

Ecosystem Approach to Management in DFO Maritimes

Implementation Experience

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Background

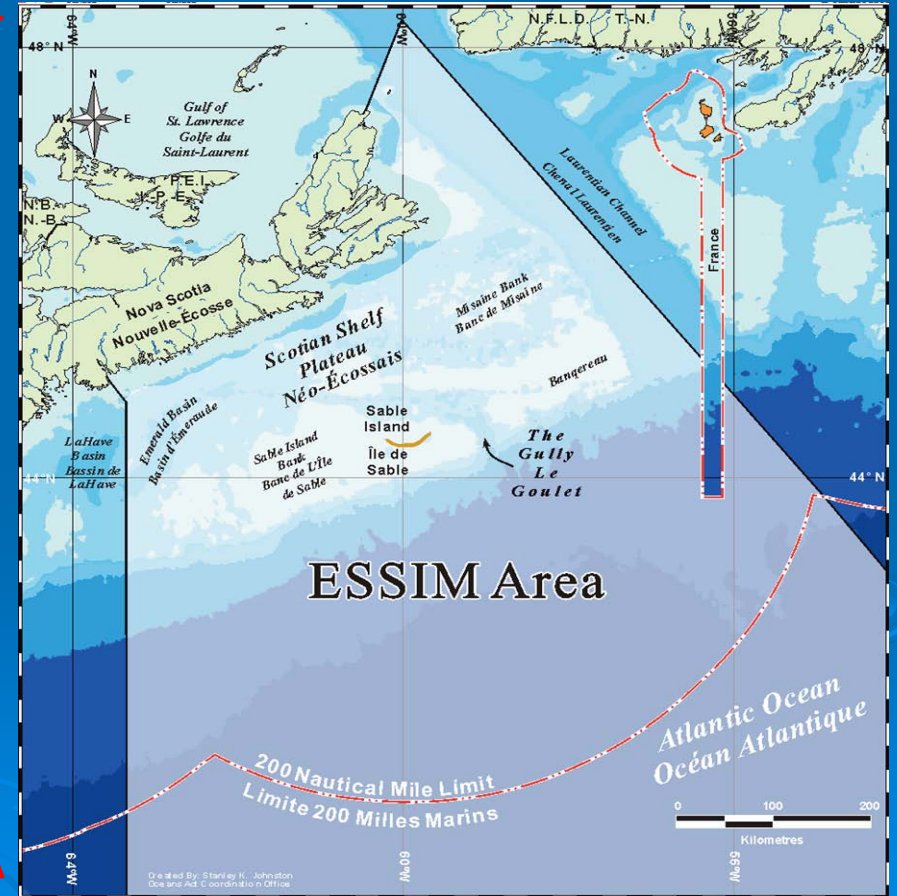
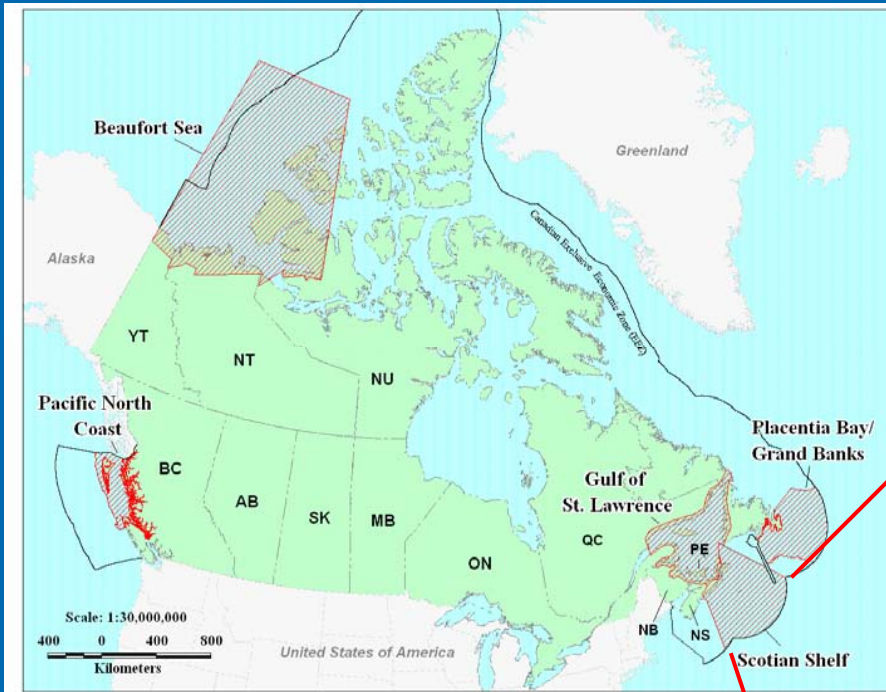
➤ Two 'Laboratories'

- Eastern Scotian Shelf (ESSIM)
 - One of first DFO pilots (started in 1998)
 - Governance (Oceans lead)
 - Ecosystem objectives (Science lead)
- Gulf of Maine Area (GOMA)
 - Emerging since first interaction with US in 2004

➤ Challenges

- Tension between management pragmatism & scientific elegance
- Evolving national policy & guidelines

Current Eastern Scotian Shelf Integrated Management Planning Area



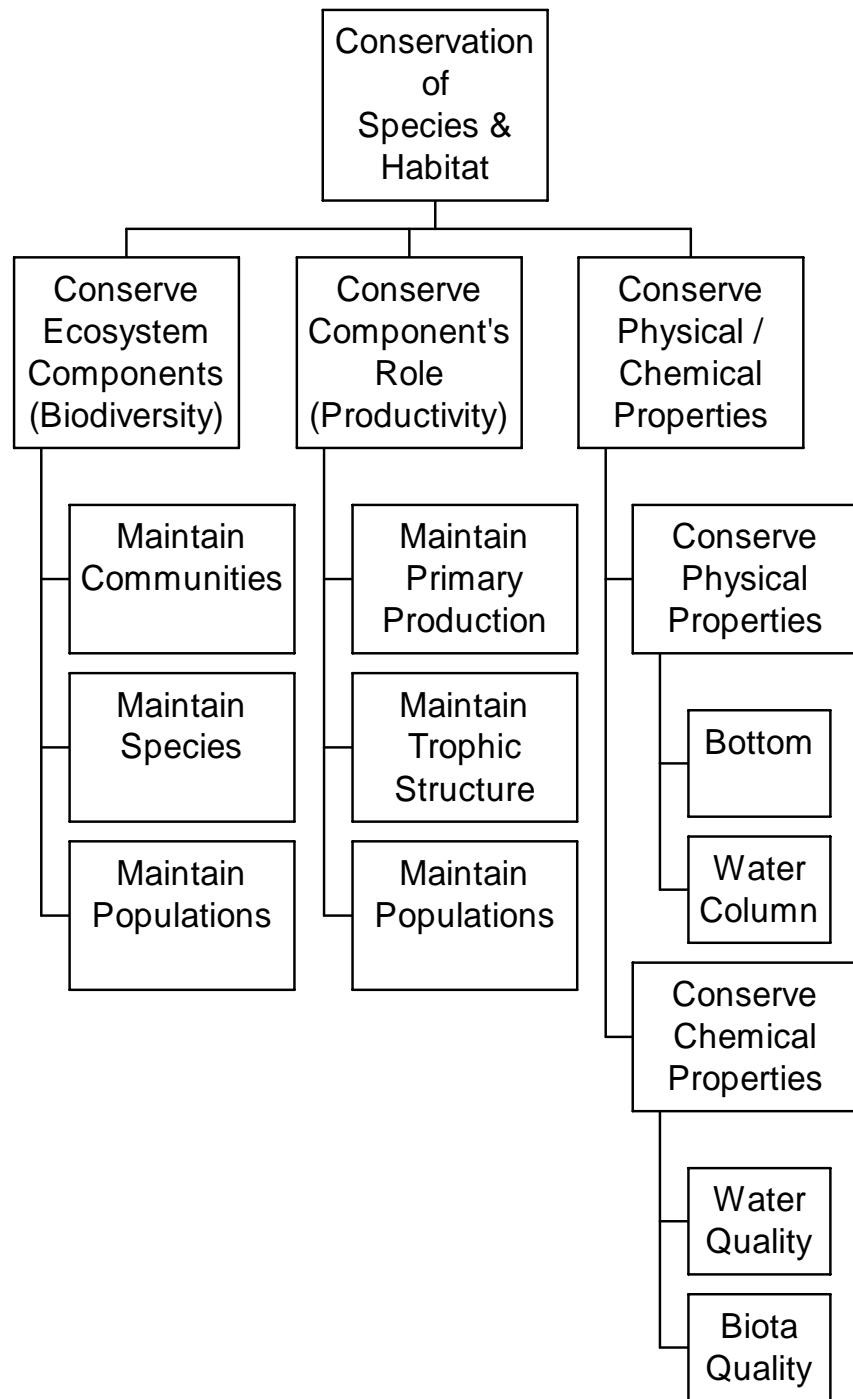
Ongoing Dialogue on
Western Boundary
&
Inshore / Offshore
Boundary

Planning Hierarchy



Identification of Issues & Ecosystem Components in ESSIM Area

- Determined IM Area specific Issues
 - Key issues from Science & stakeholder perspective
 - Working Groups & Workshops
 - Product was layman's understanding of Issues at IM Area Level
- Organized by national ecosystem objective



National Ecosystem Objectives (2001 Workshop)

Draft ESS Ecosystem Objectives developed consistent with this framework

Issues & Ecosystem Components in ESSIM Area

Conservation Objective	Issues	Specific Ecosystem Components on ESS related to the Issues
Community Diversity	Protection of Fragile Benthic Communities I.e. Coral and in Gully	Benthic & coral communities & high diversity benthic community in Gully
Species Diversity	Protection of Species at Risk, low productivity & narrow niche species Introduction of Invasive Species through Ballast water	Bottlenose Whales & Leatherback Turtles
Population Diversity	Loss of genetic diversity	Fish spawning components e.g. cod
Trophic Structure	Harvesting of forage species	Krill & sand lance
Generation Times	Fishing Mortality on directed & by-catch species Impact of oily discharges on Seabirds	Commercial & non-commercial populations
Physical Properties	Seismic Impacts	Acoustic environment
Chemical Properties	Ship Source Pollution Oil & Gas	Sediments & water column

Draft Ecosystem Objectives for ESSIM Area

A. Conservation Objectives Related to Biodiversity

National Conservation Objective	Ecosystem Component	Conservation Objective (in increasing order of specificity)
Maintain communities within bounds of natural variability	Diversity of Benthic Communities	<ul style="list-style-type: none"> • Protect Benthic Communities susceptible to disturbance <ul style="list-style-type: none"> • Prevent significant adverse alteration of each benthic community <ul style="list-style-type: none"> • Maintain area of disturbance within identified limits
	Diversity of Fragile Coral Community	<ul style="list-style-type: none"> • Protect Fragile Benthic Communities <ul style="list-style-type: none"> • Prevent significant adverse alteration of Coral Communities in Stone Fence area
	High Diversity Benthic Community in Gully	<ul style="list-style-type: none"> • Protect High Diversity Benthic Communities <ul style="list-style-type: none"> • Prevent significant adverse alteration of Benthic Communities in the Gully
Maintain species within bounds of natural variability	Overall Species Diversity	<ul style="list-style-type: none"> • Protect Natural Communities from Invasive Introductions <ul style="list-style-type: none"> • Prevent significant adverse introduction of exotic species
		<ul style="list-style-type: none"> • Maintain Continued Existence of all Species <ul style="list-style-type: none"> • Minimize impact of human activity on non-target species <ul style="list-style-type: none"> • Minimize incidental mortality
	Status of Species at Risk	<ul style="list-style-type: none"> • Restore Abundance of Species at Risk <ul style="list-style-type: none"> • Manage recovery of SAR (e.g. Cod, Bottlenose Whale, Leatherback, Cusk & Harbour Porpoise)
Maintain populations within bounds of natural variability	Genetic Diversity of populations under human pressure	<ul style="list-style-type: none"> • Maintain meta-population structures <ul style="list-style-type: none"> • Maintain Components of Populations impacted by human activity <ul style="list-style-type: none"> • Prevent elimination of spawning/breeding component by human activity



Driven by issues specific to ESSIM Area

ESSIM Area Ecosystem Objectives

- Ecosystem Objectives released in Fall 2005 in draft ESSIM Plan
 - Still high level
 - Further refinement upon determination of:
 - Ecological & Biological Significant Areas (EBSAs)
 - Ecological & Biological Significant Species
 - Degraded Areas
 - Depleted Species
- Need for formal prioritization process
 - Quantitative vs Qualitative Risk Analysis
 - Risk of NOT achieving overarching objective

IM Area Operational Objectives

- ESSIM Science WG developed workplan by ecosystem objective to define operational objectives
 - Some completed (e.g. Primary Productivity, Sediment, cod, plaice, halibut)
 - Project put on hold to await refinement of ecosystem objectives
- GOMA Science WG developed draft operational objectives based upon early ESSIM work
 - Focus on monitoring
 - Specific to fisheries
- Regional DFO Workshop (October 2005)
 - Engage & educate all sectors on integrated management
 - Opportunity to compare / contrast ESSIM & GOMA approaches
 - Developed generic working set of IM area operational objectives

IM Area Operational Objectives

Strategies (performance indicator)

Productivity

Primary Productivity

- Control alteration of vital nutrient concentrations affecting primary production at the base of the food chain by algae

Community Productivity

- Manage trophic level removals taking into account consumption requirements of higher trophic levels
- Manage total removals taking into account system production capacity

Population Productivity

- Keep fishing mortality moderate
- Allow sufficient spawning biomass to escape exploitation
- Promote positive biomass change when biomass is low
- Target % size/age/sex of capture to avoid wastage
- Limit disturbing activity in spawning areas/seasons
- Manage discarded catch for all harvested* species

Biodiversity

Species Diversity

- Control incidental bycatch or mortality for all non-harvested* species
- Minimize change in distribution of invasive species

Population Diversity

- Distribute population component mortality in relation to component biomass

Habitat

- Manage area disturbed of bottom habitat types
- Limit amounts of contaminants, toxins and waste introduced in habitat
- Minimize amount of lost gear
- Control noise or light level/frequency

* Harvested species refers to any species that may be retained for sale or use, by some fishery. Discarded catch pertains to catch of any harvested species in any fishery while incidental by-catch or mortality pertains to catch of any non-harvested species in any fishery.

Conservation of Benthic Communities

- Oceans requested Science advice on this objective in 2000
- Three phase process
 - June 2001: Benthic Classification Systems
 - July 2005: Classification of Scotian Shelf Benthic Community
 - 2006/07: Characterization on impacts, indicators & reference points
- Since initiation of process, complementary related initiatives (e.g. EBSA) underway

Scope for Growth

Based on Southwood Model

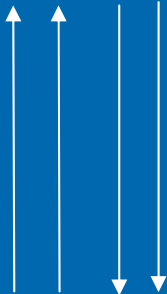
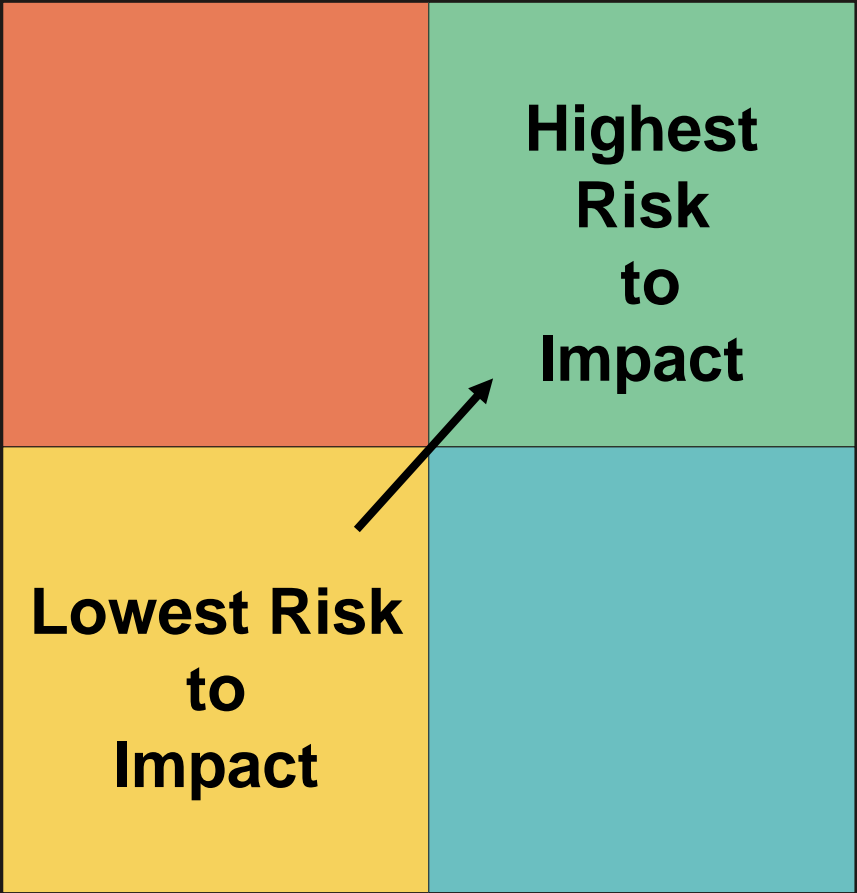
High Productivity (Benign)

Low Productivity (Adverse)

Disturbance

Stable

Disturbed

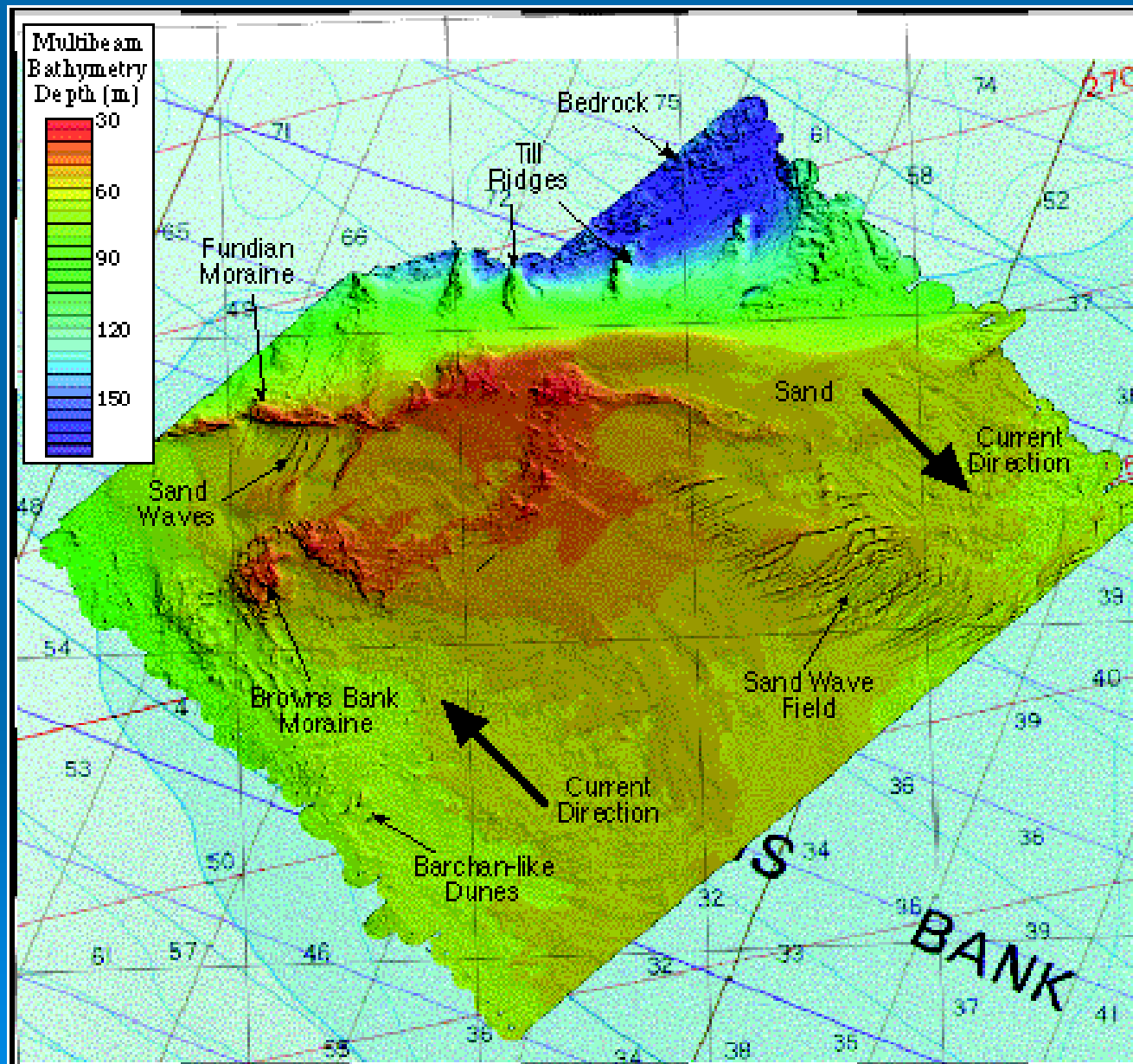


Depth
Grain size
Current
Wave height/period

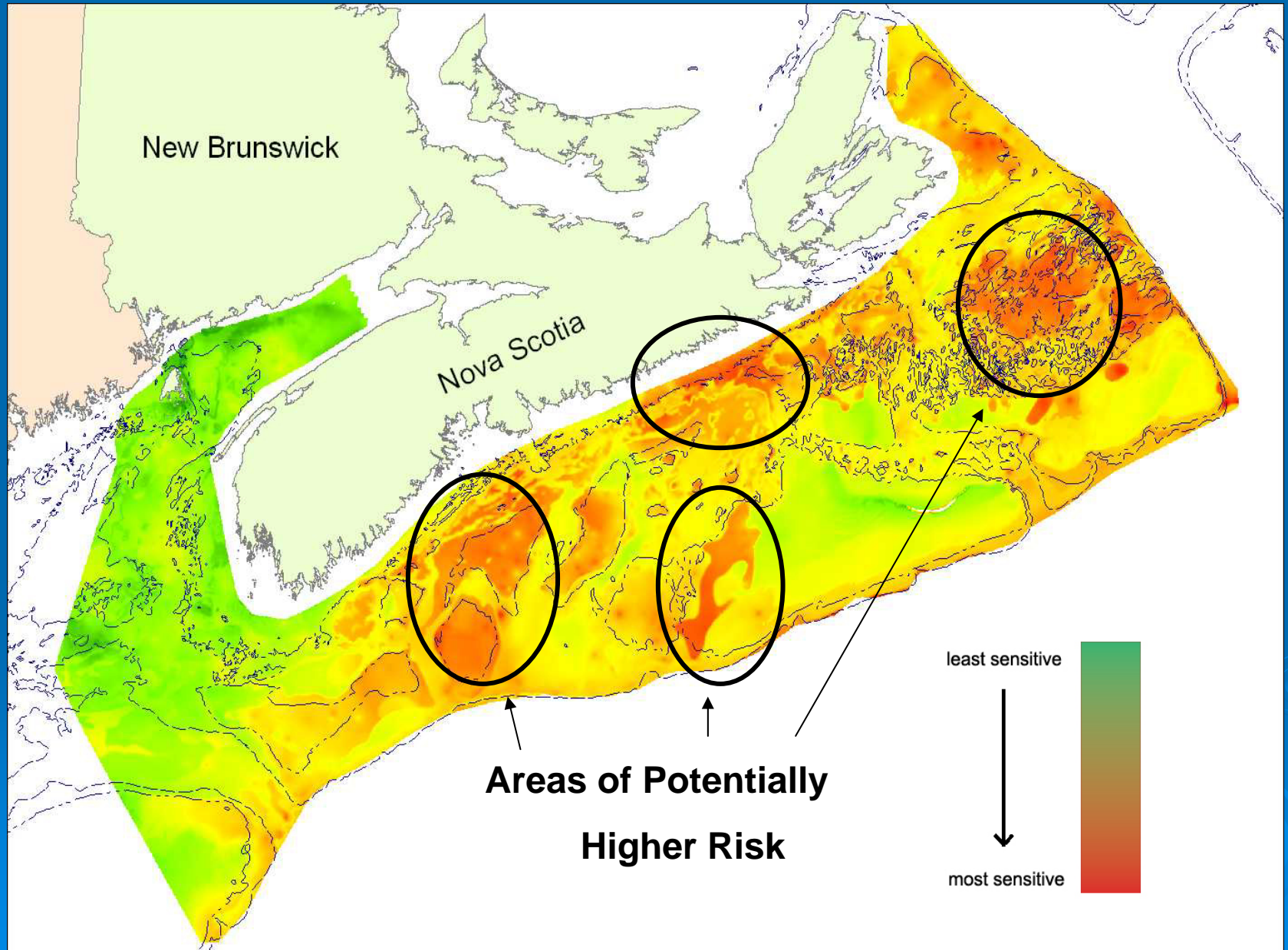
Food Availability
Water temperature
Variability in temperature
Oxygen Saturation
Stratification



Multibeam Profiling

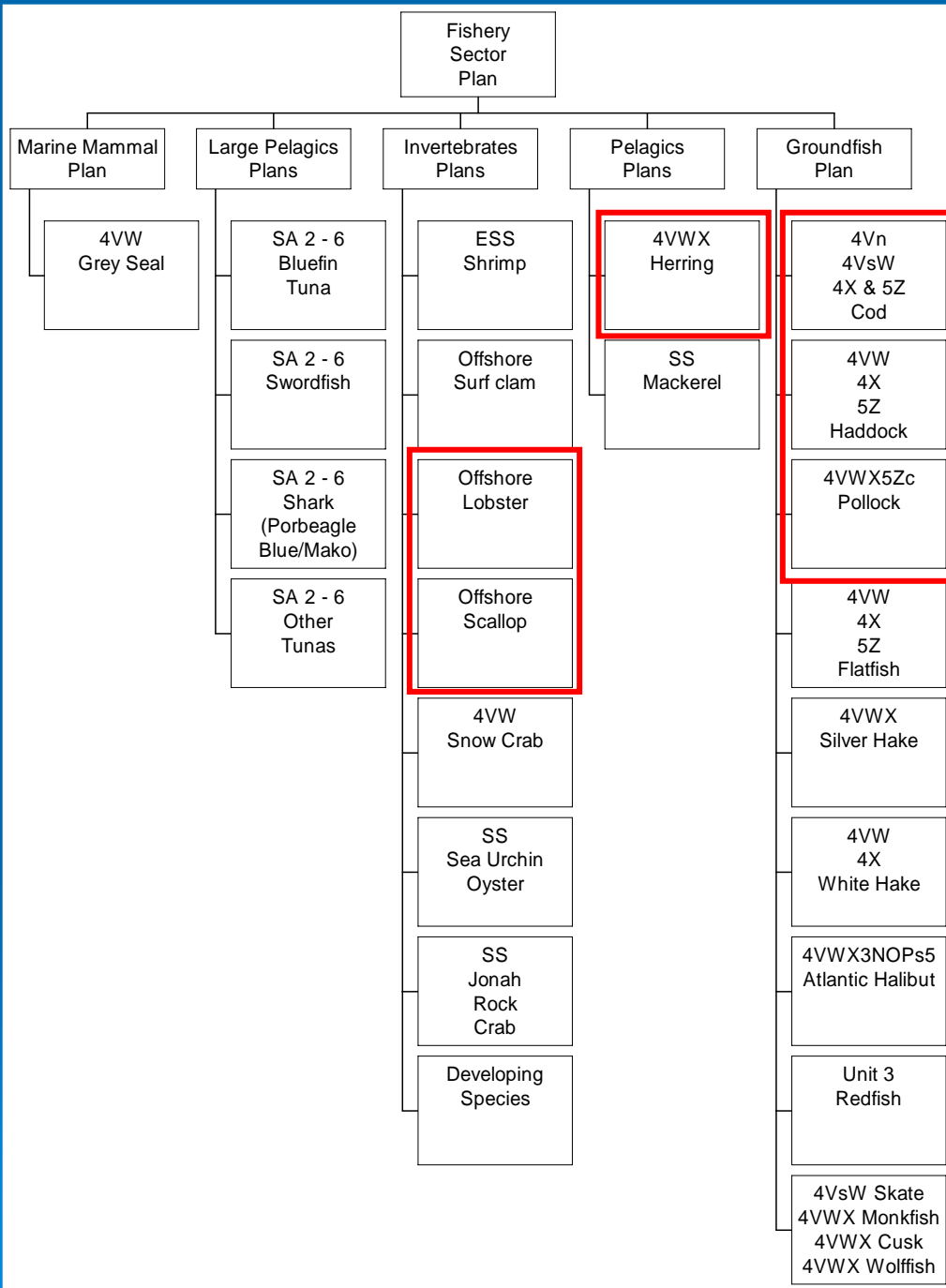


High Risk Areas



Sector Operational Objectives

- Decided to engage fishing sector on EBM
 - Presented generic IM area operational objectives to Scotia-Fundy Industry Roundtable (Jan 2006)
 - Fishing industry agreement to evaluate Fisheries Management Plans (FMPs) against objectives



Maritimes Fisheries Management Plans

Evaluations Completed

Preliminary Evaluation of Georges Bank FMPs

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

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

Monitoring & Reporting

➤ Regulatory

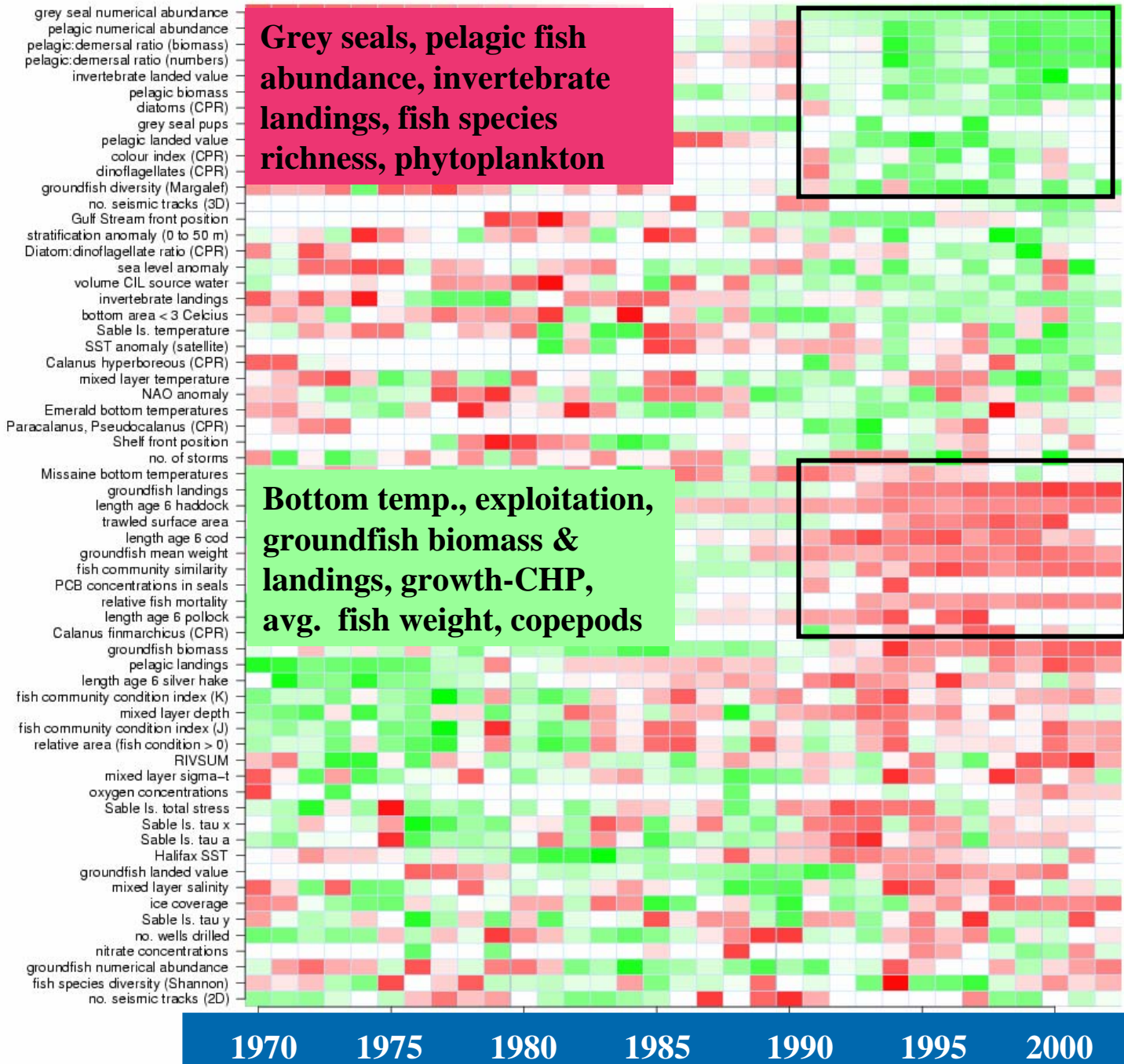
- Performance indicators

➤ Ecosystem

- Contextual indicators
 - Study of ecosystem processes e.g. causality
 - Changes in reference points e.g. regimes shifts

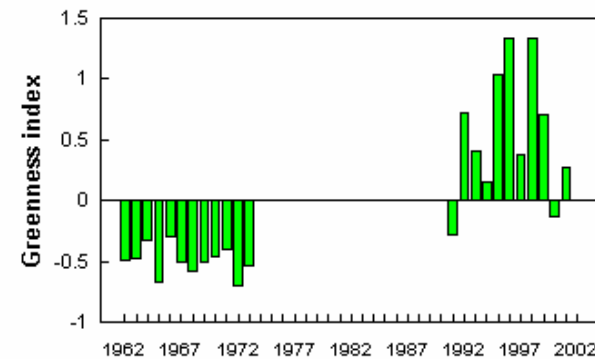
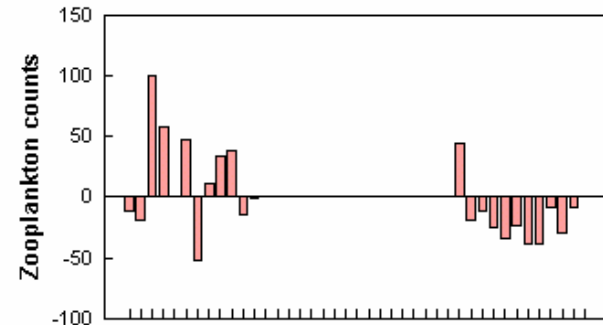
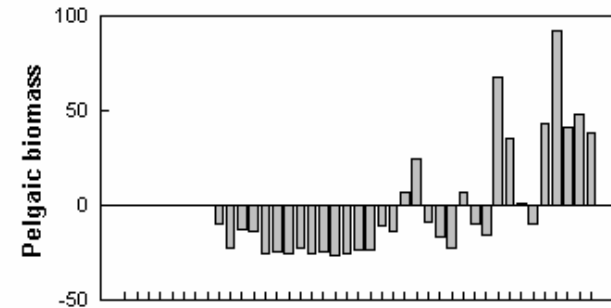
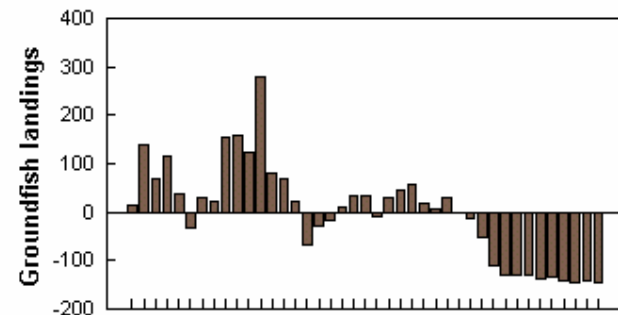
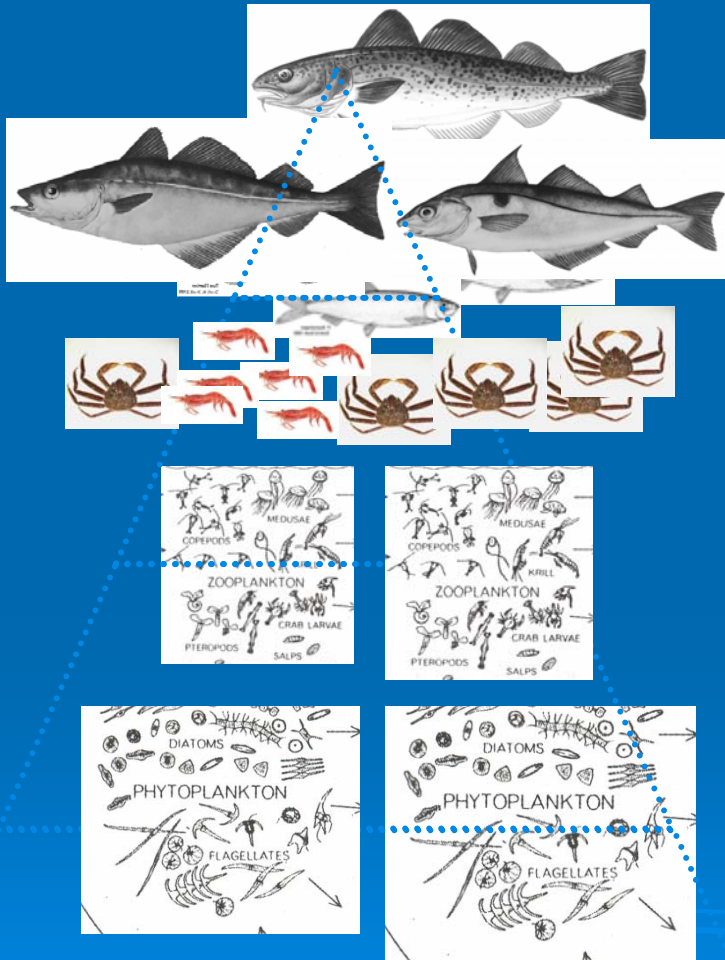
- Suite of 60+ indicators reported in 2003
Ecosystem Status Report

- Now working on set for Gulf of Maine Area
- More formally linked to ecosystem objectives



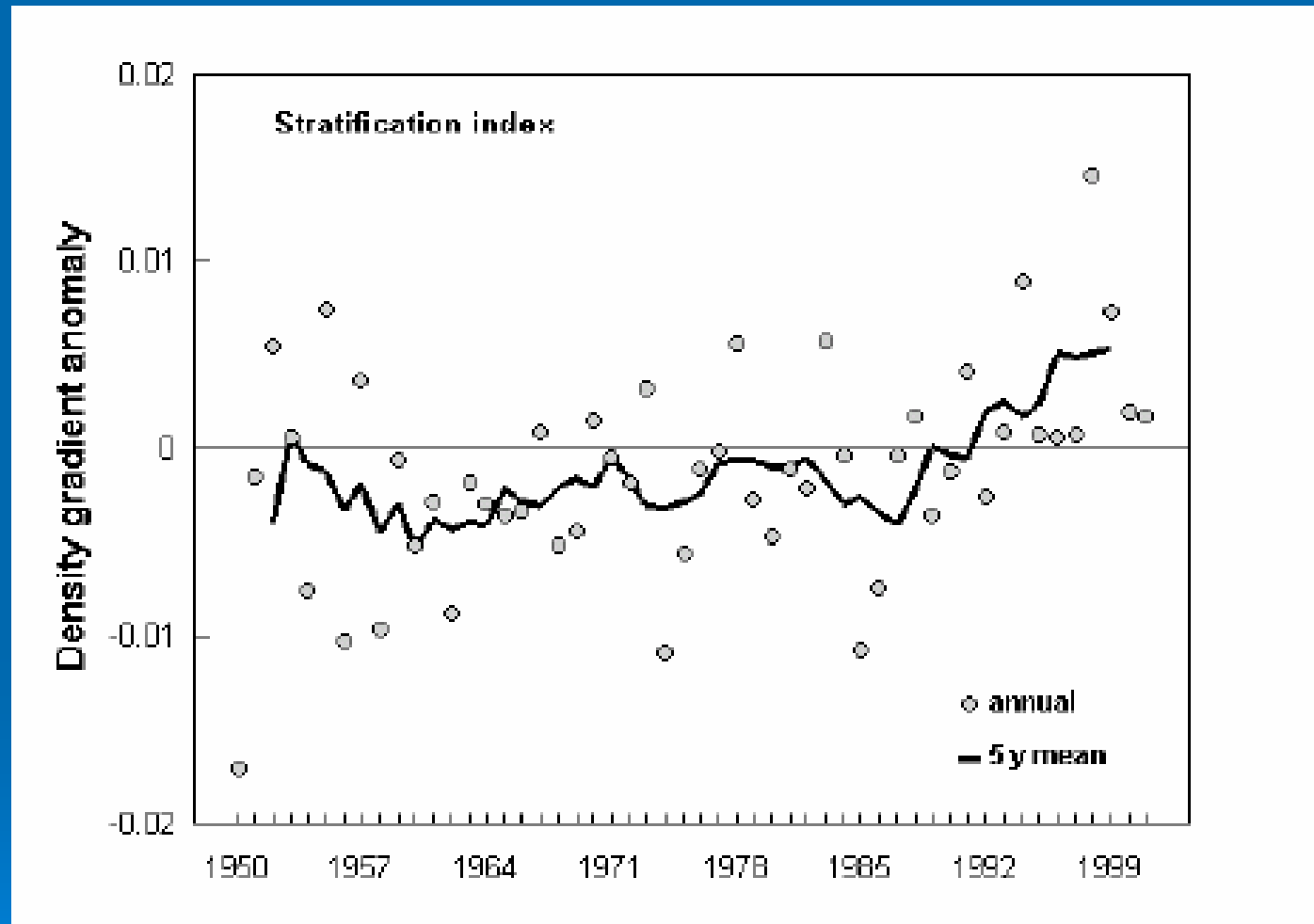
Why these Changes?

1) Top - Down Control?



Why these Changes?

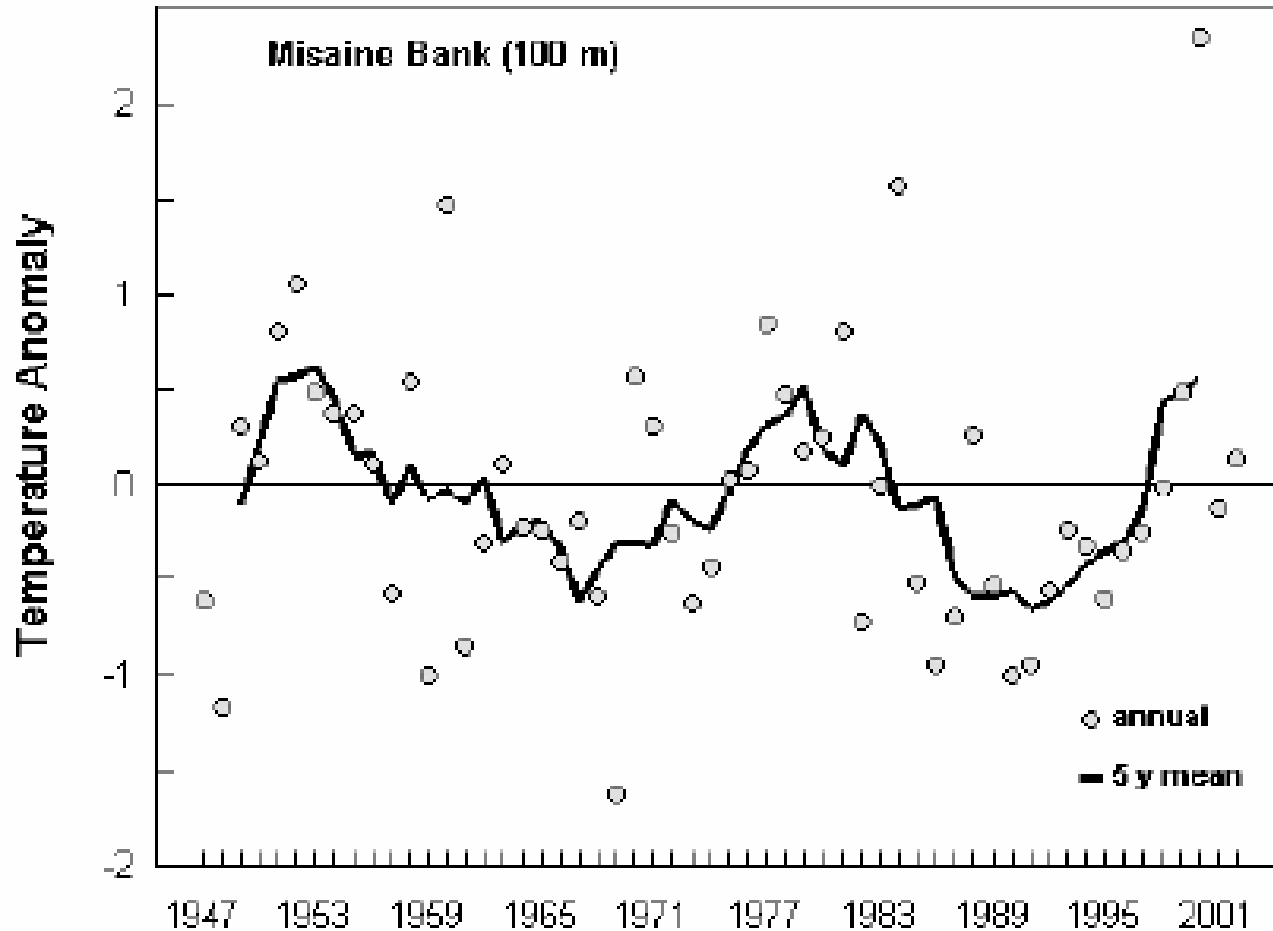
2) Increased Stratification?



Would favour proliferation of pelagic food web & limit flux of nutrients to benthos

Why these Changes?

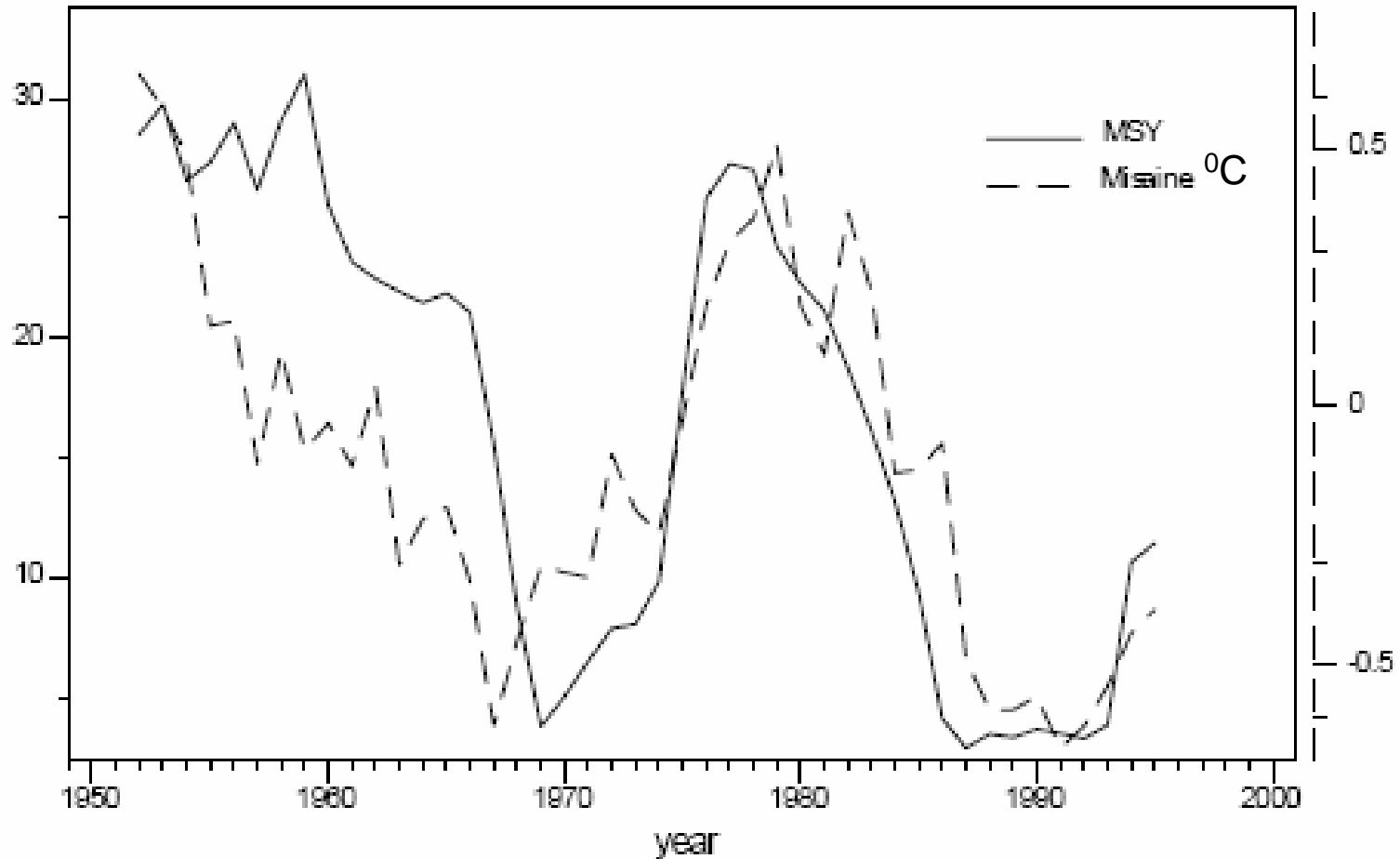
3) Cooling?



Cooling & increased advection associated with increases in cold water species

4TVW Haddock and Environment

Tons



°C

Management Reference Points would be modified based upon environment

Implications for inclusion of 'Regime Shifts' in management actions

Future ESR Proposal

Suite of Operational Objectives At Planning Area Level Would define Ecosystem Health

Colour indicates Performance Of Operational Objective

Green: Good
Yellow: Caution
Red: Poor

Overarching Conceptual Objective	Planning Area Conceptual Objective	Planning Area Operational Objective	Fisheries Sector OO	Groundfish Fishery OO	Oil & Gas Sector OO	Transport Sector OO	Defense Sector OO
	Diversity of Benthic Communities					N/A	N/A
Community Biodiversity	Diversity of Fragile Coral Community		N/A			N/A	
	High Diversity Gully Benthic Community		N/A			N/A	
	Overall Species Diversity		N/A	N/A	N/A		N/A
Species Biodiversity	SAR Diversity				N/A	N/A	N/A
			N/A		N/A		N/A
Population Biodiversity	Genetic Diversity		N/A		N/A	N/A	N/A
Primary Productivity	Productivity at base of food chain		N/A	N/A	N/A	N/A	N/A
			N/A	N/A	N/A	N/A	N/A
	Productivity of Forage Species			N/A	N/A	N/A	N/A
Trophic Structure	Trophic Level Productivity		N/A	N/A	N/A	N/A	N/A
			N/A	N/A	N/A	N/A	N/A
	Energy transfer			N/A	N/A	N/A	N/A
	Growth Productivity		N/A		N/A	N/A	N/A
Population Generation Time	Recruitment Productivity		N/A		N/A	N/A	N/A
			N/A	N/A		N/A	N/A
	Sediment Quality		N/A	N/A		N/A	N/A
Physical Features			N/A	N/A		N/A	N/A
	Sound Environment		N/A	N/A		N/A	
	Chemical Environment		N/A	N/A		N/A	N/A
Chemical Features			N/A	N/A		N/A	N/A
	Physiological Processes		N/A	N/A		N/A	N/A
			N/A	N/A		N/A	N/A

Lessons for Workshop

- Develop common understanding of high level objectives
 - Compare regional sets of objectives & associated issues specific to planning area
 - Stakeholder workshop?

- Planning area level

- Contextual indicators
 - Ecosystem processes
 - Relevant to RP / RDs

**Time trends by
functional group
& area**

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graph TD; A[Relevant to RP / RDs] --> B[Time trends by functional group & area]; B --> C[Regulatory / tactical indicators & Reference points / Directions];
```

- Fishery level

- Regulatory / tactical indicators & Reference points / Directions
 - Management action?

- PICES Report

- Keep general but move towards objectives structure
- Maintain array of indicators


Final Thoughts

- Need Stakeholder buy-in to IM
 - IM provides framework that links policies & initiatives
- Need Manager buy-in to IM
 - Currently putting FMPs into framework to show what exists now & what gaps exist
- Need Science buy-in to IM
 - Currently reviewing science work plans in relation to ecosystem objectives

Thank You!



Outline

- Background
 - Management Area Boundaries
 - Planning Hierarchy
 - Monitoring & Reporting
- 

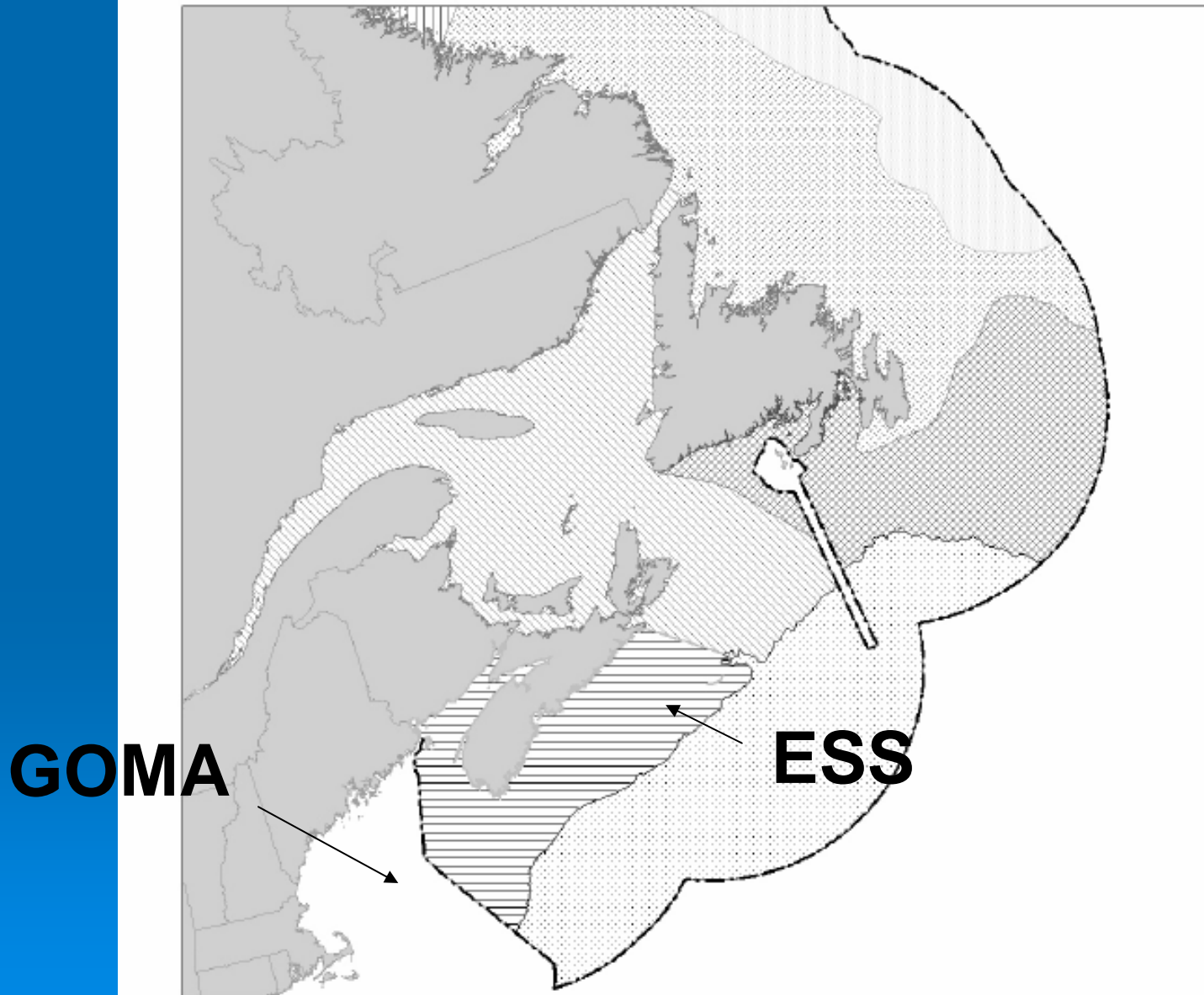
Developments since 1998

	NATIONALLY	MARITIMES
2000	WG ON ECOSYSTEM OBJECTIVES	
2001	NATIONAL WORKSHOP ON ECOSYSTEM OBJECTIVES	
2002		ILLUSTRATIVE PILOT OF ESSIM
2003		ESSIM ECOSYSTEM OBJECTIVES WITH SCIENCE & STAKEHOLDERS
2004	ECOREGIONS WORKSHOP	SCIENCE WG ON OPERATIONAL OBJECTIVES ASSOCIATED WITH ESSIM ECOSYSEM OBJECTIVES DICUSSION WITH US ON MONITORING REQUIREMENTS OF GOM IM
2005	NATIONAL GUIDELINES ON DEVELOPMENT OF ECOSYSTEM OBJECTIVES REVIEWS OF INITIAL ECOSYSTEM OVERVIEW & ASSESSMENT REPORTS	RELEASE OF DRAFT ESSIM PLAN IM REQUIRMENTS OF FISHERIES MANAGEMENT PLANS

Management Area for EAM

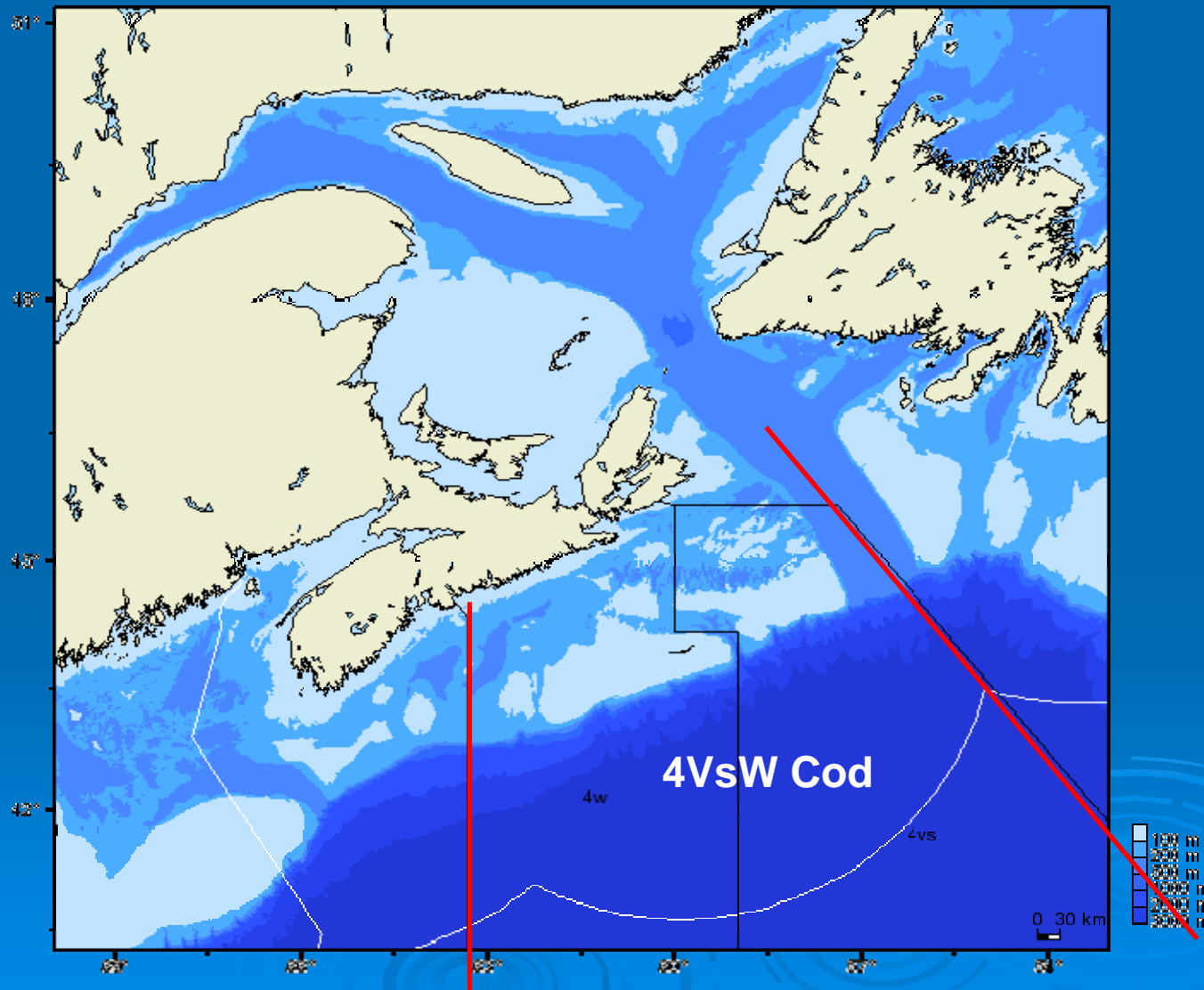
- Ecological Features across wide range of spatial scales
- Many existing administrative areas for fisheries & other ocean uses
- Challenge
 - Need to find consensus amongst diverse perspectives

Scientist Perspective 2004 Ecoregions Workshop



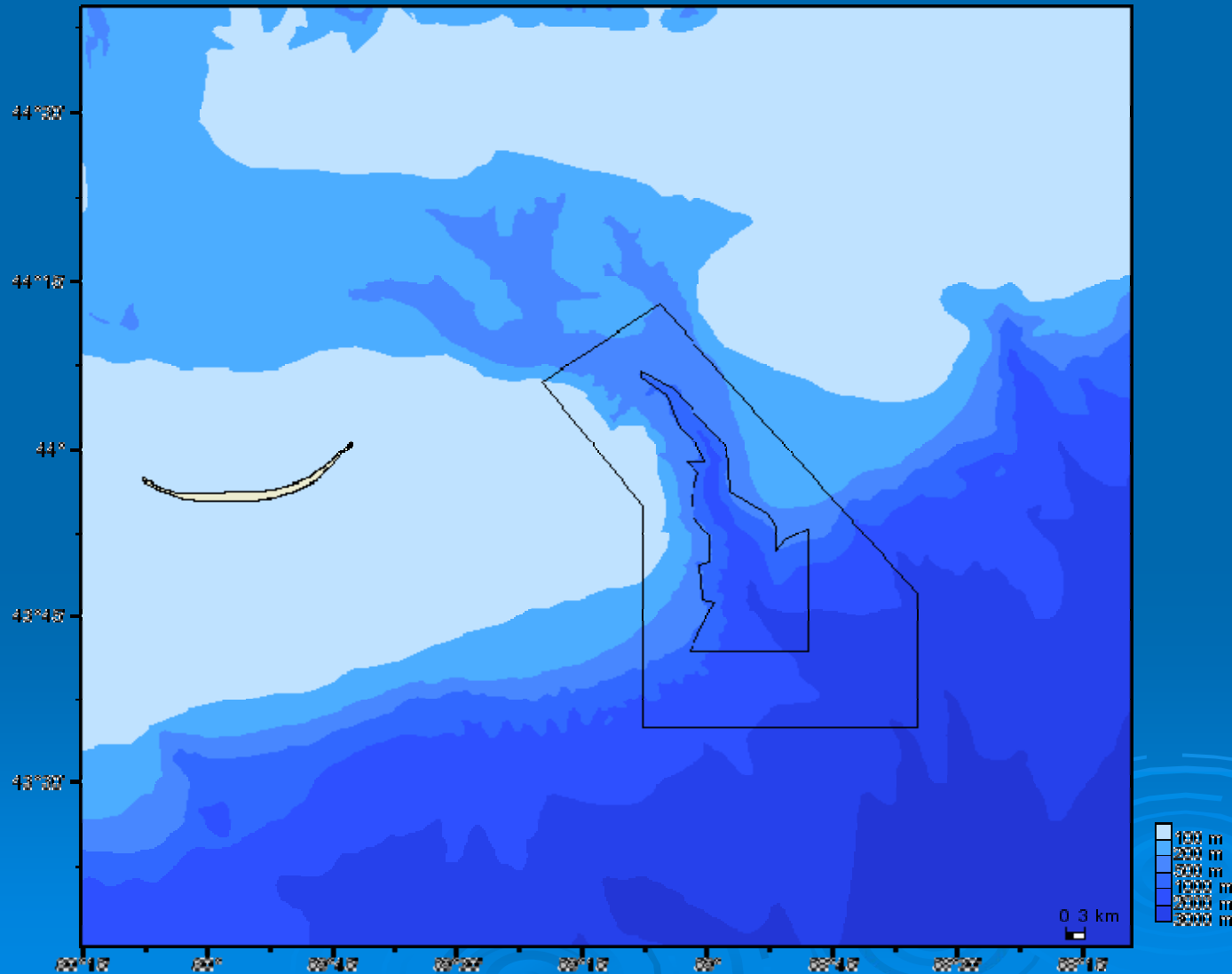
Fishery Manager Perspective

4VsW Cod



Ocean Manager Perspective

ESS Gully MPA



Proposed Solution

- Select management areas based on established governance structures
- Use nested approach
 - Ecological features larger than IM area require coordinated management actions amongst relevant contiguous areas
 - Small ecological features require fine spatial resolution of management actions within IM area

Two Types of Objectives

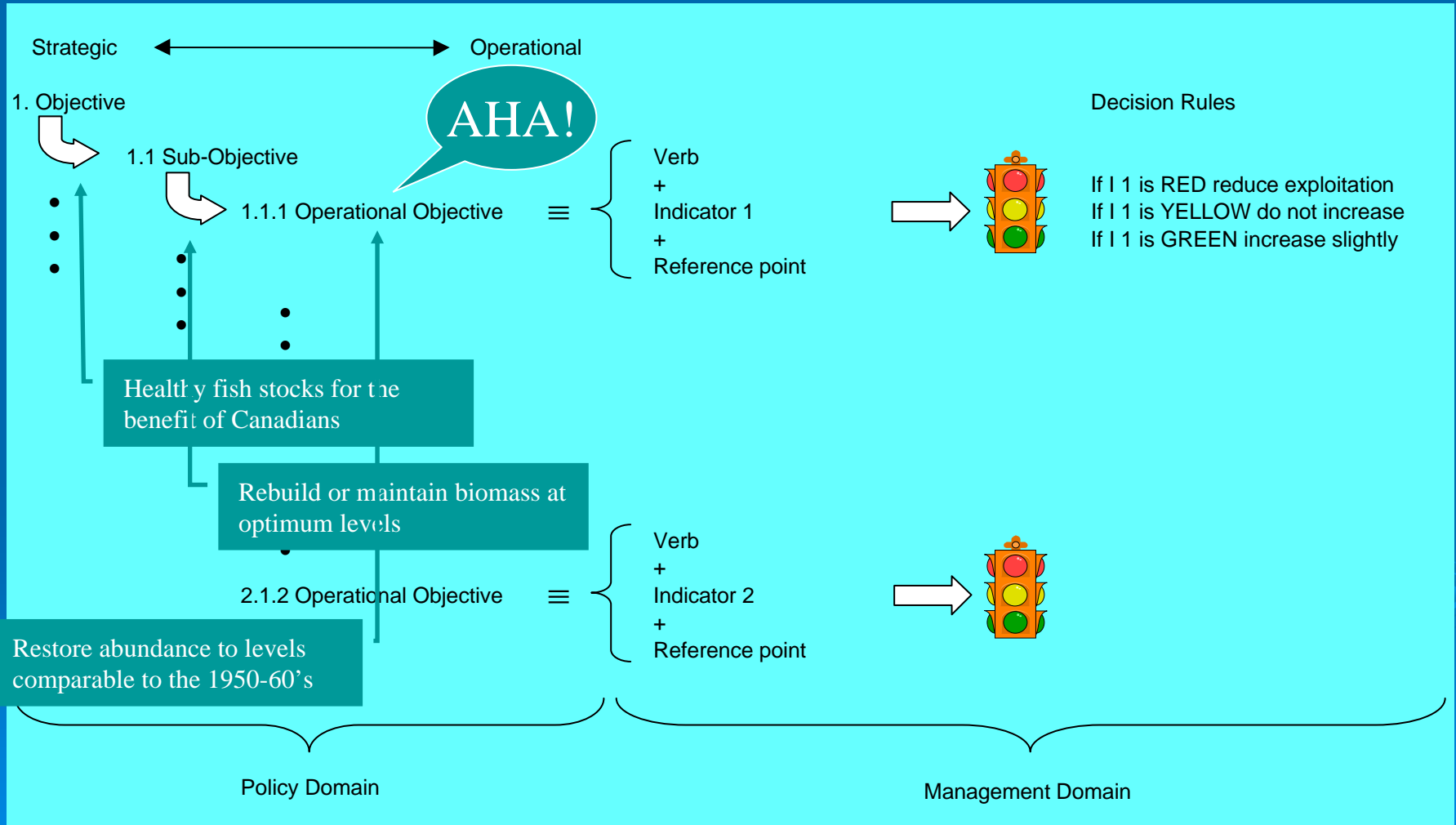
➤ Conceptual Objective or Goal

- Interpret legislative mandate to be understandable to broad audience
 - E.g. Restore Coral Community Biodiversity to pre-1980 levels

➤ Operational Objective or Strategy

- Link between Conceptual Objective & Management Action
- Specific enough to be clear to all
 - Refers to indicator (e.g., biomass) & reference point (e.g., 50,000 t)
 - E.g. Limit Area (sq Km) disturbed of Coral Community to 5000 sq km

Unpacking

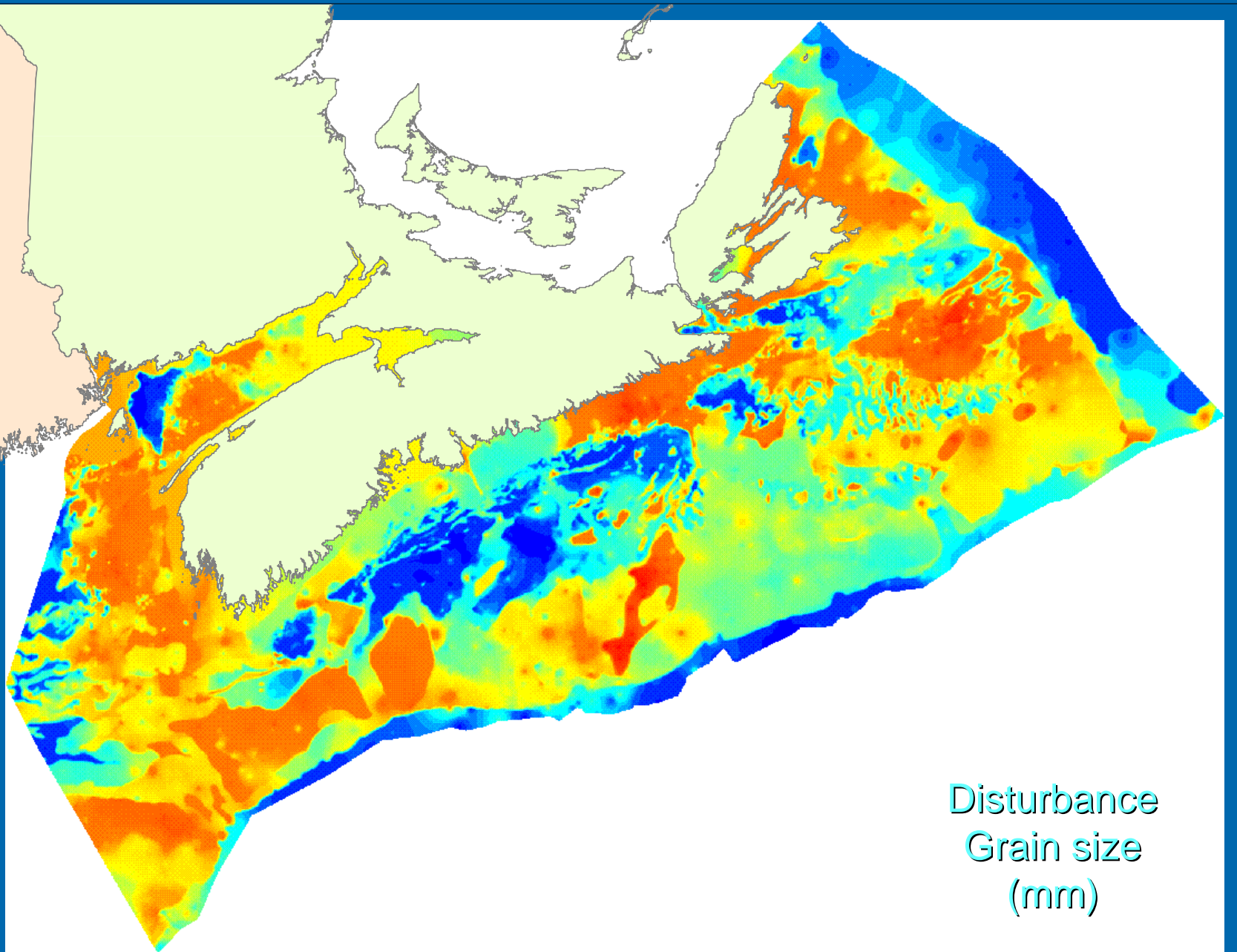


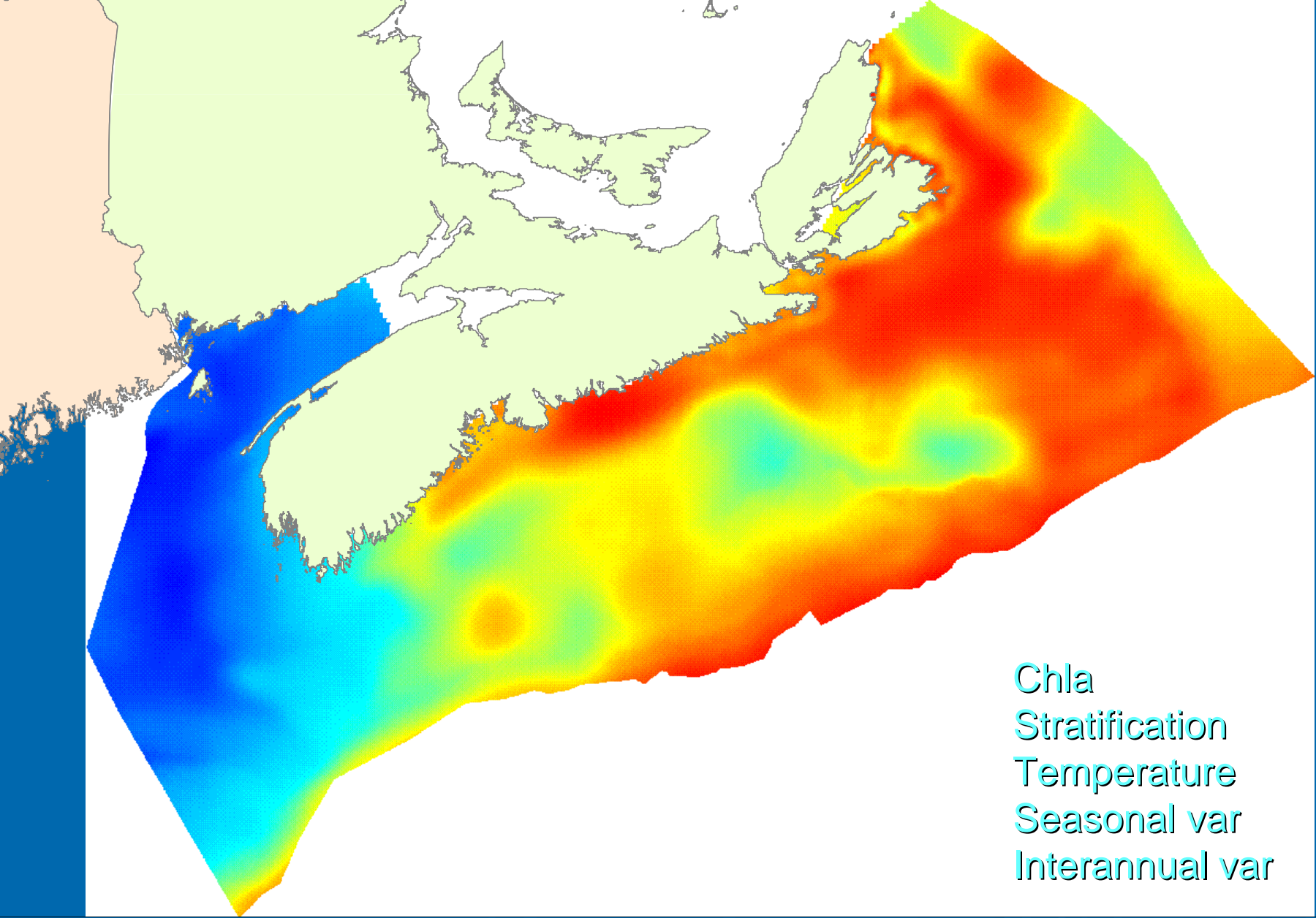
Steps to Operationalize ESSIM Plan

1. Identify conservation issues & impacted ecosystem components
2. Organize issues / components using national objectives as guide & state as ESSIM Ecosystem Objectives
3. Identify Ocean Sectors implicated in implementation of ESSIM Ecosystem Objective
4. Define Operational Objectives for ESSIM Area
5. Define Operational Objectives for each Ocean Sector

Management of Cumulative Impacts

Level of Hierarchy	Conceptual Objective	Operational Objective
Overarching	Conserve Community Biodiversity	N/A
Planning Area	Restore Coral Community Biodiversity to pre-1980 levels	Limit Area (sq Km) disturbed of Deep Sea Coral Community to 6000 sq km
Fishery Sector	N/A	Limit Area (sq Km) disturbed of Deep Sea Coral Community to 50% of 6000 sq km (3000 sq km)
Crab Fishery	N/A	Limit Area (sq Km) disturbed of Deep Sea Coral Community to 1000 sq km
Groundfish Fishery	N/A	Limit Area (sq Km) disturbed of Deep Sea Coral Community to 1000 sq km
Shrimp Fishery	N/A	Limit Area (sq Km) disturbed of Deep Sea Coral Community to 1000 sq km





Sectors Implicated in Implementation

Specific Ecosystem Components on ESS related to the Issues	Fisheries Sector	Oil & Gas Sector	Transportation Sector	Defense Sector
Diversity of Benthic Community	x	x	x	
Diversity of Coral Community	x	x	x	x
High Diversity Benthic Community in Gully	x	x	x	x
SAR	x	x	x	x
Spawning Components	x			
Commercial & non-commercial populations	x			
Acoustic Environment		x	x	x
Sediment & Water Column		x	x	

Based upon Qualitative Human Impact Threats Analysis

Other Sectors

- Aquaculture
 - Decision rules for Sulphides developed
 - Working on additional indicators e.g. oxygen
- Oil & Gas
 - Code of Practice for seismic noise
 - Discharge guidelines
- Transport
 - Ballast water regulations (invasives)

**Consolidation under one framework
required to address cumulative effects**

IM Area Operational Objectives

Strategies (performance indicator)

Productivity

Primary Productivity

- Control alteration of **vital nutrient concentrations** affecting primary production at the base of the food chain by algae

Community Productivity

- Manage **trophic level removals** taking into account consumption requirements of higher trophic levels
- Manage **total removals** taking into account system production capacity

Population Productivity

- Keep **fishing mortality** moderate
- Allow sufficient **spawning biomass** to escape exploitation
- Promote positive **biomass change** when biomass is low
- Target **% size/age/sex** of capture to avoid wastage
- Limit disturbing **activity in spawning areas/seasons**
- Manage **discarded catch** for all harvested* species

Biodiversity

Species Diversity

- Control incidental **bycatch or mortality** for all non-harvested* species
- Minimize **change in distribution** of invasive species

Population Diversity

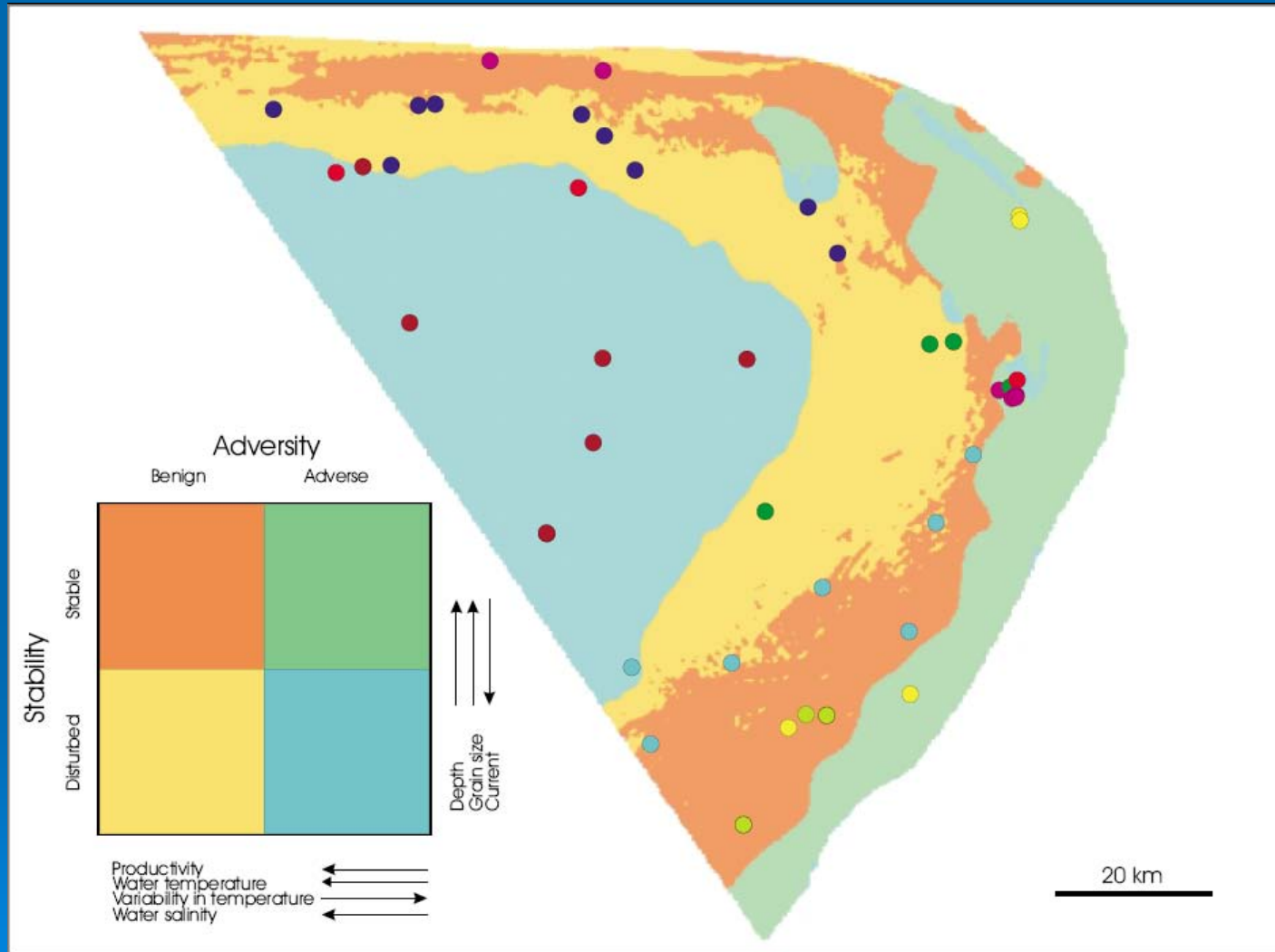
- Distribute population **component mortality in relation to component biomass**

Habitat

- Manage **area disturbed** of bottom habitat types
- Limit **amounts of contaminants, toxins and waste** introduced in habitat
- Minimize **amount of lost gear**
- Control **noise or light level/frequency**

* Harvested species refers to any species that may be retained for sale or use, by some fishery. Discarded catch pertains to catch of any harvested species in any fishery while incidental by-catch or mortality pertains to catch of any non-harvested species in any fishery.

Habitat Classification



Contextual Indicators

Study of ecosystem processes

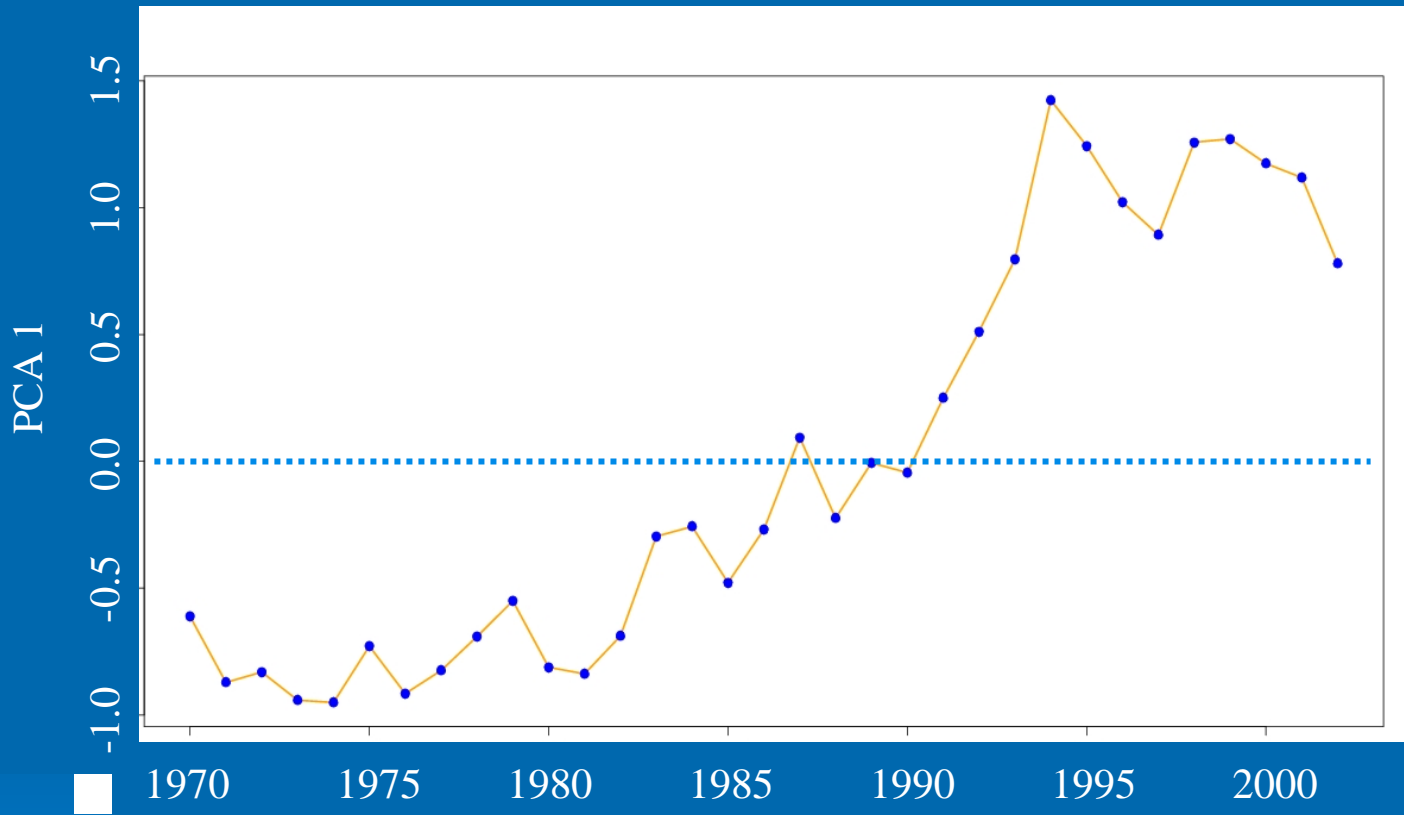
➤ Physical & Chemical

- Salinity, temperature, stratification
- Sea level, currents
- NAO index, wind stress
- Nutrients

➤ Biological

- Phyto & zoo plankton
- Finfish & small pelagic community condition
- Pelagic / demersal Biomass ratio

Index of Ecosystem Change



Demersal ----- Pelagic/invertebrate system

Clear shift in ecosystem state based on 60+ indicators

4VsW Cod Total Annual Mortality

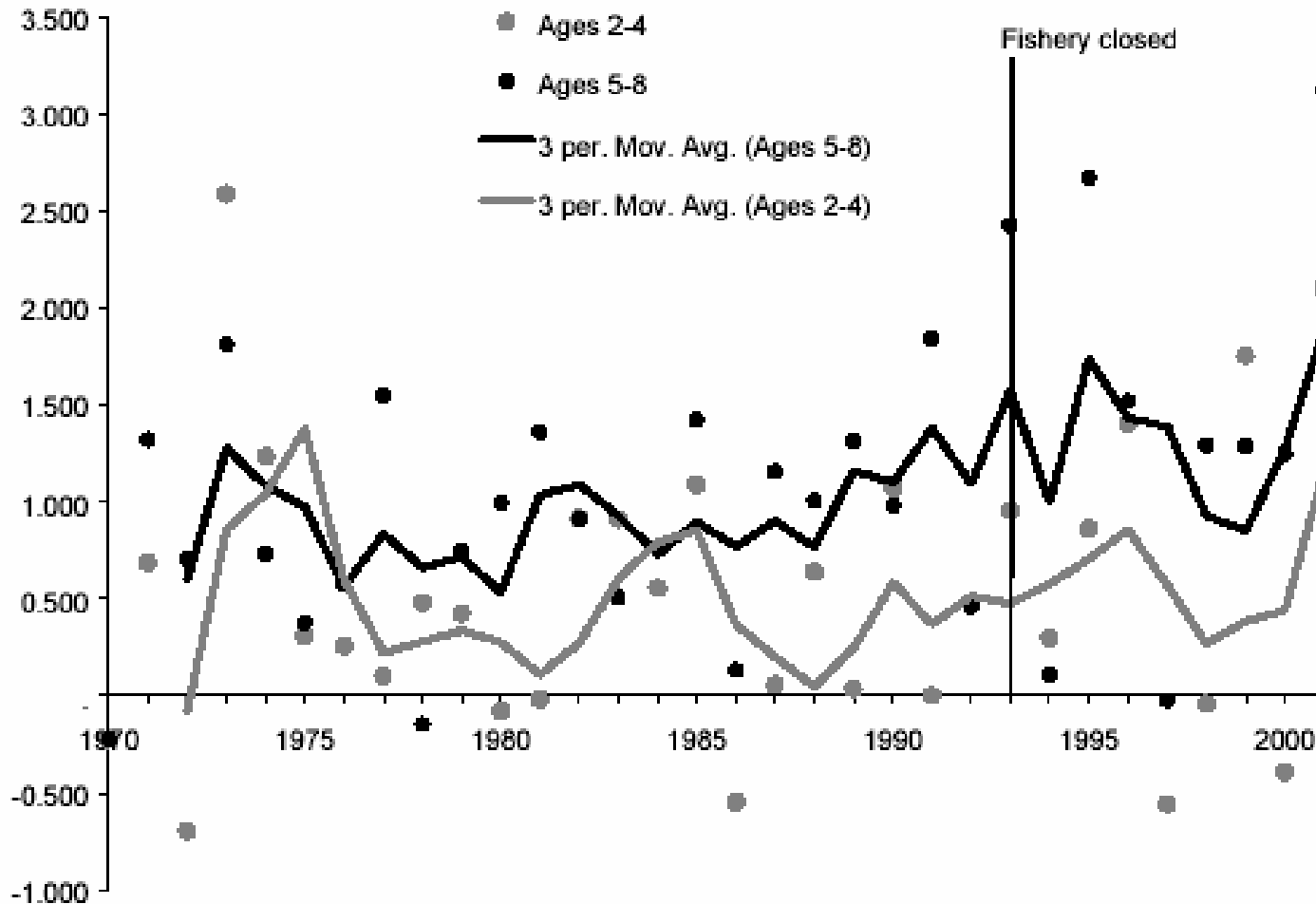


Figure 21. Estimates of total mortality (Z) from q-corrected July RV survey population numbers at age. Ages 2-4 refers to the mean Z between ages 2-4 and ages 3-5 the following year. The lines are 3-year running means.

Grey Seal Impact on 4VsW Cod

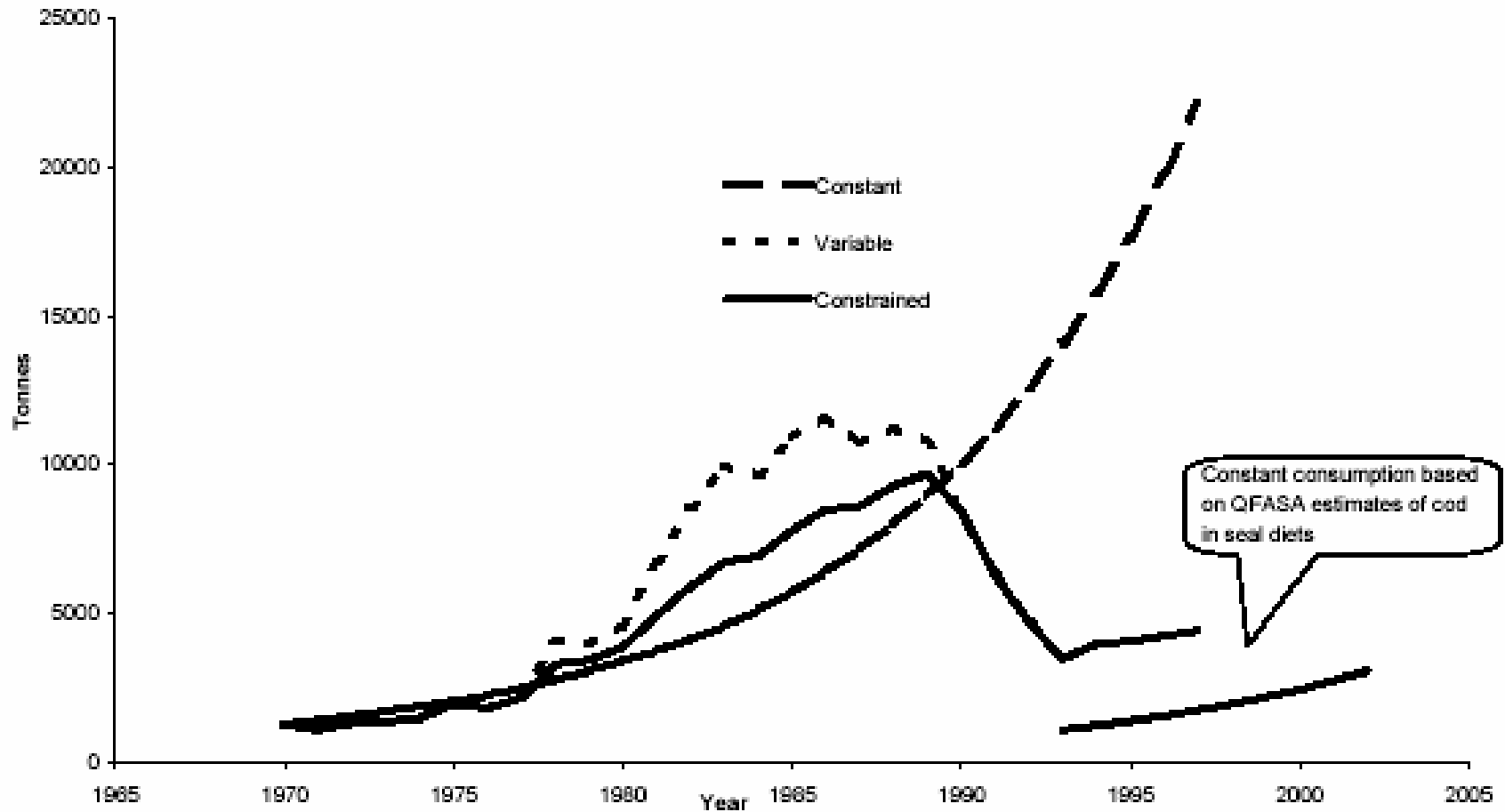
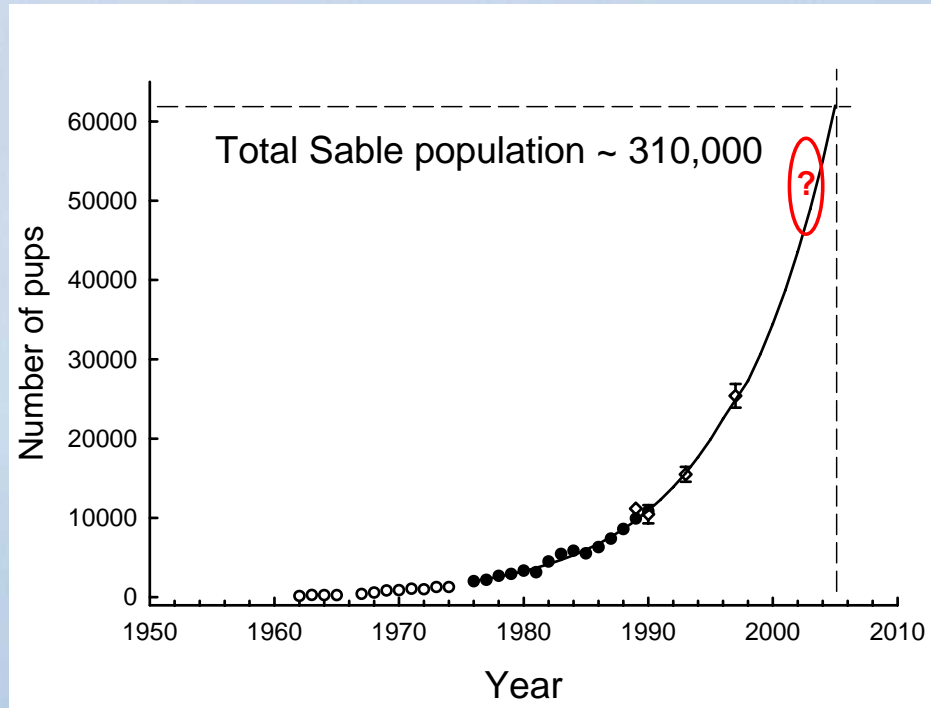


Figure 3. Biomass of 4VsW cod consumed by grey seals under three models of predation

Grey seal population size

- Southern Gulf ~ 60,000
- ~370,000 grey seals in Canadian Atlantic waters
- Today roughly 700,000 t of prey consumed each year compared to 6,000 t 40 yr ago




Contextual Indicators

Changes in Reference Points

- For example, F0.1 function of
 - Fishery Partial Recruitment
 - Stock Growth
 - Function of
 - Environment (e.g. temperature)
 - Food availability (prey)
 - Stock Natural Mortality
 - Function of
 - Predators
 - Disease
- Challenge
 - To determine influential contextual indicators on changes in reference points of operational objectives

Ecosystem Status Report

- Have been numerous 'State of the Oceanography' reports
- First Ecosystem Status Report on Atlantic Coast done in 2003
- Synopsis of changes in the ESS ecosystem based upon trends on over 60 indicators

 Fisheries and Oceans Canada
Pêches et Océans Canada
Science Sciences

Maritimes Region

Ecosystem Status Report 2003/004

State of the Eastern Scotian Shelf Ecosystem

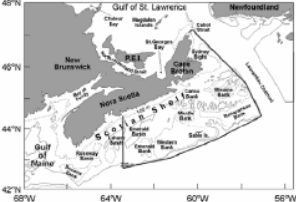
Background

The Eastern Scotian Shelf, comprising NAFO Div. 4VW, is a large geographic area (~108,000 km²) supporting a wide range of ocean uses such as fisheries, oil and gas exploration and development, and shipping. It is currently the focus for the development of an integrated management plan intended to harmonize the conduct of the various ocean use activities within it (referred to as Eastern Scotian Shelf Integrated Management or ESSIM). The area is unique for having a year-round closure for directed fishing of groundfish since 1987, associated with Emerald and Western Banks. In addition, The Gully has been declared a pilot marine protected area.

The Eastern Scotian Shelf consists of a series of outer shallow banks and inner basins separated by gullies and channels. The mean surface circulation is dominated by southwestward flow, much of which originates from the Gulf of St. Lawrence with anticyclonic circulation tending to occur over the banks and cyclonic circulation around the basins. The northeastern region of the Shelf is the southern-most limit of winter sea ice in the Atlantic Ocean.

This document provides an assessment of the current state of the Eastern Scotian Shelf ecosystem. The analysis focuses on time trends in all available data series associated with three categories of variables: biotic, abiotic, and human. Biotic variables generally include information on the abundance, distribution and composition of finfish and invertebrates, phytoplankton, and marine mammals. Abiotic variables include oceanic and atmospheric data that provide insights into ocean climate conditions. Human variables range from fishery landings, fishery revenue, activities associated with oil and gas development to contaminants. The current evaluation uses over 60 data series, most of which extend back to at least 1970. A comprehensive picture of the baseline or unperturbed state of the system is unknown.

This report is a product of a working group that compiled and analyzed various data relevant to the evaluation of the Eastern Scotian Shelf ecosystem. It also benefited from input from several DFO staff, industry participants and external reviewers as part of DFO's Regional Advisory Process (RAP).



Summary

Many features of the Eastern Scotian Shelf ecosystem have changed dramatically during the past thirty years:

- A major cooling event of the bottom waters occurred in the mid-1980s that persisted for a decade and recent intensive stratification in the surface layer has been apparent; both phenomena are associated with flow from upstream areas.
- The index of zooplankton abundance was low in the decade of the 1990s when phytoplankton levels were high and the opposite pattern was evident in 1960s/early 1970s.
- Major structural changes have occurred in the fish community: groundfish have declined while small pelagic species and commercially exploited invertebrate species have increased.
- Changes in the physical environment were associated with the expansion of range of some species and the occurrence of species new to the area.
- Reductions in average body size of groundfish have occurred and there are currently very few large fish – a situation likely to have never been witnessed in the past.
- Condition and growth of several groundfish species has remained low during the past decade contrary to expectations for improvement.

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Canada

Maritimes EAM Report Card

Overarching
Conceptual Objectives



Used National Ecosystem
Objectives as Guide



Planning Area
Conceptual Objectives



Still high level
Need to be refined & prioritized



Planning Area
Operational Objectives



Generic objectives developed
Still need to address cumulative effects



Sector
Operational Objectives



Progress in some sectors
Fishing, Oil & Gas, Aquaculture
Still need to be integrated into IM
framework



Sub - Sector
Operational Objectives

Science Priority Highlights

- Draft ecosystem objectives being revisited
 - Ecologically & biologically significant areas & species
 - Degraded areas & depleted species
- Ecosystem objectives being used to
 - Evaluate science needs of all regional Fisheries Management Plans
 - Develop research program with NMFS (Northeast) on indicators / reference points to support EBFM in GOMA
- Ecosystem status report for GOMA
 - Similar to ESS report but linked to ecosystem objectives
 - New suite of contextual indicators

Science Priority Highlights (cont'd)

- Benthic Community Biodiversity
 - Characterization & scale of human impacts
 - Evaluation of sensitivity of each community & reference points
- Coral Community Biodiversity
 - Deepwater coral distribution study
- Specie Biodiversity
 - By-catch study across all Fisheries Management Plans