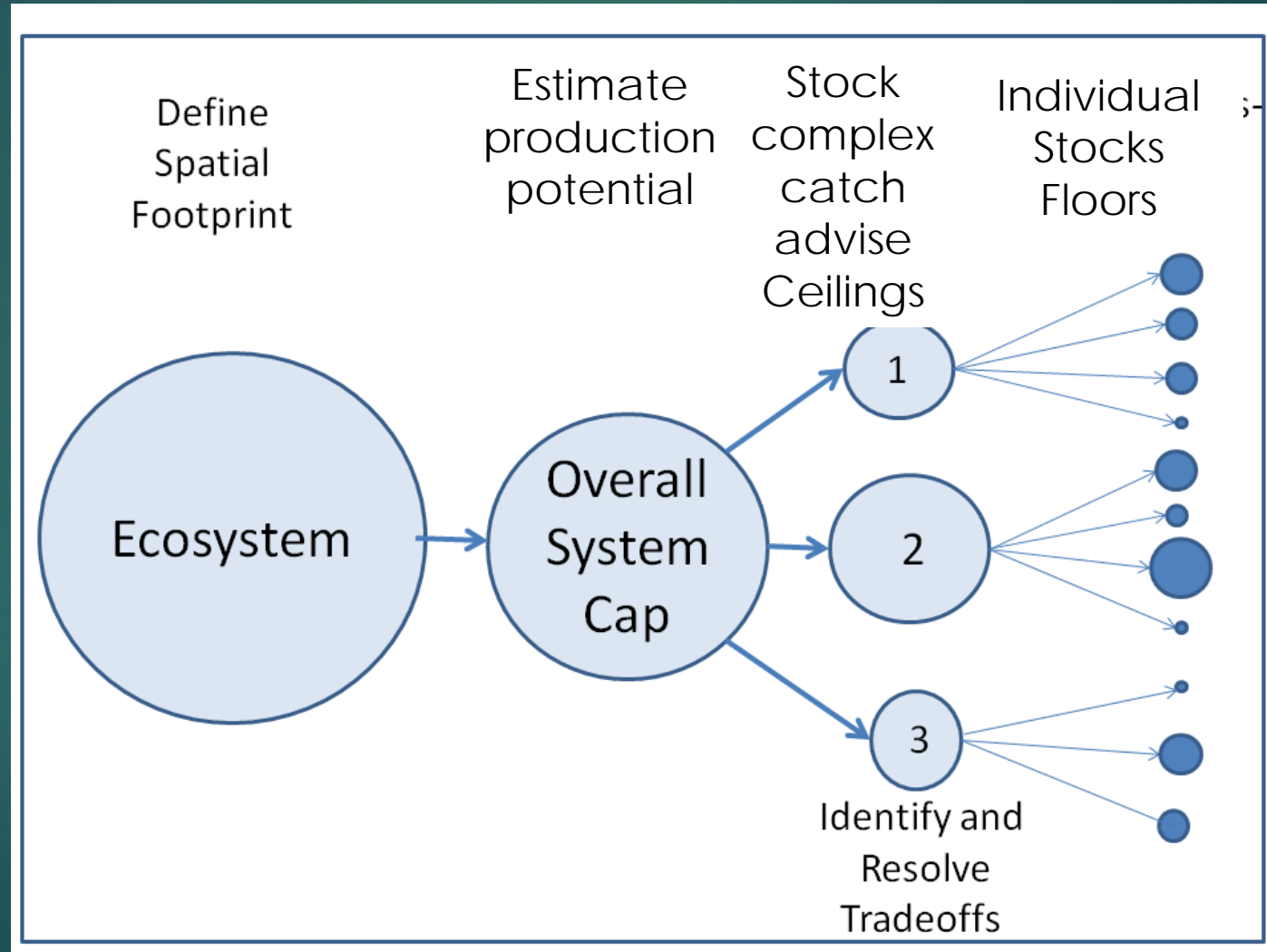


Catch management framework and limits for stock complexes

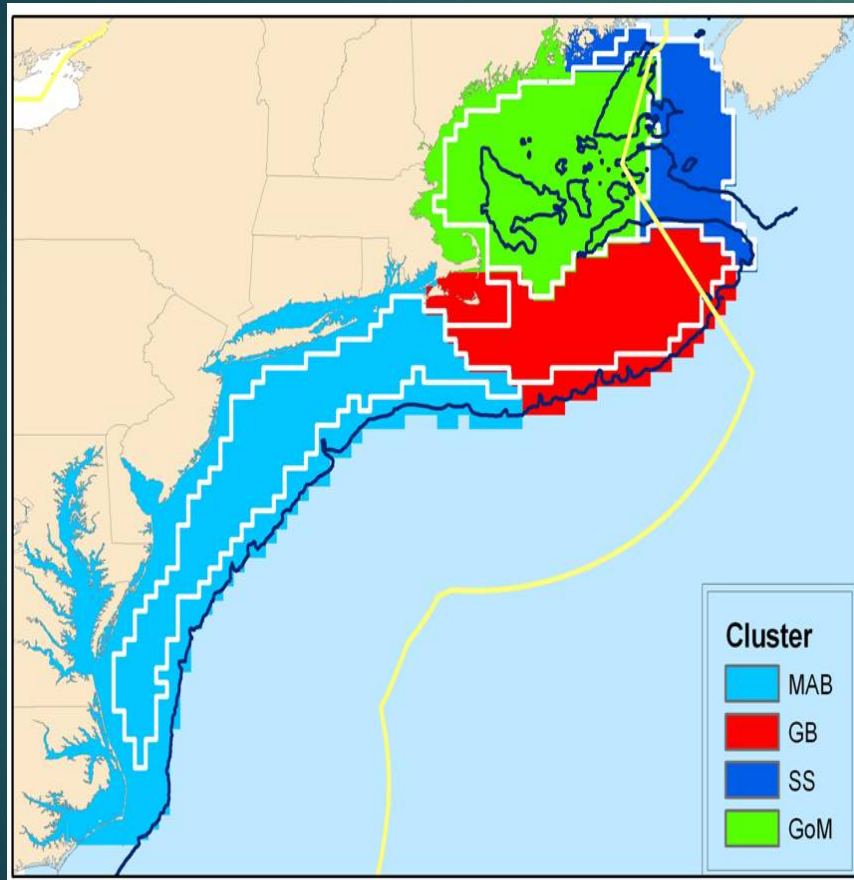
NEW ENGLAND FISHERIES MANAGEMENT COUNCIL

SEPTEMBER 24, 2019

Overview



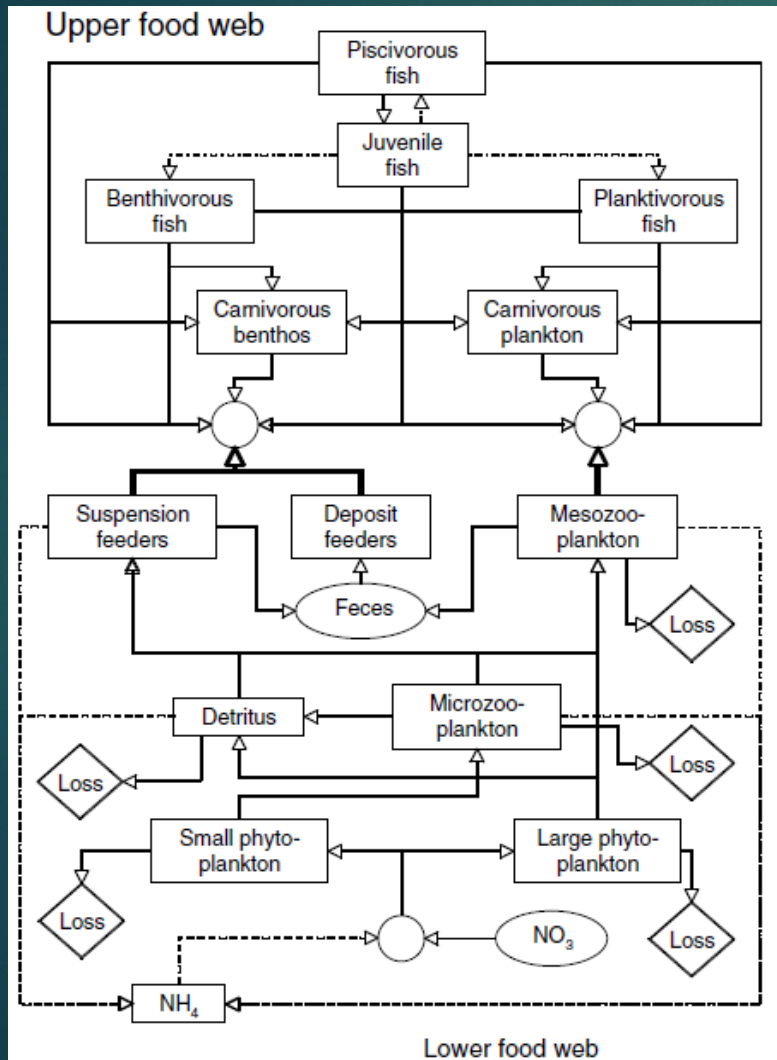
Define Spatial Management Unit



Place based
Management

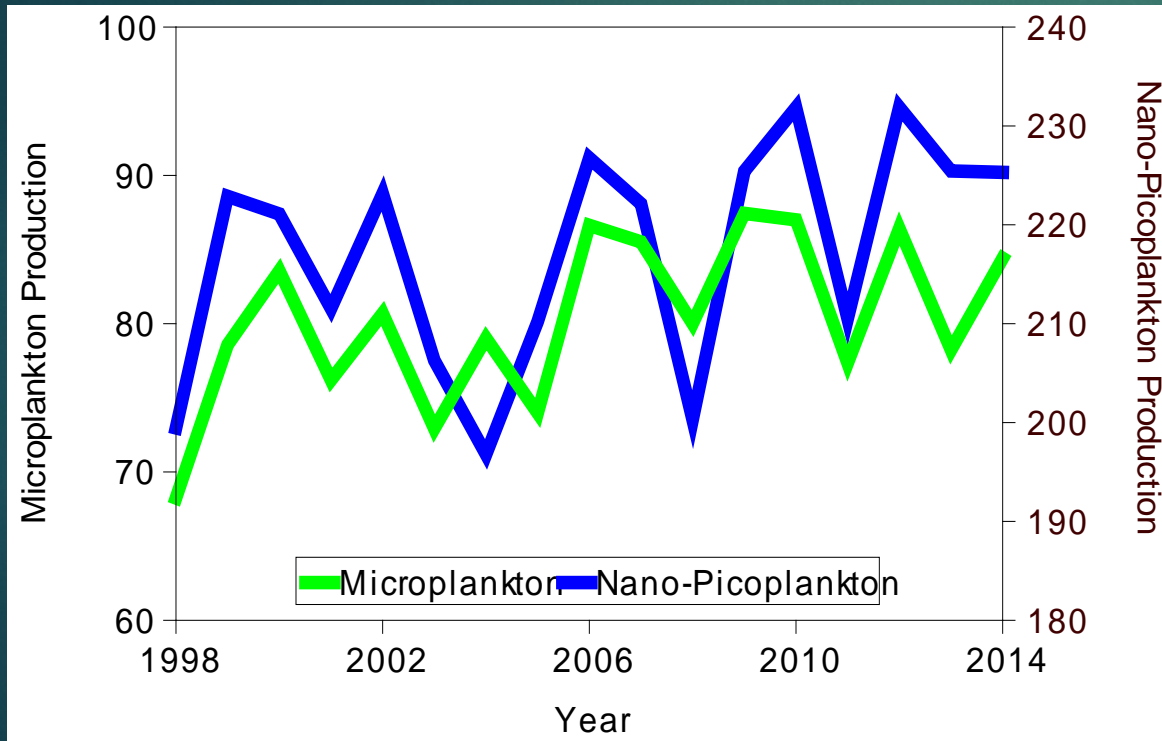
Ecological Production
Units (EPU)

Total Ecosystem Catch Cap



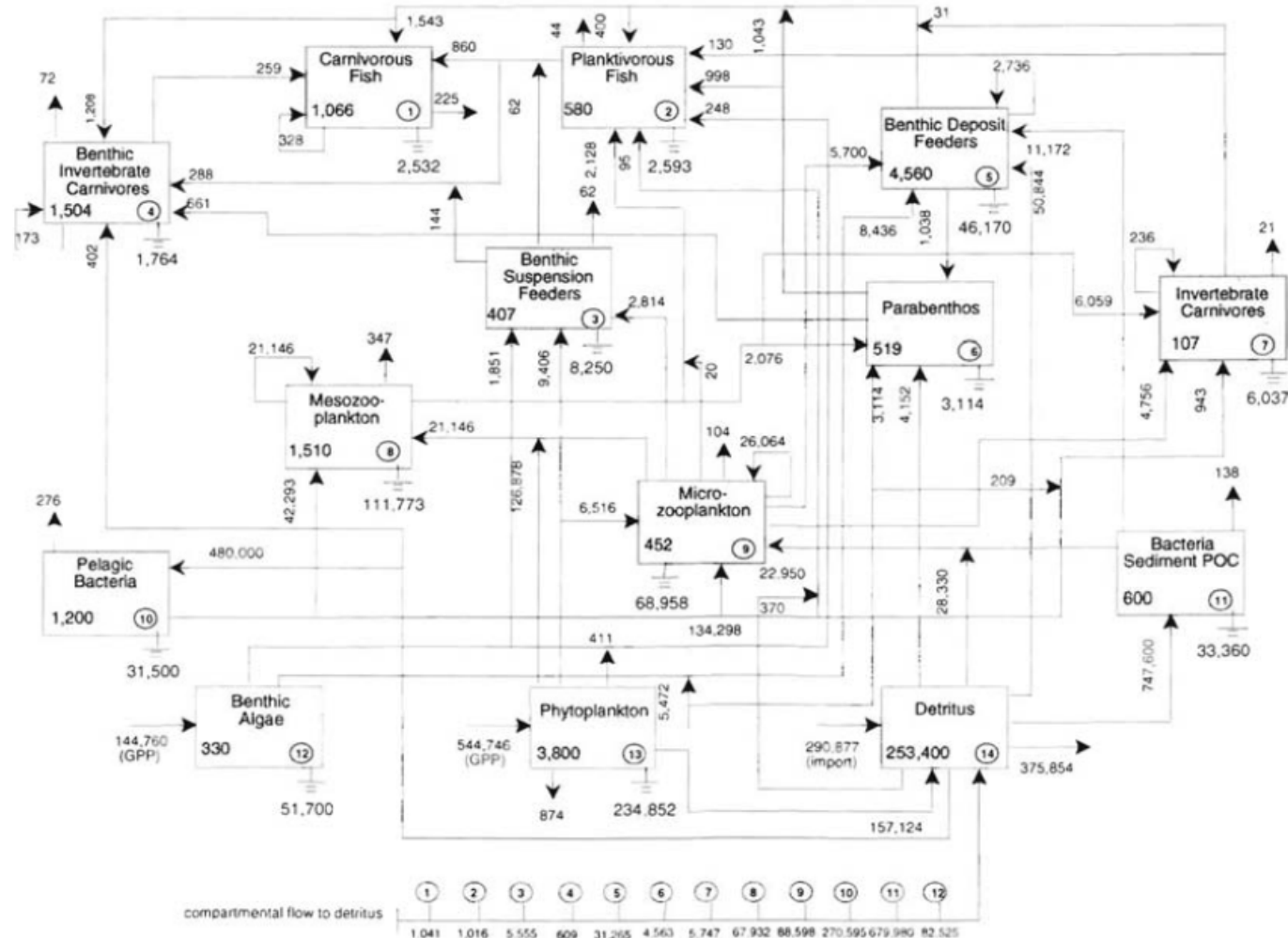
Based on productivity of the ecosystem (EPU), set a limit on total removals

Primary Productivity



Ratio of new production to recycled production to determine how much energy is available to higher trophic levels
Iverson 1990

End – End Food Web Model



Utilize Mass balance models to determine an appropriate overall catch cap that accounts for the needs of all the components of the ecosystem

System Thresholds and Indicators

BOX 1: Example estimation of catch cap: Large et al. (2013, 2015) and Tam et al. (2017) used survey data to identify values of total catches from ecosystems that were associated with large changes in the values for a set of ecosystem indicators. These thresholds could be used as a reference level for the total catch cap.

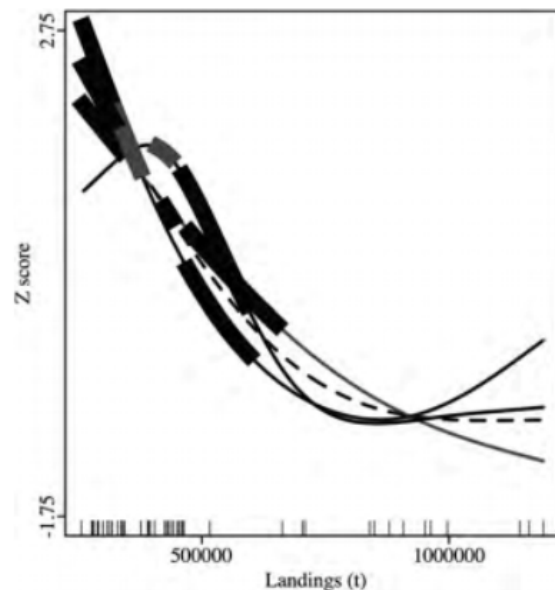


Figure 6. Centred and scaled (z-score) ecological indicators with a significant GAM (with smoothing term included) in response to landings. Rug plot represents the spread of the data, and significant derivatives are highlighted accordingly.

(Figures from Large et al. 2013, Tam et al. 2017 showing responses of ecosystem indicators to system-wide landings)

Tam et al.

Comparative Thresholds in Marine Ecosystems

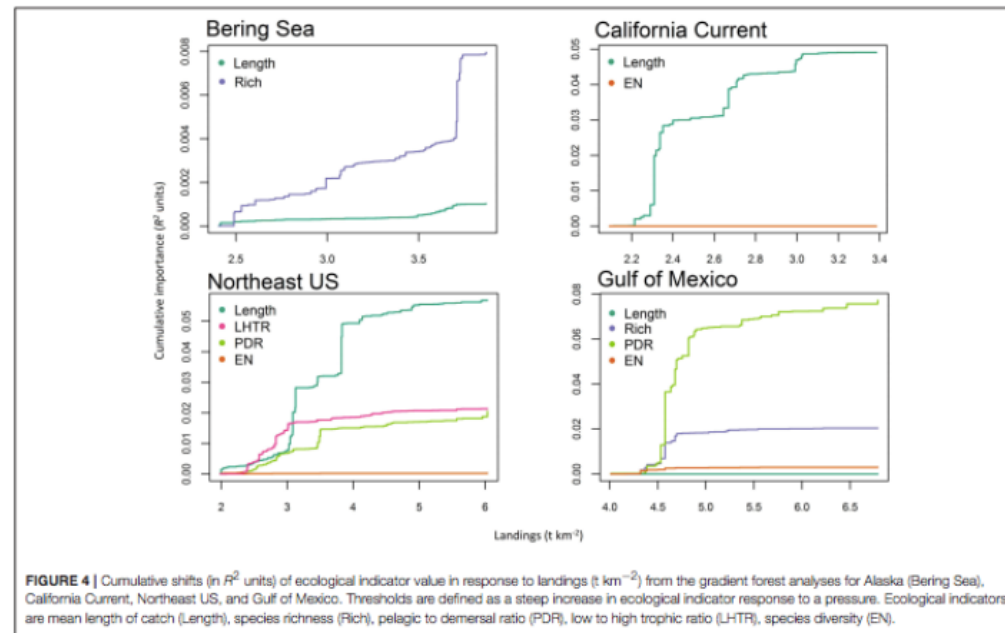


FIGURE 4 | Cumulative shifts (in R^2 units) of ecological indicator value in response to landings ($t\ km^{-2}$) from the gradient forest analyses for Alaska (Bering Sea), California Current, Northeast US, and Gulf of Mexico. Thresholds are defined as a steep increase in ecological indicator response to a pressure. Ecological indicators are mean length of catch (Length), species richness (Rich), pelagic to demersal ratio (PDR), low to high trophic ratio (LHTR), species diversity (EN).

Catch advise for Stock Complexes

- ▶ Primary catch advise provided at the stock complex level – Ceiling
 - ▶ Stock complexes - groups of species that share similar diet and habitat niches
 - ▶ Fishery functional group - Stock complexes that are caught together in a particular fishery (e.g. piscivores in the trawl fishery)
 - ▶ Related to the European métiers concept
- ▶ Limits for individual species as needed – Floors
- ▶ Process would mirror current single species process
 - ▶ Fit population models to available data
 - ▶ Provide catch advise for the group of species
 - ▶ Total allowable catch summed across stock complexes can not exceed the ecosystem catch cap

Aggregate Production models

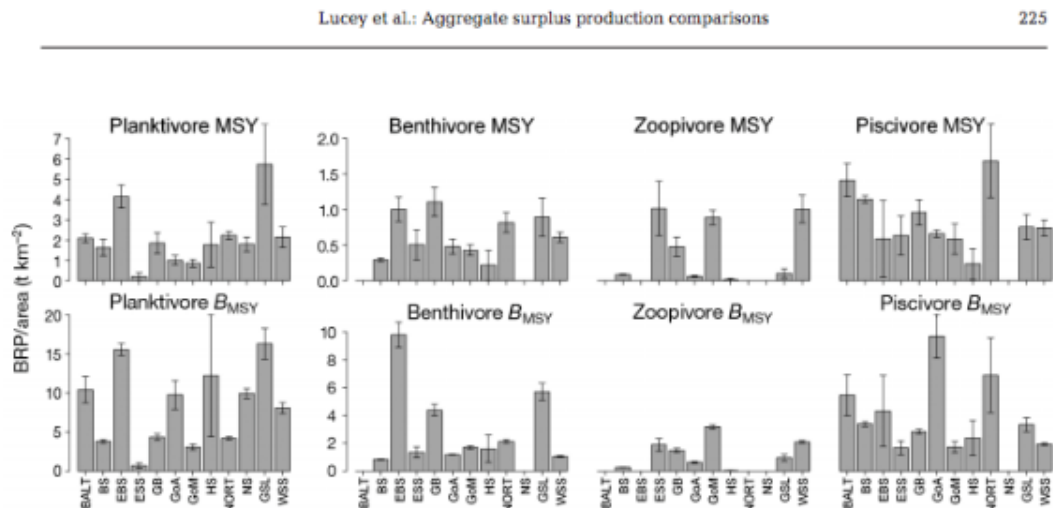


Fig. 4. Area-corrected maximum sustainable yield (MSY) and biomass at maximum sustainable yield (B_{MSY}) derived from the process error model for the feeding guild aggregation type by ecosystems. Note the different scale for the planktivore aggregate group than the other 3 aggregate groups. See Table 1 for definition of ecosystem abbreviations

(from Lucey et al. 2012; estimates of MSY and BMSY for different stock complexes, example of aggregate production model fit)

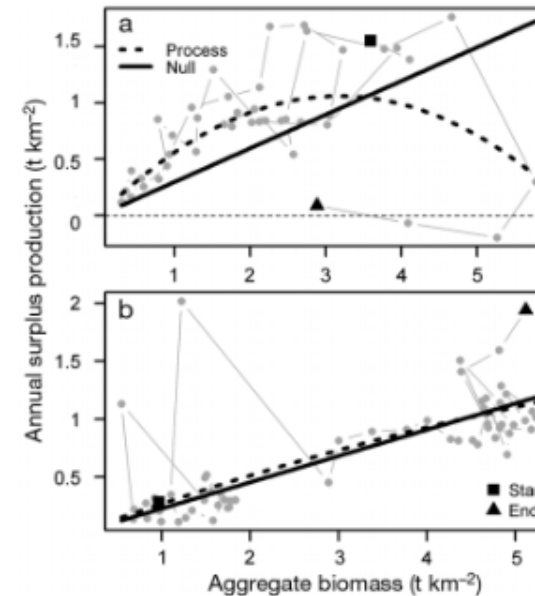


Fig. 2. Examples of the fit by the models to the data. (a) Example where the process error model (thick dashed line) fits the data well (North Sea pelagic aggregate group). This occurs for the majority of the aggregate groups across the ecosystems. (b) Example of where the null model (solid line) fits the data well (Gulf of Alaska 'large' aggregate group). This occurred in only 3 aggregate groups. The thin dashed line shows where annual surplus production equals 0

Do not explicitly include species interactions

Multispecies models

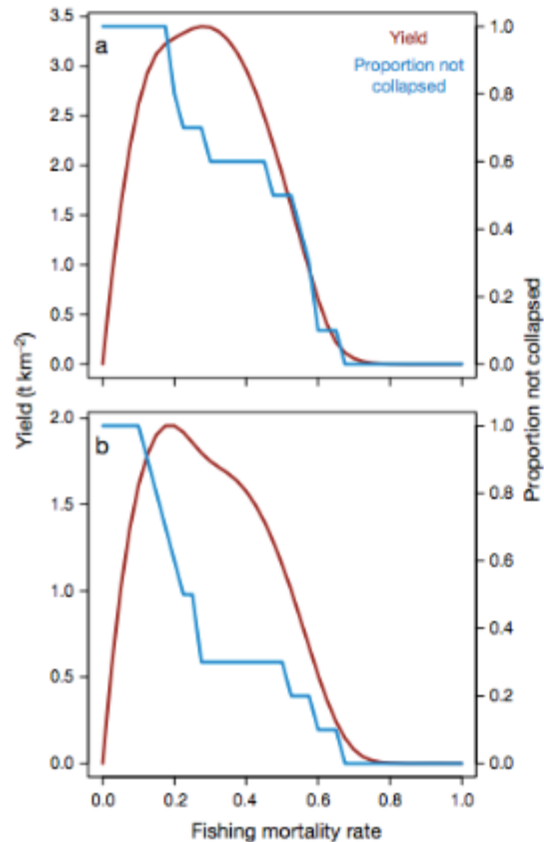


Fig. 2. Full 10-species system aggregate yield and collapse curves (where collapse is defined as biomass <10% of unfished biomass) for (a) Georges Bank and (b) Gulf of Alaska

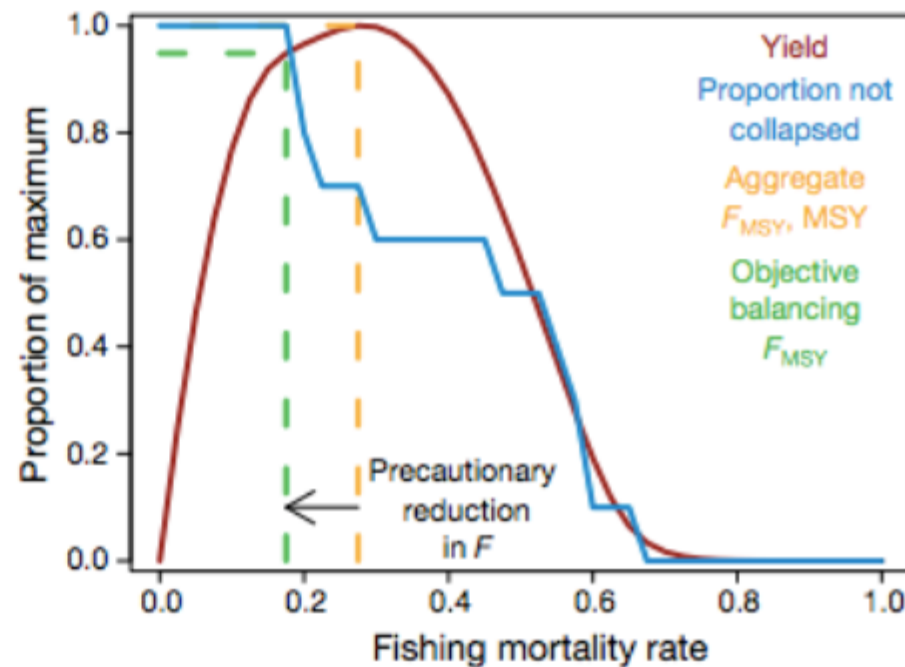
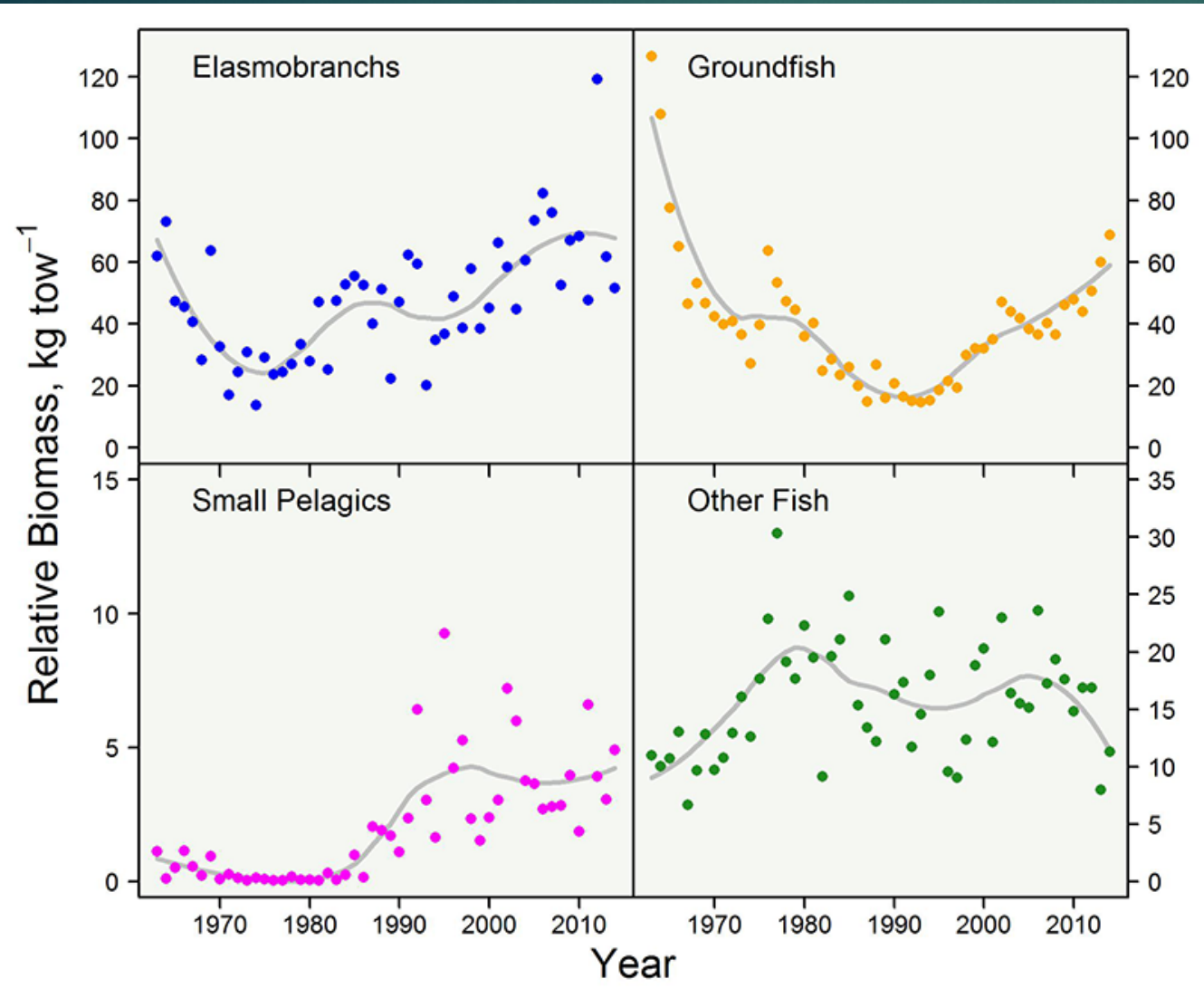


Fig. 4. In multispecies complexes, fishing mortality rate F can be reduced from aggregate F_{MSY} (MSY, maximum sustainable yield) to prevent collapses. For the full 10-species Georges Bank model, nearly 95% of MSY can be achieved with no species dropping below 10% of unfished biomass

Explicitly account for interactions among species

(example multispecies yield curves for stock complexes; from Gaichas et al. 2012)

Index based methods



Examine trends in time series of an index

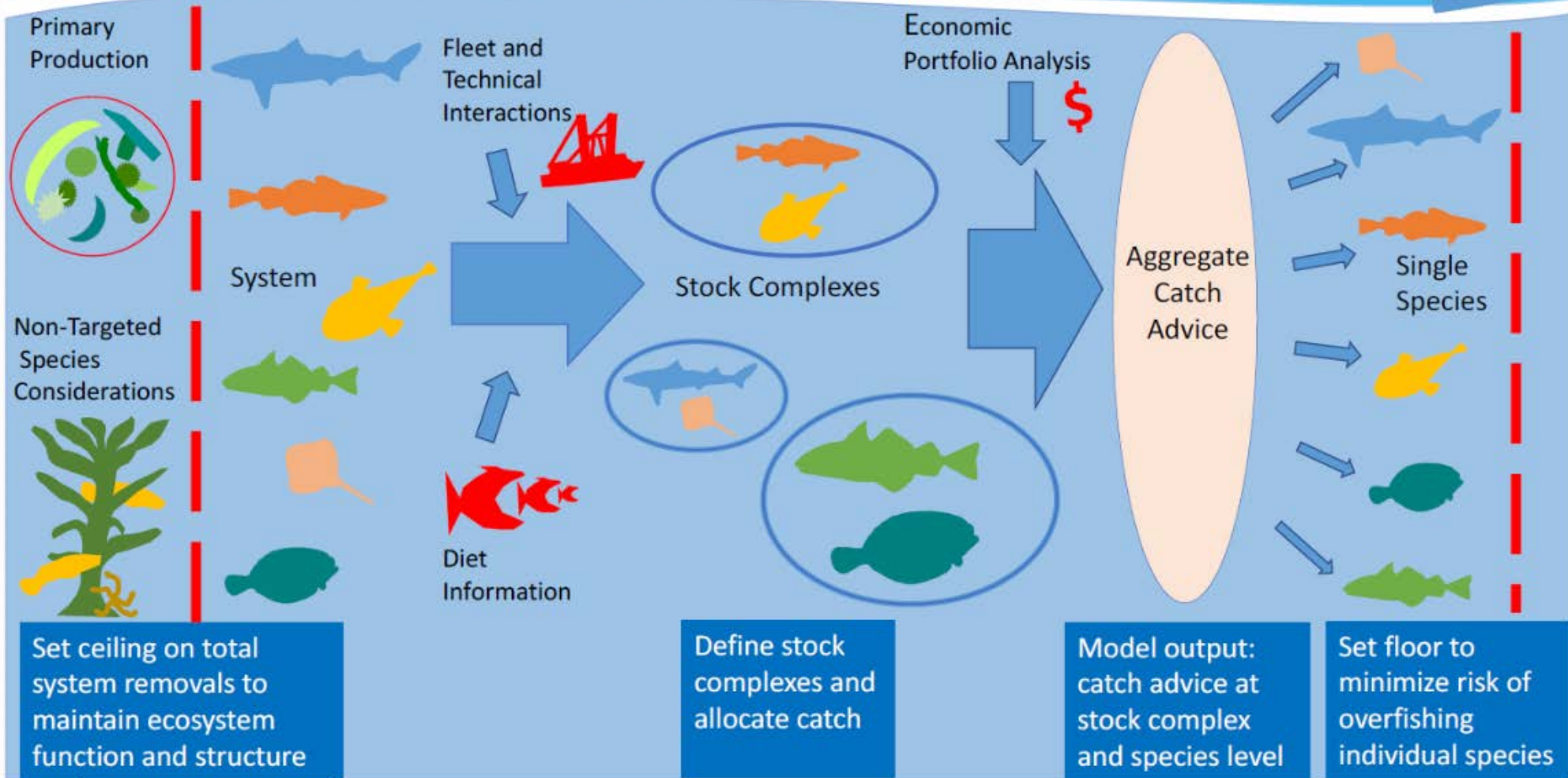
Similar to the Plan B assessment method

Floors to protect individual species

- ▶ Threshold levels for individual species to ensure species are not overharvested.
- ▶ Methods similar to stock complex methods, which are variants of single species methods
 - ▶ Simple population models
 - ▶ Statistical catch at age models
 - ▶ Index based assessments (e.g. Plan B)

EBFM Framework

Ecosystem Based Fishery Management Strategy Framework



Overview

- ▶ Place based management
- ▶ Overall ecosystem catch cap
- ▶ Catch advise at the stock complex level - ceilings
- ▶ Quota divided among fishery functional groups
- ▶ Protections in place to ensure individual species are not overharvested - floors
- ▶ Potentially incorporate economic theory to ensure catch advise aligns with management goals