Catch Advice Framework a Worked Example

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EBFM Committee
September 12, 2017

New England Fishery Management Council

NOAA Fisheries Definition EBFM Strategic Policy

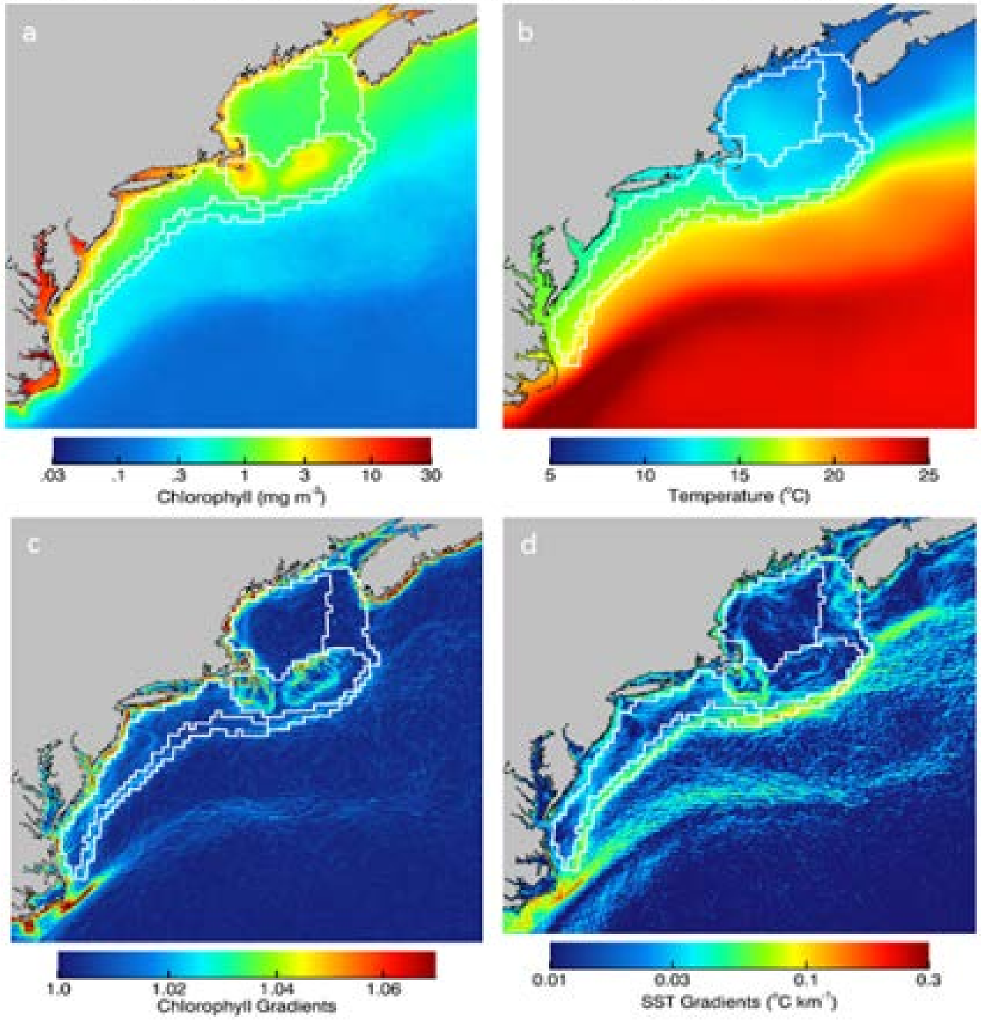
- A systematic approach
- In a geographically specified area
- That ensures resilience and sustainability of the ecosystem
- Recognizes the physical, biological, economic, and social interactions
- Among the affected components of the ecosystem, including humans

EBFM Steps

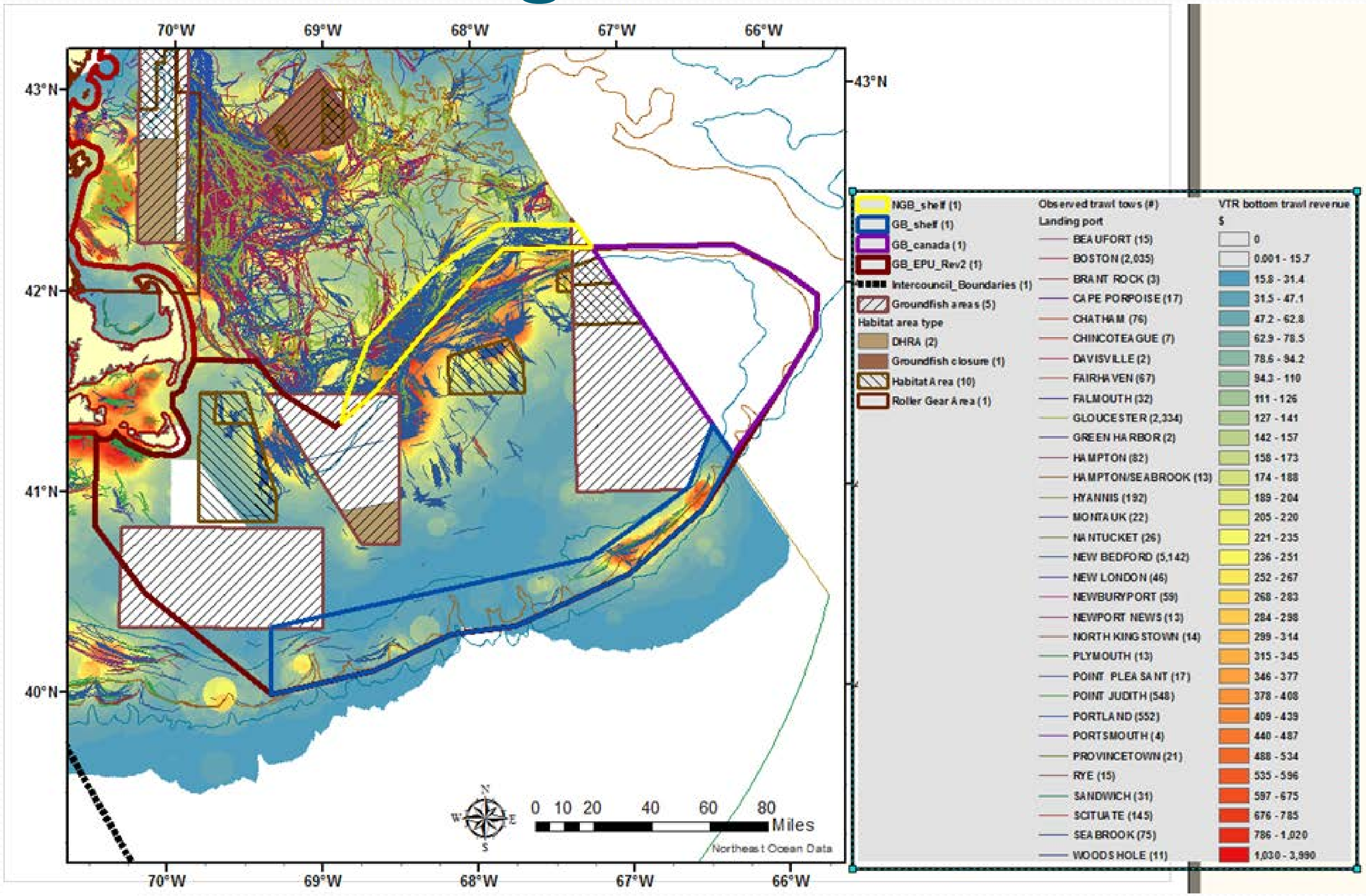
1. Specify spatial management units
2. Define stock complexes
3. Establish specific management objectives and exploitation reference points.
4. Establish biomass thresholds (floors)
5. Devise an ecosystem-based harvest control rule
6. Simulate the performance of EBMP
7. Identify and reconcile tradeoffs.

EPU identification

Figure 3. Satellite-derived maps of chlorophyll a concentration (upper left), chlorophyll gradient (lower left), Sea surface temperature (upper right) and SST gradient (lower right).

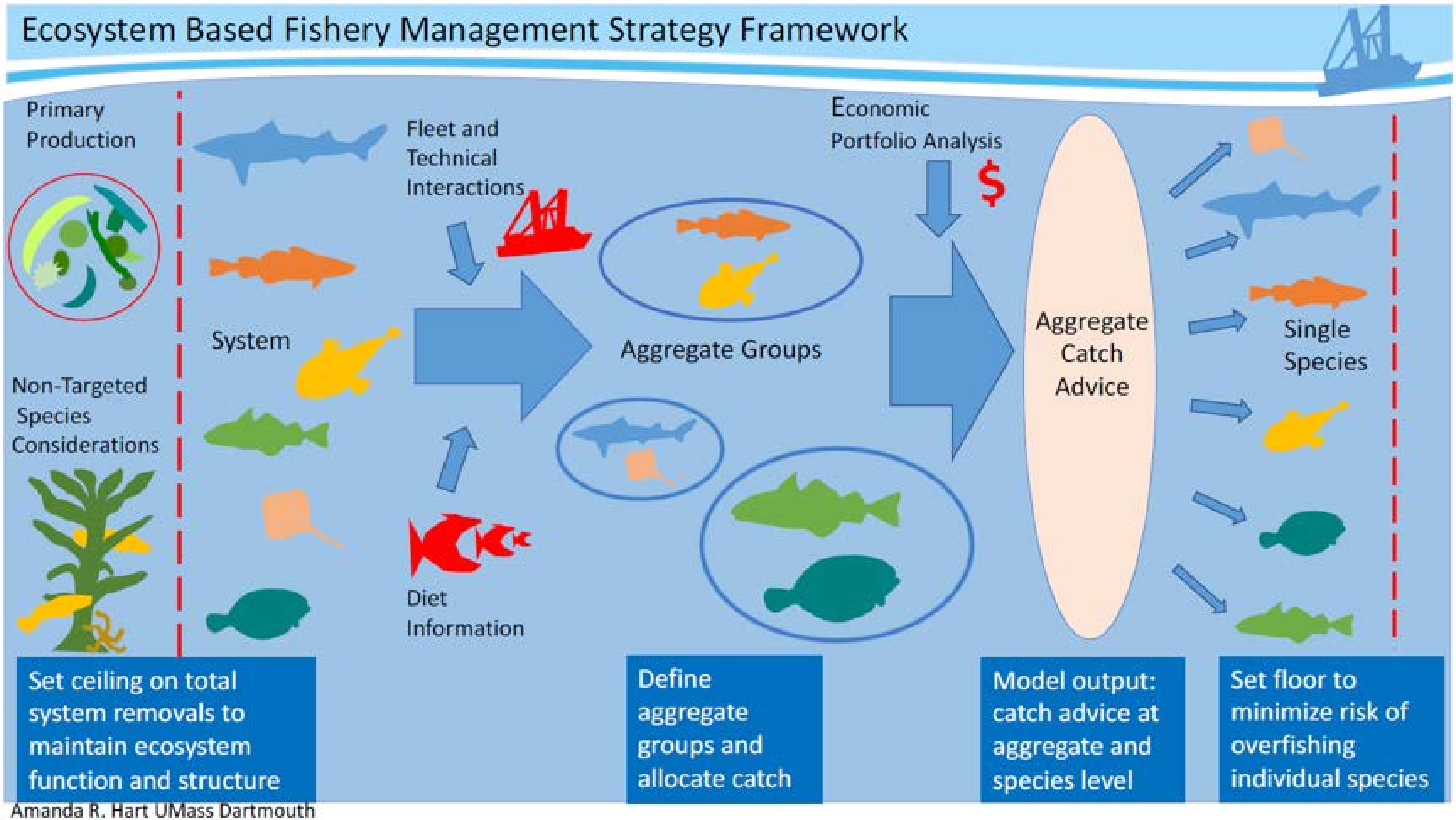


Scope – area to be included Georges Bank EPU?



EBFM Framework
Aggregate groups = stock complexes

Figure 1. Proposed catch advice framework diagram.



Scope – species/stocks Georges Bank EPU

Common Nam	Scientific Name	Management authority	FMP	PopB/Yield etc	Feeding guild	Functional Group	Trophic level	Adul bo	Primary Offshore Habitat	Preferred Depth Rang (m)	On Georges Bank?	ECS	Otter Trawl	Gillne	Longli	Pot	Sei	Dredg e
American Plaice	*Hippoglossoides platessoides*	NEFMC	NE Multispecies	1	Benthivore	Benthivore	3.7	83	Mud and sand	40-300	X		X					
Haddock	*Melanogrammus aeglefinus*	NEFMC	NE Multispecies	1	Benthivore	Benthivore	4.1	112	Sand, shells, gravel, along margins of rocky reefs	40-160	X		X	X			X	
Winter Flounder	*Pseudopleuronectes americanus*	NEFMC	NE Multispecies	1	Benthivore	Benthivore	2.8	64	Mud, sand, and hard bottom	10 to 70	X		X				X	
Yellowtail Flounder	*Limanda ferruginea*	NEFMC	NE Multispecies	1	Benthivore	Benthivore	3.2	64	Sand with and w/o shells, gravel, and rocksd	30-90	X		X				X	
Atlantic Wolffish	*Anarhicas lupus*	NEFMC	NE Multispecies	1	Benthivore	Benthivore	3.2	150	Sand and gravel, spawn in rocky habitats	70-184	?							
Little Skate	*Leucoraja erinacea*	NEFMC	NE Skate Complex	1	Benthivore	Benthivore	3.6	54	Sand and gravel	10-100	X		X	X			X	
Red Hake	*Urophycis chuss*	NEFMC	NE Small-mesh Multispecies	1	Benthivore	Benthivore	3.6	66	Soft sediments and shells	50-300	X		X				X	
Sculpin	*Myoxocephalus octodecemspinos*	NEFMC	NE Multispecies	1	Benthivore	Benthivore	3.7	46				X						
American Lobster	*Homarus americanus*	ASMFC	Lobster	1	Benthivore	Benthivore										X		
Atlantic Sea Scallop	*Placopectin magellanicus*	NEFMC	Sea Scallop	1	Suspension Feeder	Benthos	1.94		Sand and gravel	18-110	X							X
Atlantic Cod	*Gadus morhua*	NEFMC	NE Multispecies	1	Demersal Piscivore	Demersal Piscivore	4.4	200	Complex hard bottom habitats, sand and gravel	30-160	X		X	X	X		X	
Atlantic Halibut	*Hippoglossus hippoglossus*	NEFMC	NE Multispecies	1	Demersal Piscivore	Demersal Piscivore	4.5	470	Sand, gravel, or clay	60-140, also on slope	X				X			
Barndoor Skate	*Dipturus laevis*	NEFMC	NE Skate Complex	1	Benthivore-Piscivore	Demersal Piscivore		152	Mud, sand, and gravel	40-400	X	X	X					
Fourspot Flounder	*Hippoglossina oblonga*	Unmanaged	NA	1	Demersal Piscivore	Demersal Piscivore		41				X						
Monkfish	*Lophius americanus*	NEFMC/MAFMC	Monkfish	1	Demersal Piscivore	Demersal Piscivore	4.45	120	Variety of habitats, prefer soft sediments	50-400	X		X	X			X	X
Offshore Hake	*Merluccius albidus*	NEFMC	NE Small-mesh Multispecies	1	Demersal Piscivore	Demersal Piscivore	4.3	41	?	160-500	X		X					
Silver Hake	*Merluccius bilinearis*	NEFMC	NE Small-mesh Multispecies	1	Demersal Piscivore	Demersal Piscivore	4.3	76	Sand	40-400	X		X		X		X	
Spiny Dogfish	*Squalus acanthias*	MAFMC/NEFMC	NE Skate Complex	1	Demersal Piscivore	Demersal Piscivore	4.3	160		20-300	X			X	X			
Summer Flounder	*Paralichthys dentatus*	MAFMC/ASMFC	Summer Flounder, Scup, and Black Sea Bass	1	Demersal Piscivore	Demersal Piscivore	4.5	94			X		X	X	X			
Bluefin Tuna	*Thunnus thynnus*	NMFS-SFD	HMS	1	Large Pelagic Piscivore	Piscivore Pelagic			Pelagic						X			
Swordfish	*Xiphias gladius*	NMFS-SFD	HMS	1	Large Pelagic Piscivore	Piscivore Pelagic			Pelagic						X			
Shortfin squid	*Illex illecebrosus*	MAFMC	Mackerel, Squid, and Butterfish	1	Piscivore Pelagic	Piscivore Pelagic	3.33		Pelagic	70-400	X							
Pollock	*Pollachius virens*	NEFMC	NE Multispecies	1	Planktivore-Piscivore	Planktivore	4.4	130	Over rocky substrates	80-300	X		X	X				
Atlantic Herring	*Clupea harengus*	NEFMC/ASMFC	Herring	1	Planktivore	Planktivore	3.2	45	Pelagic	60-140	X		X				X	
Atlantic Mackerel	*Scomber scombrus*	MAFMC	Mackerel, Squid, and Butterfish	1	Planktivore	Planktivore	3.7	60	Pelagic				X				X	
Acadian Redfish Blackbelly	*Sebastes fasciatus*	NEFMC	NE Multispecies	1	Planktivore-Piscivore	Planktivore	4	30	Soft sediments, gravel, and rocky habitats	100-300	X		X	X				

Functional groups

Table 2. Catchability-adjusted average biomass for the Georges Bank EPU derived from spring and fall trawl surveys, categorized by feeding guild (columns) and functional group (rows representing technical interactions).

Functional group	Value Total biomass, '000 mt # of Species	Feeding guild										
		Apex Predator	Benthivore	Benthos	Macro-planktivore	Macrozoo-piscivore	Meso-planktivore	Piscivore	Planktivore	Planktivore-Piscivore	Small Shark	Total
Bottom trawl	Biomass				34.3			569.1		0.0		
	Species		10		4	7		10		1		32
Mid-water Trawl	Biomass								62.2			
	Species						5		2			7
Sink gillnets	Biomass				0.3	68.3		553.1		0.0		
	Species		2		2	2		6		1		13
Drift gillnets	Biomass											
	Species	1										1
Bottom longline	Biomass				0.3			411.0				
	Species		1		2	2		5				10
Drift longline	Biomass											
	Species	3										3
Pot	Biomass											
	Species		11									11
Seine	Biomass		949.3		5.3	83.0		26.6	50.8			
	Species		3		1	3	4	3	1			15
Dredge	Biomass							1.2				
	Species		2	4				1				7
Demersal recreational	Biomass				10.8			569.1		0.0		
	Species		12		4	6		10		1		33
Pelagic recreational	Biomass							5.6	50.8			
	Species	4						1	1			6
P. species consumption	Biomass				30.3							
	Species				2		4					6

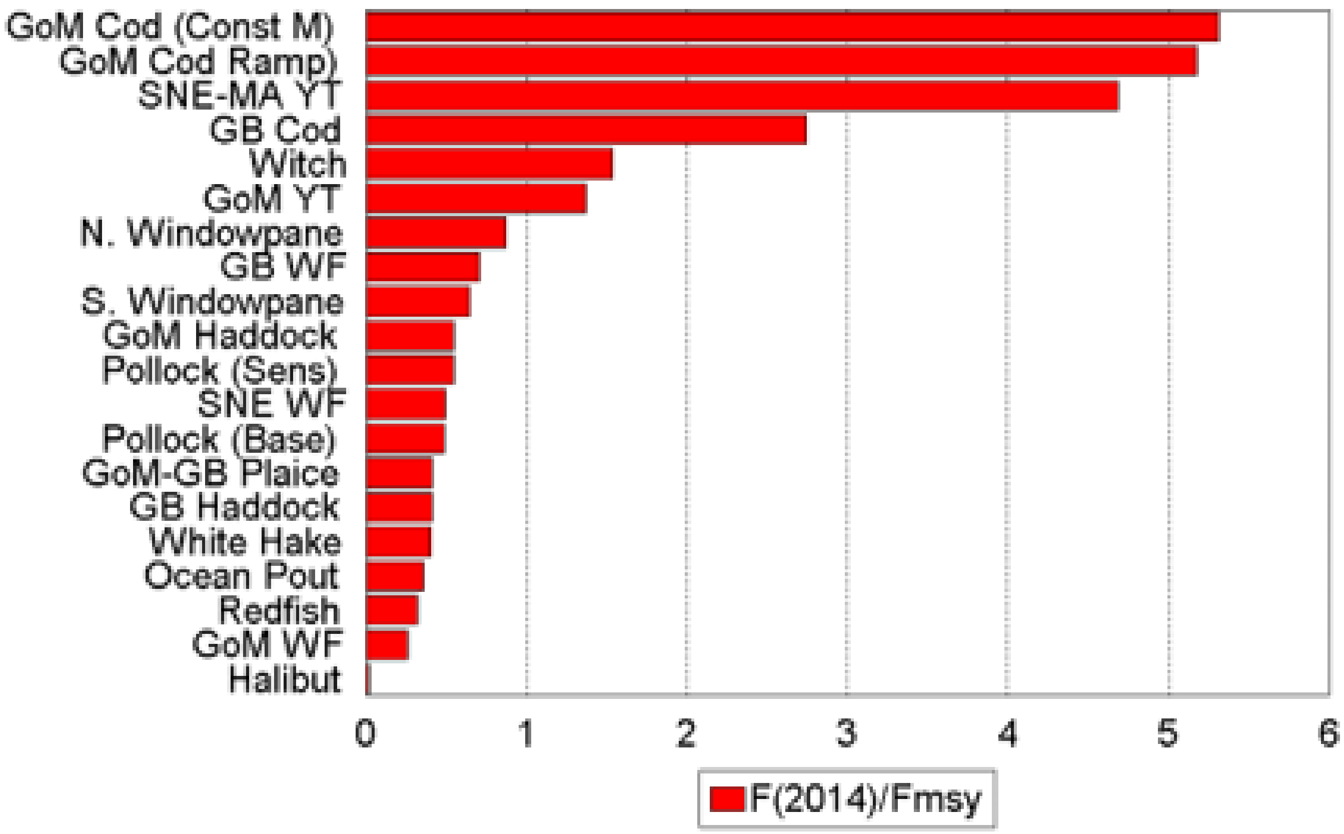
Functional group	Value Total biomass, '000 mt # of Species	Feeding guild										
		Apex Predator	Benthivore	Benthos	Macro-planktivore	Macrozoo-piscivore	Meso-planktivore	Piscivore	Planktivore	Planktivore-Piscivore	Small Shark	Total
Ecosystem component	Biomass							34.5				
	Species	1	9	1	3	3		4	1			22

NEFMC Managed Species

Figure 2. NEFMC-managed species. This update report focuses on the major fish species in the multispecies groundfish, spiny dogfish, small mesh (hake), skate, monkfish, and herring management plans

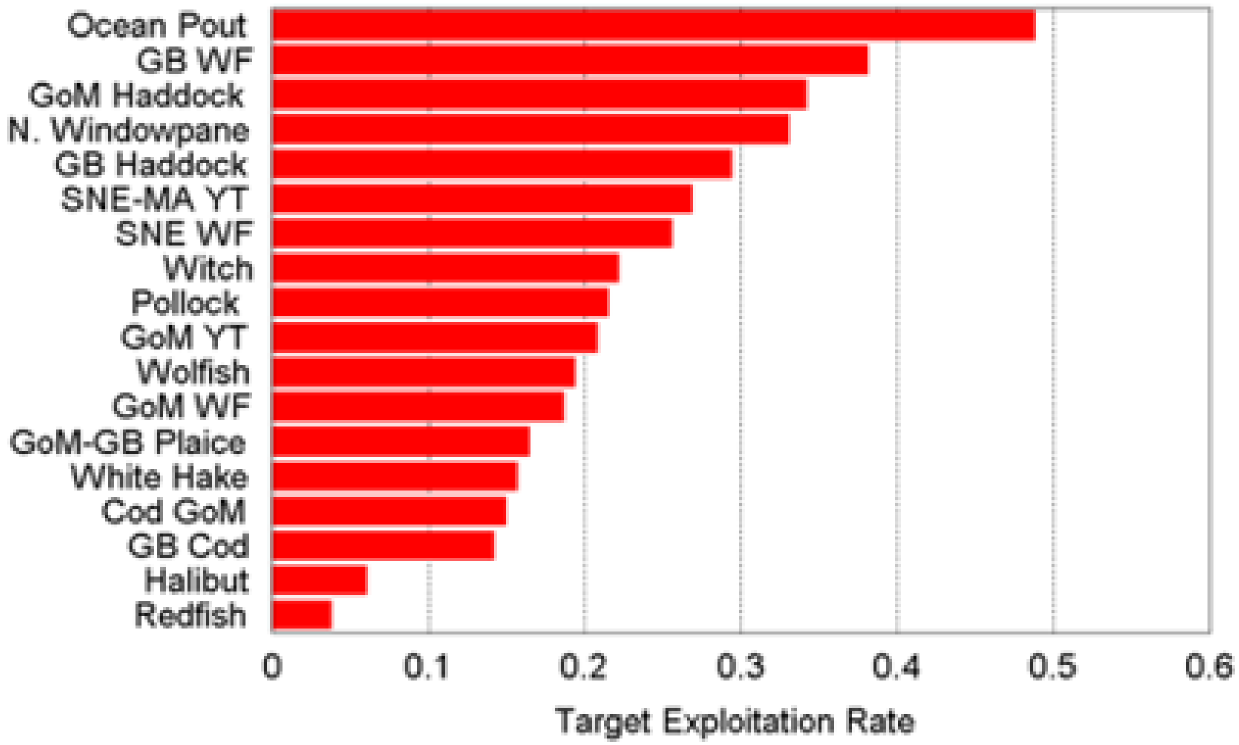
Recent Fishing Mortality

Figure 6. Ratio of the estimated fishing mortality rate in 2014 to the target (F_{msy}) fishing mortality rate in recent operational assessments for groundfish species (NEFSC 2015).



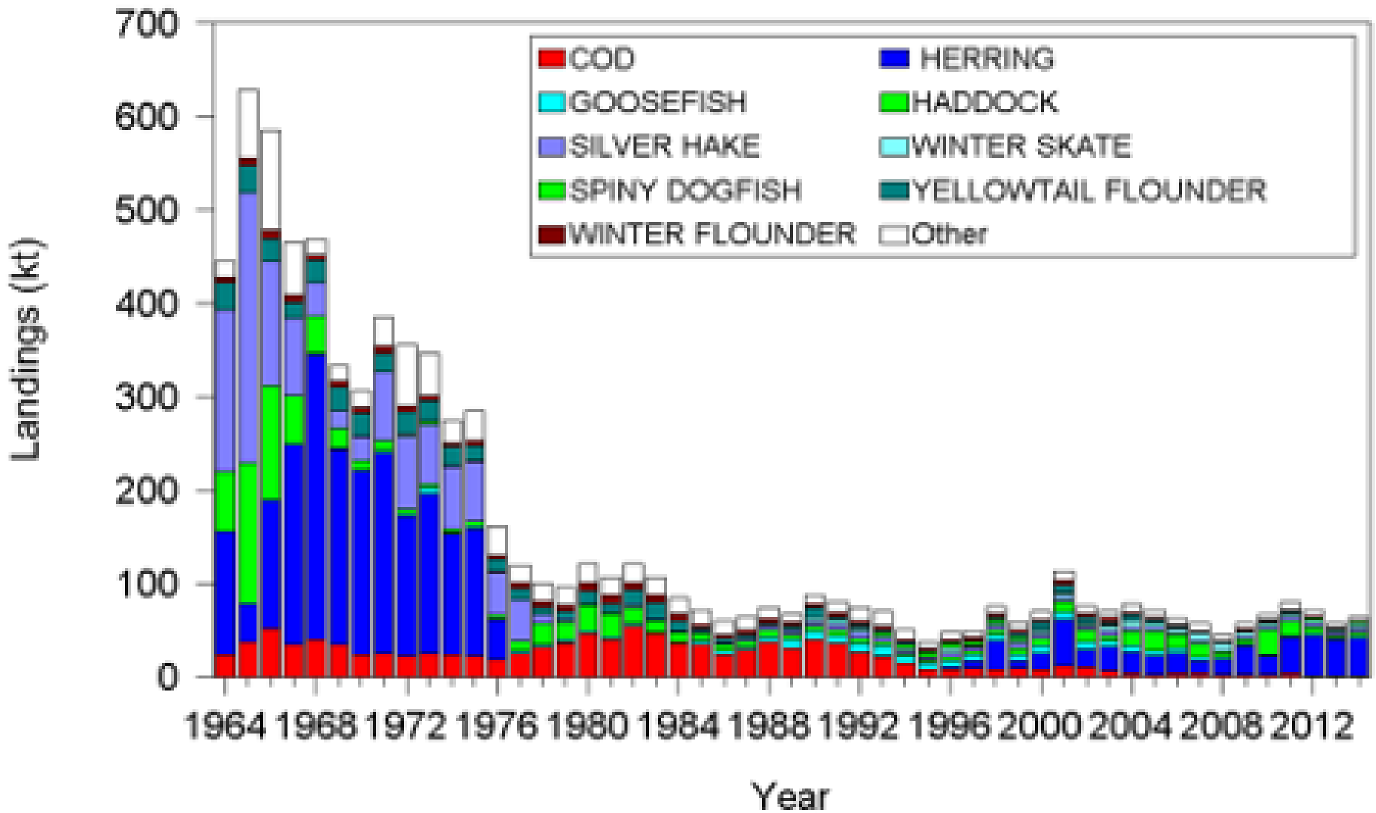
Status Quo Target Exploitation

Figure 7. Target exploitation rate for groundfish species in recent operational assessments or groundfish species (NEFSC 2015). We have converted target Fmsy levels to annual exploitation rates based on natural mortality rates

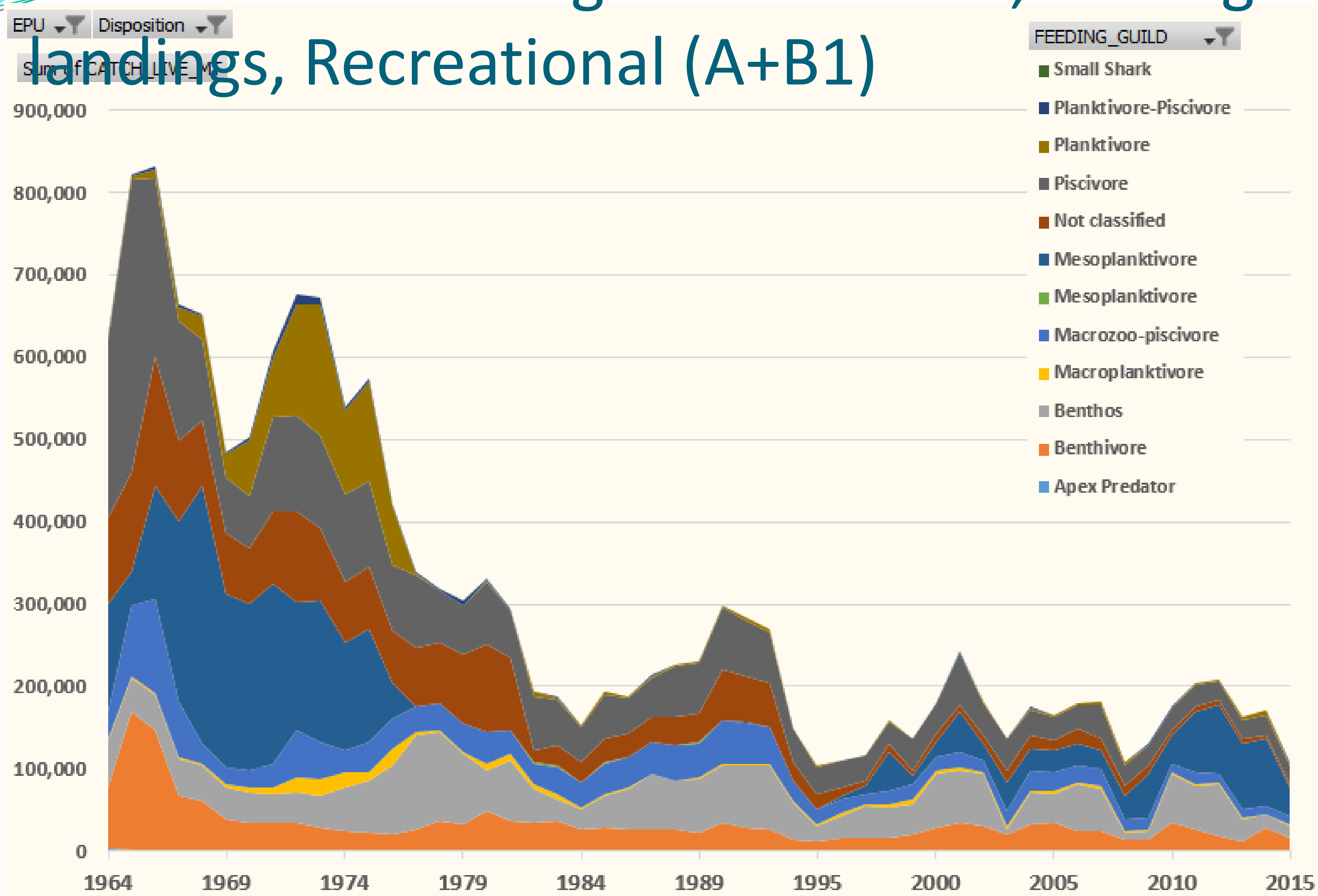


Georges Bank Landings

Figure 8. Landings of NEFMC-managed fish species included in the Hydra simulations and other fish species also managed by NEFMC

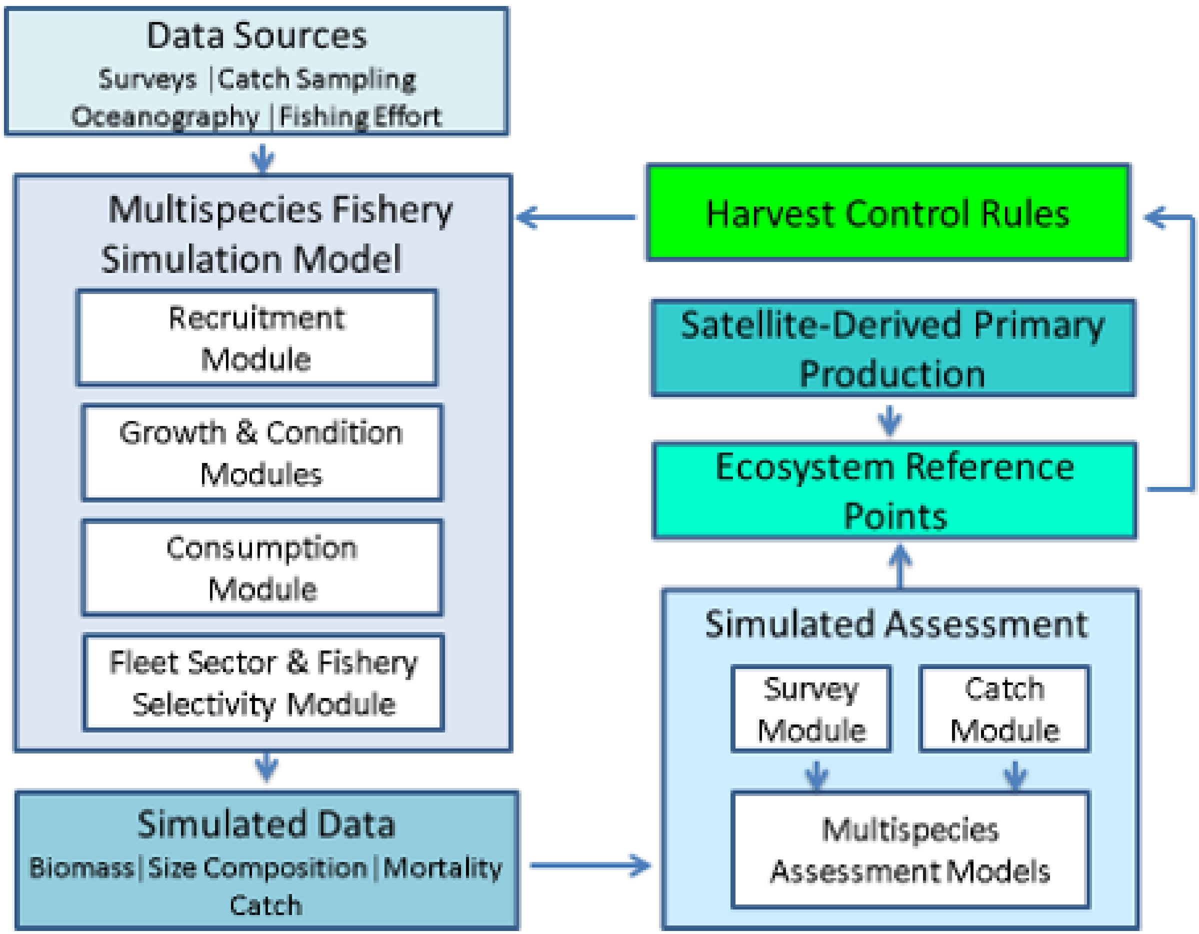


Georges Bank catch (mt) by Feeding guild: Commercial landings and discards, herring landings, Recreational (A+B1)



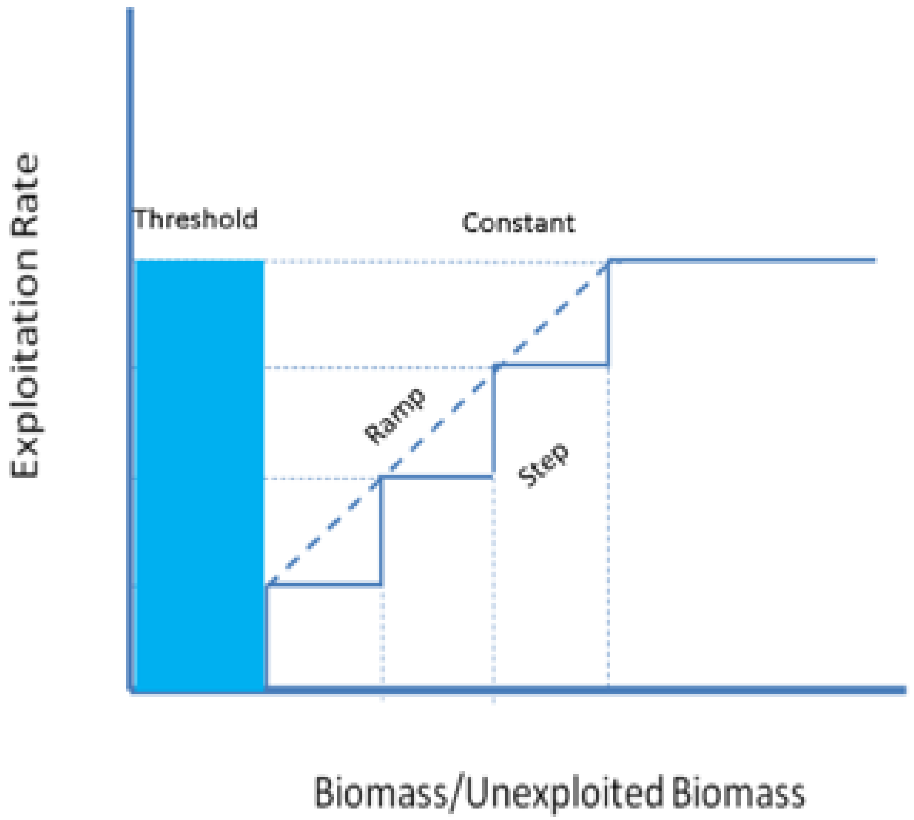
Testing management procedures

Figure 9. Components of the simulation model used to test management procedures in Hydra



Harvest Control Rules

Figure 10.. Structure of the ecosystem-based harvest control rules tested. Overfishing is determined at the species complex level. Overfished status is determined at the species complex or individual species levels (see details in Table 1).



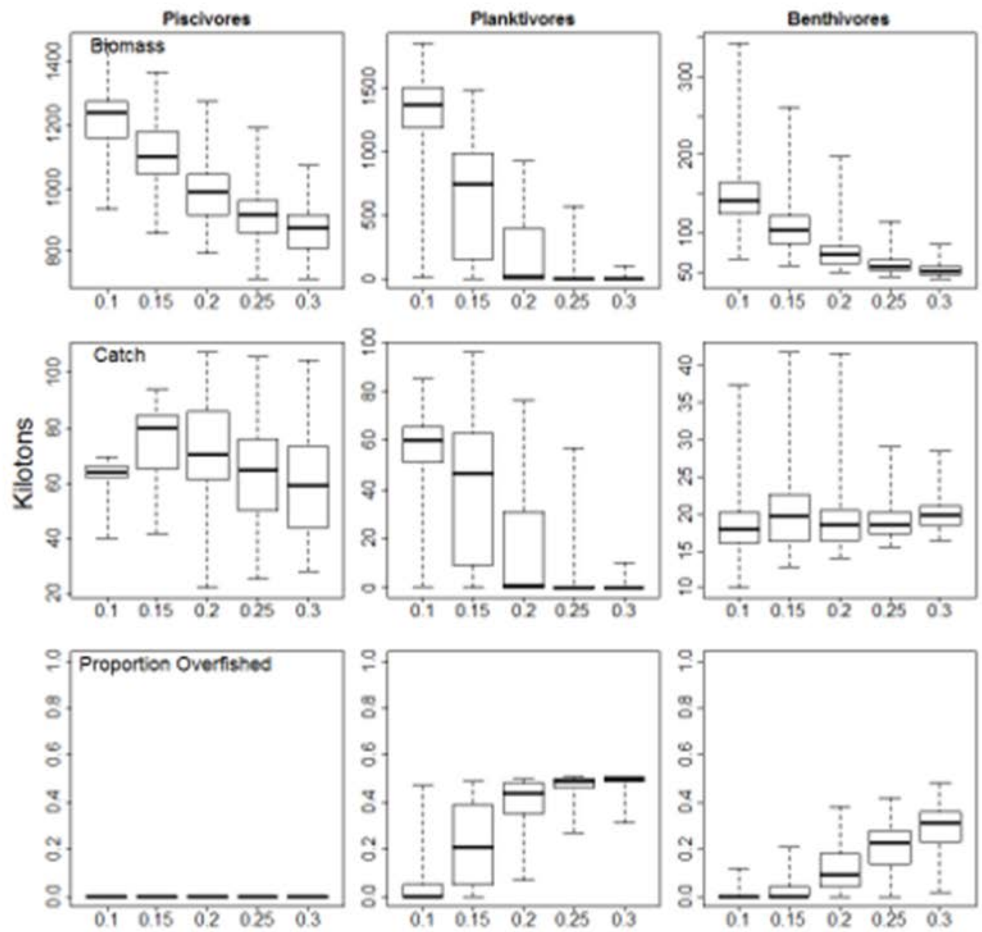
Worked examples of potential HCRs

1. Threshold exploitation (no ramp down) at Ex=0.15, 0.2, 0.25, 0.3 and Floor=0.2 of unfished biomass applied at the species complex level
2. Threshold exploitation (no ramp down) at Ex= 0.15, 0.2, 0.25, 0.3 and Floor=0.2 of unfished biomass applied at the individual species level
3. Threshold exploitation (no ramp down) at Ex= 0.15, 0.2, 0.25, 0.3 and Floor=0.2 of unfished biomass for each species except winter skate and dogfish (Floor=0.3 of unfished biomass) applied at the individual species level
4. Ramp-down exploitation using 'steps' at Ex=0.15, 0.2, 0.25, 0.3 and Starting at B/Bo = 0.4 applied at the species complex level
5. Ramp-down exploitation using 'steps' at Ex=0.15, 0.2, 0.25, 0.3 and Starting at B/Bo = 0.4 applied at the individual species level
6. Ramp-down exploitation using 'steps' at Ex=0.15, 0.2, 0.25, 0.3 and Starting at B/Bo = 0.5 applied at the individual species level for winter skate and dogfish

Scenario 1
Fixed exploitation

- Catch, biomass, and proportion overfished
- Fixed exploitation for all biomass levels

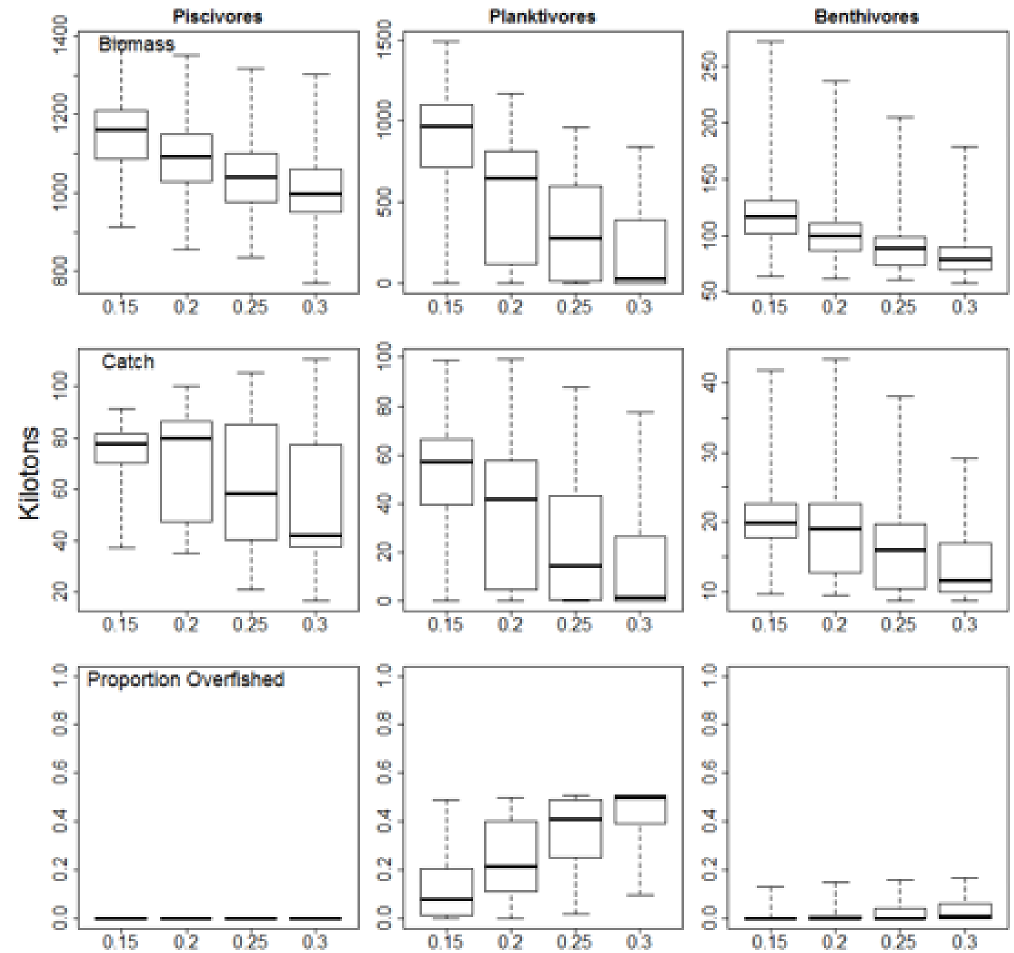
Figure 11. Scenario 1 (fixed exploitation) box plots for biomass, catch, and exploitation status by species complex aggregated over all gear types. Values on the X-axis represent the exploitation rate applied to the stock complex.



Scenario 4
Ramp applied to depleted stock complex

- Exploitation reduced for guilds
- Threshold: Stock complex biomass < 40% of unexploited state
- Floor, no landings: Stock biomass biomass < 20% of unexploited

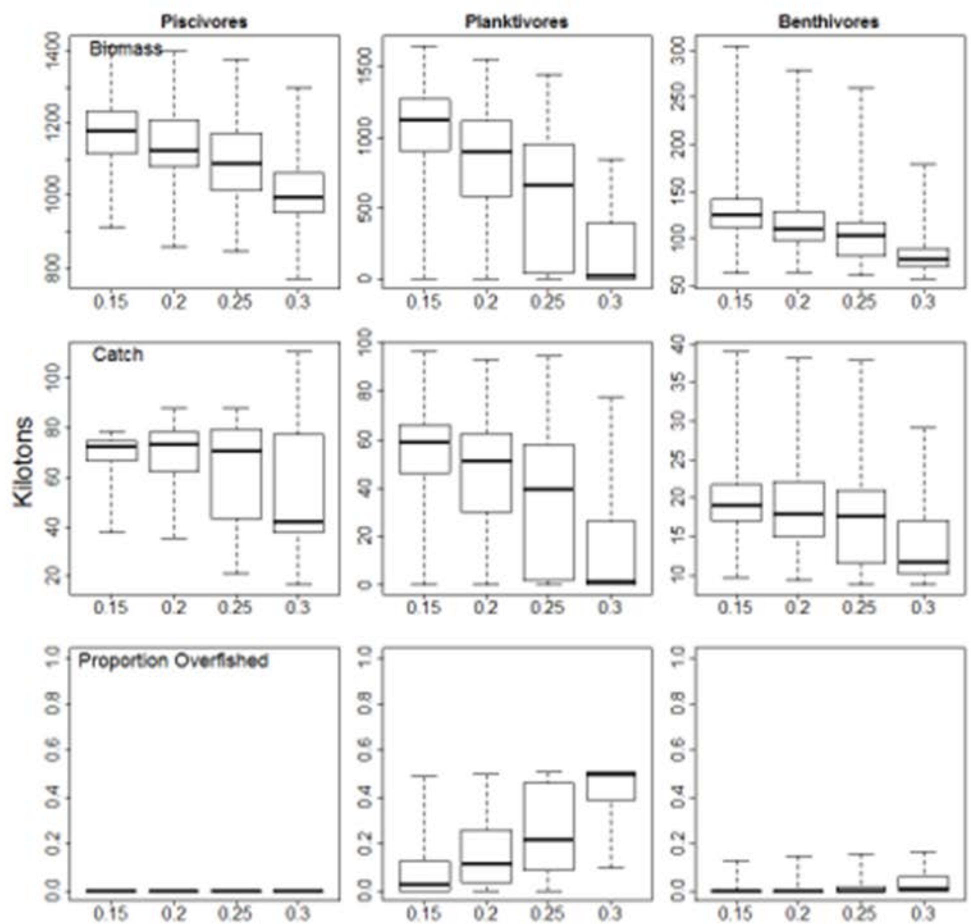
Figure 12. Scenario 4 (ramped exploitation below 0.4 B_0) box plots for biomass, catch, and exploitation status by species complex aggregated over all gear types Values on the X-axis represent the exploitation rate applied to the stock complex.



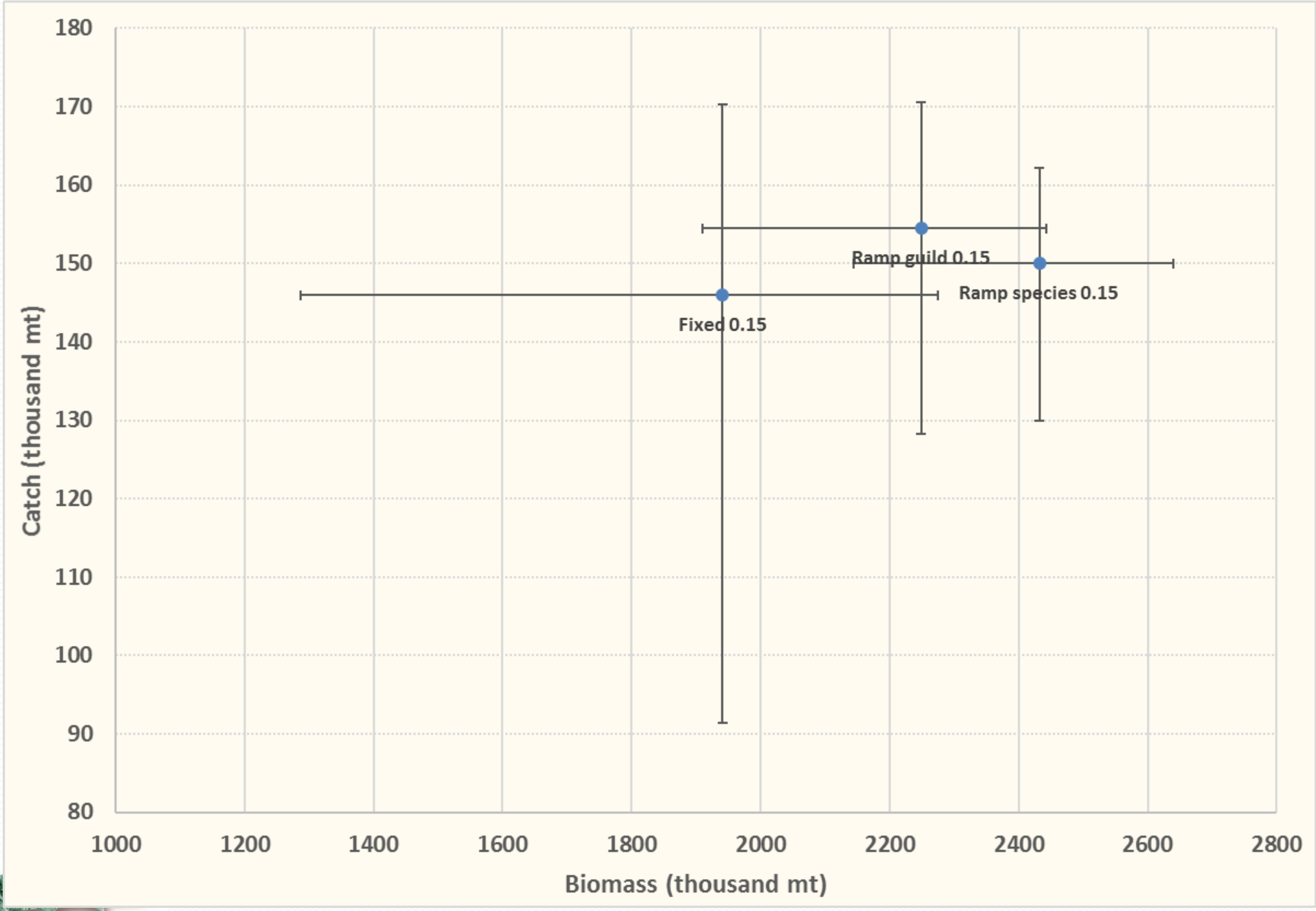
Scenario 5
Ramp applied to depleted species

- Exploitation reduced for species
- Threshold: Species biomass < 40% of unexploited state
- Floor, no landings: Species biomass < 20% of unexploited state

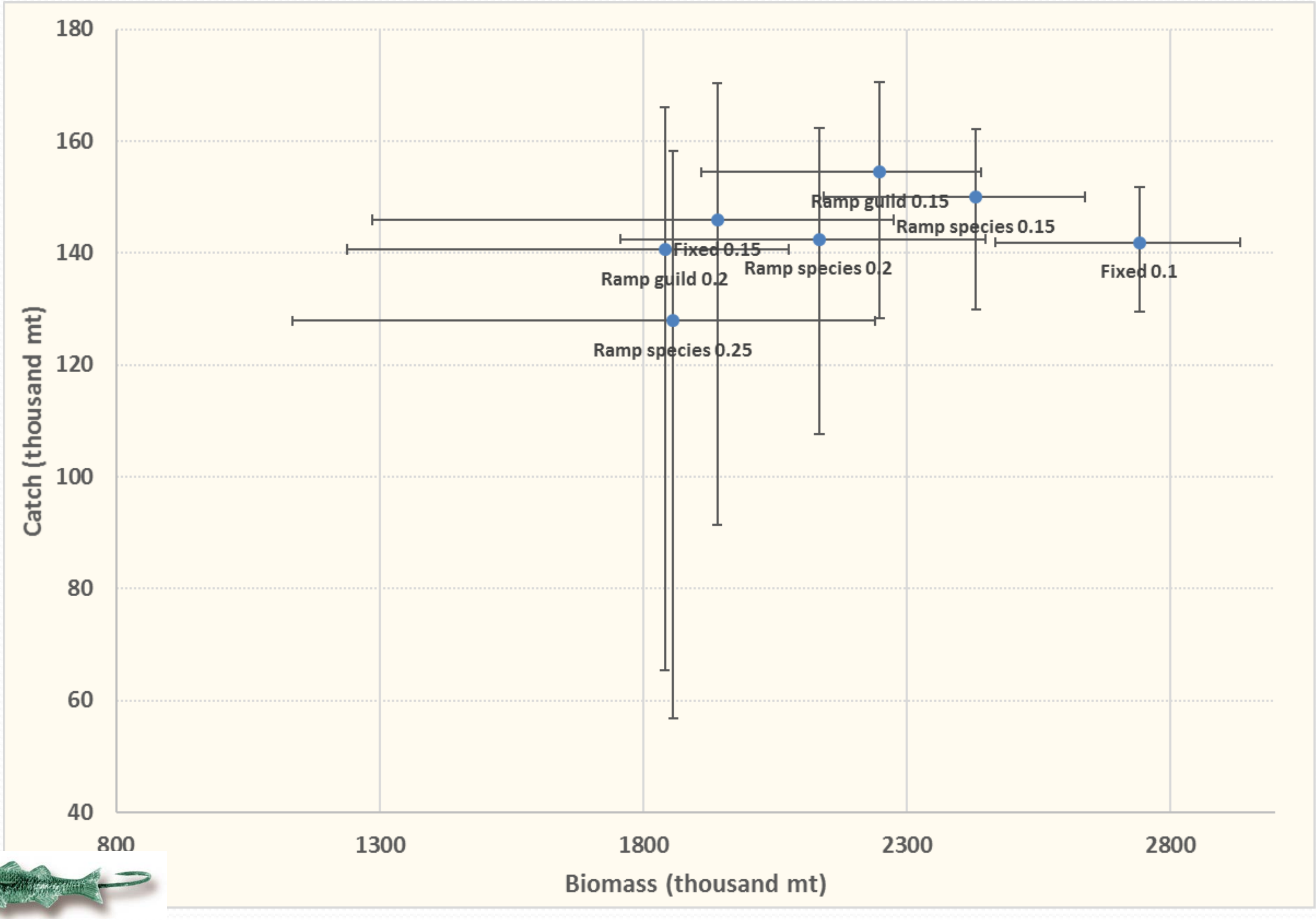
Figure 13. Scenario 5 (ramped exploitation for individual stocks below 0.4 B_0) box plots for biomass, catch, and exploitation status by species complex aggregated over all gear types. Values on the X-axis represent the exploitation rate applied to the stock complex.



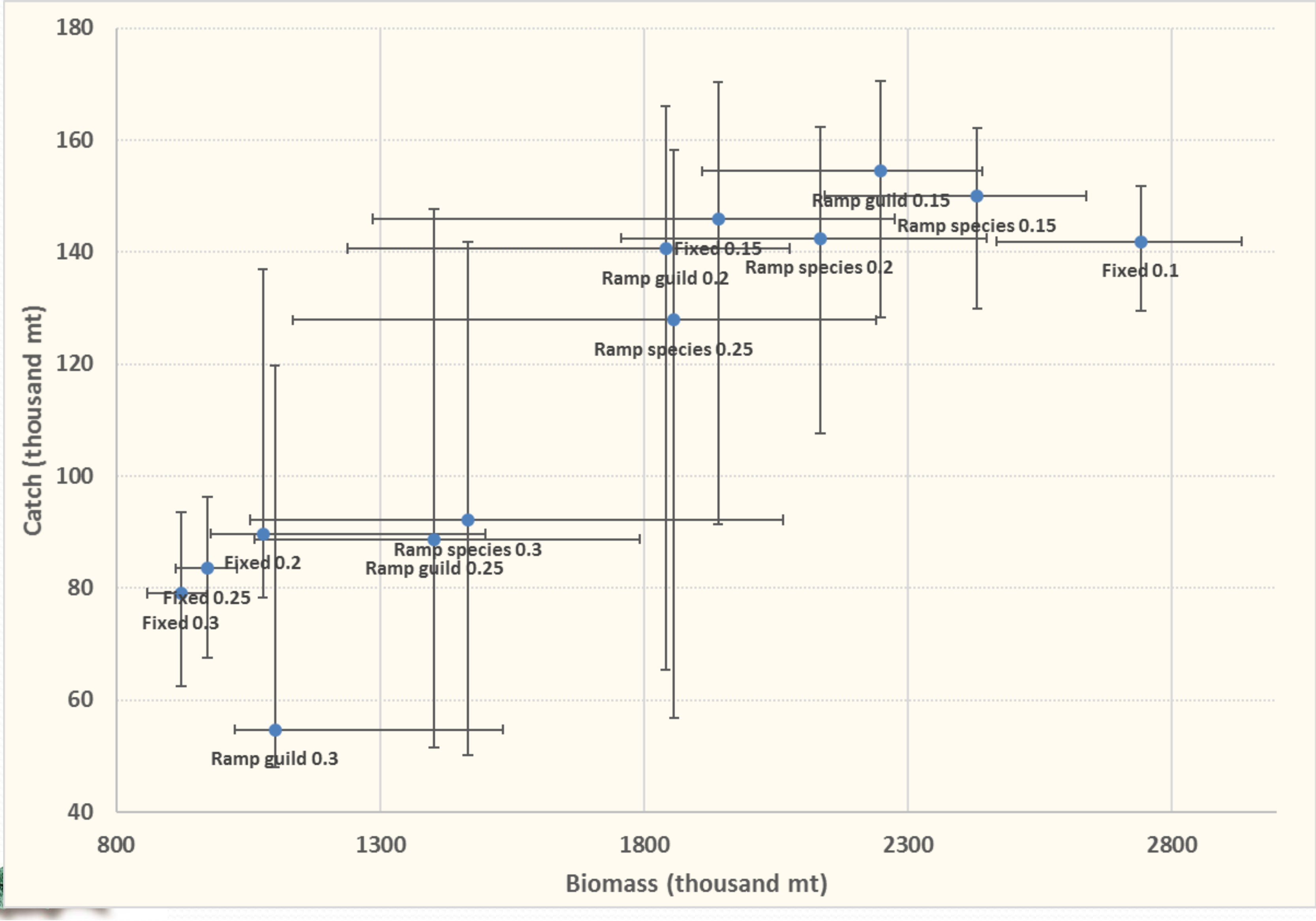
Catch biomass comparisons



Catch biomass comparisons



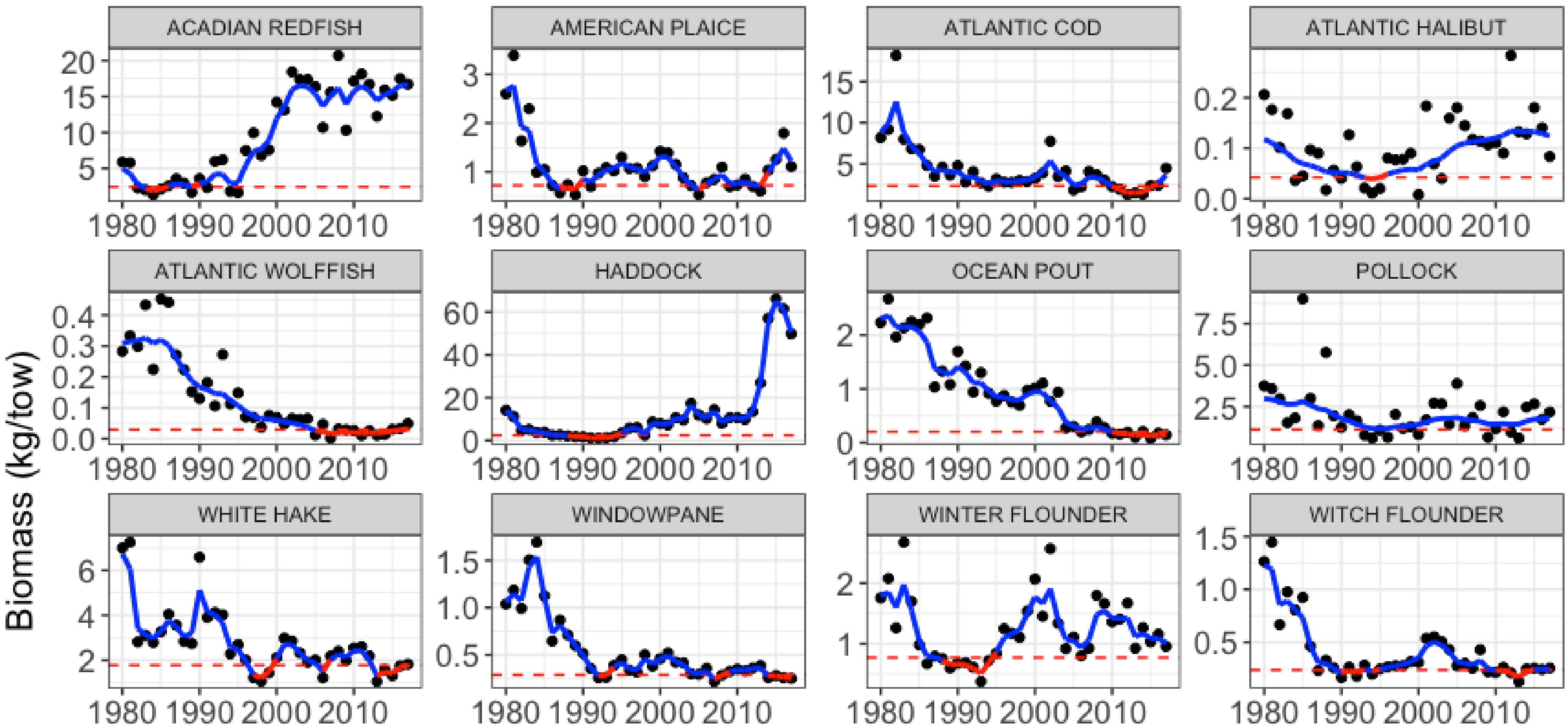
Catch biomass comparisons



Catch advice framework

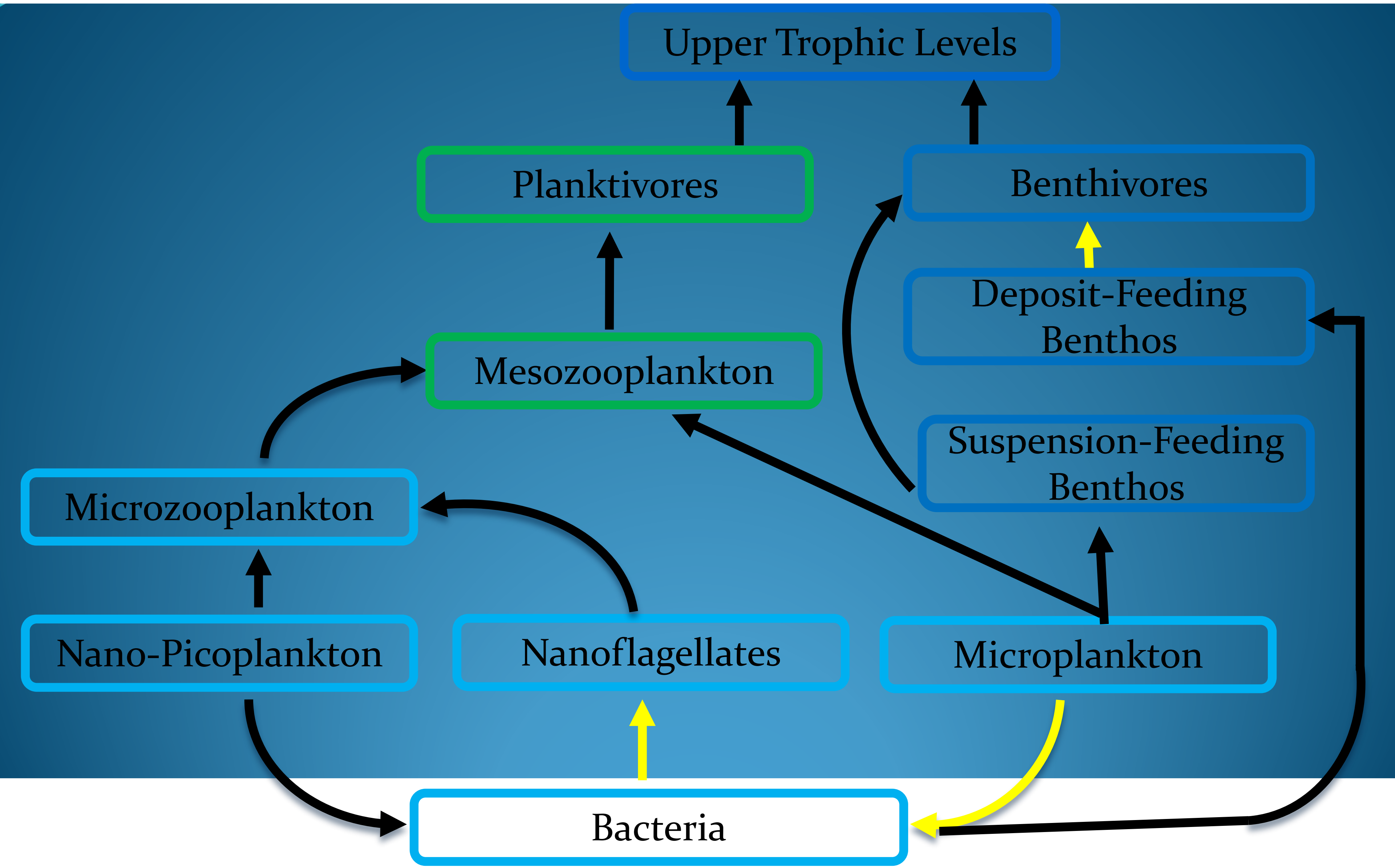
1) Species complex exploitation from simulation and tradeoff analyses
2) Current biomass of managed species determined from expanded survey data or multispecies assessment results
3) Apply exploitation rate to above; group target catches by stock complex to set catch limits
4) Aggregate amount is the ecosystem catch cap

Historic biomass estimates

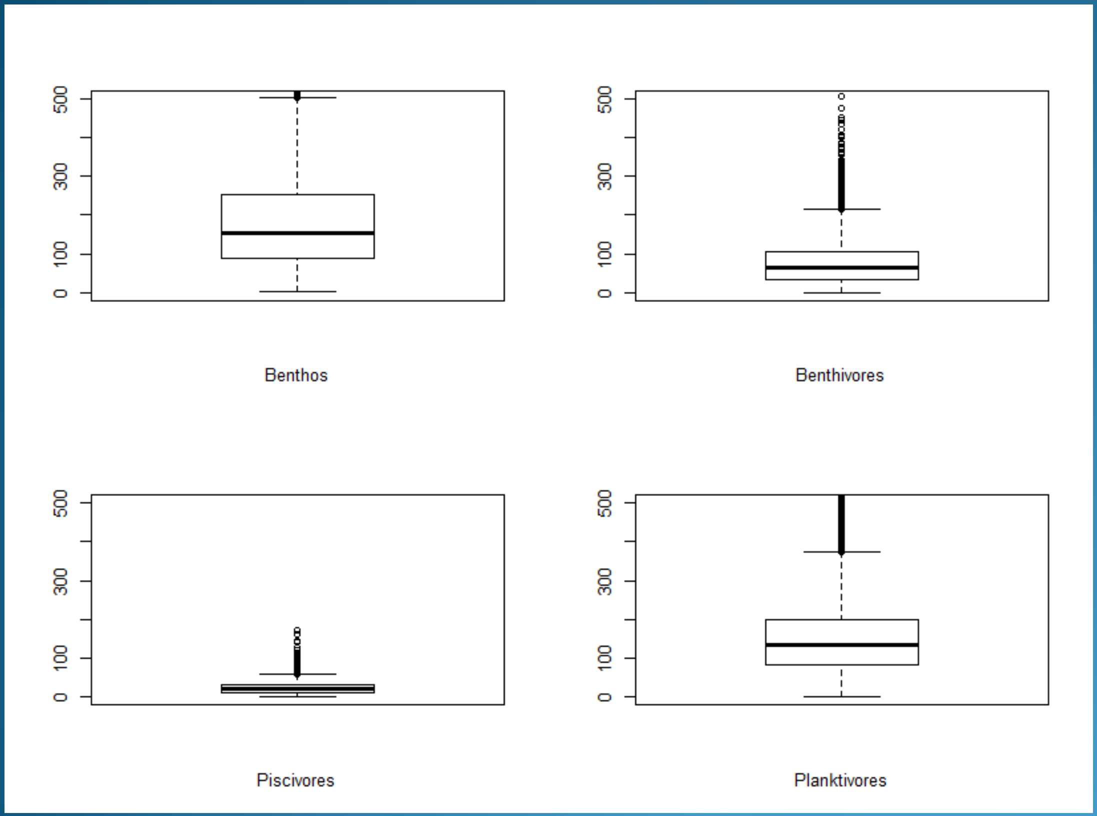


Smooth research vessel survey estimates using Kalman filter
Species classified as depleted when below 20% percentile

Other broad scale models
Production Potential



Back to the Real World:
Fishery Production *Potential* by stock complex



Median Production Potential for Bivalves ~ 20kt (Live Weight)

Median Production Potential all others ~ 220kt (Live Weight) [~160kt for currently Exploited species]

Exploitation Rate= 0.2 for each stock complex
Production Potential includes all size classes and species

Performance metrics Punt et al. 2016

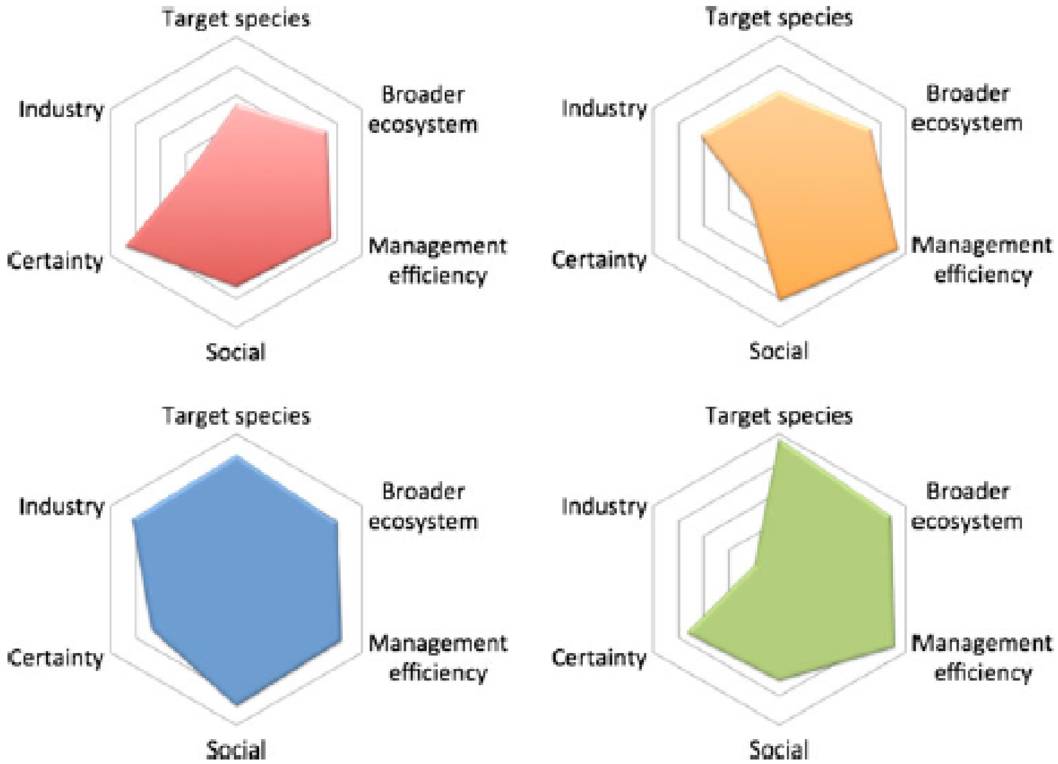
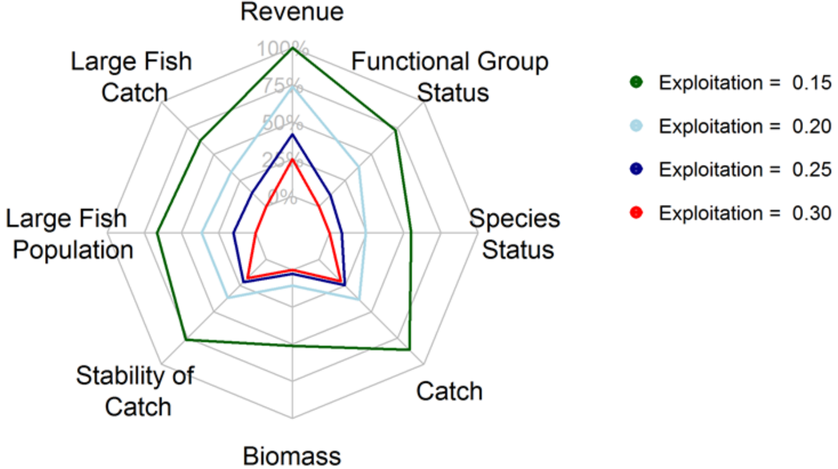


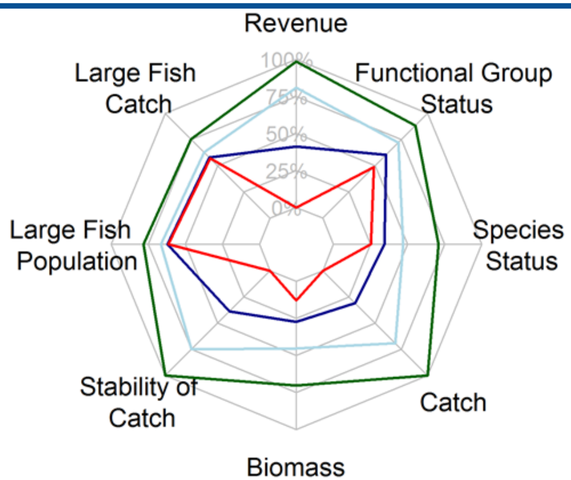
Figure 5 Example of plots which qualitatively compare four management strategies across six general areas of mean performance for a large multisector, multispecies fishery in southeastern Australia (E. Fulton, CSIRO, personal communication). A better result for a performance statistic is indicated by a vertex which is further from the centre of each hexagon.

Performance metrics

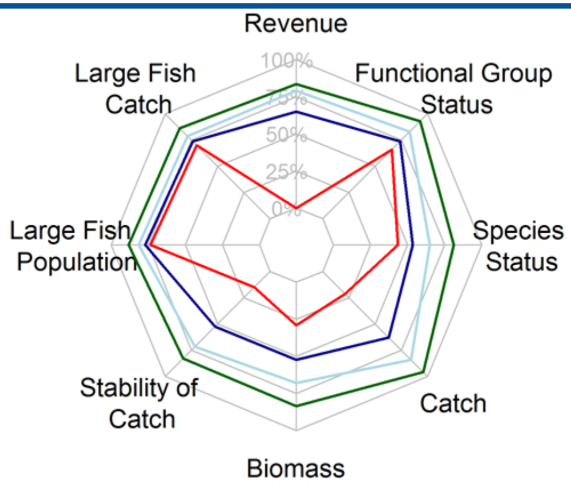
Fixed Exploitation



Ramp by species complex



Ramp by species



eFEP Development

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September 12, 2017

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Fishery Management Council

NEFMC Process

Don’t design solution without understanding the problem

- Phase I – decide on application
- Phase II – develop example Fishery Ecosytem Plan (eFEP)
- Phase III – testing, verification, engage public (scoping)
- Phase IV – develop alternatives for final FEP
- Phase V – implement and make adjustments

NEFMC Approach

- To prepare:

1. A policy describing goals and objectives, and approaches, for taking account of ecosystem processes in fishery management, and
2. An example of a fishery ecosystem plan that is based on fundamental properties of ecosystem (e.g., energy flow and predator/prey interactions) as well as being realistic enough and with enough specification such that it could be implemented. The example should not be unduly constrained by current perceptions about legal restrictions or policies.

NEFMC Process

- To prepare:

3. With respect to number 2, it is understood that the example might not be implemented, but it should make clear what a fishery ecosystem plan would actually entail and it should focus debate. To the extent practicable, these documents should be completed in about one year. In consideration of these documents, the Council will adopt a plan for implementation. The EBFM PDT will have the technical lead in developing these documents and the EBFM committee will recommend the documents for Council consideration.

Fishery Ecosystem Plan Goals

To protect the ecological integrity of US marine resources as a sustainable source of wealth and well-being for current and future generations

- **Strategic Goals**
  (Derived from Magnuson definition of OY as in Risk Policy Document):
  - Optimize Food Provision through targeted fishing and fishing for species for bait
  - Optimize Employment
  - Optimize Recreational Opportunity
  - Optimize Intrinsic (Existence) values
  - Optimize Profitability
  - Promote stability in both the biological and social systems

Fishery Ecosystem Plan Objectives

- Maintain/restore functional production levels (ecosystem, community scale emphasis)
- Maintain/restore functional biomass levels (community/species scale emphasis)
- Maintain/restore functional trophic structure
- Maintain/restore functional habitat

Committee guidance to focus eFEP development on a worked example:

1. Describe a trophic web area based operating model that specifies:
   - an ecosystem area
   - species present in the area that will be dynamically model
   - species present in the area that will be treated as externalities (they participate in the food web, but their numbers and biomass is determined outside the model- e.g., mammals, birds, most benthic invertebrates)
   - feeding models that account for preference, suitability and availability
   - matrix of production attributable to ecosystem area (incorporating seasonality)
   - stochastic nature of these relationships- could use Bayesian approach

Committee guidance to focus eFEP development on a worked example:

2. Test alternative approaches to management including:
   - current single species approach
   - guild (trophic level) approach
   - Total ecosystem productivity approach

3. For each approach, specify:
   - criteria for overfishing
   - rebuilding strategy
   - mechanism to protect most targeted or vulnerable stocks (min, biomass, but not necessarily linked to BMSY)

Additional eFEP components
Draft discussion documents

- Goals and strategic objectives
- Overfished status determination and rebuilding
- Forage fish management
- Habitat management
- Jurisdictional cooperation and coordination
- Limited access and authority to fish

EBFM Committee guidance

- Identification of and response to an overfished condition
- Hindcast models to compare with status quo management
- Evaluate maximum retention policies
- Evaluate use of fishery-dependent data

Phase III
2018?

- eFEP Management Strategy Evaluation
  - Operational framework defined by Phase II
  - Participation by fishermen and interested parties
  - Evaluate tradeoffs and optimize outcomes
  - Verification of model
  - Testing