

ICES Symposium on Fisheries Management Strategies.

Theme Session 1:

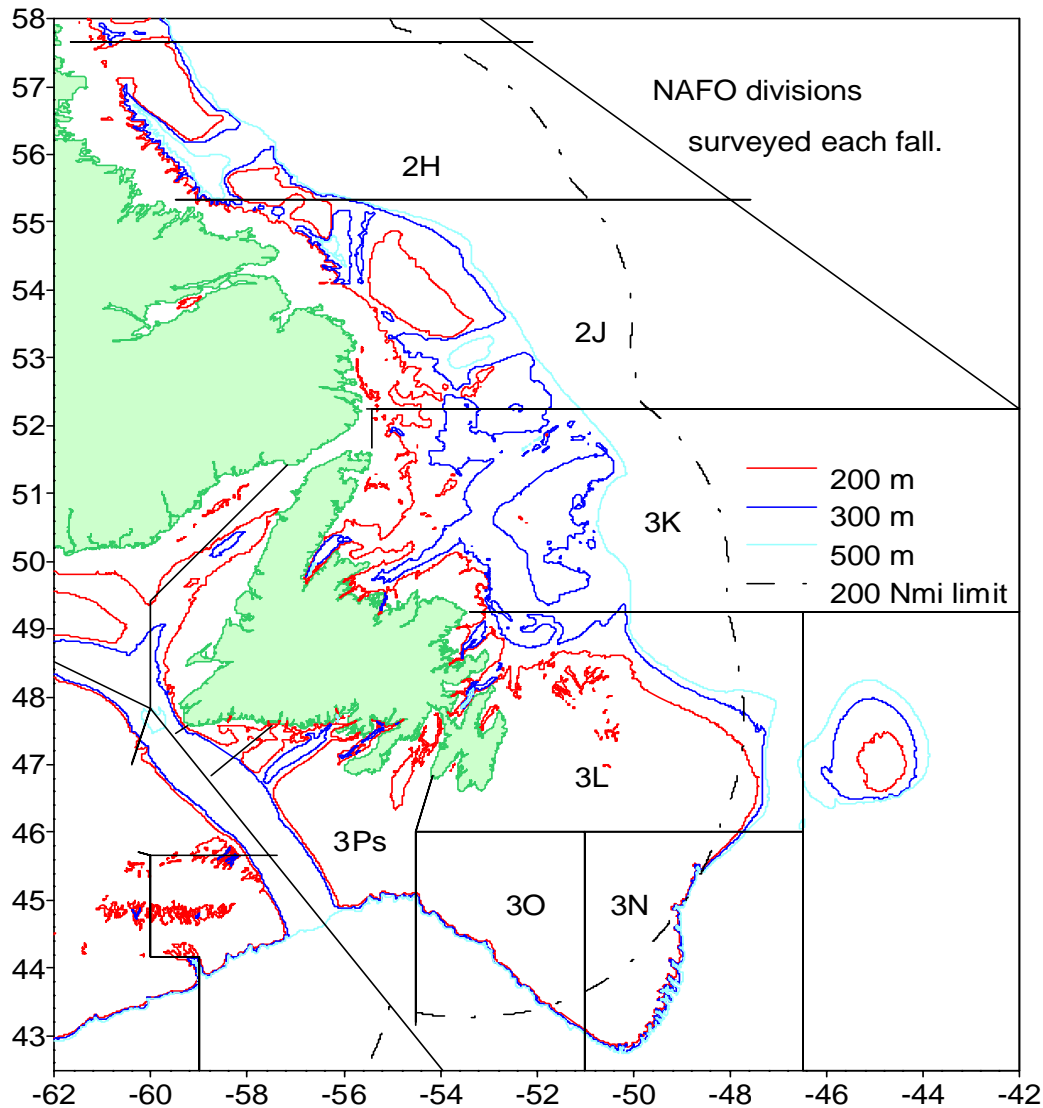
**Ecosystems, Predictability and Robustness**

**Developing predictive models for crustacean resources on the  
Newfoundland-Labrador Shelf (thinking inside the box).**

Earl Dawe, Don Parsons, and Eugene Colbourne

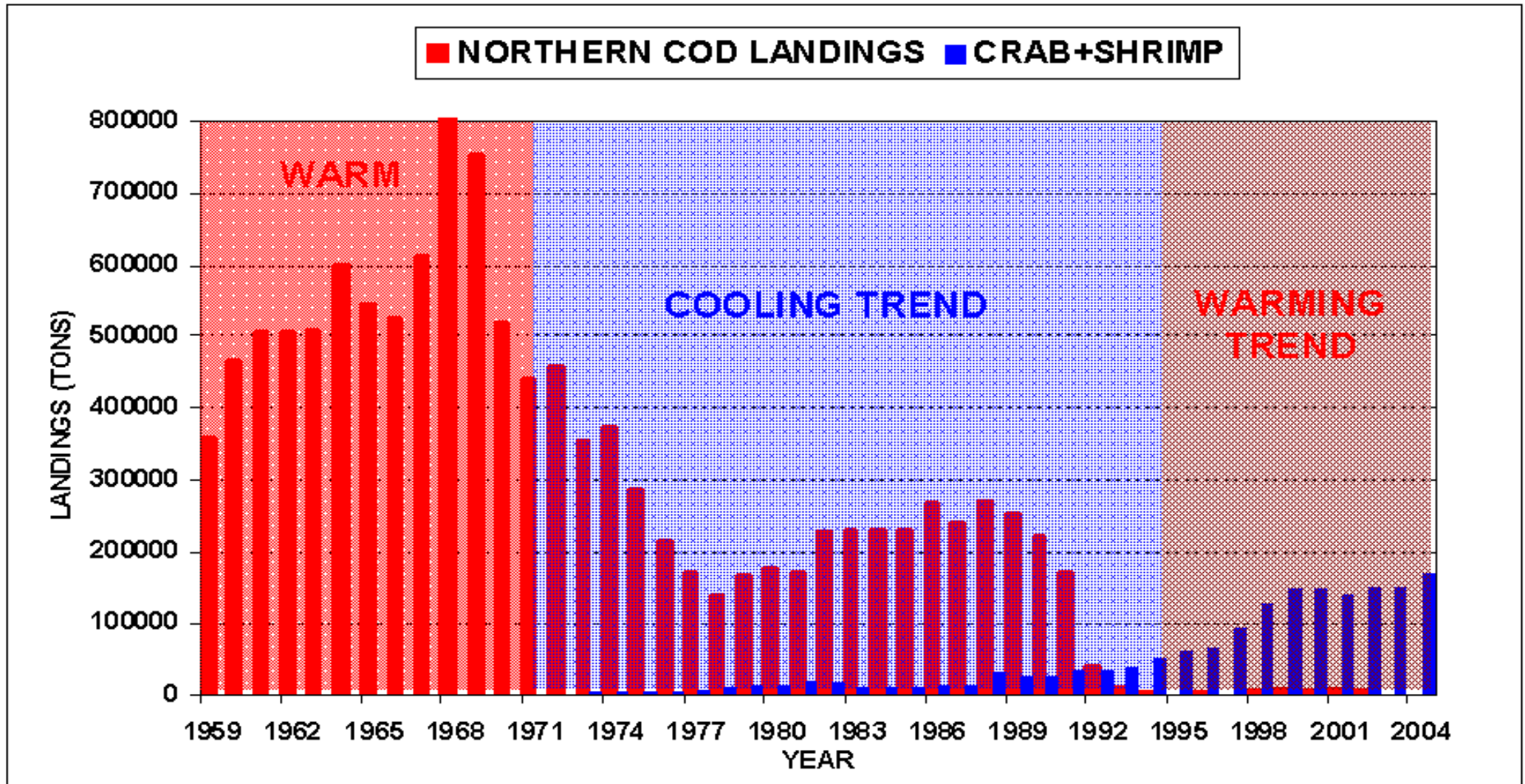
*Fisheries and Oceans Canada  
Northwest Atlantic Fisheries Centre  
St. John's, NL*

# Newfoundland and Labrador Continental Shelf



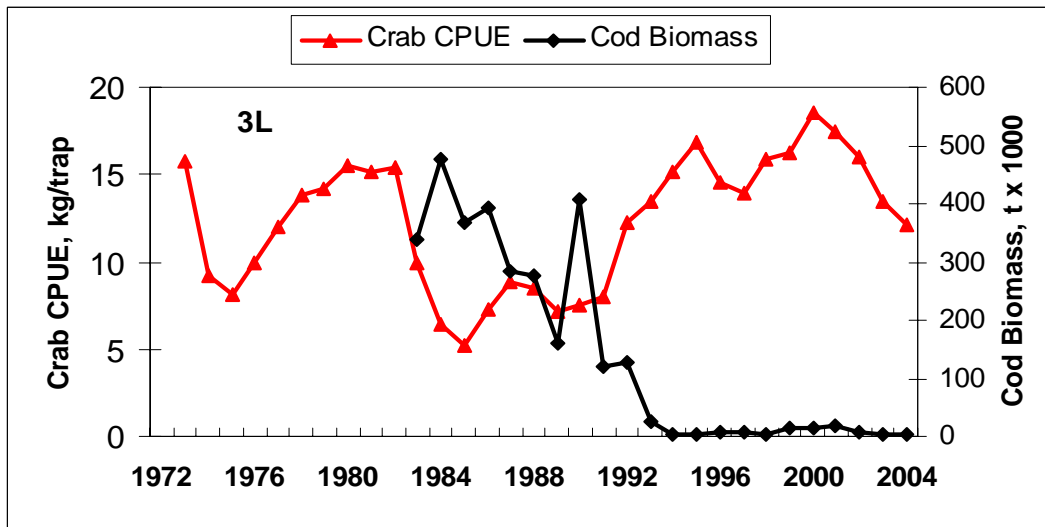
- Resources managed by NAFO Division
- Short time series of fall Campelen trawl surveys in Div. 2J3KLNO
- Longer time series of fishery CPUE

# Changes in the Newfoundland and Labrador Fishery

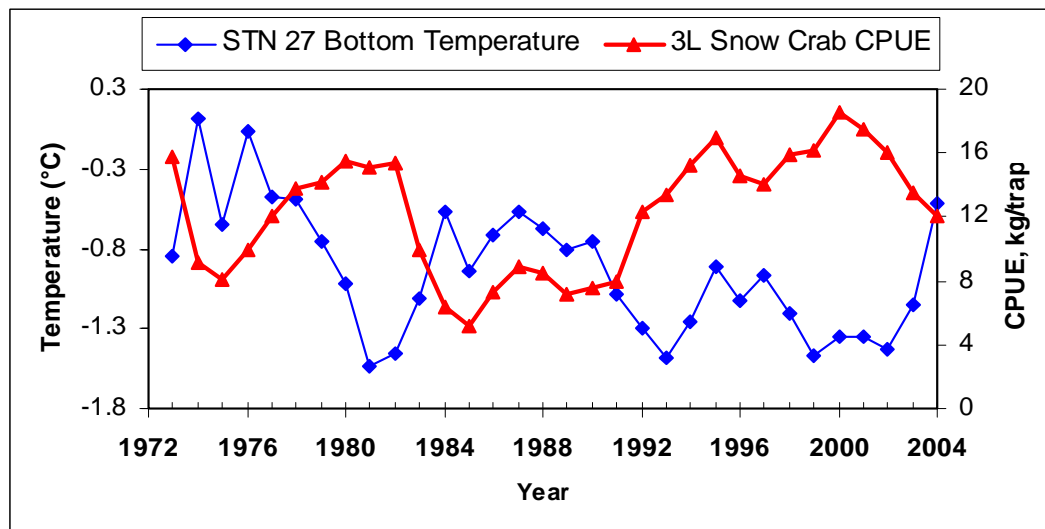


# Outline

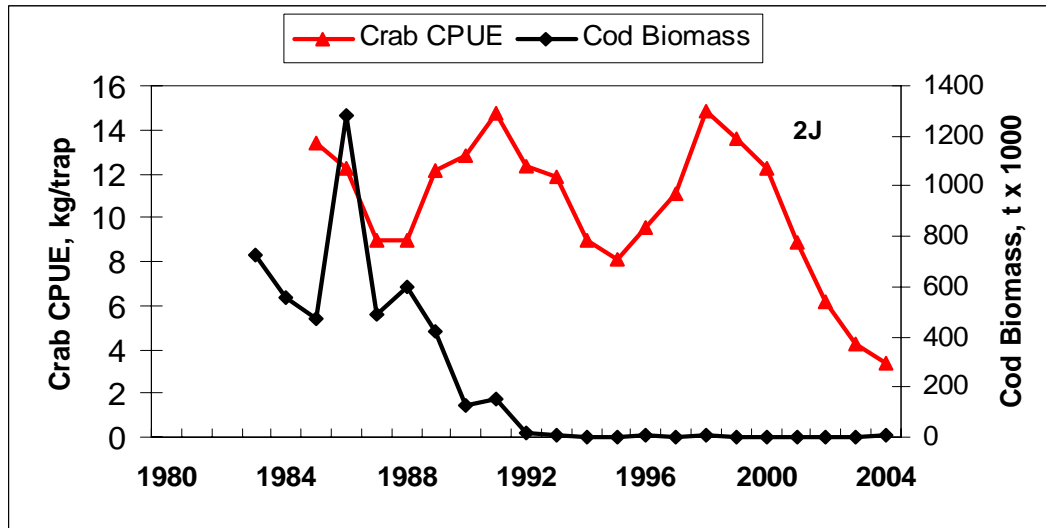
- Review evidence for effects of predation (top-down) and production (bottom-up) on northern shrimp and snow crab abundance.
- Describe the development of predictive models that include environmental information.
- Discuss limitations of current models and requirements for improvement.
- Implications for management.



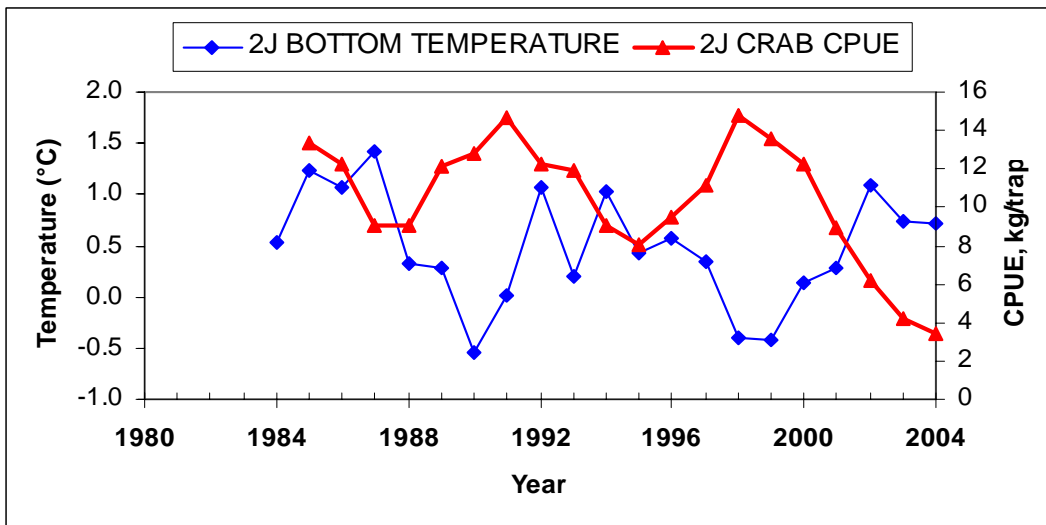
3L cod survey  
biomass vs.  
crab CPUE trend



Crab CPUE  
inversely related  
to temperature  
**8 years earlier**



2J cod survey biomass  
vs. crab CPUE trend



Crab CPUE  
inversely related  
to temperature  
**6 years earlier**

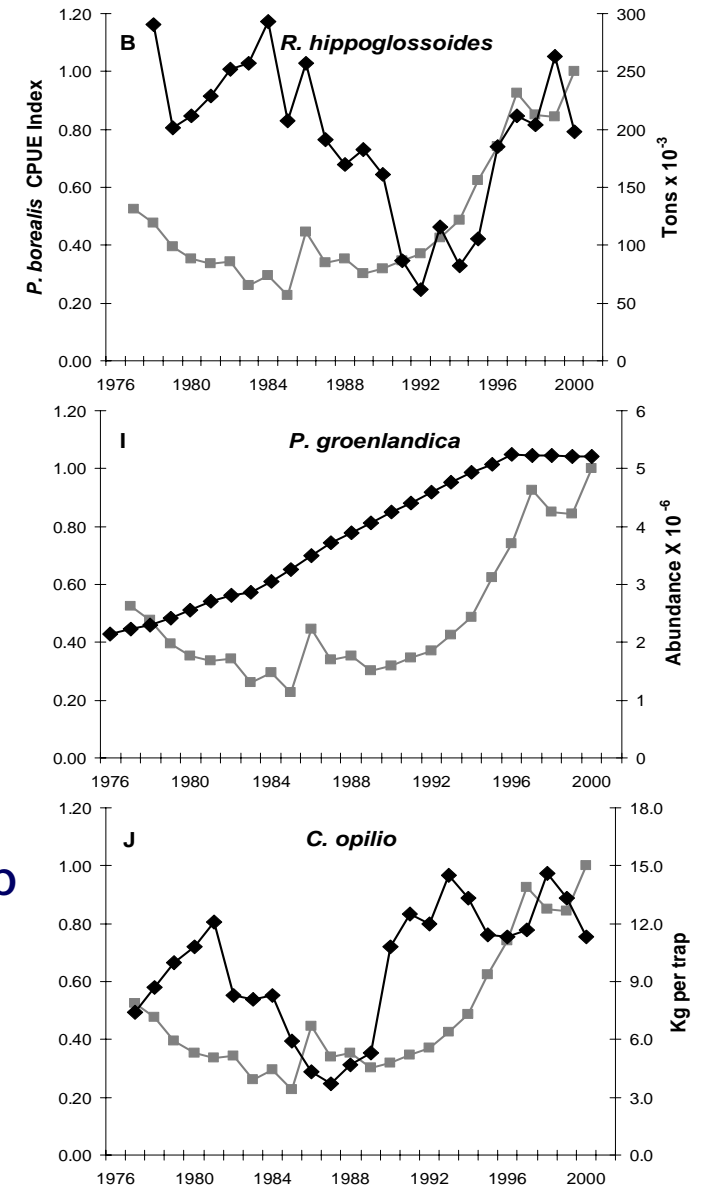
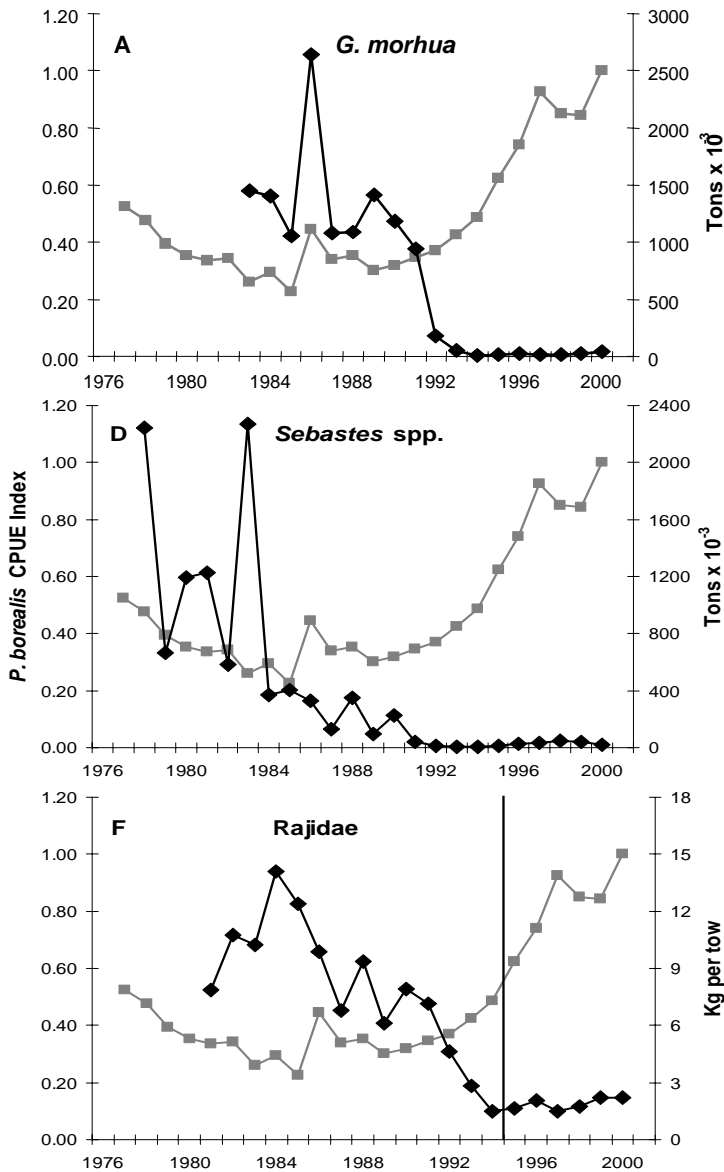
# Predator-Prey Relationships Northern Shrimp

(Parsons, 2005)

Several predatory fish species (e.g. cod, redfish and skate) declined to historically low levels by the early 1990's

Other predators (e.g. Greenland halibut, harp seals and snow crab) increased along with shrimp.

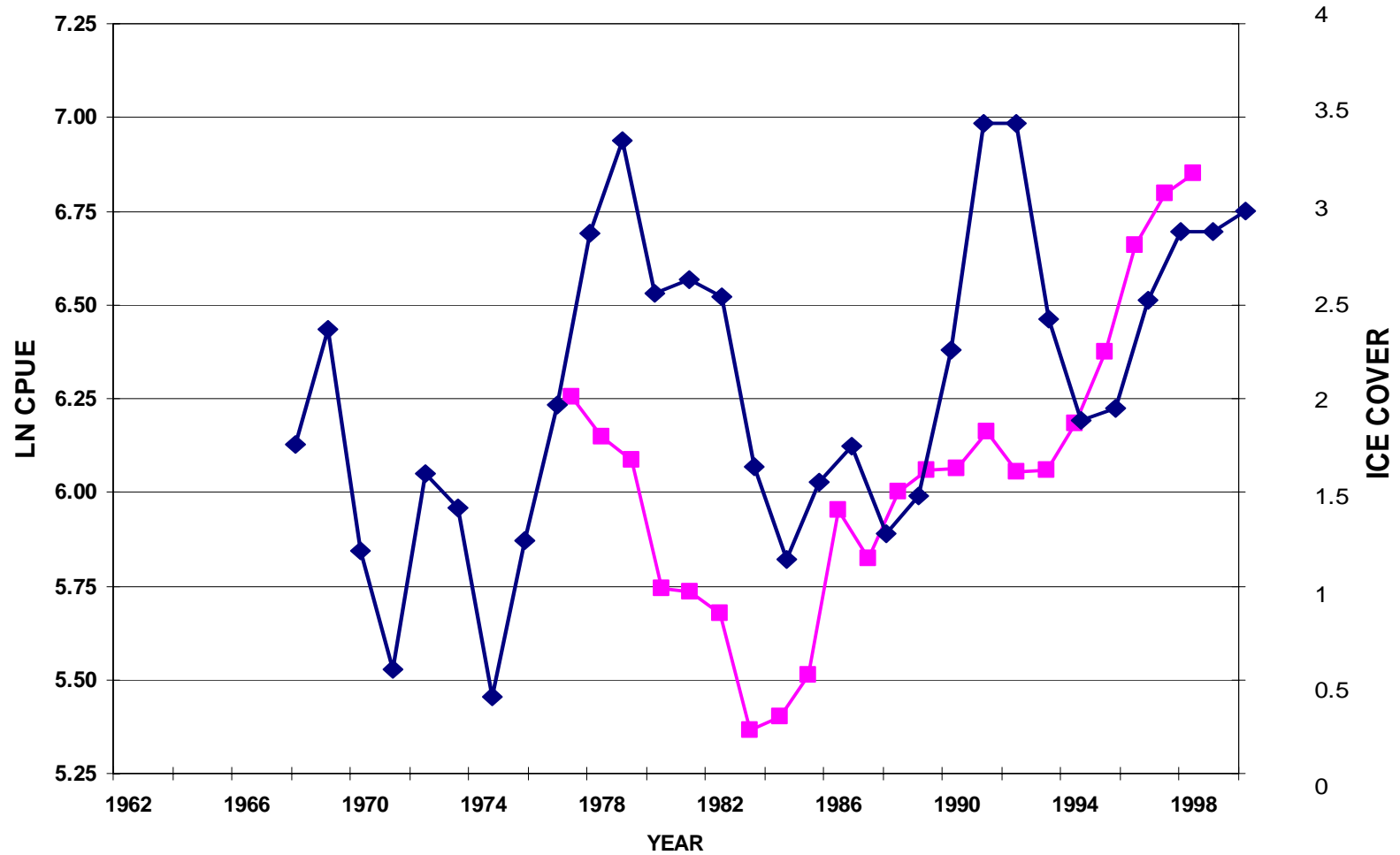
It cannot be established that the increase in shrimp biomass off NL resulted from a reduction in predation.



Shrimp CPUE - Div. 2HJ

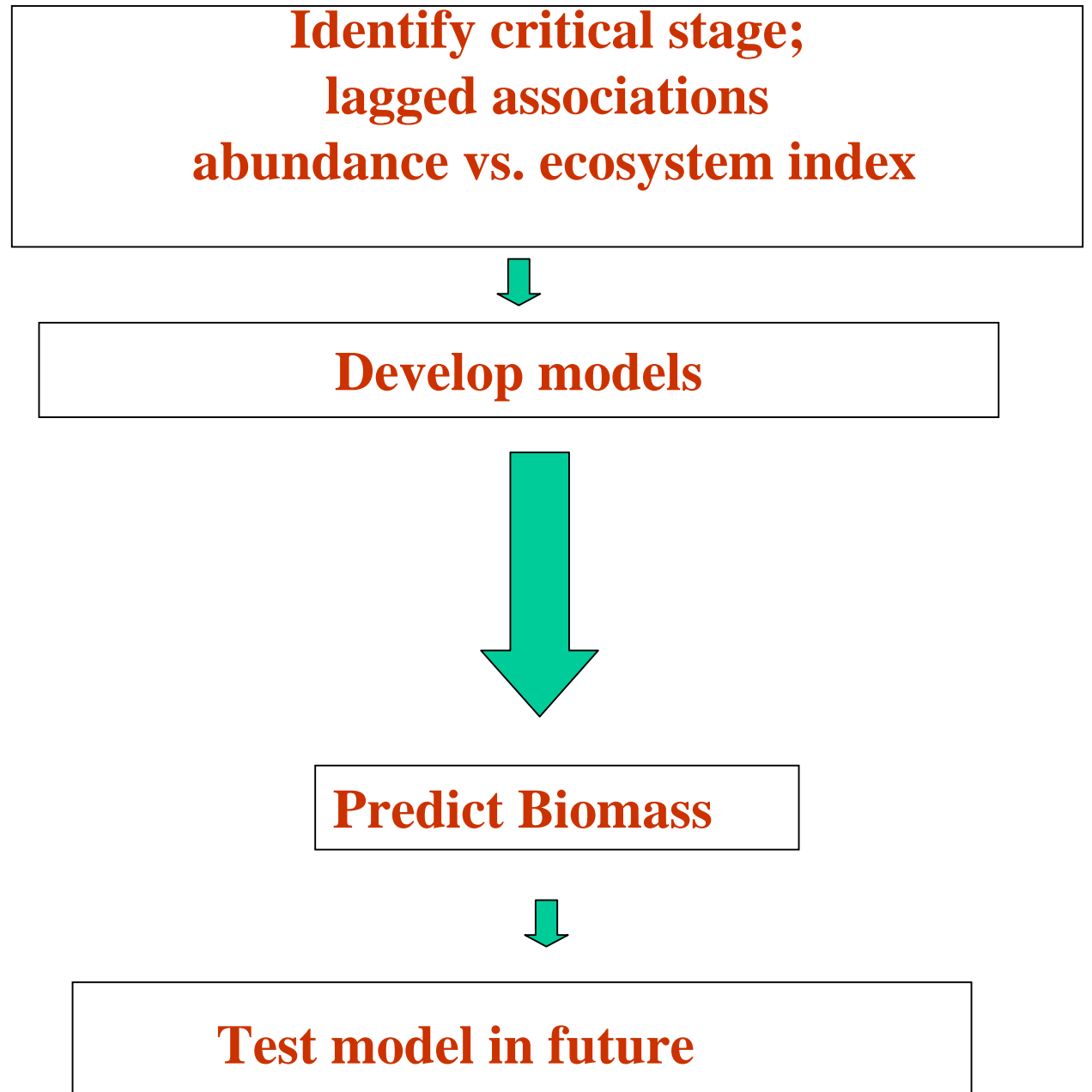
Ice cover 45° - 55° N

Lagged 6 years

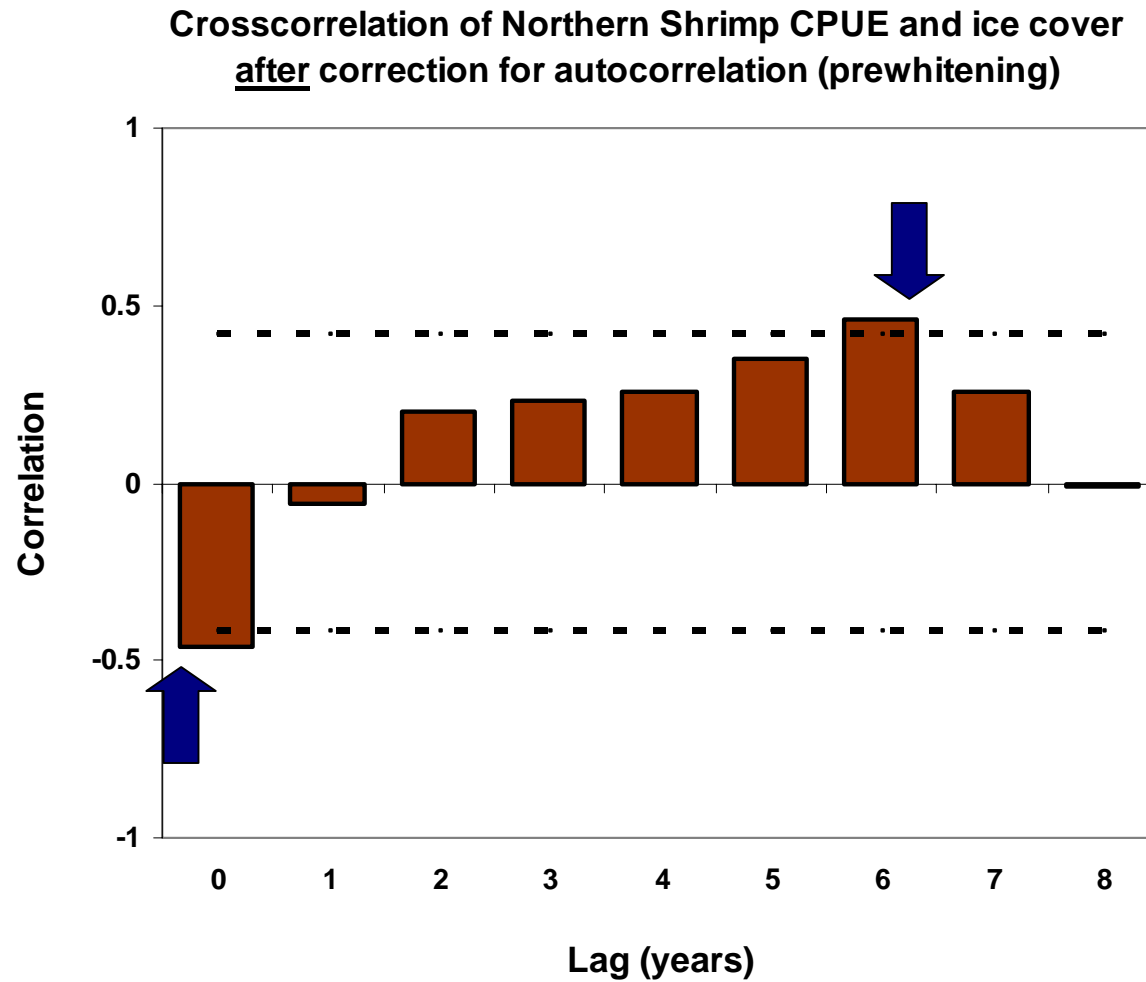


**An approach to  
modeling ecosystem  
effects**

**Time Series analysis**

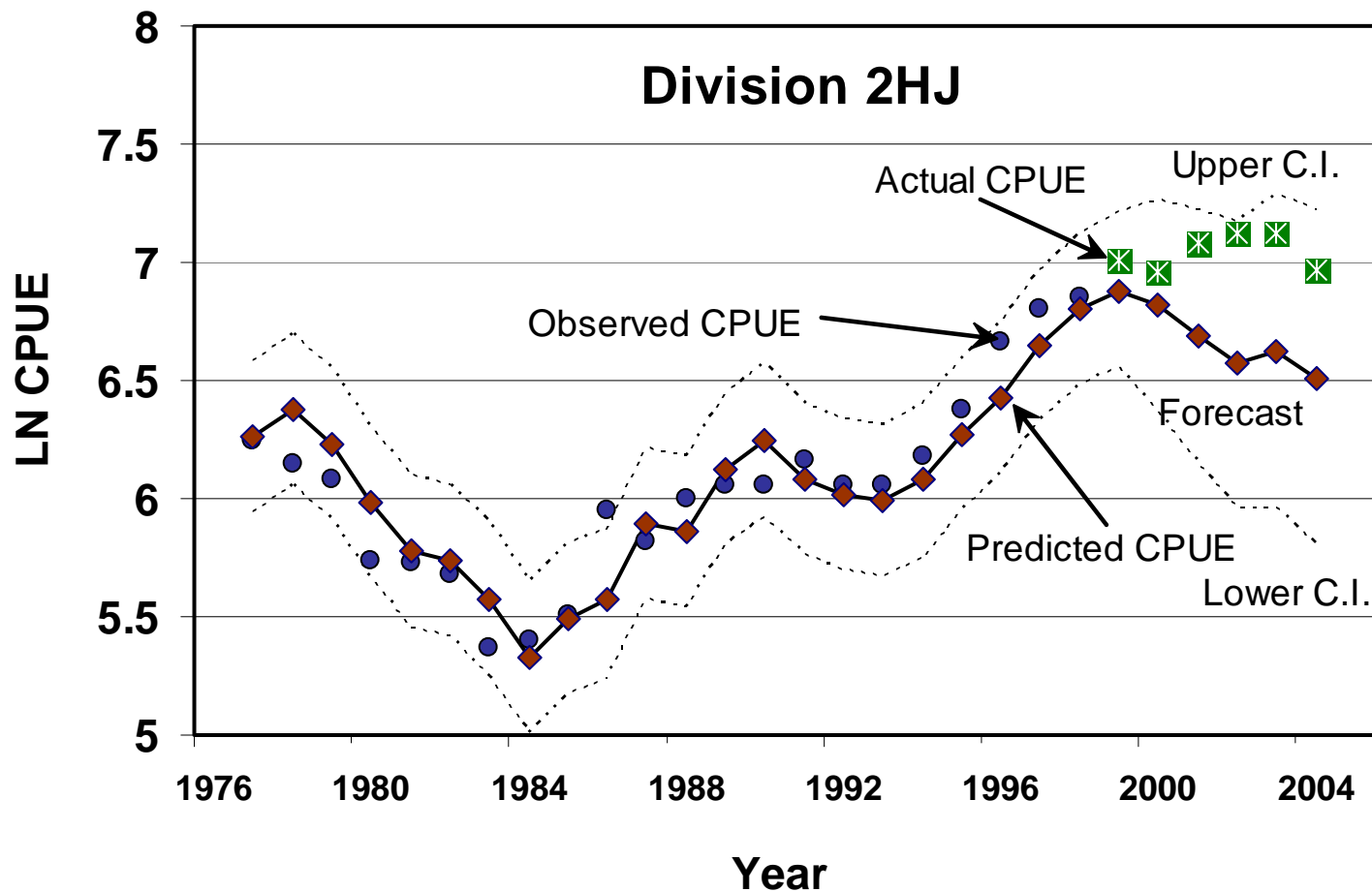


# Crosscorrelations after prewhitening



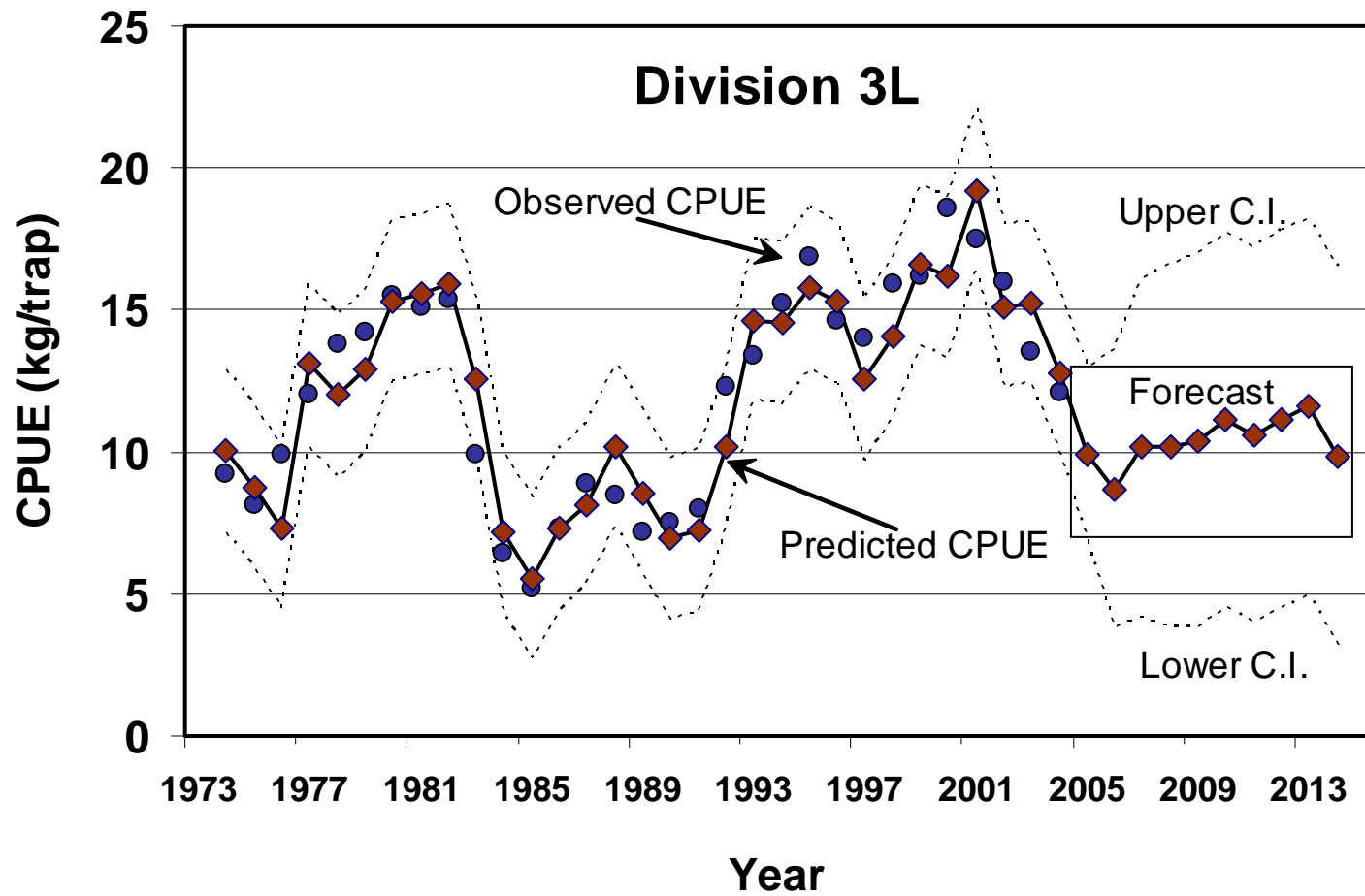
# Transfer Function for Shrimp CPUE – Div. 2HJ

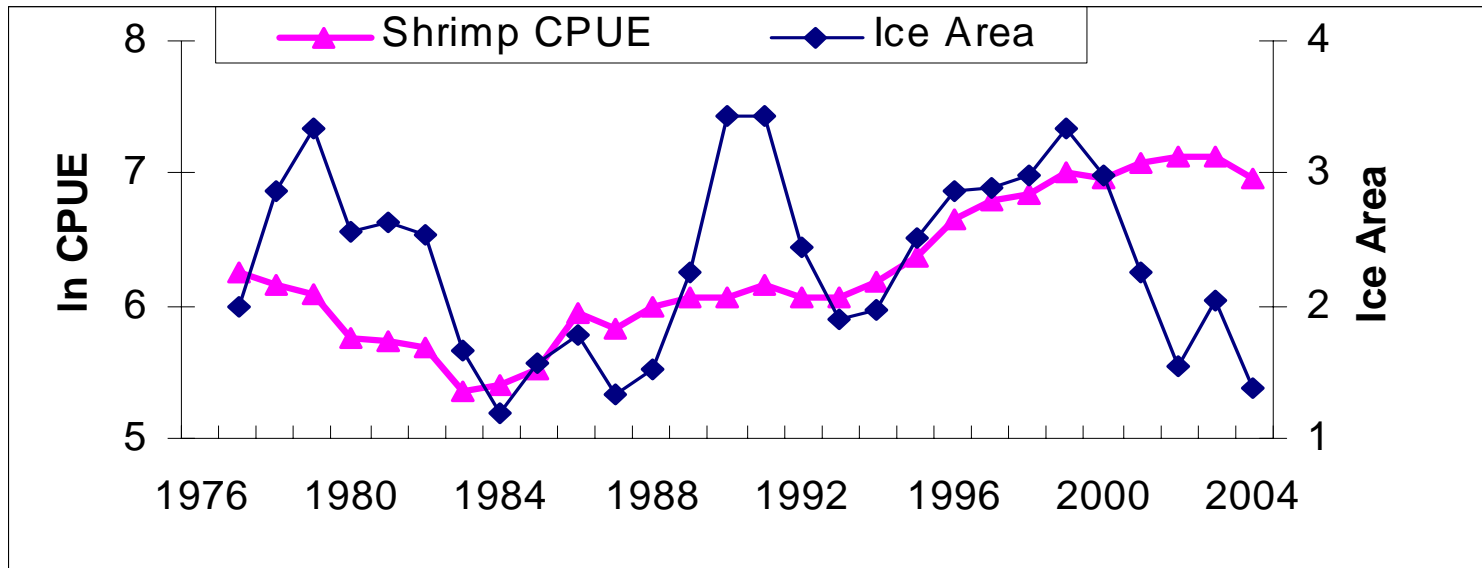
➔ Incorporate first-order autoregression of the CPUE *response* series and winter ice cover *input* with a delay of 6 years.



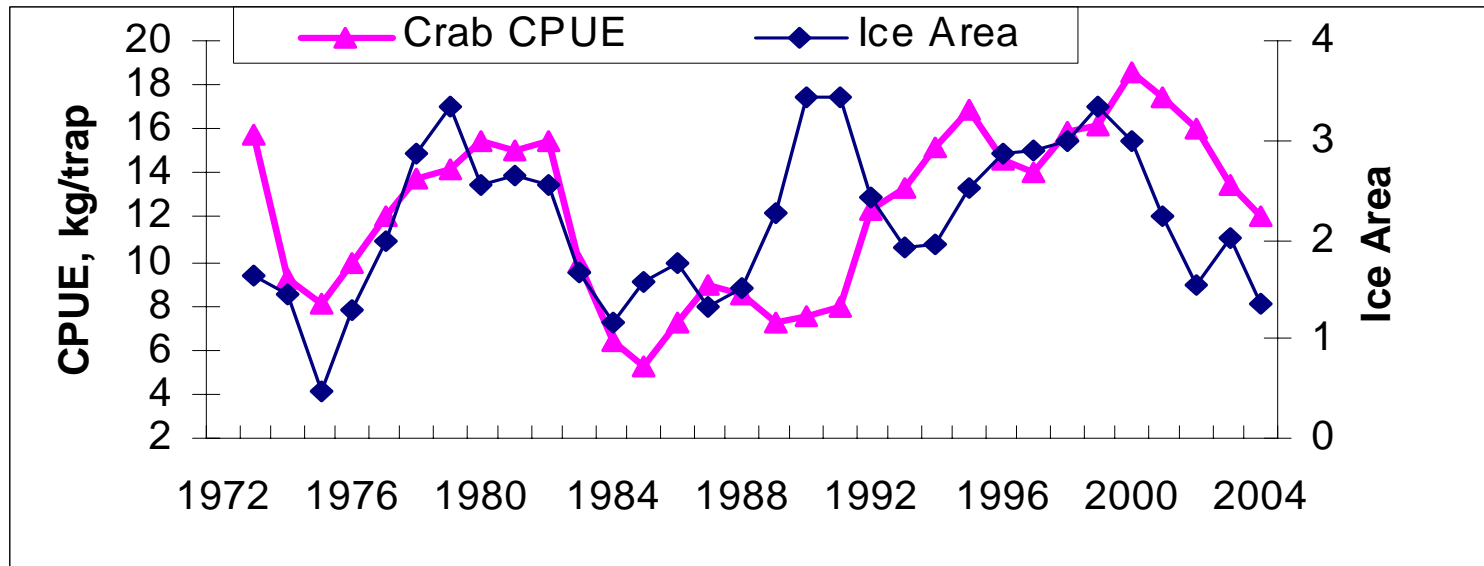
# Transfer Function Model for Snow Crab

Incorporate first and second-order autoregressive parameters of the CPUE series and total ice cover *input* with time lags of 0 and 10 years.





Shrimp  
CPUE  
vs ice



Crab  
CPUE vs  
ice

# A Framework for modeling ecosystem effects

## Correlated effects

- Ice, stratification,
- Temp. (metabolism)
- prey
- etc.

## Confounding effects

- Predation
- Competition
- Exploitation
- etc.

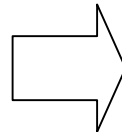
Identify critical stage;  
lagged associations  
abundance vs. ecosystem index

Develop models

Functional process??

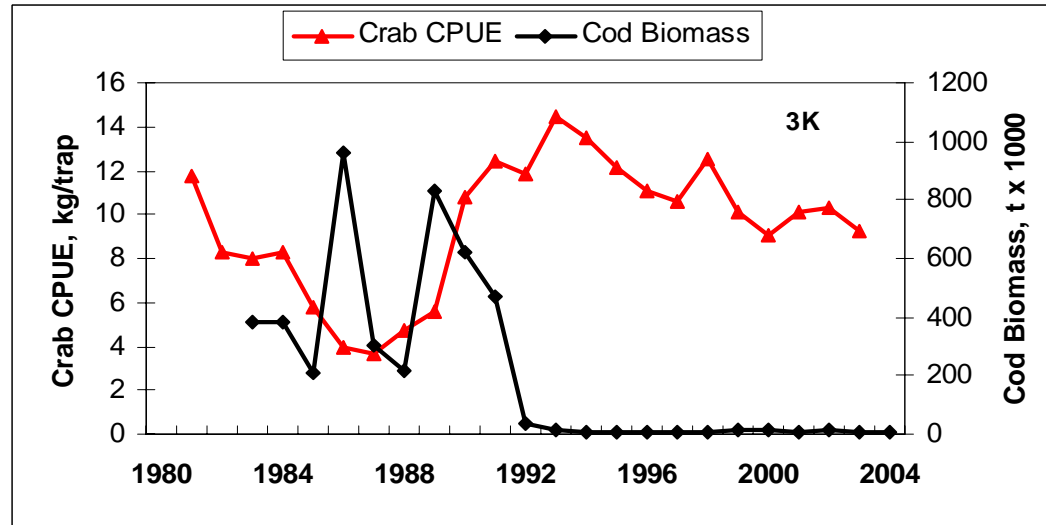
Predict Biomass

Test model in future

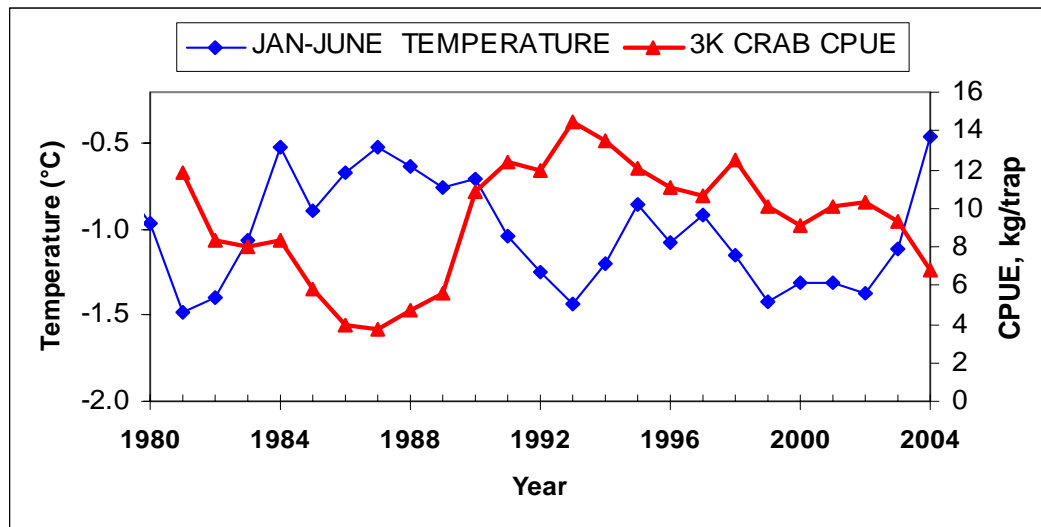


# Conclusions

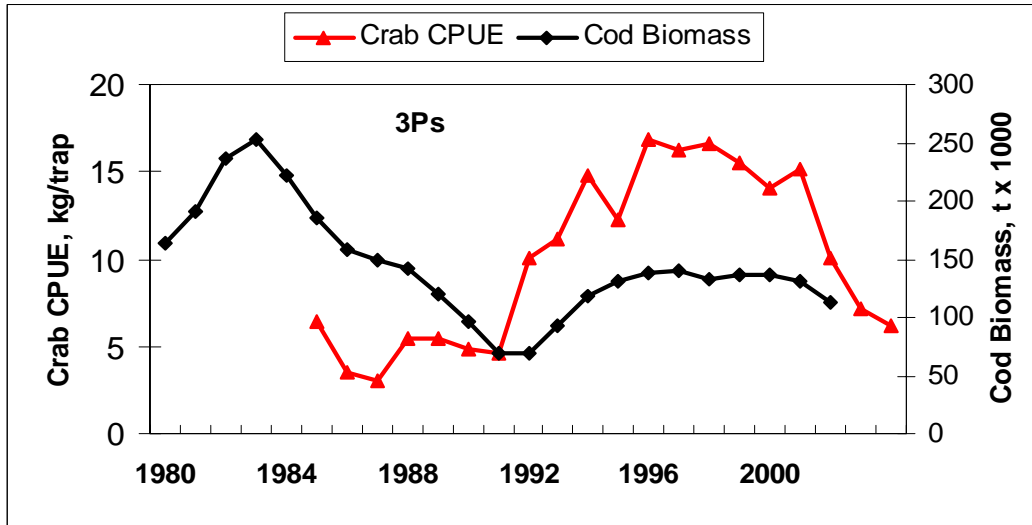
- The relative importance of predation vs. production is unclear.
- There is evidence of bottom-up processes affecting crustacean abundance.
- Predictive models can be improved by including environmental indices, but predictions remain tentative.
- Improving models will require longer time series and better understanding of functional processes.
- What does ‘sustainability’ mean and is it a realistic objective within such highly variable ecosystems?



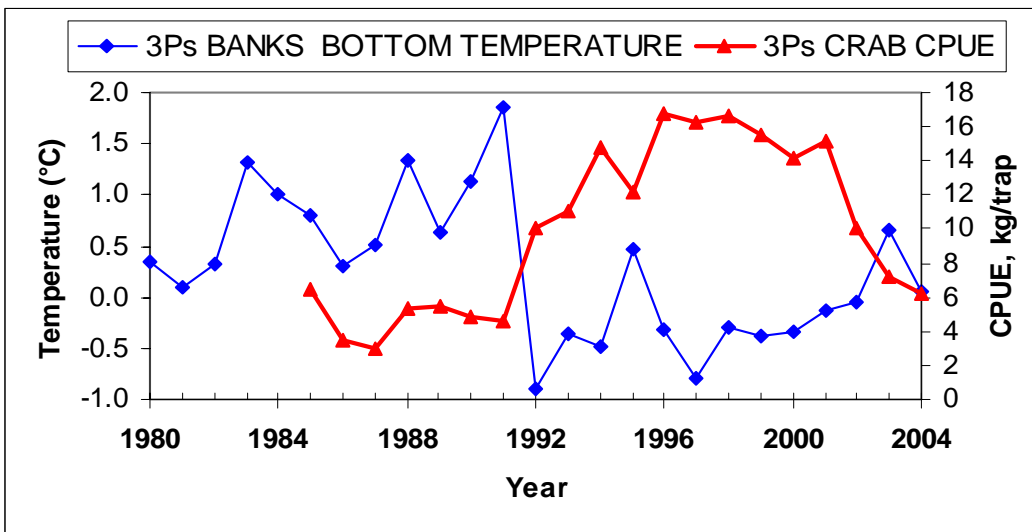
3K cod survey  
biomass vs.  
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**8 years earlier**



3Ps cod survey  
biomass  
vs.  
crab CPUE trend



Crab CPUE  
inversely related  
to temperature  
**7 years earlier**

# Changes in the Newfoundland and Labrador Fishery

