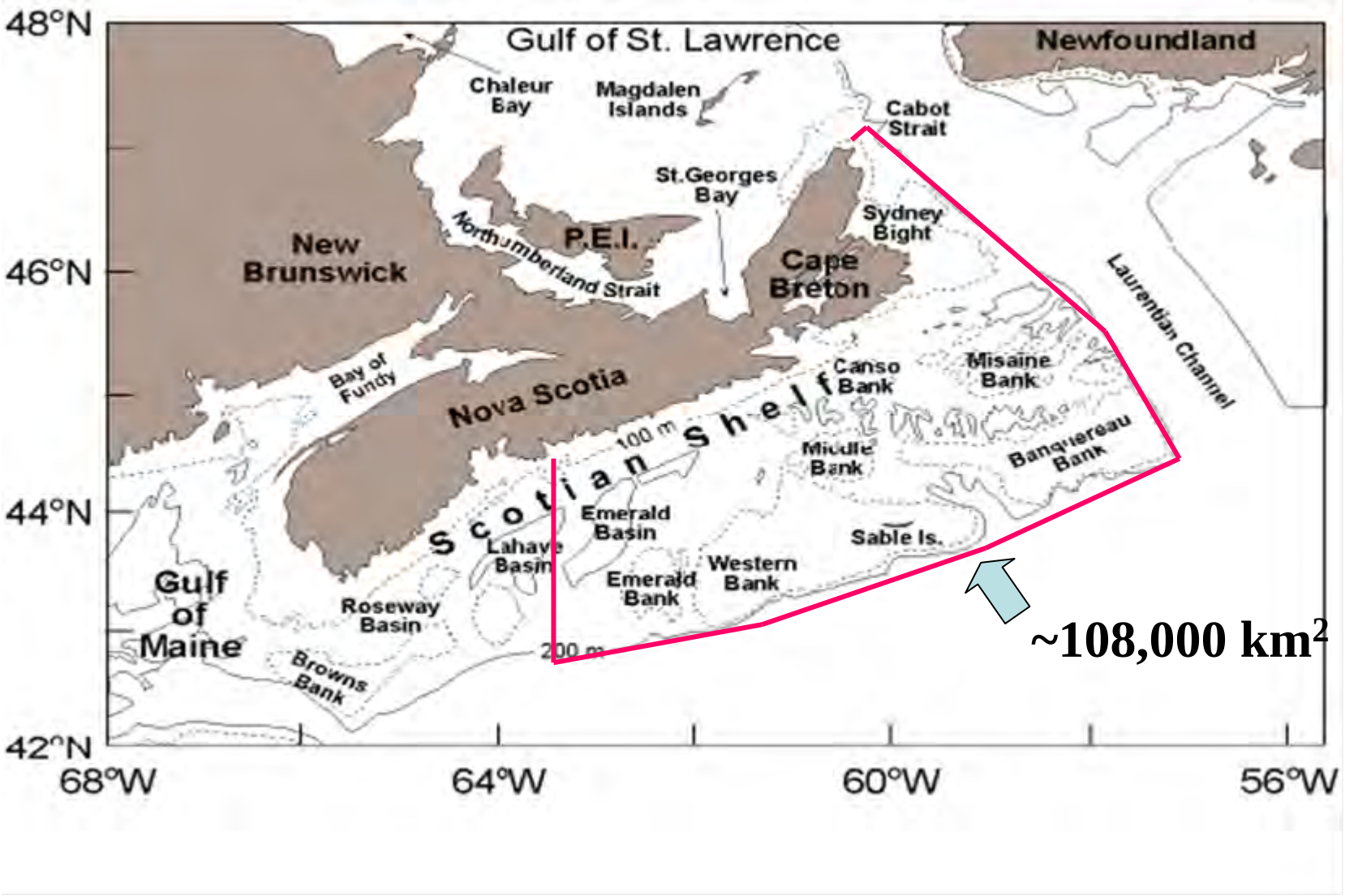
Ecosystem Approach to Management (EAM): a Canadian example of pragmatism undermined by “hubris”, and lack of explanatory power

Mike Sinclair
Bedford Institute of Oceanography
Dartmouth, Nova Scotia
Canada

Presentation Outline

- Scotian Shelf and Georges Bank examples of ecosystem approaches to Integrated Management
- Criticisms of our implementation approaches
- Description of a “regime shift” in the late 1980s
- Controversy on the role of grey seals in the “regime shift”
- Conclusions

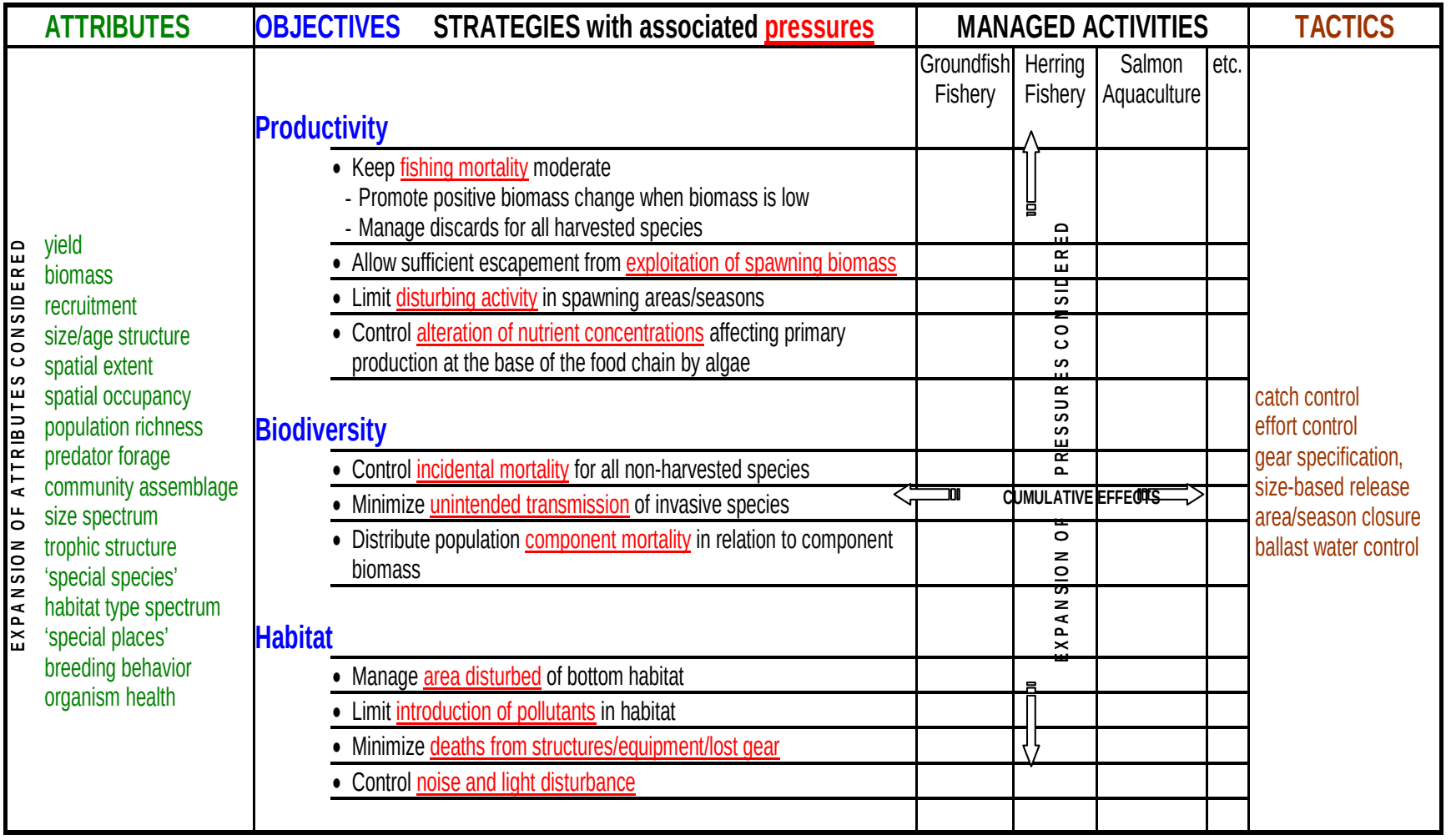
Eastern Scotian Shelf Integrated Management Area (ESSIM)



Broader Conservation Objectives

- **Maintain Productivity**
  - do not cause unacceptable reduction in productivity so that components can play their role in the functioning of the ecosystem
- **Preserve Biodiversity**
  - do not cause unacceptable reduction in biodiversity in order to preserve the structure and natural resilience of the ecosystem
- **Protect Habitat**
  - do not cause unacceptable modification to habitat in order to safeguard both physical and chemical properties of the ecosystem

Management Area Objectives



Preliminary Evaluation of Georges Bank FMPs

		GF	HF	SF	L/CF
Productivity					
Primary	Limit alteration of ***essential nutrient concentrations*** affecting primary production				
Community	Limit ***trophic level catch biomass*** with respect to trophic demands of higher levels				
	Limit ***total catch biomass*** within system production capacity				
Population	Keep ***fishing mortality*** moderate				
	Permit sufficient ***spawning biomass*** to evade exploitation				
	Promote positive ***biomass change*** when biomass is low				
	Manage ***% size/age/sex*** of capture				
	Prevent disturbing ***activity in spawning areas/seasons***				
	Manage ***discarded catch***				
Biodiversity					
Biotope/seascape	Limit ***% area disturbed*** of seascape/biotope types				
Species	Limit incidental ***bycatch or mortality***				
	Minimize ***change in distribution*** of invasive species				
Population	Distribute population ***component catch as a % of component biomass***				
Habitat					
Bottom	Limit ***% area disturbed*** of habitat types				
Water Column	Limit ***amounts of contaminants, toxins and waste*** introduced in habitat				
	Minimize ***amount of lost of gear***				
	Control ***noise level/frequency*** with respect to species of risk				

- **Blue: high relevance that currently receive attention**
- **Red: high relevance & require attention**
- **Others: of low relevance**

Biodiversity & Habitat

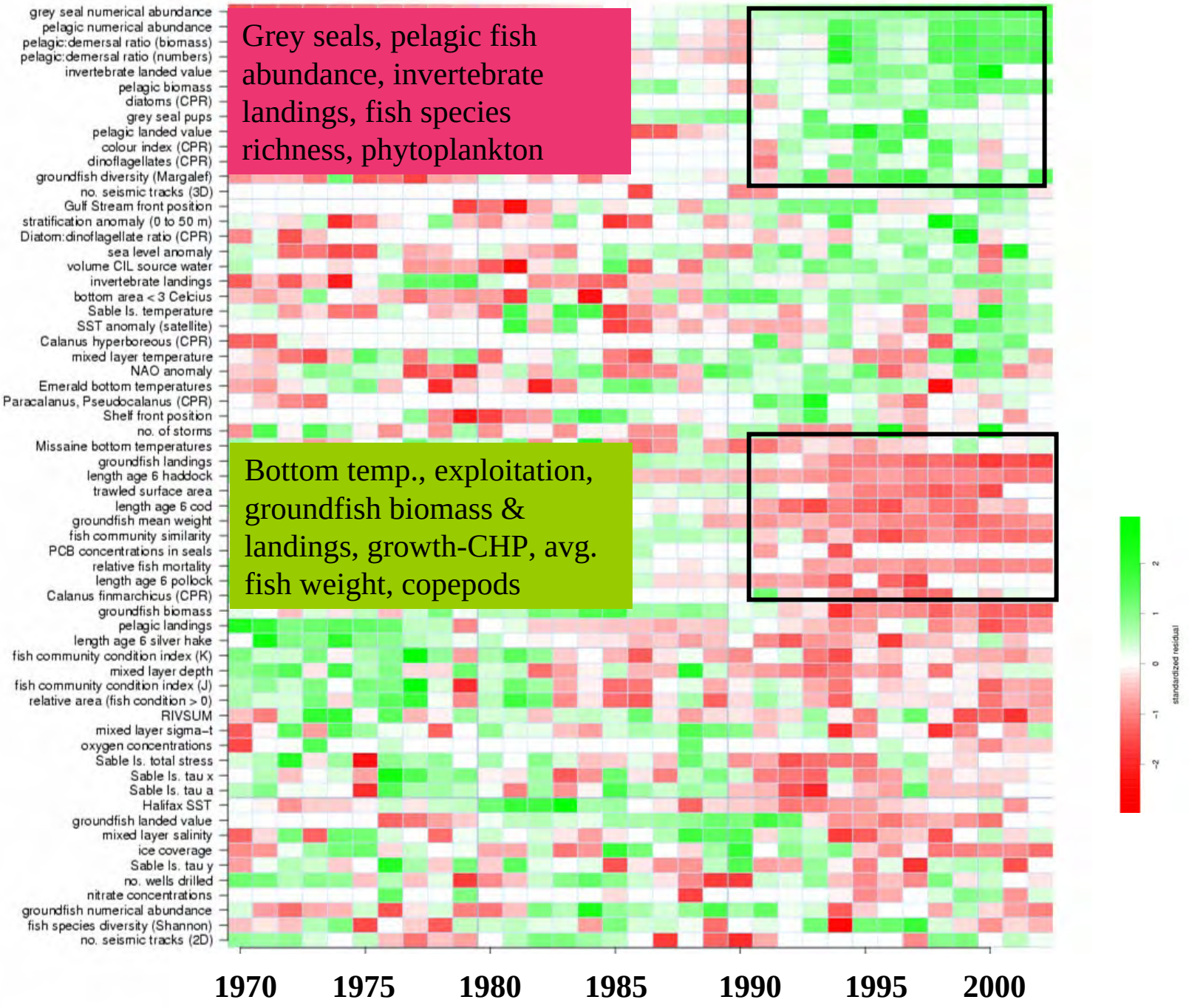
		Activities												
Strategies with associated pressures	**Management Unit**	**GRO-OTB**	**GRO-LLS/LHP**	**GRO-GNS**	**YTF-OTB**	**SCA-DR**	**LBA-FPO**	**CRR-FPO**	**SWO-LL**	**SWO-HAR**	**BFT-LTL/LHP**	**BFT-HAR**	**HER-PS**	**HER-OTM**
Control incidental mortality for all non-harvested species	4X5Zc white hake	√	√	√	√	√	√	√						
	4VWX5Zc cusk	√	√				√	√						
	Atlantic wolfish	√	√			√								
	spotted wolfish	√	√			√								
	5Z other flounders	√			√	√								√
	winter skate	√	√		√	√								√
	thorny skate	√	√		√	√								
	barndoor skate	√	√	√	√	√								
	smooth skate	√	√		√	√								
	spiny dogfish	√	√										√	
	blue shark		√						√		√			√
	basking shark	√	√	√										
	porbeagle shark	√							√				√	
Minimize unintended transmission of invasive species														
Distribute population component mortality in relation to component biomass														
Manage area disturbed of bottom habitat	Coral Conservation Area	√	√	√	√	√	√	√						
Limit introduction of pollutants in habitat														
Minimize deaths from structures/equipment/lost gear														
Control noise and light disturbance														

What does EAM mean for fisheries under this approach?

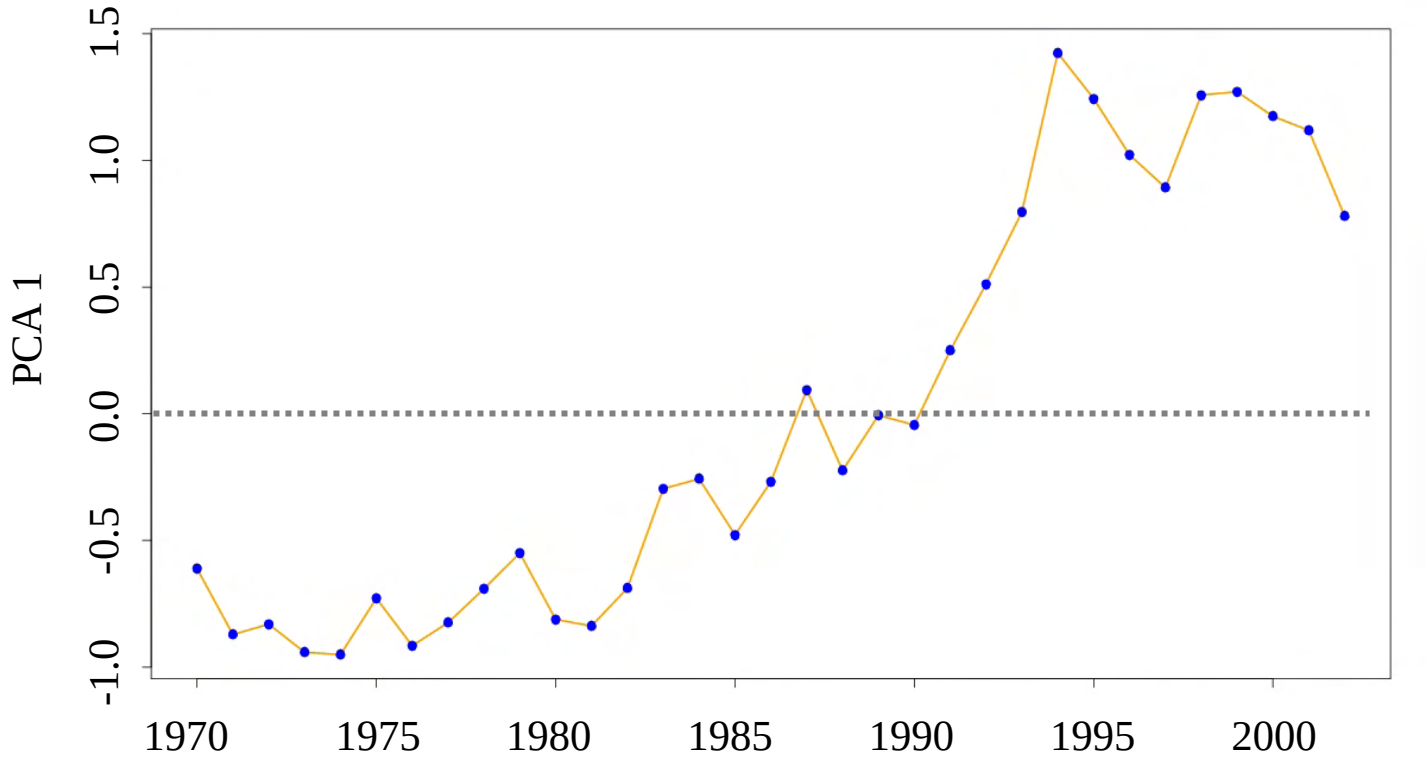
- In addition to concern about impacts of fishing on harvested resources
  - Impacts of fishing on components of ecosystem other than harvested resources
    - Manage by-catch & bottom contact; consider impacts on additional ecosystem attributes
  - Implications of environmental forces and prevailing ecosystem conditions on how fishing is conducted
    - Review references wrt changes in growth, mortality, species interactions, etc.

Some Shortfalls of Approach

- Focused on needs by individual conservation objective
- Lack of attention to ecological interactions and ecosystem structure/function issues
- “Ecological risk analysis” for prioritization of issues not done
- Socio-economic issues not considered in an integrated manner

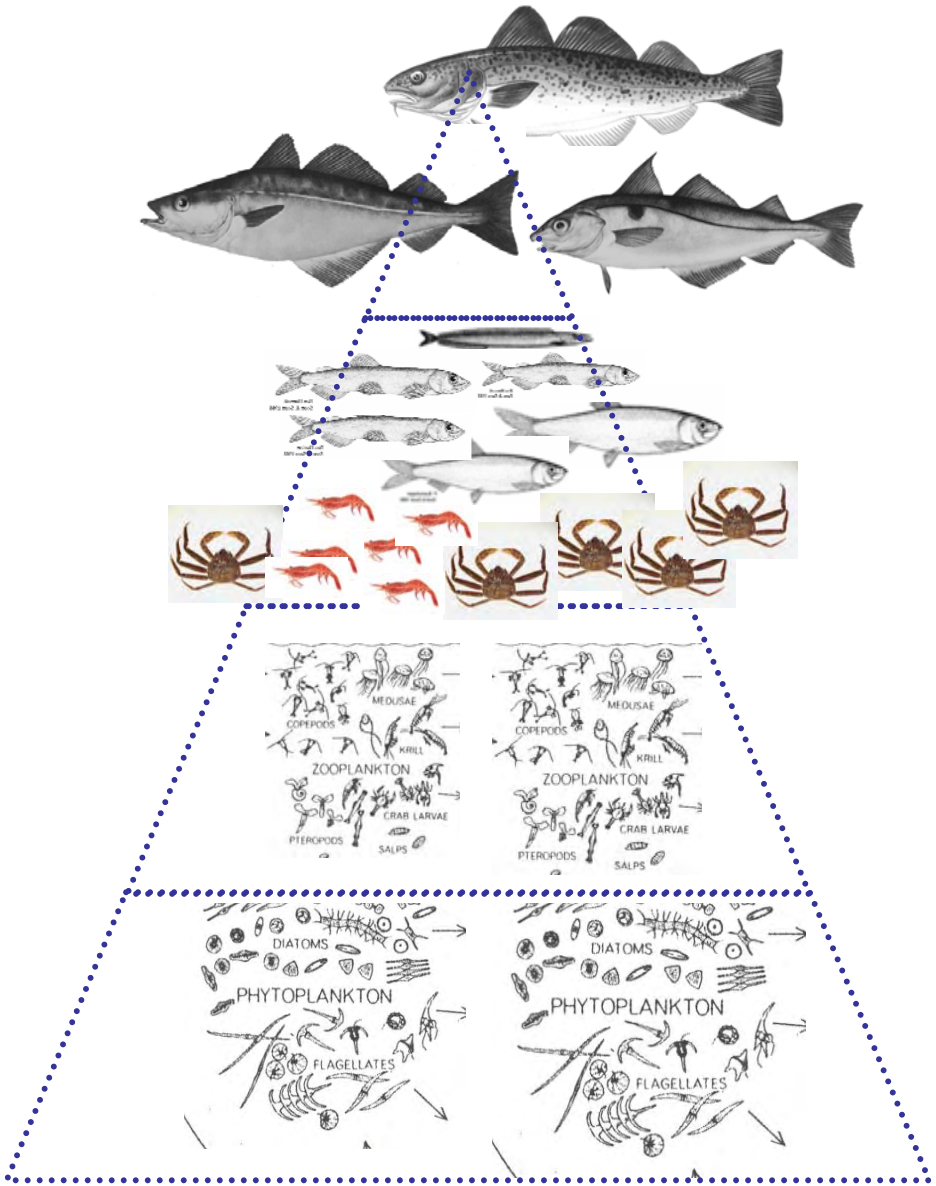

grey seal numerical abundance
pelagic numerical abundance
pelagic:demersal ratio (biomass)
pelagic:demersal ratio (numbers)
invertebrate landed value
pelagic biomass
diatoms (CPR)
grey seal pups
pelagic landed value
colour index (CPR)
dinoflagellates (CPR)
groundfish diversity (Margalef)
no. seismic tracks (3D)
Gulf Stream front position
stratification anomaly (0 to 50 m)
Diatom:dinoflagellate ratio (CPR)
sea level anomaly
volume CIL source water
invertebrate landings
bottom area < 3 Celcius
Sable Is. temperature
SST anomaly (satellite)
Calanus hyperboreous (CPR)
mixed layer temperature
NAO anomaly
Emerald bottom temperatures
Paracalanus, Pseudocalanus (CPR)
Shelf front position
no. of storms
Missaine bottom temperatures
groundfish landings
length age 6 haddock
trawled surface area
length age 6 cod
groundfish mean weight
fish community similarity
PCB concentrations in seals
relative fish mortality
length age 6 pollock
Calanus finmarchicus (CPR)
groundfish biomass
pelagic landings
length age 6 silver hake
fish community condition index (K)
mixed layer depth
fish community condition index (J)
relative area (fish condition > 0)
RIVSUM
mixed layer sigma–t
oxygen concentrations
Sable Is. total stress
Sable Is. tau x
Sable Is. tau a
Halifax SST
groundfish landed value
mixed layer salinity
ice coverage
Sable Is. tau y
no. wells drilled
nitrate concentrations
groundfish numerical abundance
fish species diversity (Shannon)
no. seismic tracks (2D)
Grey seals, pelagic fish abundance, invertebrate landings, fish species richness, phytoplankton
Bottom temp., exploitation, groundfish biomass & landings, growth-CHP, avg. fish weight, copepods
1970
1975
1980
1985
1990
1995
2000
standardized residual
2
1
0
-1
-2

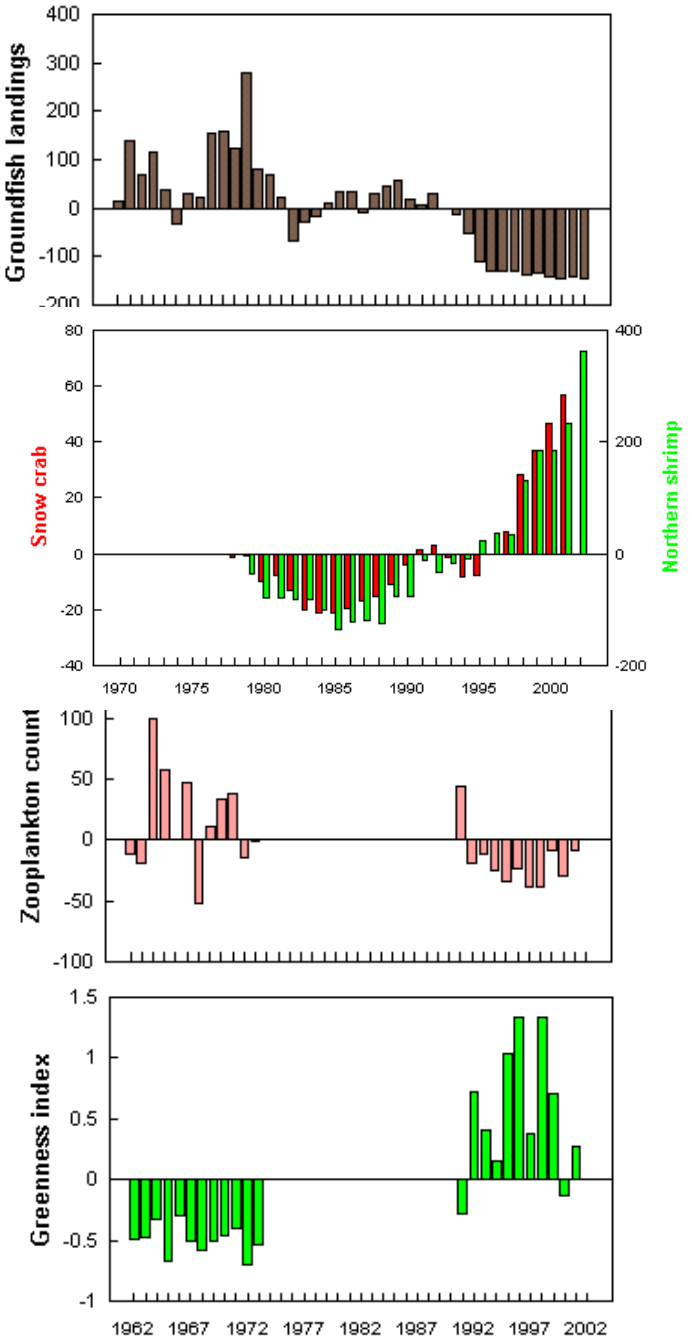
Index of Ecosystem Change



Demersal ---------- Pelagic/invertebrate system

Clear shift in ecosystem state based on 60+ metrics

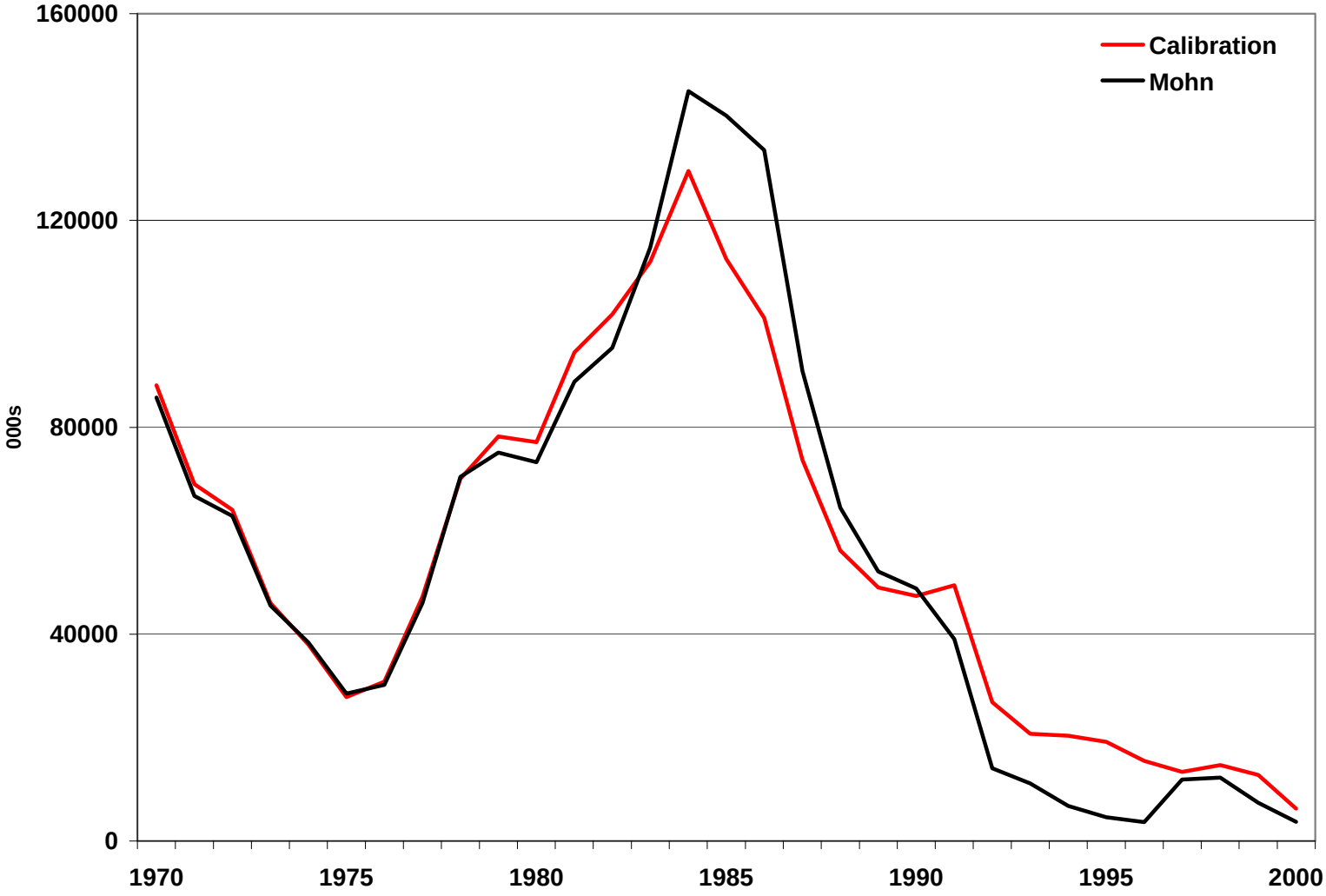

MEDUSAE
COPEPODS
KRILL
ZOOPLANKTON
CRAB LARVAE
PTEROPODS
SALPS
DIATOMS
PHYTOPLANKTON
FLAGELLATES


Groundfish landings
400
300
200
100
0
-100
-200
Snow crab
Northern shrimp
80
60
40
20
0
-20
-40
400
200
0
-200
1970
1975
1980
1985
1990
1995
2000
Zooplankton count
100
50
0
-50
-100
Greenness index
1.5
1
0.5
0
-0.5
-1
1962
1967
1972
1977
1982
1987
1992
1997
2002

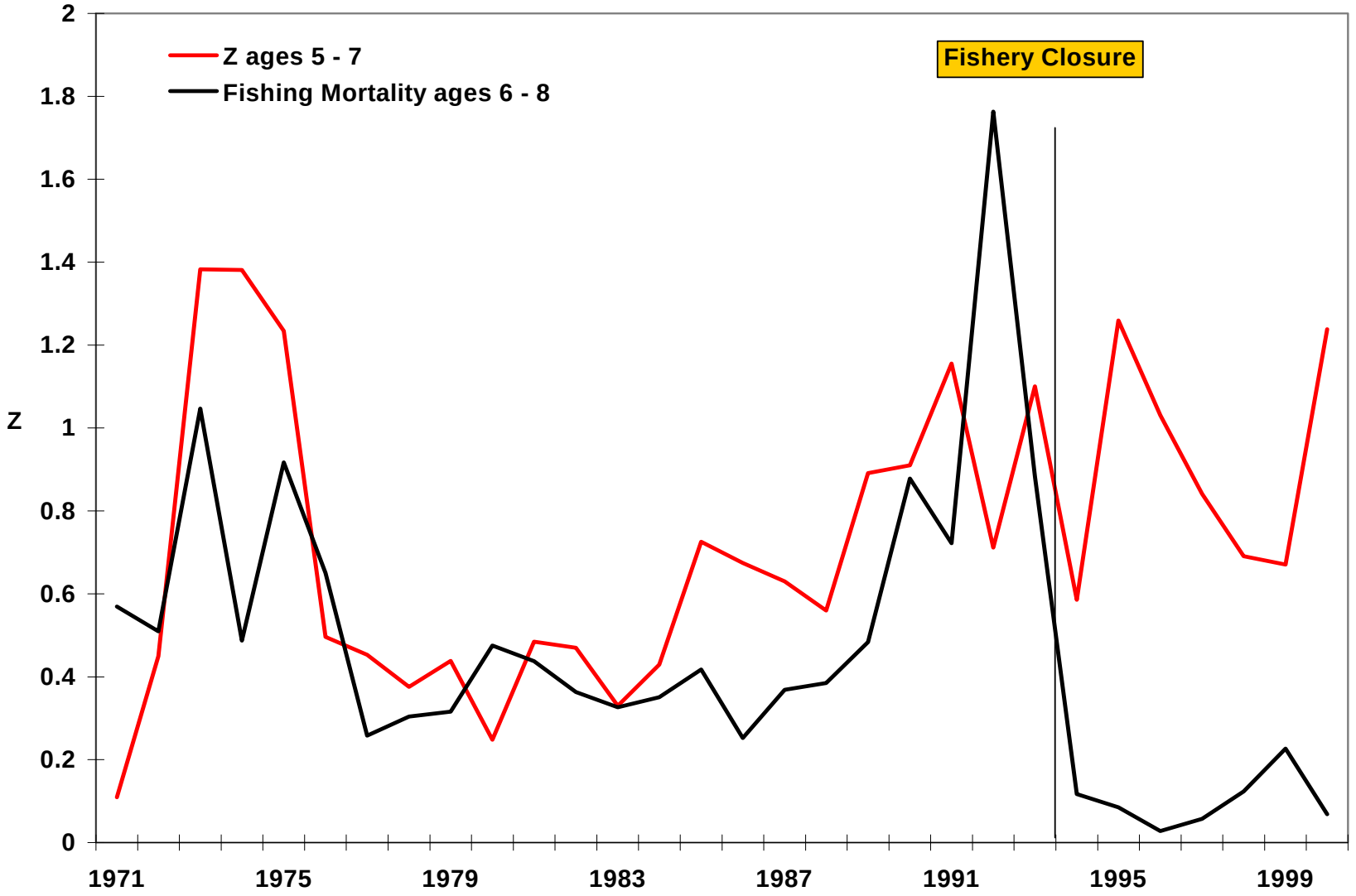
Key Related Issues for Interpretation of Trophic Cascade and Regime Shift

- What has caused the temporal changes in natural mortality of larger predators on the eastern Scotian Shelf since the late 1980s?
- What has caused the lack of recovery of cod in this area since the fishery closure in 1993?

Cod Abundance Trends: Fishing, Climate Variability, and Seal Predation?

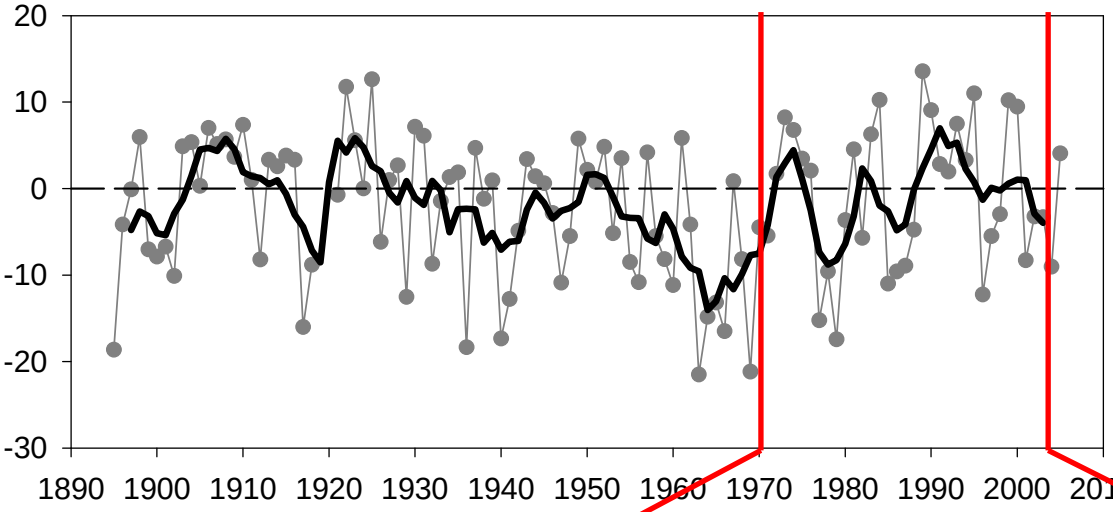


Trends in 4VsW Cod Total Mortality (Z)

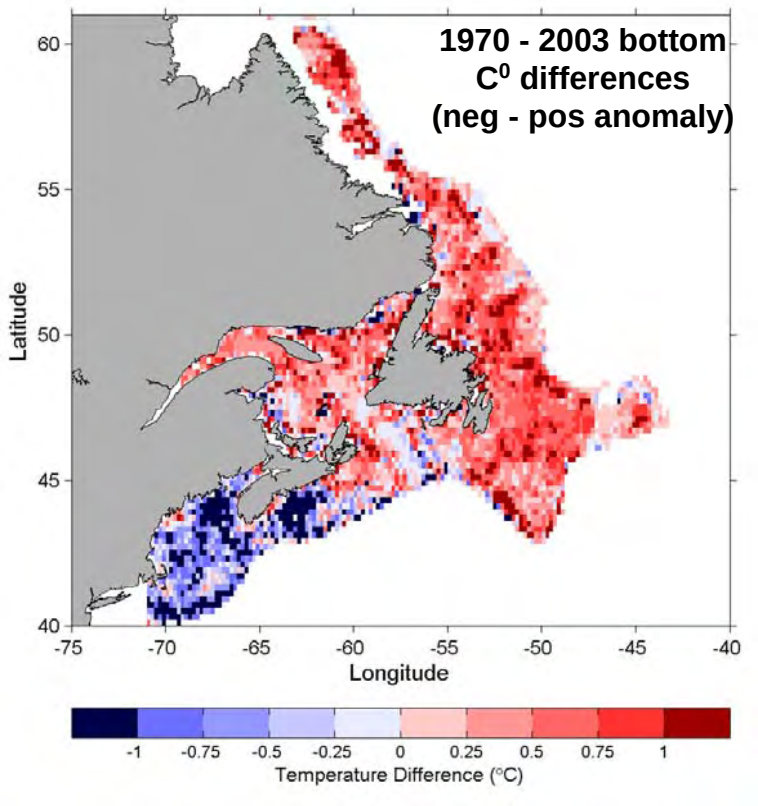


No decline in Z of older ages following moratorium: lack of compelling explanation

NAO Winter Anomaly

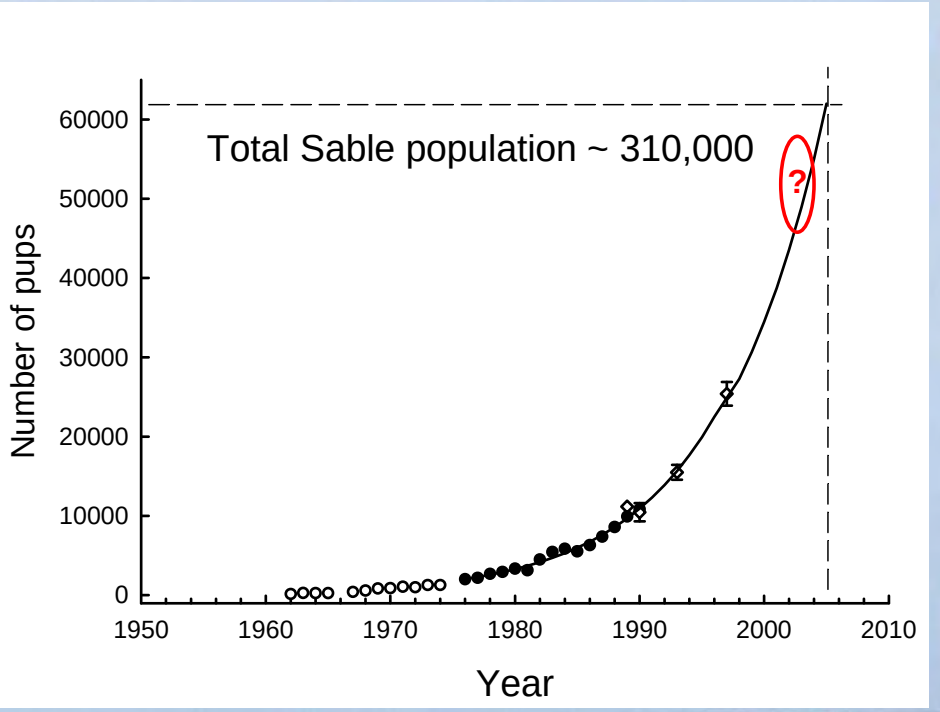


- Linkage of Scotian Shelf with larger North Atlantic atmospheric system
  - Different response to NAO north & south of Halifax



Grey Seal Population Size

- ~370,000 grey seals in Canadian Atlantic waters
- Today roughly 700,000 t of prey consumed each year compared to 6,000 t 40 years ago



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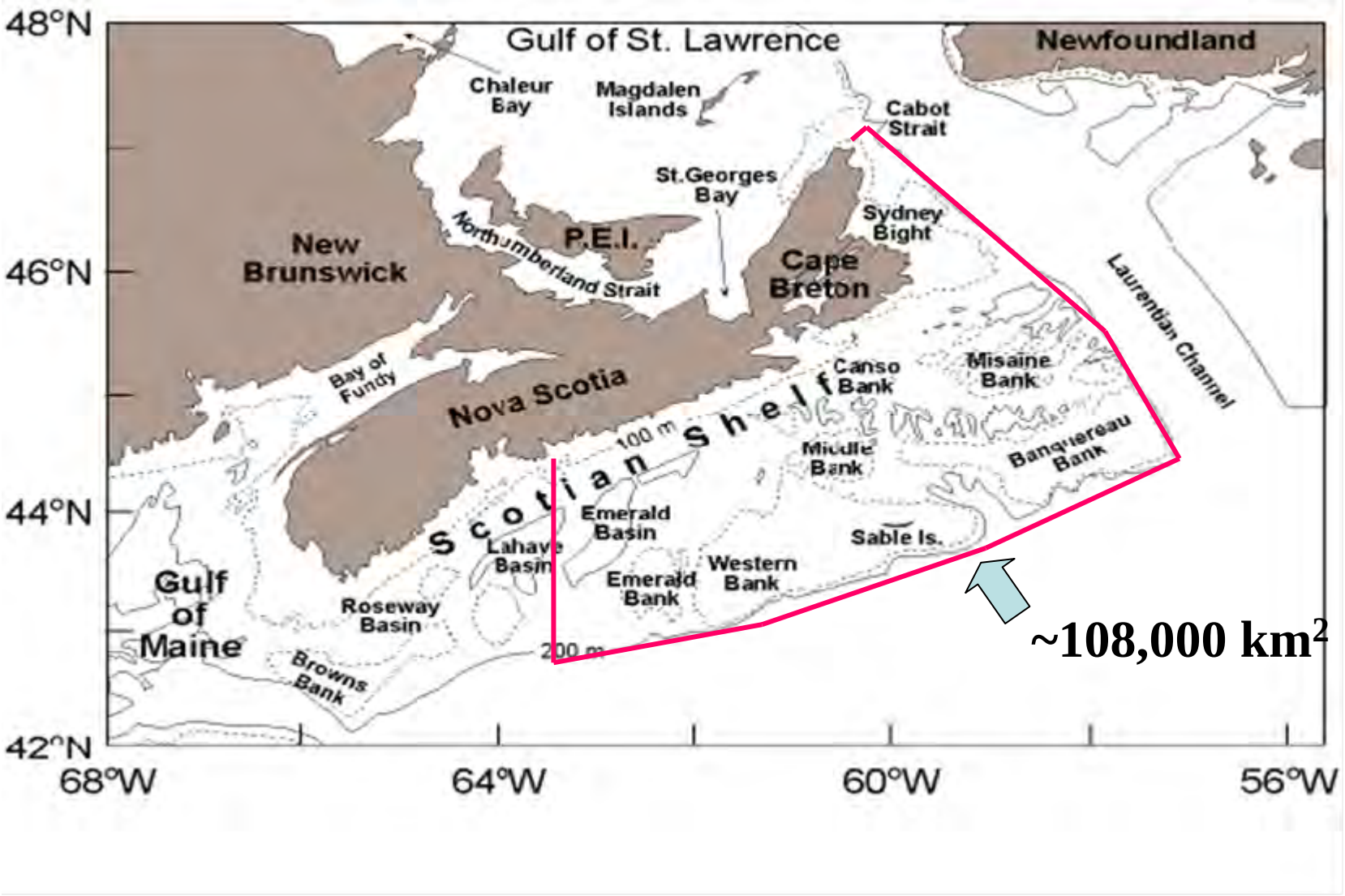


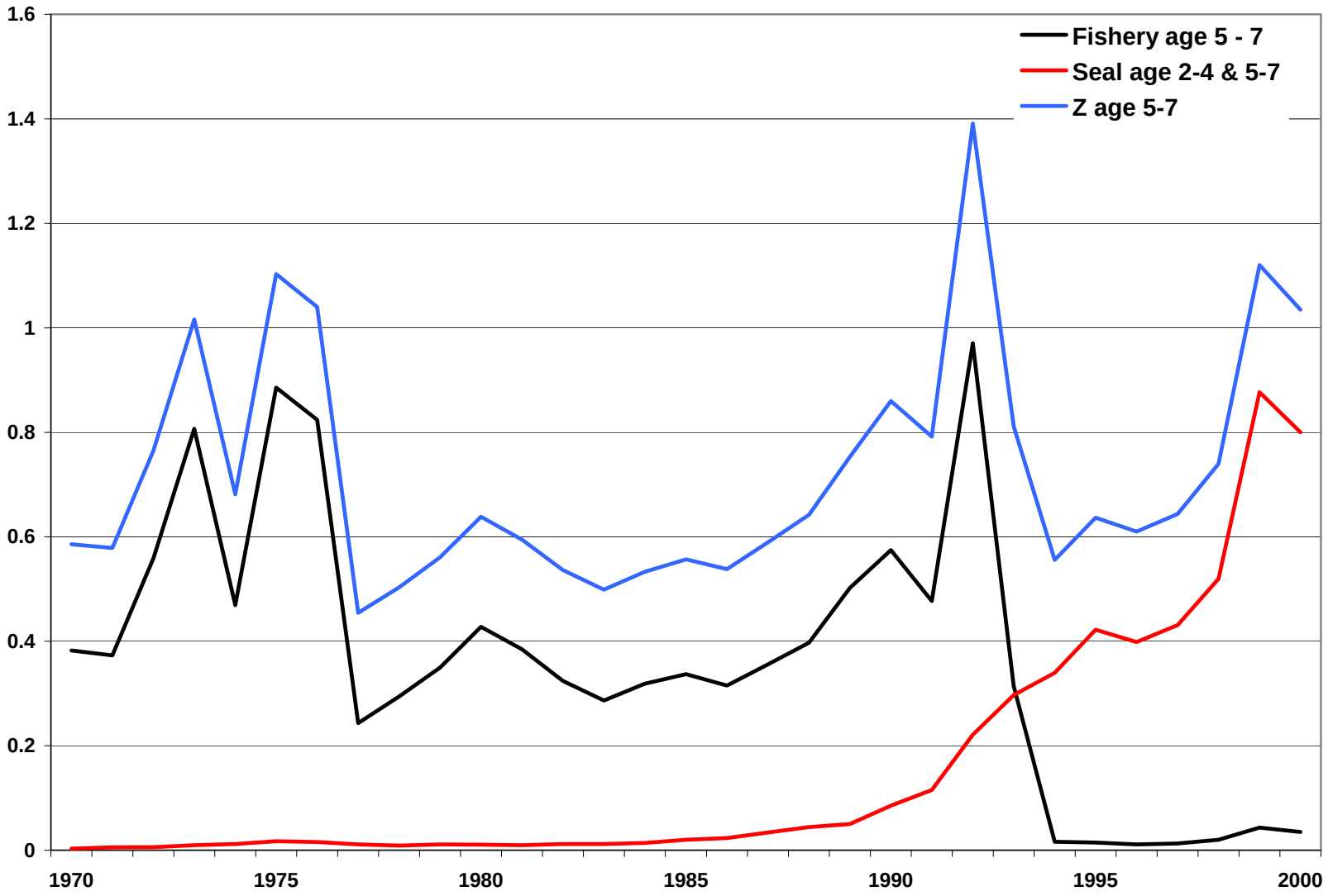
Controversy on Role of Grey Seals

Summary of % Cod in Seal Diet

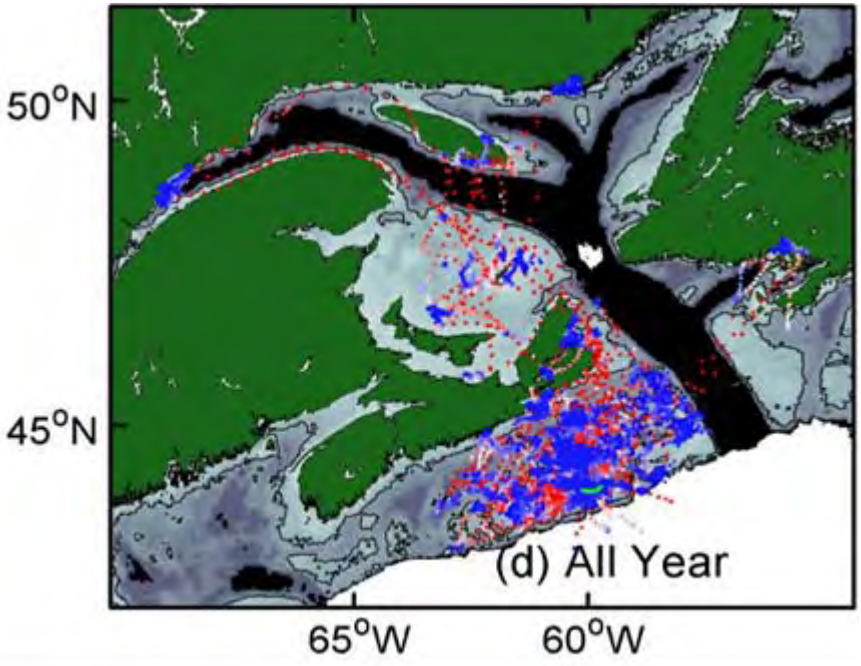
Cod Biomass

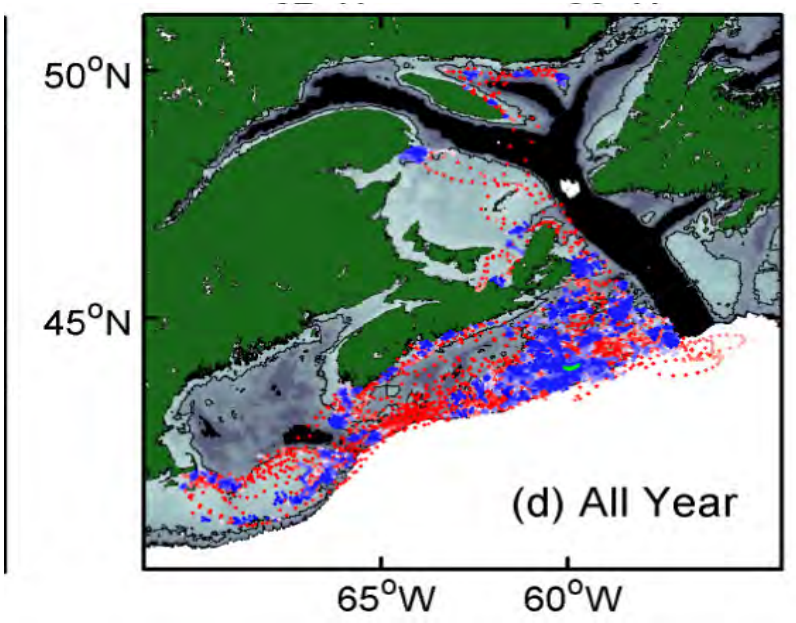
% Cod in Diet	V. Low & Low	Med – Low	Medium
15+ %	16.7, 21.7 25.9, 30.9	15.3, 16.0 17.9, 22.0 25.0, 28.4 43.5	21.3, 22.8
5 – 15 %	6.6, 9.6 9.8, 10.3 12.8		13.5. 13.6
0 – 5 %	1.1	4.2	

Seal and Fishery Induced Cod Mortality Trends



Adult Grey Seal Foraging: females left, males right (Breed et al 2009)





Concluding Points

Pragmatic: an evolutionary strategy to EAM well received by Industry and management

Hubris: earlier over-confidence in single species models by stock assessment scientists still a legacy, and an important lesson for ecosystem level models

Lack of explanatory power on decadal scale ecosystem changes in ESSIM area: a challenge to credibility of scientific advice during implementation of EAM