Climate and Fish Population Dynamics:
A Case Study of Atlantic Croaker

Kenneth W. Able

**Marine Field Station
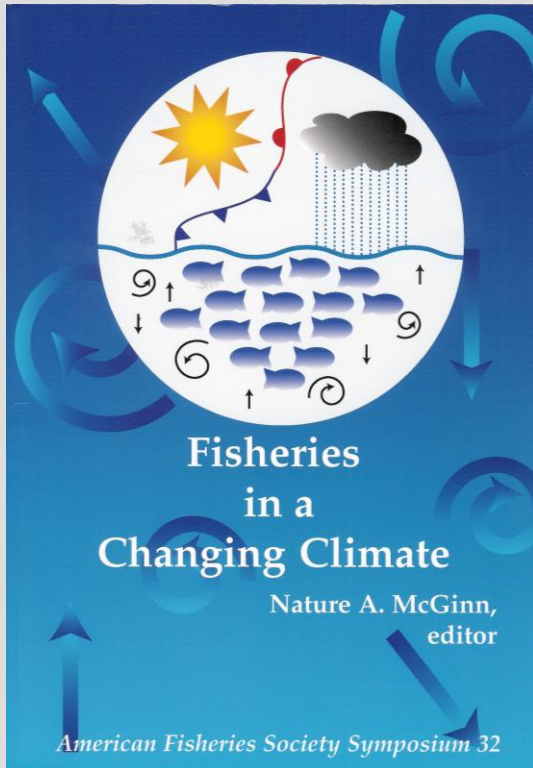Institute of Marine and Coastal Sciences**

Climate and Fisheries

Longer-term effects

- **Distribution of fishes likely very different during glacial periods**
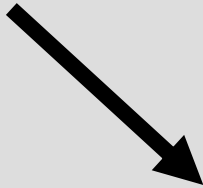
Climate and Fisheries

Fisheries in a Changing Climate

Nature A. McGinn,
editor

American Fisheries Society Symposium 32

Shorter term effects

- **Regime shifts in the Pacific**

- **El Nino ~ La Nina cycles**

- **Recent northward extension (retraction) of warm-water (cold water) species**

Climate and Fisheries

Many correlations between climate and fisheries have not survived the test of time

Climate

Fisheries

Need mechanistic hypotheses (causation) to explain the link (correlation) between climate and fisheries
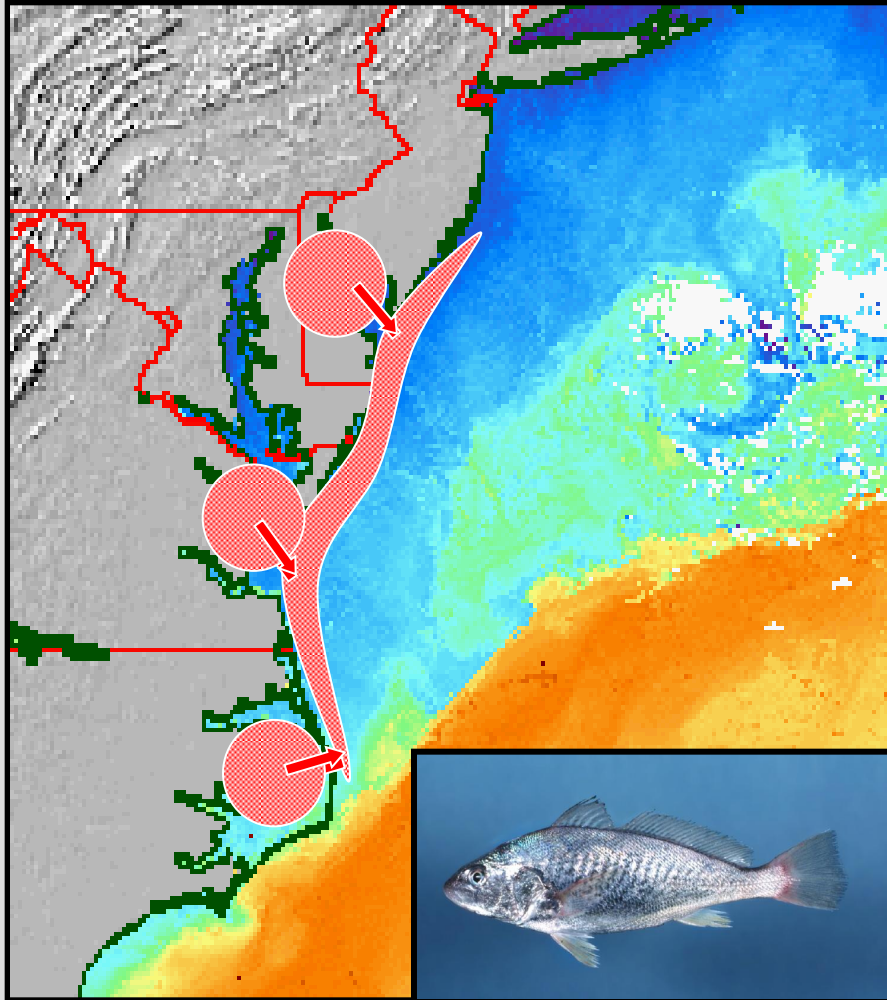
Climate and Atlantic Croaker

- **In 2002, ~26 million pounds of Atlantic croaker caught in commercial fishery worth ~$8 million**

# Climate and Atlantic Croaker

Su F W Sp Su F

- **Spawn on continental shelf – late summer & fall**

- **Juveniles enter estuaries in fall**

- **Juveniles overwinter in estuaries**

- **Juveniles feed and grow in estuaries through summer**
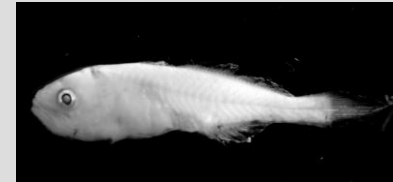
- **Leave in fall to spawn**

Objectives

- **Overall purpose is to examine links between Atlantic croaker population dynamics and climate**

- **Unlike prior studies, we examine larval, juvenile, and adult stages from North Carolina to New Jersey**

Data Sources
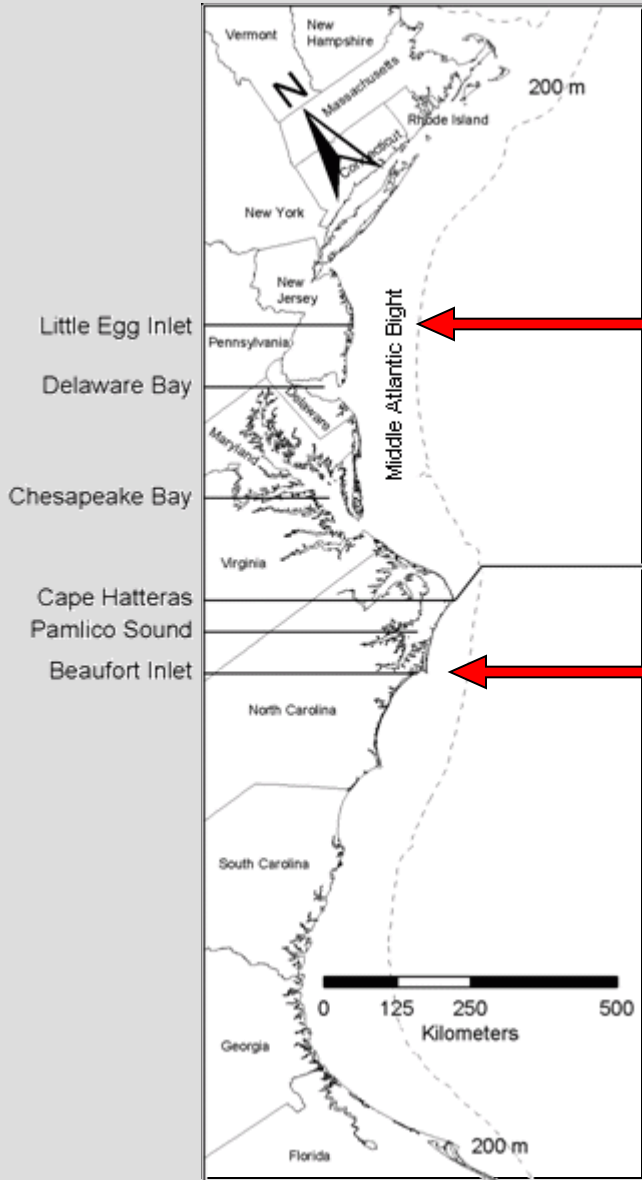
Late-stage larvae

Little Egg Inlet

Beaufort

Approach

Determine where in the Early Life History year-class strength is determined based on correlation (or lack of) across life history stages
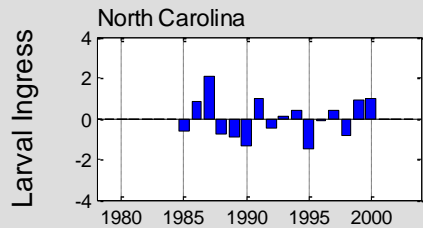
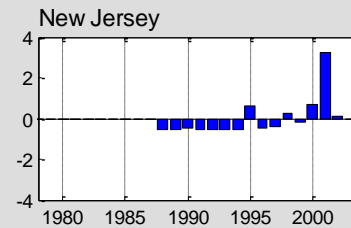|	
Larvae	North Carolina, New Jersey
Fall Juveniles	New Jersey, Chesapeake Bay
Spring Juveniles	North Carolina, New Jersey, Chesapeake Bay
Adults (Age-2)	Coast-wide

Results

Determine where in the Early Life History year-class strength is determined
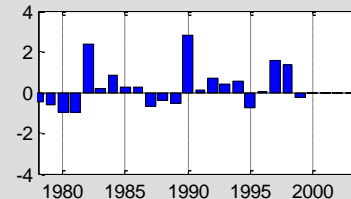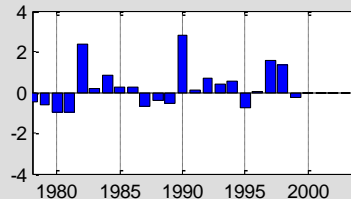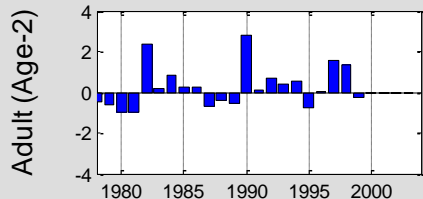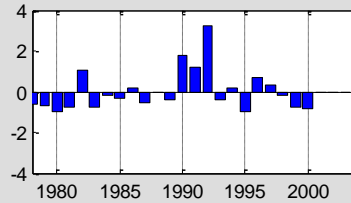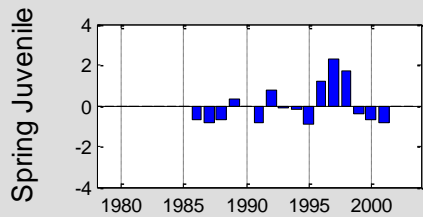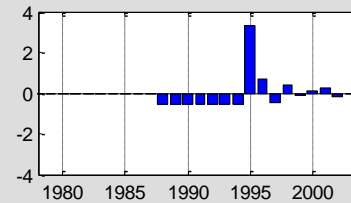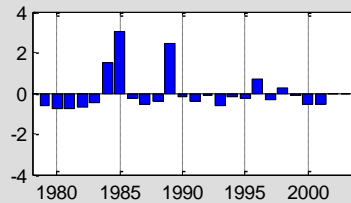

- **In NC, spring juveniles are correlated to age-2 adult**
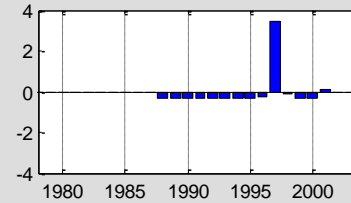
- **In VA, spring juveniles are correlated to age-2 adult**

- **In NJ, larvae are correlated to fall juveniles**

Results

Examine relation between estuarine winter temperature and juvenile and adult abundance

- **Estuarine water temperatures from Beaufort Inlet, Chesapeake Bay and Little Egg Inlet**

- **Virginia spring juvenile significantly correlated to winter temperature**

- **Above average New Jersey and North Carolina spring juveniles only occurred in warm years**
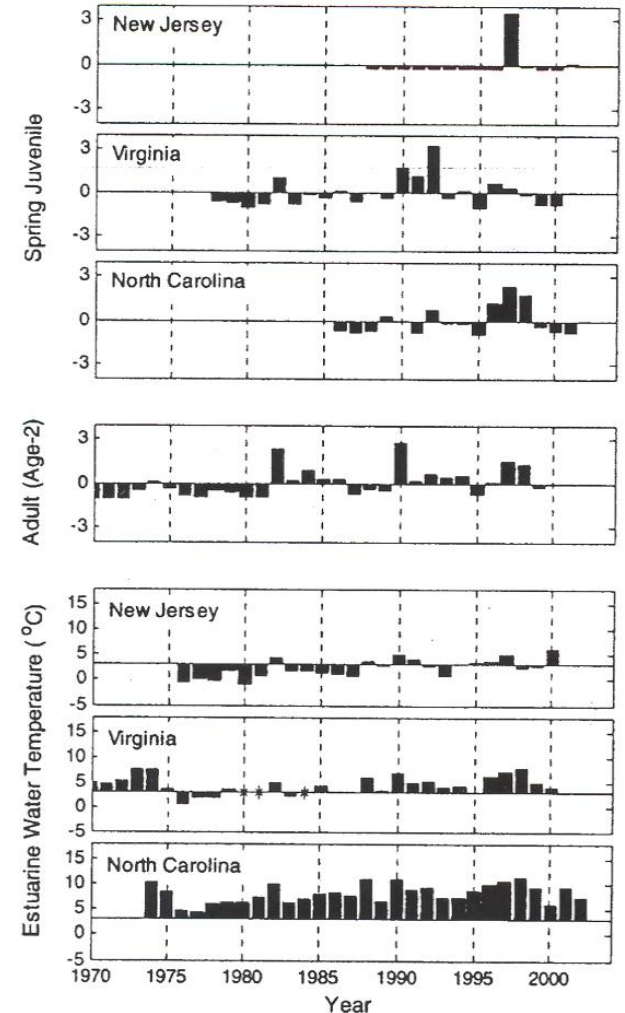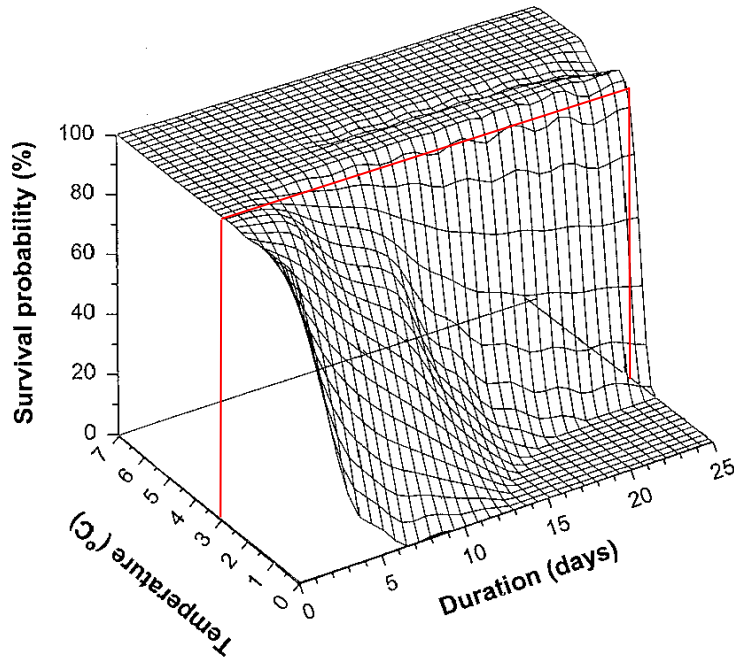
Complimentary Literature

FIGURE 4.——Response surface diagram depicting the survival response of age-0 Atlantic croakers to variation in winter severity and duration.

Laboratory studies demonstrate that juvenile croaker survival is dependent on water temperature (Lankford and Targett 2001)
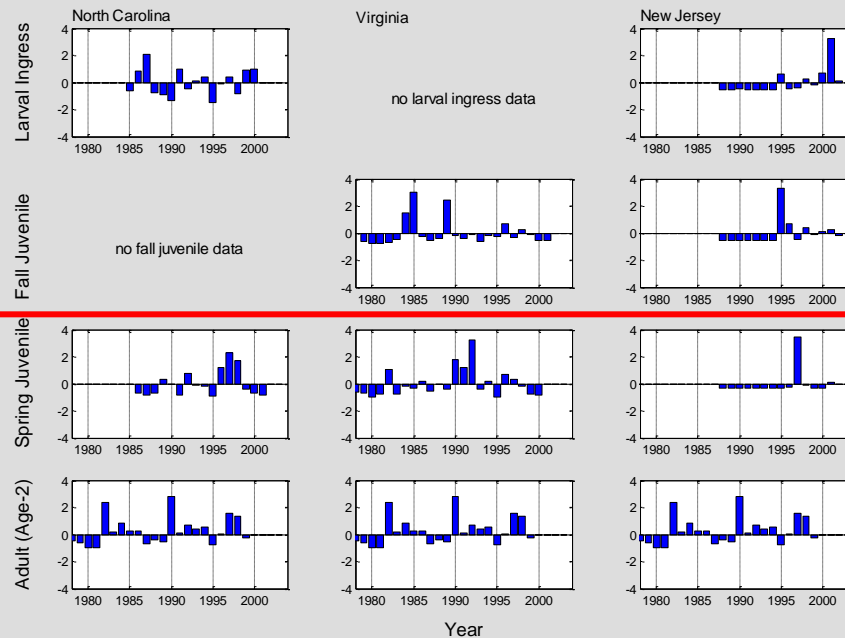
Juvenile croaker abundance in Chesapeake Bay linked to water temperatures during wintertime estuarine residency (Norcross and Austin 1981)
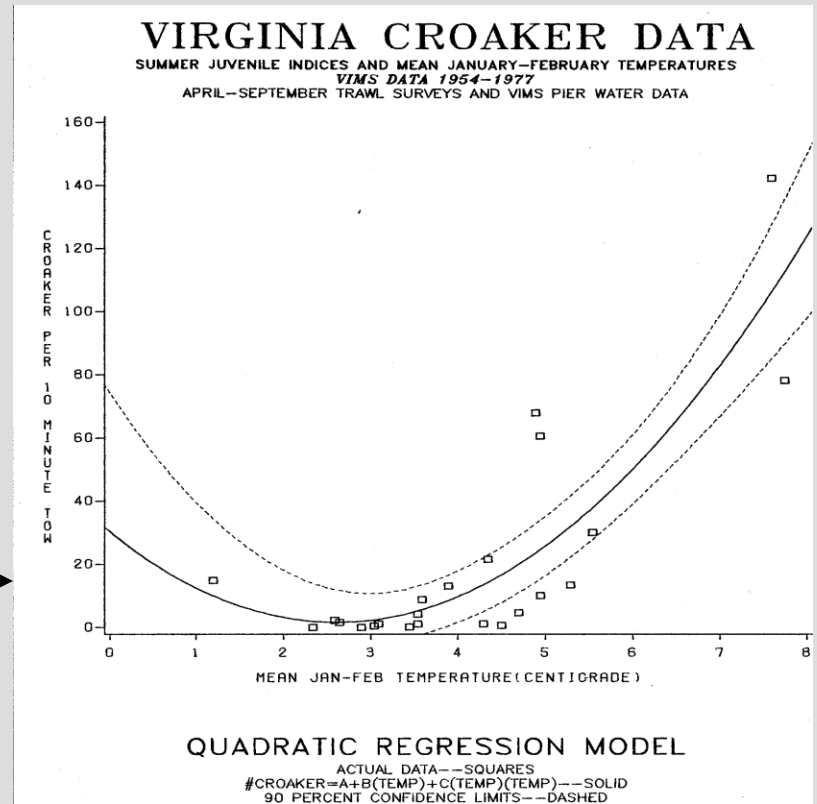
Results

**Determine where in the Early Life History
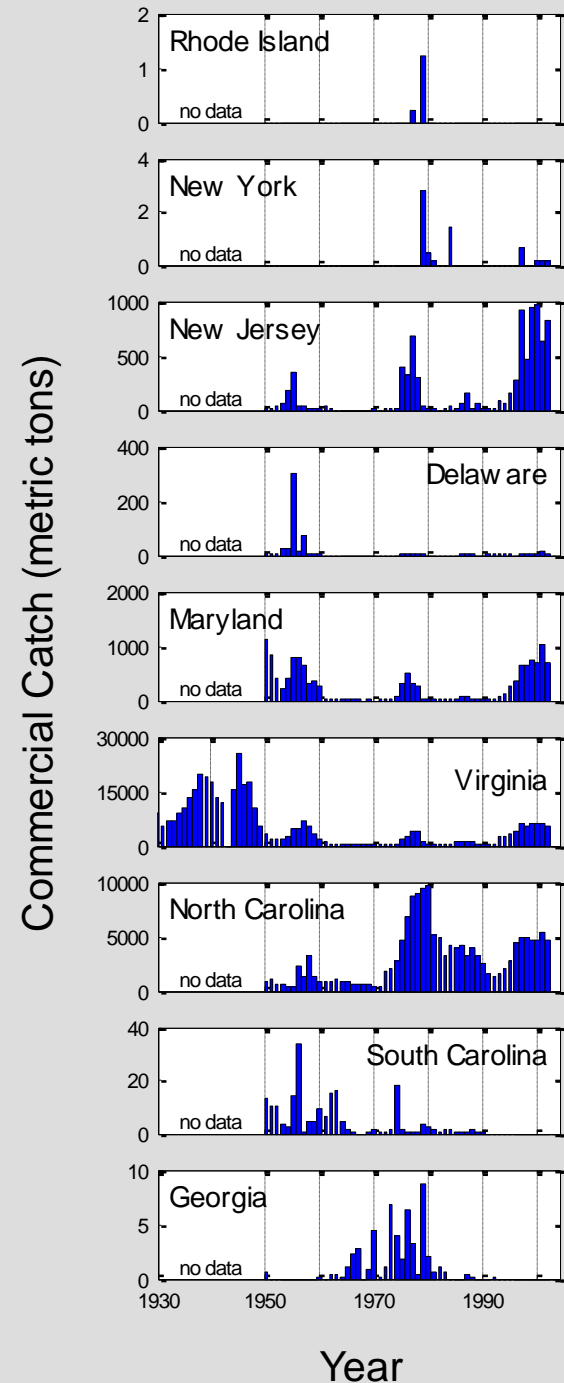year-class strength is determined**

- **Year-class strength is determined between the fall
and spring juvenile stage**

Results

**Examine relation between long-term trends in adult catch and winter temperatures**

- **Temperature variation is coherent along the coast**

- **Variation in adult catch is coherent along the coast**

Results

Examine relation between long-term trends in adult catch and winter temperatures

- Adult catch is significantly correlated to estimated winter estuarine temperature

- Adult catch is significantly correlated to estimated North Atlantic Oscillation
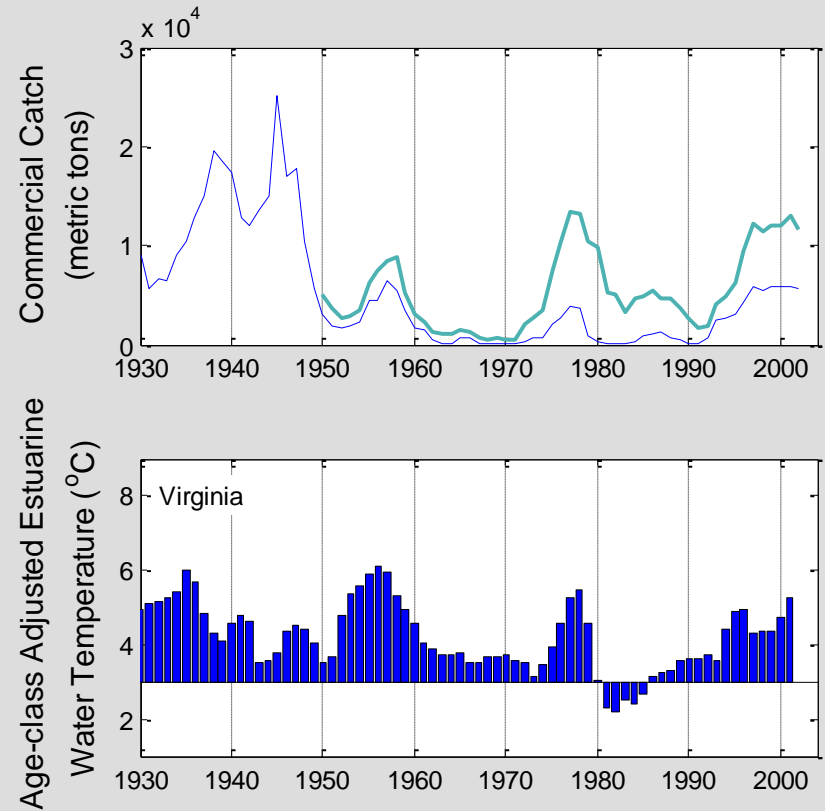
Summary

- **Outburst begins with relatively warm winters and enhanced juvenile survival**

- **Outburst ends with relatively cold winters and lower juvenile survival**

- **Following cold winters, strong year-classes pass owing to natural mortality and fishing**
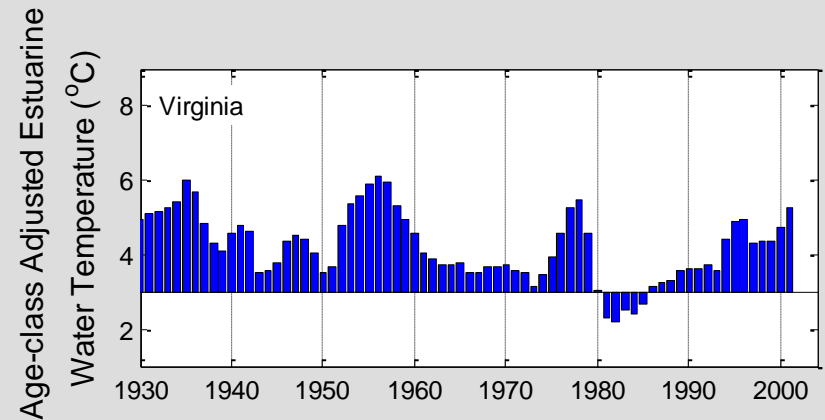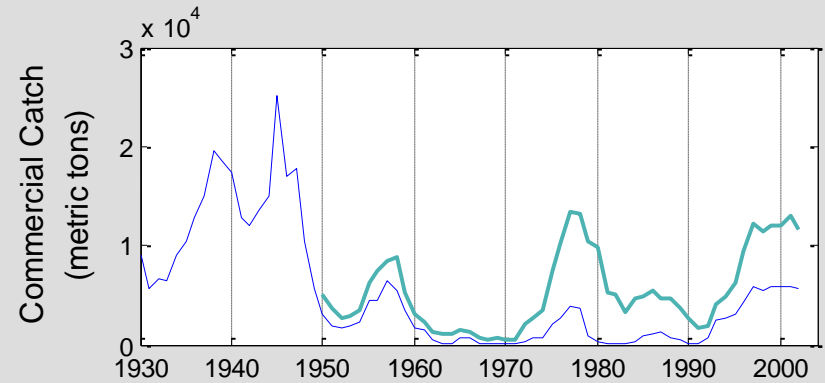
Implications

- Change in distribution of recreational and commercial fisheries

- Likely to influence other fish species along the East Coast of US
    - expansion of southern species to the north
    - retreat of northern species from the south

- Influence ecosystem dynamics in estuaries and the ocean?

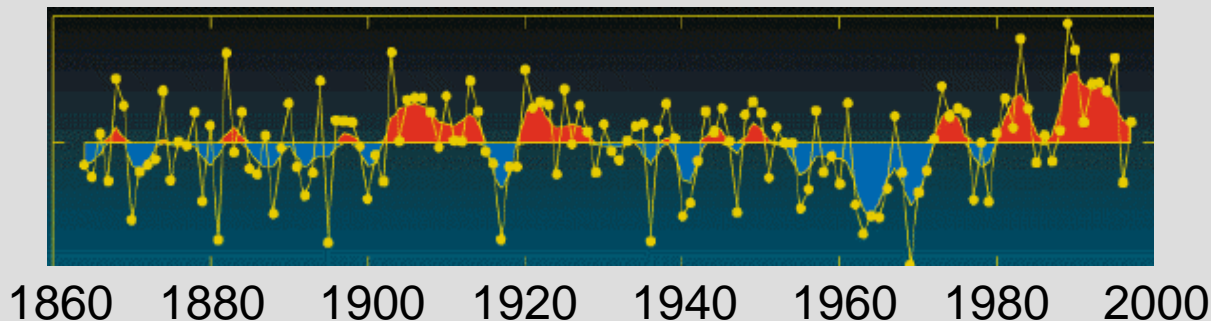# Climate and Atlantic Croaker

Evaluate links between larger North Atlantic climate and population dynamics

- **Winter temperature is coherent over much of the east coast of the United States**

- **Winter temperature linked to North Atlantic Oscillation**

NAO Index

1860   1880   1900   1920   1940   1960   1980   2000
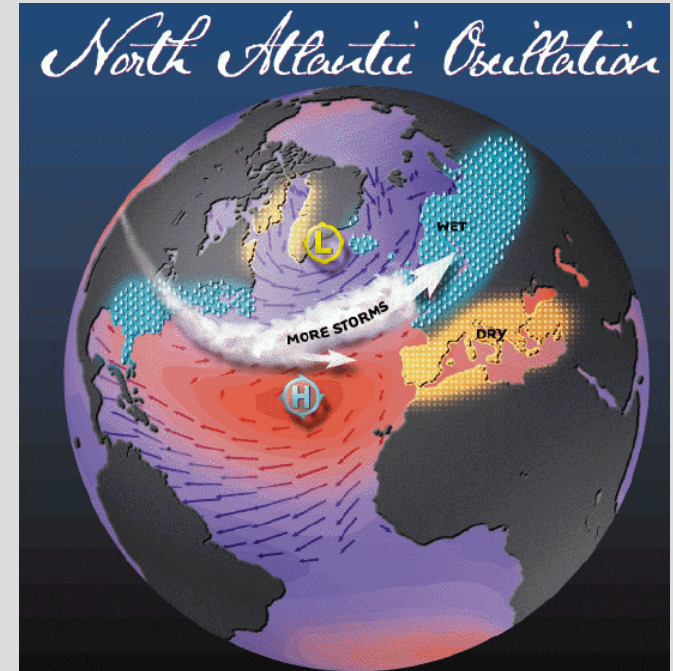
Positive NAO – East coast mild and wet