Implications of Ecosystem Approaches to Fisheries Management (EAFM) for Pelagic Fisheries

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Pelagic Fisheries: US and European Perspectives and Shared Experiences

May 1, 2018

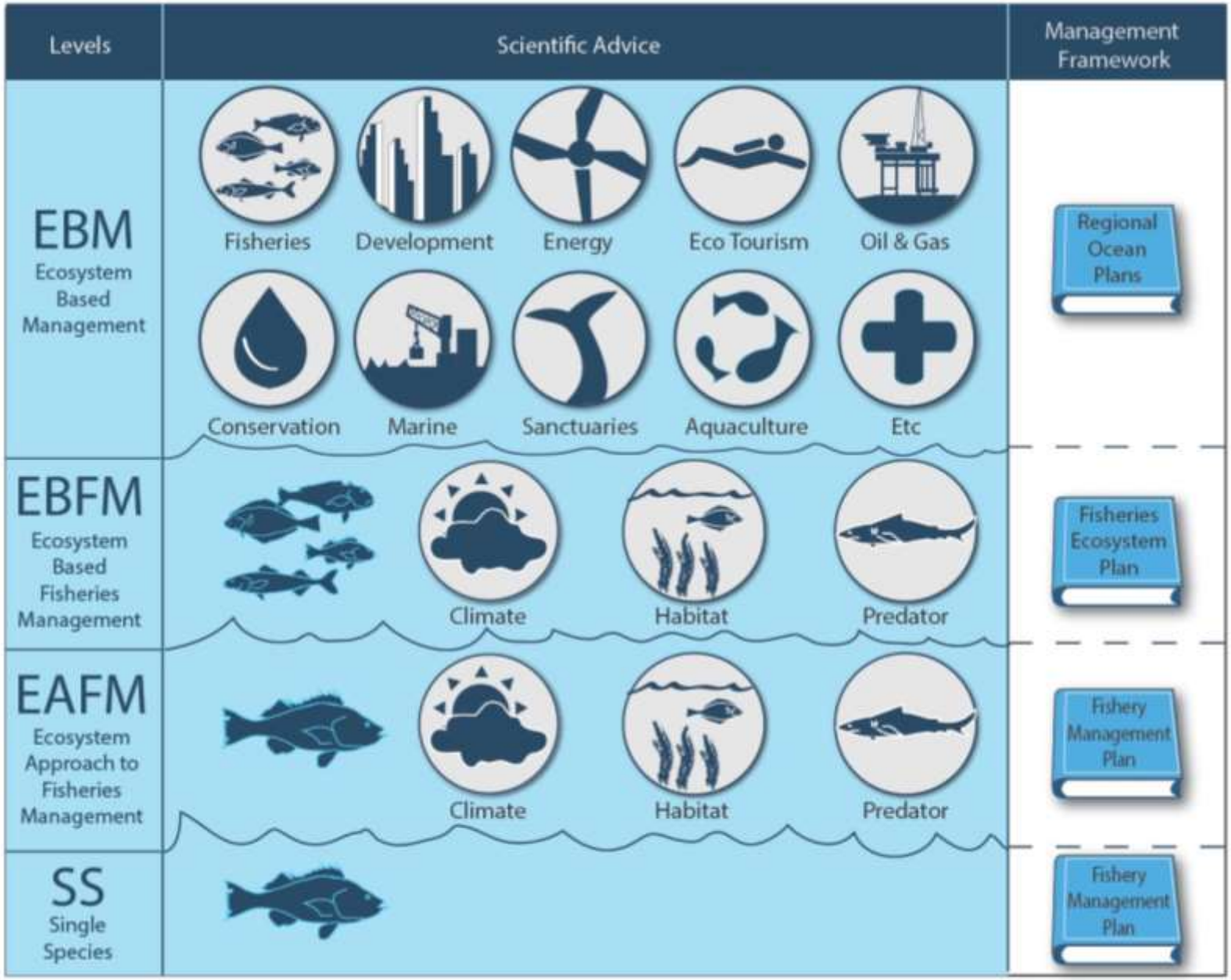
Science for multispecies / ecosystem TACs

- Why consider ecosystem/multispecies interactions?
- How to consider them—flexible frameworks
  - Which level of interactions to consider?
  - Integrated ecosystem assessment components
- Specific examples
  - Mid-Atlantic ecosystem approach
  - New England herring-as-forage approach
  - New England proposed ecosystem based fishery management

Why consider whole systems/interactions?

- Highlight linkages
- Understand how human well-being is affected by changing conditions
- Improve sustainability

Which level?


Levels
Scientific Advice
Management Framework
EBM
Ecosystem Based Management
Fisheries
Development
Energy
Eco Tourism
Oil & Gas
Conservation
Marine
Sanctuaries
Aquaculture
Etc
Regional Ocean Plans
EBFM
Ecosystem Based Fisheries Management
Climate
Habitat
Predator
Fisheries Ecosystem Plan
EAFM
Ecosystem Approach to Fisheries Management
Climate
Habitat
Predator
Fishery Management Plan
SS
Single Species
Fishery Management Plan

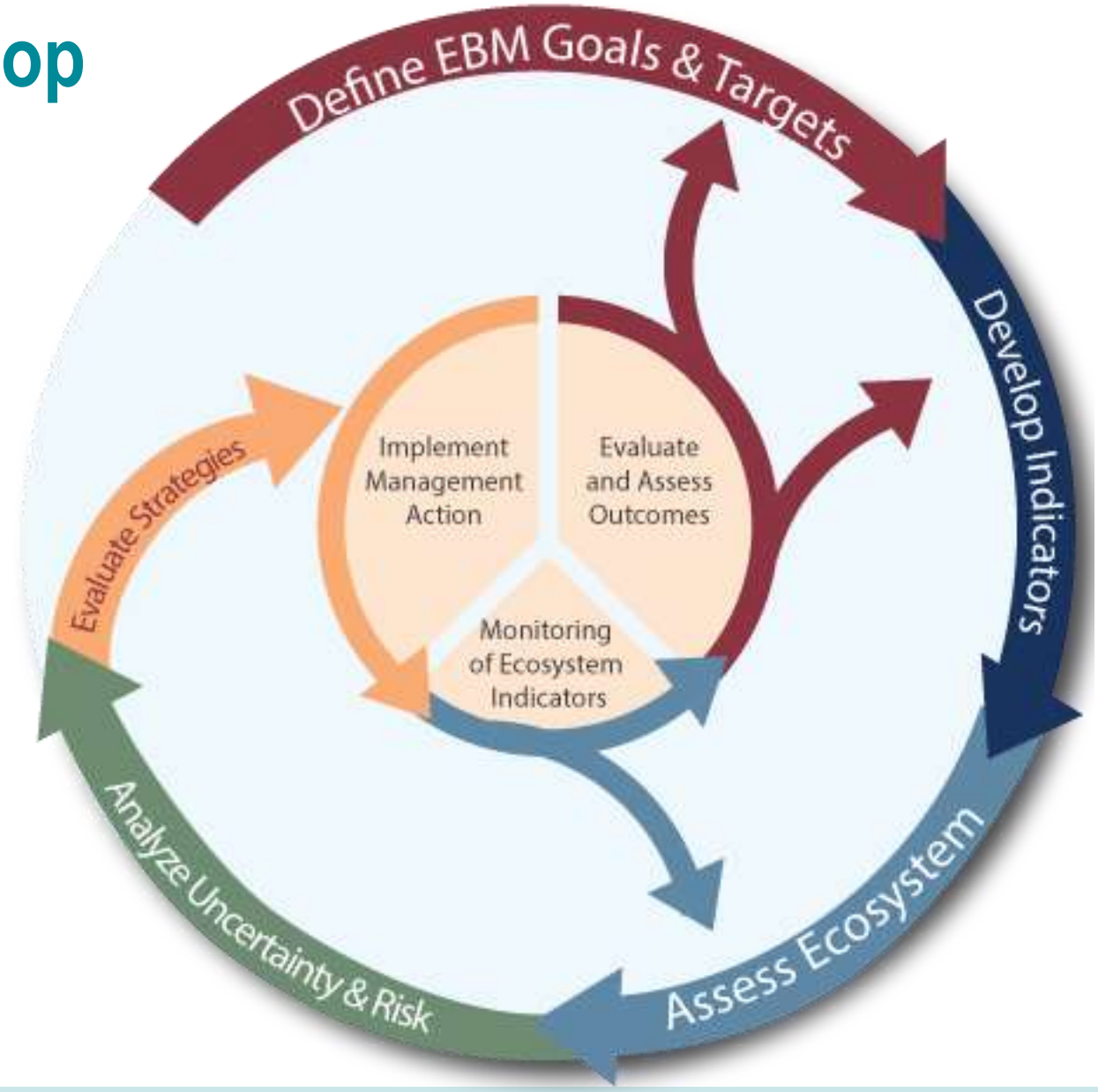
NOAA's Integrated Ecosystem Assessment (IEA) Program

IEAs Provide an Analytical Framework to Implement EBM

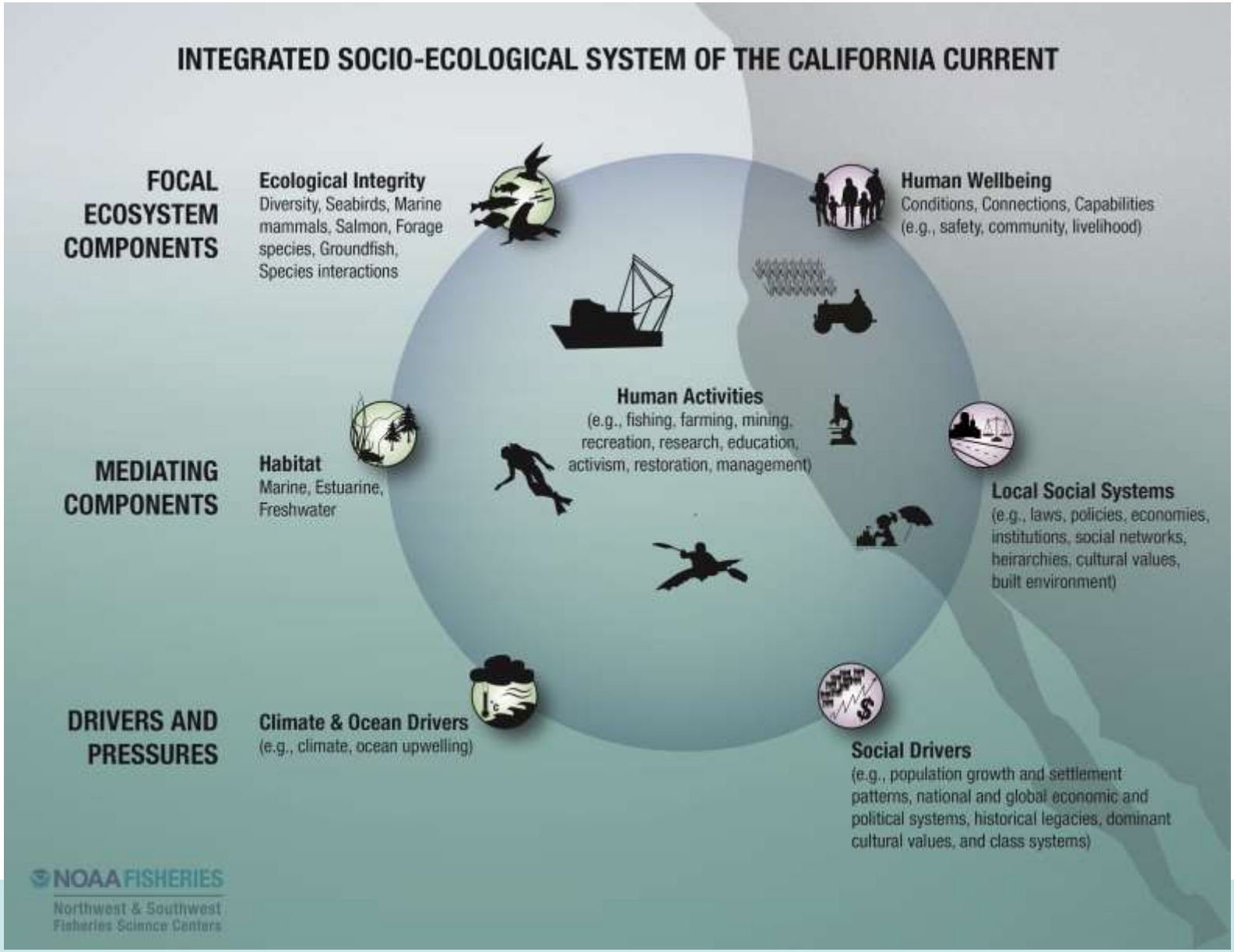
Vision:

To provide the sound interdisciplinary, ecosystem-based science, tradeoff evaluation, and management advice required to ensure the sustainable delivery of a broad spectrum of benefits and services from our Nation's marine, coastal, estuarine, and Great Lakes ecosystems; thus, enhancing the well-being of current and future generations.

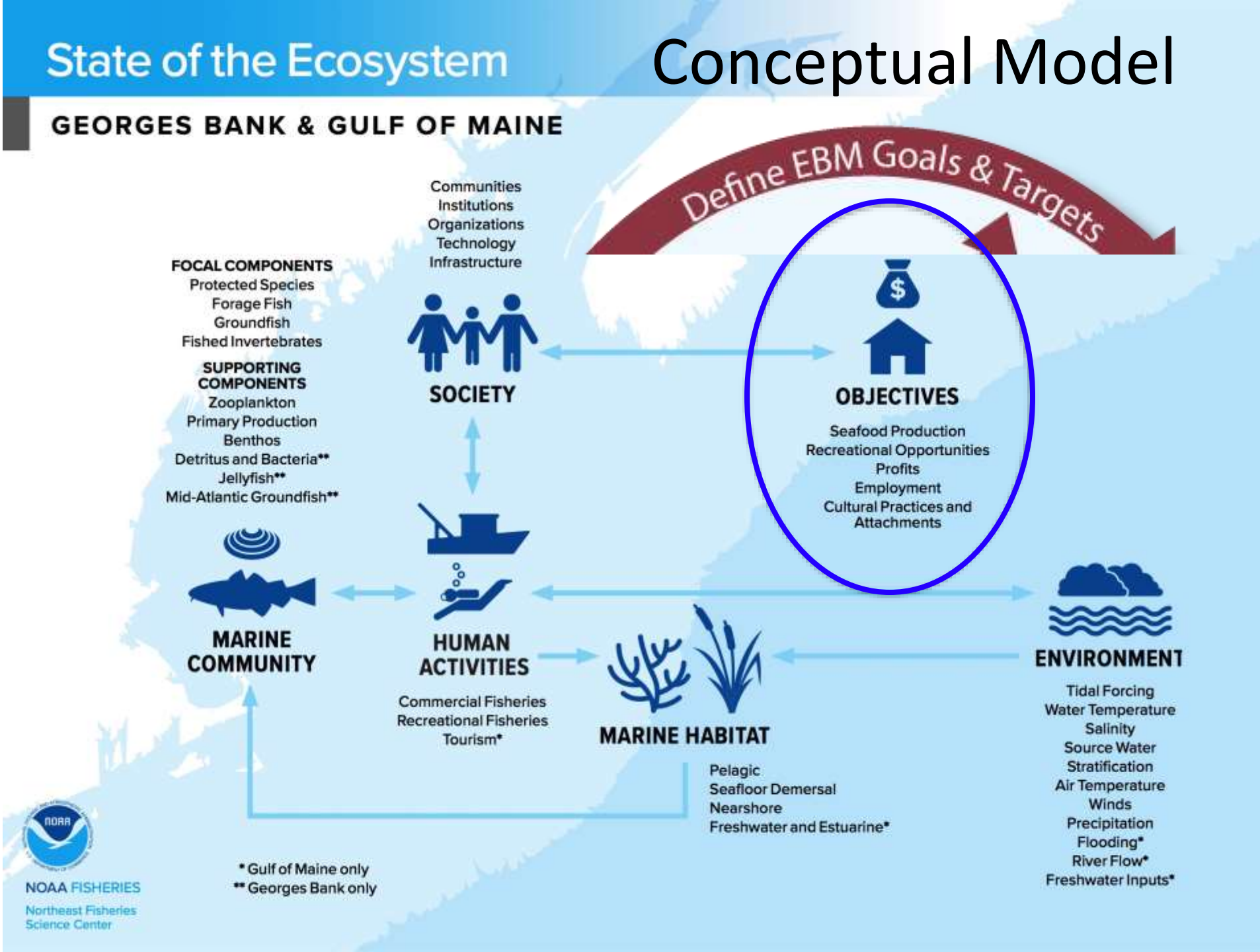
IEA loop


Define EBM Goals & Targets
Develop Indicators
Assess Ecosystem
Analyze Uncertainty & Risk
Evaluate Strategies
Implement Management Action
Evaluate and Assess Outcomes
Monitoring of Ecosystem Indicators

Scoping: conceptual model of integrated system



Conceptual Model



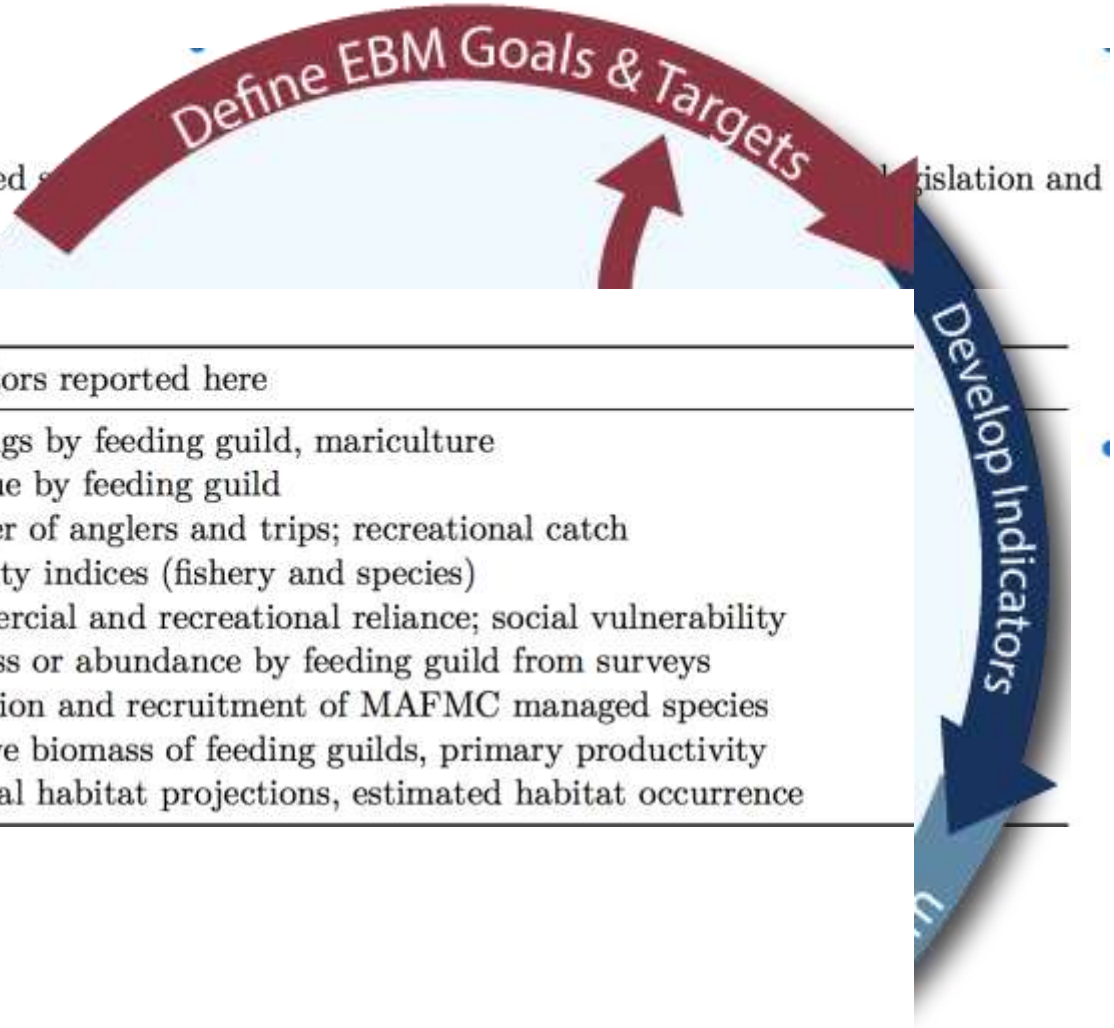
Summary: performance relative to objectives

Executive Summary

We have organized this report using a proposed s… …islation and current management practices.

Table 1: Mid-Atlantic ecosystem objectives

Objective Categories	Indicators reported here
Seafood production	Landings by feeding guild, mariculture
Profits	Revenue by feeding guild
Recreation	Number of anglers and trips; recreational catch
Stability	Diversity indices (fishery and species)
Social-Cultural	Commercial and recreational reliance; social vulnerability
Biomass	Biomass or abundance by feeding guild from surveys
Productivity	Condition and recruitment of MAFMC managed species
Trophic structure	Relative biomass of feeding guilds, primary productivity
Habitat	Thermal habitat projections, estimated habitat occurrence

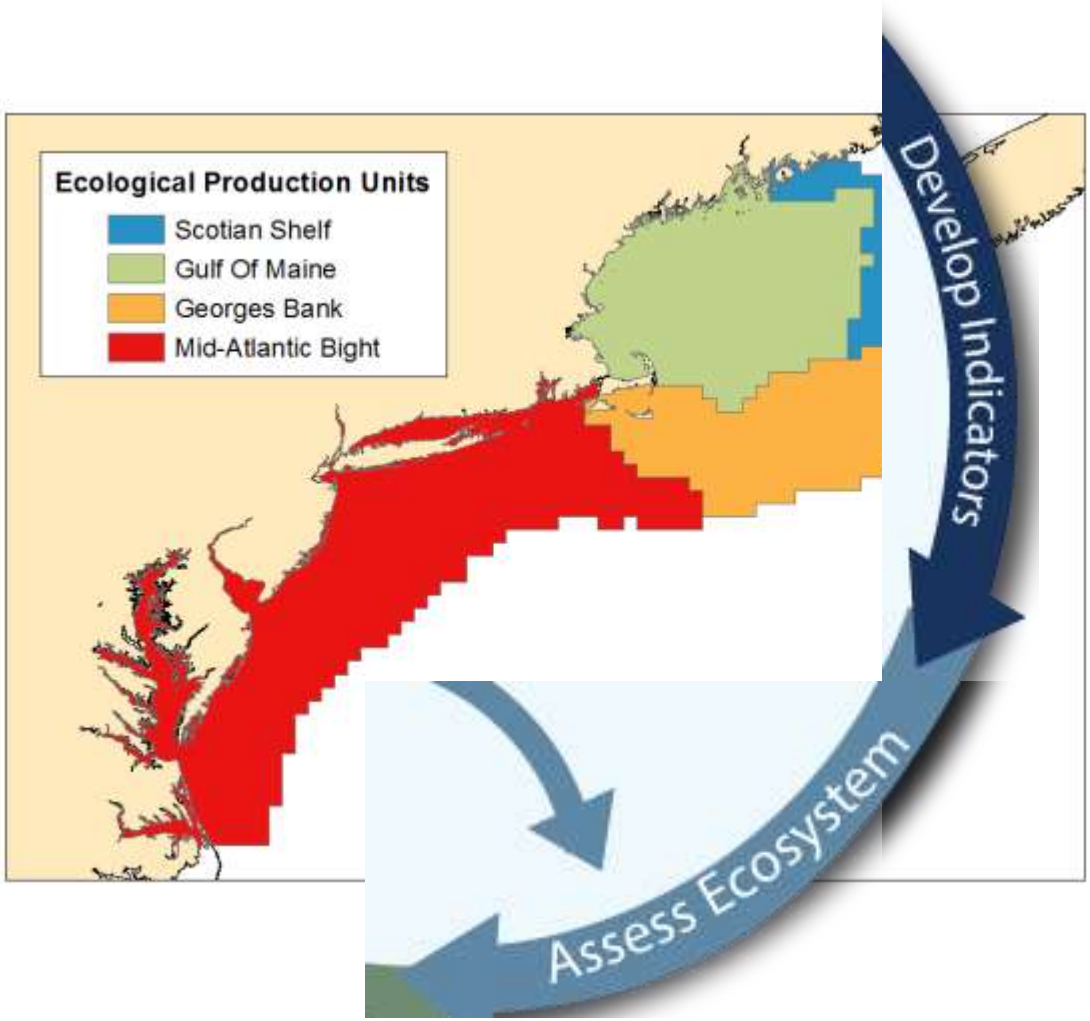


Data for ecosystem indicators, modeling?

- Many collaborations within and across agencies
  - National and state fishery landings reporting
  - Recreational angler surveys
  - Fishery observers
  - National and state scientific oceanographic and fishery trawl surveys
  - Satellites, ships of opportunity
- Academic partners, ocean observation systems
- Cooperative research with fishing industry

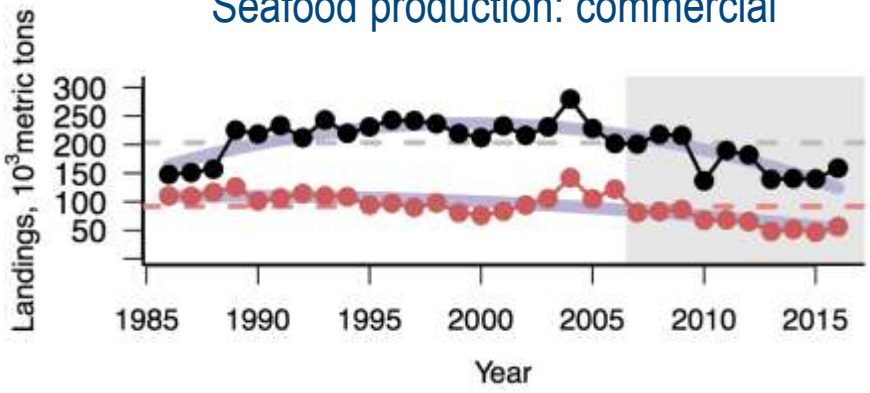
Ecosystem indicators and assessment

- Big picture
- Human dimensions
- Protected species-fishery interactions
- Resource Species
- Ecosystem conditions and productivity

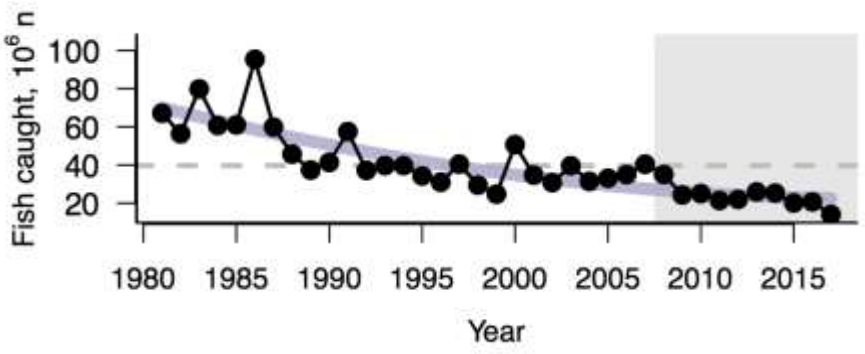


Ecosystem indicators addressing objectives

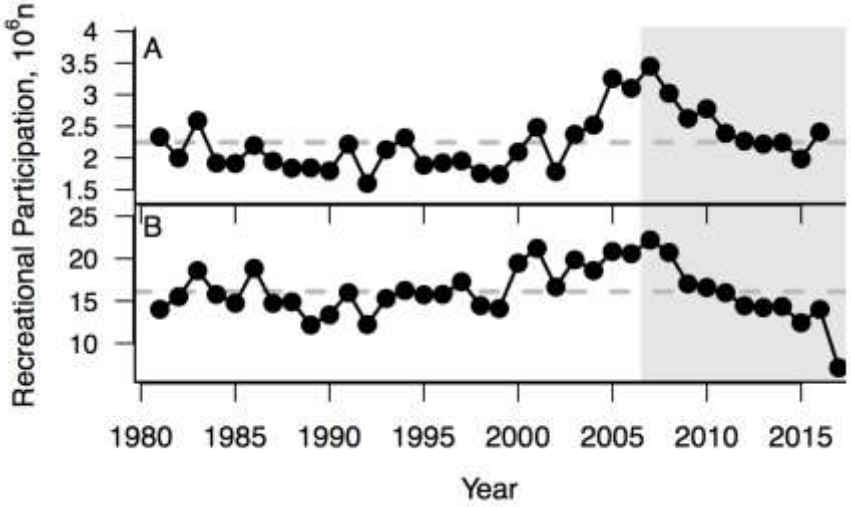
Seafood production: commercial



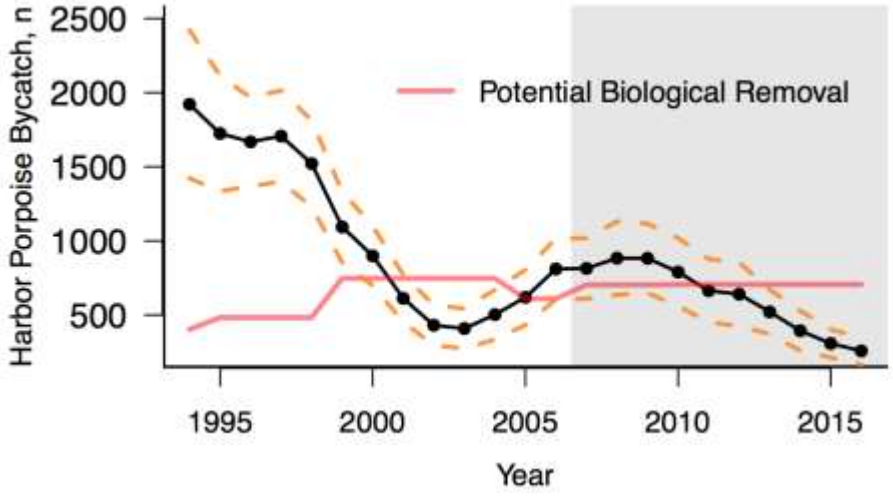
Seafood production: recreational



Recreational opportunities



Reducing fishery-protected species interactions



Ecosystem indicators for shifting species and habitats

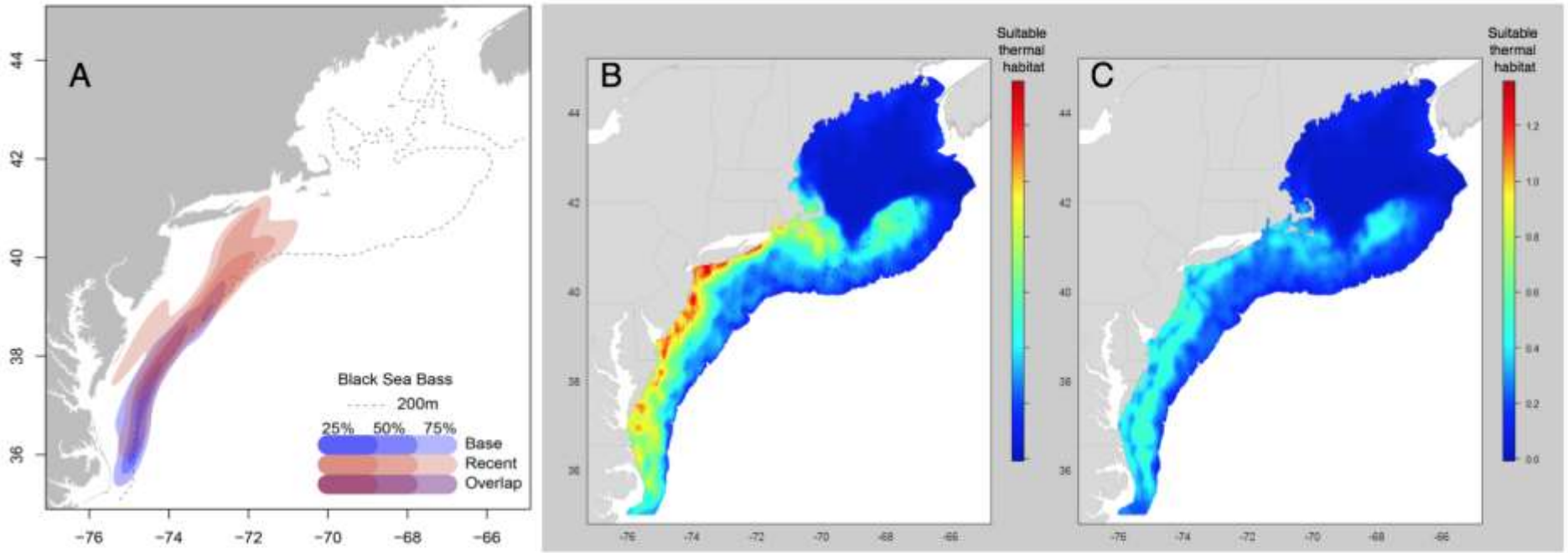
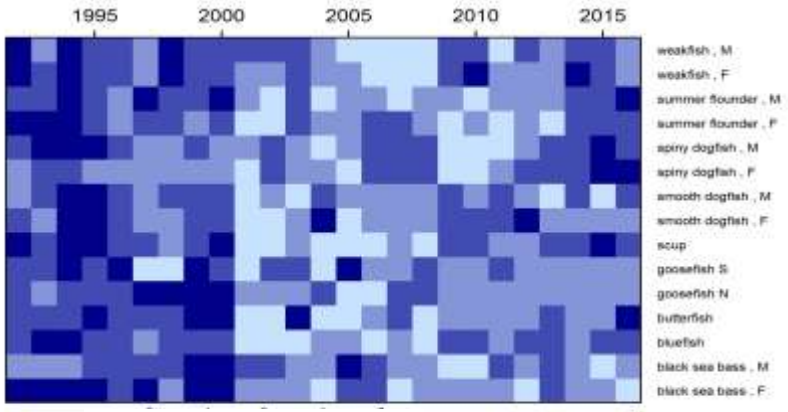
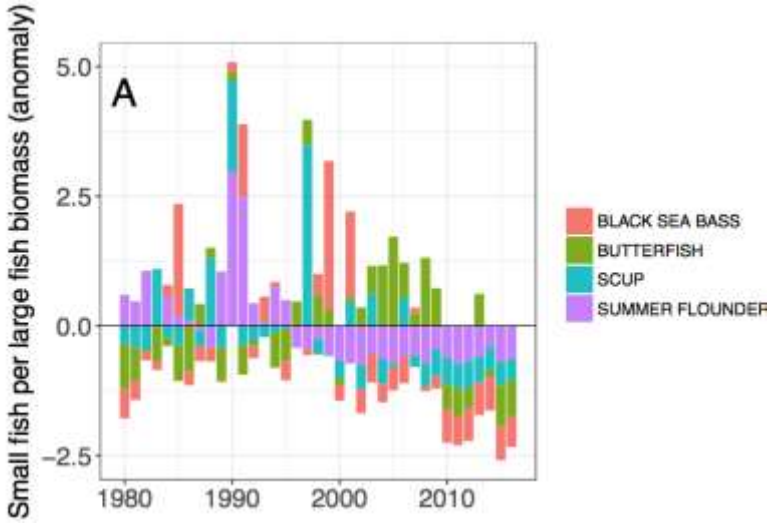


Figure 19: Black sea bass historical and current abundance estimates (A), current thermal habitat estimate (B), and 20-40 year thermal habitat projection (C).

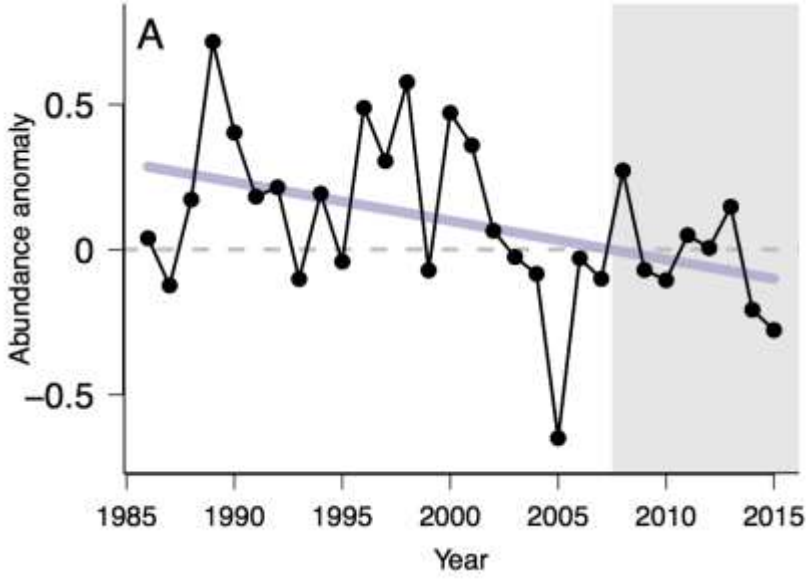
Ecosystem indicators for system productivity

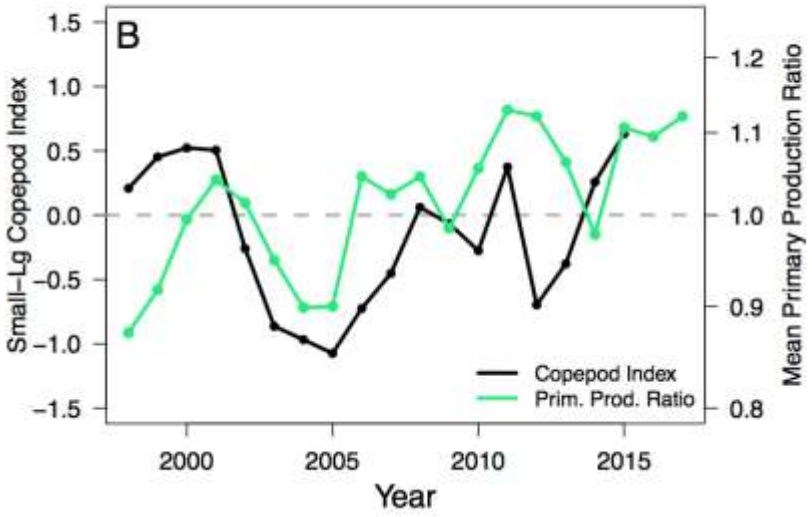
Groundfish condition and productivity





Base of the food web: Copeopods and primary production





Mid-Atlantic Council Fishery Management Plans

Summer Flounder, Scup, Black Sea Bass

Spiny Dogfish

Atlantic Mackerel, Squid, Butterfish

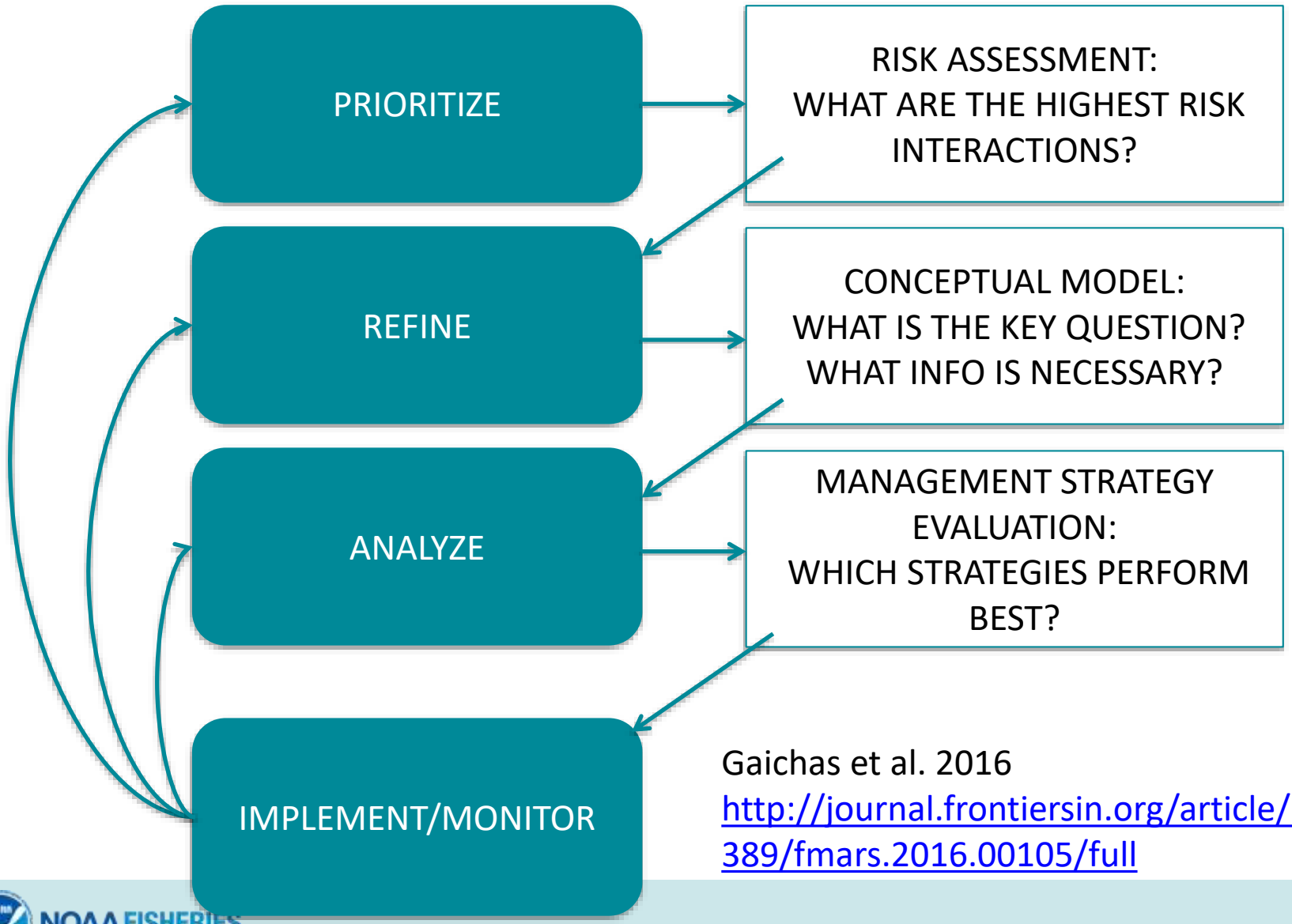
Bluefish

Surfclam and Ocean Quahog

Golden Tilefish

http://www.mafmc.org/fishery-management-plans

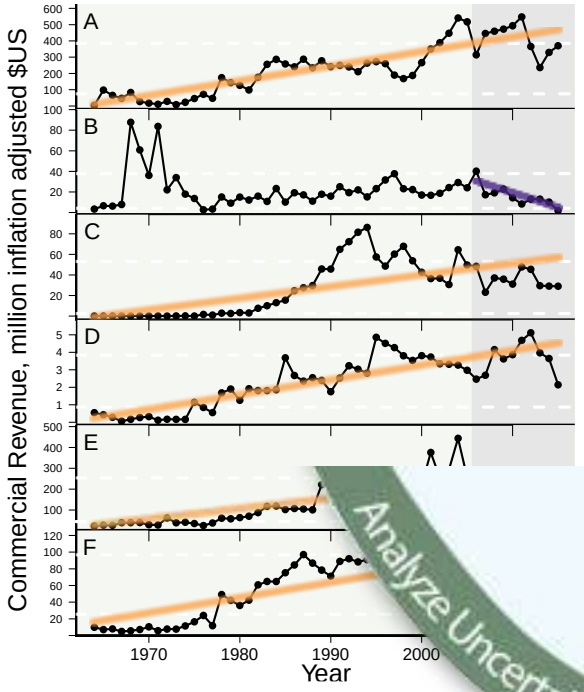
Mid Atlantic EAFM Framework



Gaichas et al. 2016
http://journal.frontiersin.org/article/10.3389/fmars.2016.00105/full

Indicators → Mid Atlantic EAFM

- Opportunity: use indicators from State of the Ecosystem to inform EAFM risk assessment



Indicator	Risk
Revenue	Low
Employment	Low-moderate
Seafood	Low
Production	Low-moderate
	Moderate-high
	High

Types of Risk Elements

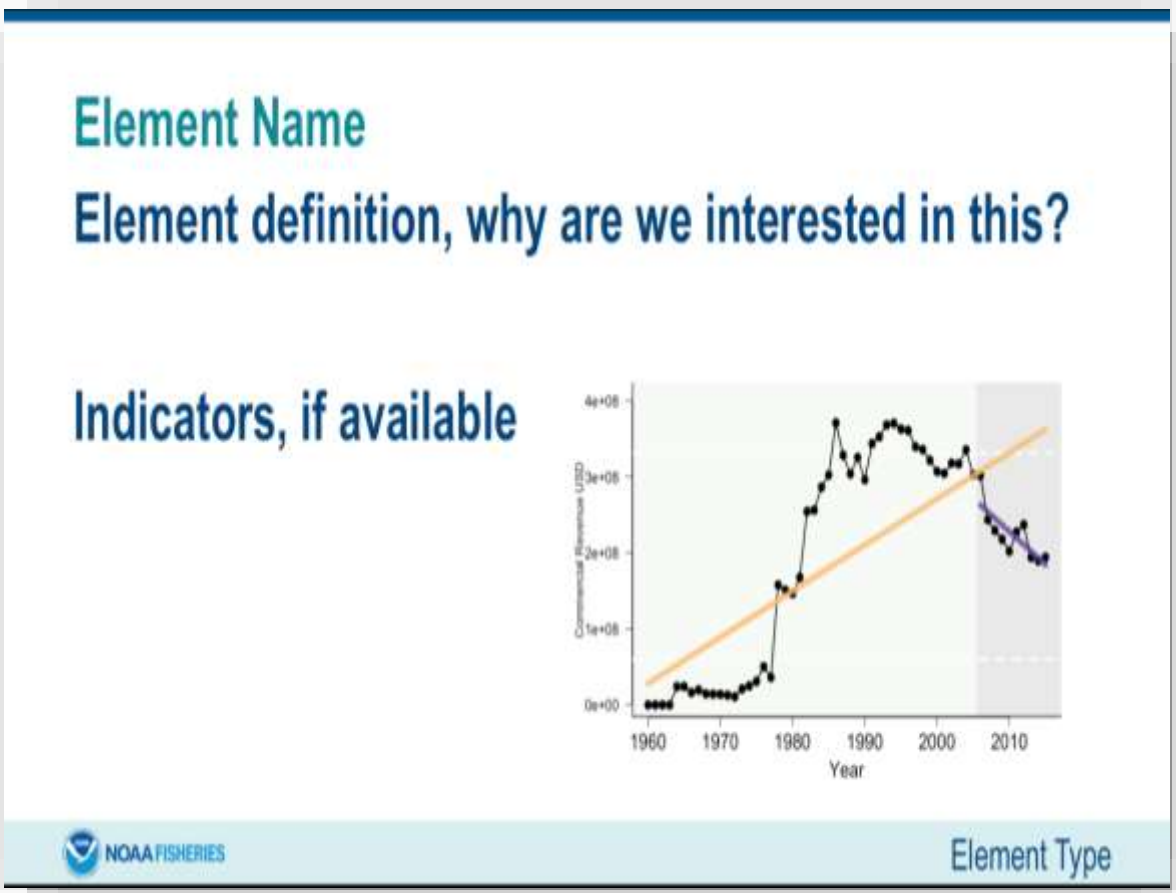
Ecological

Economic

Social

Food Production

Management



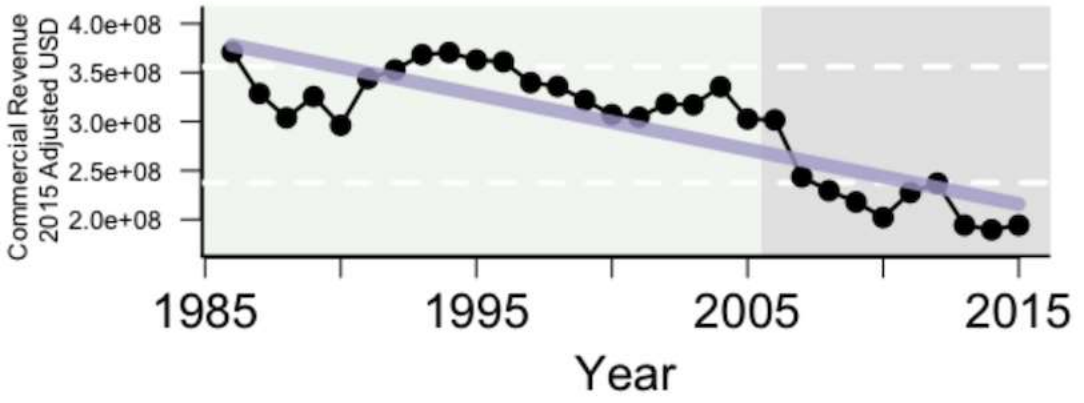
Full document reviewed in December 2017:
http://www.mafmc.org/s/SOE_MAB_RiskAssess-lzyt.pdf

Example Risk Element and Indicator

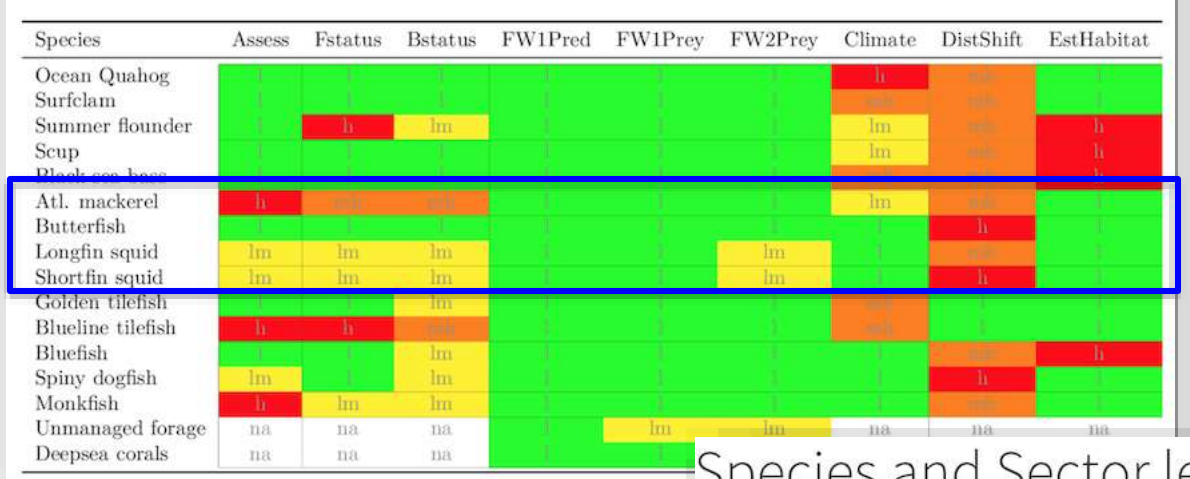
Commercial Revenue

This element is applied at the ecosystem level. Revenue serves as a proxy for commercial profits.

Risk Level	Definition
Low	No trend and low variability in revenue
Low-Moderate	Increasing or high variability in revenue
Moderate-High	Significant long term revenue decrease
High	Significant recent decrease in revenue

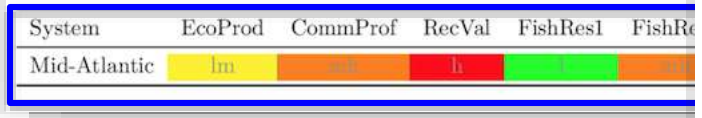


Species level



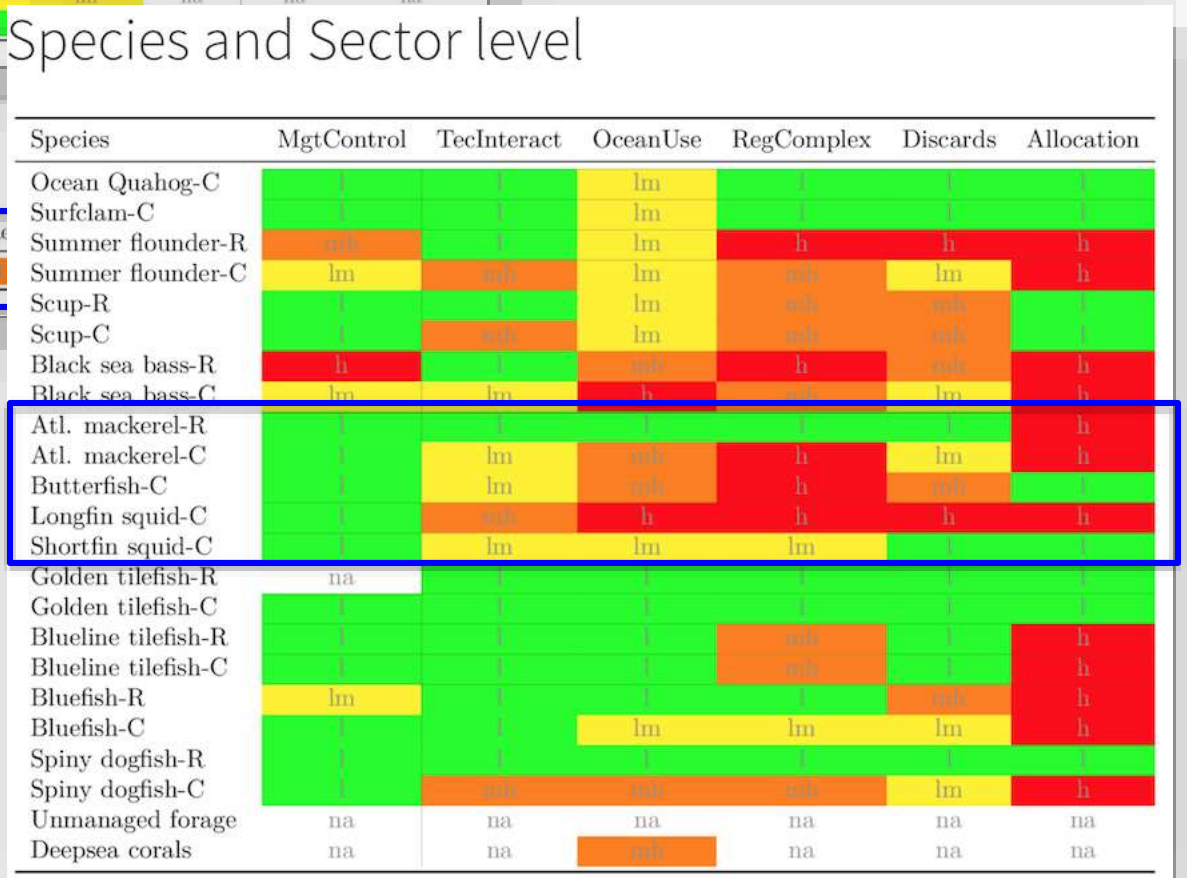
Species	Assess	Fstatus	Bstatus	FW1Pred	FW1Prey	FW2Prey	Climate	DistShift	EstHabitat
Ocean Quahog							h	mlh	
Surfclam							mlh	mlh	
Summer flounder		h	lm				lm	mlh	h
Scup							lm	mlh	h
Black sea bass									h
Atl. mackerel	h	mlh	mlh				lm	mlh	
Butterfish								h	
Longfin squid	lm	lm	lm			lm		mlh	
Shortfin squid	lm	lm	lm			lm		h	
Golden tilefish			lm				mlh		
Blueline tilefish	h	h	mlh				mlh		
Bluefish			lm					mlh	h
Spiny dogfish	lm		lm					h	
Monkfish	h	lm	lm					mlh	
Unmanaged forage	na	na	na		lm	lm	na	na	na
Deepsea corals	na	na	na						

Ecosystem level



System	EcoProd	CommProf	RecVal	FishRes1	FishRe
Mid-Atlantic	lm	mlh	h		mlh

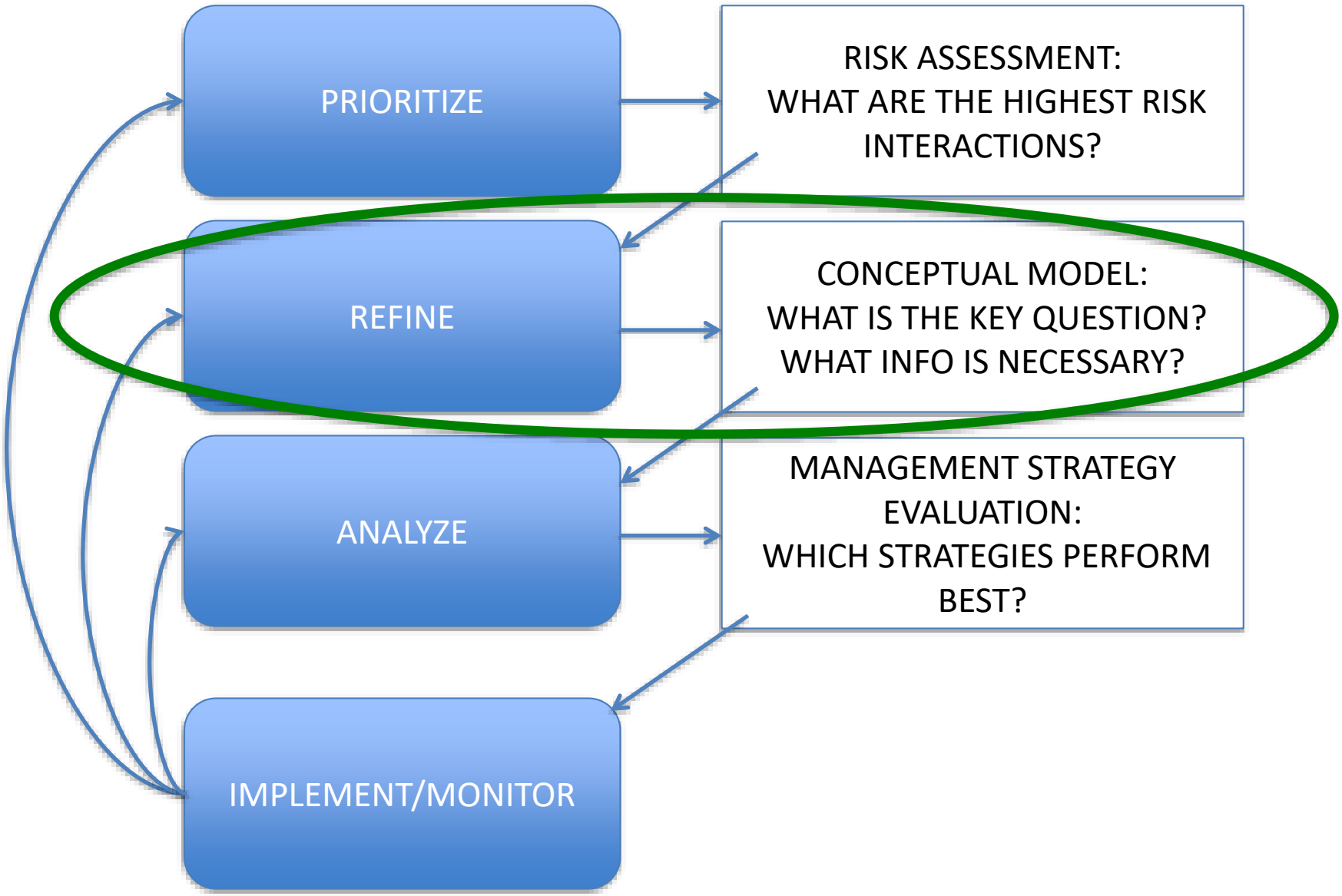
Species and Sector level

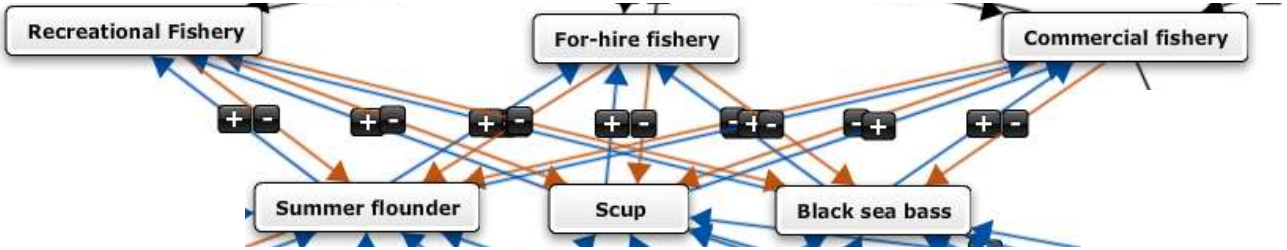


Species	MgtControl	TecInteract	OceanUse	RegComplex	Discards	Allocation
Ocean Quahog-C			lm			
Surfclam-C			lm			
Summer flounder-R	mlh		lm	h	h	h
Summer flounder-C	lm	mlh	lm	mlh	lm	h
Scup-R			lm	mlh	mlh	
Scup-C		mlh	lm	mlh	mlh	
Black sea bass-R	h		mlh	h	mlh	h
Black sea bass-C	lm	lm	h	mlh	lm	h
Atl. mackerel-R						h
Atl. mackerel-C		lm	mlh	h	lm	h
Butterfish-C		lm	mlh	h	mlh	
Longfin squid-C		mlh	h	h	h	h
Shortfin squid-C		lm	lm	lm		
Golden tilefish-R	na					
Golden tilefish-C						
Blueline tilefish-R				mlh		h
Blueline tilefish-C				mlh		h
Bluefish-R	lm				mlh	h
Bluefish-C			lm	lm	lm	h
Spiny dogfish-R						
Spiny dogfish-C		mlh	mlh	mlh	lm	h
Unmanaged forage	na	na	na	na	na	na
Deepsea corals	na	na	mlh	na	na	na

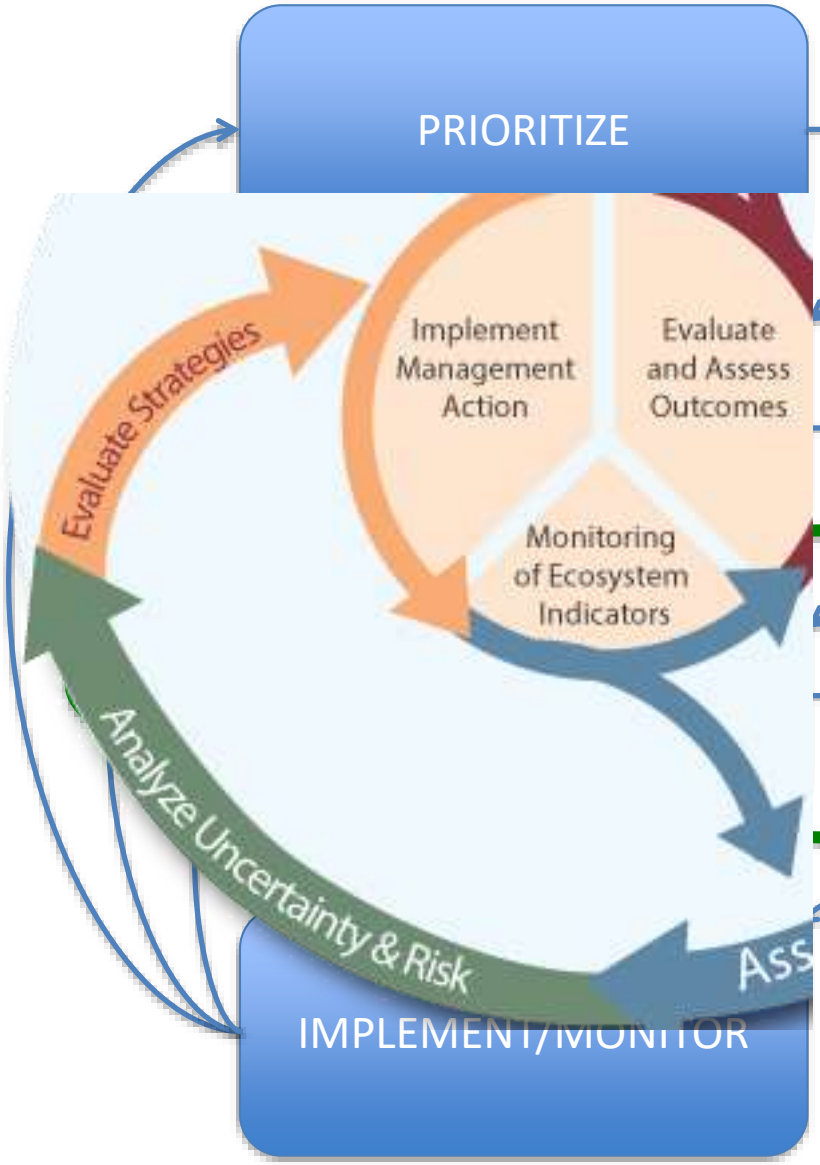
Results

Framework for addressing interactions




Recreational Fishery
For-hire fishery
Commercial fishery
Summer flounder
Scup
Black sea bass

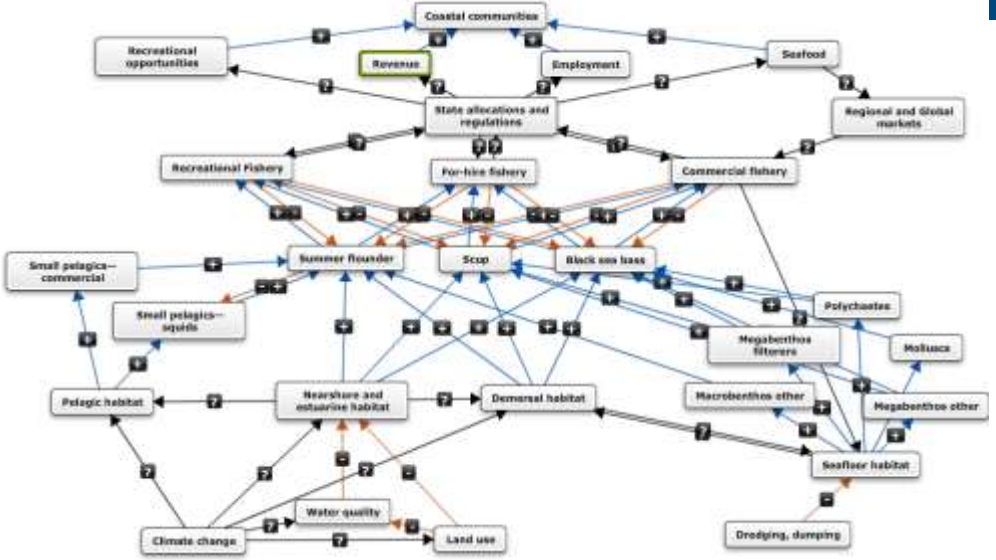
Framework for addressing interactions



RISK ASSESSMENT:
WHAT ARE THE HIGHEST RISK INTERACTIONS?

CONCEPTUAL MODEL:
WHAT IS THE KEY QUESTION?
WHAT INFO IS NECESSARY?

MANAGEMENT STRATEGY EVALUATION:
WHICH STRATEGIES PERFORM BEST?



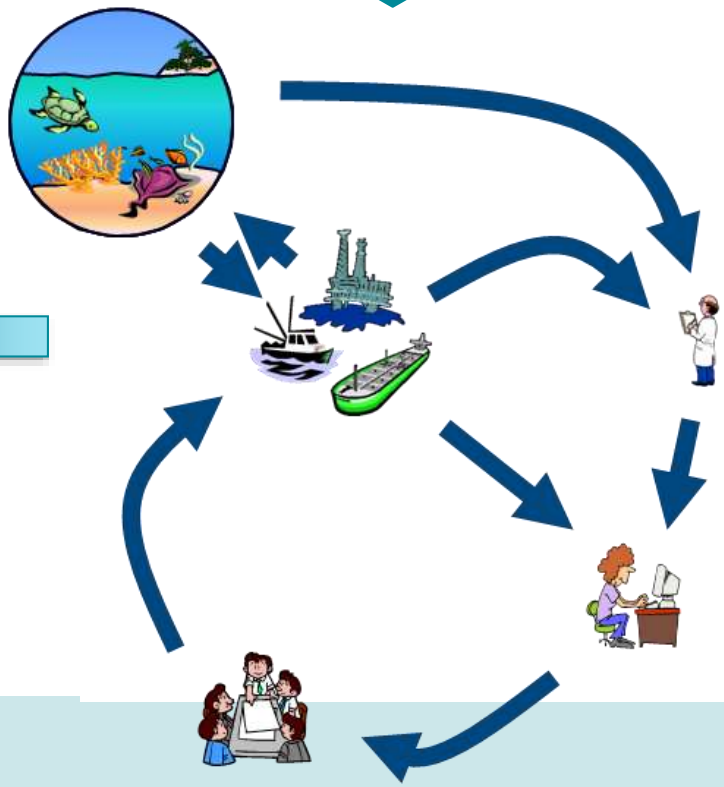
Strategy Evaluation:
Stakeholder process
Specifies MSE objectives,
Performance measures,
Range of strategies

Scientists develop tools

Decision Support:

- **Tradeoffs** between objectives
- Potential management strategy **performance** considering
  - key interactions
  - risks
  - uncertainties

Performance measures



NOAA FISHERIES

Fisheries management: NEFMC

Herring as Forage

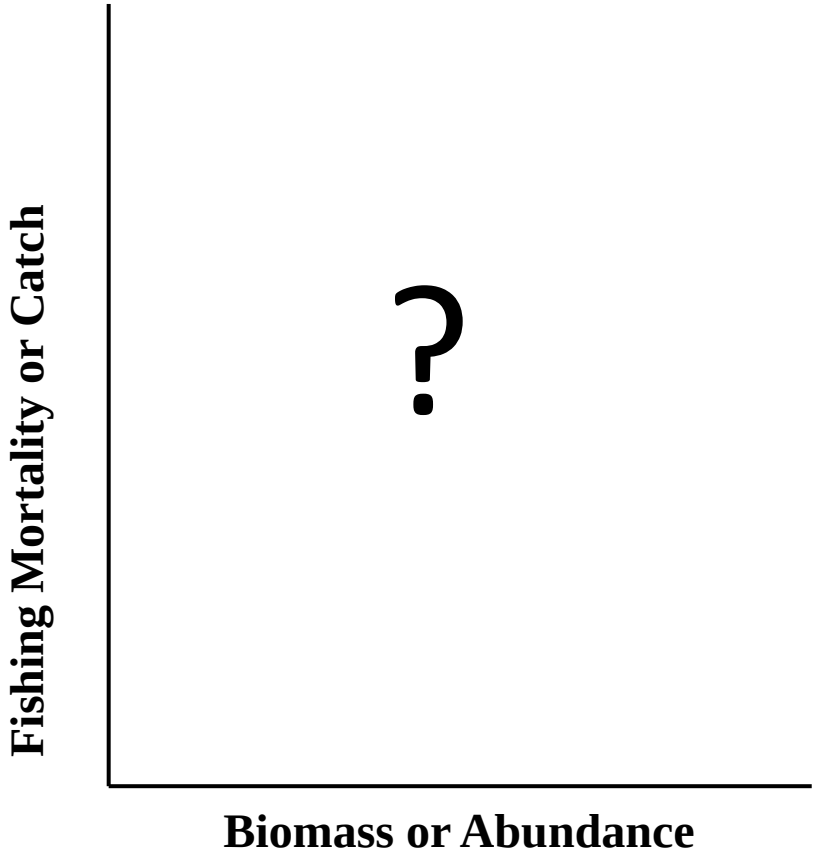
20% of diet for some fish

In times and places, 50% of tuna and seabird diet

Marine mammal consumption ≈ fishery catches

How Many Herring to Harvest?

Harvest Control Rules (the management strategy of interest):



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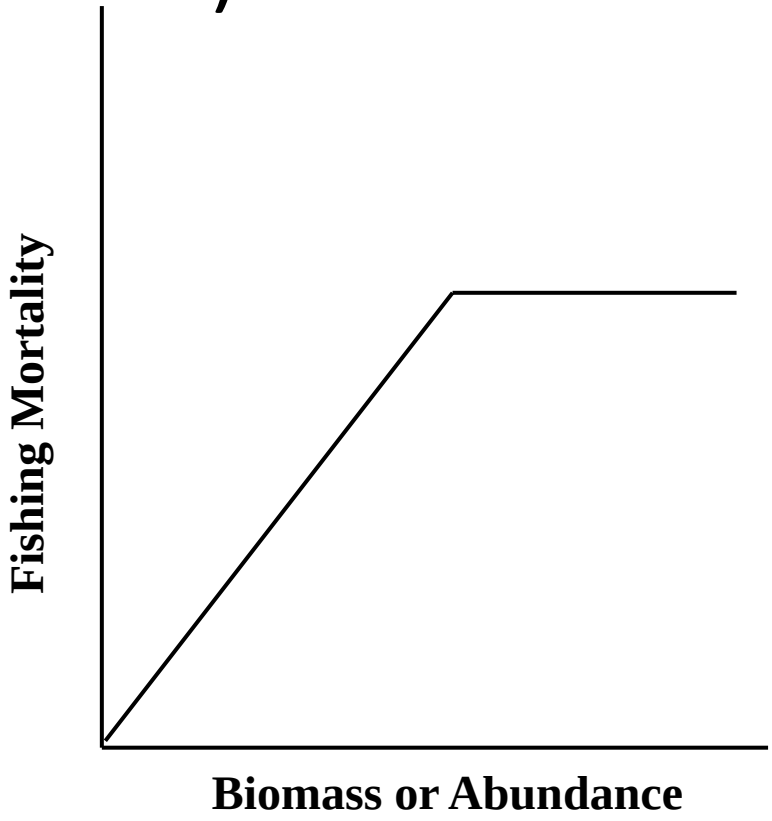
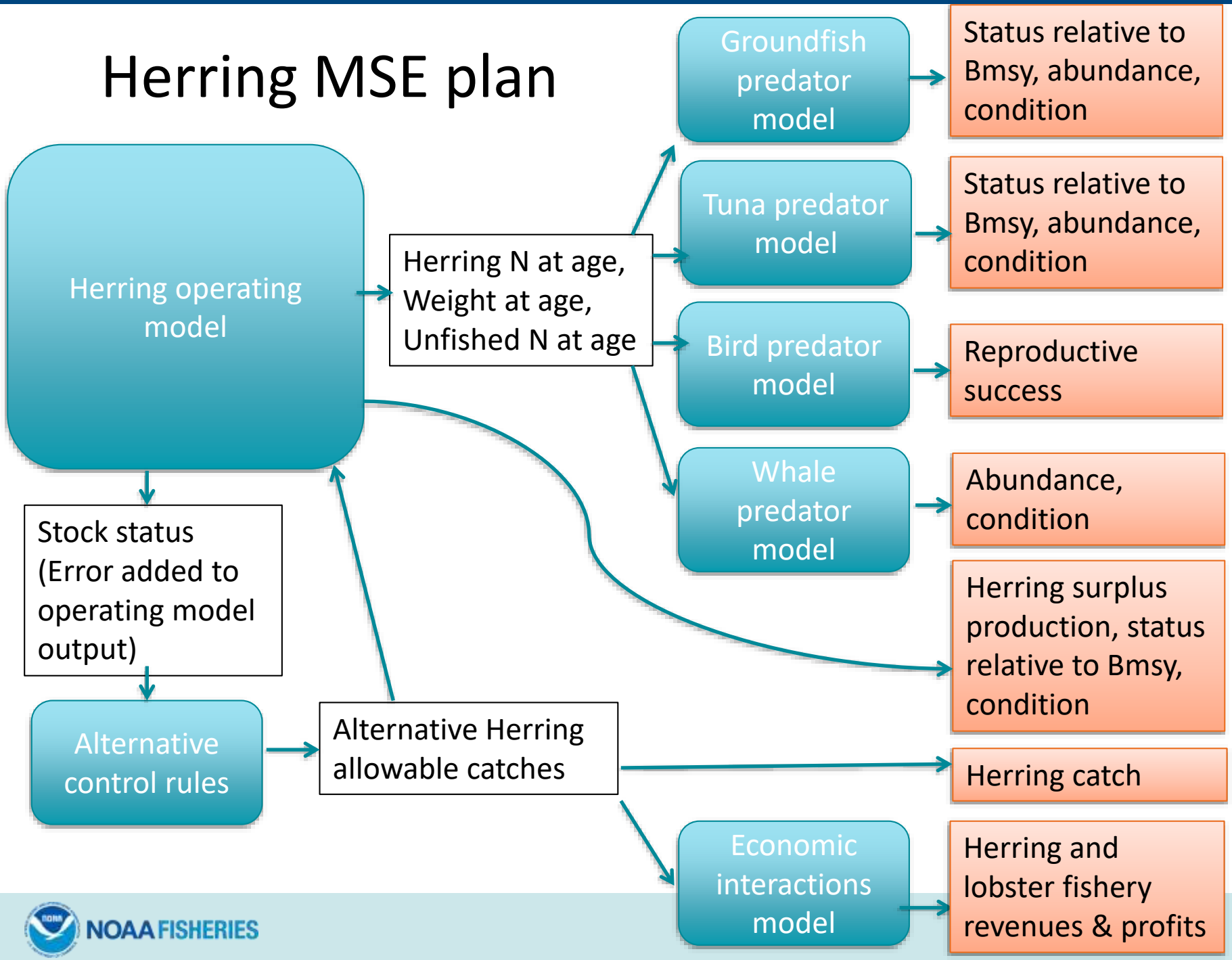


We tested thousands of shapes

Herring MSE plan



Herring control rules → predators?

Population average weight

Growth

Total biomass

Reproductive success

Total abundance

Survival

Production scenarios

Aggregate production

Herring control rules → predators?

Similar growth response across all control rules (but differed with herring growth!)

Poorer reproductive success for three control rule types

Poorer stock status for three control rule types

Unable to test specific control rules

Many ways to consider species interactions

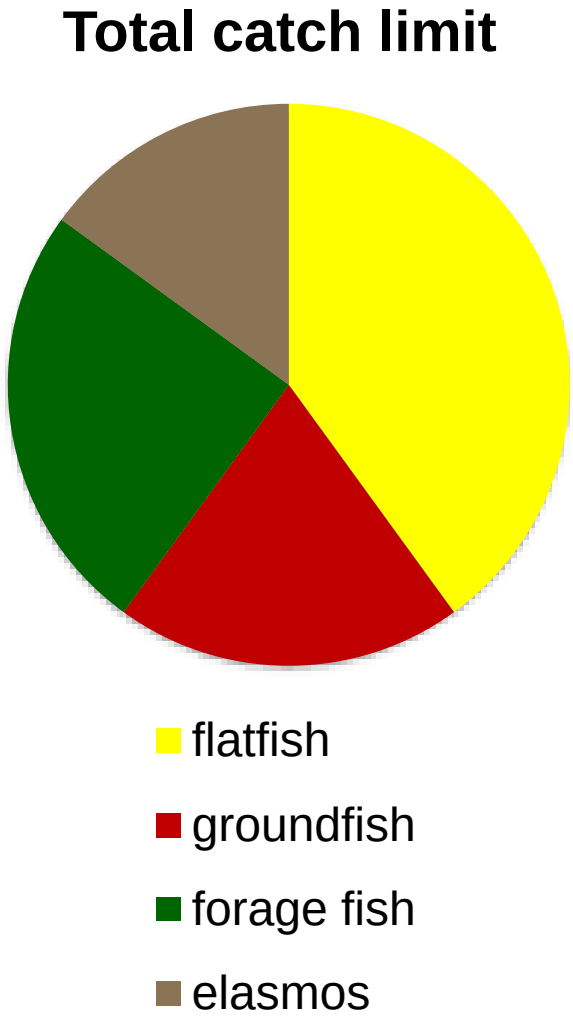
- Herring: Single species harvest control rules tested for impacts on predators, fishing fleets
  - Rules with poor predator performance eliminated
  - Many rules remained with good predator support
- Georges Bank: New England EBFM pilot project
  - Simulations to evaluate multispecies TACs
  - Simpler (less data) and more complex (more data) models address sustainability and yield objectives

New England EBFM: What could multispecies status determination criteria look like?

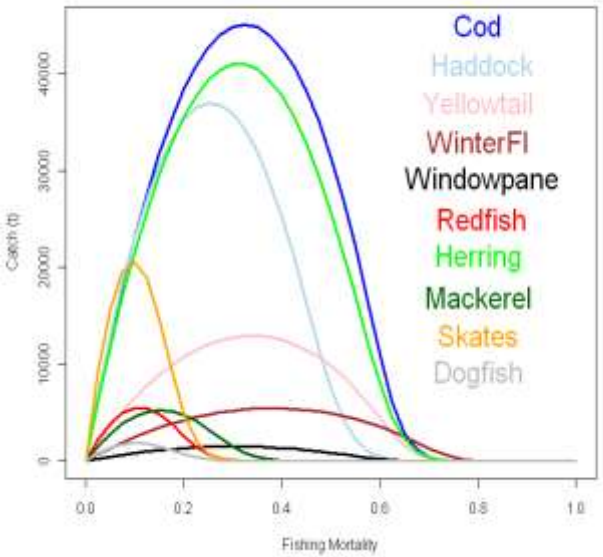
Four component management procedure:

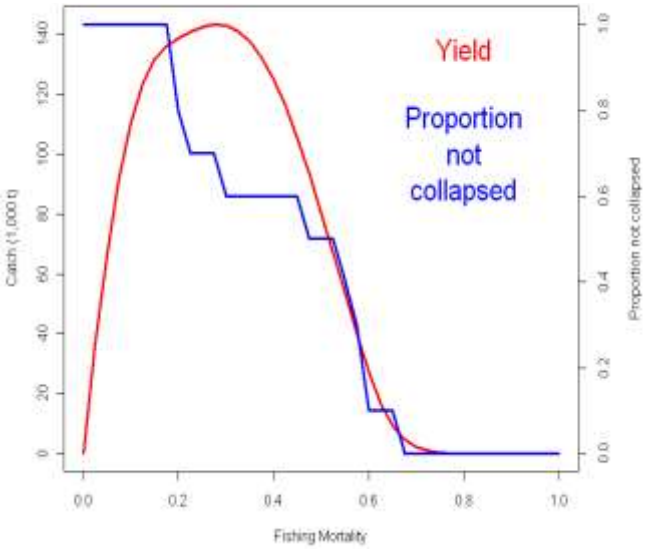
1. a limit on total removals for the ecosystem;
2. an allocation of the total removals limit to aggregate species groups;
3. minimum stock size thresholds for individual species; and
4. guidance for optimizing the species mix (within aggregates) based on bio-economic portfolio analysis.

- Manage fewer catch limits—simple, flexible
- Integrated assessment of species status

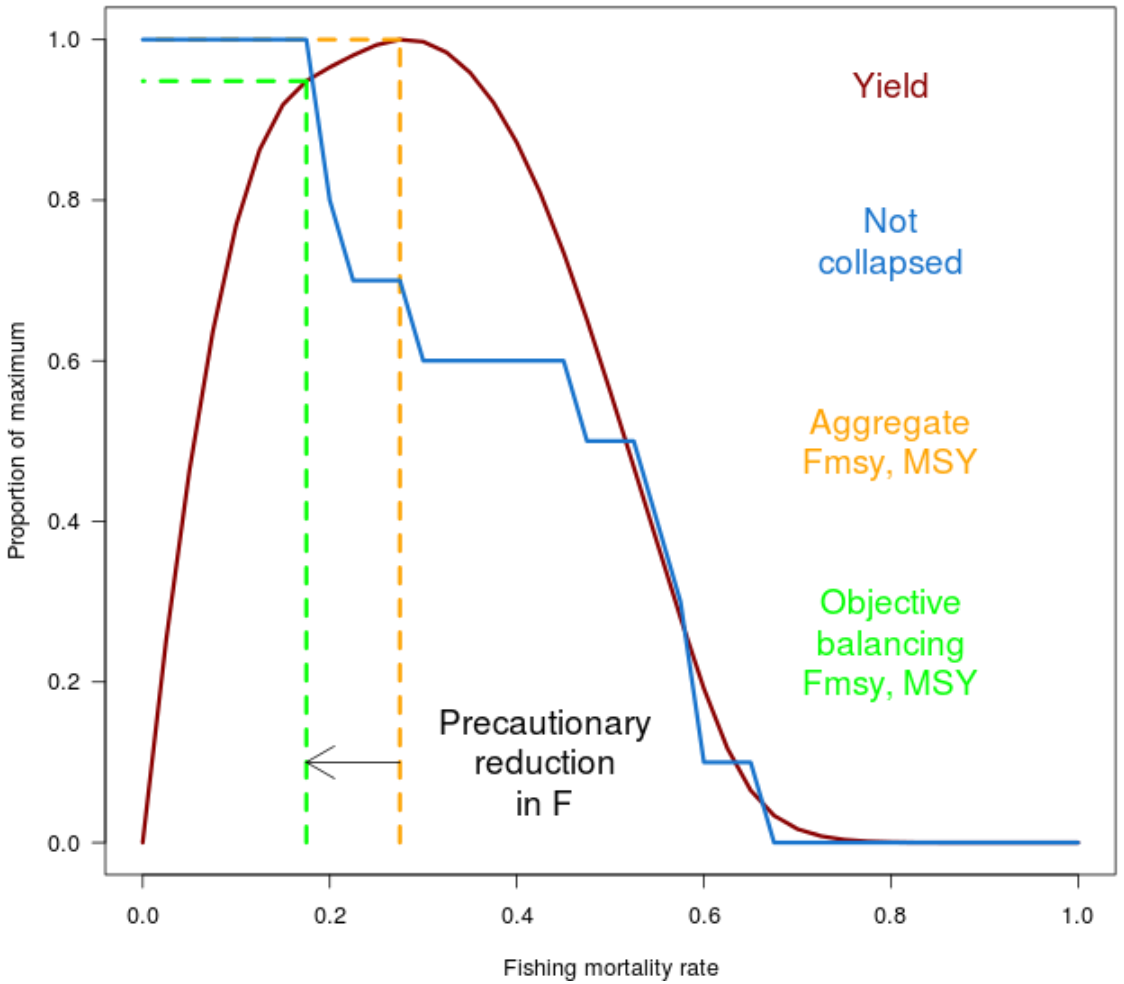


Simulations: balancing objectives with multispecies TACs





Yield maximizing biodiversity is ~95% of MMSY



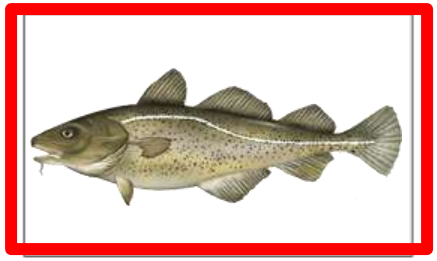
Gaichas et al. 2012 MEPS

dogfish

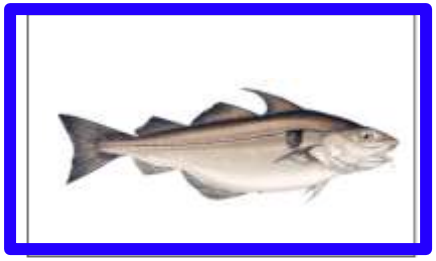
skate

herring

cod



haddock



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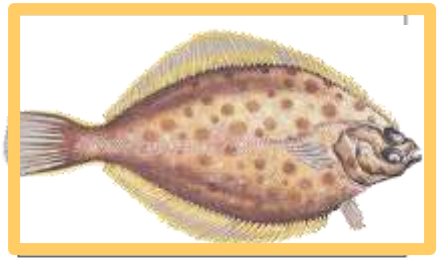
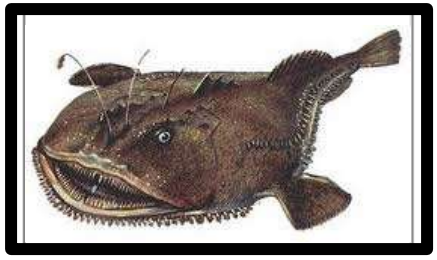


wint_fl

mackerel

silverhake

goosefish



Species and color codes

Addressing tradeoffs with more realistic multispecies fisheries

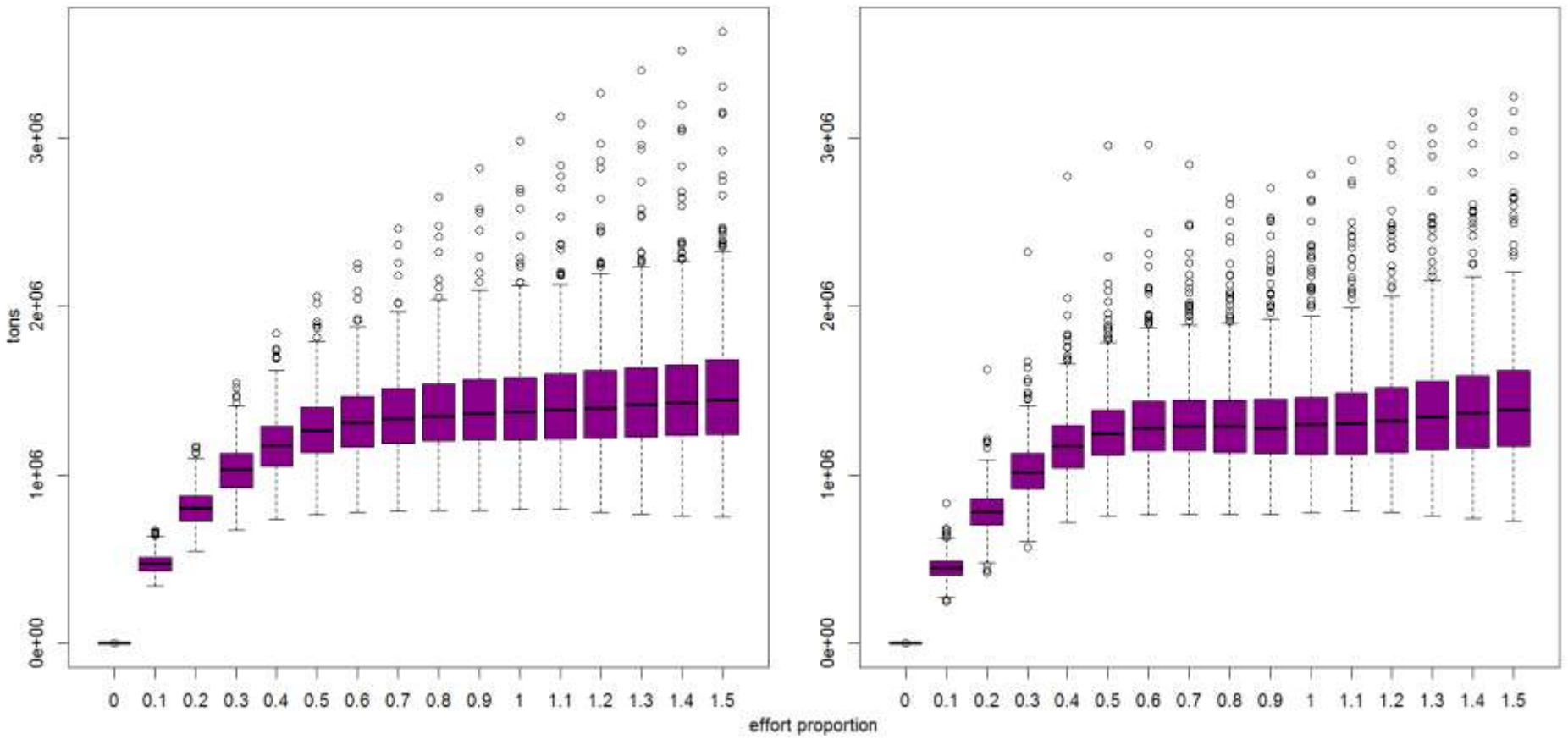
Gaichas et al. ICES JMS 2017

Possible species groupings

- Full system
- Taxonomic
- Habitat
- Taxonomic + Feeding guild
- Size based
- Fleet based
- Area based
- …

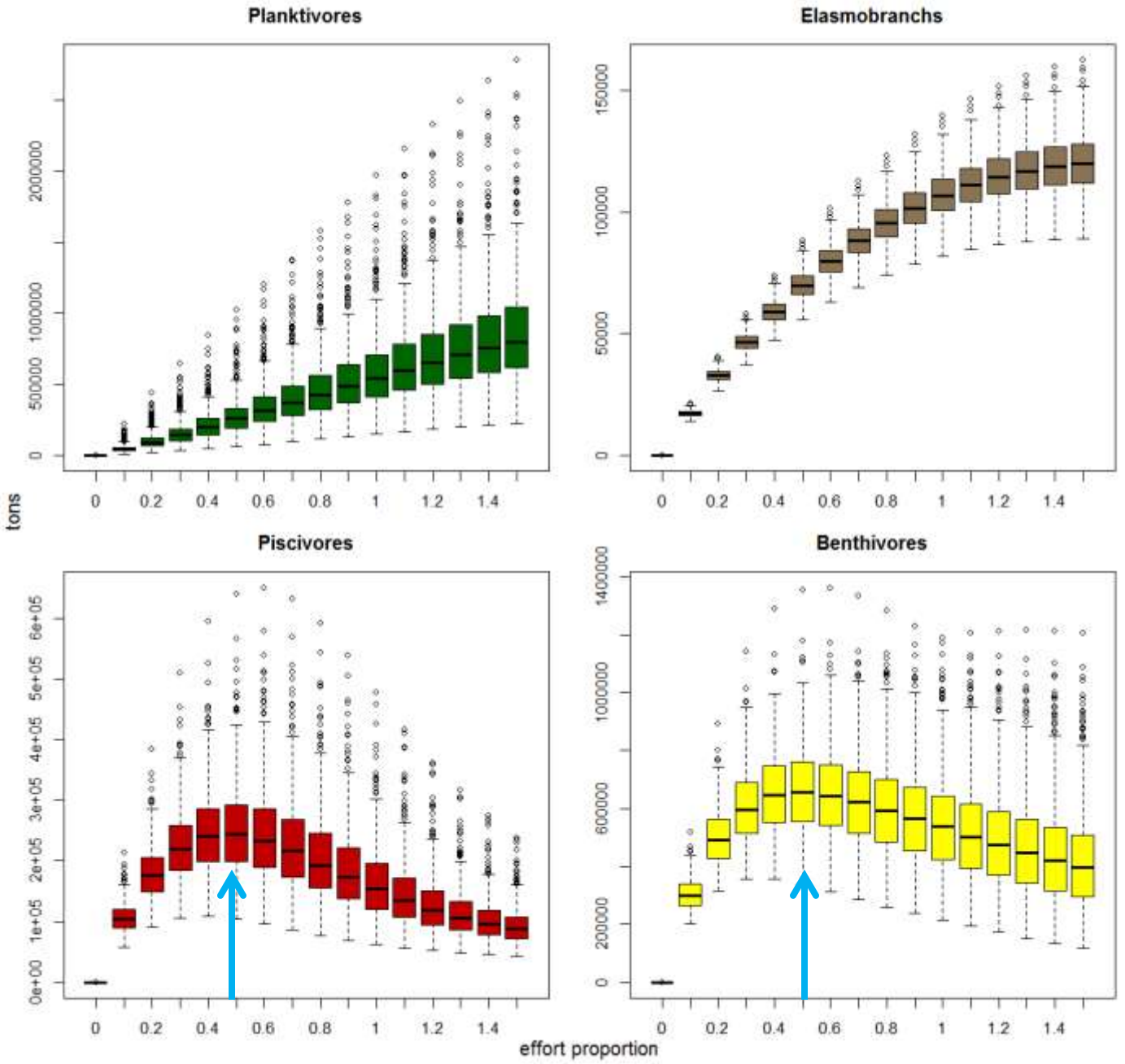
Full system yield, flat at high effort

Year 20

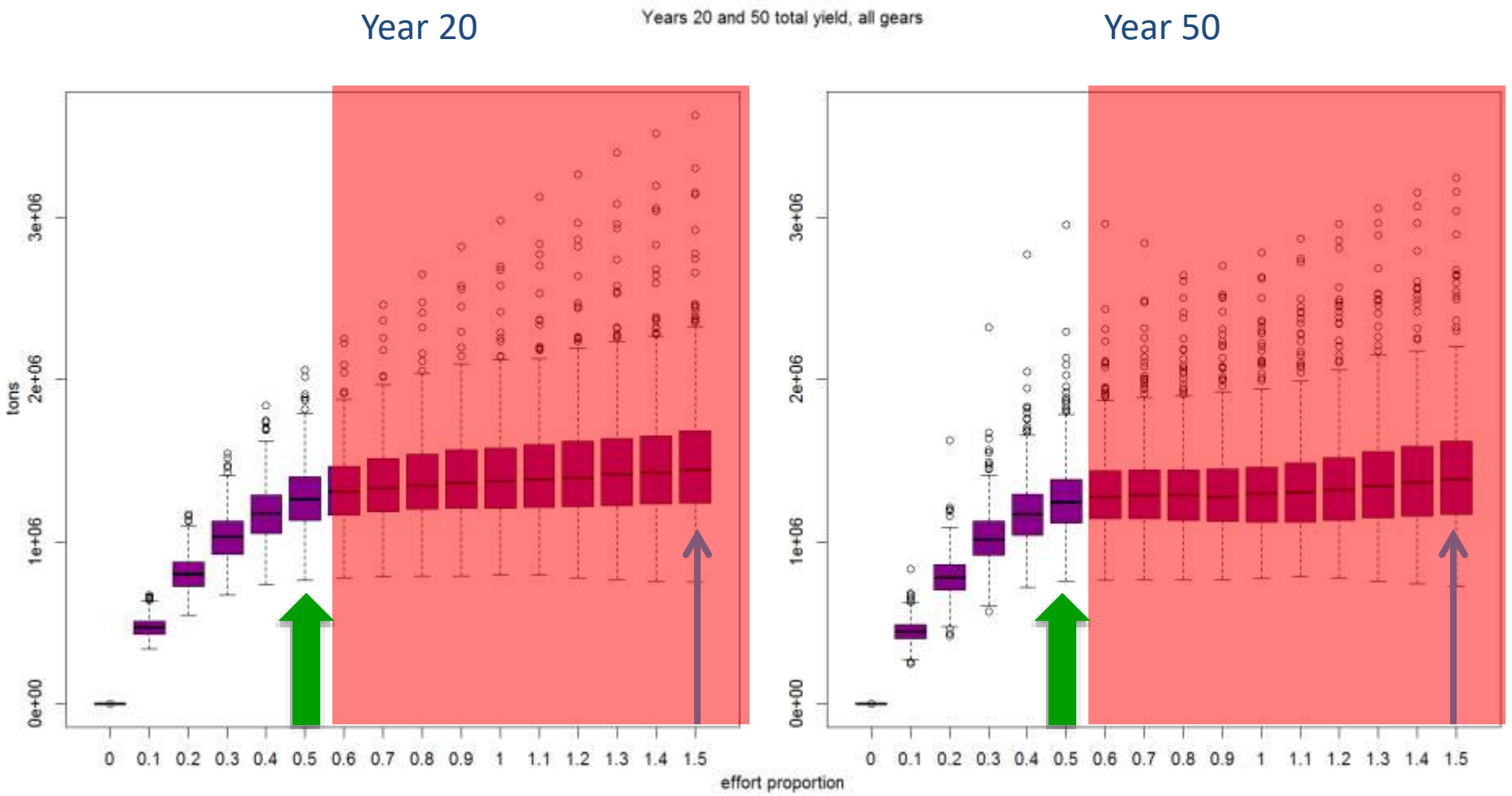


Year 50

Multispecies yield, best at moderate effort

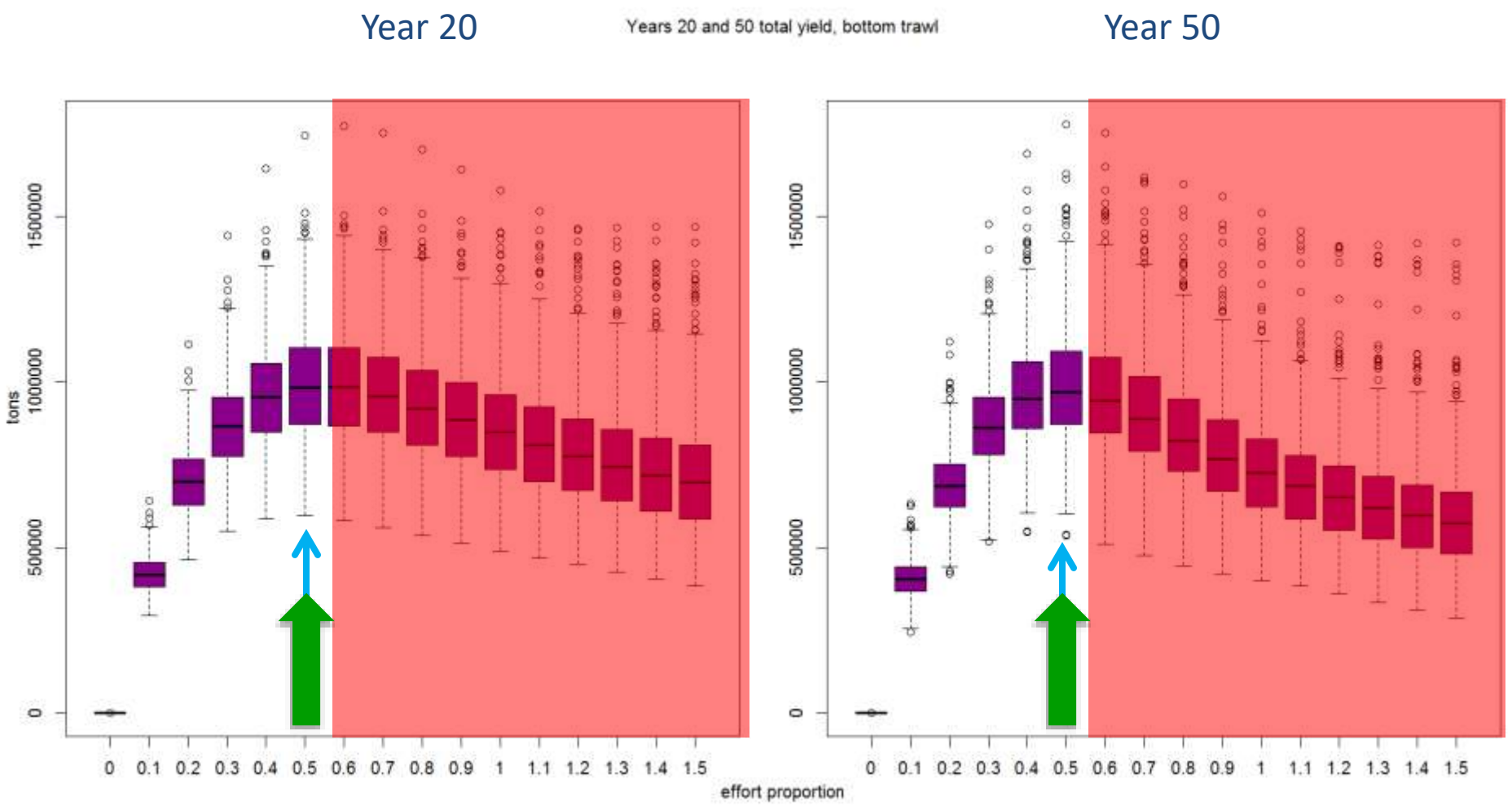


Best economic and weight yield: full system

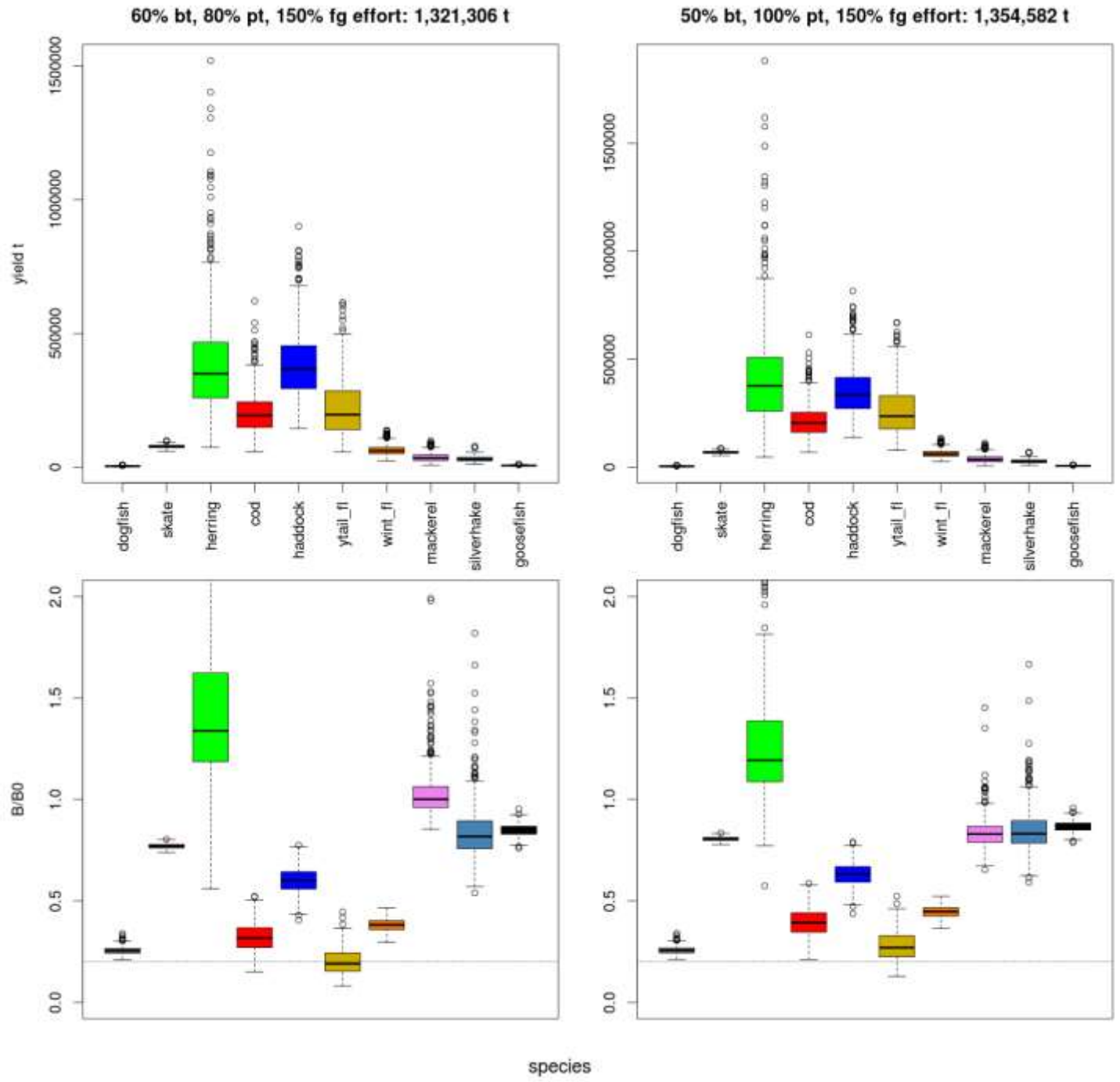


Shaded red effort levels have at least one stock below 20% of unfished level

Best economic and weight yield: trawl fleet



Shaded red effort levels have at least one stock below 20% of unfished level



Can an improved mix of gears → higher system yields?

+ ~15%

Conclusions

Species interactions and environmental signals change qualitative outcomes and yield over time

Multispecies TACs that maximize yield and conserve biomass exist, can consider economics

Community composition and (likely) value trade off across the range of fishing effort

Flexible frameworks exist for implementing EAFM


Thank you for your attention
I welcome any questions