A comparison of northern shrimp population dynamics among multiple ecosystems:

Influences of gadoid predation and temperature

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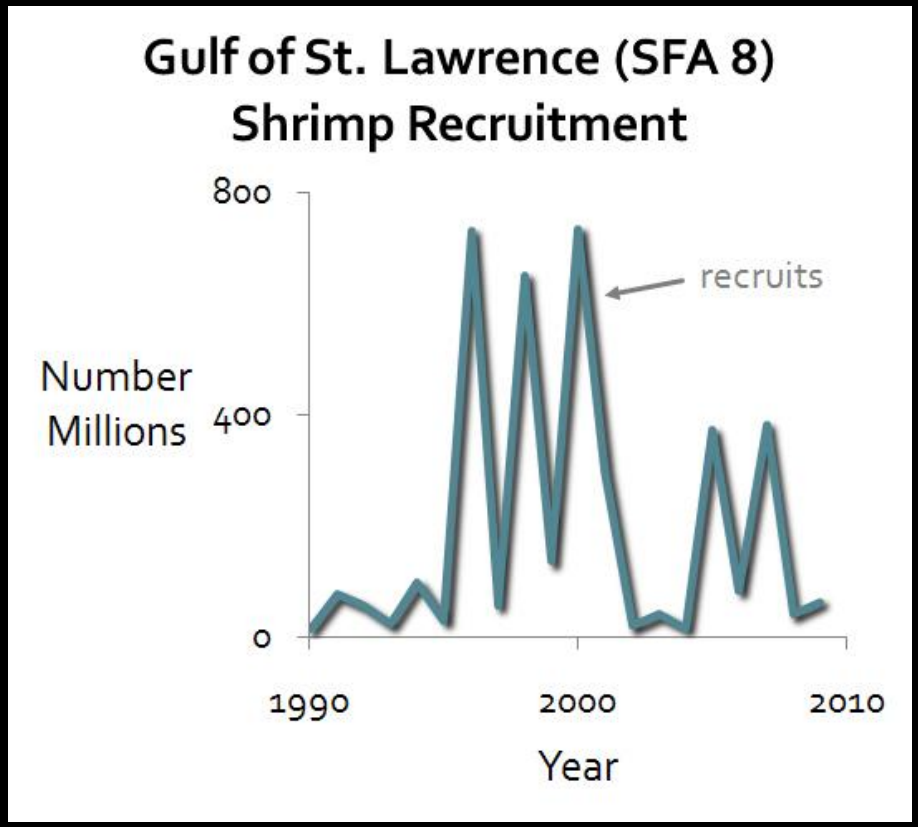
Background

Objectives

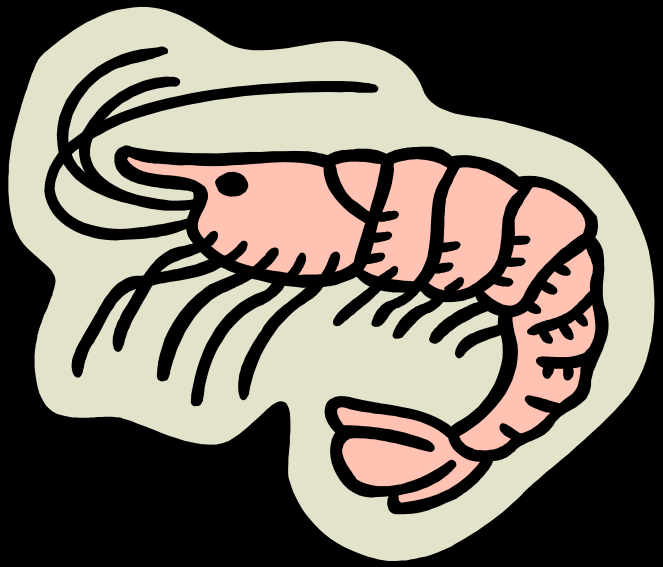


- **What drives variability?**
  - Spawning stock (when possible)
  - Gadoid predation
  - Temperature
- **Are ecosystems similar?**
  - 4 areas

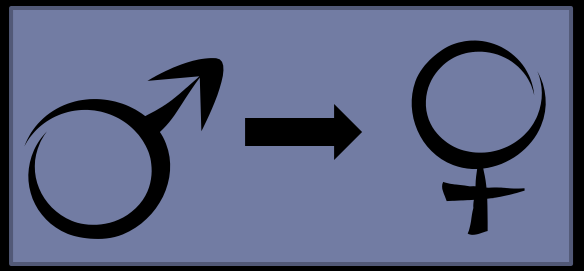
Northern Shrimp Basics

- Important fisheries
  - 70% of cold-water shrimp harvest

    (Greene et al. 2009)



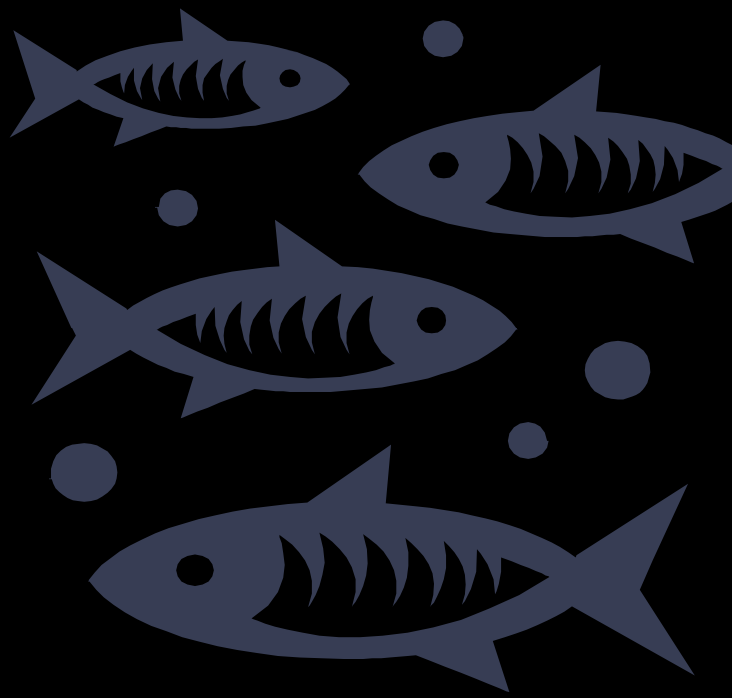
- *Pandalus borealis*
  - Females carry eggs
  - Larvae planktonic
  - Post-larvae deeper
  - Sex transition



  - Live up to 8 years

Relationship with Fishes

- Predation main source of mortality
- Gadoid fishes
  - Atlantic cod
  - Haddock
- Other fish
  - Greenland halibut
  - Redfish



Relationship with Environment

- Development, hatch timing
- Larval transport
- Timing of sex transition, lifespan
- Food availability
  - Spring phytoplankton bloom

Methods


Barents Sea
Iceland
Gulf of St. Lawrence
10
8
Google Maps

Exploratory Analyses

- Biologically reasonable lags
- Interaction?
  - Environmental variables
- Non-linear relationships?
  - Examine using GAM models

Modeling Approach

$$\ln(y)_t = \beta_0 + \beta_1 S_{t-k1} + \beta_2 P_{t-k2} + \beta_3 E_{t-k3} + \varepsilon$$

Modeling Approach

$$\ln(y)_t = \beta_0 + \beta_1 S_{t-k1} + \beta_2 P_{t-k2} + \beta_3 E_{t-k3} + \varepsilon$$

Shrimp Recruits

Shrimp Index

Modeling Approach

$$\ln(y)_t = \beta_0 + \beta_1 S_{t-k1} + \beta_2 P_{t-k2} + \beta_3 E_{t-k3} + \varepsilon$$

Intercept

Modeling Approach

$$\ln(y)_t = \beta_0 + \beta_1 S_{t-k1} + \beta_2 P_{t-k2} + \beta_3 E_{t-k3} + \varepsilon$$

Spawning Stock / Proxy

(when possible)

Modeling Approach

$$\ln(y)_t = \beta_0 + \beta_1 S_{t-k1} + \beta_2 P_{t-k2} + \beta_3 E_{t-k3} + \varepsilon$$

Atlantic cod

Modeling Approach

$$\ln(y)_t = \beta_0 + \beta_1 S_{t-k1} + \beta_2 P_{t-k2} + \beta_3 E_{t-k3} + \varepsilon$$

Environment

-sea surface temperature

-deep temperature

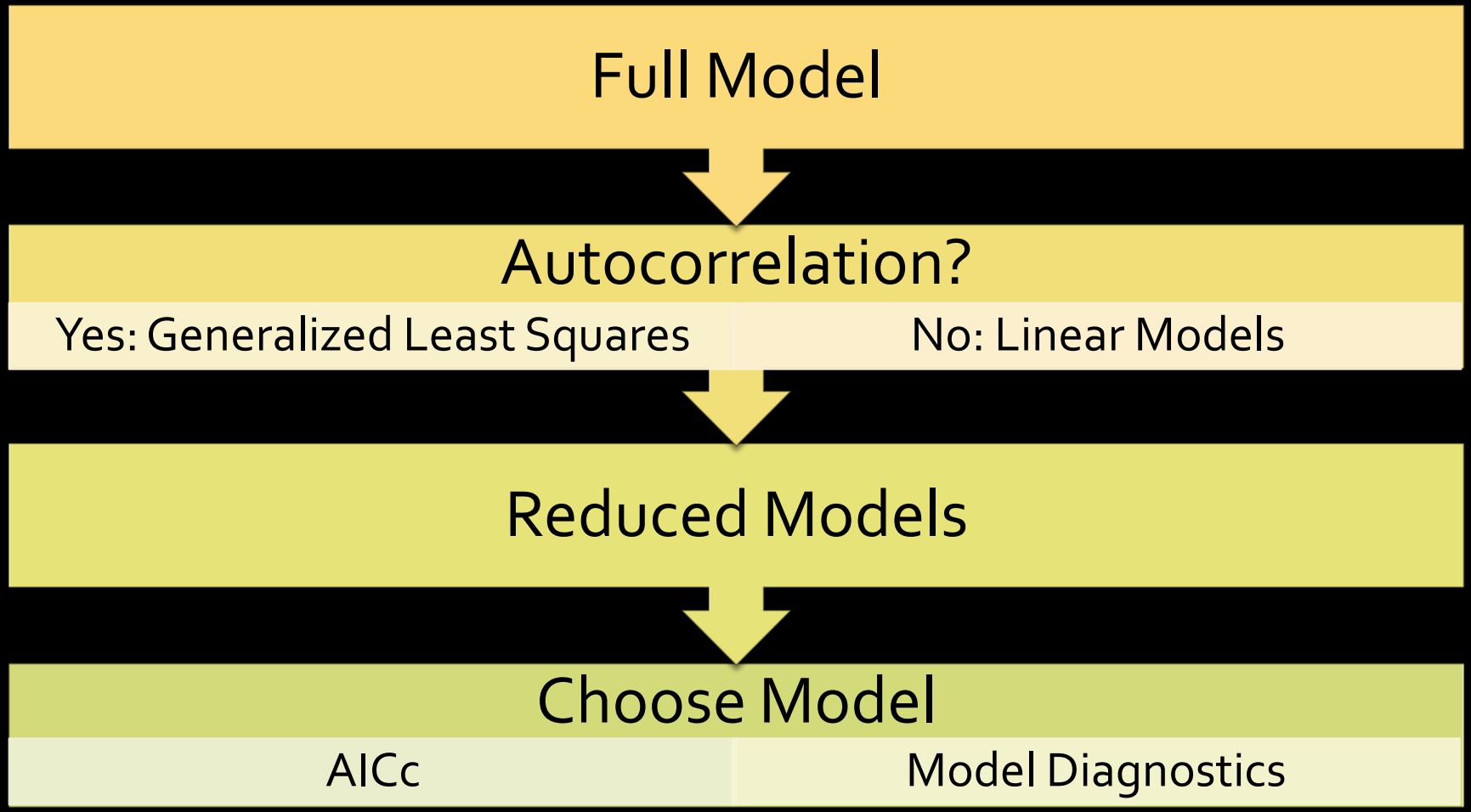
-salinity (Iceland only)

Modeling Approach

$$\ln(y)_t = \beta_0 + \beta_1 S_{t-k1} + \beta_2 P_{t-k2} + \beta_3 E_{t-k3} + \varepsilon$$

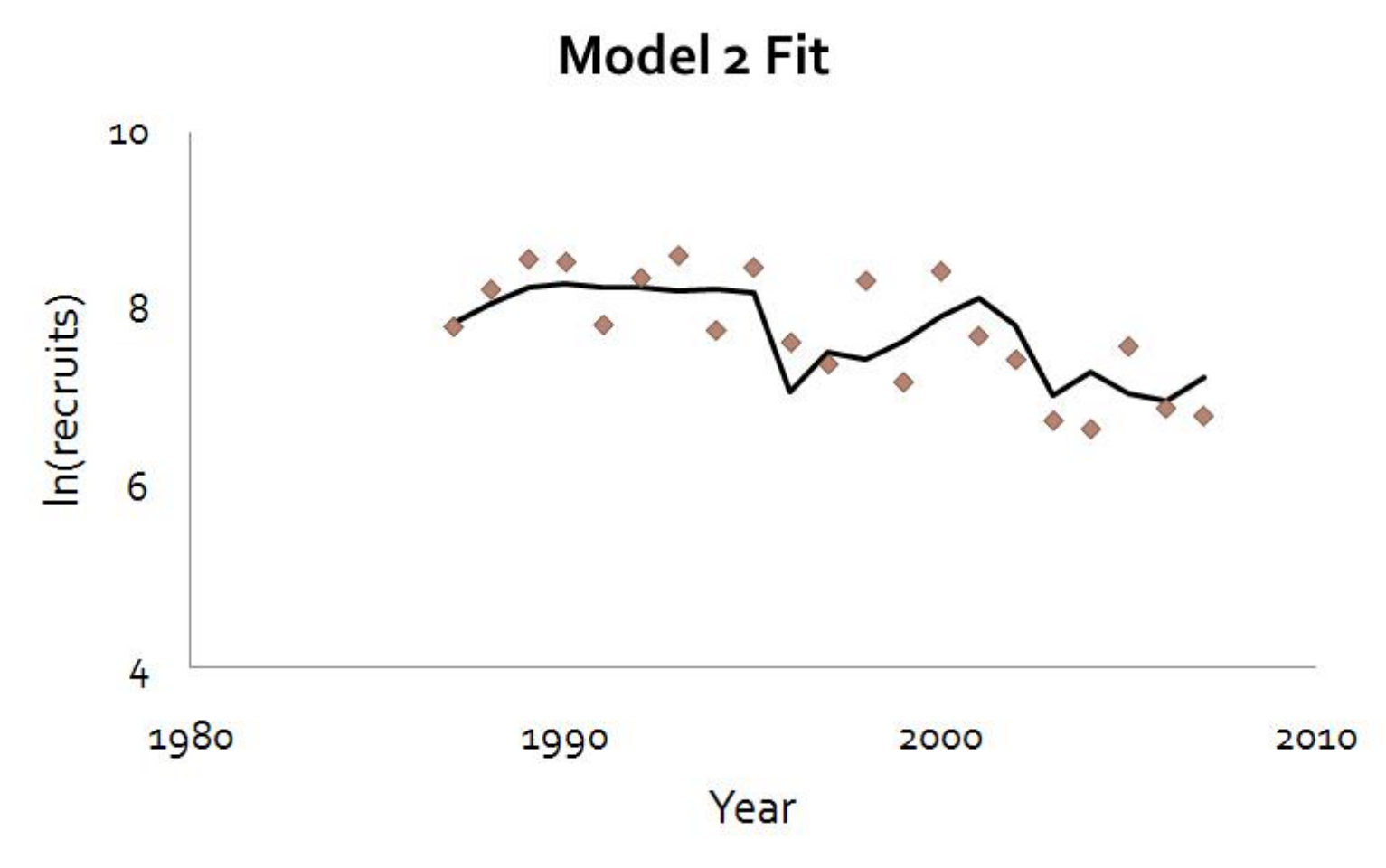
error

Model Selection



Results

Example Model Fit – Iceland



$\ln(\text{recruits}) = 7.76 - 1.75(\text{cod}) + 1.25(\text{cod})^2$

$R^2 = 0.50$

Model Results

- Gulf of St. Lawrence SFA 10 (west)
  - No significant model
- Other areas
  - R^2 0.29 to 0.68

Spawning Stock

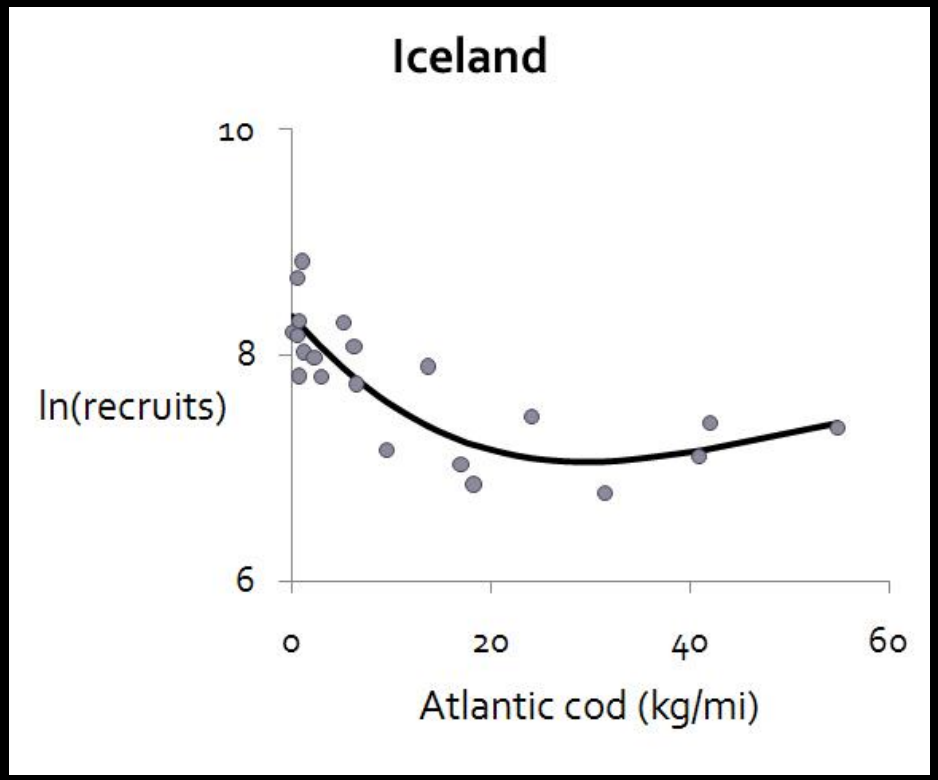
Ecosystem	Result
Gulf of St. Lawrence SFA 10	NS
Gulf of St. Lawrence SFA 8	NS
Iceland	+/NS
Barents Sea	not tested

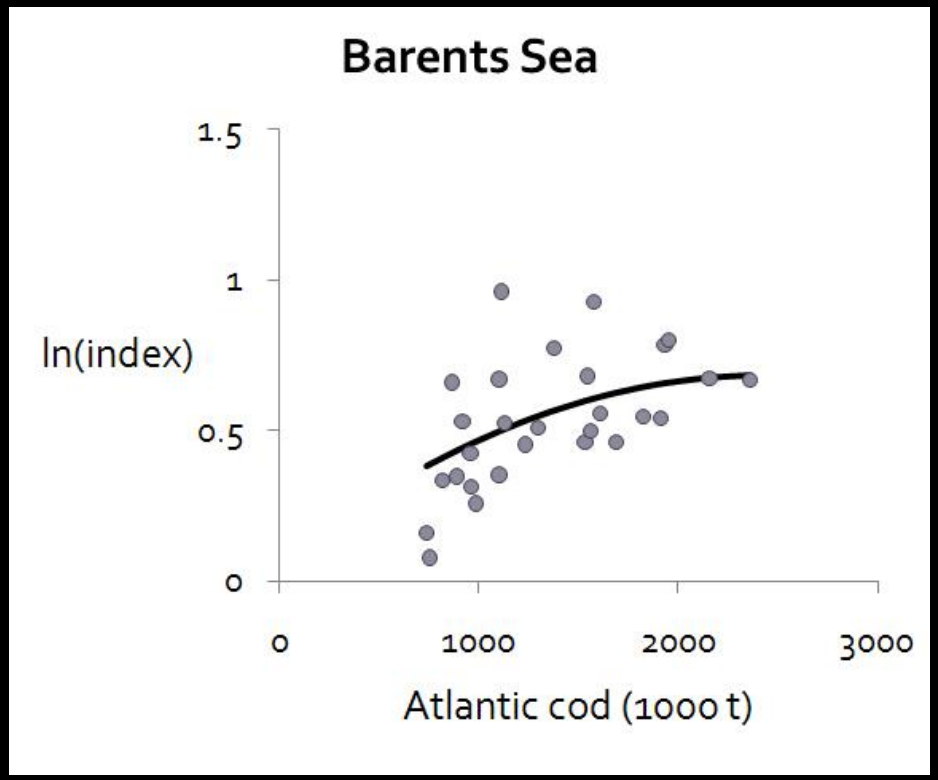
Temperature

Ecosystem	SST	DT
Gulf of St. Lawrence SFA 10	NS	NS
Gulf of St. Lawrence SFA 8	+	NS
Iceland	NS	not tested
Barents Sea	NS	not tested

Atlantic Cod

- Not significant in Gulf of St. Lawrence
- Inconsistent in other ecosystems





Conclusions

Northern Shrimp Models

Spawning stock

Temperature

Atlantic cod predation

Each matters somewhere, but….

Northern Shrimp Models

Spawning stock

Temperature

Atlantic cod predation

No clear main driver.

Not consistent among regions.

Ways to improve?

- Spawning stock
  - Female size
  - Proportion spawning

Ways to improve?

- Environment
  - Advection
  - Seasonality
  - Change in temperature

Ways to improve?

- Predators
  - Consider other fishes
  - Season, location, ontogeny
  - Alternate prey sources
    - Capelin?

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