# Ecosystem Catch Advice Framework & Examples of Operating Model Application

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New England
Fishery Management Council

# EBFM PDT

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- Dr. Daniel Palmer, Protected Resources, GARFO
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# Today's presentation

- Respond to request and issues raised

- Explain framework for providing ecosystem catch advice

- Demonstrate HCR worked examples using an operating model

- Discuss how it fits into an eFEP and how it can be used for MSE to develop management policy

# Committee guidance to focus eFEP development on the following steps:

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 the following steps:

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

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

# Draft Operational Framework
# Sep 2016

- **<u>Ecosystem simulation models</u>**
  - Hydra – 10 species length-structured model with trophic interactions
  - Ecosym/Ecopath (EwE) – mass-balance energy flow
  - Atlantis – end-to-end with physical and biological processes

- **<u>Operating model</u>**
  - Combination of above models to provide strategic advice and guidance

- **<u>Operational Framework</u>**
  - Operating model
  - Management Strategy Evaluation process
  - Assessments to provide tactical advice
  - Functional groups and EPU catch cap
  - Overfishing definition
  - Overfished/depleted definition

# Ecosystem Catch Advice Framework

- Overall catch cap based on system energetics

- Derived from satellite-based measures of primary production

- Allowance for diversions to microbial loop and non-fished species

# Ecosystem Catch Advice Framework

- Catch limits defined for stock complexes
  - Not to exceed the EPU catch cap

- Minimum biomass thresholds to protect species from depletion
  - Measures to prevent too much catch of highly-valued vulnerable, less-resilient species

- Catch limits balanced to achieve multiple objectives

# Ecosystem Based Fishery Management Strategy Framework

Primary Production

Non-Targeted Species Considerations

Ceiling on Total Removals

Set ceiling on total system removals to maintain ecosystem function and structure

Fleet and Technical Interactions

Diet Information

Aggregate Groups

Define aggregate groups and distribute catch among groups to satisfy management objectives

Economic Portfolio Analysis

Aggregate Catch Advice

Output: catch advice at aggregate and species level

Floors for Individual Species

Set floors to ensure individual species do not become overfished

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Amanda Hart UMass Dartmouth

# Operating Model (OM) example

- Example application of harvest control rules (HCRs)

- Demonstration of how OMs could be used to evaluate alternatives management strategies

- Performance metrics and multiple objectives

# Operating Model (OM) example

- OM: Hydra

- 10 species on Georges Bank
  - Majority of commercial catch
  - Species having parameterized trophic interactions
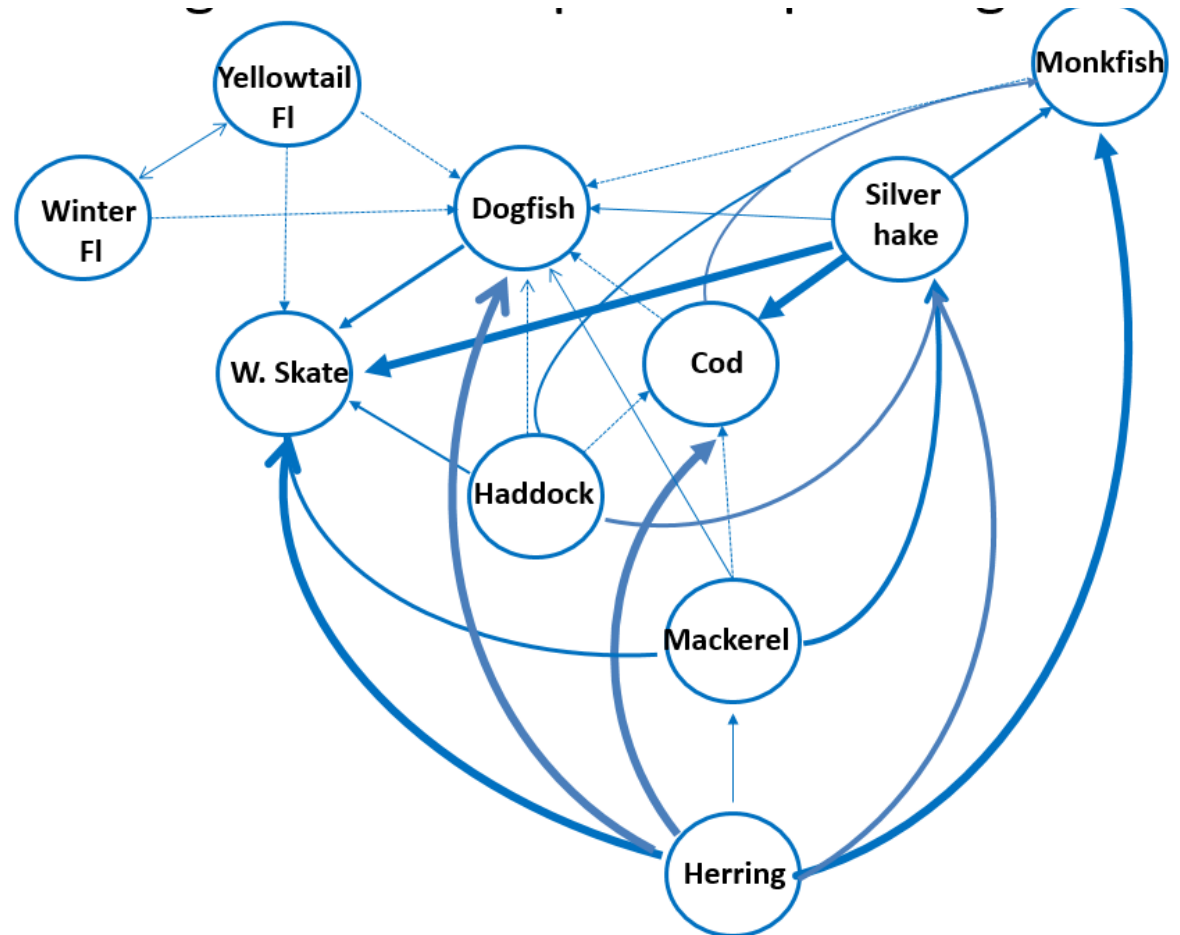
# Interaction strength

Stock complex – group related species at a defined trophic level.

Functional group – Intersection of stock complexes with a fishery, i.e. they are caught together.

| Species | Fishery Functional Group: Species Complex | | | | |
|---|---|---|---|---|---|
| Common Name | Demersal Trawl-Piscivore | Demersal Trawl-Benthivore | Fixed Gear Piscivore | Fixed Gear Benthivore | Pelagic Trawl Planktivore |
| Atlantic cod | | | | | |
| Silver hake | | | | | |
| Monkfish | | | | | |
| Spiny dogfish | | | | | |
| Winter skate | | | | | |
| Winter flounder | | | | | |
| Yellowtail flounder | | | | | |
| Haddock | | | | | |
| Atlantic herring | | | | | |
| Atlantic mackerel | | | | | |

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# Example HCRs

- Constant mortality – three alternative levels
- Hockey stick with alternative minimum biomass thresholds



Example Harvest Control Rule

Exploitation Rate

Biomass/Unexploited Biomass
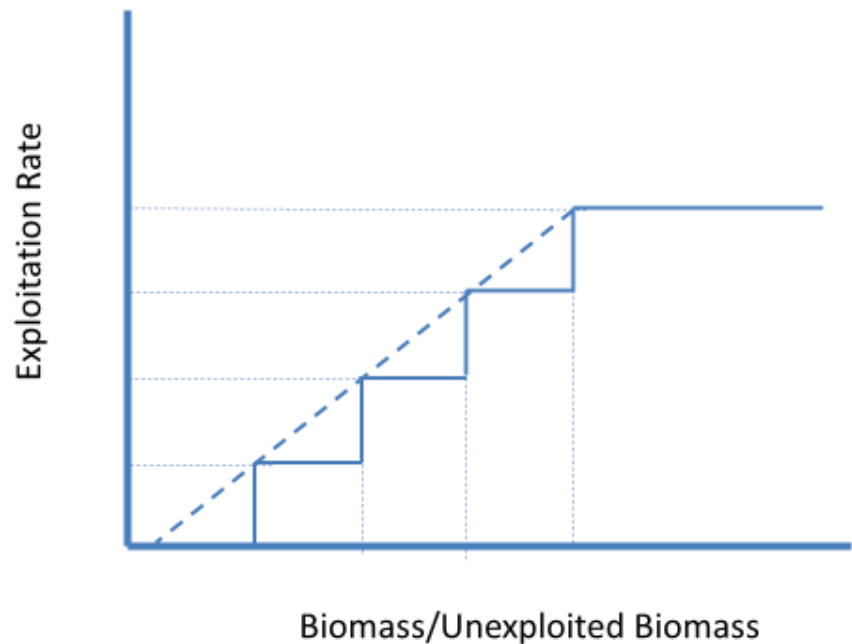
- Scaled biomass and catch
- Proportion of runs exceeding threshold

- Catch lower & fewer runs above biomass threshold at F=0.3
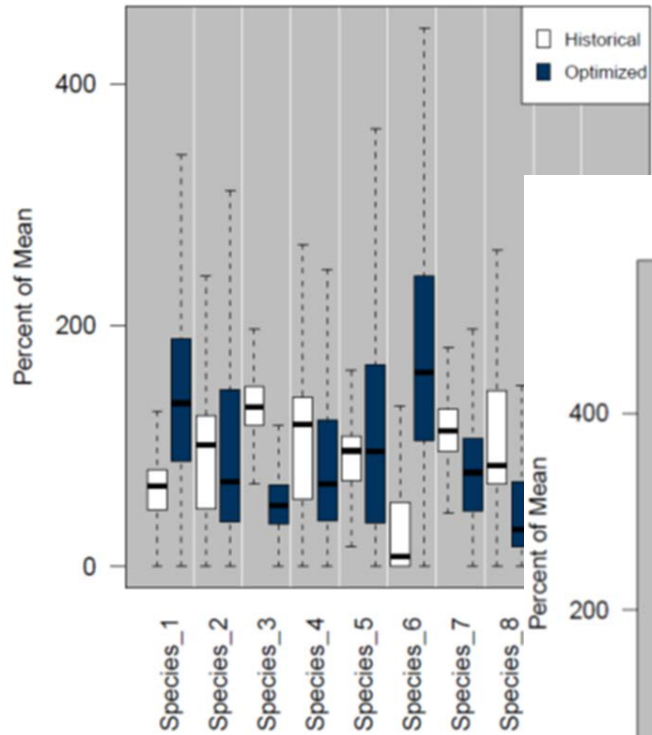- Threshold and F ramping improved performance at F=0.3
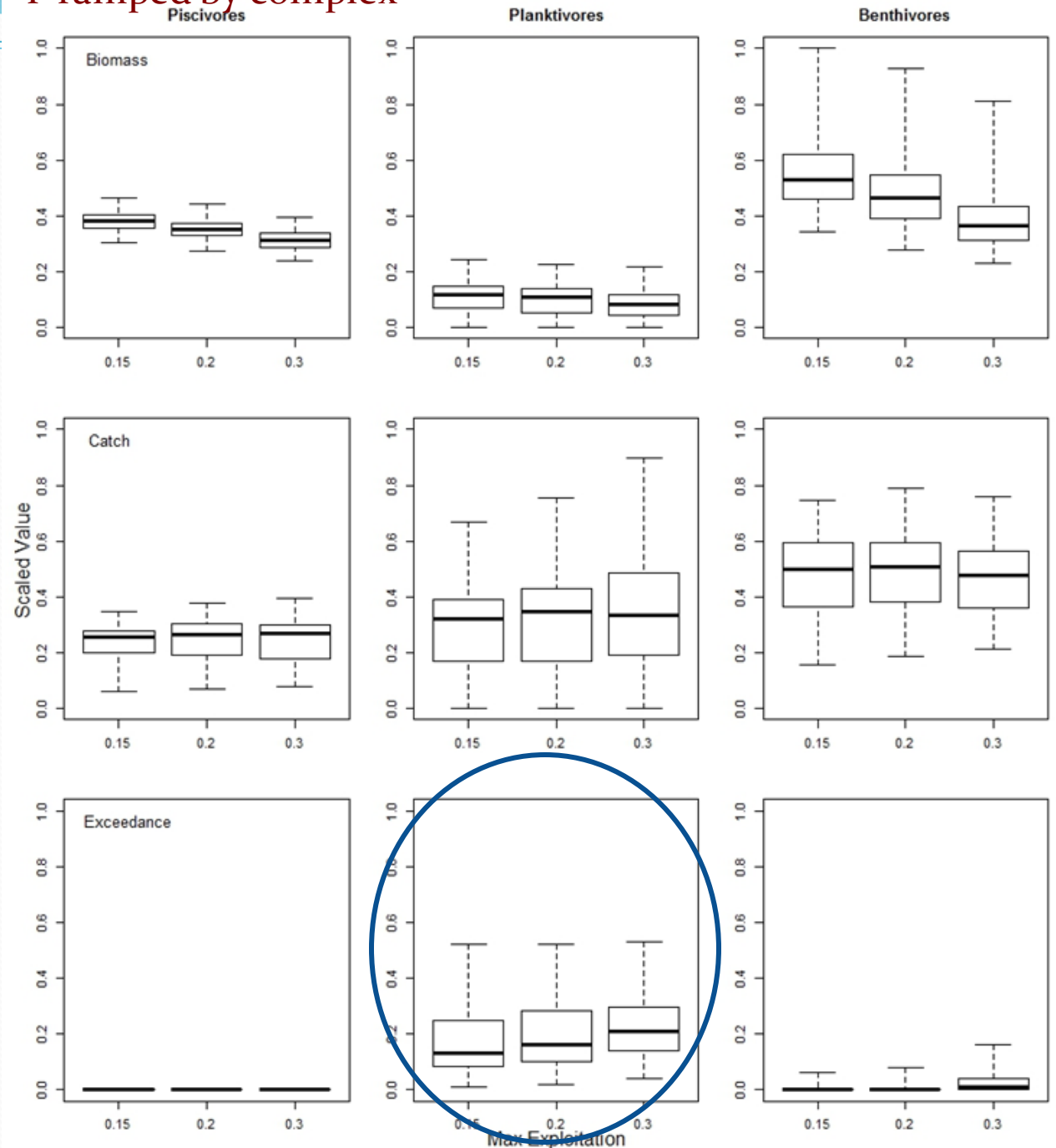
- Proportion of runs exceeding threshold (generally 20%$B_0$)

- More risk at F=0.3, particularly for dogfish, herring, cod, mackerel, and yellowtail flounder.

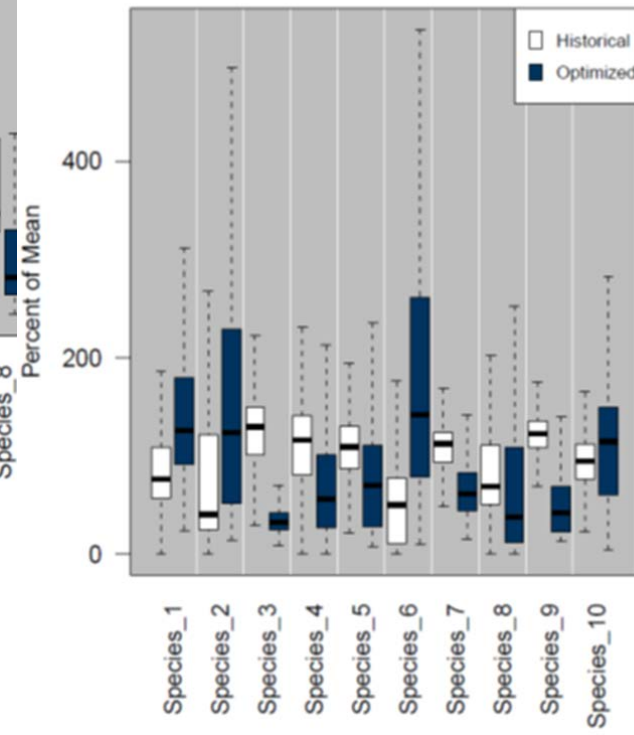- F ramp applied to complex when a stock is below its threshold.
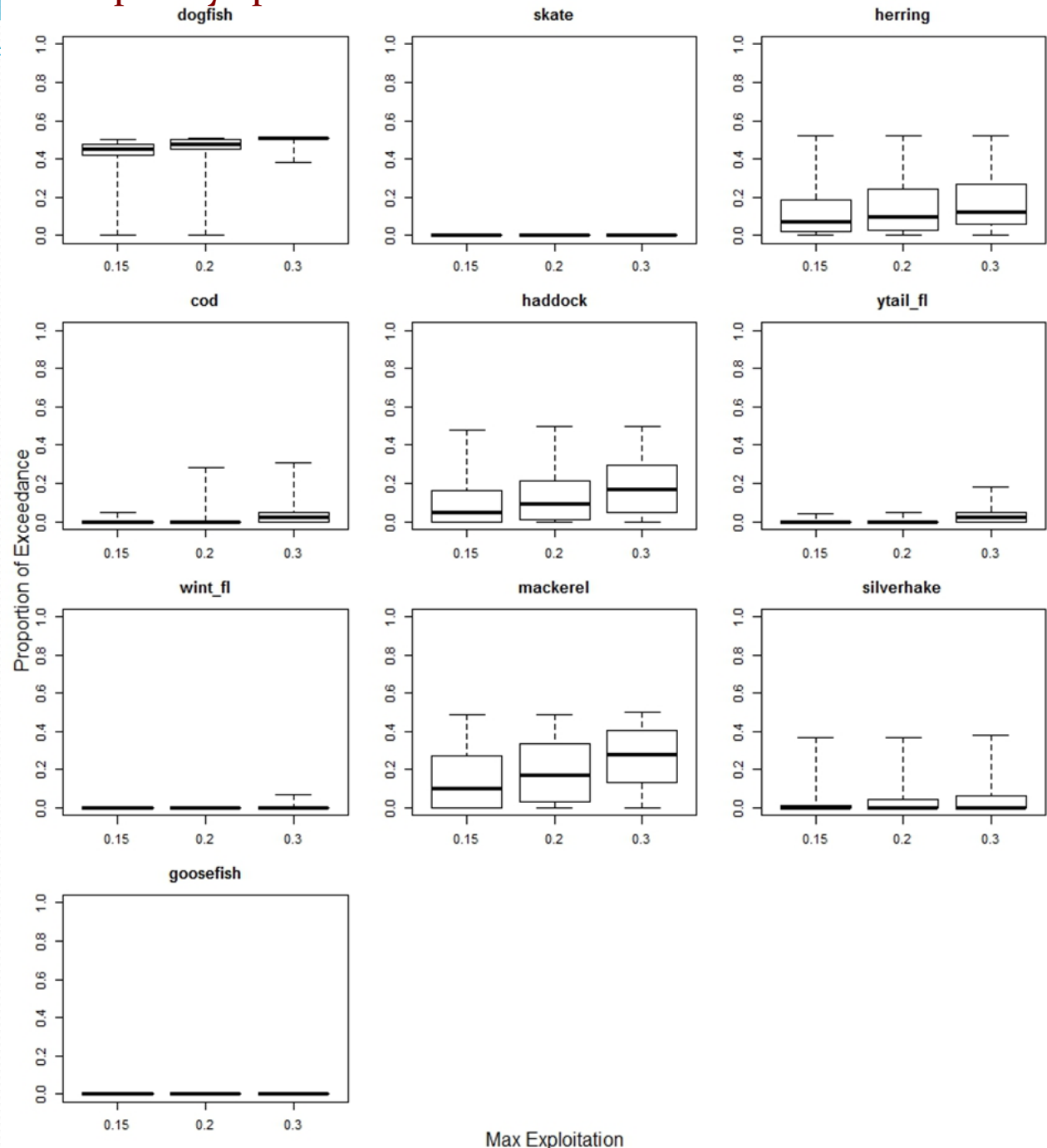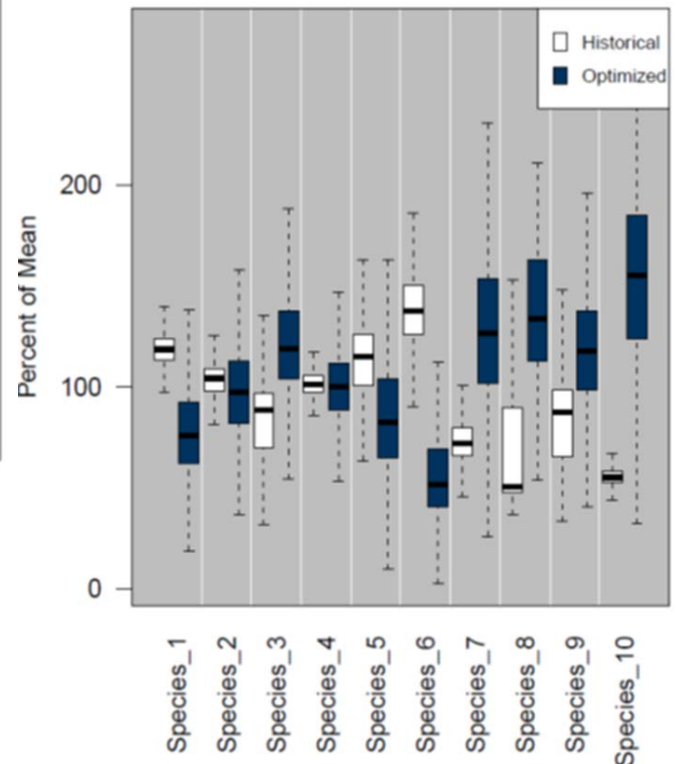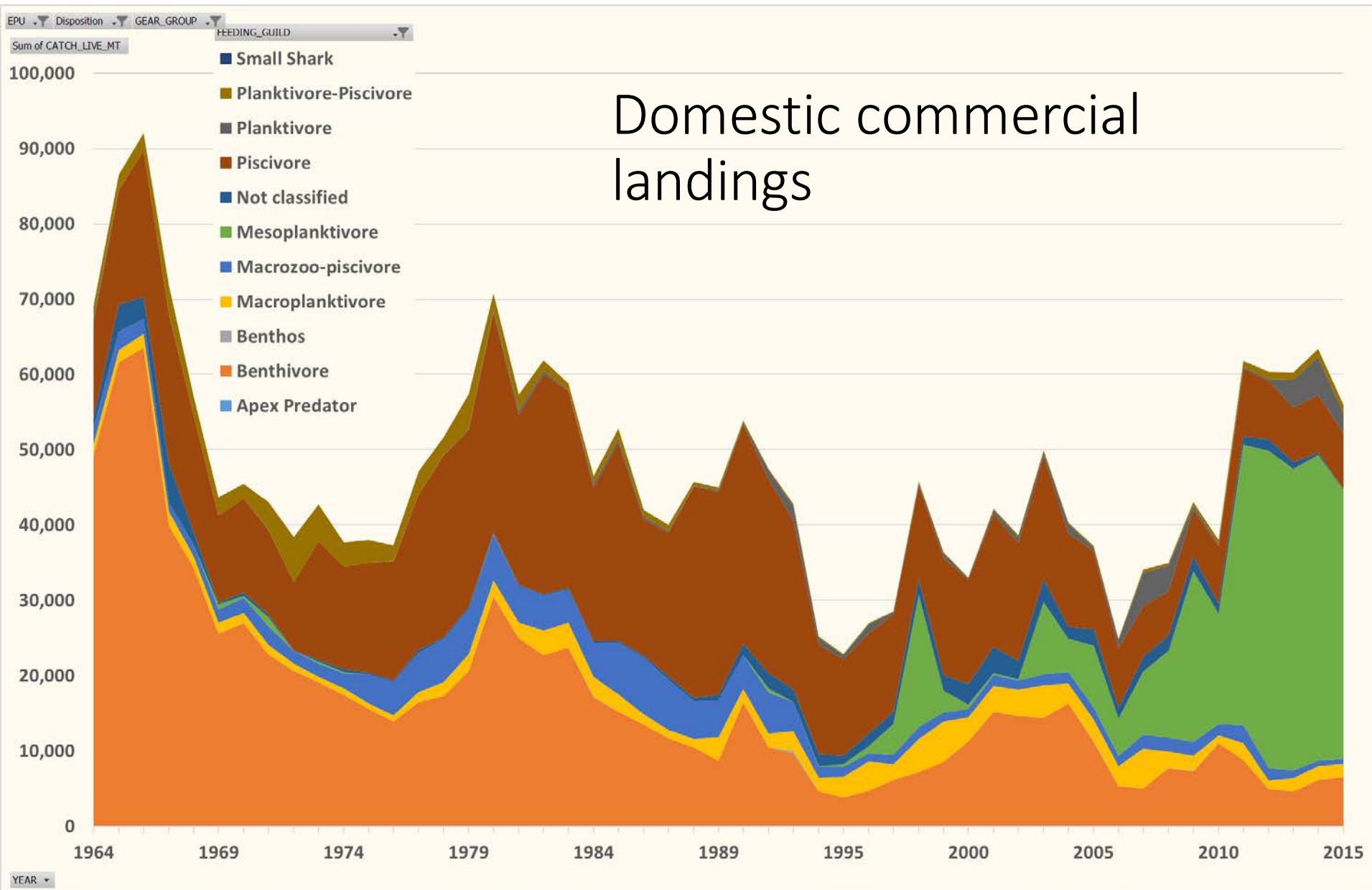
# Balancing variation in revenue
# Portfolio analysis

Domestic commercial landings

Total commercial landings
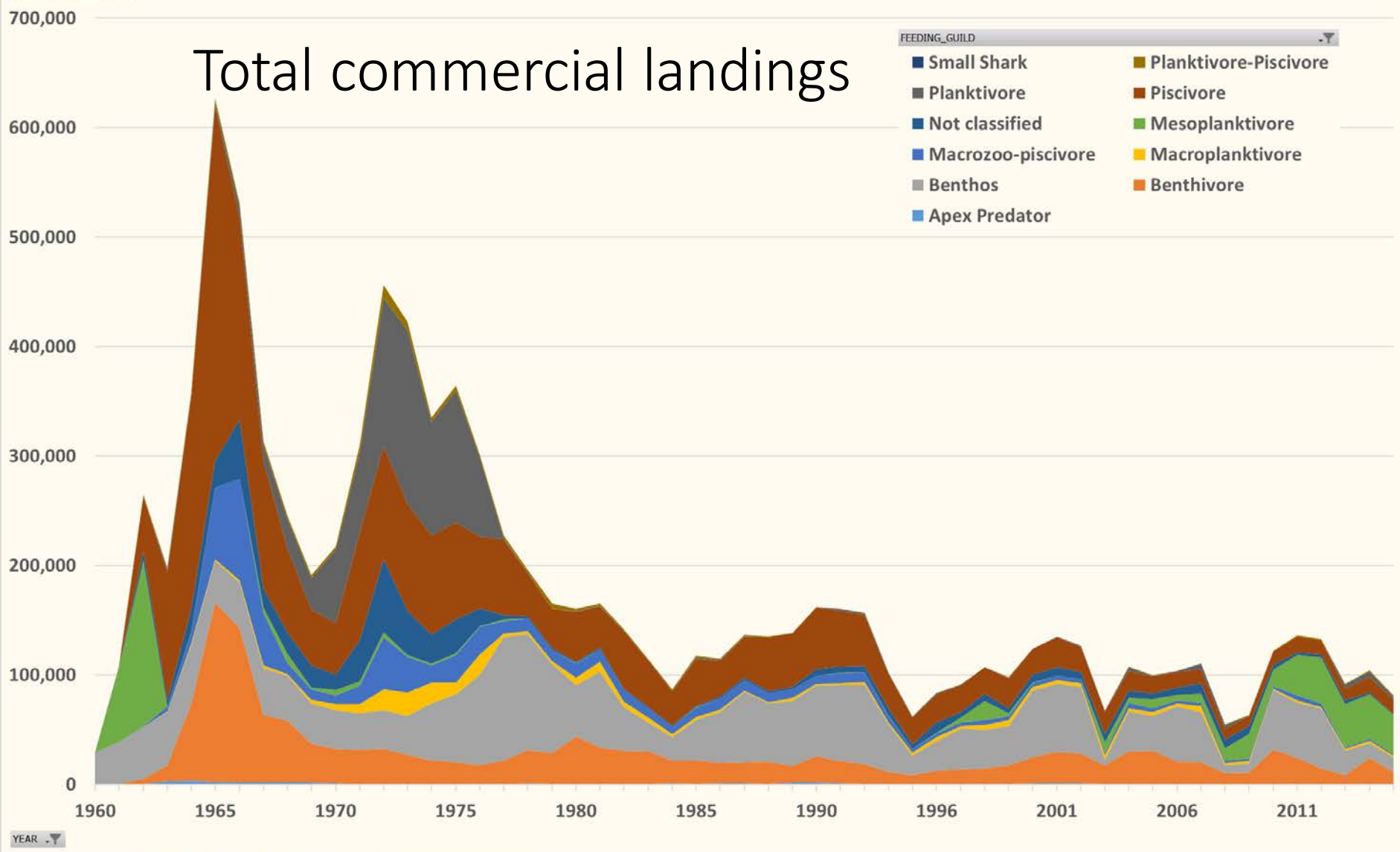
Commercial Catch
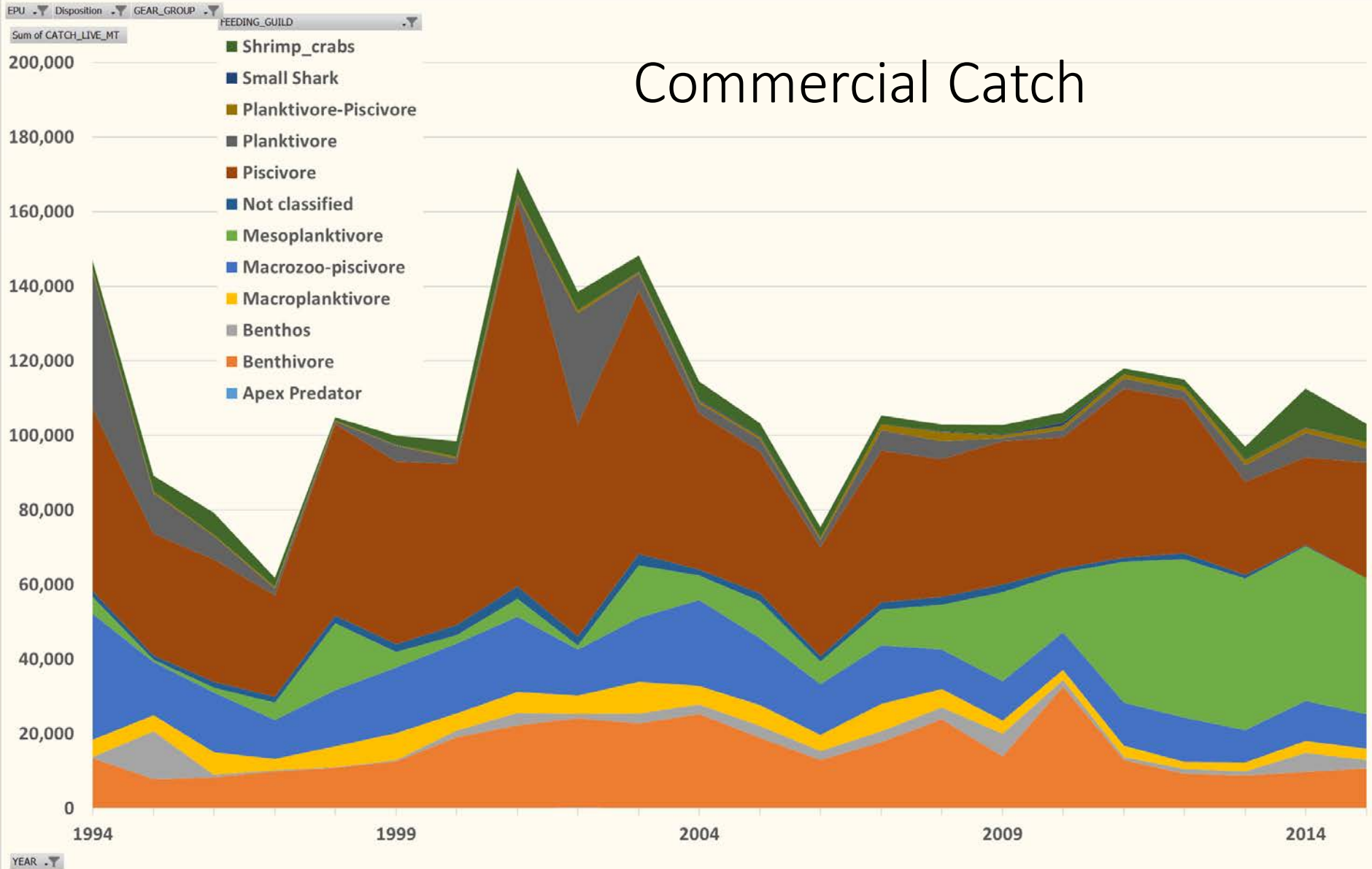
# NEFMC Approach

- 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.

# FEP Concept

- Place based approach

- Ecosystem cap based on primary productivity

- Catch limits by stock complex (functional group)

# FEP Structure

- Catch control rules

- Stock complex specifications

- Species specifications or other conservation measures when overfished and/or valuable or vulnerable

# FEP Elements

- Goals and objectives
- Ecological overfishing thresholds
- Species depletion/ecosystem risk
- Ecological habitat consideration and spatial management
- Access to fisheries
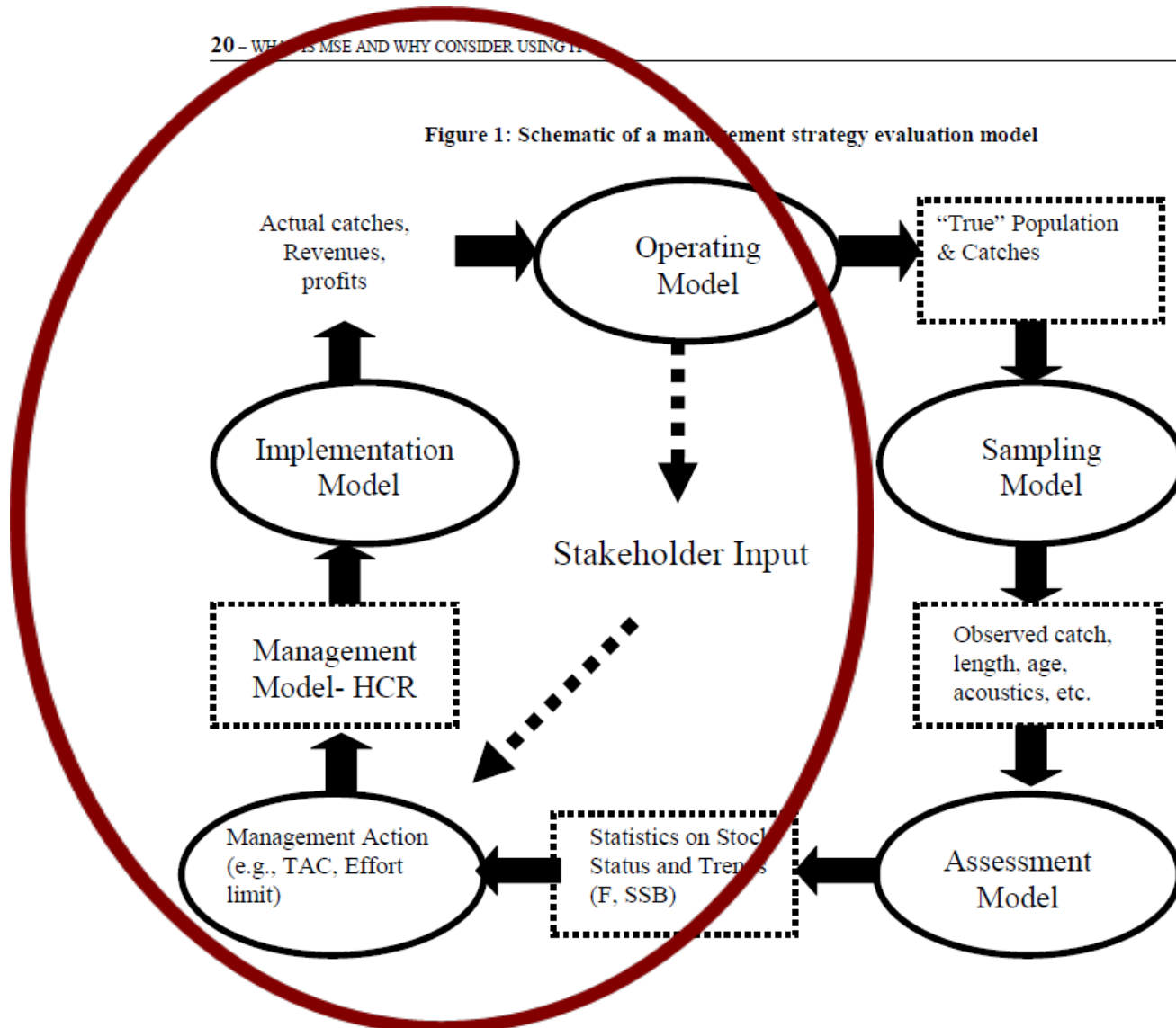- Coordination by management bodies

# FEP Technolgy

- Realistic operating models to support strategic decision-making
- Compatible assessments for tactical decision-making
- Management Strategy Evaluation – to be developed, Phase III
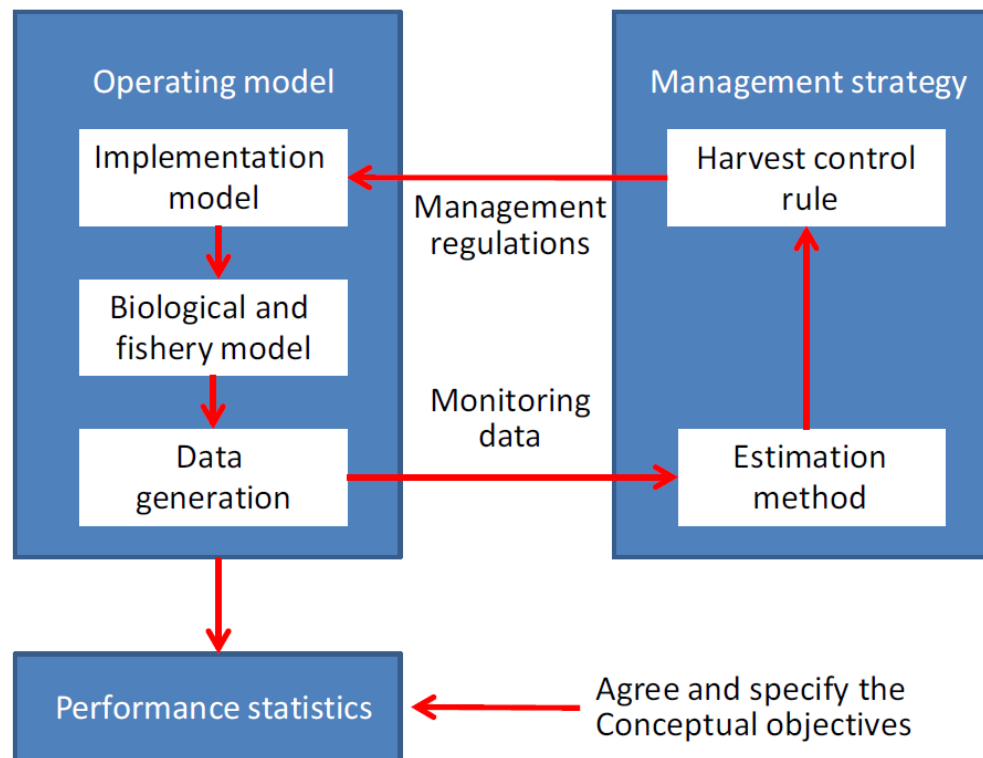
# MSE loop – Holland (2010)



Figure 1: Schematic of a management strategy evaluation model

Actual catches, Revenues, profits

Operating Model

"True" Population & Catches

Implementation Model

Sampling Model

Stakeholder Input

Management Model- HCR

Observed catch, length, age, acoustics, etc.

Management Action (e.g., TAC, Effort limit)

Statistics on Stock Status and Trends (F, SSB)

Assessment Model

# MSE loop – Punt et al. 2016
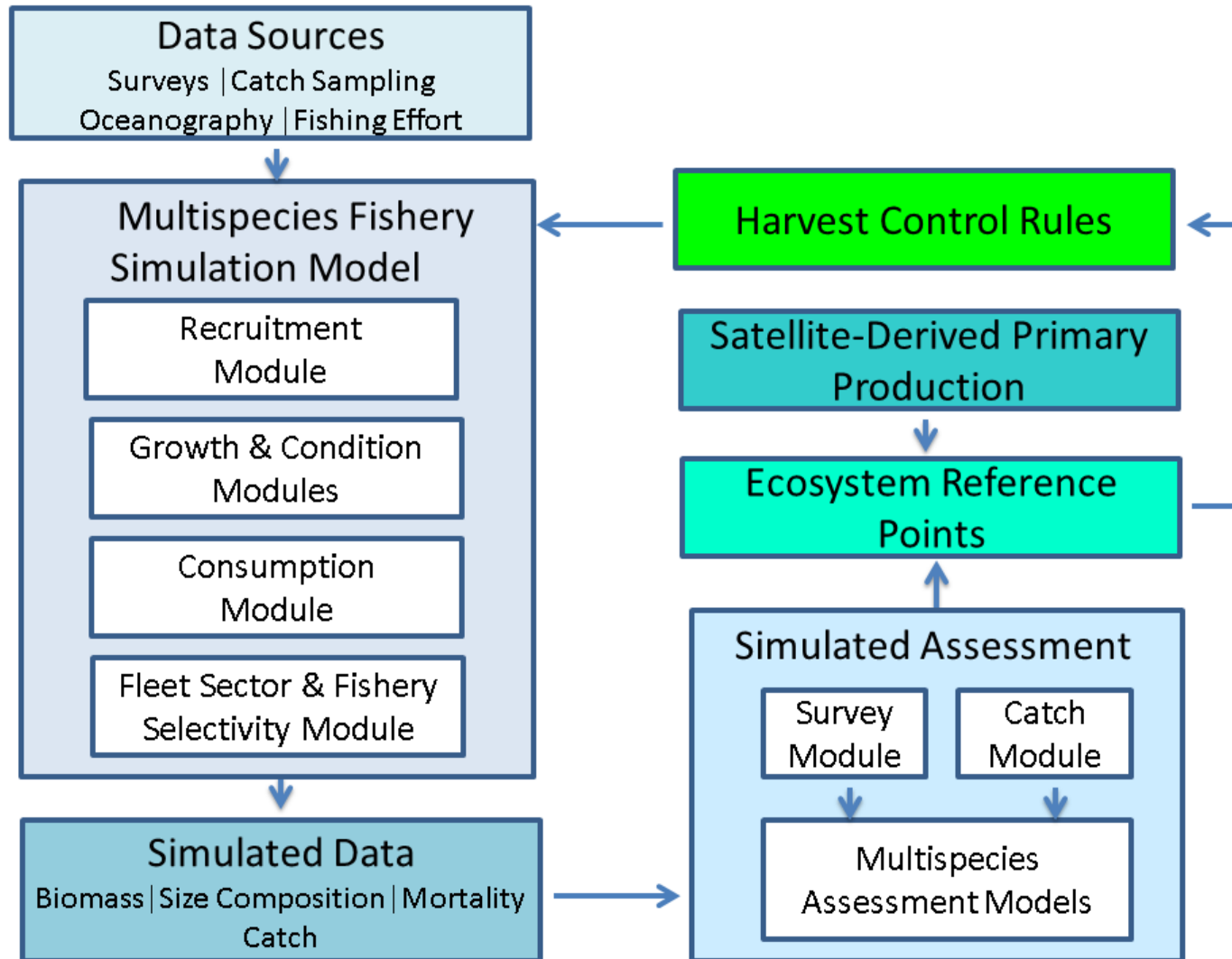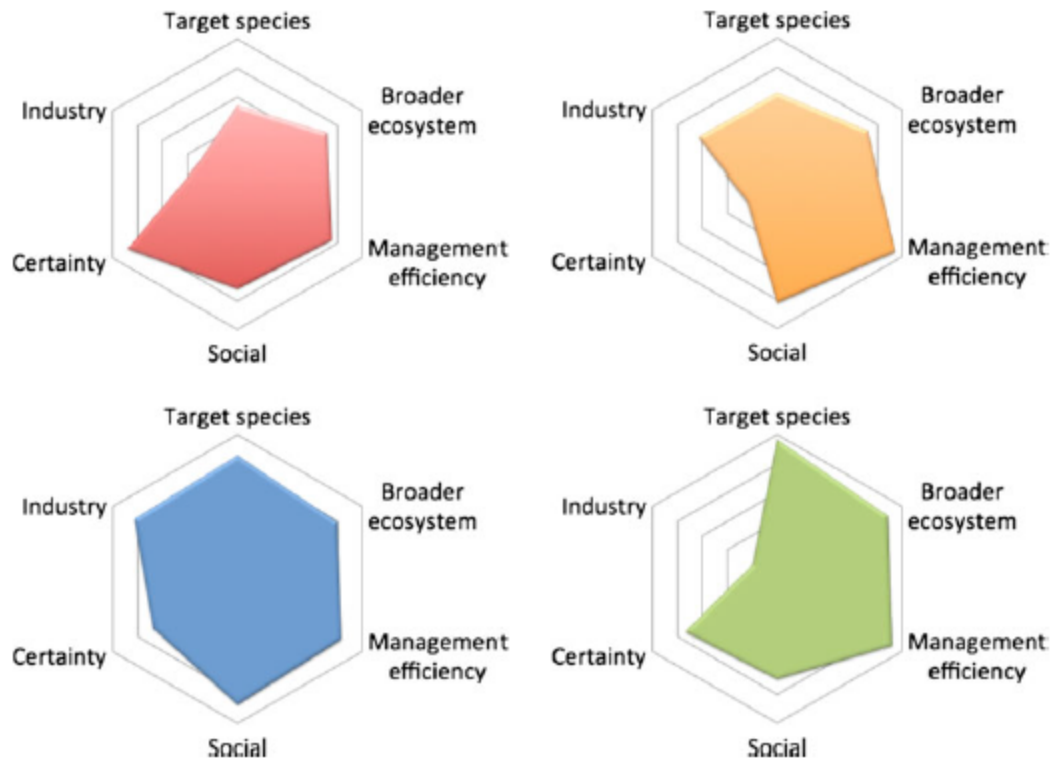
Best practices MSE  *A E Punt et al.*



**Figure 1** Conceptual overview of the management strategy evaluation modelling process.

# MSE loop – EBFM PDT

# Performance metrics and tradeoffs
## (from 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.