# Source–sink recruitment of red snapper: Connectivity between the Gulf of Mexico and Atlantic Ocean

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# Motivation

- "Uncertainty in connectivity between the Gulf and South Atlantic and episodic recruitment might lead to incorrect conclusions on status." – SAFMC SSC 2017 review of red grouper assessment

- Similar concerns raised for other species, such as blueline tilefish and gray snapper

- Interested in examining connectivity for a suite of species, starting with red snapper

- Approach combines an individual-based larval transport model (biology) with an oceanographic circulation model

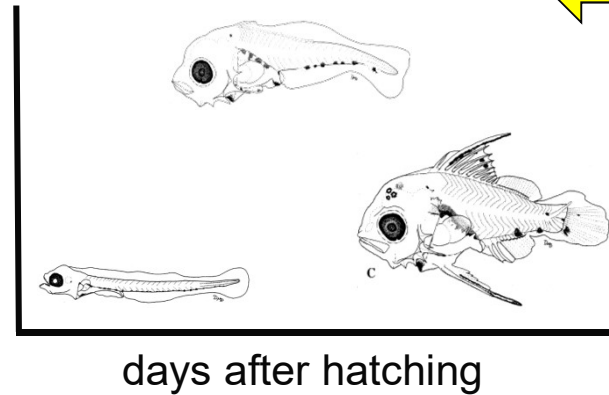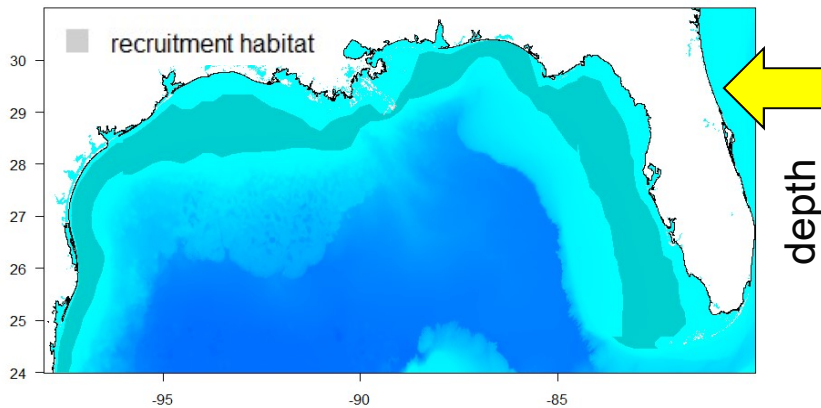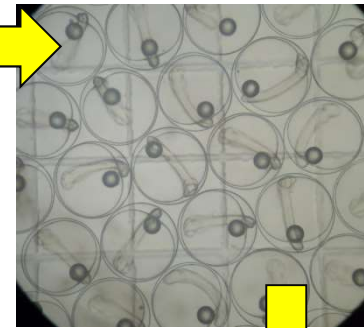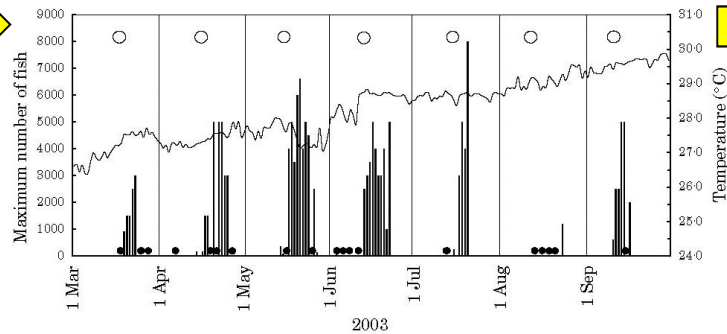# Connectivity Modeling System (CMS)

Paris et al. (2013)
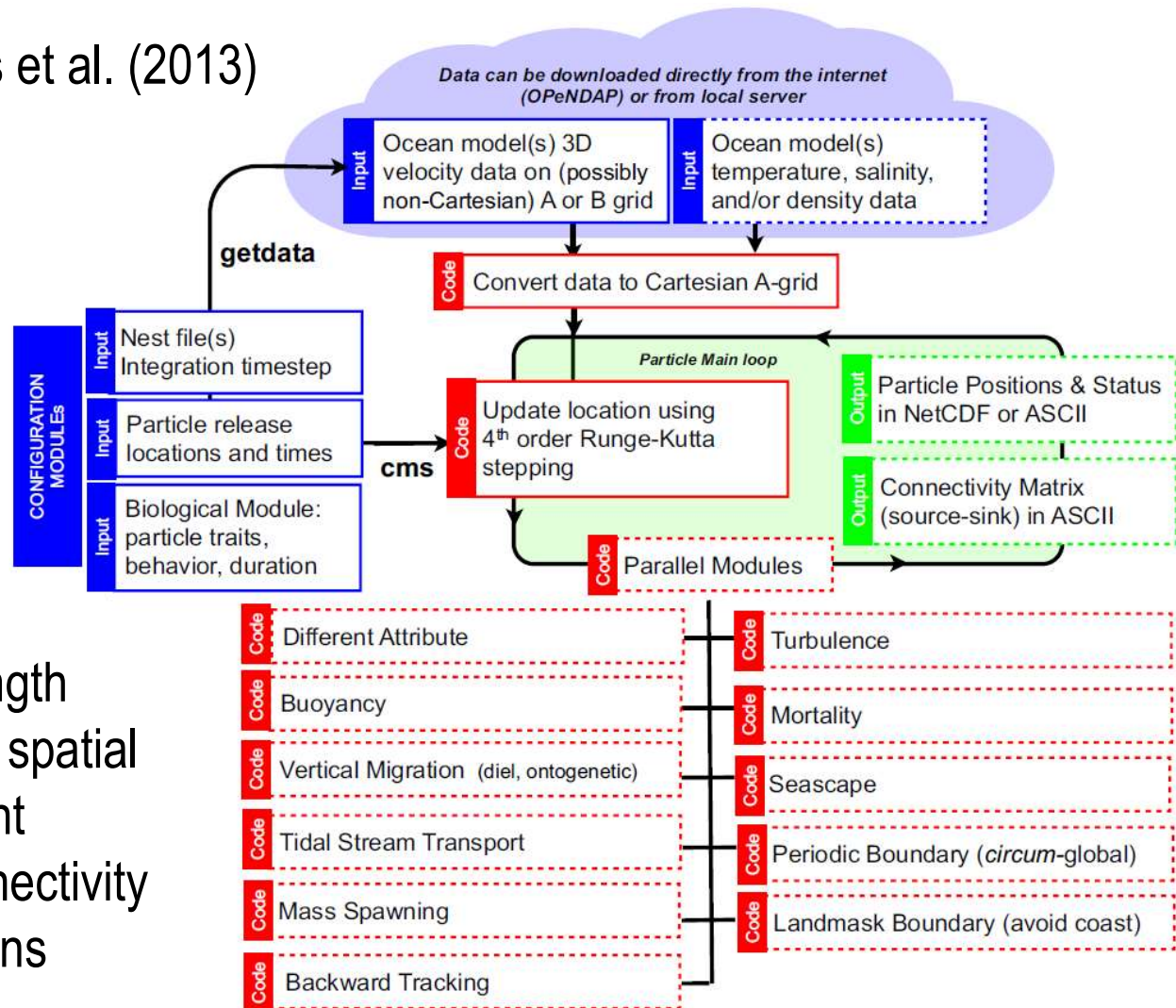
Applications:
- Predict annual recruitment strength
- Derive inputs for spatial stock assessment
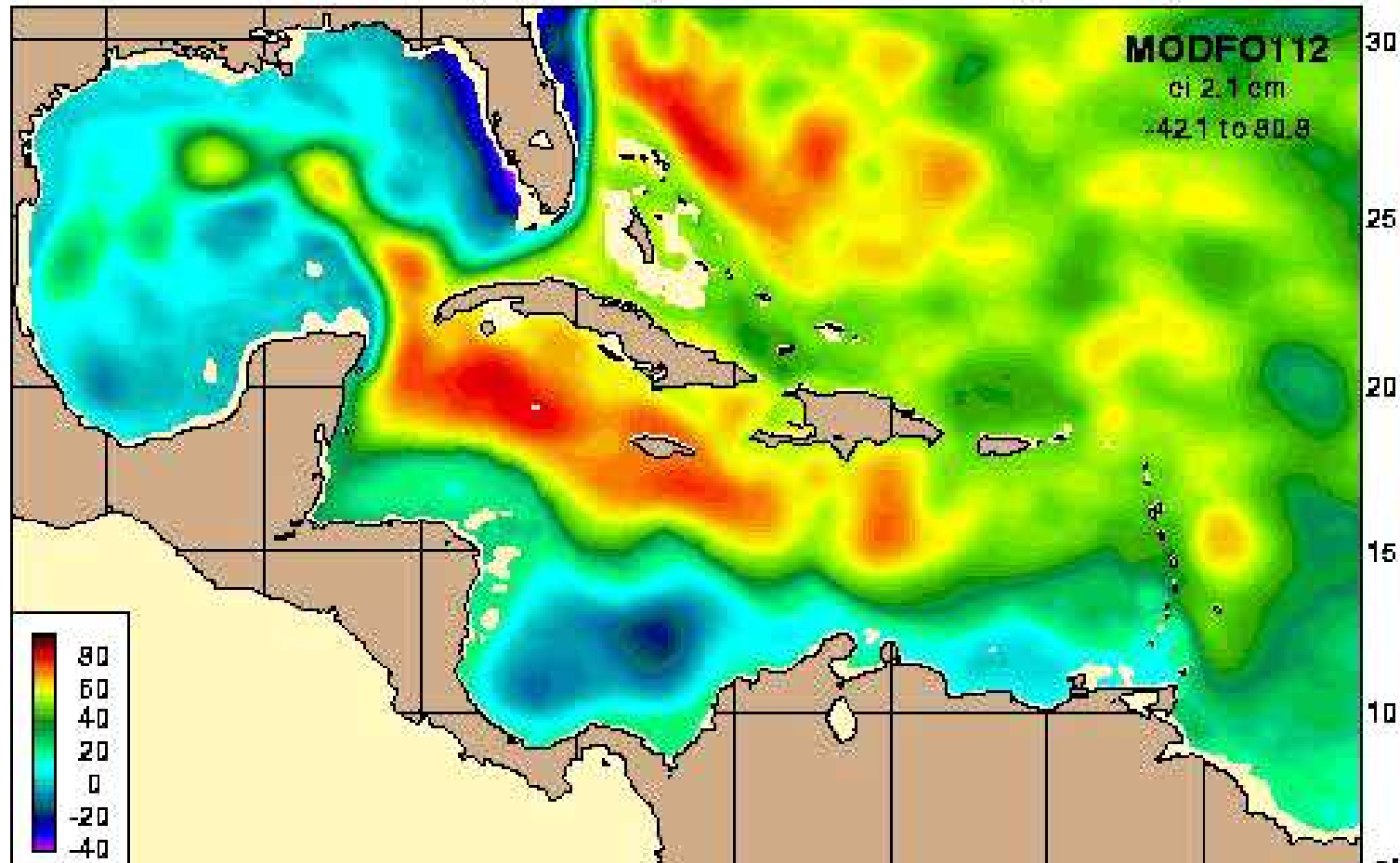- Understand connectivity across jurisdictions

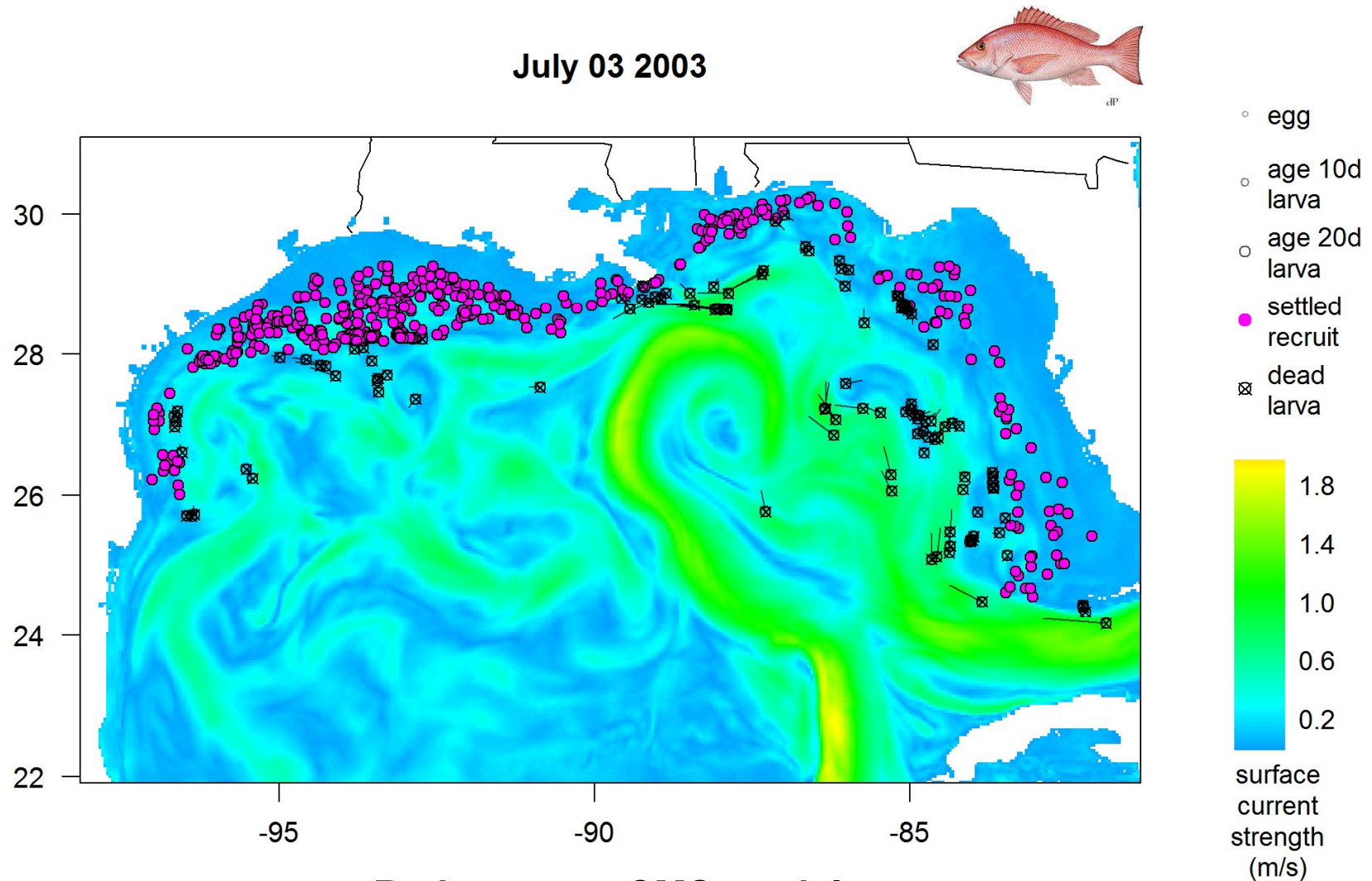# We can observe spawning, egg properties, and larval behavior…

# ...and we can observe the currents...
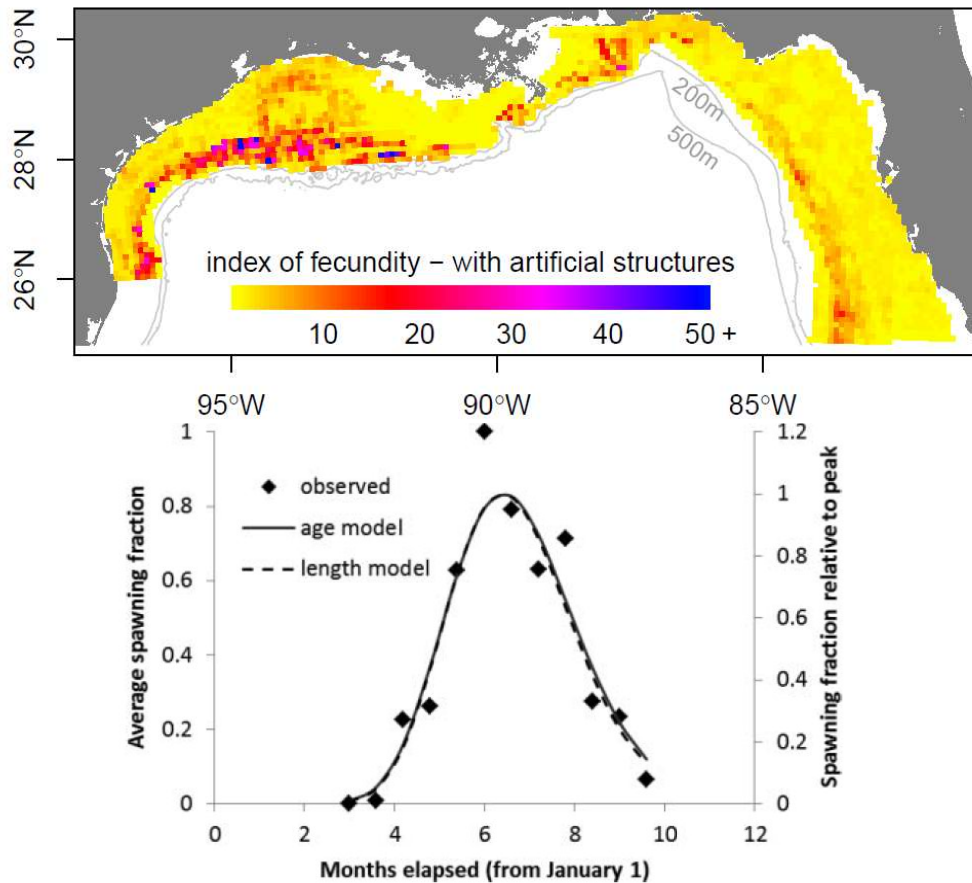


sea surf. height   Sep 21, 2005  00Z   [09.1H]

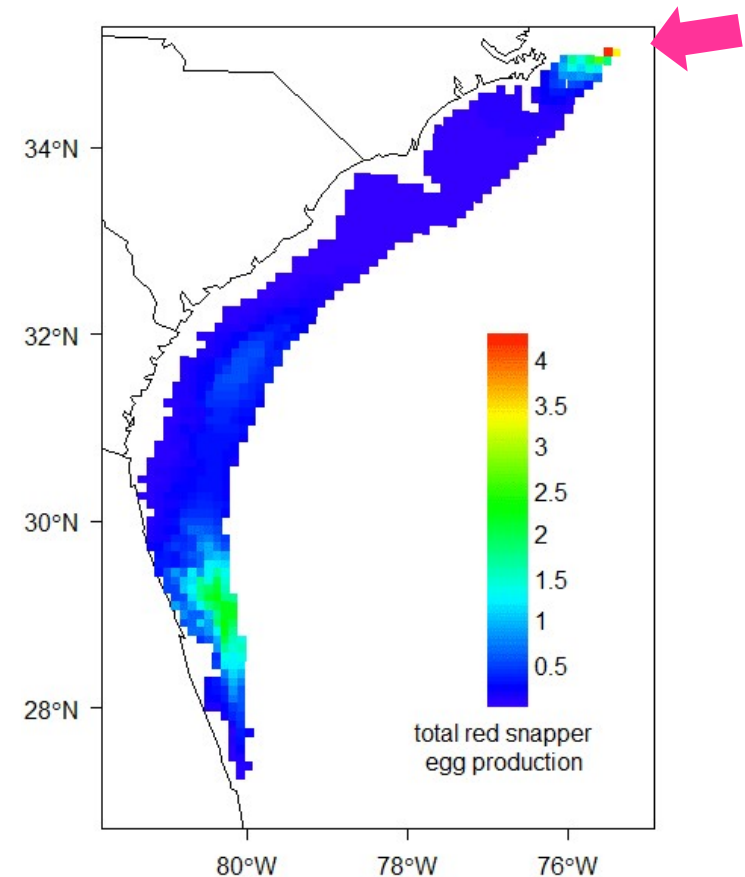# …so we can model the process of recruitment!



July 03 2003

Red snapper CMS model
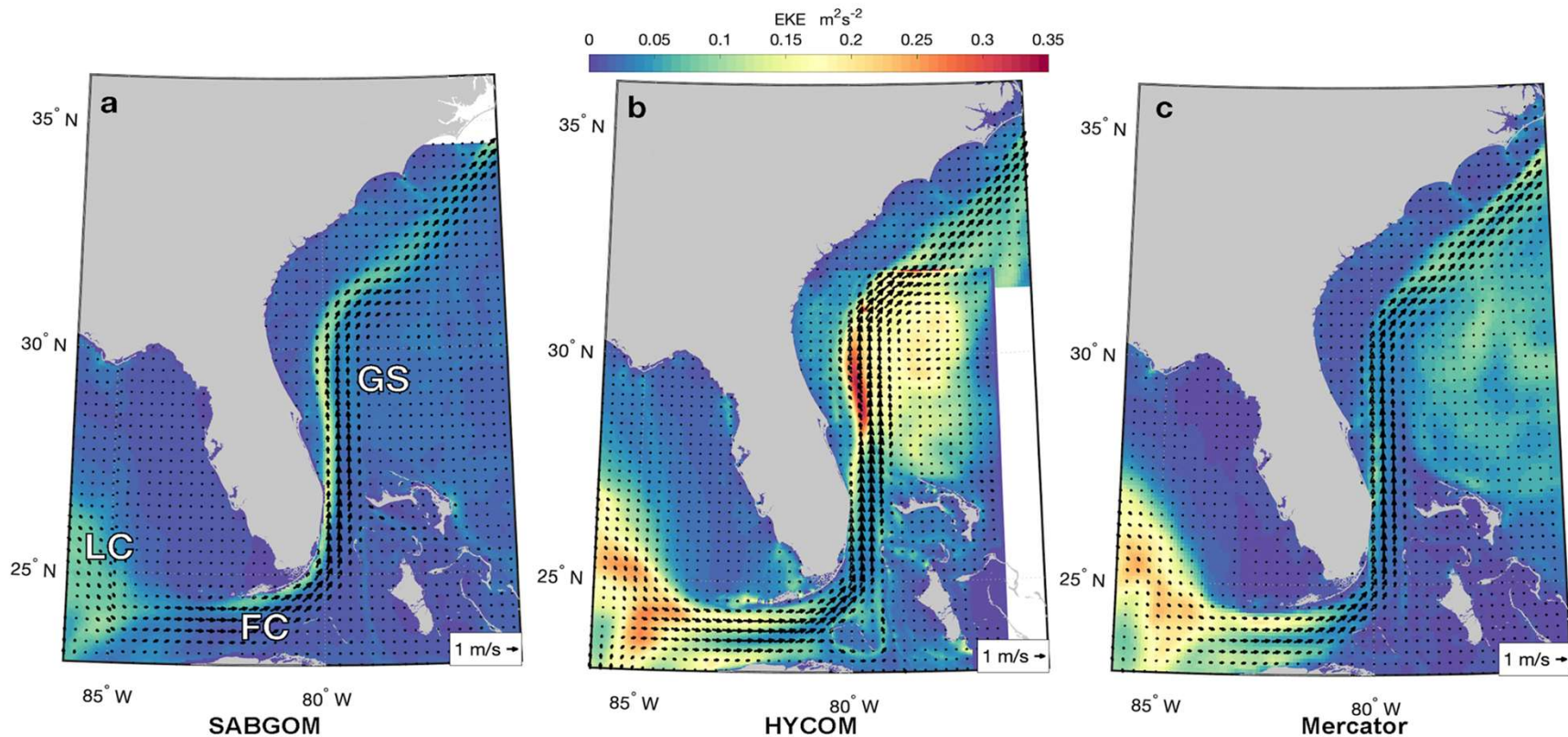
# Estimated distribution of egg production



**Gulf:** Karnauskas et al. 2017 (distribution in space)
x Porch et al. 2015 (distribution in time)

**Atlantic:** Updated from Farmer et al. 2017, spatiotemporal GAM predictions of egg production

# Sensitivity runs considered



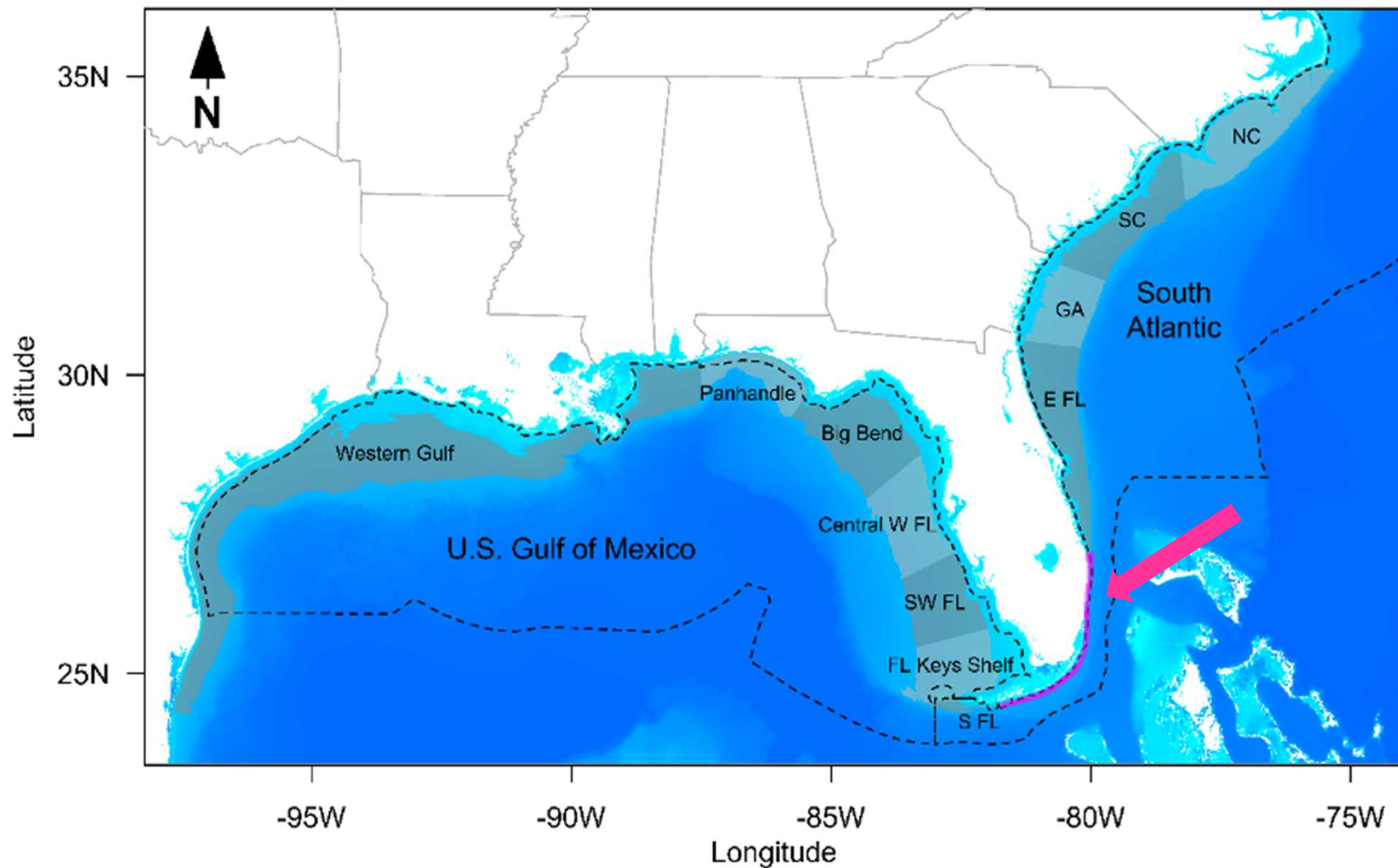| | SABGOM | HYCOM | Mercator |
|---|---|---|---|
| **Horizontal resolution** | 1/25° | 1/25° | 1/12° |
| **Vertical resolution (in upper 100m)** | 20 layers | 20 layers | 22 layers |
| **Years of simulation** | 2006 - 2010 | 2014 - 2018 | 2013 - 2017 |
| **Type of product** | Hindcast | Hindcast | Reanalysis |

# Sensitivity runs considered
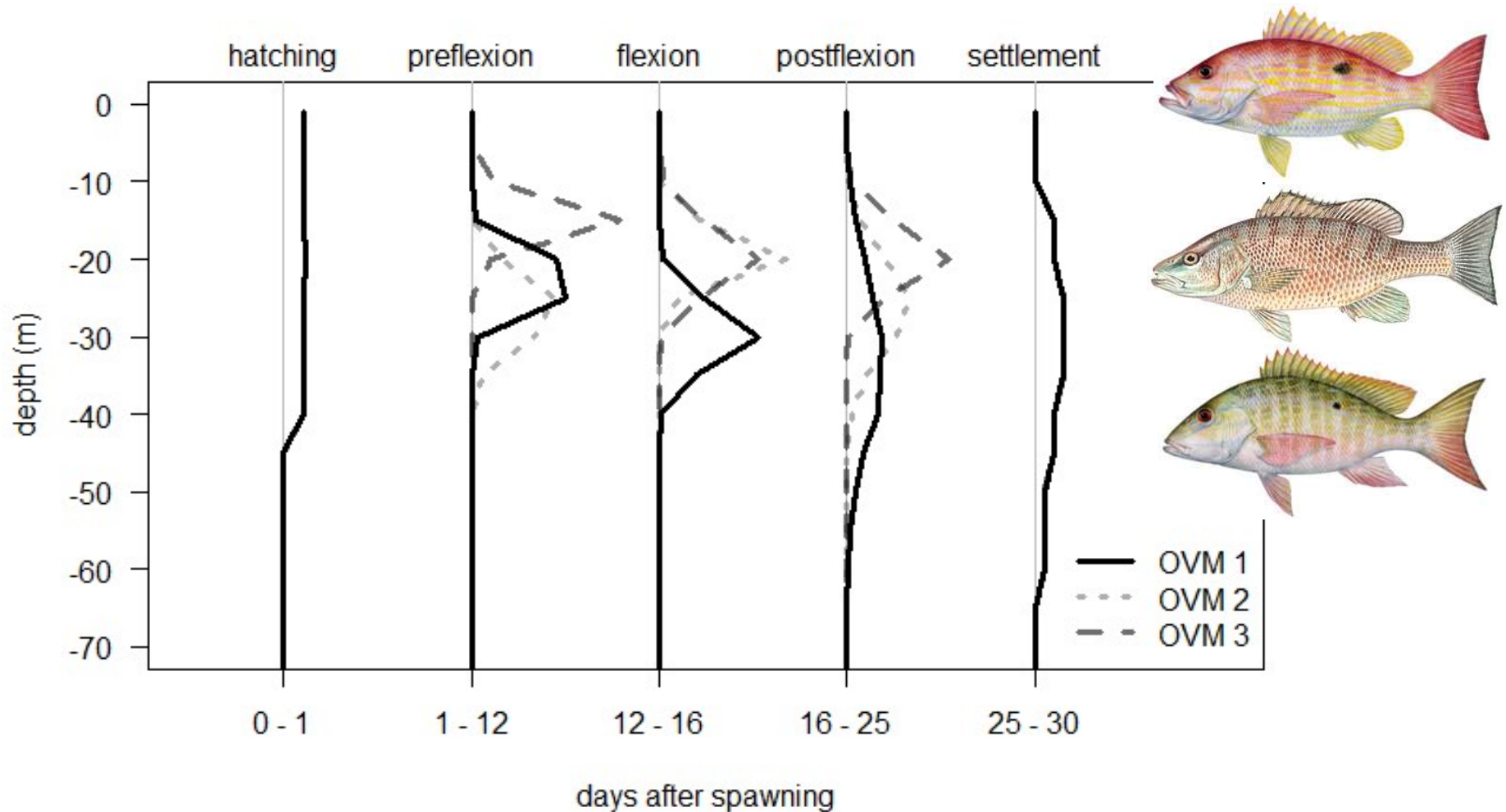
# Sensitivity runs considered

# What areas of the GoM are seeding Atlantic?



Of particles released from spawning locations in the Gulf of Mexico, which have the ability to successfully recruit in the Atlantic?

Legend:
- Yellow: All trajectories from GoM spawning areas
- Black circle: Source locations of larvae settling in Atlantic
- Red circle: Settlement locations of larvae settling in Atlantic
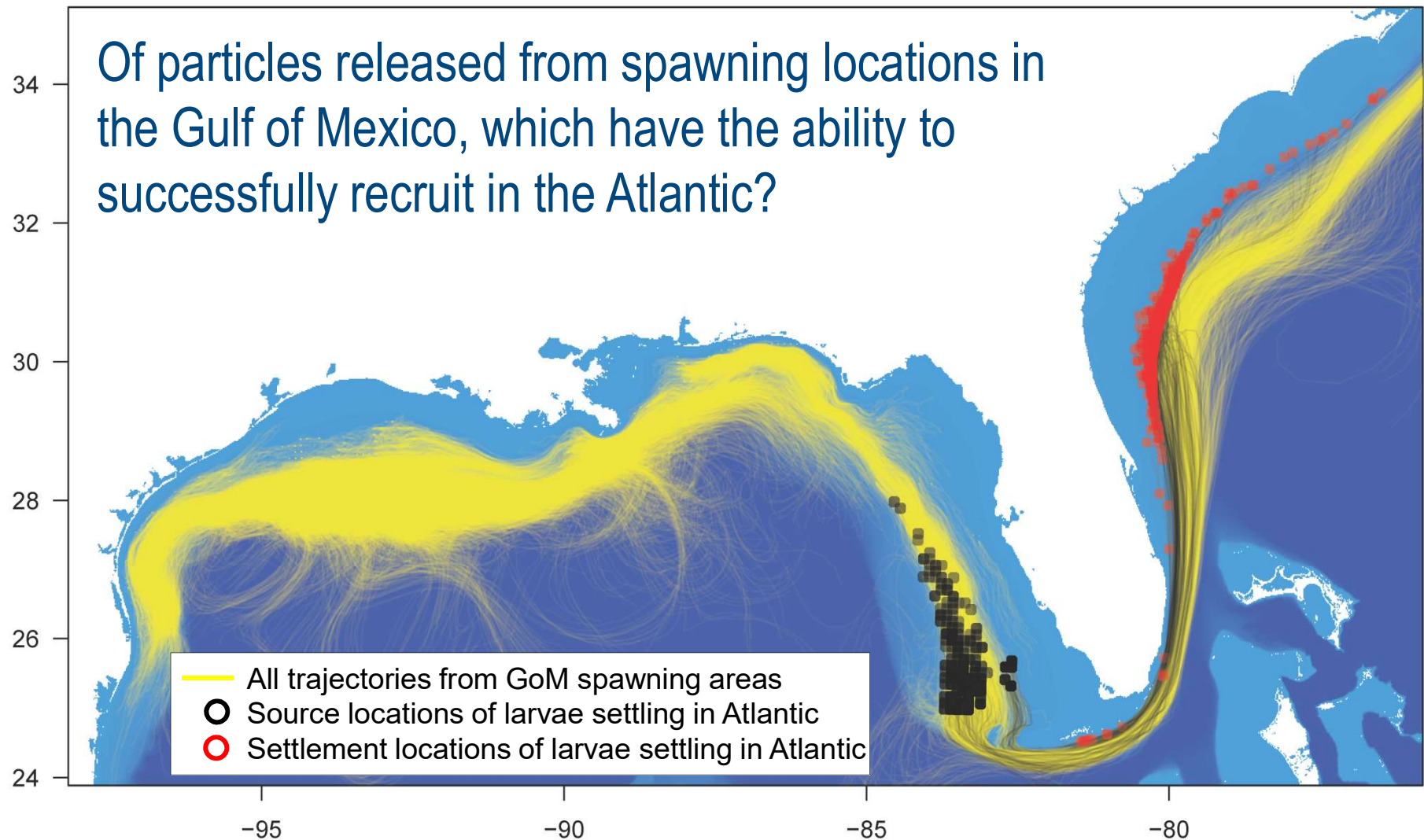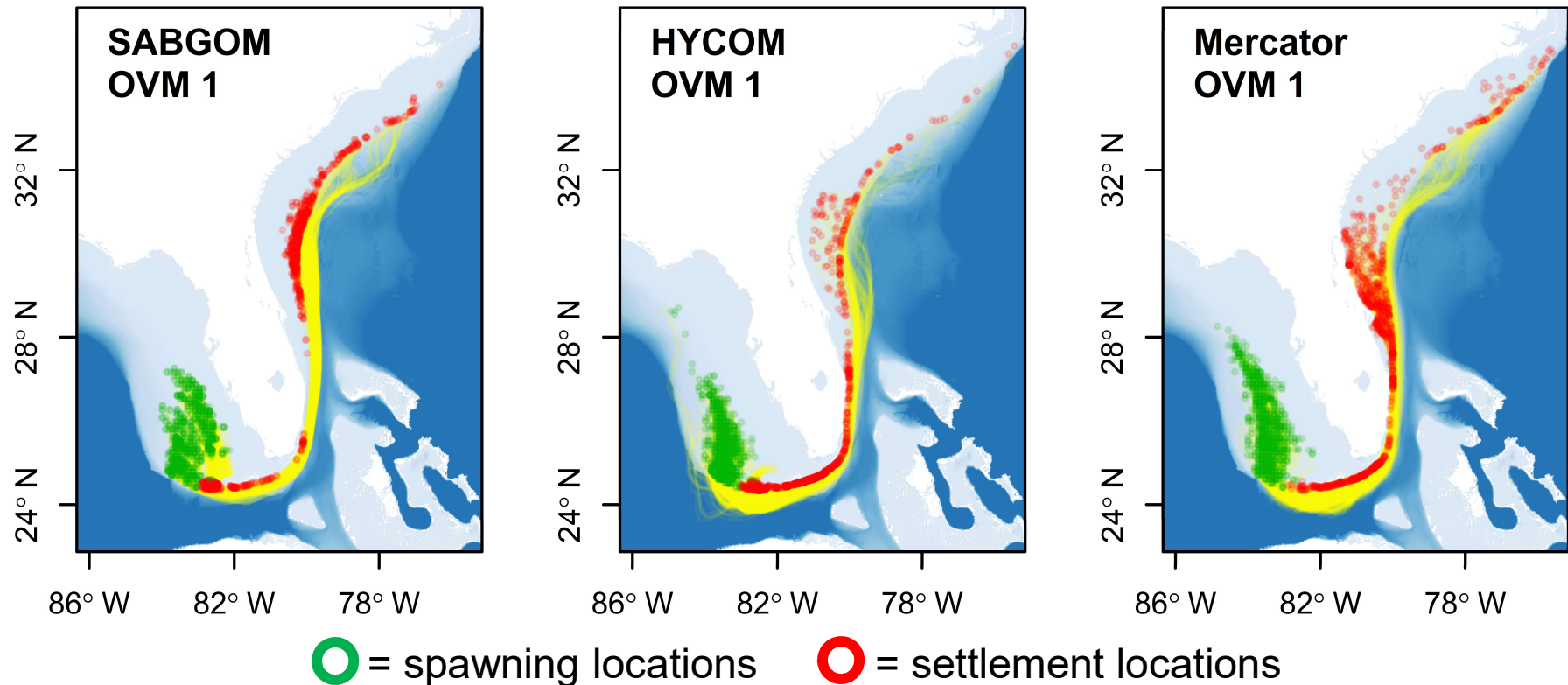
# What areas of the GoM are seeding Atlantic?

Model estimates larval supply to Atlantic limited to West Florida Shelf (Big Bend and south)



○ = spawning locations     ○ = settlement locations

# Biomass hotspot off NC

- Accounts for 16% of the total egg production in the region (but northern extent of hotspot unresolved)
- Separate hi-resolution oceanographic models for dynamic area



SABGOM — 9.1%
HYCOM — 14.1%
Mercator — 2.3%
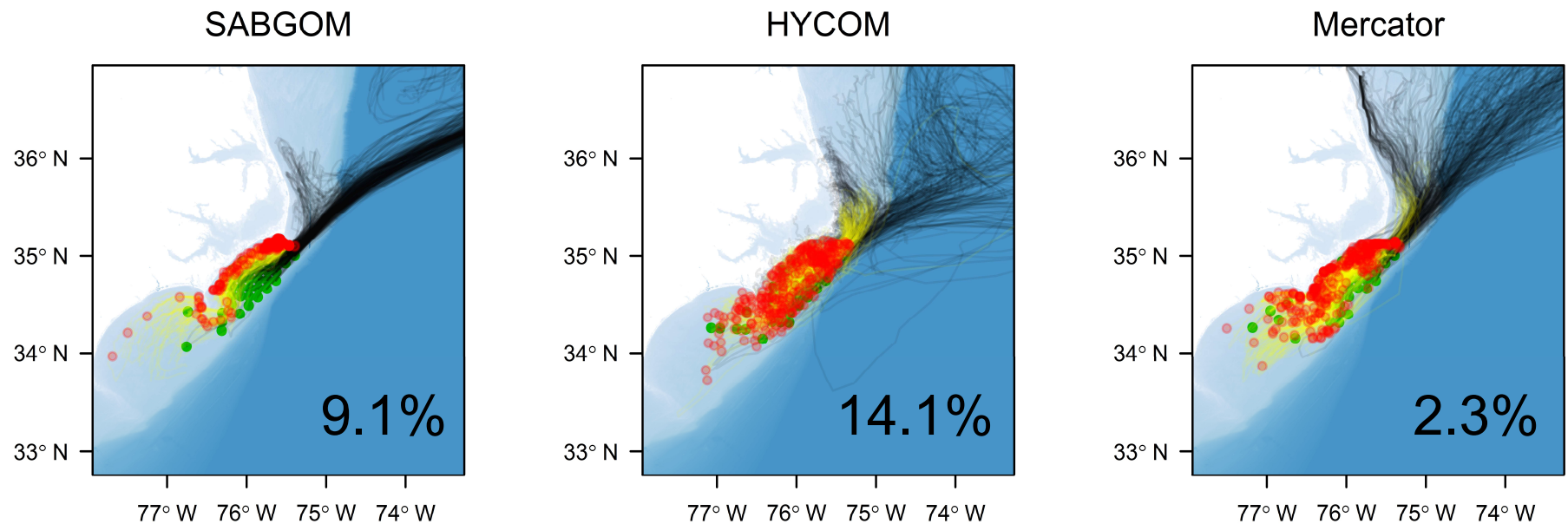
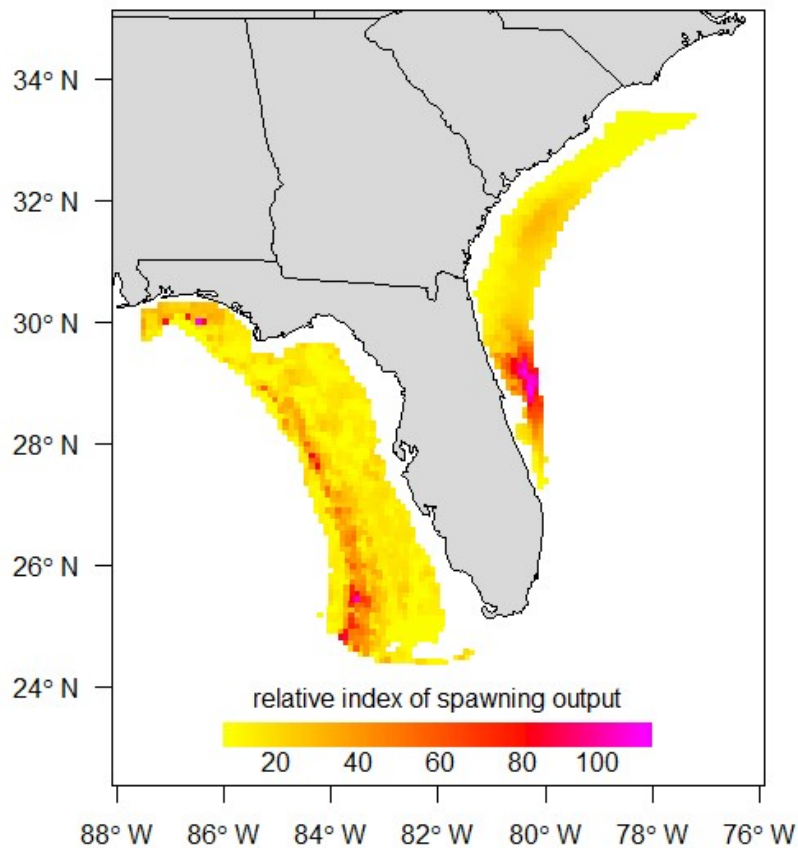🟢 = spawning locations  🔴 = settlement locations, % of particles successfully settling

## Relatively low self-recruitment, negligible contribution south of NC

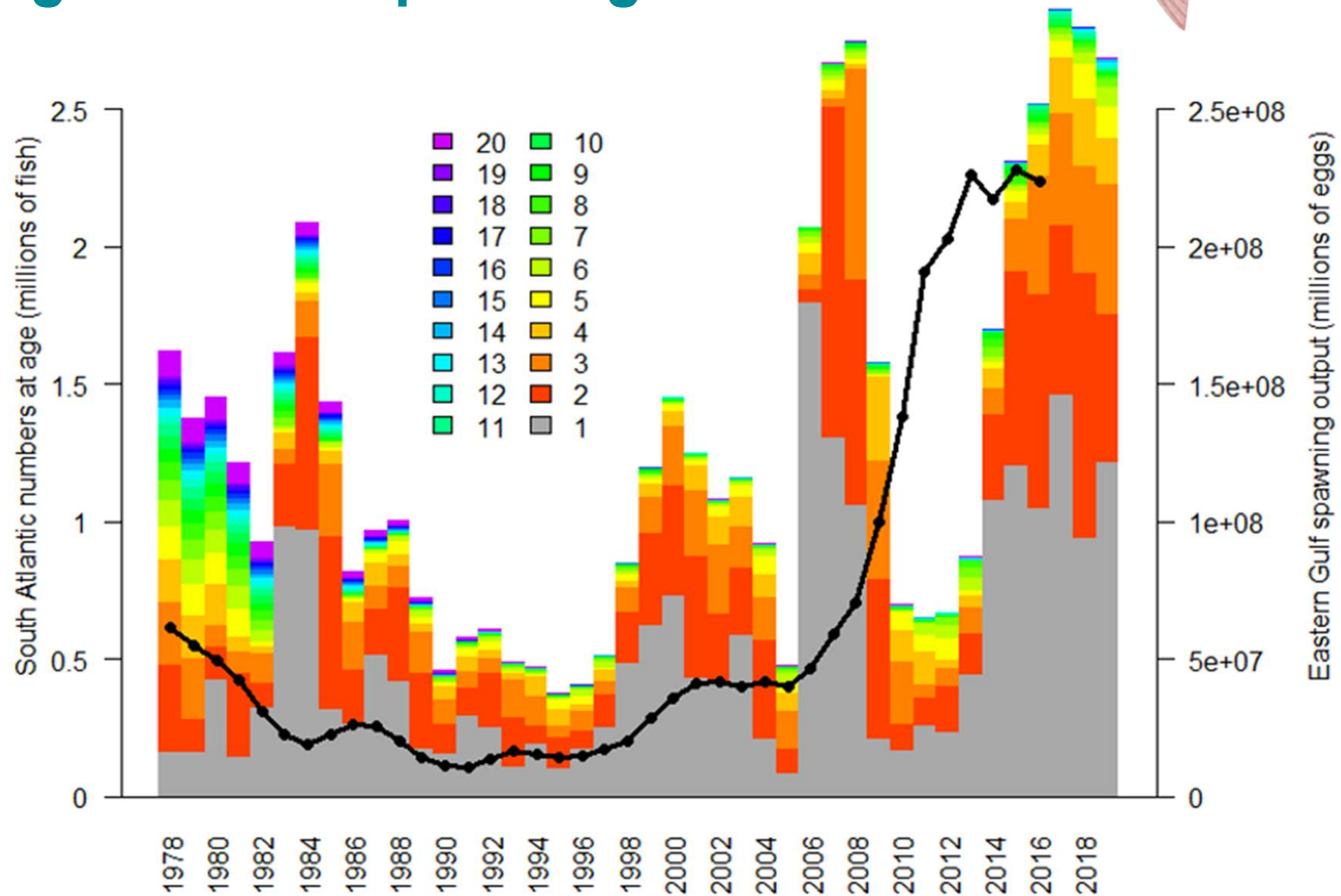# Overall estimated Gulf-Atlantic connectivity



With Florida Keys          Without Florida Keys
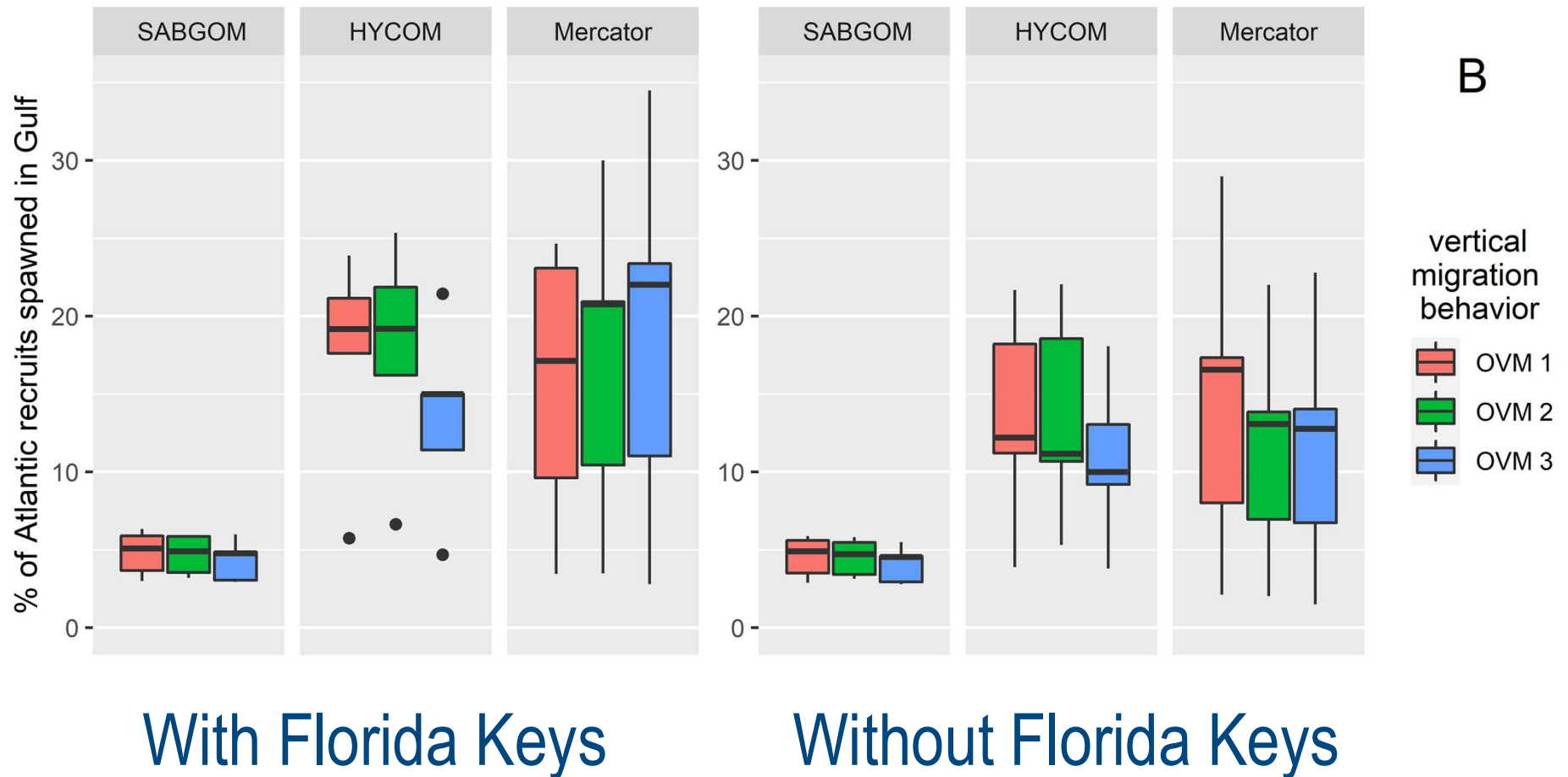
# Contributions dependent on ratio of egg production



| Gulf:Atlantic ratio | Overall |
|---|---|
| 1:1 | 11.0 (2.8–34.8) |
| 2:1 | 18.6 (5.6–51.2) |
| 3:1 | 27.2 (8.1–61.3) |
| 4:1 | 34.5 (10.6–68.0) |
| 5:1 | 38.6 (13.0–72.4) |
| 6:1 | 41.7 (15.1–76.0) |
| 7:1 | 46.2 (17.3–79.8) |
| 8:1 | 49.8 (19.4–81.0) |
| 9:1 | 52.8 (21.1–82.6) |
| 10:1 | 56.6 (22.9–84.1) |

# Number of Atlantic red-snapper at-age vs. Gulf spawning

# Thank you

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Fisheries and the Environment

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