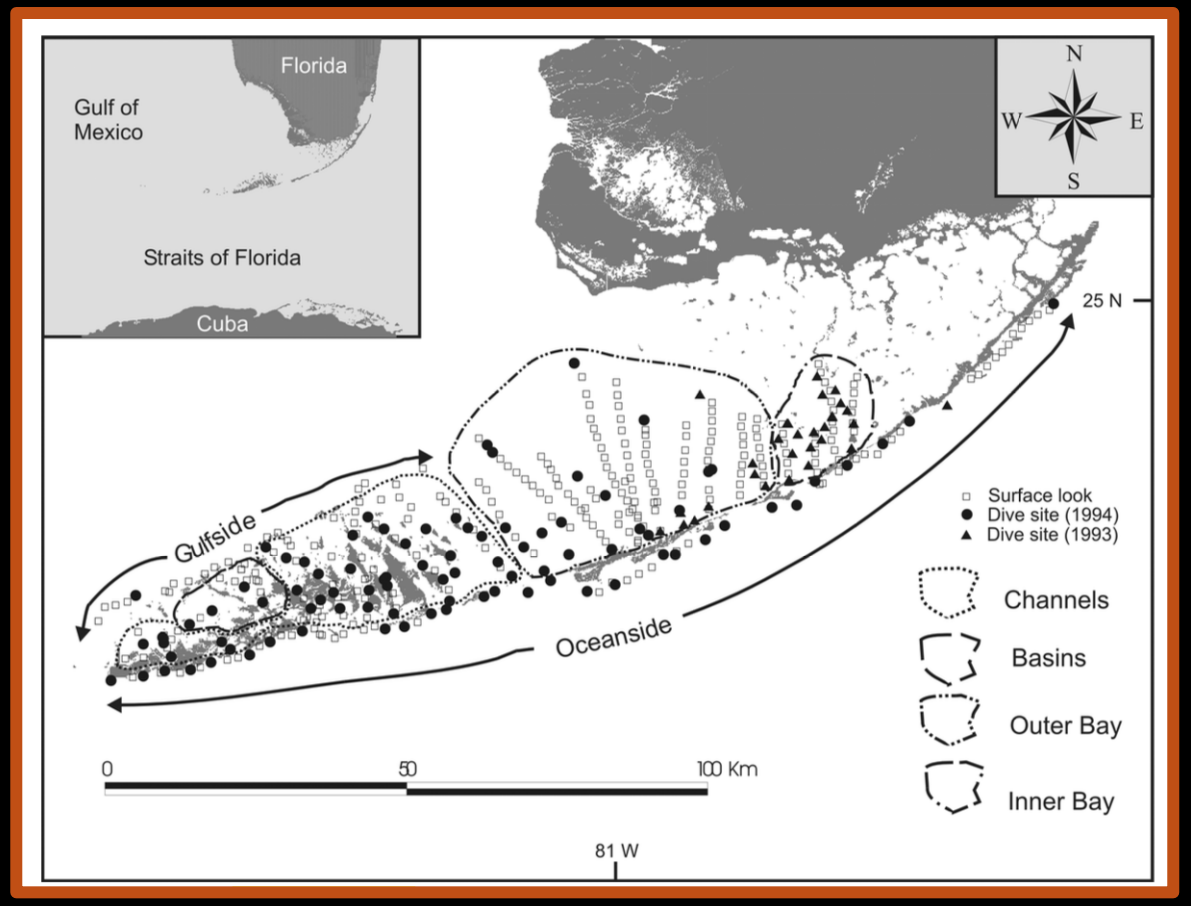
Re-Evaluation of Hardbottom Surveys

New Zealand Journal of Marine and Freshwater Research, 2009, Vol. 43: 299–312
0028–8330/09/4301–0299 © The Royal Society of New Zealand 2009

Regional characterisation of hard-bottom nursery habitat for juvenile Caribbean spiny lobster (*Panulirus argus*) using rapid assessment techniques

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MARK J. BUTLER IV[2]
WILLIAM F. HERRNKIND[3]
JOHN H. HUNT[1]

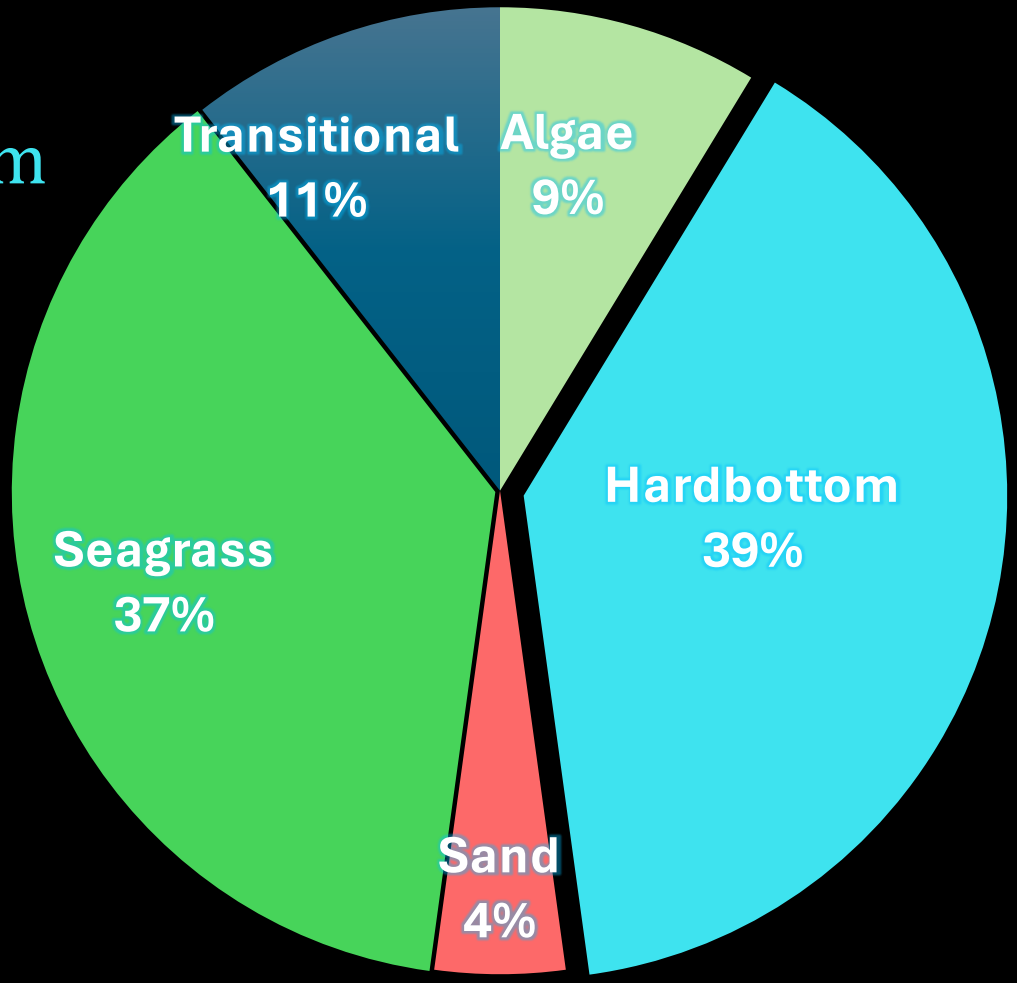
between habitat and size-specific juvenile lobster abundance and quantitatively verified the existence of six generally accepted biogeographic subregions. Although the types of hard-bottom shelters used by juvenile lobsters varied somewhat among these



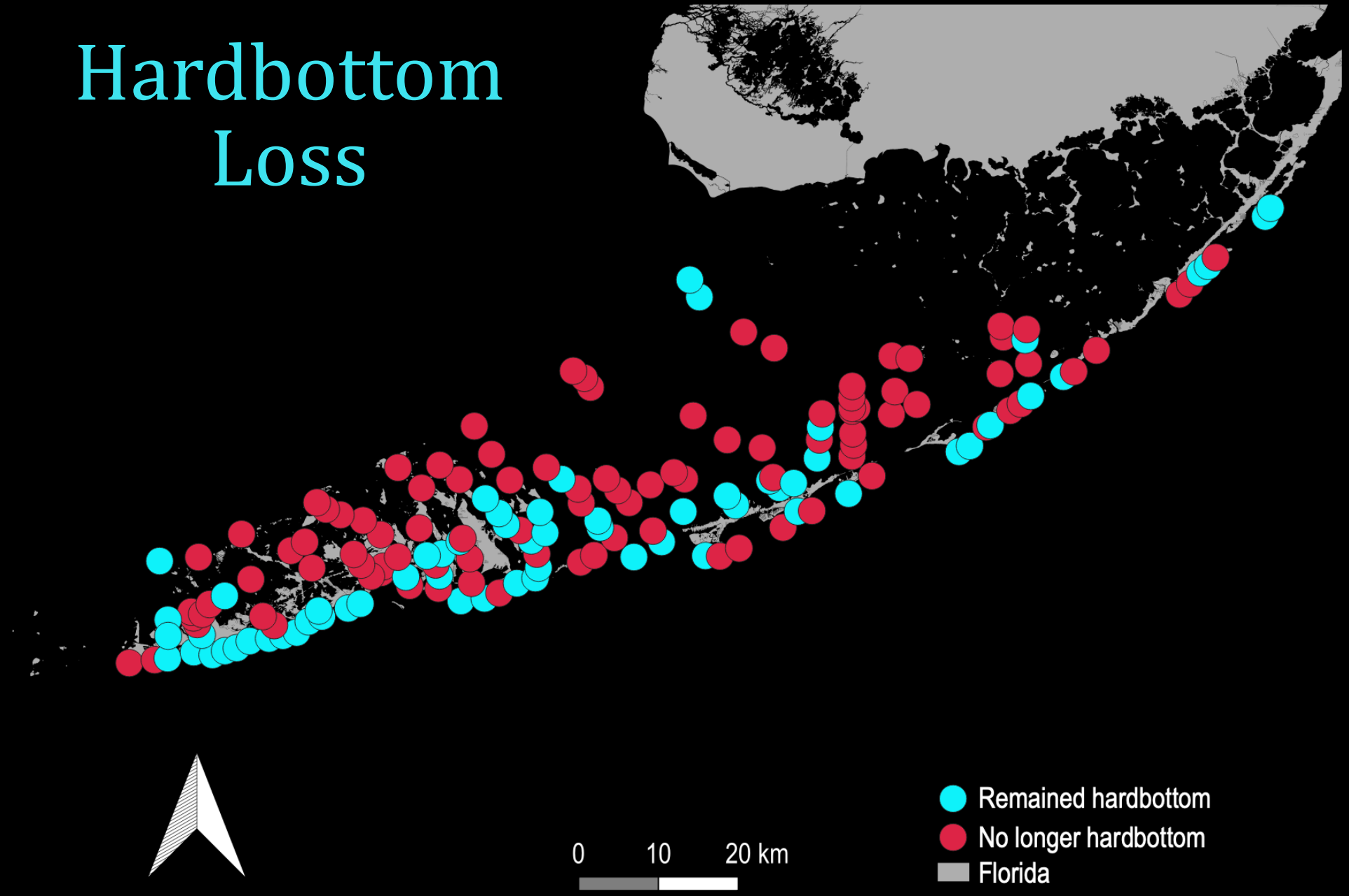
Change in Benthos

Sites that were Hardbottom in 1994 are now

- Of the 160 hardbottom sites in 1994
  - **61% no longer hardbottom**



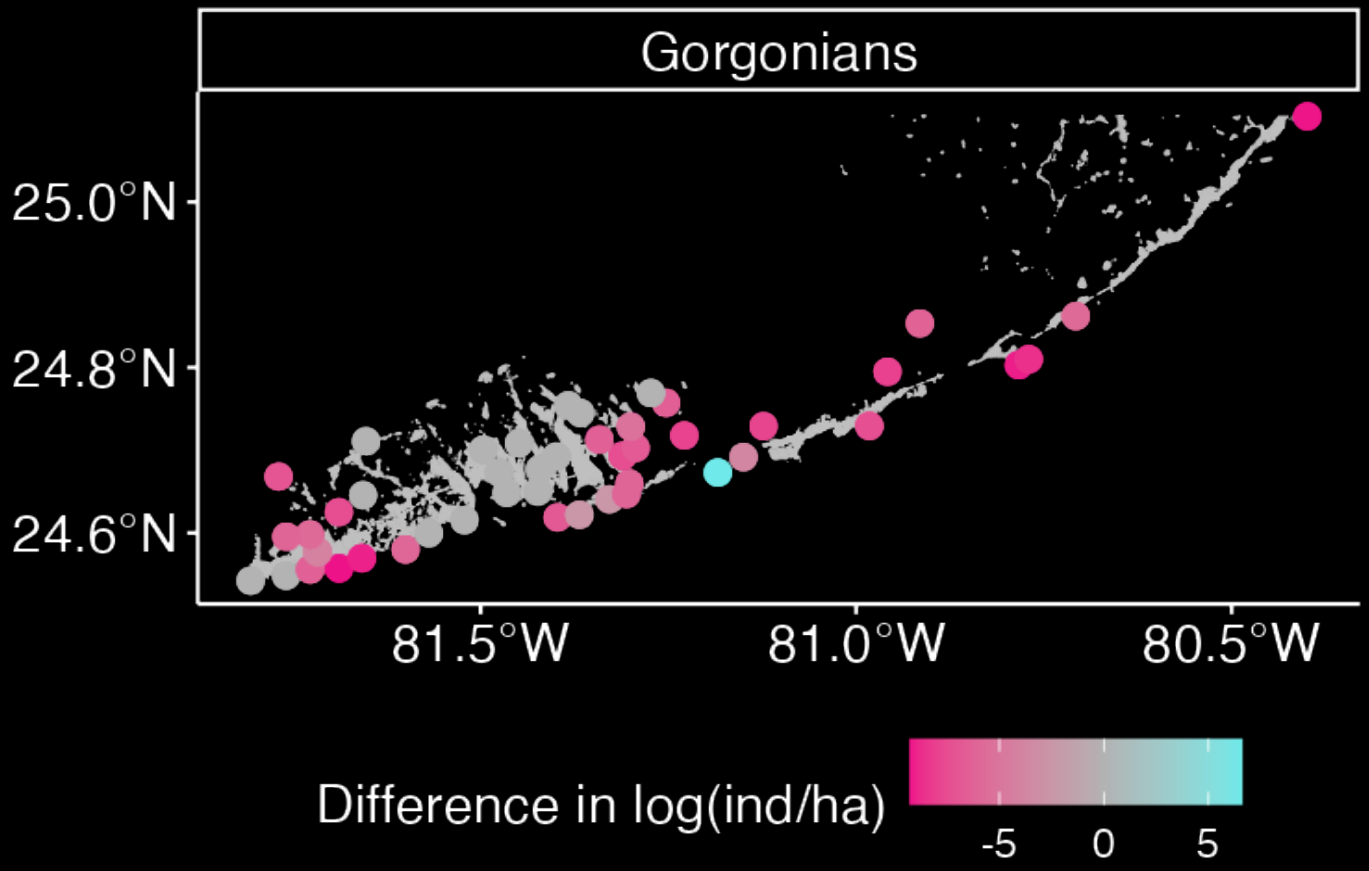
Hardbottom Loss



New Hardbottom Sites

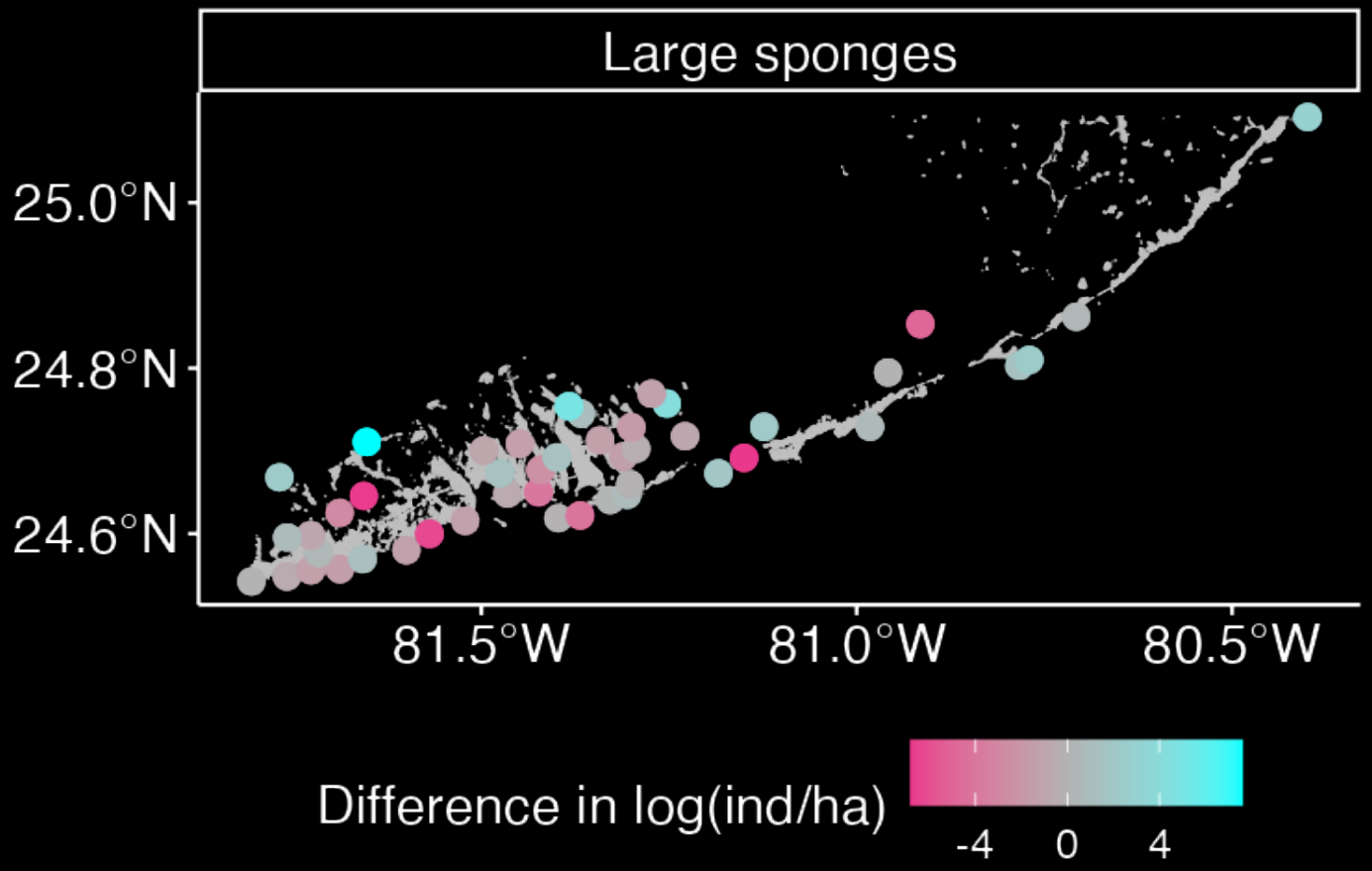


Loss of Hardbottom Structures





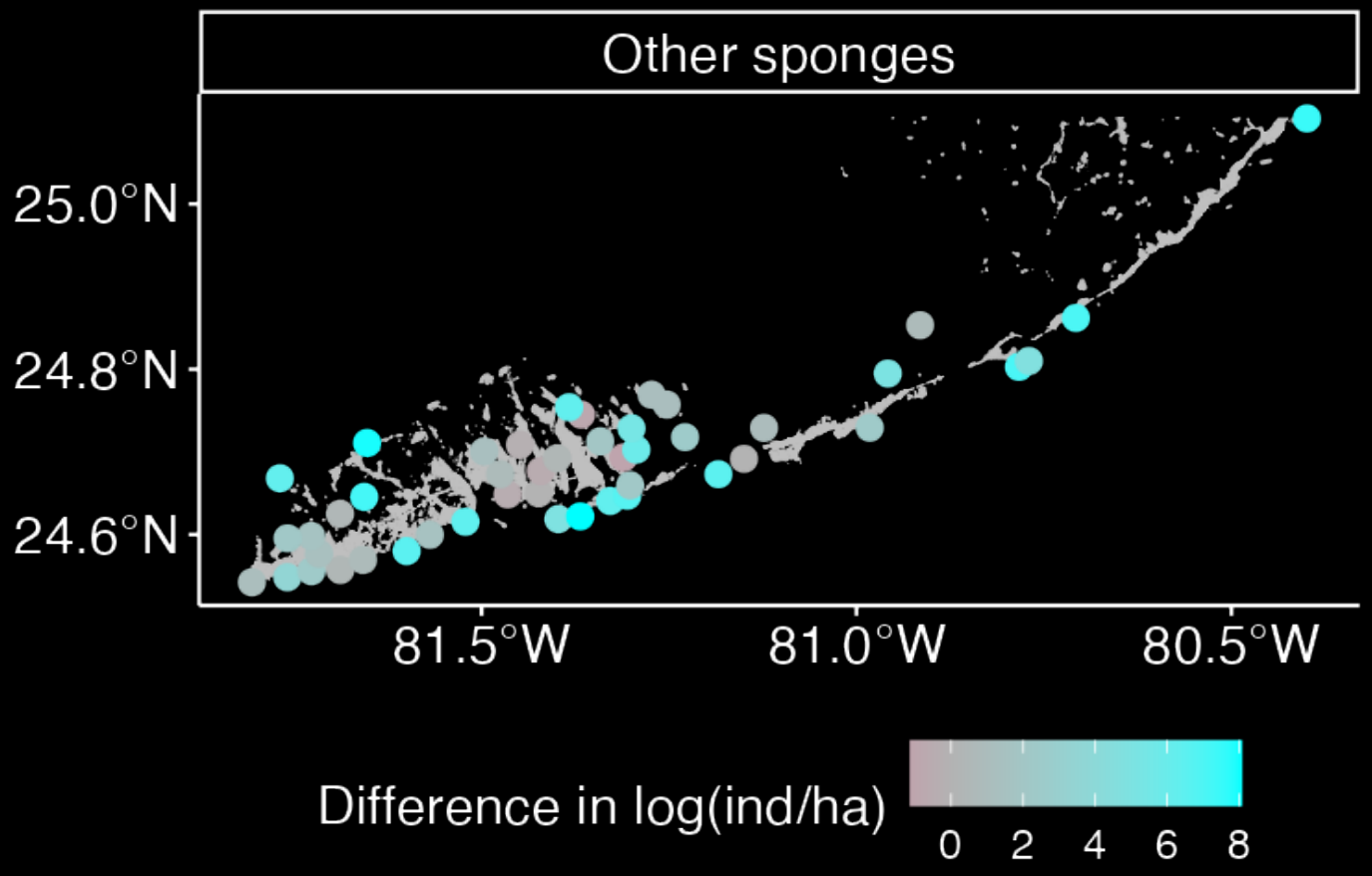
Loss of Hardbottom Structures







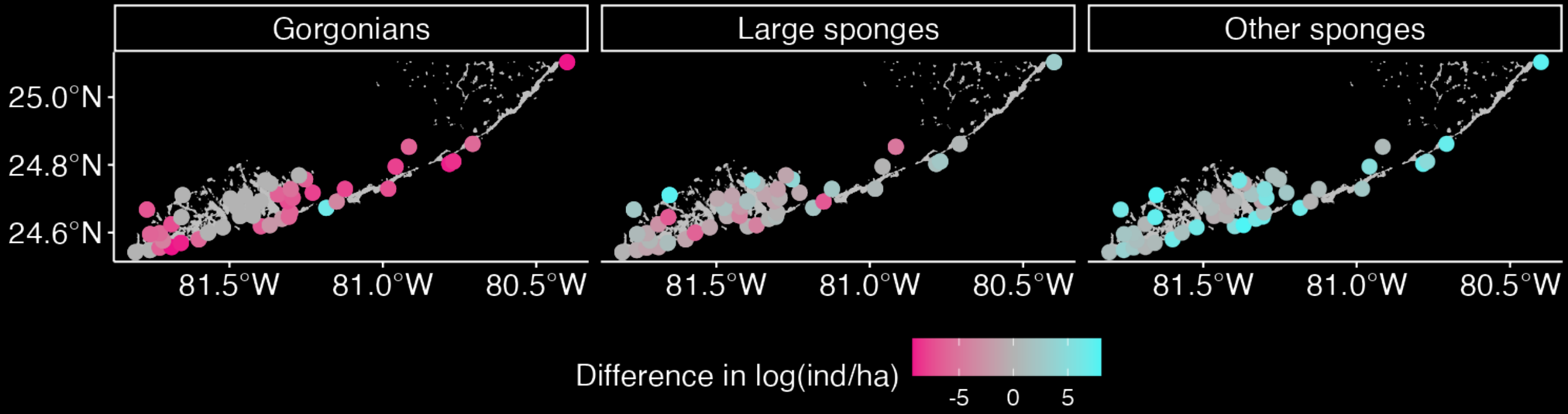
Loss of Hardbottom Structures







Loss of Hardbottom Structures







Next Steps for Hardbottom

- Use *P. argus* as a lens of change of hardbottom food webs
- Evaluate how habitat quality affects lobster survival, growth, diet, nutritional condition
- Evaluate loss of ecosystem functioning
- Work toward mitigating loss with restoration



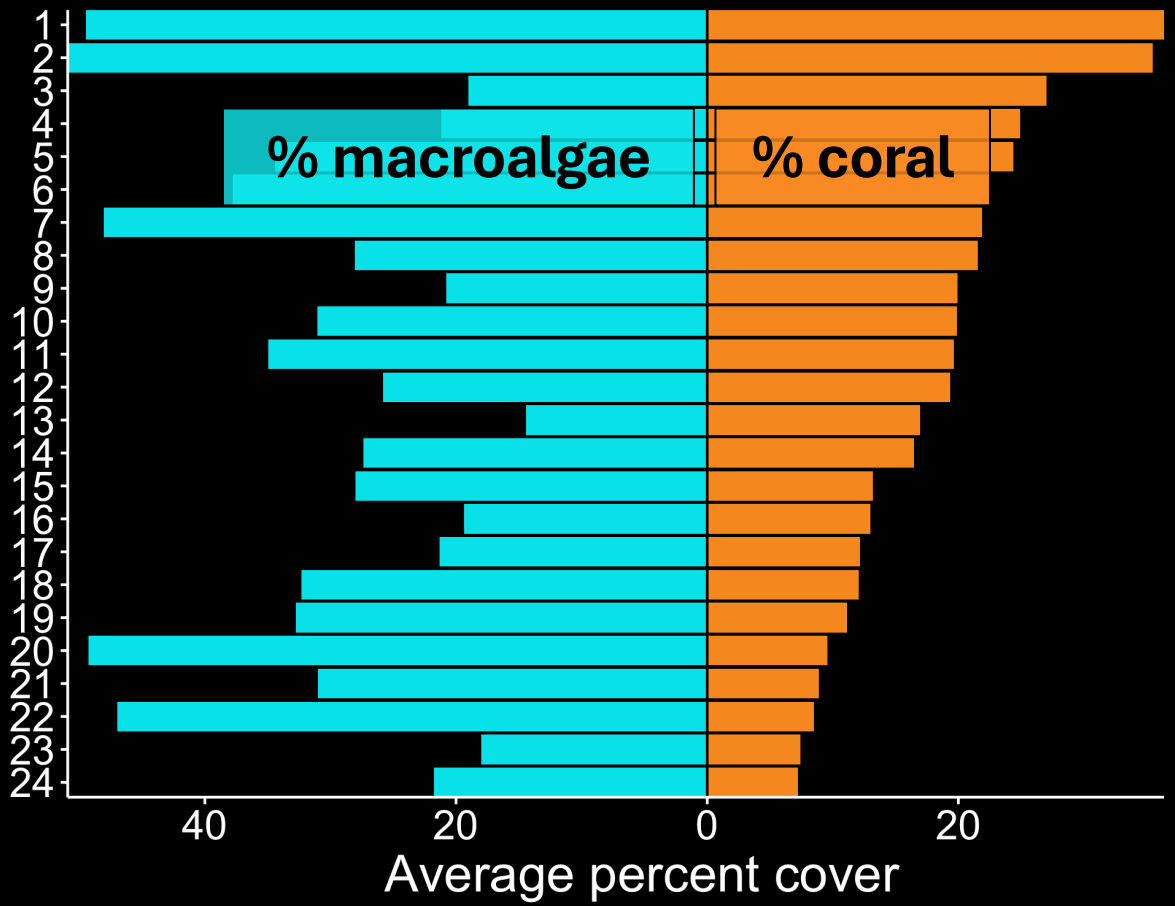
Acknowledgements

- Fish and Wildlife Foundation of Florida CWT 22-10
- Permitted under FKNMS–2021-131
- Shedd Aquarium Coral Reef II
- FWRI and FIU divers

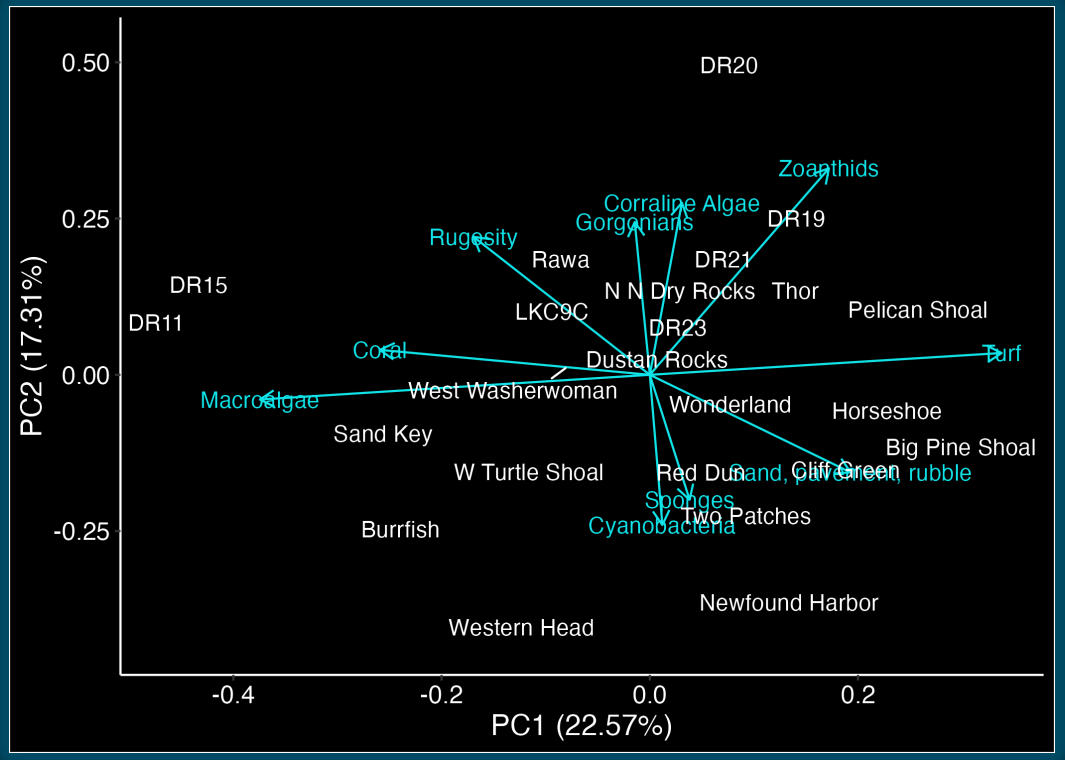


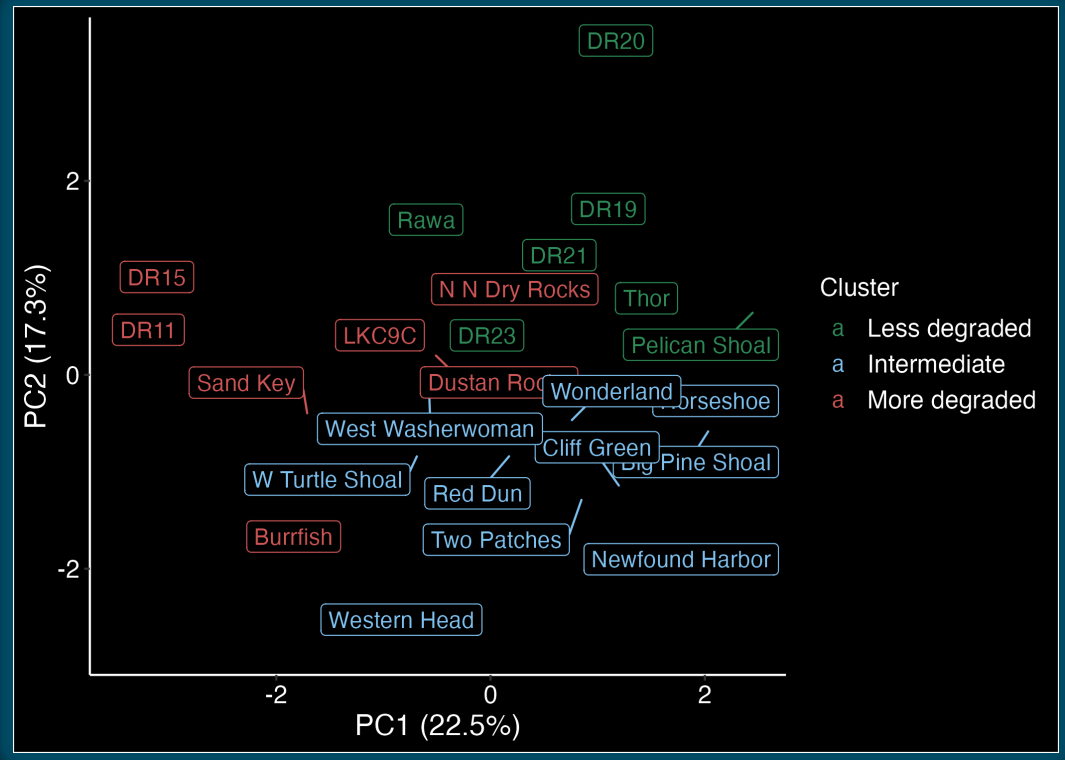
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Results – Habitat Condition



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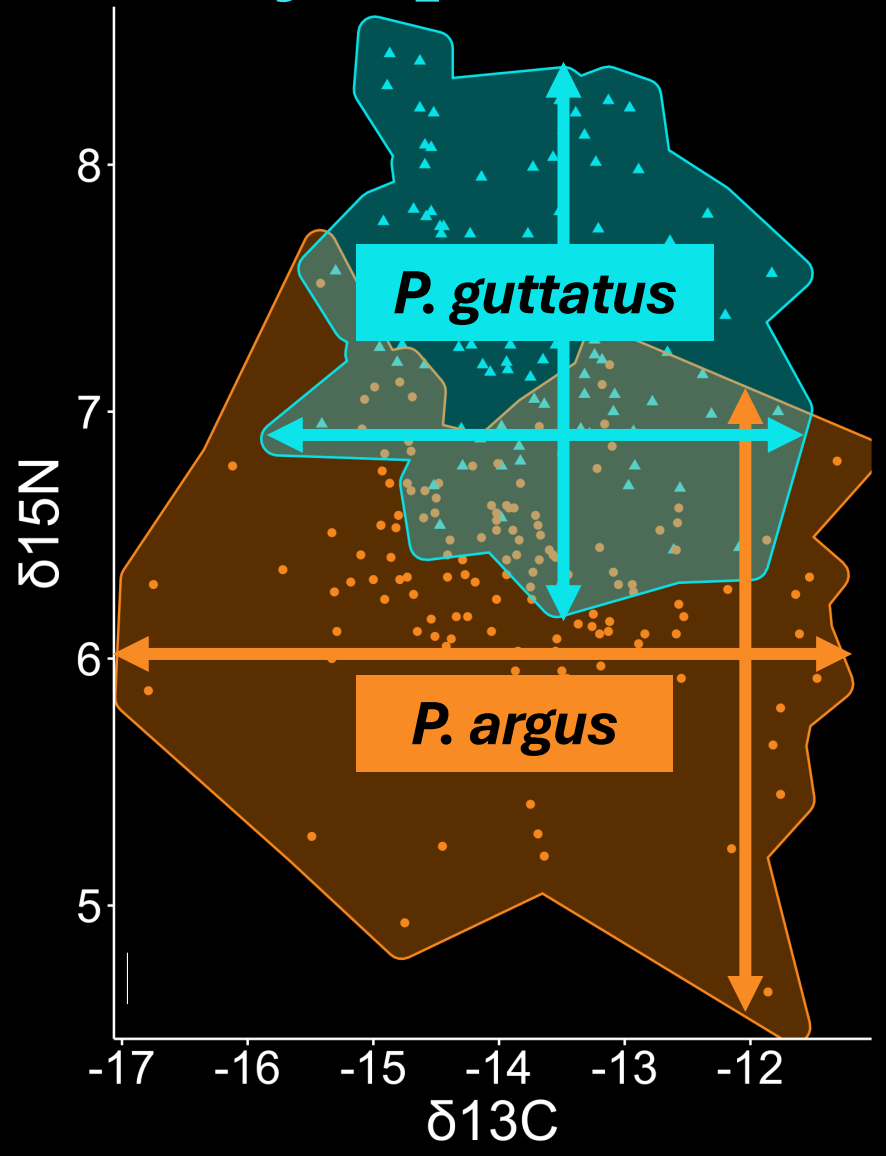




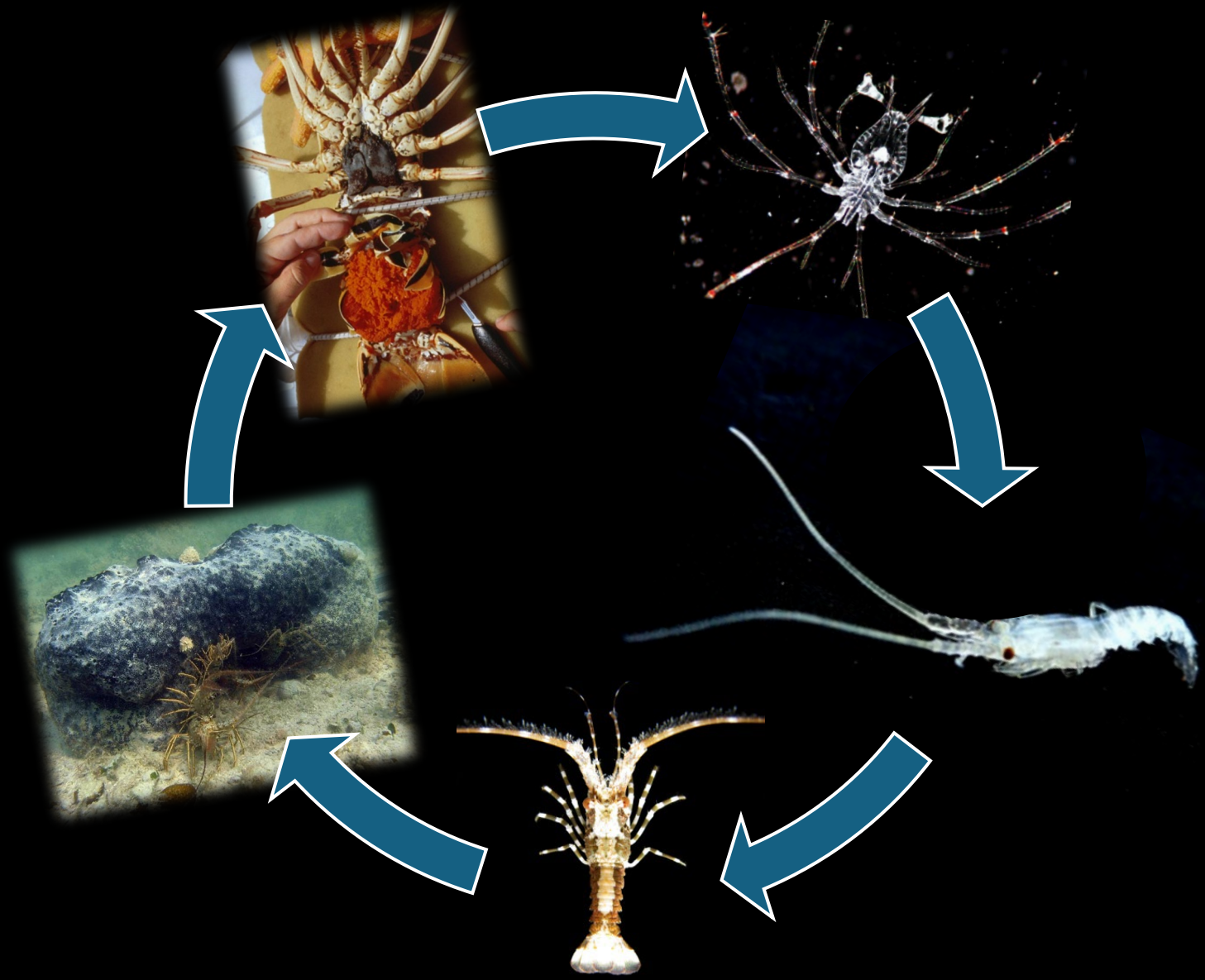
- Two PC scores represent 40% of variance
- K-means clustering into 3 site condition groupings

Results – Trophic position by species

- Across all sites, *P. guttatus* had higher trophic position
- *P. argus* had wider d13C range



Life Cycle



Lobsters migrate to the reef to mature



Loss of Hardbottom Structures

