Understanding Larval Fish Ingress into Estuarine Nurseries: Advantages of a Long-Term Sampling Program

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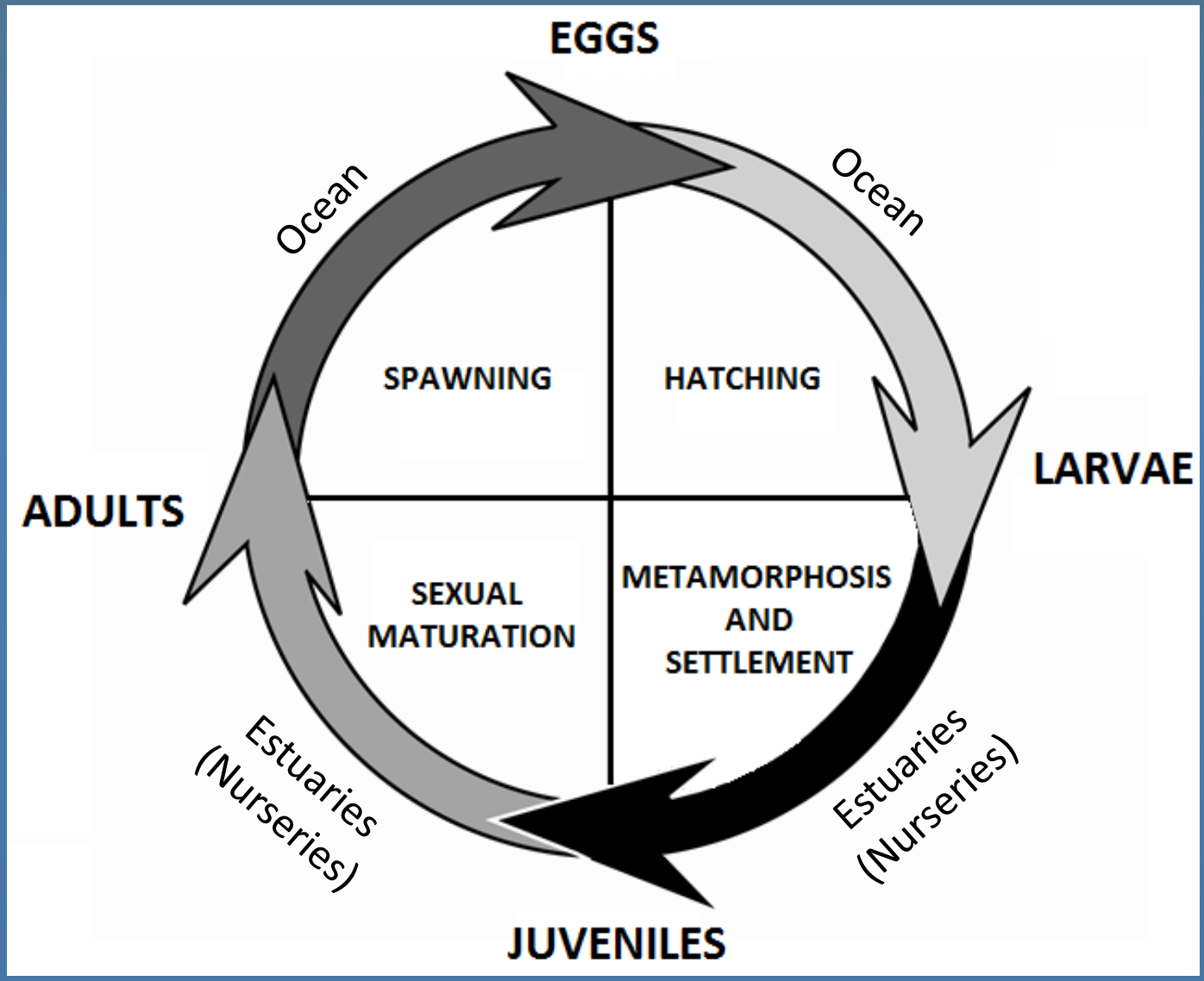
Estuarine Dependent Fishes have Complex Life Histories

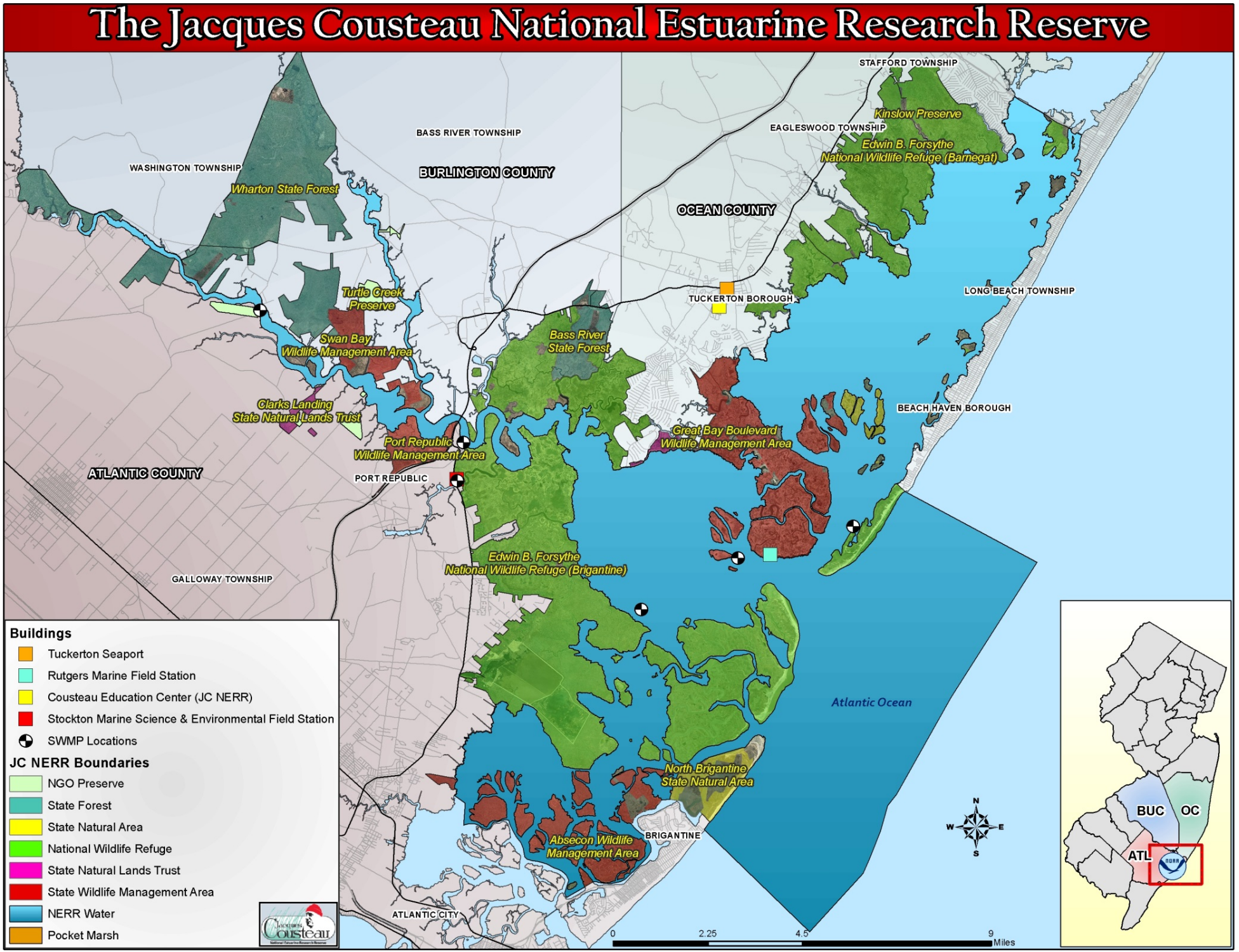


The Ecology of Place

- Pursuit of a general understanding through the detailed understanding of a particular place
- “Place” incorporates a spatial location (often an intact ecosystem) and time period (frequently long term)
- Best practiced at terrestrial and marine field stations

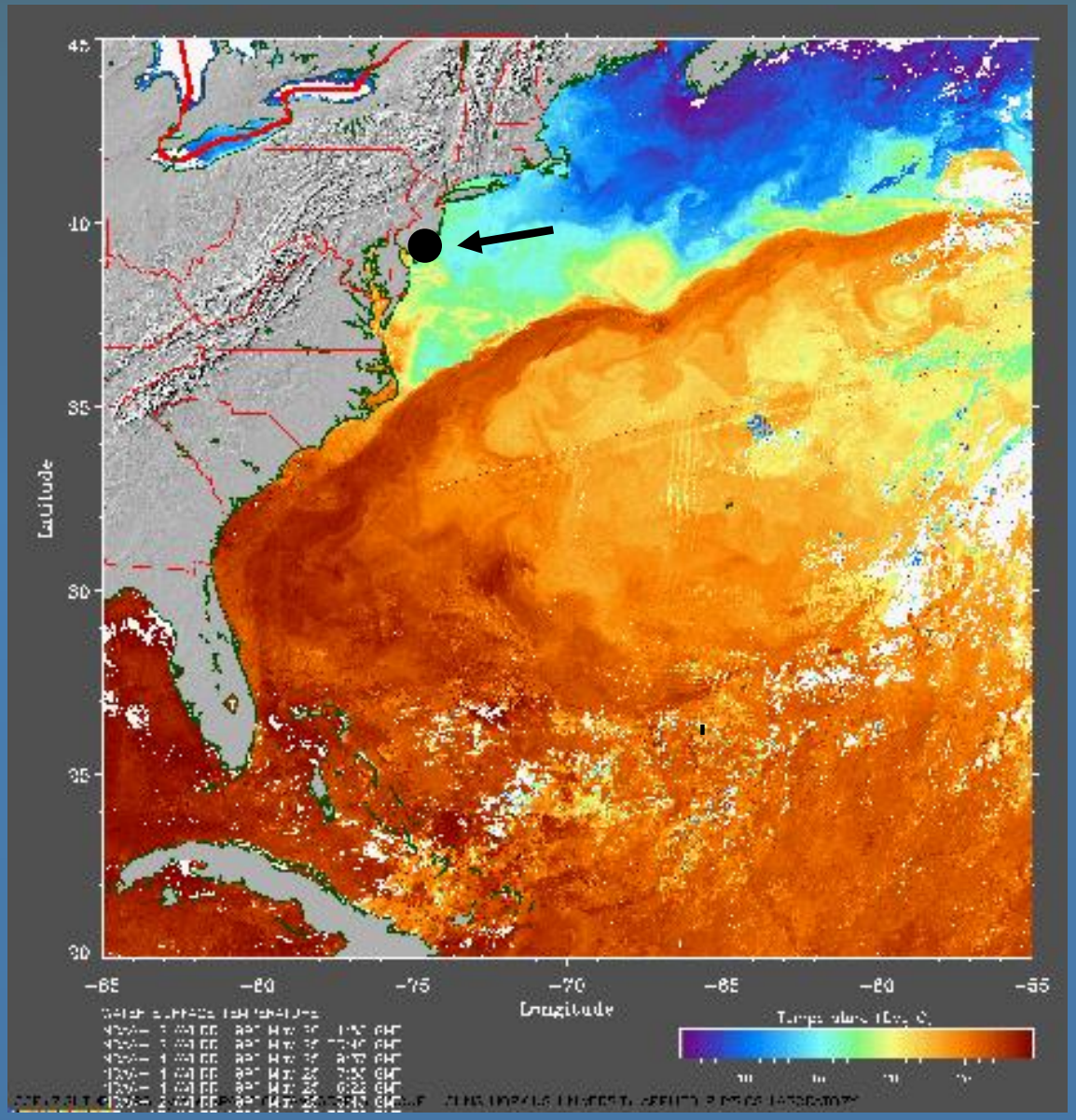
Billick, I. and M.V. Price. 2010.The ecology of place: Contributions of place-based research to ecological understanding. University of Chicago Press, Chicago, IL.

The Jacques Cousteau National Estuarine Research Reserve



Primary Study Site

- Relatively unaltered inlet and estuary
- Long term data sets
  - Temperature
  - Larval fish
  - Juvenile fish



Methods at Little Egg Inlet, NJ

- Weekly, night time sampling on flood tides from 1989-Present
- Sampling with plankton nets (1m with 1mm mesh)

Values of This Approach

Potential Disadvantages

- Taxonomically diverse – some larvae poorly described
- Sample sorting can be time consuming

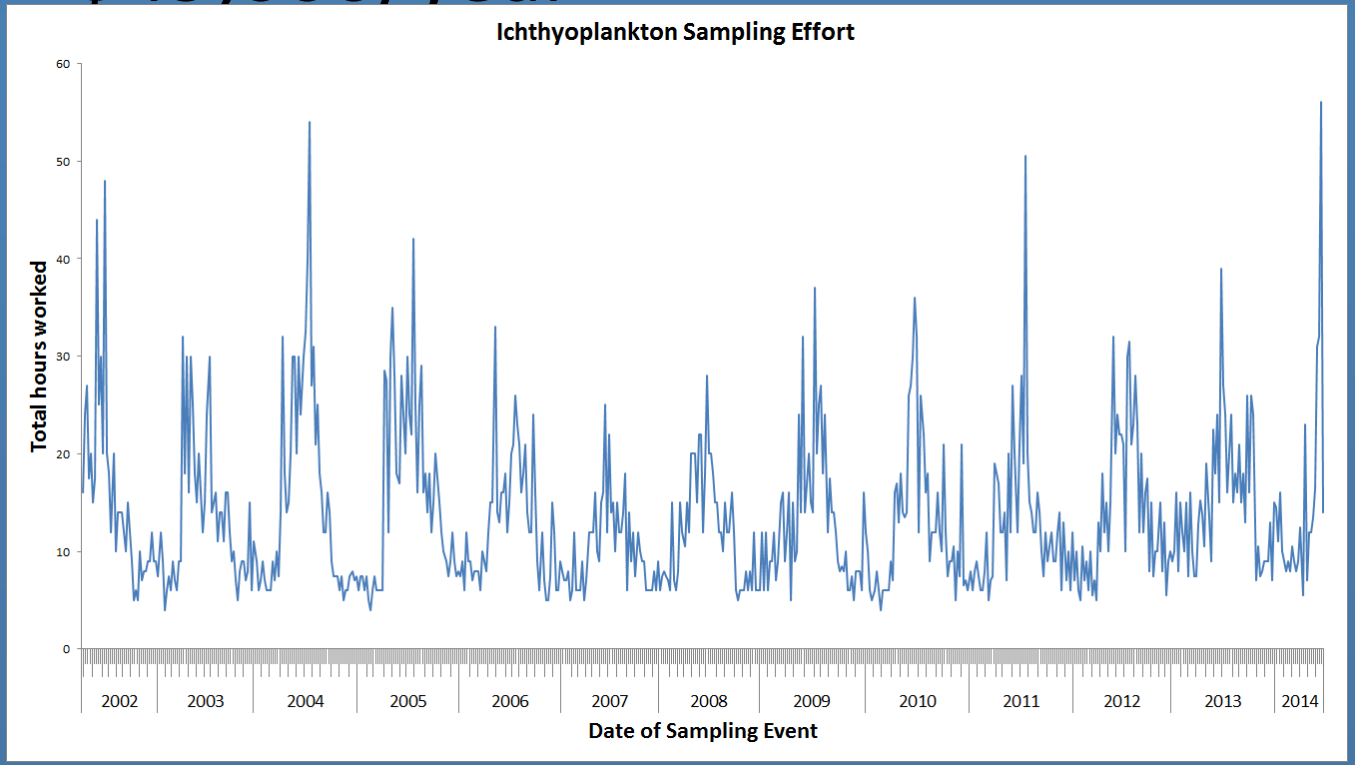
Potential Advantages

- Relative ease of sampling
- Large number of species represented
- Many economically important
- Fishery independent indices
- Focus on larval ingress – better estimates of year class strength
- Multiple metrics (abundance, size, stage, condition, otolith [sources for microchemistry, daily aging, hatch dates, growth])

Costs at Little Egg Inlet

- Sample collection
- Equipment/Supplies
- Data entry/ Data checking/Verification

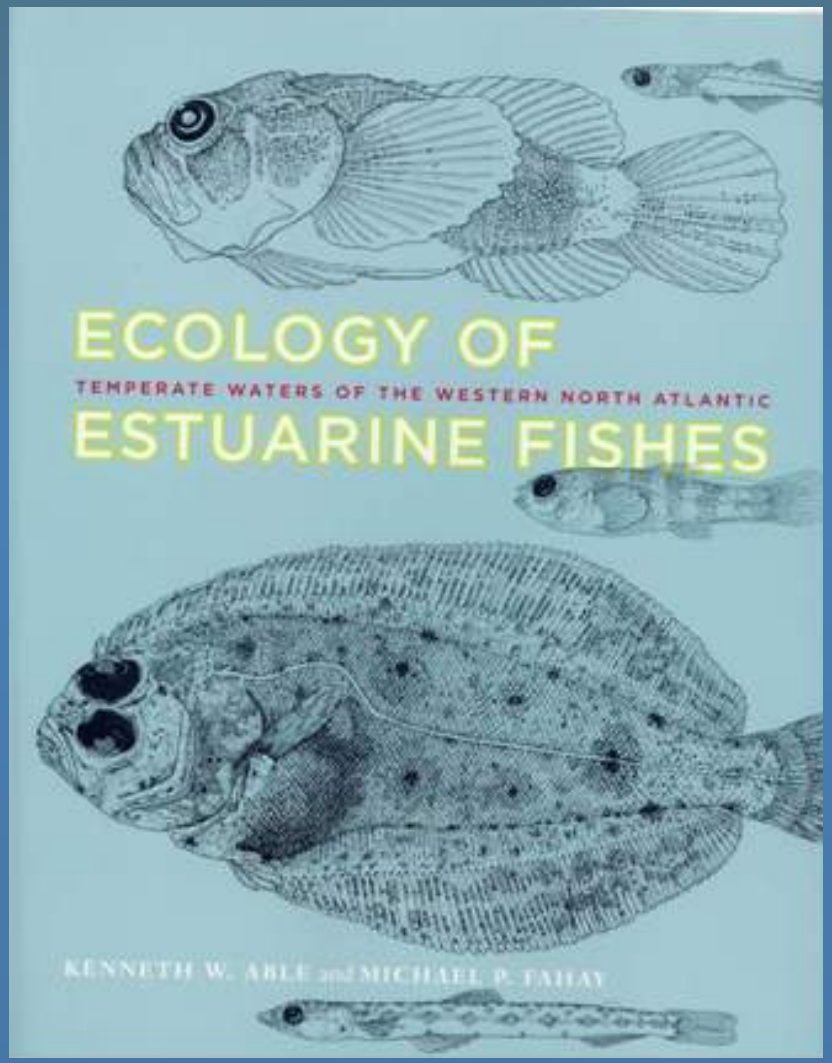
Total ~ $49,000/year



Volunteers

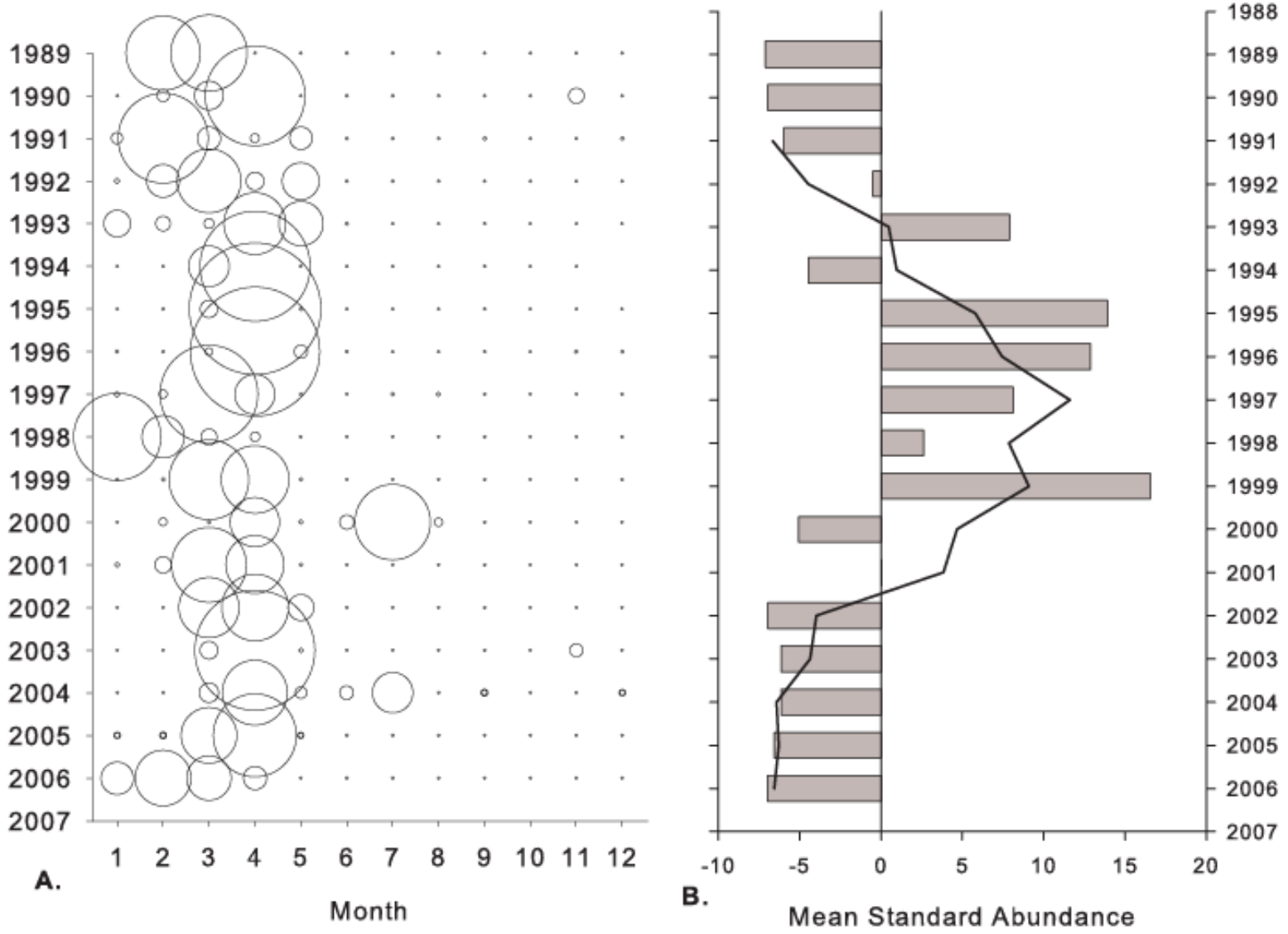
- Contribute ~250 – 350 hrs/yr
- Contribute as ambassadors to local communities

Results



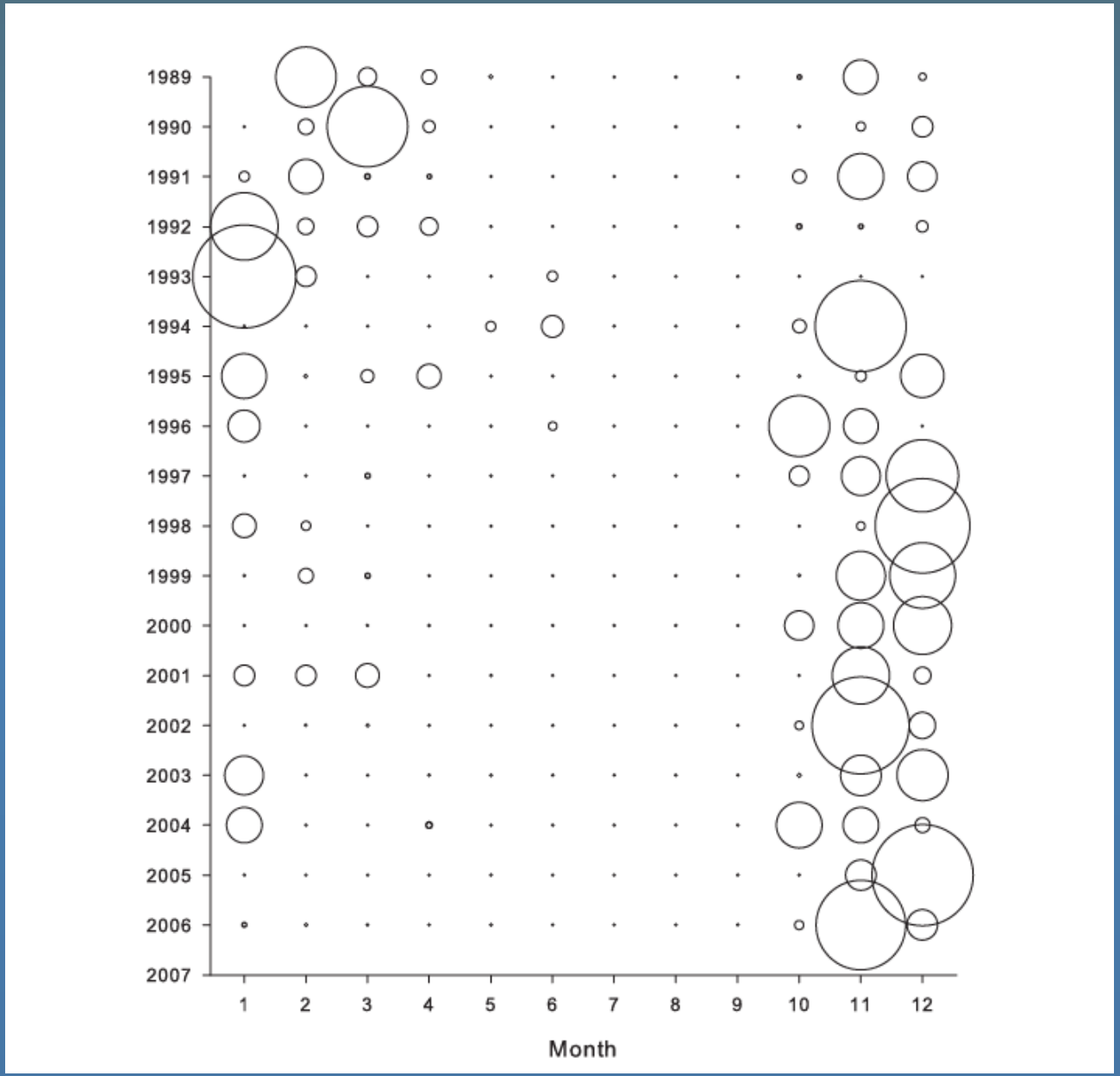
- Provided enhanced understanding of reproduction, larval periodicity, and growth for 90+ species

Atlantic herring



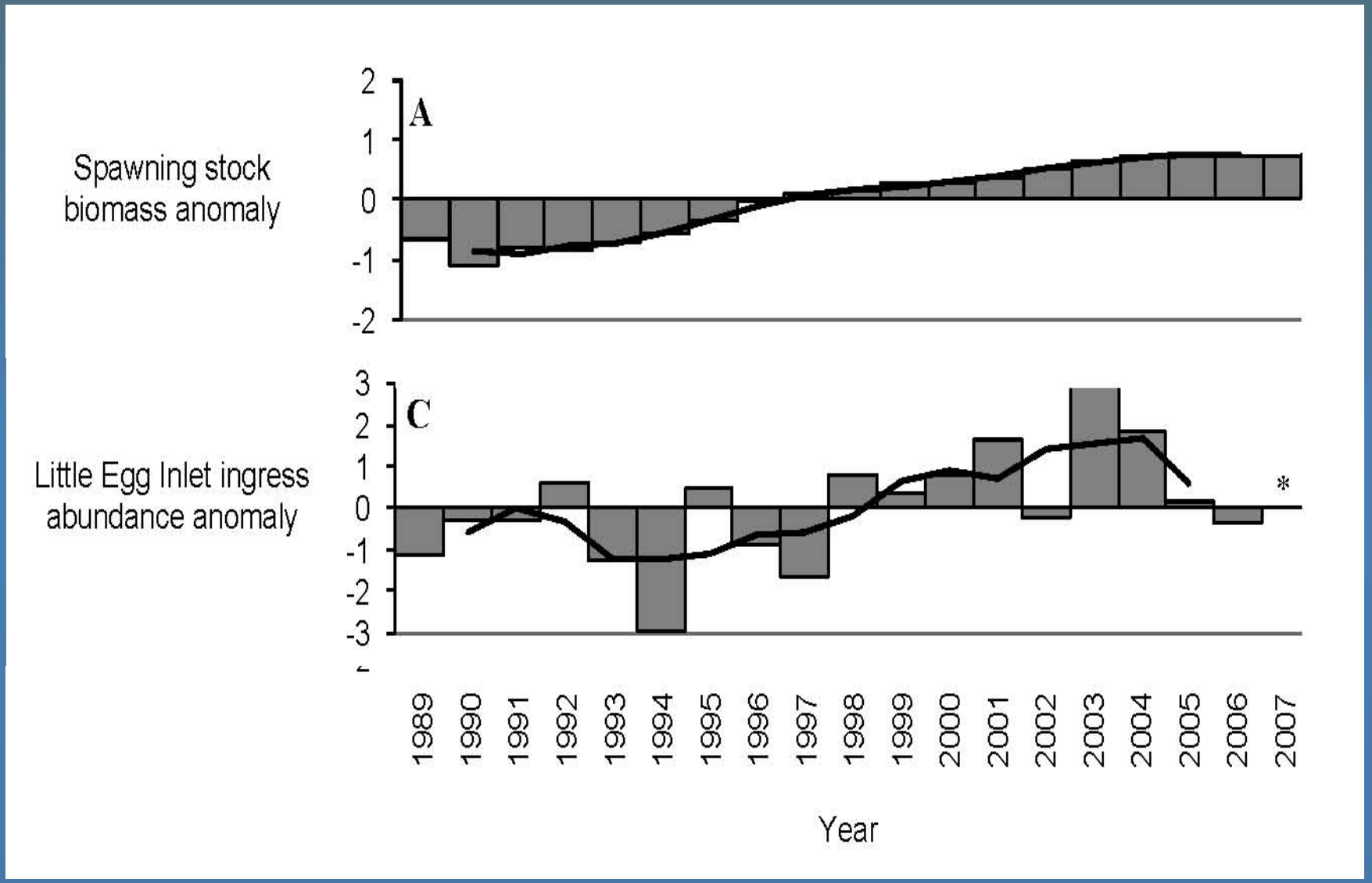
(Able and Fahay 2010)

Summer flounder



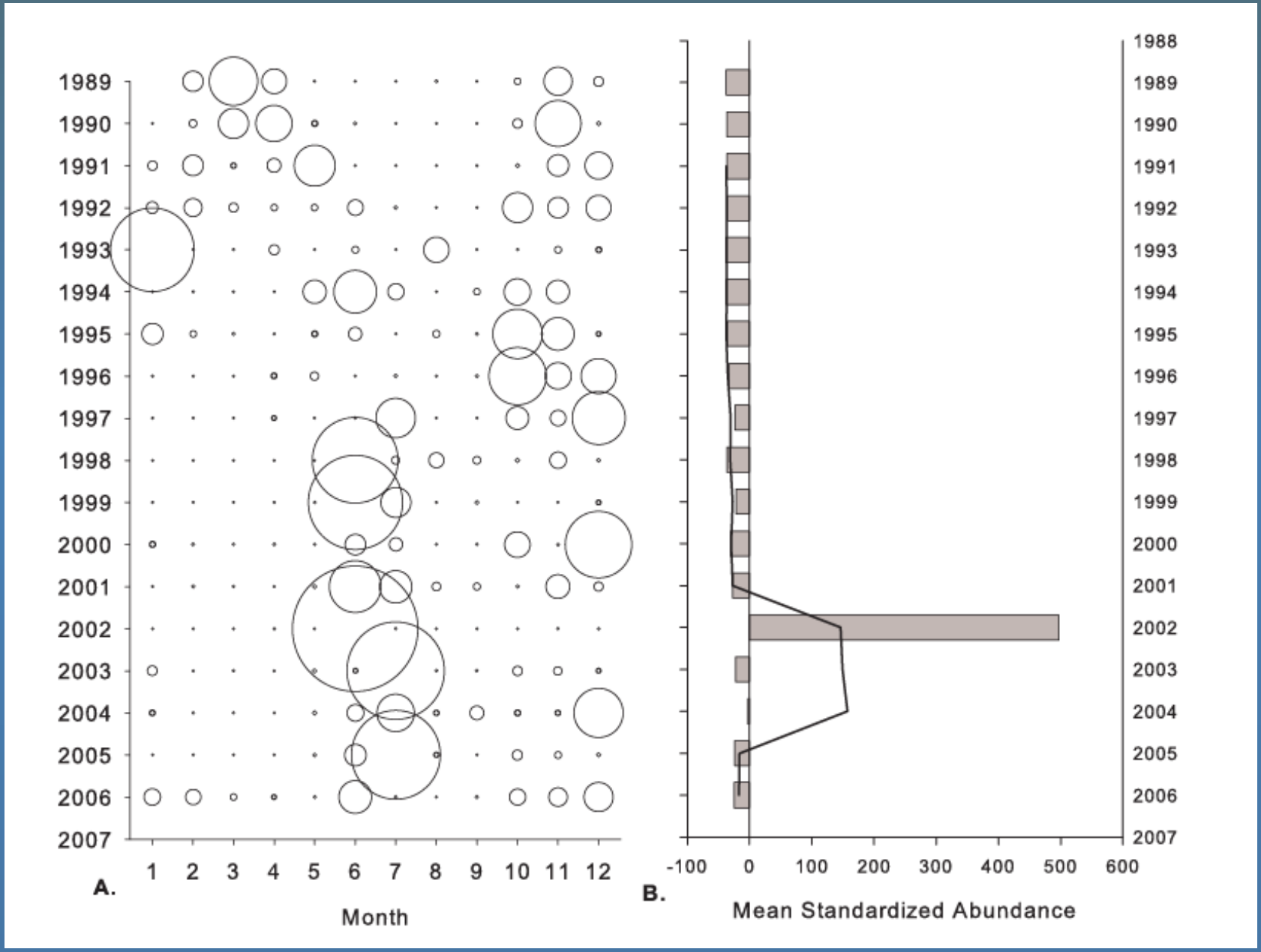
(Able and Fahay 2010, Able et. al, 2011)

Summer flounder

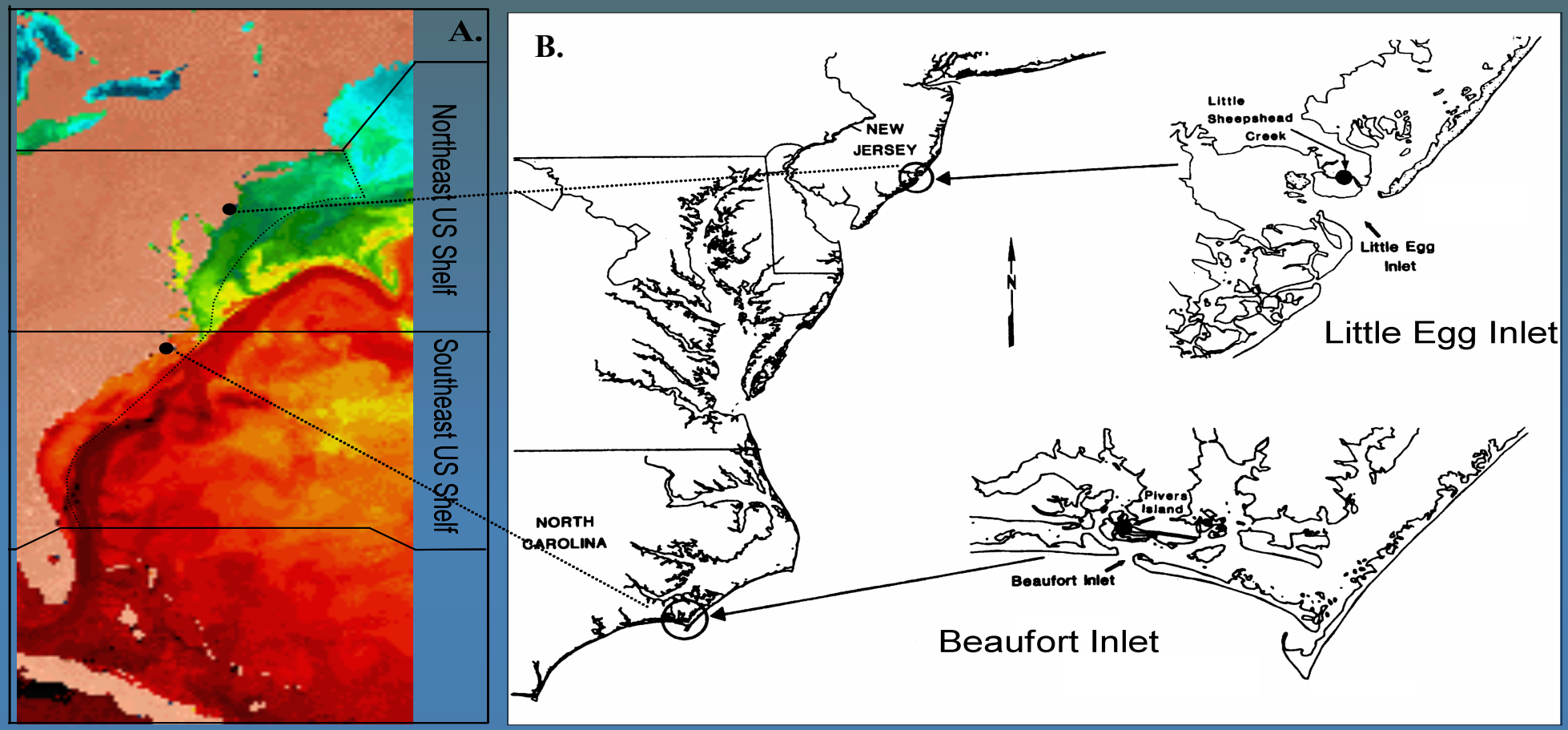


(Able et al. 2011)

Menhaden



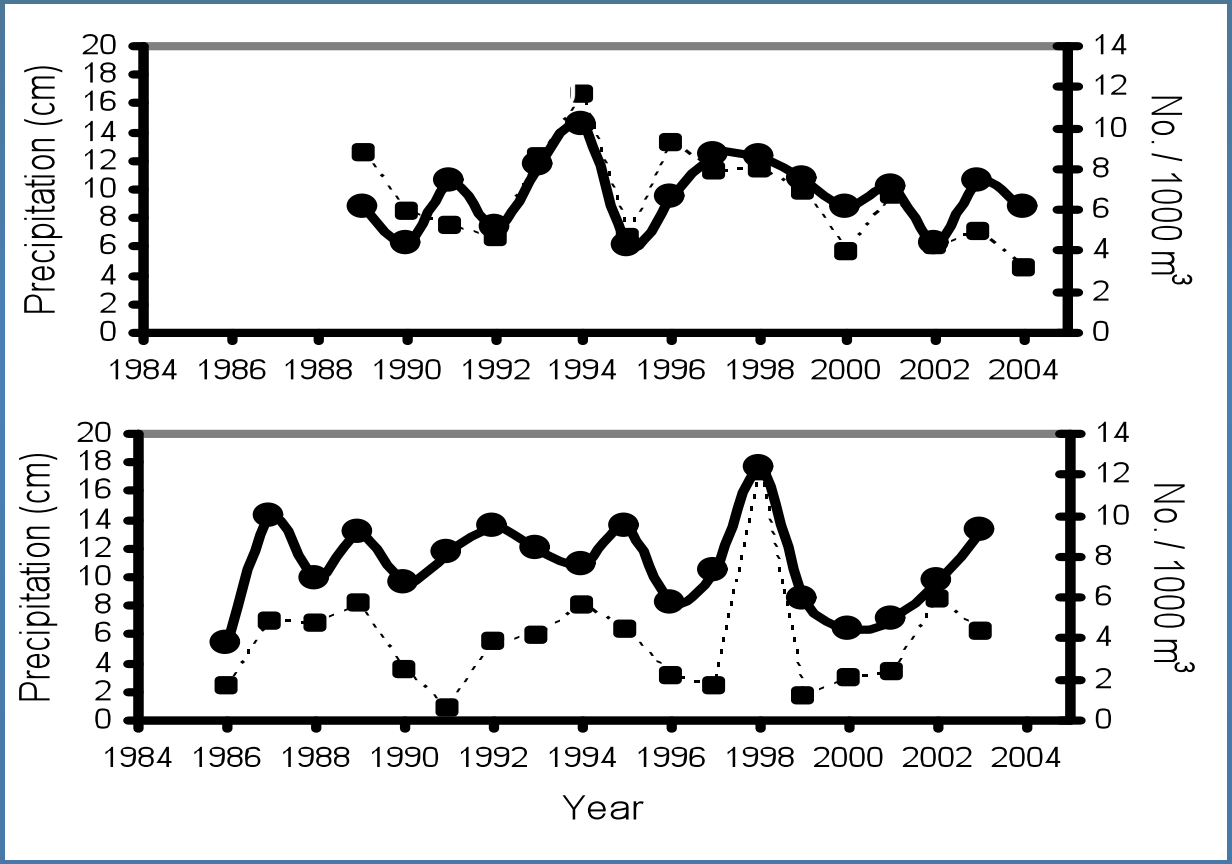
(Able and Fahay 2010)



SST satellite image **(A)** showing both the northeast and southeast U.S. shelf ecosystems. Larval ingress sampling locations **(B)** are indicated by the black dots.

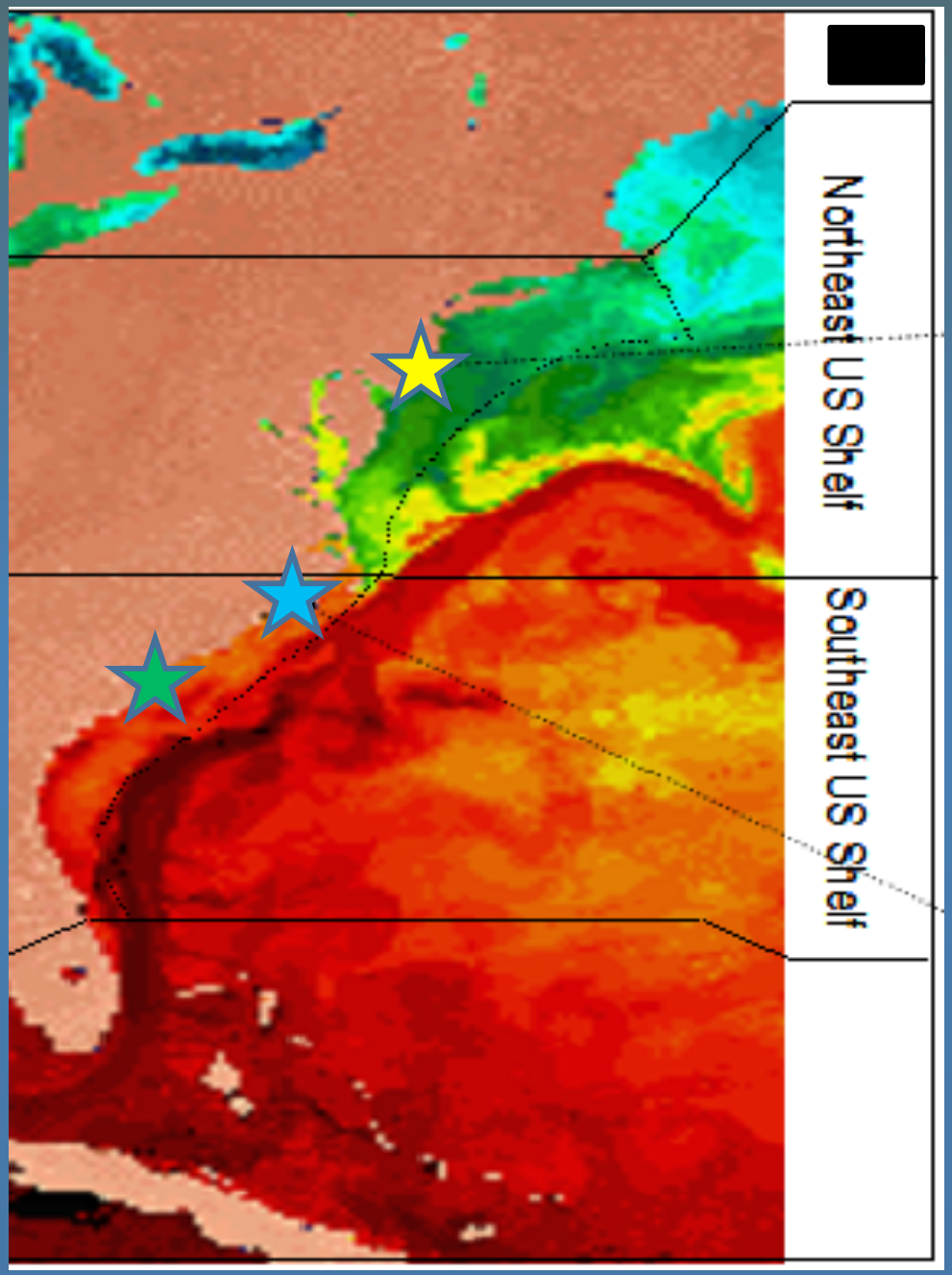
Comparisons of American Eel Ingress

Winter precipitation and ingress magnitude



- Close relationship exists between winter precipitation and abundance at both inlets

(Sullivan et al., 2006)



SST satellite image showing both the northeast and southeast U.S. shelf ecosystems.

- Little Egg Inlet
- Beaufort Inlet
- North Inlet

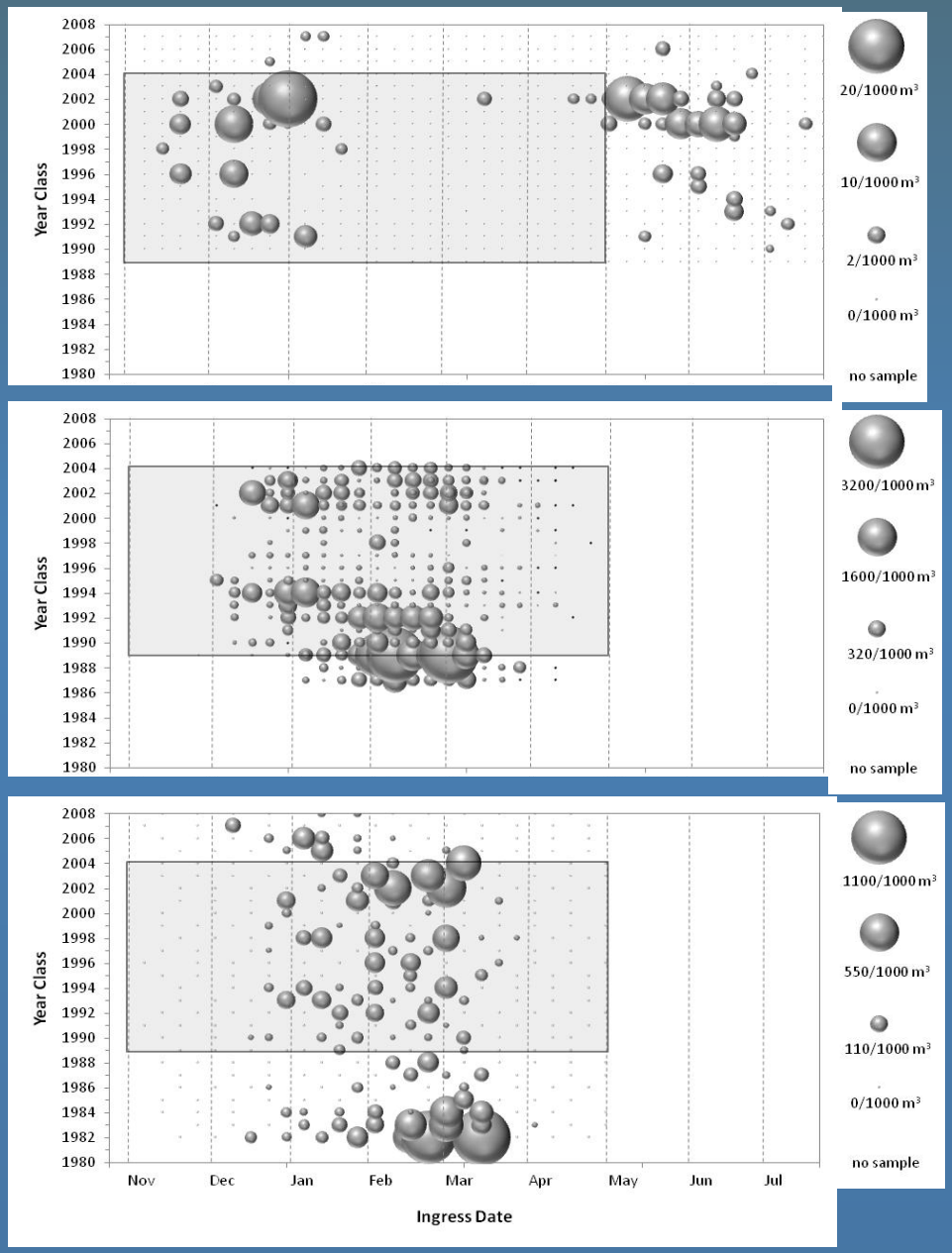
All sites associated with NERRs.

Speckled Worm Eel

Little Egg Inlet

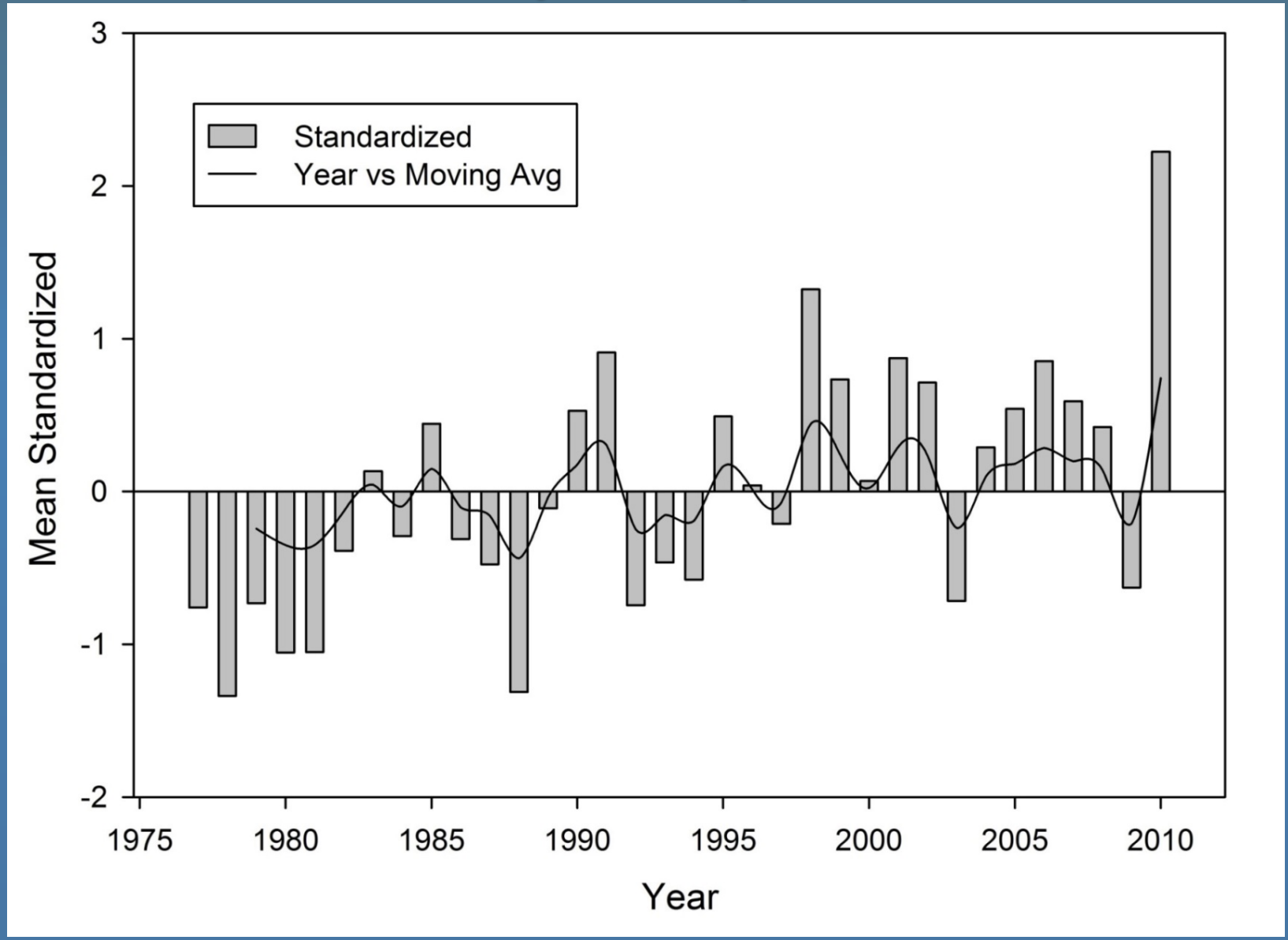
Beaufort Inlet

North Inlet

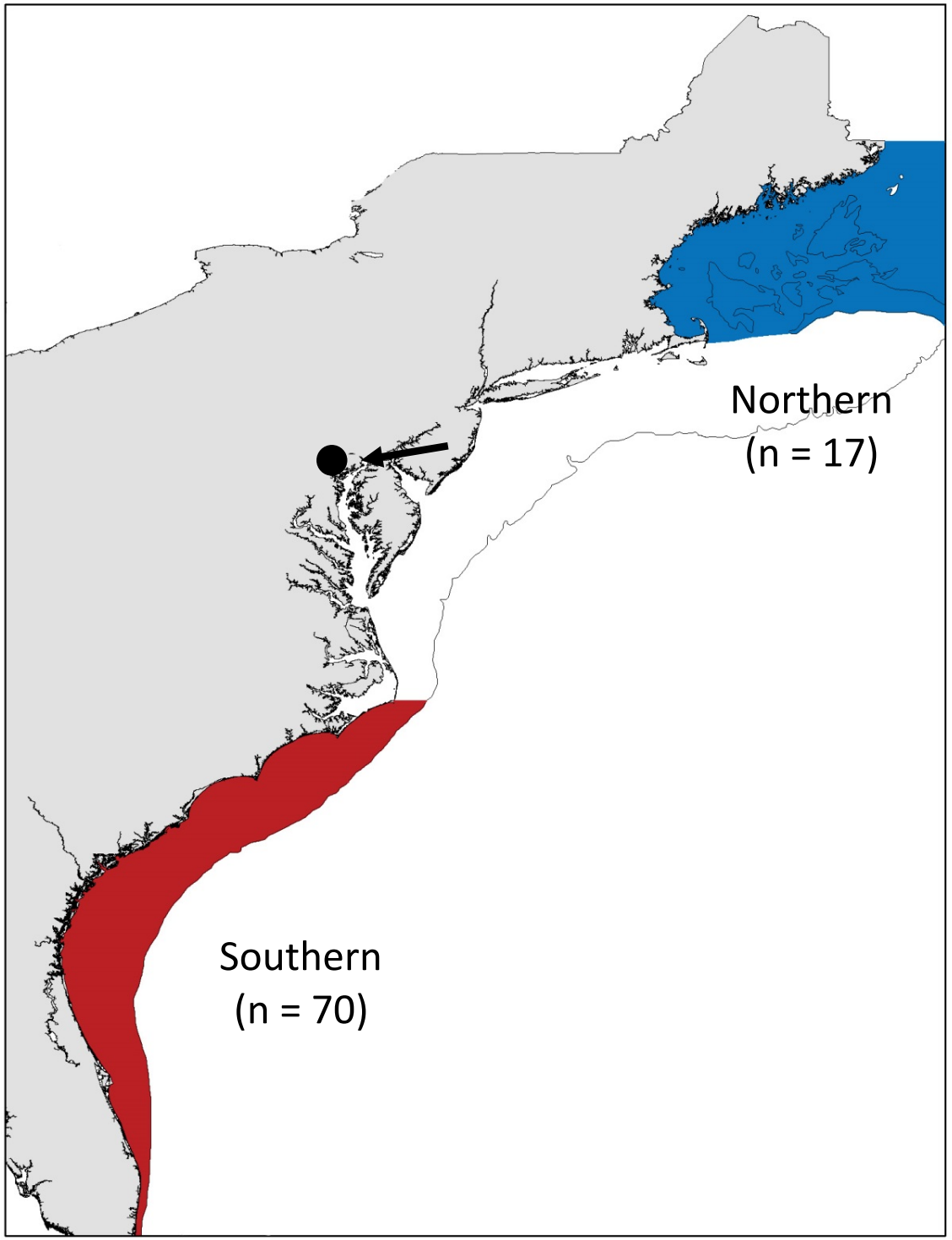


(Able et. al, 2011)

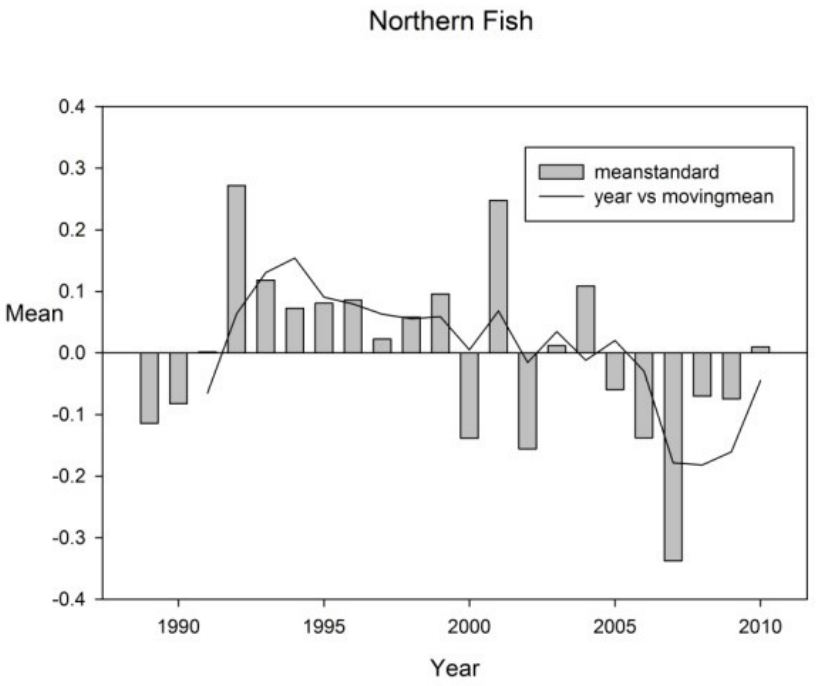
Climate Change: Long term trends in Great Bay temperatures

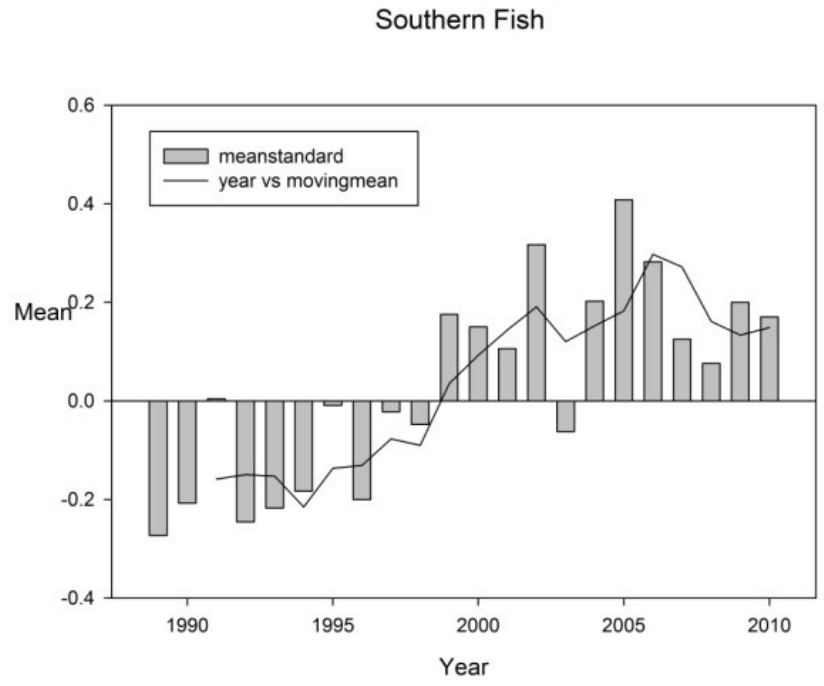


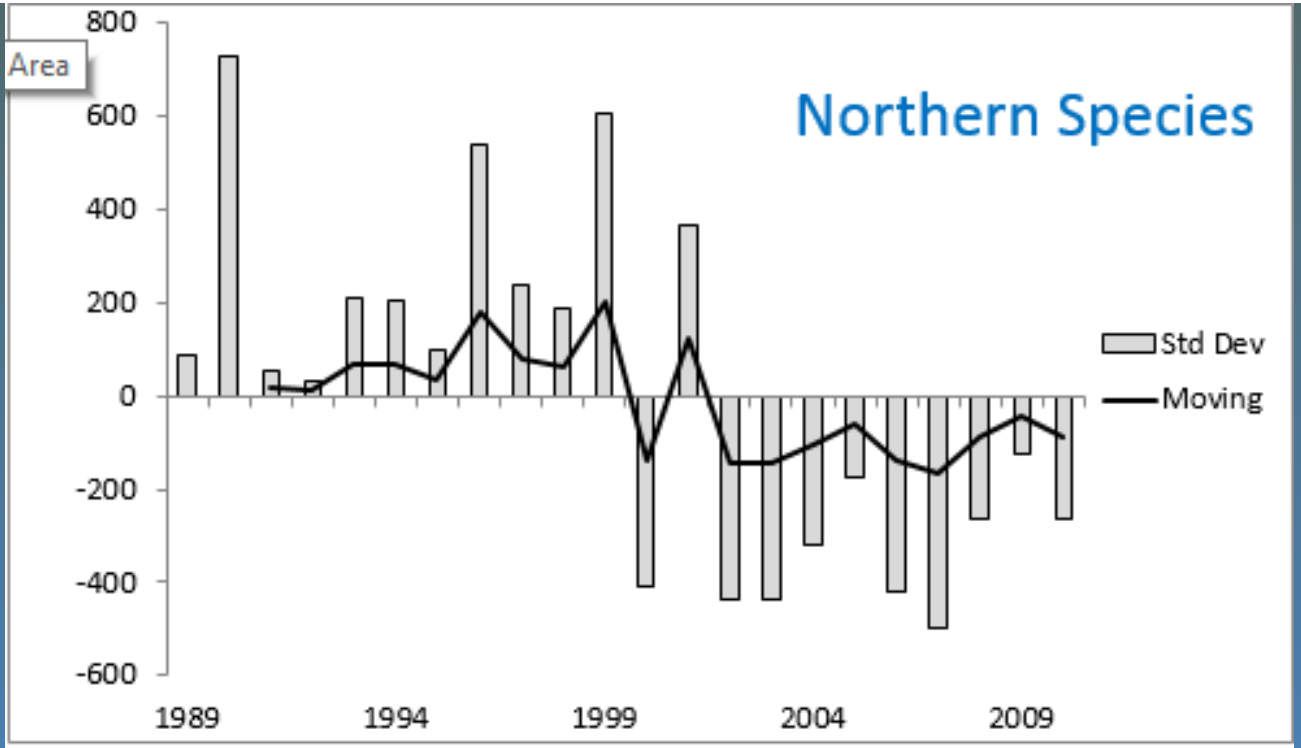
Sources of Northern and Southern Larvae

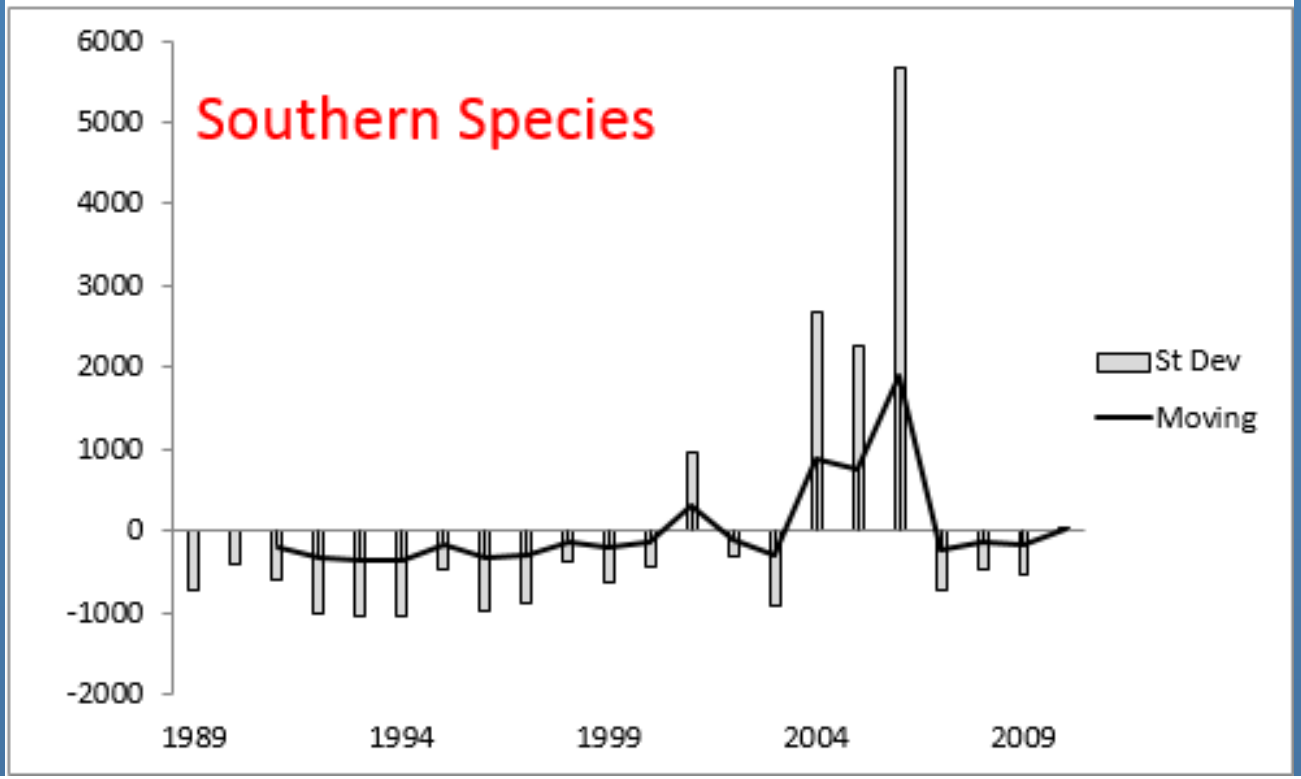


Standardized Species Richness, Including *P. americanus* as northern fish and *M. undulatus* as southern fish.






Area
800
600
400
200
0
-200
-400
-600
1989
1994
1999
2004
2009
Northern Species
Std Dev
Moving


6000
5000
4000
3000
2000
1000
0
-1000
-2000
1989
1994
1999
2004
2009
Southern Species
St Dev
Moving

Preliminary Climate Change Conclusions

- Enhanced delivery of southern larvae in response to warming temperatures (warmer averages, milder winters)
- Decreased delivery of northern larvae
- Ecological significance of enhanced delivery of southern species
  1) More delivery but no survival (e.g. expatriates)
  2) More delivery and greater survival (e.g. Atlantic croaker)
  3) Increased diversity for selected groups (e.g. gobies)

Summary

Examination of larval fish ingress at estuarine inlets has…

- Provided insights into estuarine ingress patterns
- Potential to identify linkages between:
    - Stock size and larval abundance
    - Larval supply and year-class strength
    - Climate change and larval supply
- Temporal distribution of other resident and invasive faunal components

Other Insights

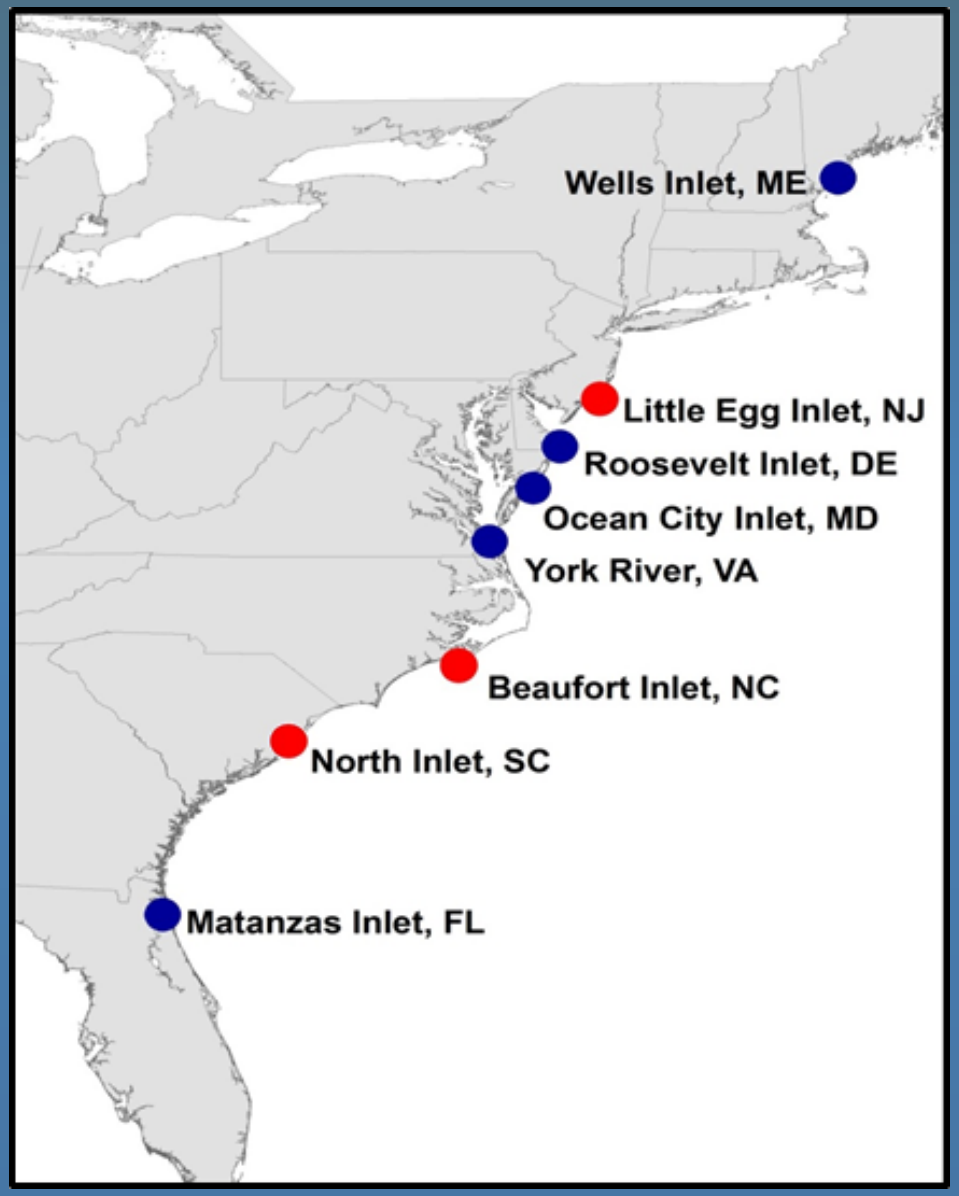
Stinging Nettle

2012-2014

Horseshoe crab

2004-2014

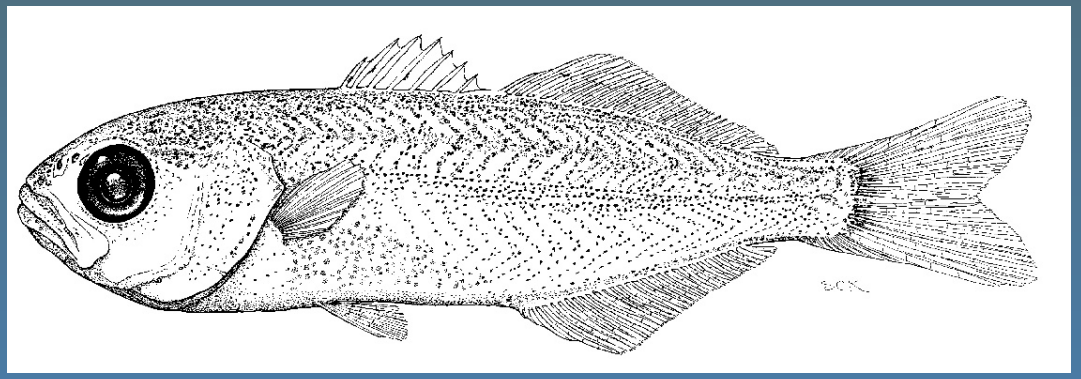
Expanding Number of Inlets

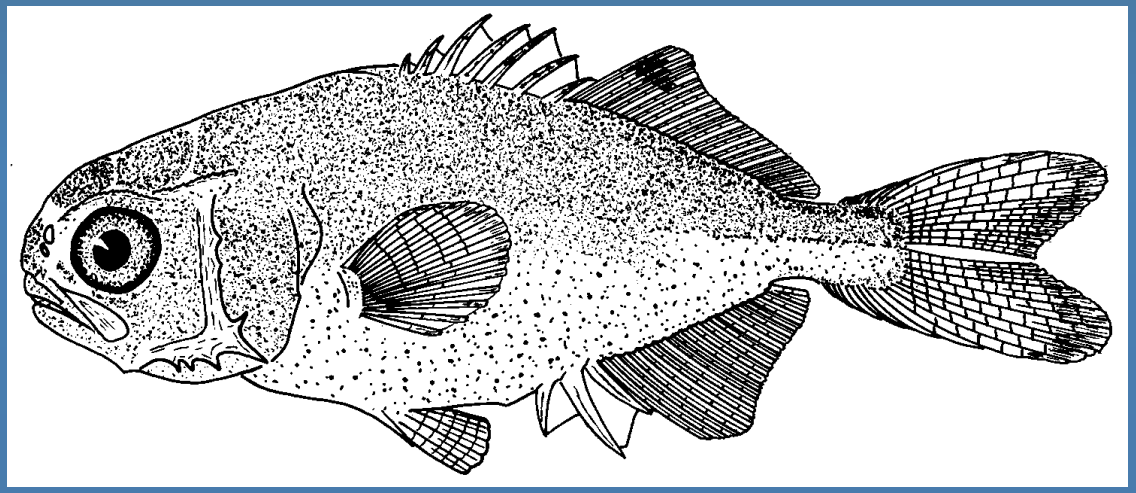


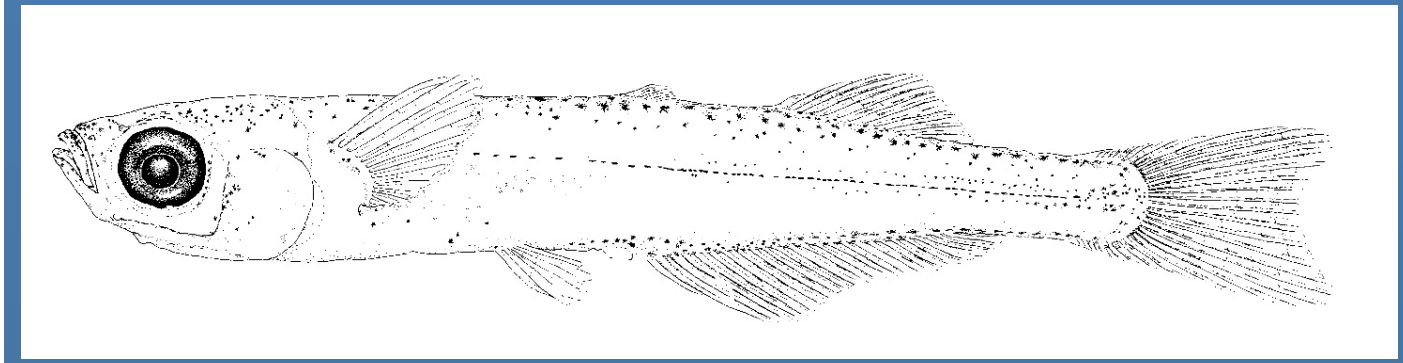
- Many associated with NERRs
- Often with similar sampling techniques
- Of varying sampling durations

Acknowledgements

Numerous RUMFS postdocs, graduate students, summer interns, technicians, volunteers, etc. and east coast collaborators, including NERRs

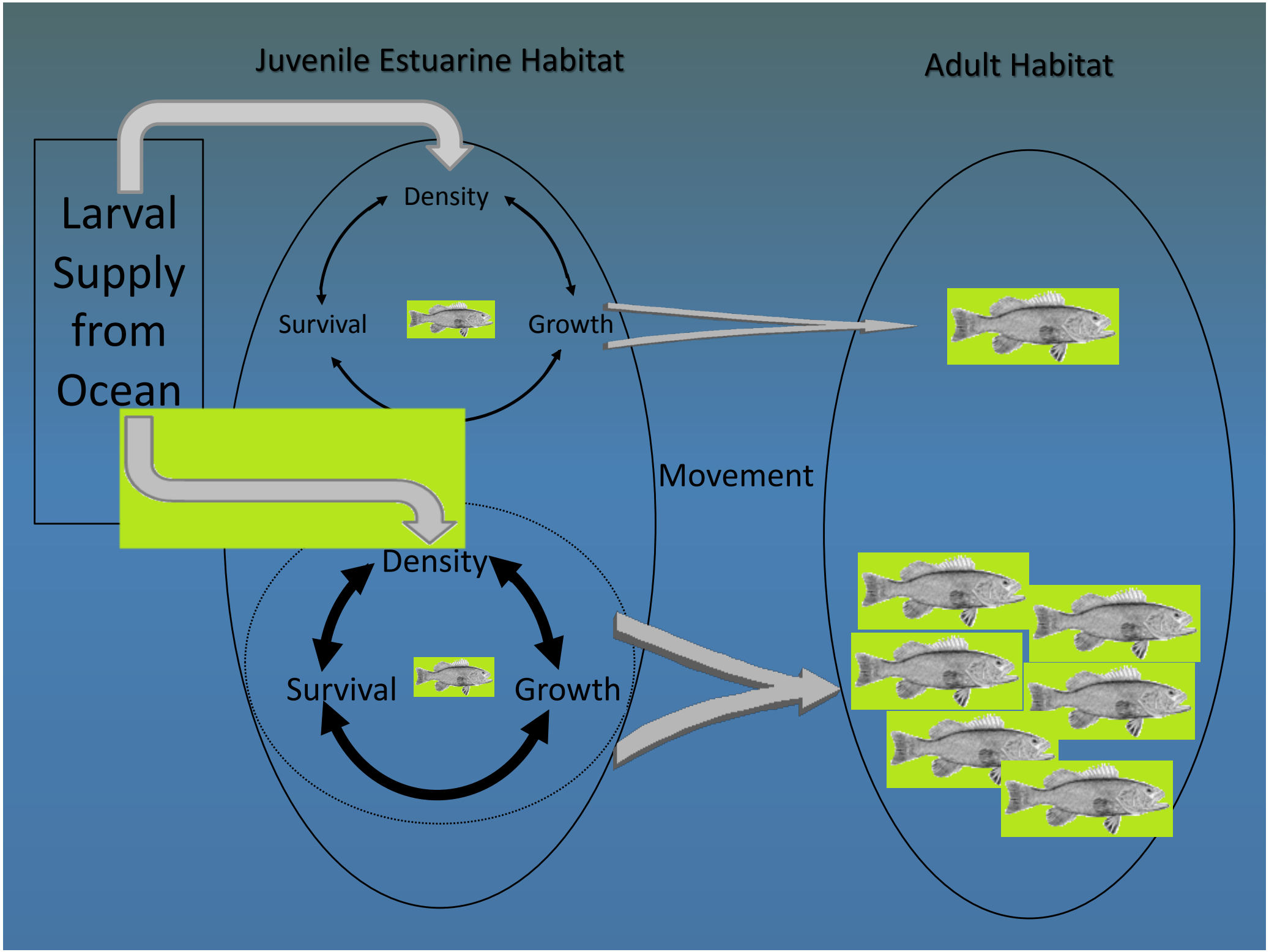


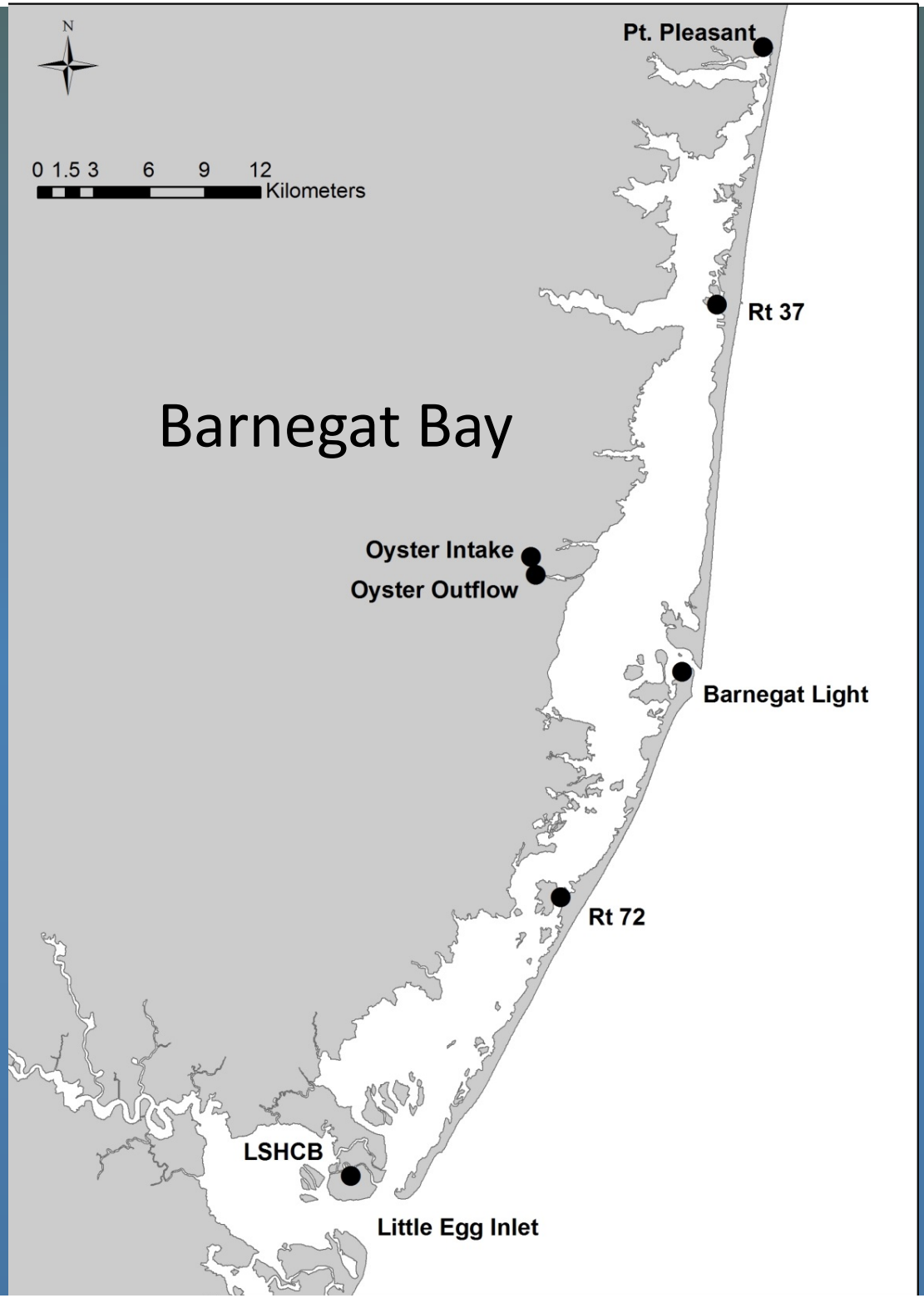


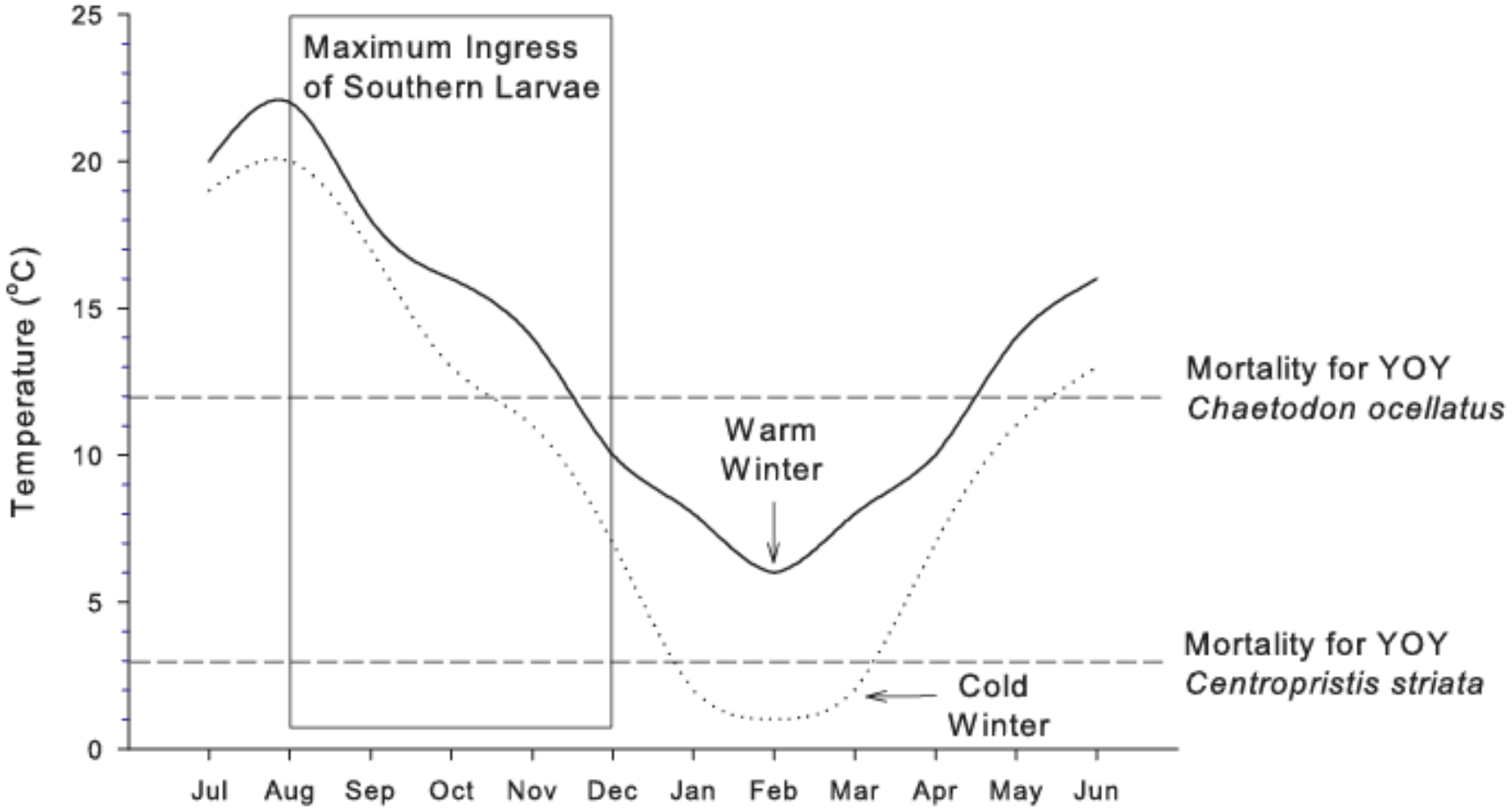


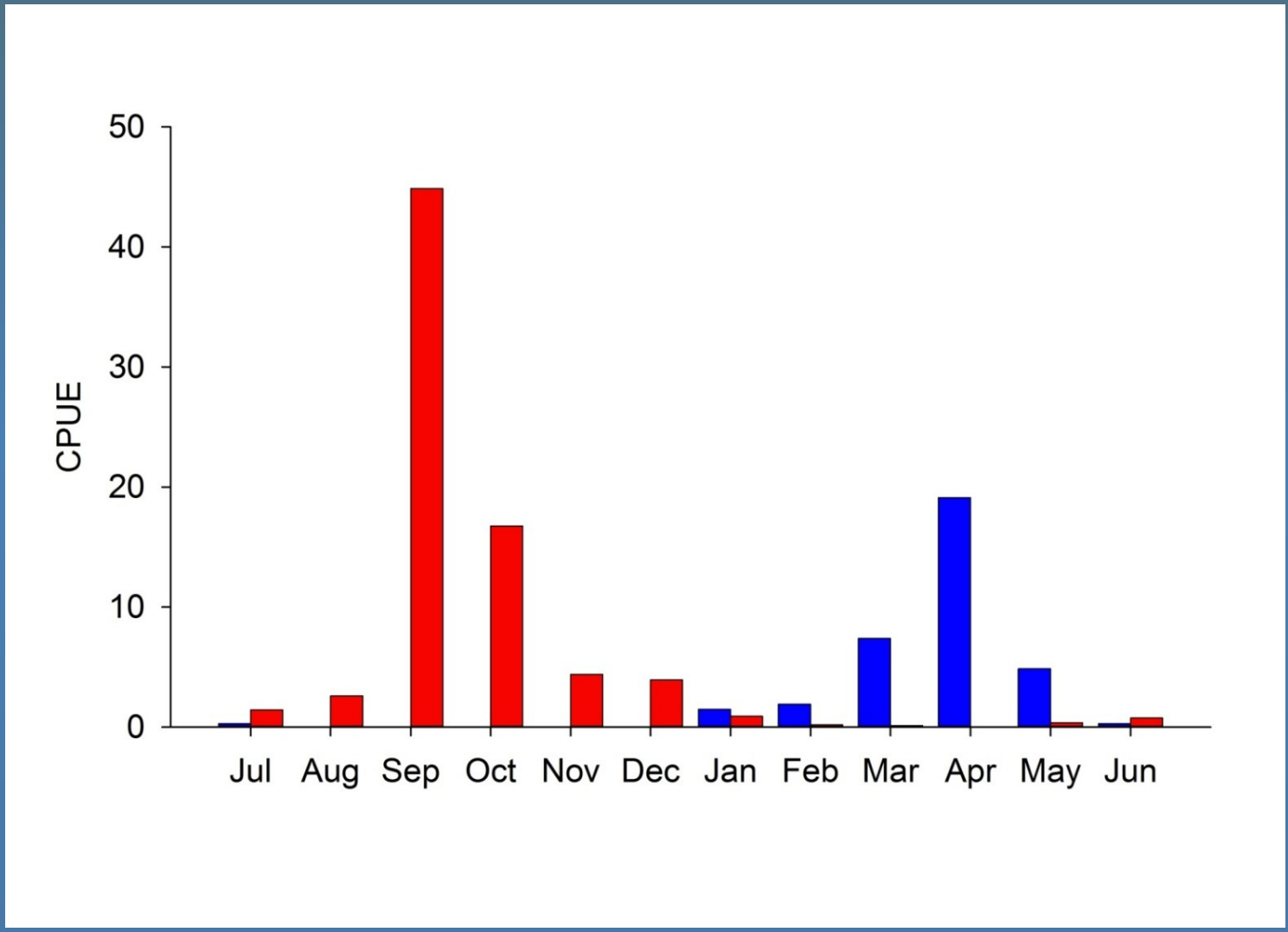
COMING SOON

SIGN UP TO BE NOTIFIED ON RELEASE DATE

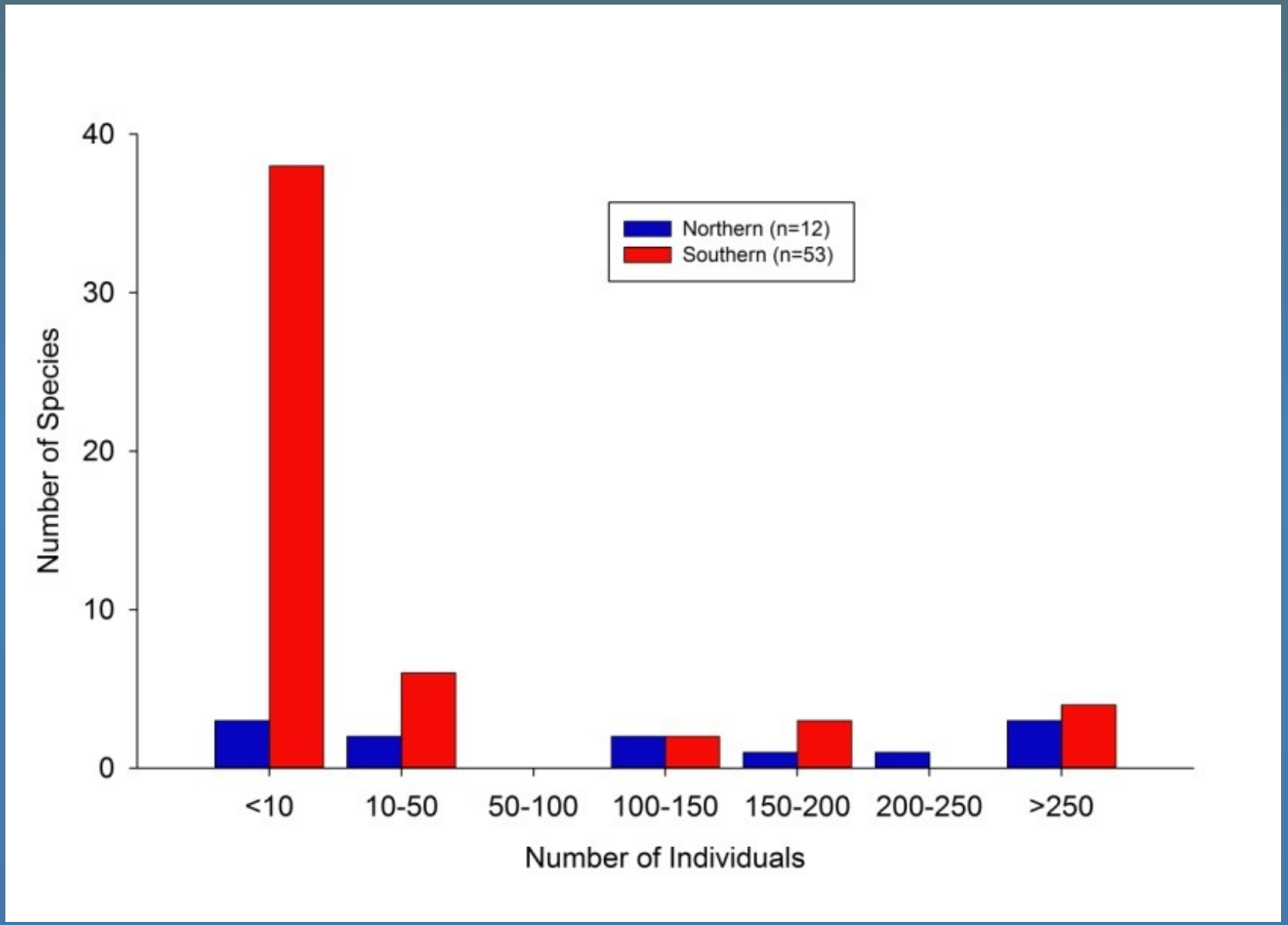

Juvenile Estuarine Habitat
Adult Habitat
Larval Supply from Ocean
Density
Survival
Growth
Movement
Density
Survival
Growth


N
0 1.5 3 6 9 12
Kilometers
Pt. Pleasant
Rt 37
Barnegat Bay
Oyster Intake
Oyster Outflow
Barnegat Light
Rt 72
LSHCB
Little Egg Inlet

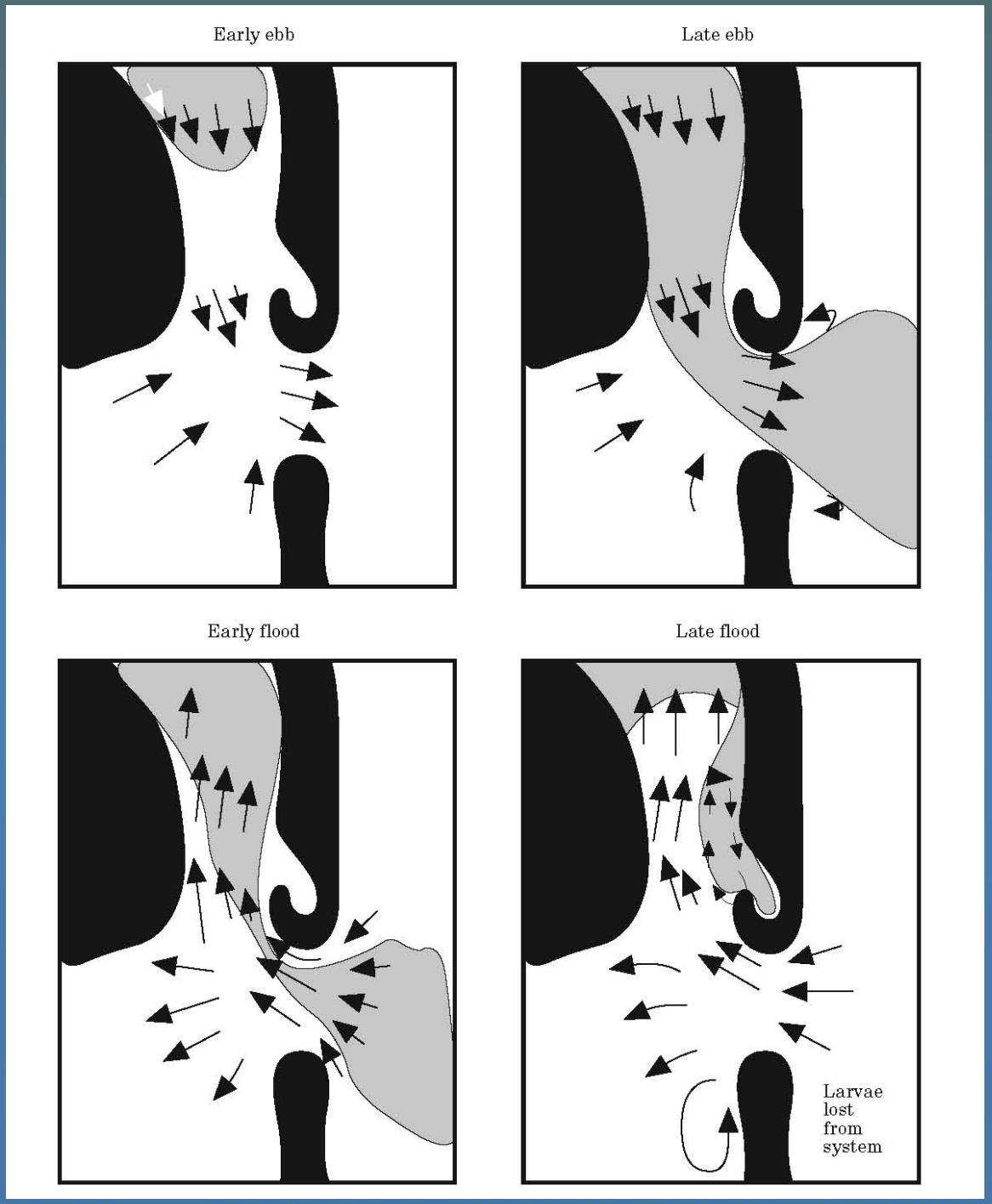

Maximum Ingress
of Southern Larvae
Temperature (°C)
25
20
15
10
5
0
Jul
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Warm
Winter
Cold
Winter
Mortality for YOY
Chaetodon ocellatus
Mortality for YOY
Centropristis striata



Able and Fahay 2010



Able and Fahay 2010

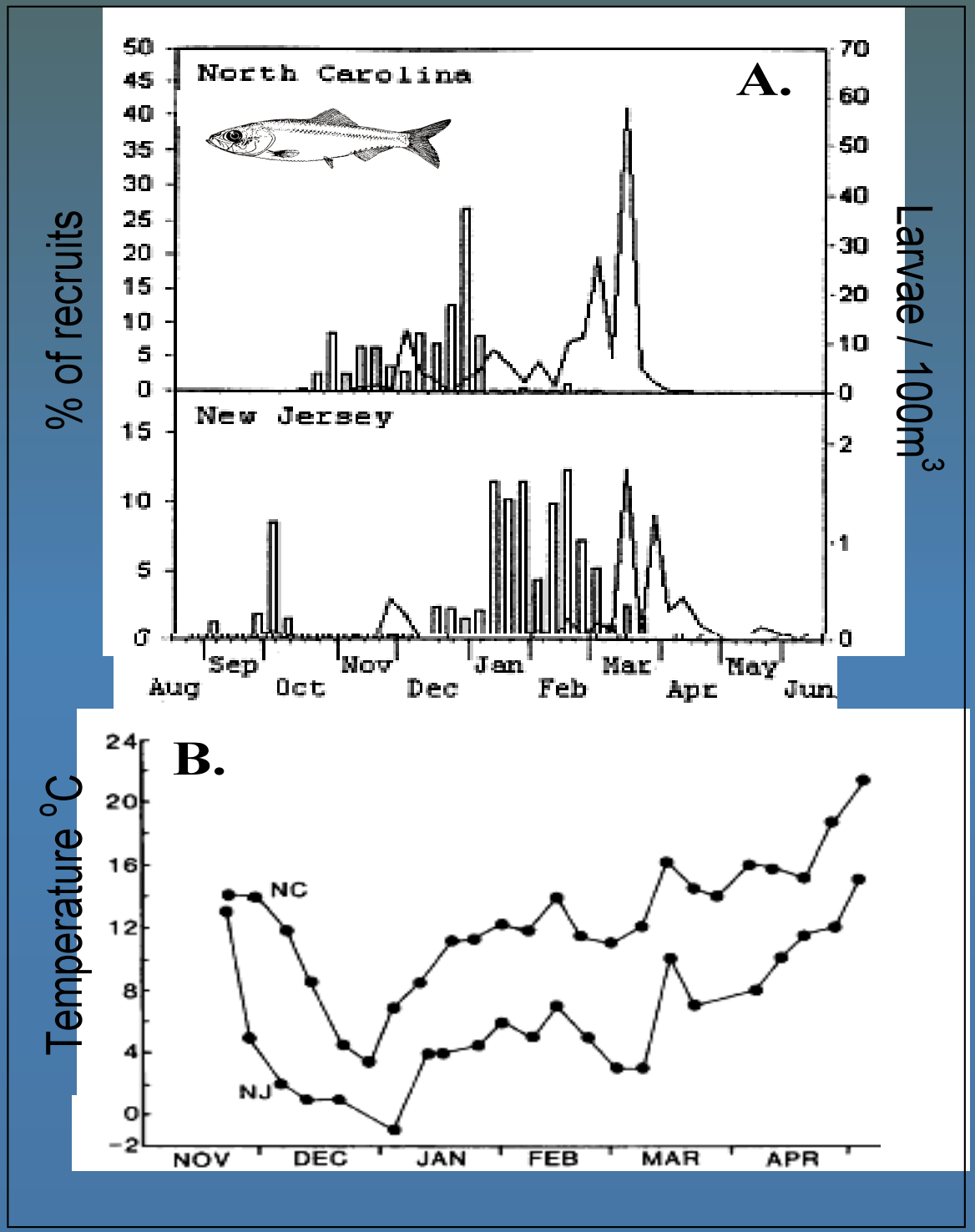

Early ebb
Late ebb
Early flood
Late flood
Larvae
lost
from
system

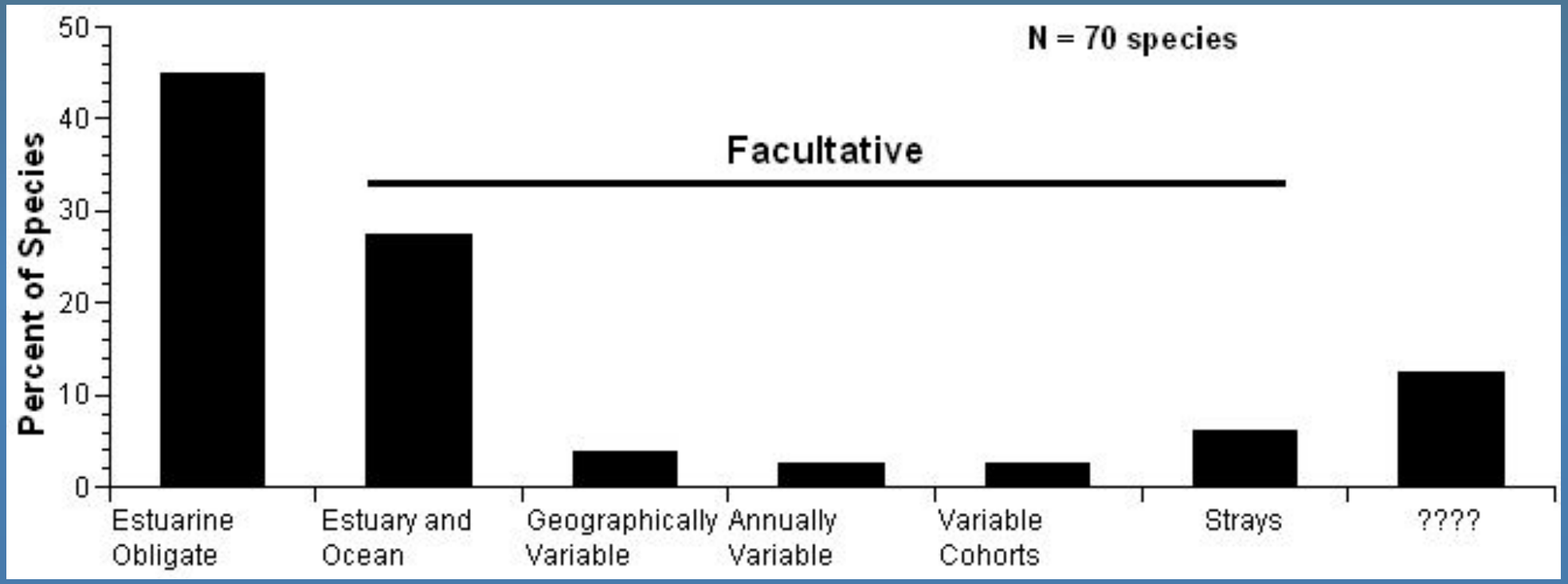
Implications / Questions

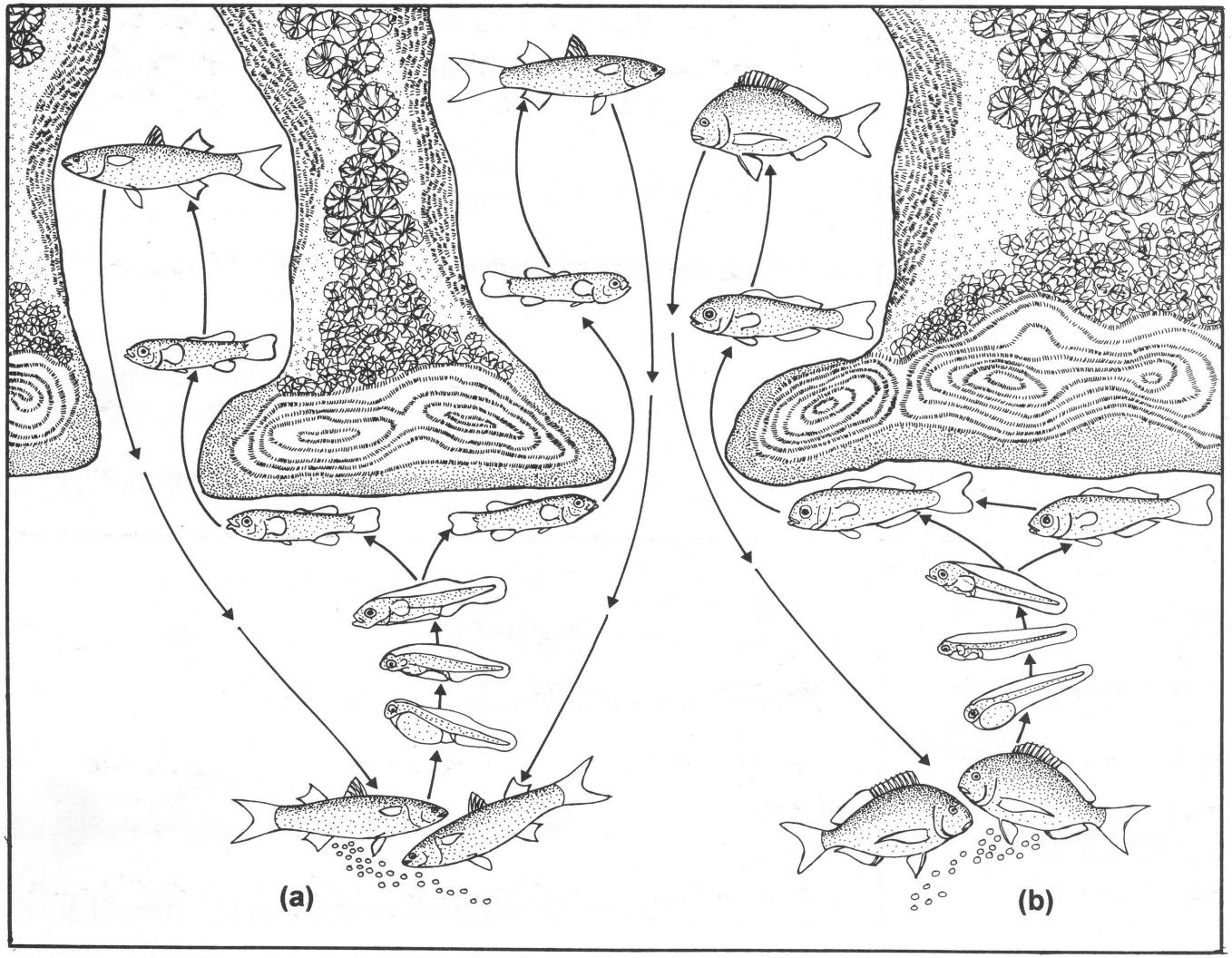
- Significant for some species (e.g. Atlantic croaker, Hare and Able 2007)
  - Fishery has developed around the shift in distribution
- Summer mortality?
- Other causal factors?
  - Habitat change?
  - Shifting adult distributions and/or spawning areas?

  *Response to changing precipitation, prevailing winds, etc?

  *Fishing effects?


% of recruits
Larvae / 100m3
North Carolina
A.
New Jersey
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
B.
Temperature °C
NC
NJ
NOV
DEC
JAN
FEB
MAR
APR

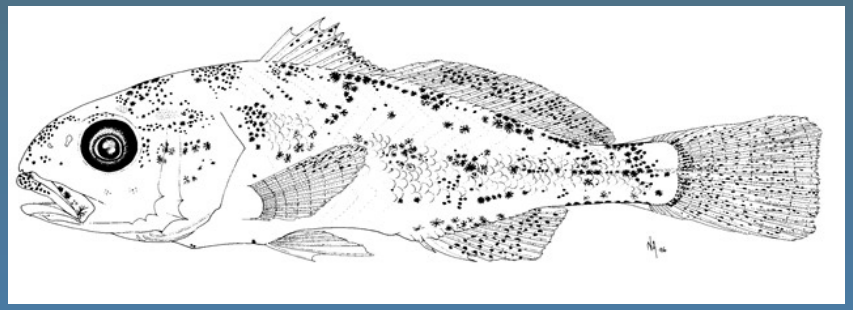

N = 70 species
Facultative
Percent of Species
50
40
30
20
10
0
Estuarine Obligate
Estuary and Ocean
Geographically Variable
Annually Variable
Variable Cohorts
Strays
????



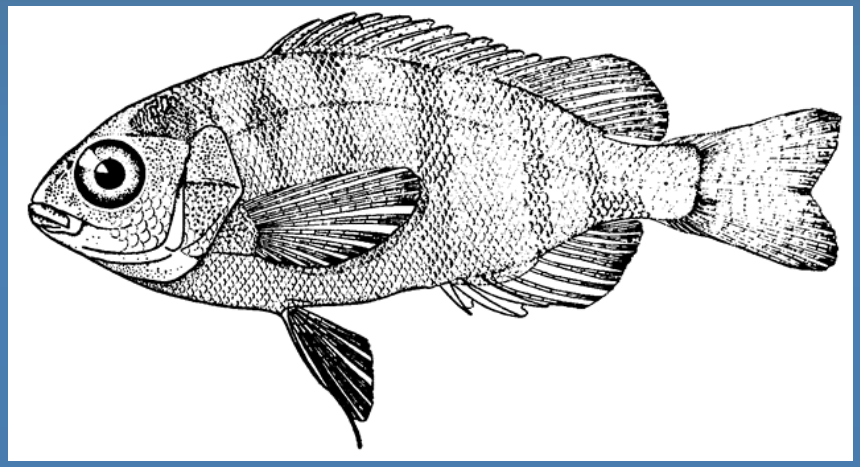
Diagrammatic representation of the dominant life cycles of estuary-associated marine spawners in southern Africa as exemplified by a) flathead mullet (*Mugil cephalus* : Mugilidae) and b) Cape stumpnose (*Rhabdosargus holubi* : Sparidae).
(From Whitfield 1998)


ATLANTIC
NURSERY
Landscape & Garden Center

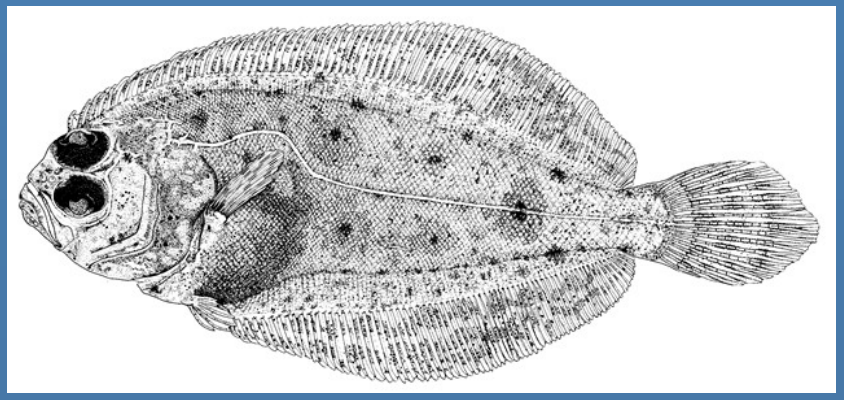
Future



Spot



Pinfish



Summer flounder