The ecology, biodiversity, and economic importance of shrimp and lobsters in Florida and nearby regions

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Outline

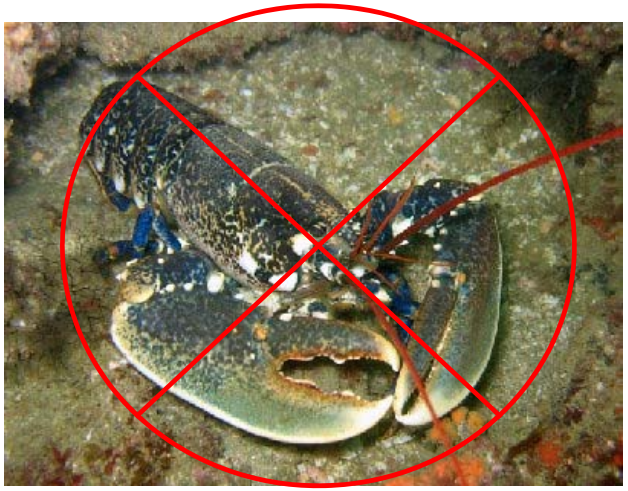
1) Introduction to the FL spiny lobster and current research initiatives
2) Introduction to pink shrimp and current research initiatives

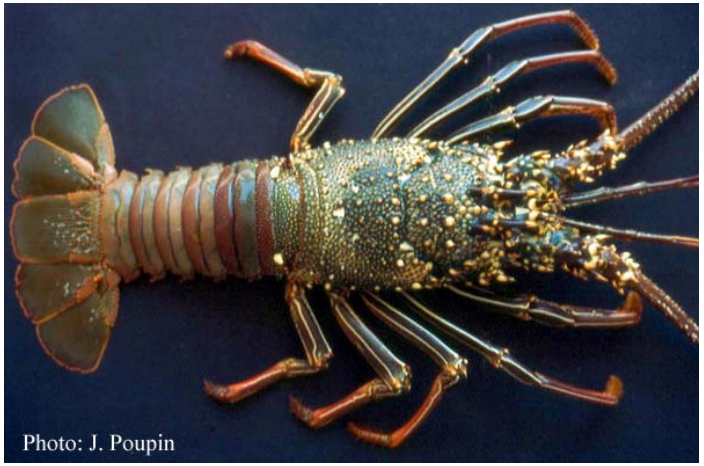
Florida Spiny Lobster
Infraorder Achelata
Panulirus argus

(Latreille, 1804)

What's an Achelata lobster?

- Decapoda Latreille, 1802
  - Suborder Dendrobranchiata Bate, 1888
  - Suborder Pleocyemata Burkenroad, 1963
    - **Achelata** Scholtz & Richter, 1995
    - Anomura MacLeay, 1838
    - **Astacidea** Latreille, 1802
    - Axiidea de Saint Laurent, 1979
    - Brachyura Linnaeus, 1758
    - Caridea Dana, 1852
    - Gebiidea de Saint Laurent, 1979
    - Glypheidea Van Straelen, 1925
    - Polychelida Scholtz & Richter, 1995
    - Procarididea Felgenhauer & Abele, 1983
    - Stenopodidea Bate, 1888





Introduction to the Spiny Lobster

Widely distributed in the tropical and subtropical waters of the Atlantic Ocean.

It has been harvested by 23 countries and supports the most valuable fisheries in the region.

It is a benthic feeder and a prey for nurse shark and moral eel. It is an important link in the food web.

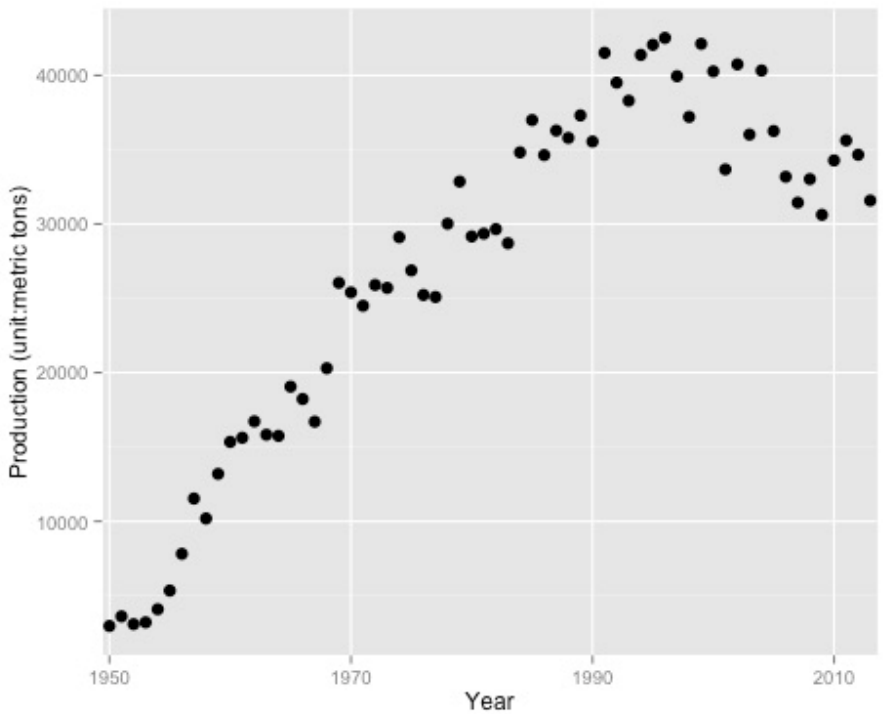
What makes spiny lobsters so special?

Panulirus argus

Pricey seafood: Spiny lobsters, Lobster fest, social and cultural livelihoods

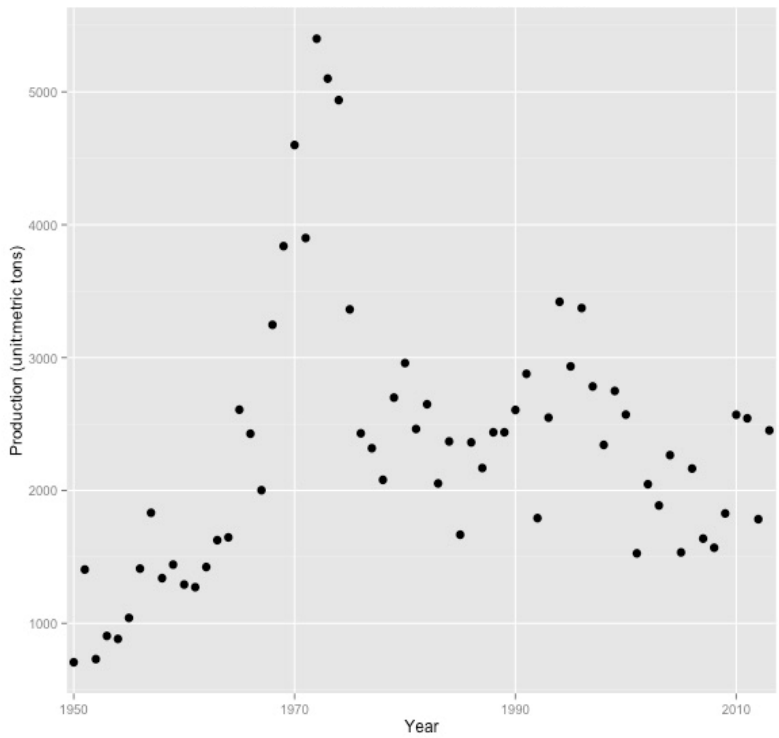
Economic Importance of FL Spiny Lobsters

Spiny Lobster Global Production*



2013 Global Production
31,580 metric tons
(69,621,982 pounds)

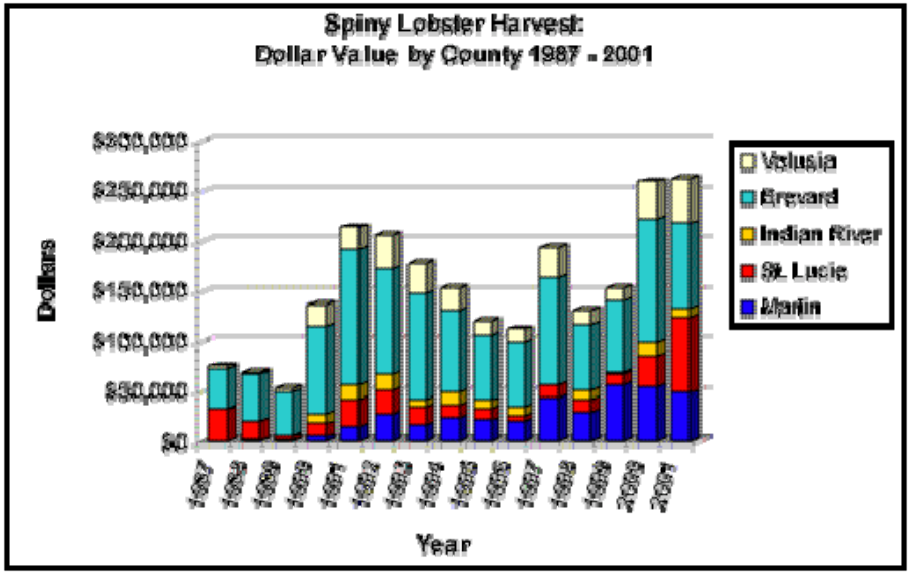
Spiny Lobster US Production*

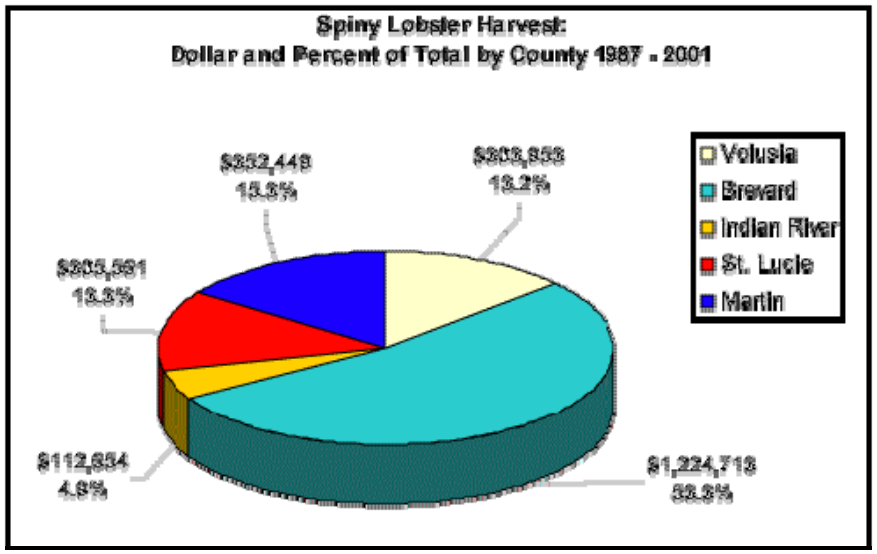


2013 US Production 2,452 metric tons
(5,405,735 pounds)

*FAO data

Second most valuable shell fishery in FL

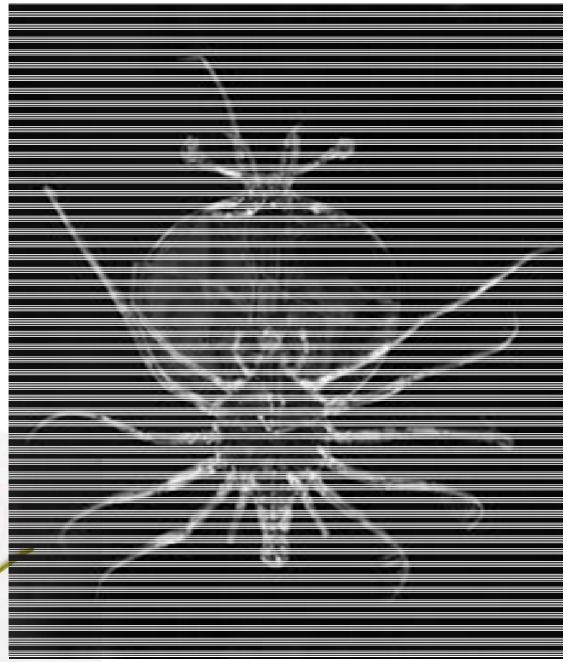




1987-2001 lobsters totaled 94.6 million pounds and was valued at $365.3 million dollars

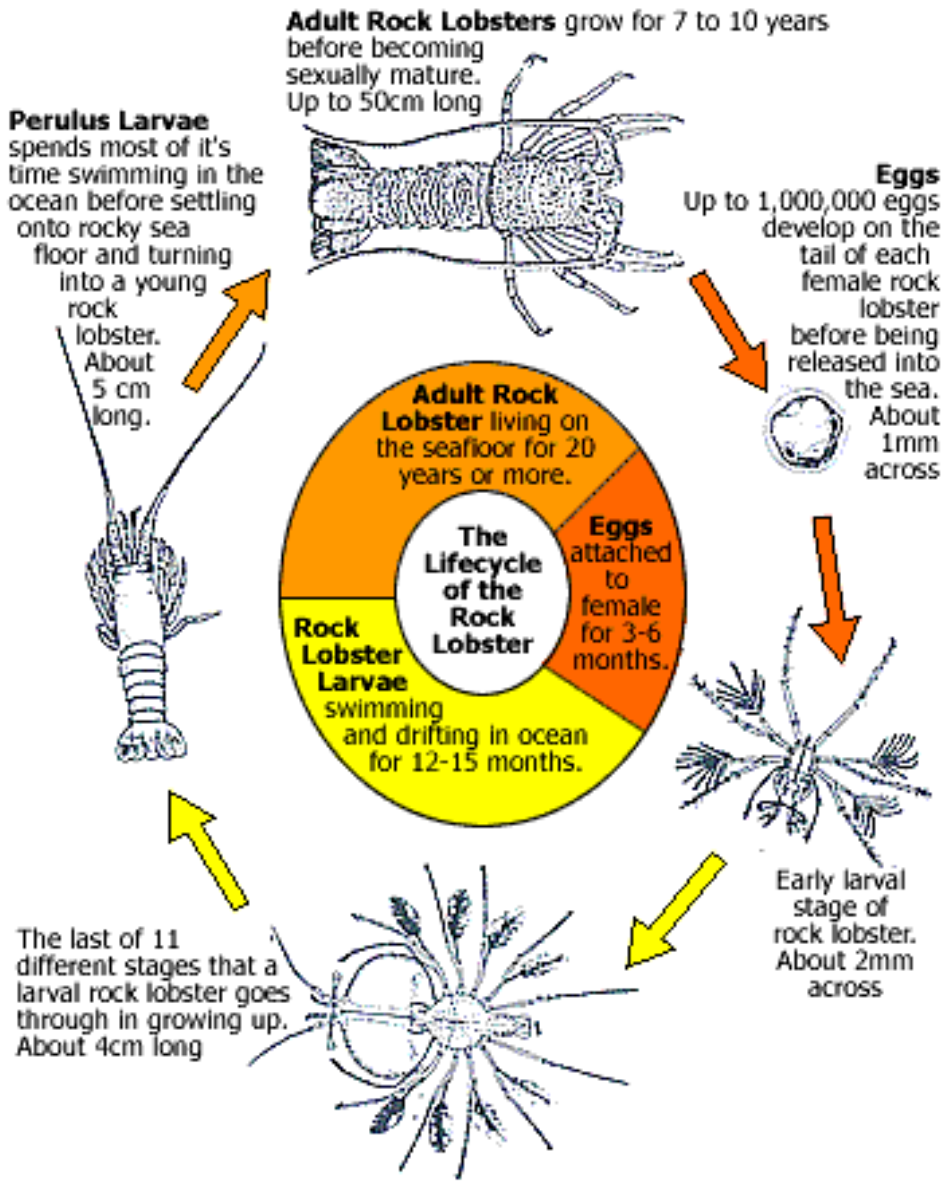
(~3.8 dollars/pound)

A unique larval stage: The Phyllosoma



Life cycle

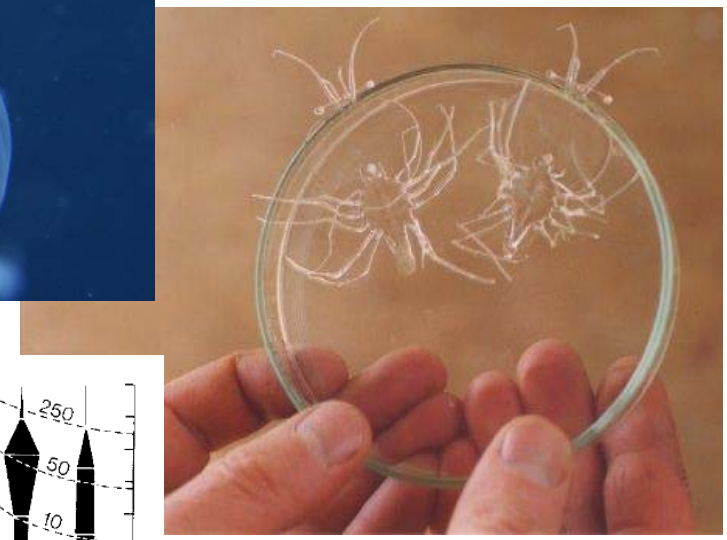
- Adults release several thousand phyllosoma larvae.
- Phyllosoma dispersal may last up to 24 months.
- Pueruli (decapodid stage) are in charge of recruitment.



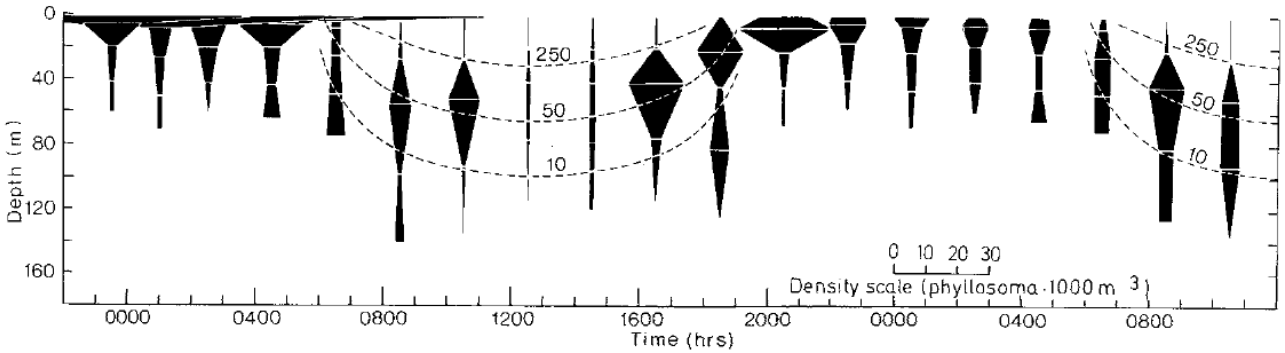
Life cycle

Phyllosoma ecology

Piggy riding



Transparent body

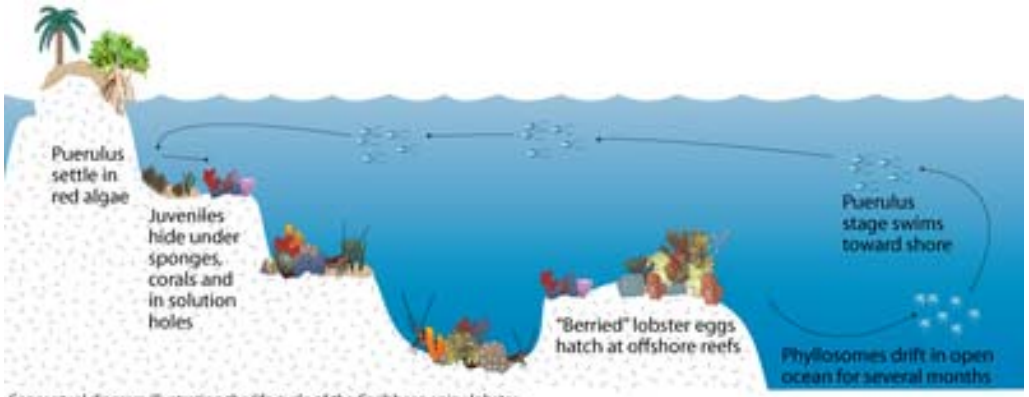


Diurnal migration (not so surprising!)

“Piggy riding”

https://www.facebook.com/quartznews/videos/1262753677091665/

Migration of Spiny Lobsters



Conceptual diagram illustrating the life cycle of the Caribbean spiny lobster.
Diagram courtesy of the Integration and Application Network (ian.umces.edu), University of Maryland Center for Environmental Science. Source: Kruczynski, W.L. and P.J. Fletcher (eds.). 2012. Tropical Connections: South Florida's marine environment. IAN Press, University of Maryland Center for Environmental Science, Cambridge, Maryland. 492 pp.

Current Research

- Resolving the evolutionary relationships of lobsters
  - Biodiversity Implications
  - Conservation Implications
  - Ecological Implications
- Develop a model for fisheries research

The Emergence of Lobsters!

The Emergence of Lobsters: Phylogenetic Relationships, Morphological Evolution and Divergence Time Comparisons of an Ancient Group (Decapoda: Achelata, Astacidea, Glypheidea, Polychelida)

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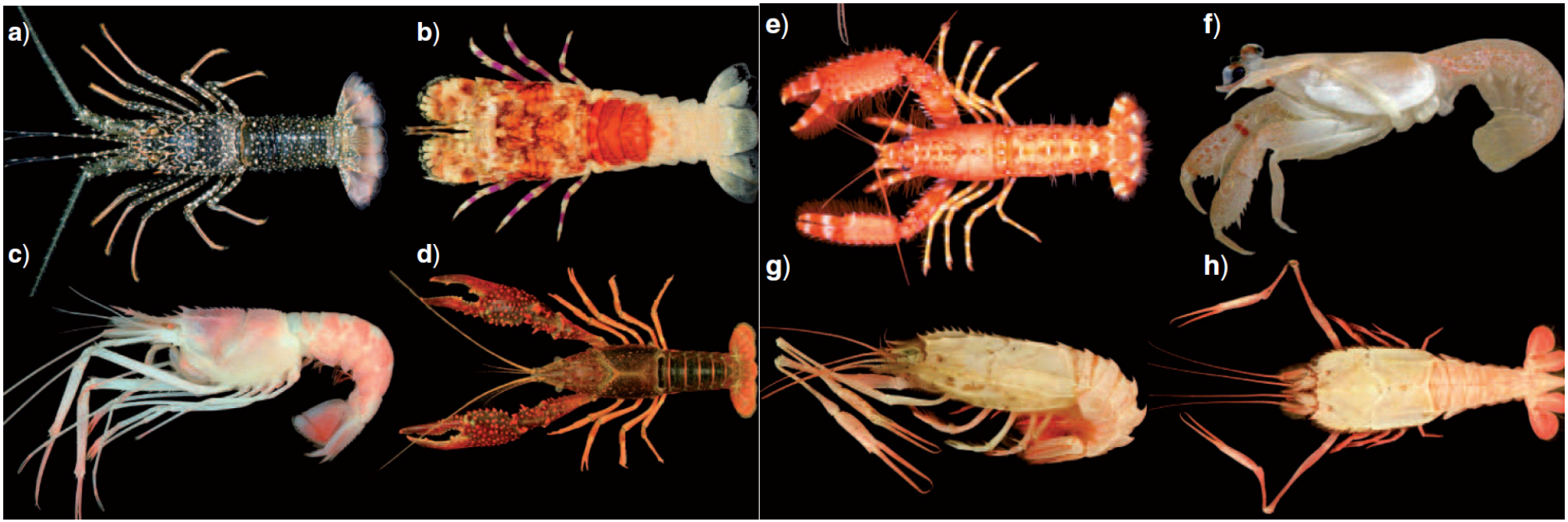
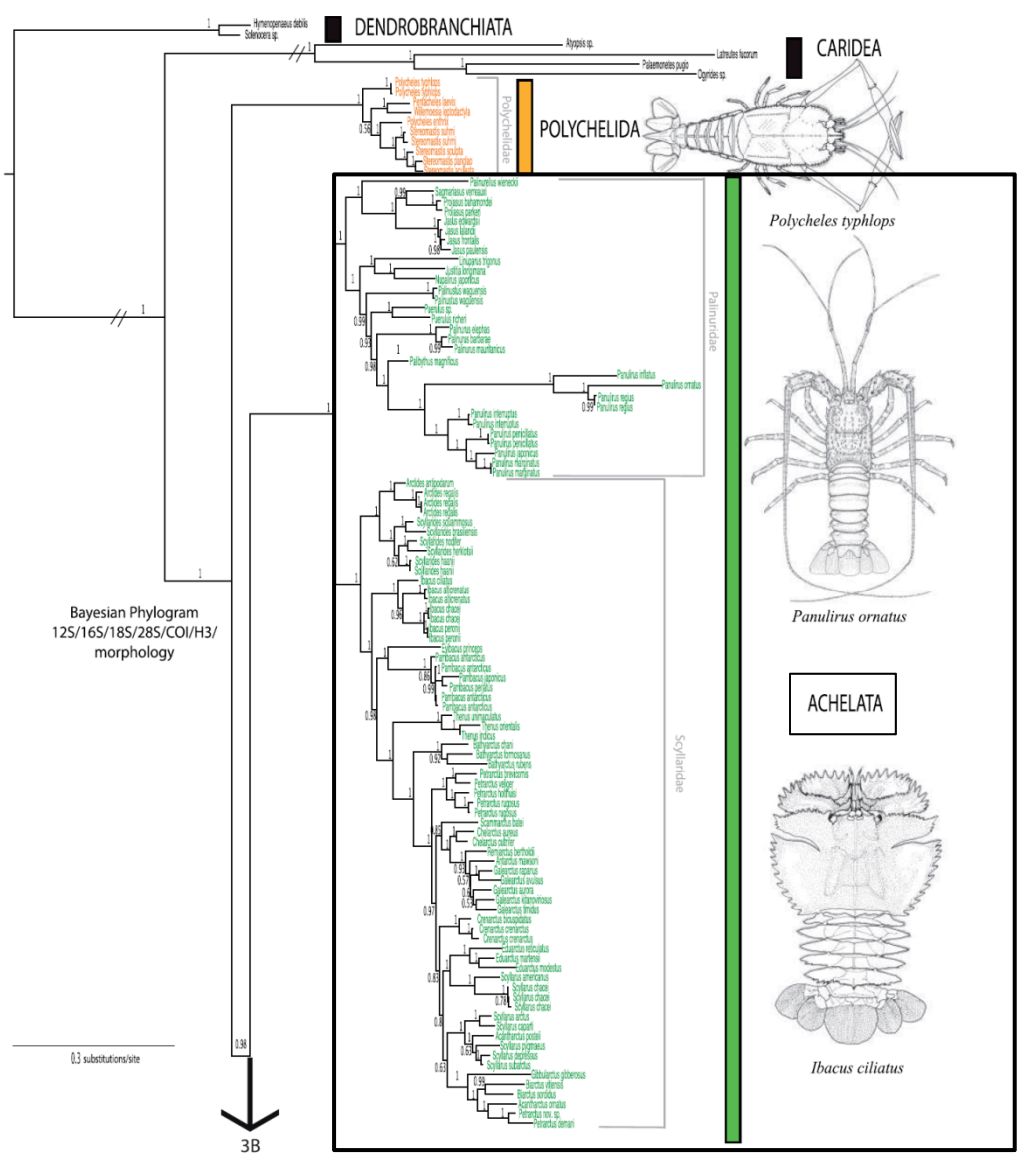
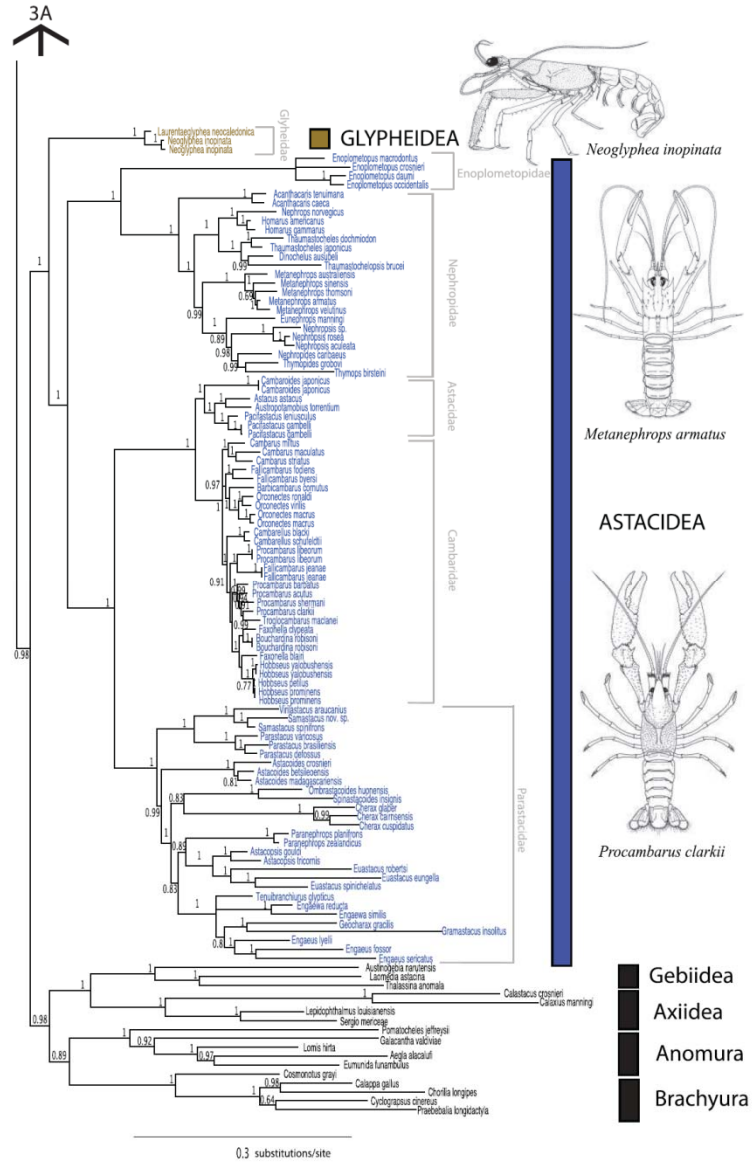


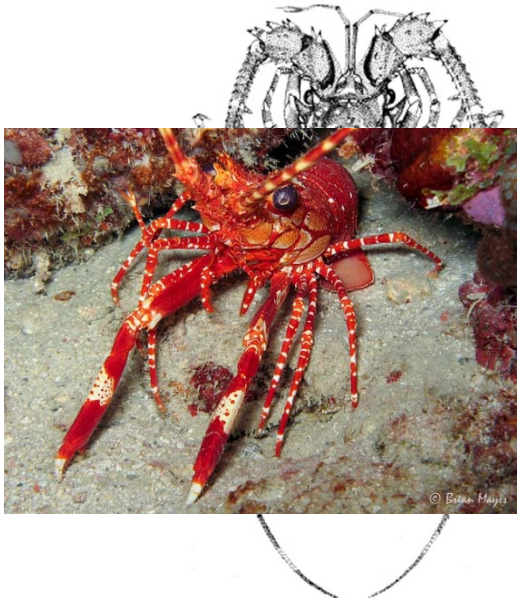
FIGURE 1. Lobster-like decapod representatives; Achelata: A, *Panulirus guttatus* ULLZ 3497; B, *Scyllarus chacei* ULLZ 6596; Astacidea: C, *Acanthacaris caeca* ULLZ 7574; D, *Procambarus clarkii* ULLZ 11947; E, *Enoplometopus antillensis* ULLZ 3623; Glypheidea: F, *Laurentaeglyphea neocaledonica* MNHN:IU200814773; Polychelida: G, H, *Stereomastis sculpta* ULLZ 8022 (Photo credits: A-E, F-H: DL Felder, F: Richer de Forges,

Phylogenetic trees can tell us the relationships between organisms



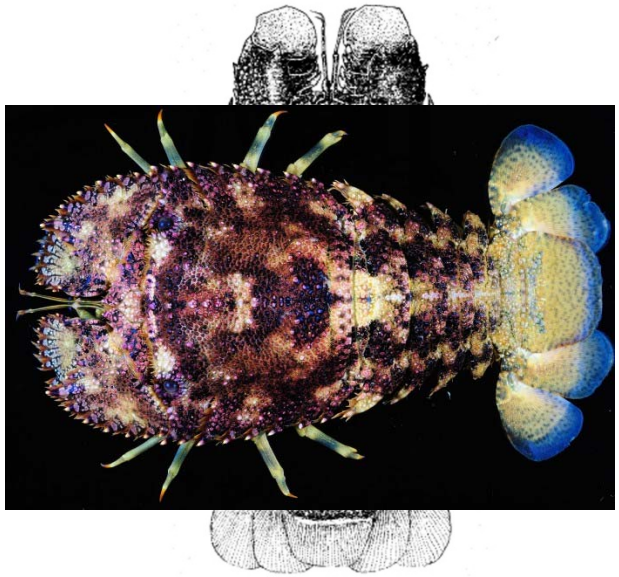


Taxonomical overview of Achelata



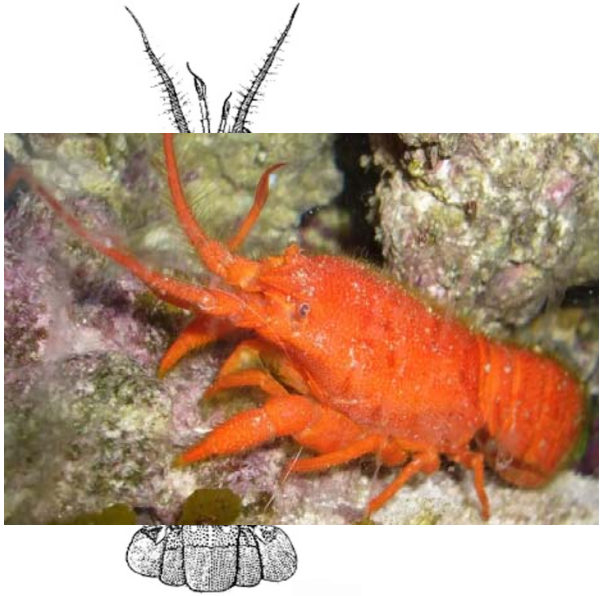
Palinuridae Latreille, 1802

”Spiny” lobsters



Scyllaridae Latreille, 1825

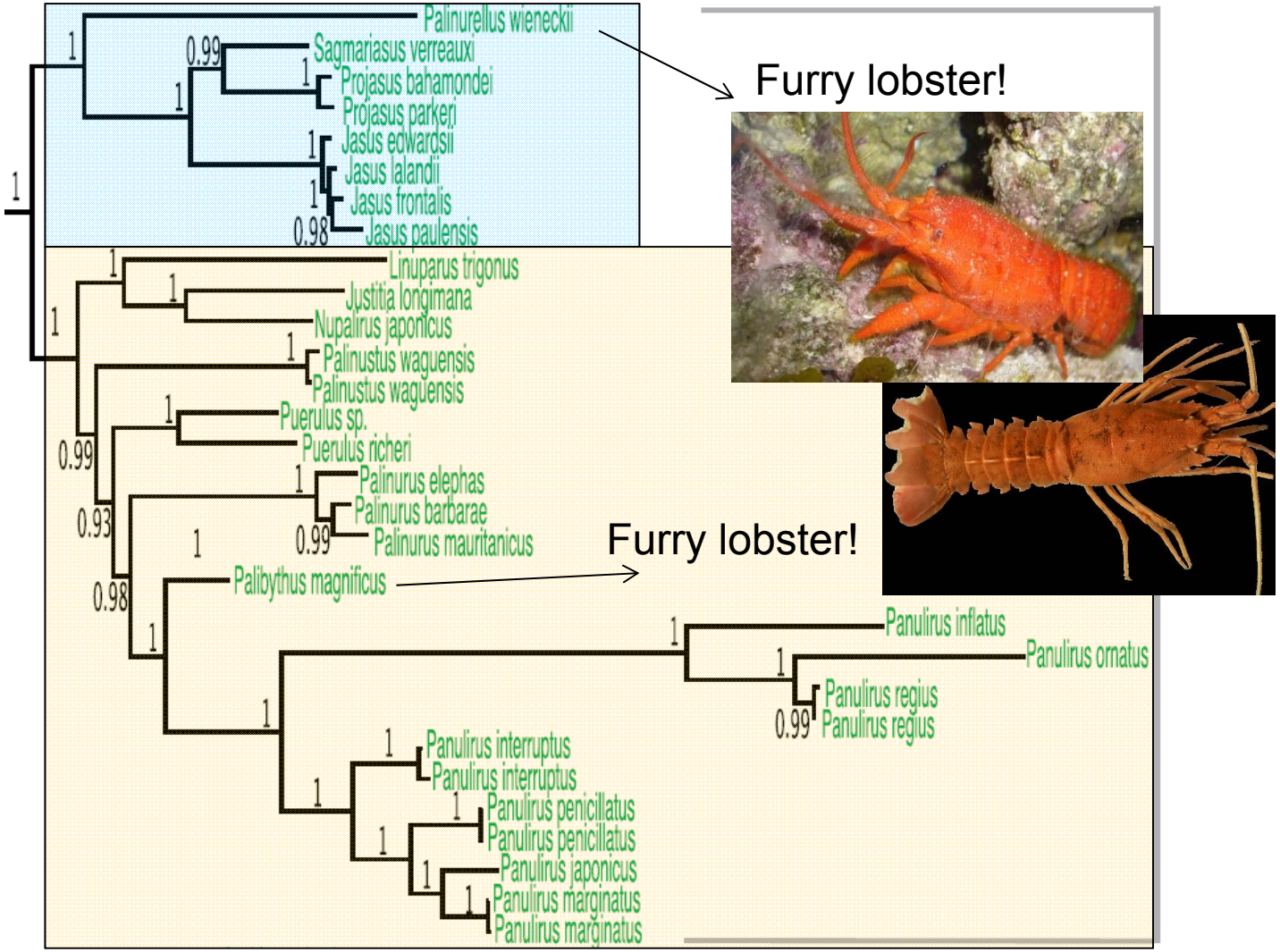
”Slipper” lobsters



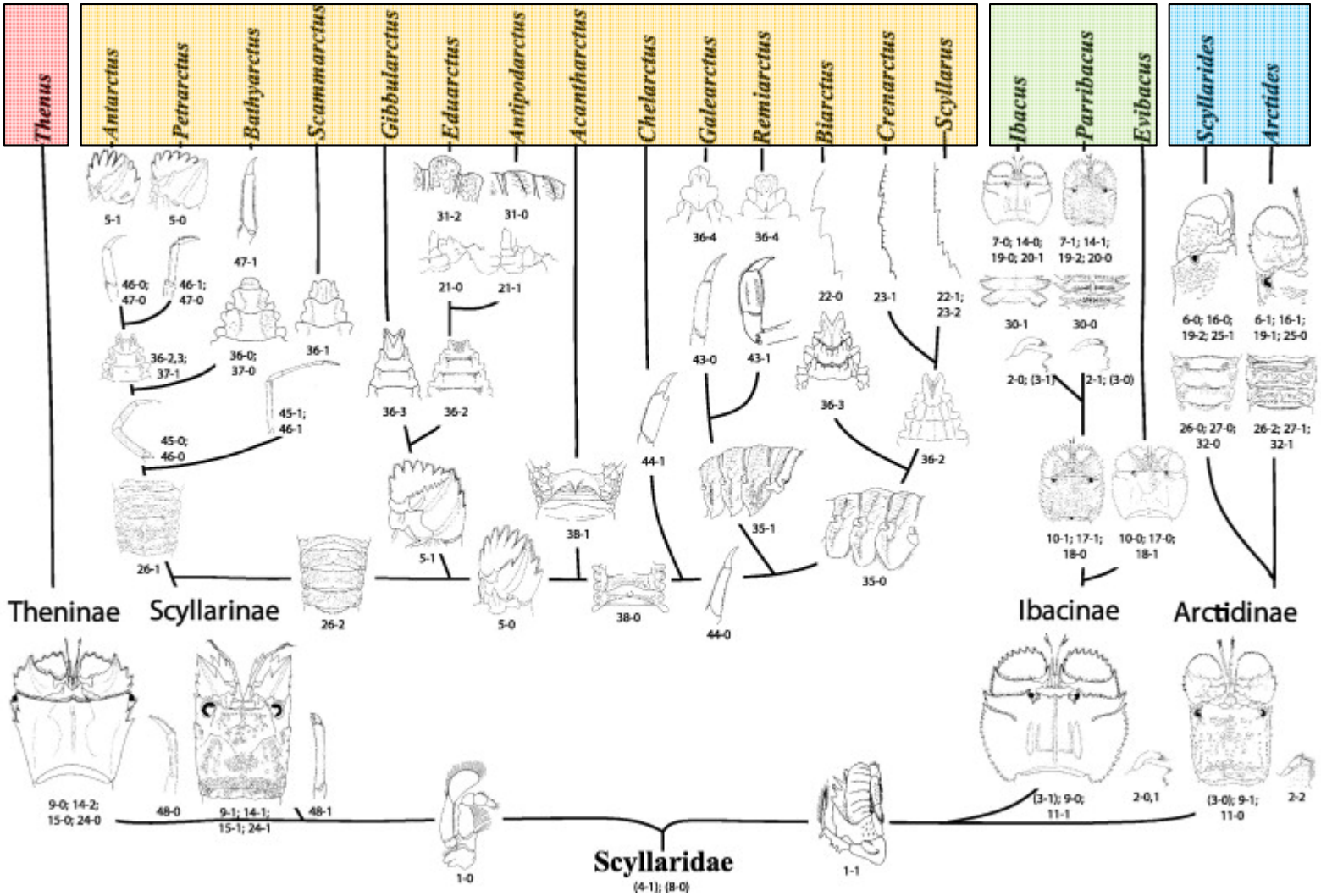
Synaxidae Bate, 1881

”Furry” lobsters

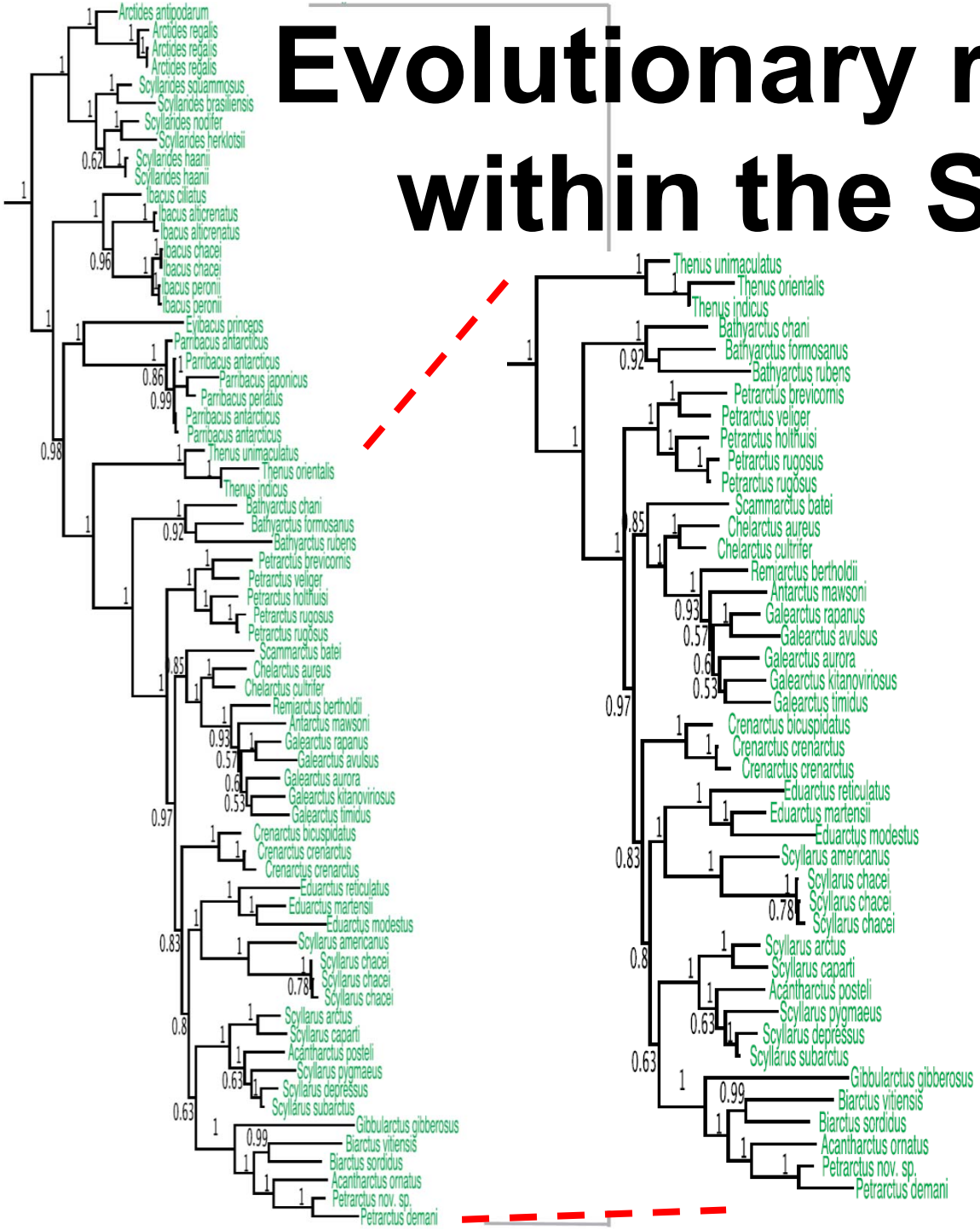
Evolutionary relationships within the Palinuridae

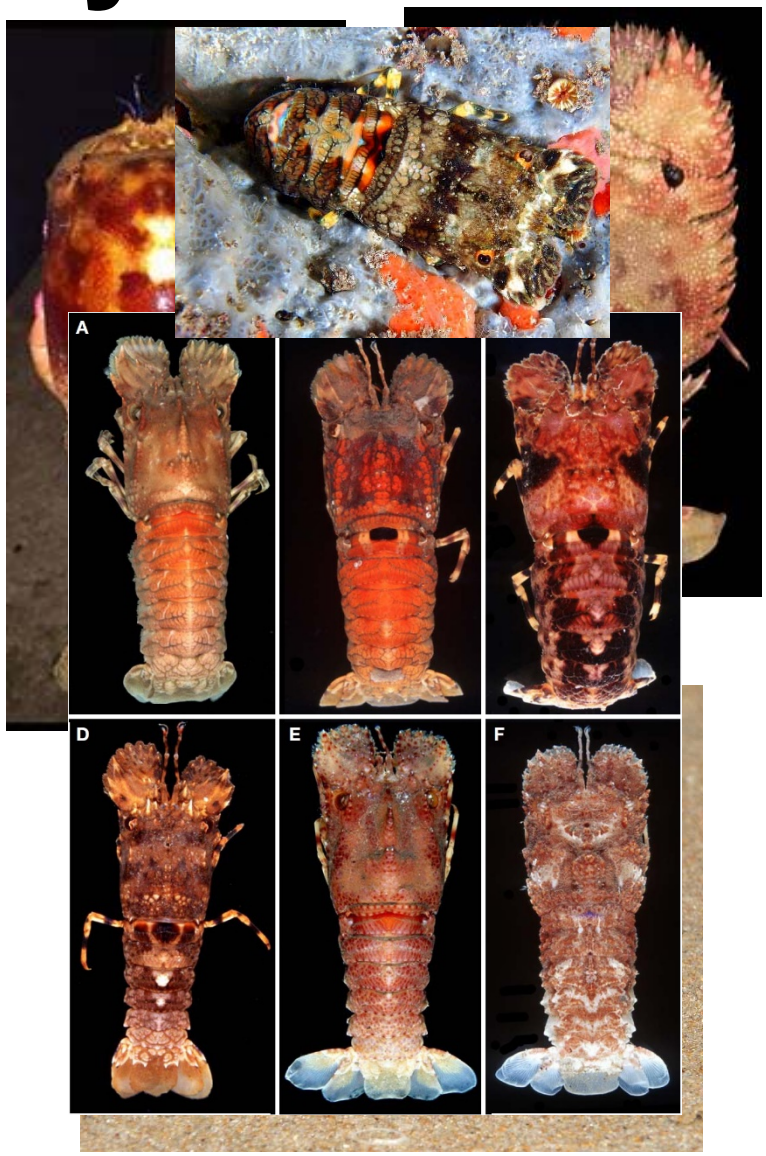


Allows us to classify organisms based on genetic information: Taxonomy within the Scyllaridae

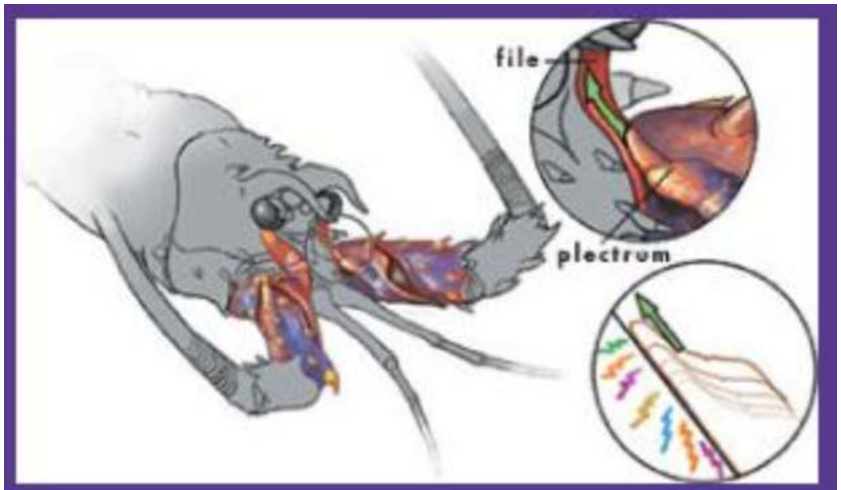


Evolutionary relationships within the Scyllaridae

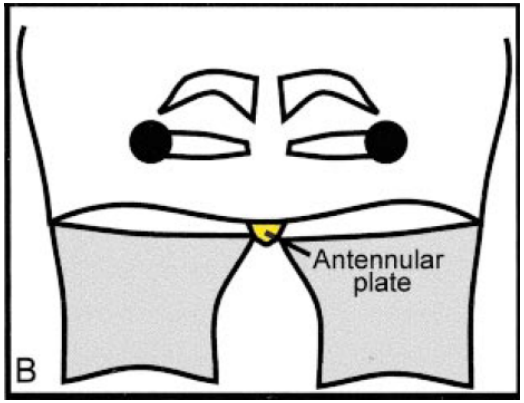




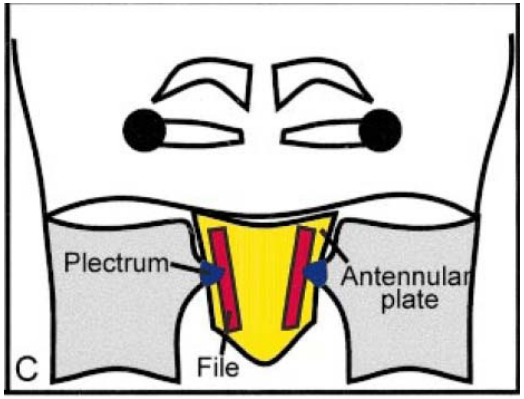
Palinuridae: The *violinist* under the ocean



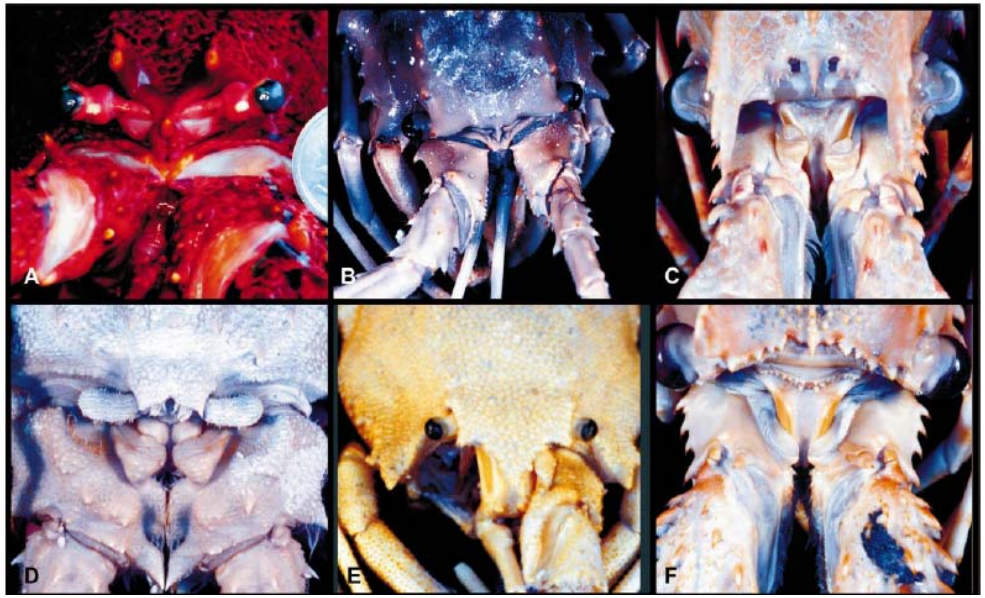
To generate its loud, raspy buzz, the spiny lobster waggles one or both of its antennae, causing a flattened projection (the plectrum) on each antenna's spiky base to skid across an oblong lump (the file) located on either side of the animal's head, near the eye. Microscopic shingles on the file create friction, which is essential to sound production.



Silentes



Stridentes



Models can help us conserve and protect the lobster fishery: Stock Assessment and Monitoring

Nan Yao, Yuying Zhang

Due to its high economical value, variable stock assessment models have been applied to investigate the population dynamics of Florida stock.

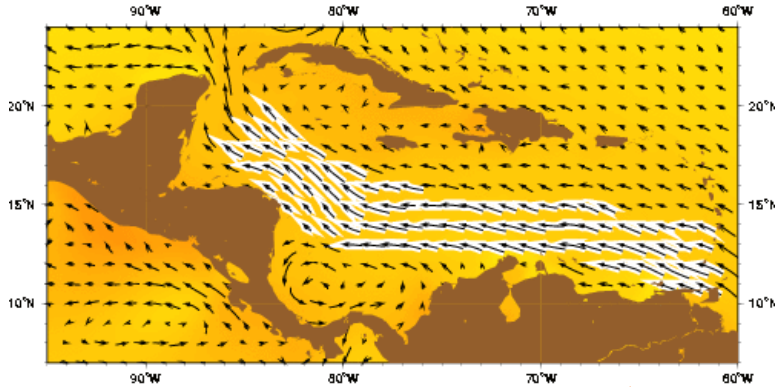
However, due to the unique biology and ecology of the spiny lobster, the current model do not yield satisfied results.

There are two obstacles that we are facing:

1. Recruitment

2. Growth

Recruitment



The phyllosoma larval could drift with the current for 6 to 9 months.

Pelagic larva

Post-larvae

Adult

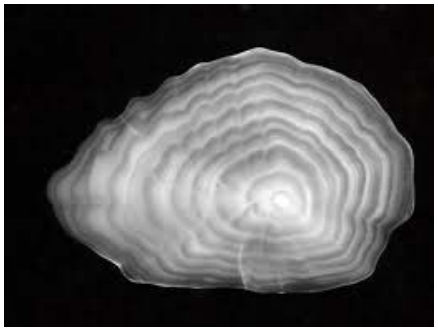
Traditional Stock Assessment treats the Florida stock as a isolated stock. However, this might not be the case (due to the phyllosoma larvae this is **probably** not the case).

New hypothesis: The Florida spiny lobster stock could be demographic open.

Age and growth are hard to calculate

1. Indeterminate Growth

2. Lack of calcified structure like otolith to identify age



Many models use age to model growth, however new model will use size

Objective and hypothesis

Objective:

To develop a stock assessment model that could fit the unique biology and ecology of the spiny lobster better. Therefore give a more accurate estimation of the stock status and yield better stock management.

New Hypotheses to be integrated into new lobster models:

1. A size-structure model (instead of age) is more suitable for Florida spiny lobster stock.
2. The Florida spiny lobster stock receives recruitment from other Caribbean countries.

Size-Structure Model is being testing

Model Structure:

Recruitment

46 to 51mm

Growth

Fishing Mortality

Natural Mortality

Unit:size

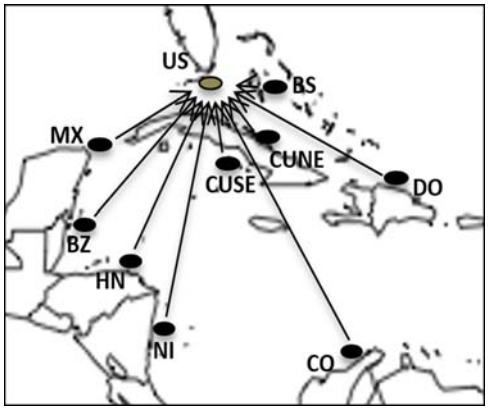
- The model is now running and will be submitted to Sea Grant for the final inspection.
- We also will test the results of size-structure against the results of age-structure to see if there is any improvement (First hypothesis).
- We will use this model to predict the future dynamics of the spiny lobster stock.

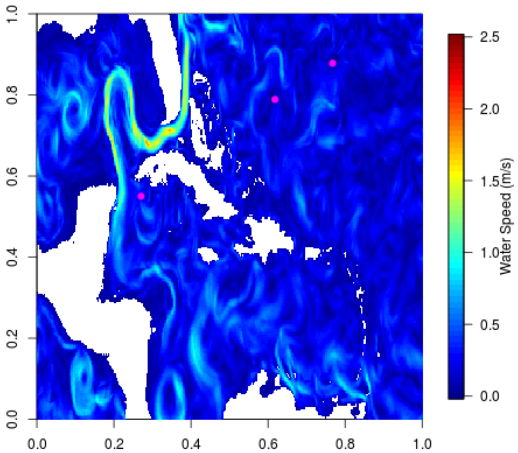
Data	Year
Commercial Landing	1985 - 2013
Recreational Landing	1985 - 2013
Size composition of commercial landing	1985 - 2010
Size composition of recreational landing	2002
Commercial Effort	1985 - 2014
Recreational Effort	1985 - 2014
Fisheries independent population survey indices	1996 – 2000 1997 - 2009
Size composition of fisheries independent survey	1996 – 2000 1997 - 2009
Recruitment Indices	1997 - 2006
Tag-recapture data	1967 - 2003

Recruitment is also being tested to improve stock assessment models

1. Bio-physical Model: allows us to predict larval migration

Potential for more source populations (9 total)

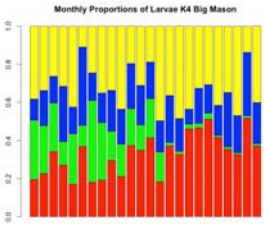


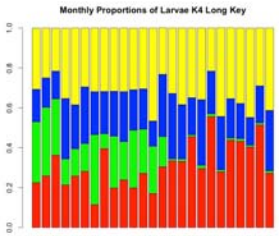


Integrates currents and larval migration

2. Stable Isotopes: allows us to "track" the larvae using measurements of nitrogen and carbon across years

3. Genetic Analysis: allows us to use DNA evidence to identify source and sink populations





Pink Shrimp
Farfantepenaeus spp. (+ relatives)

(Burkenroad, 1939)

White

Litopenaeus sp.

Brown

F. aztecus

Pink

F. duorarum

Economic Importance of Shrimp

- Six million kilograms of shrimp are fished from the Gulf of Mexico annually, representing $35 million of revenue
- Second most valuable fishery in the United States
- Majority of these shrimp are from genus *Farfantepenaeus*
- *F. duorarum* and *F. brasiliensis*, form a $1.7 million bait shrimp industry in Biscayne Bay, FL

McMillen-Jackson & Bert, 2004

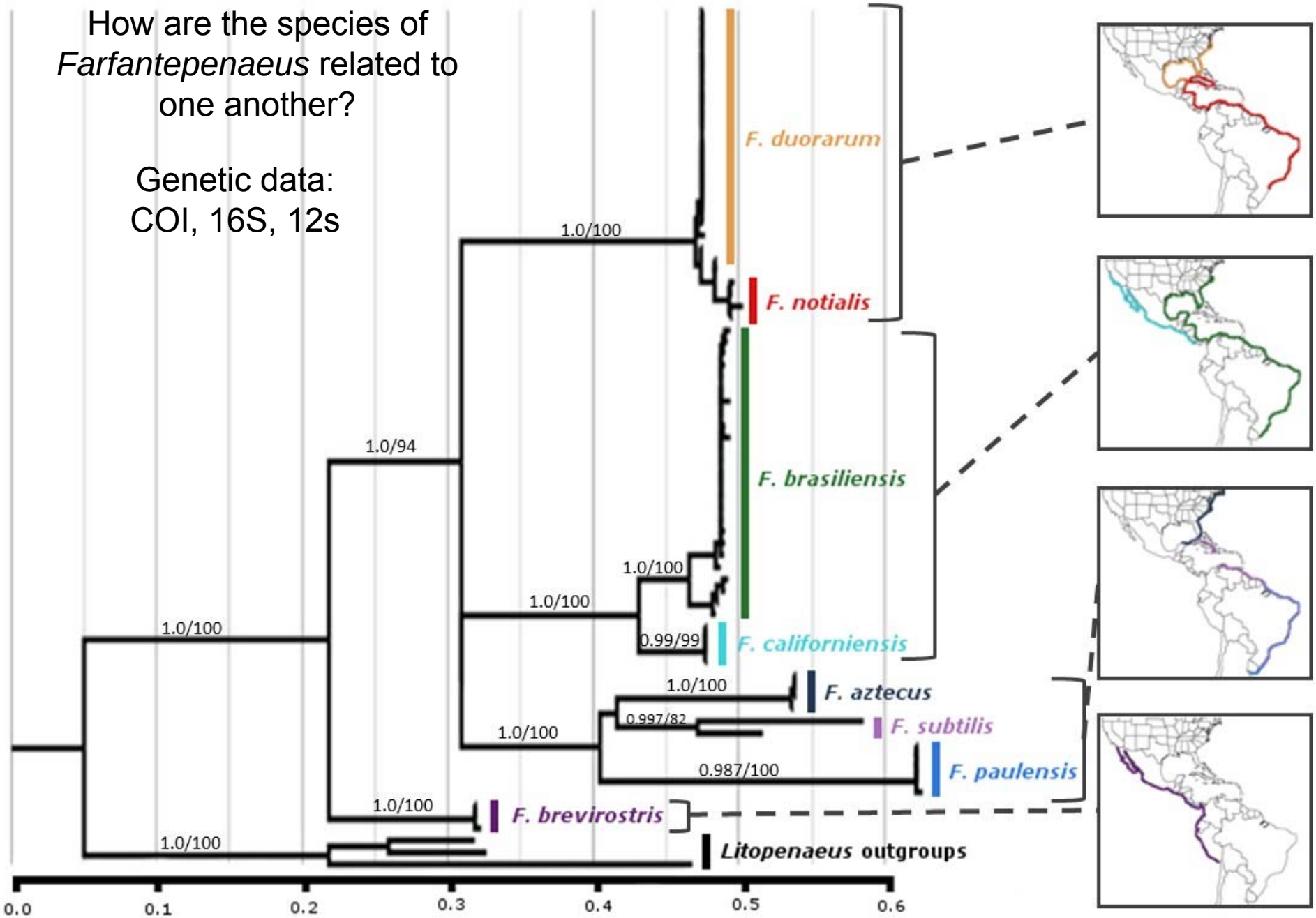
Current Research

Bracken-Grissom lab in collaboration with Joan Browder/Tom Jackson

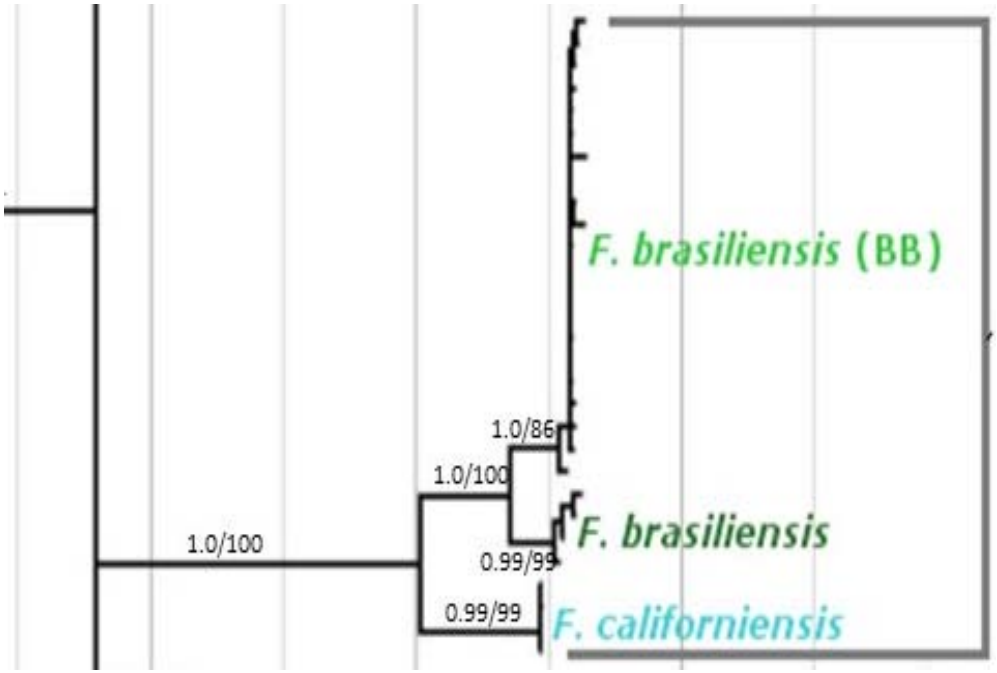
- Species management efforts is dependent on understanding the evolutionary forces driving biodiversity
- Proper classification is crucial to species conservation and management
  - 1) How are species within *Farfantepeneus* related to one another?
  - 2) Investigations of genetic diversity and connectivity of populations

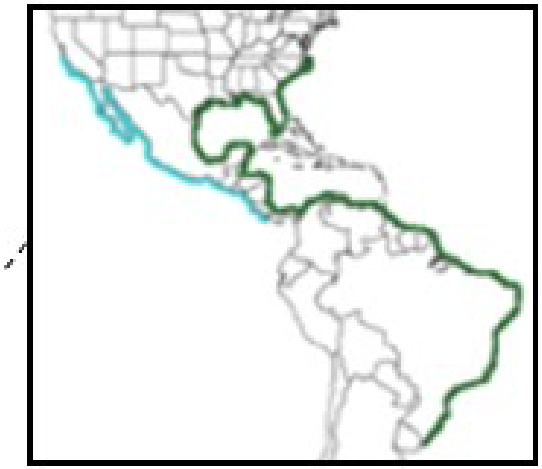
How are the species of *Farfantepenaeus* related to one another?

Genetic data:
COI, 16S, 12s



There is something unique happening in Biscayne Bay (BB)

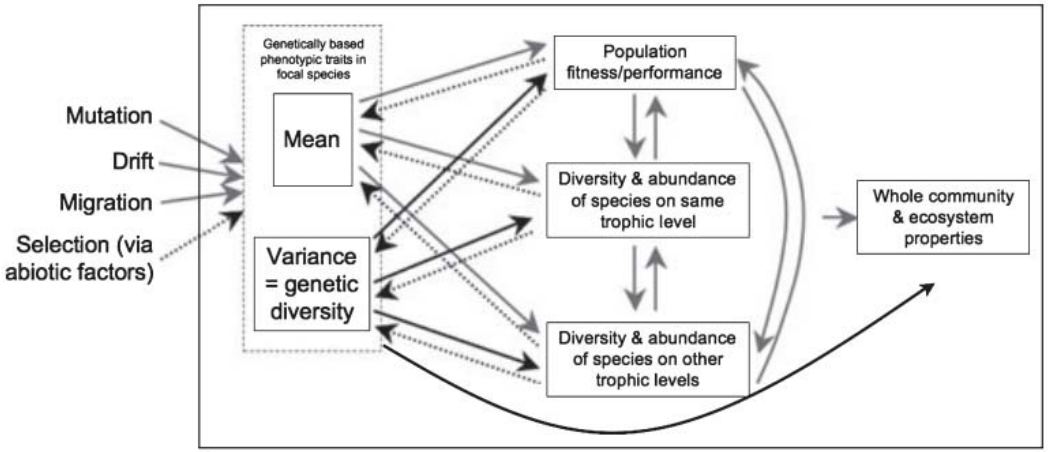




Possibly new species genetically similar to *F. brasiliensis* from GoM and Brazil

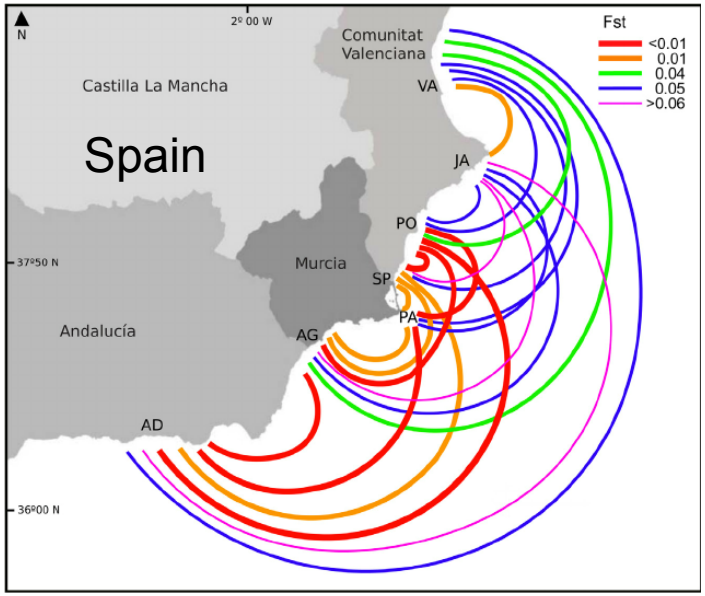
Investigations of genetic diversity and connectivity of populations of a commercially important shrimp (*F. duorarum*)

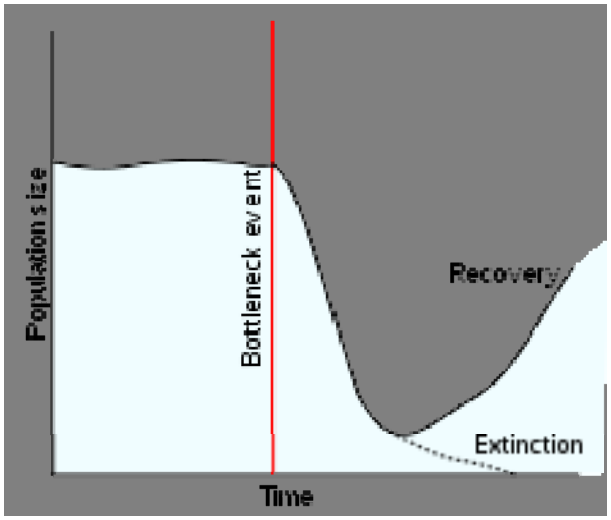
Genetic Diversity (GD) is a proxy for ecosystem health

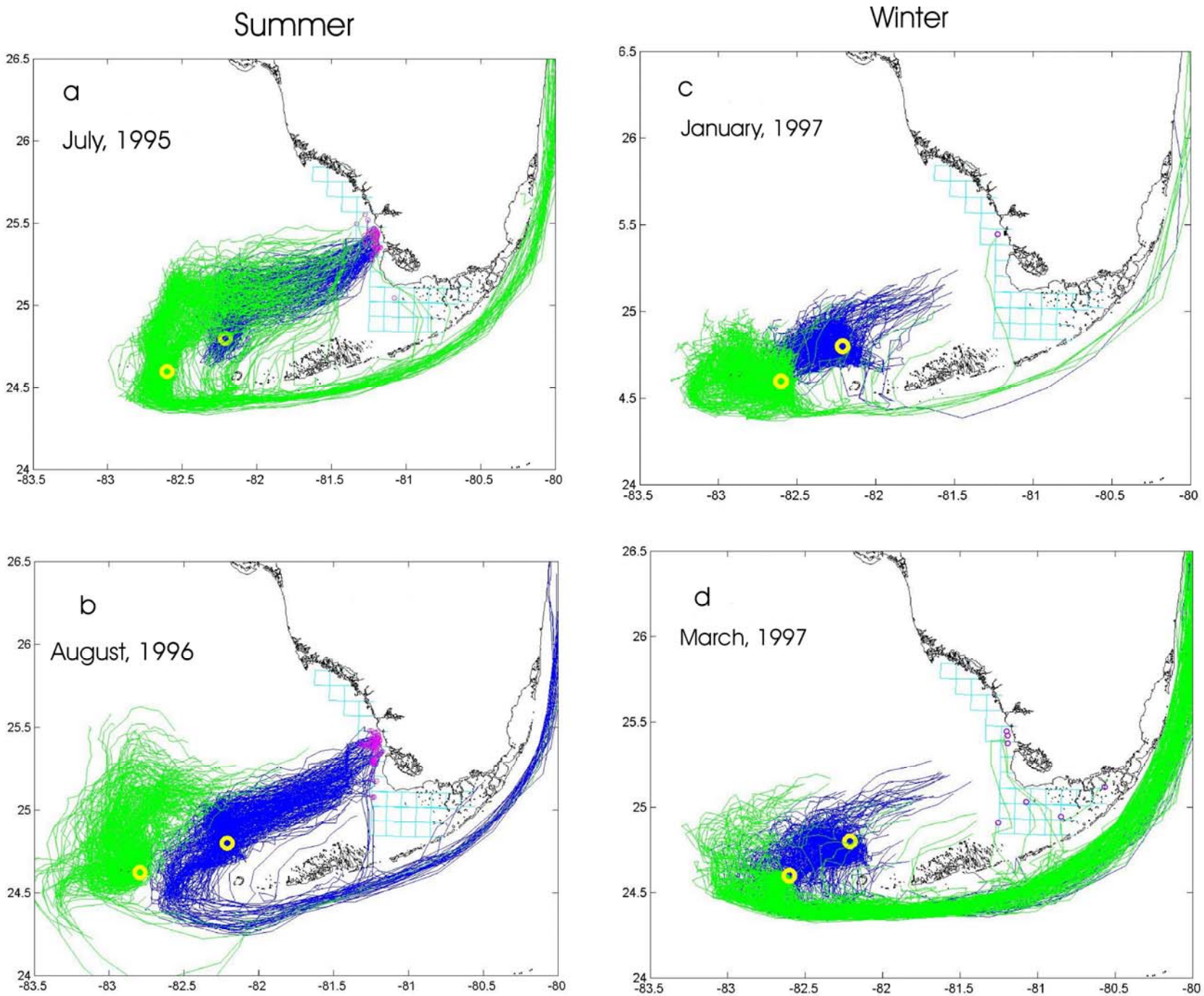


Black lines = direct ecological consequences of GD
Dotted lines = indirect ecological consequences of GD

Connectivity is a proxy for ecosystem resilience





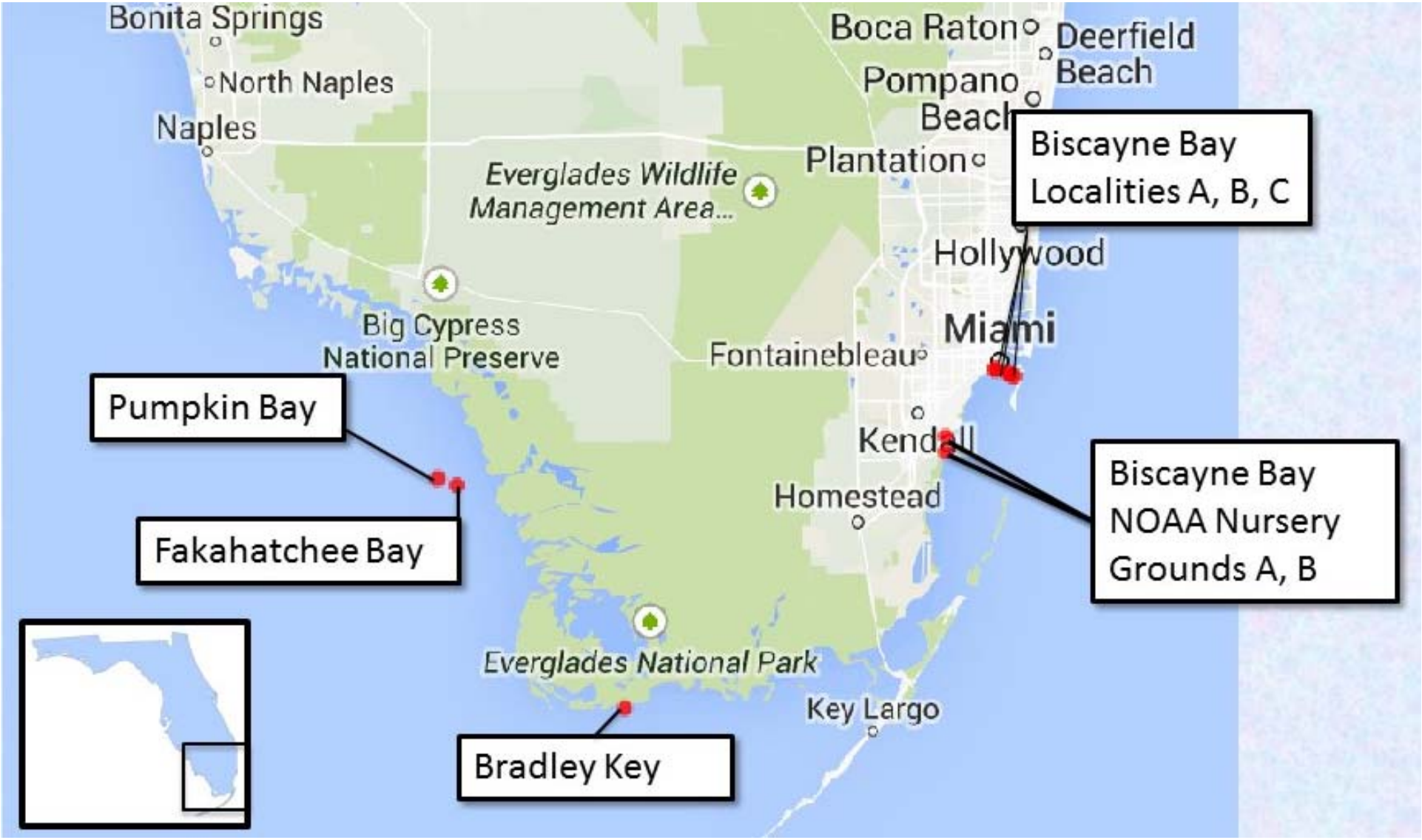


Criales et al. 2015

Population genetics of the Gulf pink shrimp

Use genetic data (diversity and connectivity) to test the model of recruitment

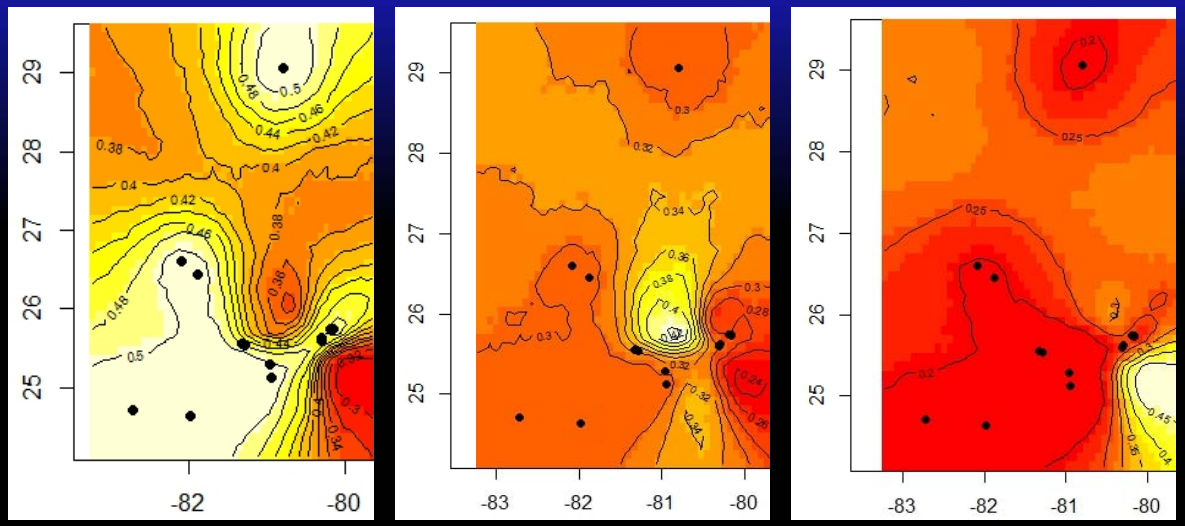
- Model suggests all *F. duorarum* originate from natal grounds and recruit around the Florida Peninsula
- Over 200 individuals collected
- Use genetic information to test genetic diversity and connectivity of populations



Collection Localities of *F. duorarum* around Florida

Traditional (Sanger) method (12S, 16S, COI)

Probability of membership in population 1, 2, or 3 (from left to right)



Pink Shrimp:
Probability Heat Map (GeneLand R)

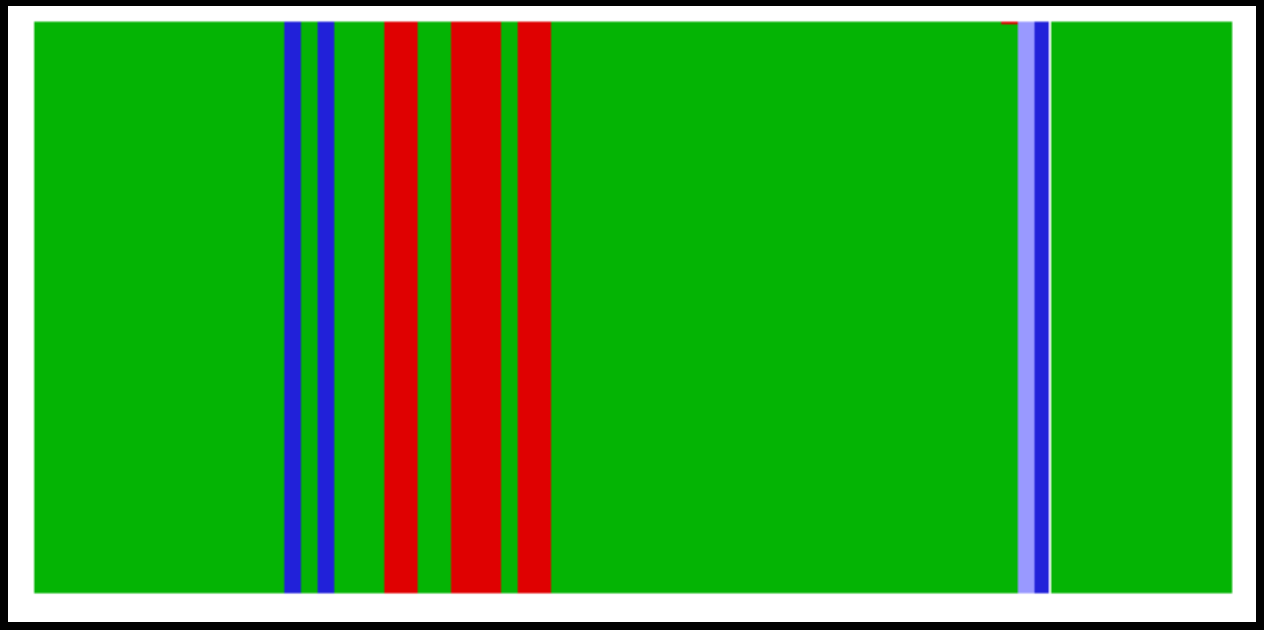
Four populations clearly indicated by four colors:

Daytona Beach

N. Biscayne Bay

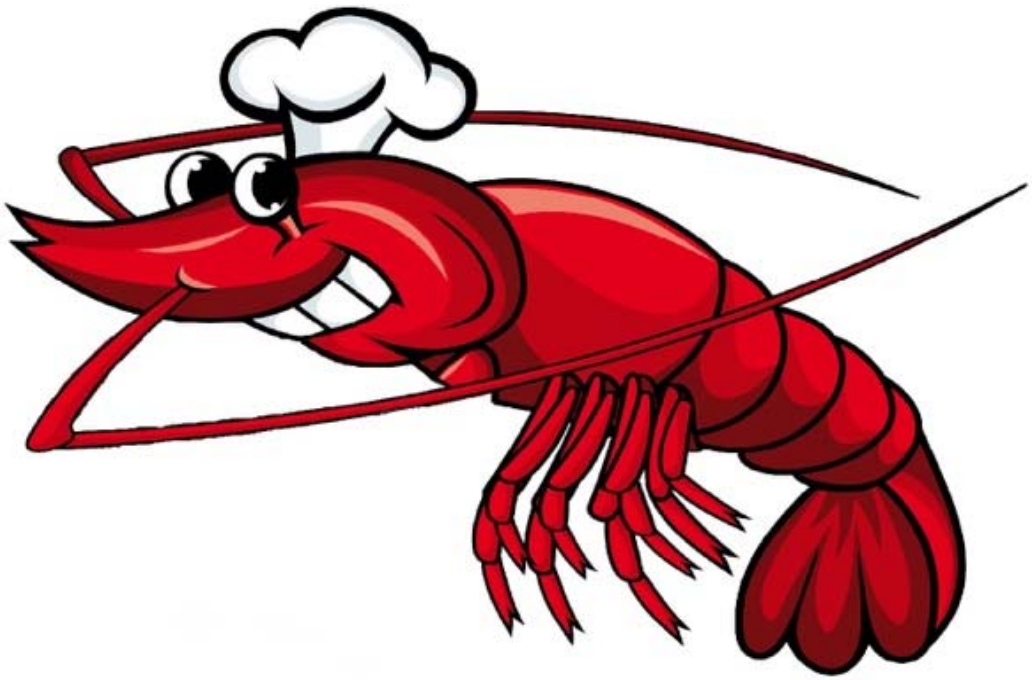
C. Biscayne Bay

S. FL Peninsula & Keys



Results

- Preliminary Results suggest at least 4 populations of *F. duorarum* around S. Florida
  - North and Central Biscayne Bay
  - Daytona Beach
  - Fl. Peninsula and Keys
- These populations need to be protected to secure the genetic diversity of the species
  - Proxy for health
- Only detected using sensitive and emergent genetic methods
- Continuing to analyze this data an publish soon

THANK YOU!

- Questions?