

# EBFM Progress Report

**Andrew Applegate**  
**NEFMC Staff**

**EBFM PDT Chair**

**Council meeting**  
**June 21, 2017**



# Intro

- Update on progress to develop a worked example of setting catch limits by functional group for the Georges Bank Ecosystem Production Unit
- EBFM terminology
- Draft strategic goals and objectives



# NEFMC Process for EBFM

Don't design solution without understanding the problem

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





## 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:

- ❖ criteria for overfishing
- ❖ rebuilding strategy
- ❖ mechanism to protect most targeted or vulnerable stocks (min, biomass, but not necessarily linked to BMSY)



# Progress

- EBFM conceptual framework described in Sep 2016  
(<http://www.nefmc.org/calendar/sept.-19-2016-ebfm-committee-meeting>)
  - Draft Operational Framework and Operational Models to Support Fishery Ecosystem Plan Development – Document 2b



# Draft Operational Framework

- **Operational Framework**

- Operating models used to evaluate management strategies
  - Require goals and objectives to evaluate effectiveness
- Management Strategy Evaluation process
- Assessments to provide tactical advice
- Functional groups and EPU catch cap
- Ecosystem overfishing definition
- Overfished/depleted definitions for individual species

- **Operating (ecosystem simulation) models**

- 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



# Progress

- PDT provided quantitative examples in Jan 2017  
(<http://www.nefmc.org/calendar/jan.-23-2017-ebfm-committee-meeting>)
  - FEP catch advice - Document 2b
  - Example application of operating models – Document 3





# Terminology and Information



## Related Documents

[List of Commonly Used EBFM Terminology](#)

[Download File](#)

[List of Species by Feeding Guild](#)

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[An article on the application of the "Hydra" Operating Model to the Georges Bank Ecosystem by Gaichas et al 2016](#)

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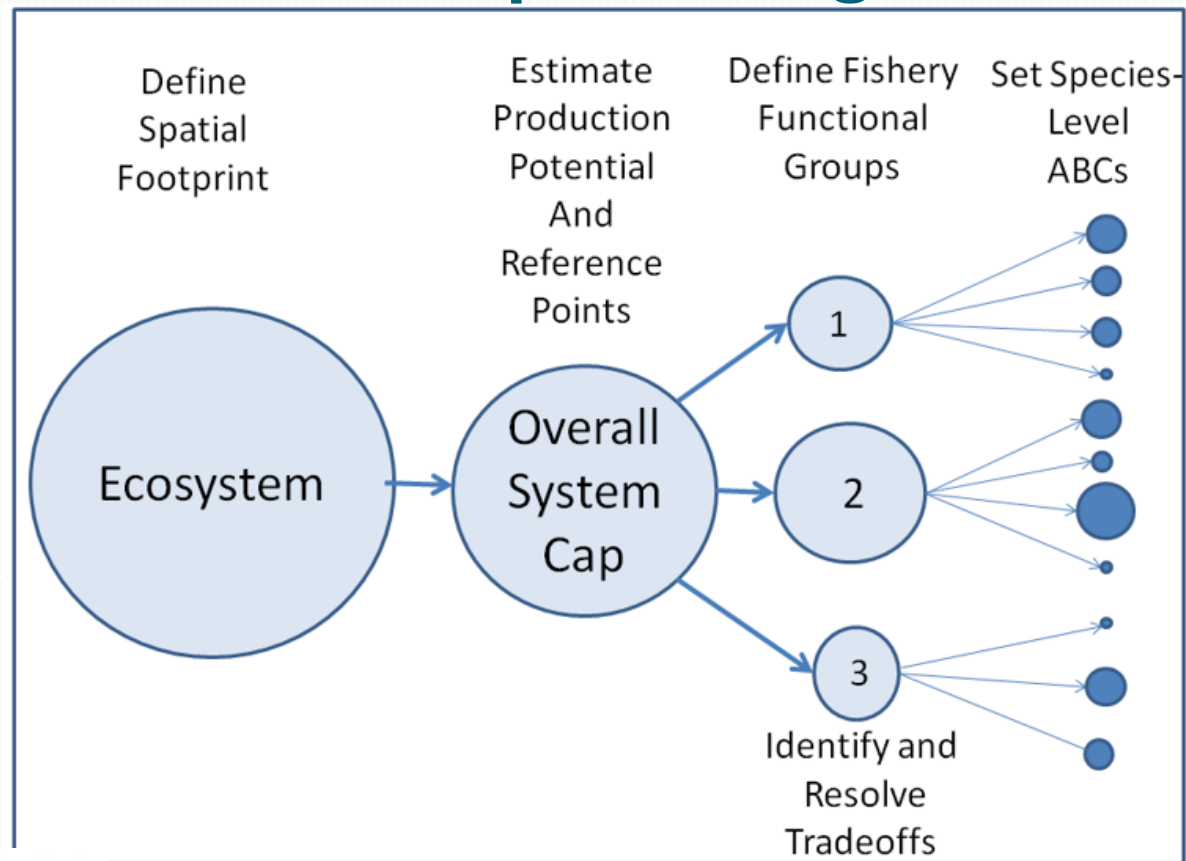
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[EBFM Pilot Project 2005](#)

[View details & documents](#)

# Draft Operational Framework

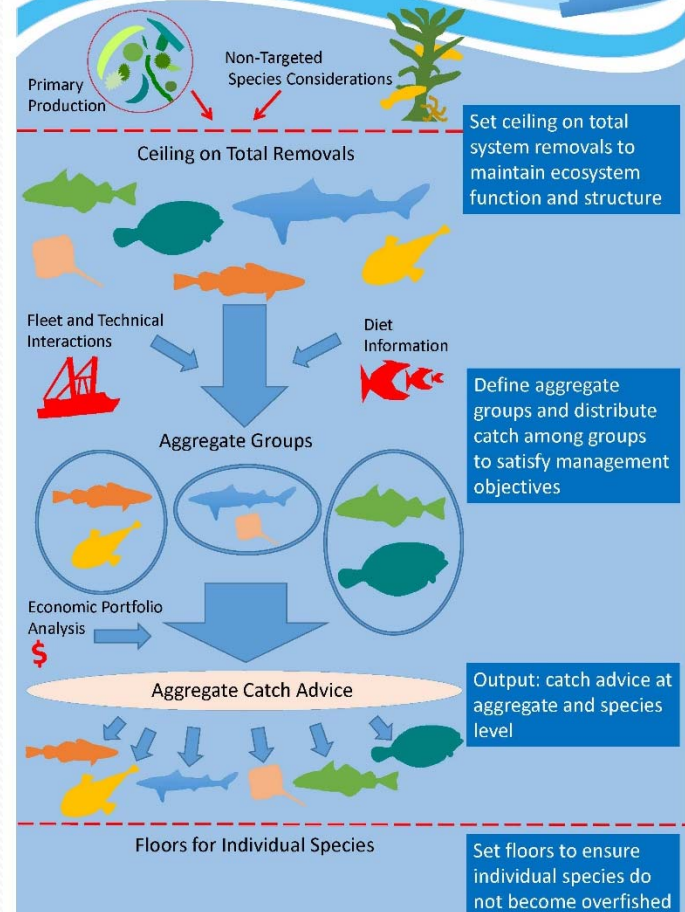
## Conceptual design



# Draft Operational Framework Conceptual design



## Ecosystem Based Fishery Management Strategy Framework



Amanda Hart UMass Dartmouth

# Progress

- Peer review issue
- June 8: PDT reviewed improvements to trophic multispecies models, scaled to abundance and biomass
  - Follow up meeting planned to develop and package “worked example”





# Progress

- PDT asked to provide 'a detailed "worked example" of the approach using actual current estimates'
  - More comprehensive (than the 10-species demonstration presented) about how stock complex control rules would be applied and also be clearer about how an ecosystem catch cap is derived from and is based on measures of primary productivity



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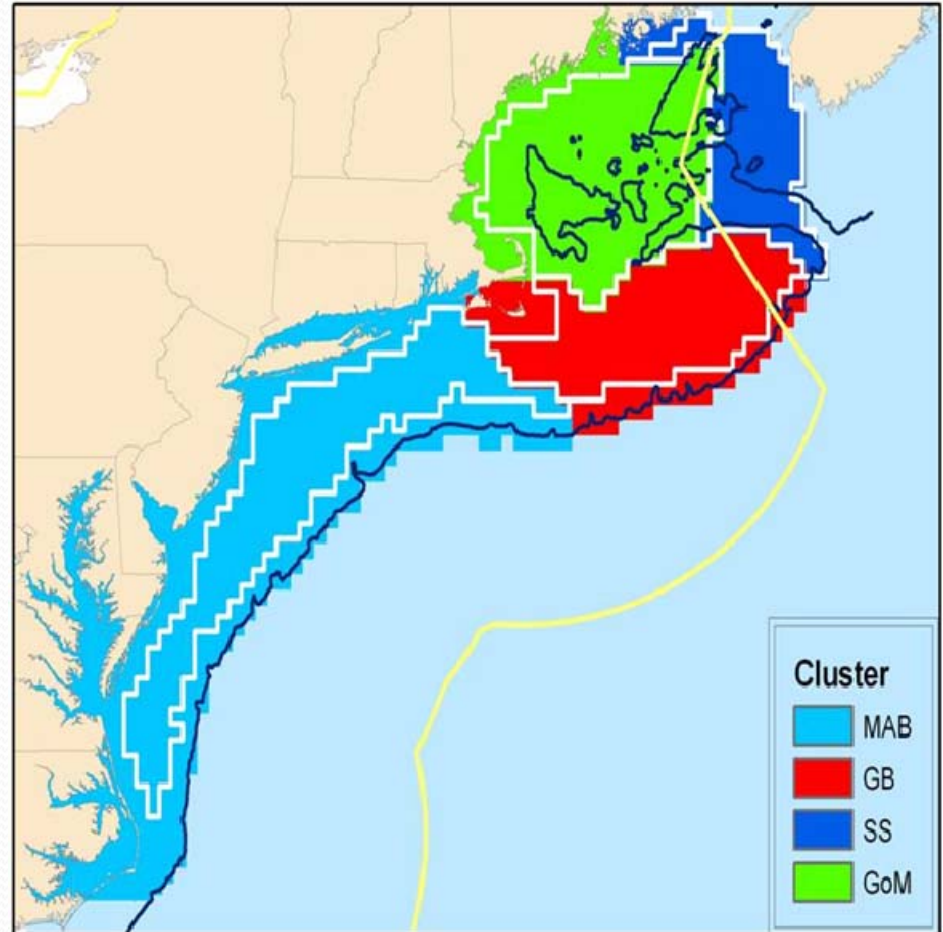
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# EBFM terminology

| Term                      | Definition  |
|---------------------------|---|
| Ecosystem Production Unit | An area specification that is chosen to contain species that interact more with each other than with species that occur elsewhere |

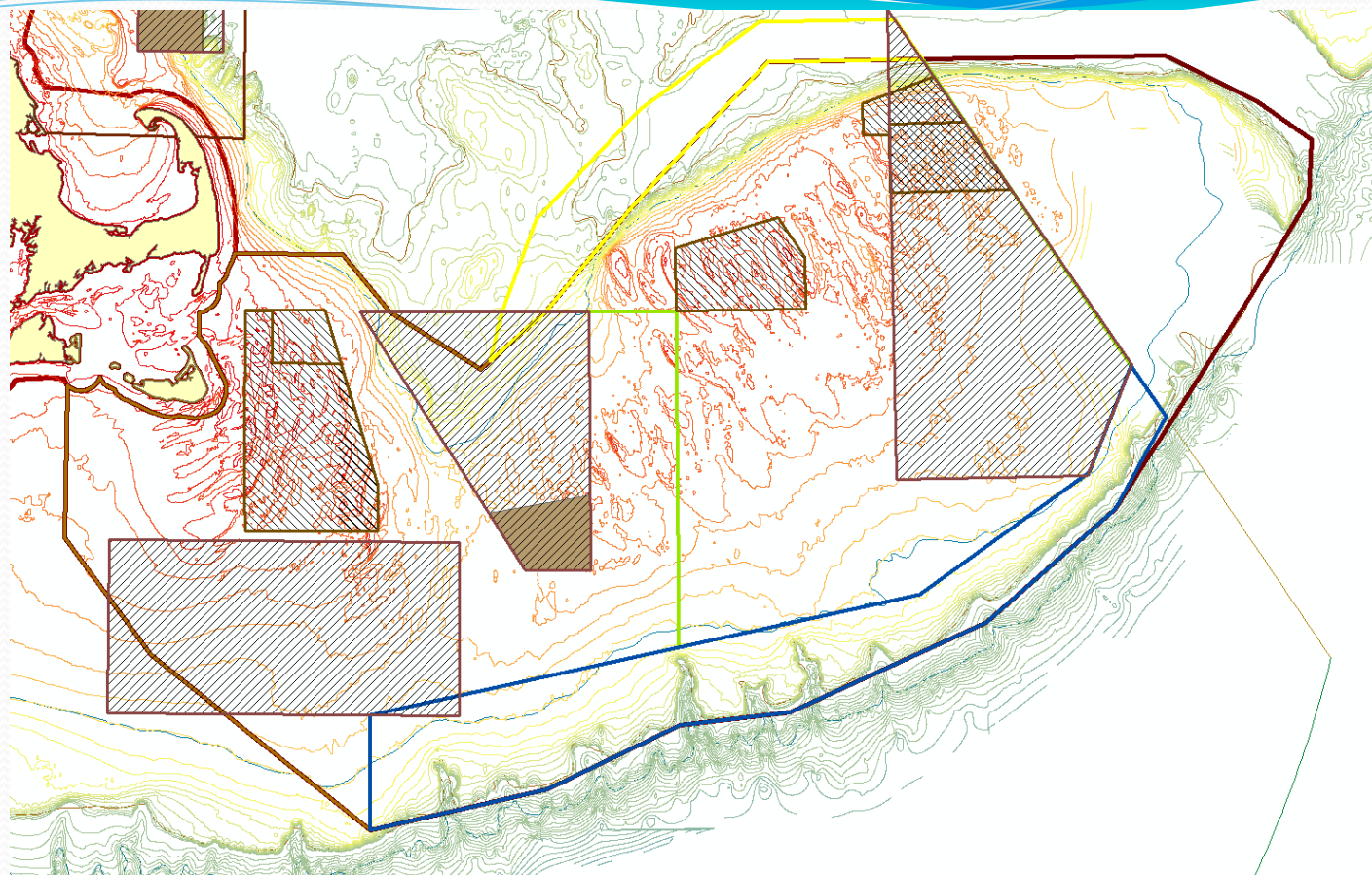


# Ecosystem Production Units Fogarty et al 2011

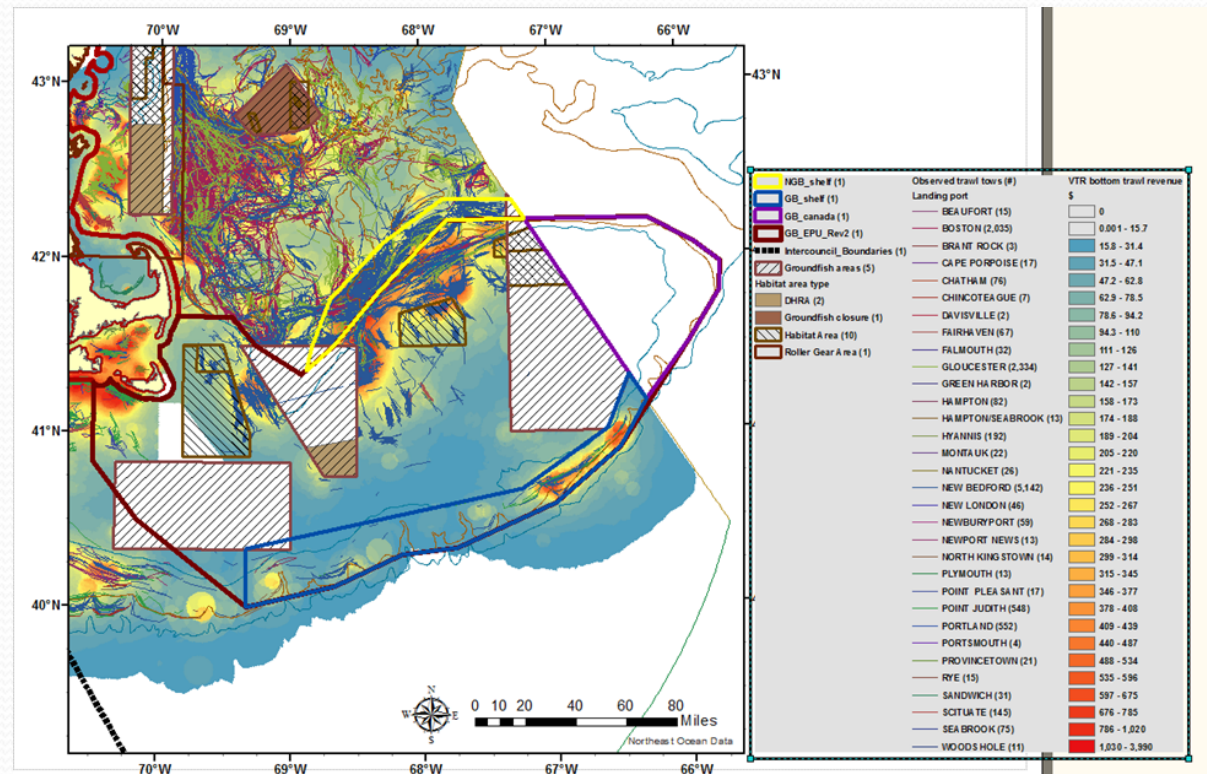




**Georges Bank  
EPU  
Bathymetry  
and Area  
management**



# Georges Bank EPU and 2015 trawl fishing



# EBFM terminology

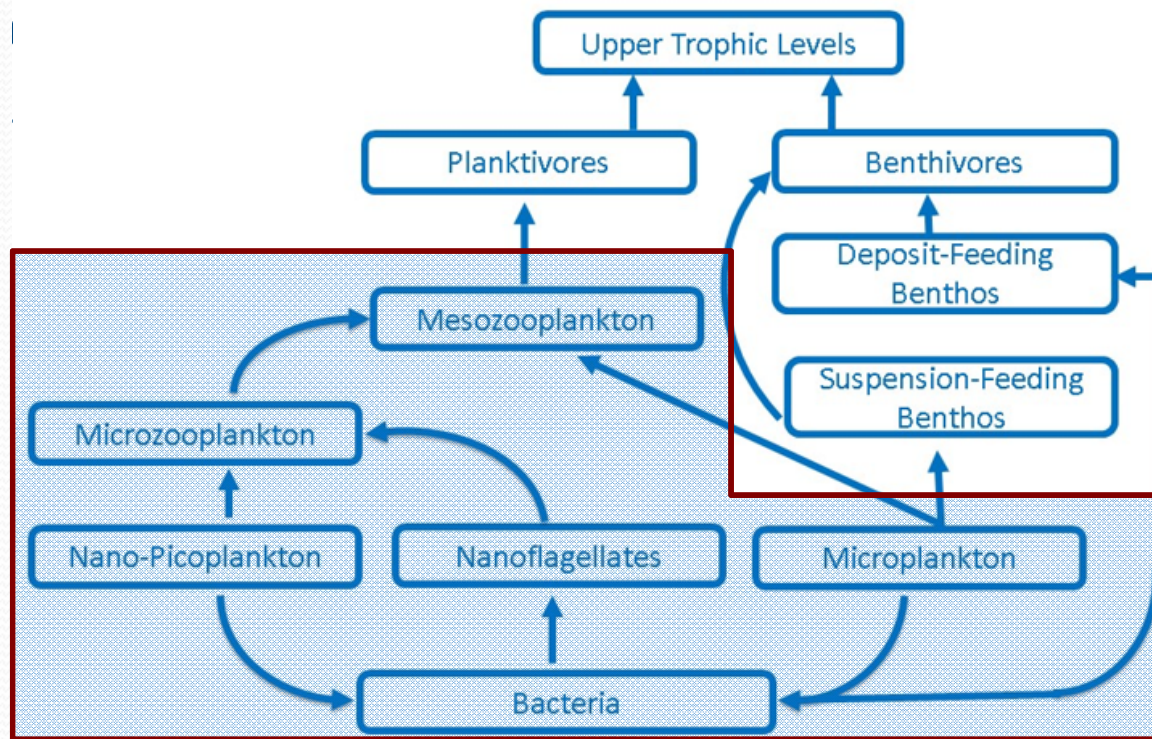
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| Trophic                   | Interactions between predators and prey species.  |
| Feeding guild             | Groups of species having similar diets  |

**“You are what you eat”**





## Trophic links - prey





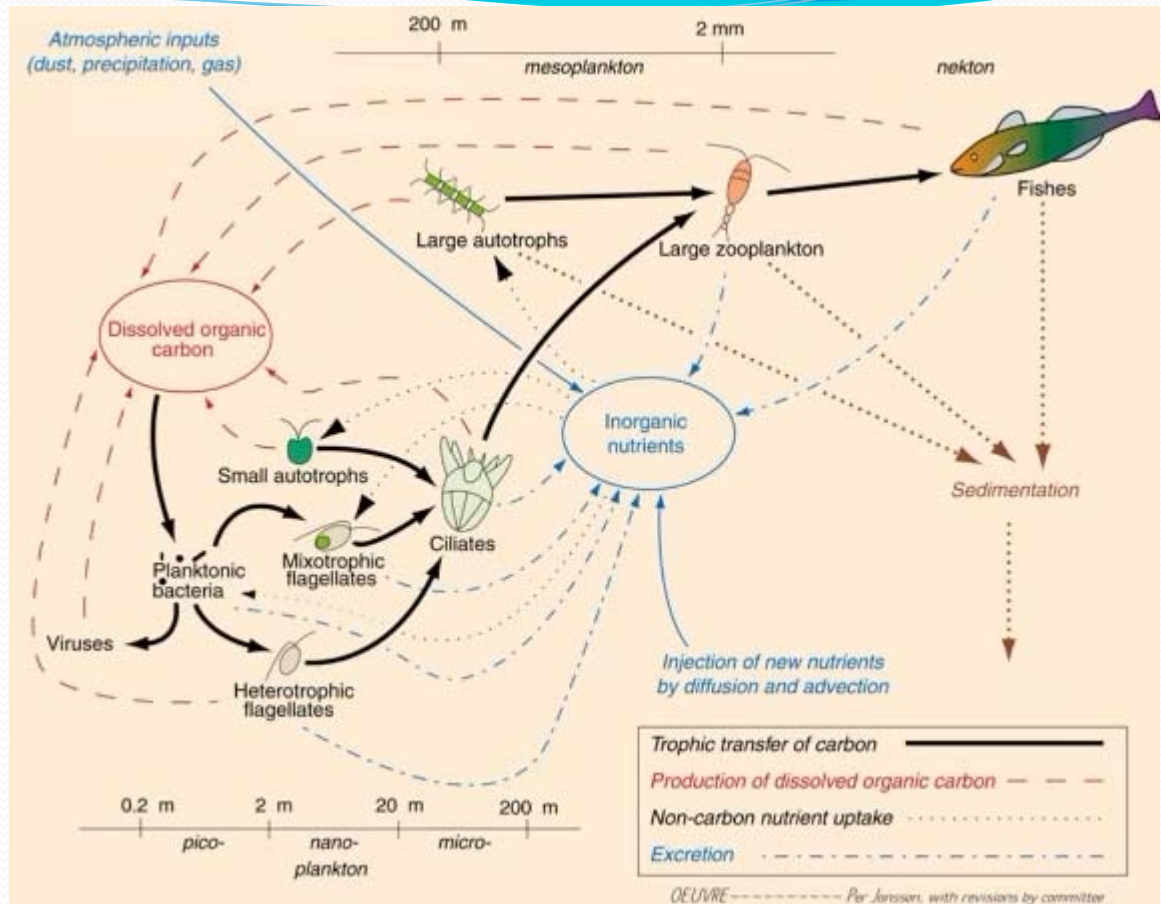
# Plankton (classified by size)

<https://www.nefsc.noaa.gov/ecosys/ecosystem-ecology/zooplankton.html>

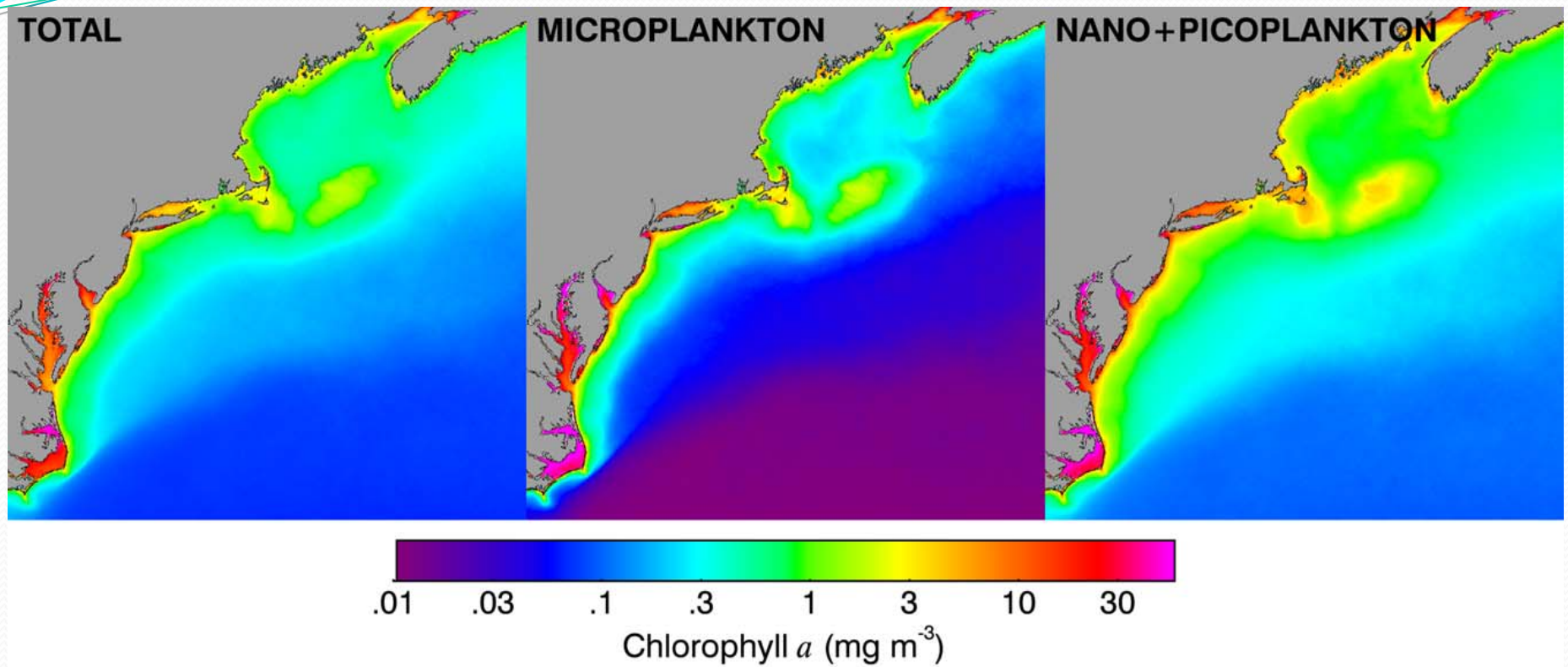
| Guild              | Size range<br>(Schutt 1892;<br>Sieberth et al. 1978) | Examples   |
|--------------------|--|--|
| Bacteria           | < 0.2 $\mu\text{m}$                                  | Nutrient recyclers; grazed by nano-flagellates                             |
| Nano-pictoplankton | 0.2-20 $\mu\text{m}$                                 | Cyanobacteria (blue-green algae, spring bloom)                             |
| Nano-flagellates   | 2-20 $\mu\text{m}$                                   | Flagellates  |
| Microplankton      | 20-200 $\mu\text{m}$                                 | Diatoms (winter bloom)<br>Dinoflagellates and ciliates                     |
| Microzooplankton   | 20-200 $\mu\text{m}$                                 | Protozoans (unicellular) and ciliates                                      |
| Mesoplankton       | 0.2-20 mm  | Copepods ( <i>Calanus finmarchicus</i> ) and<br><b>Euphausiids</b> (krill) |

# Marine ecosystem food web

Presentation by  
Heidi Sosik



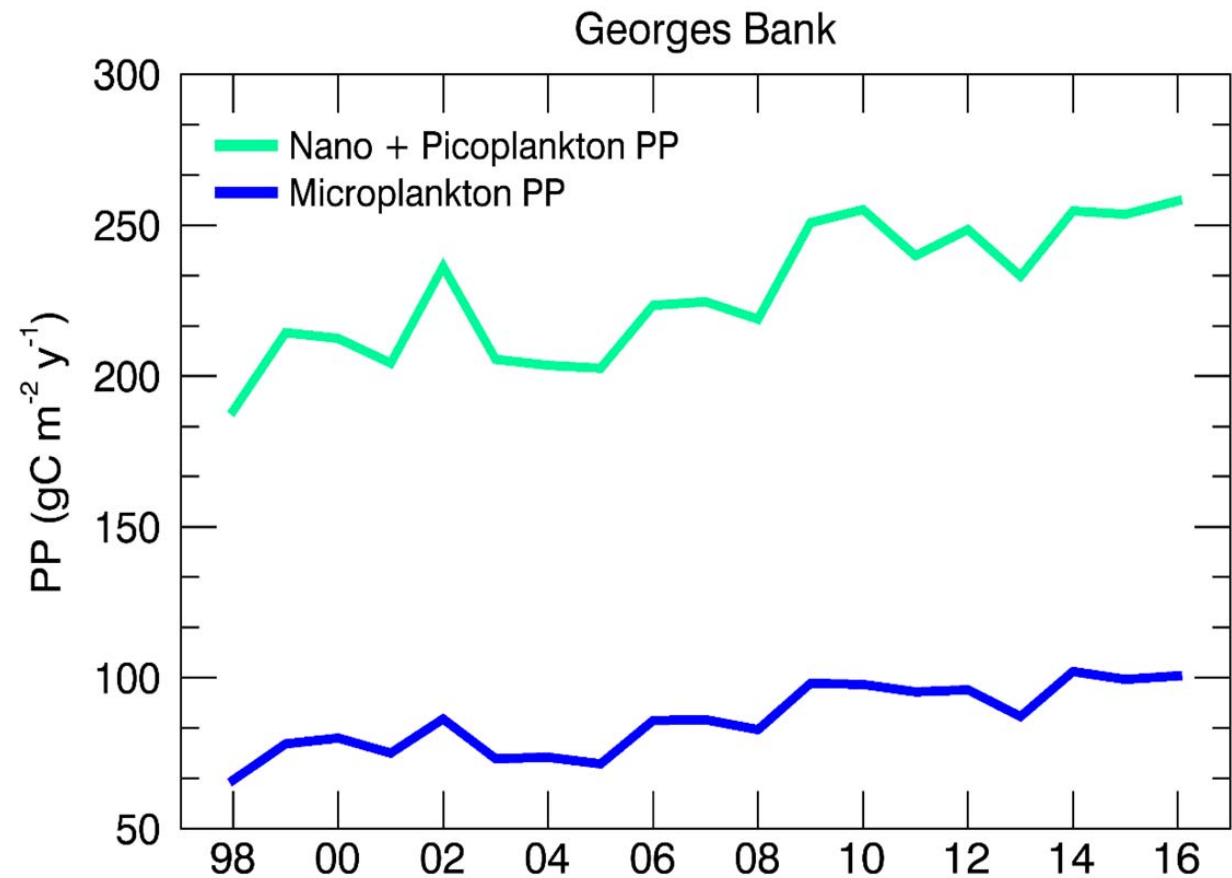
# Primary productivity



Pan 2010 & 2011

## Primary productivity

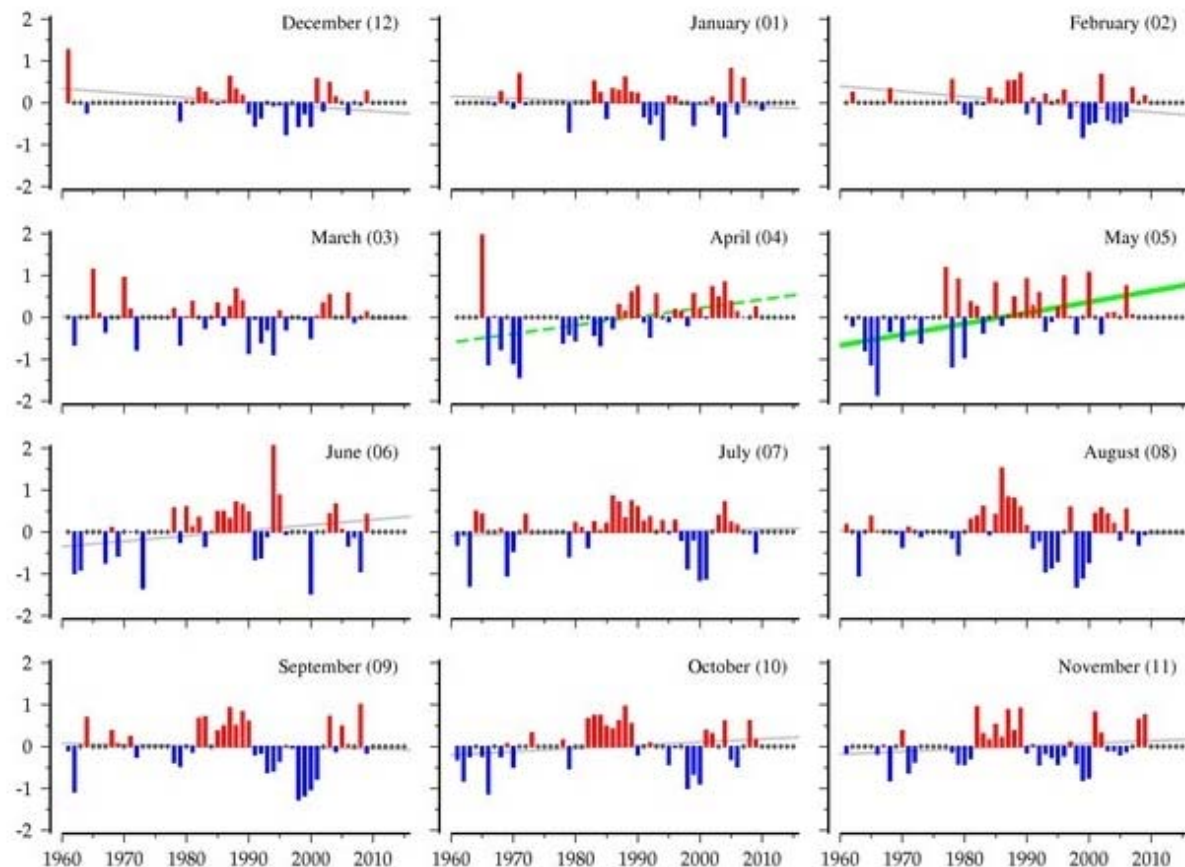
“Exploitation  
rate should not  
exceed the  
fraction of  
microplankton  
production in  
the system”  
~24 – 28 %  
Hyde & Fogarty





# *C. finmarchicus* Seasonal Trends NOAA Fisheries ECOMON

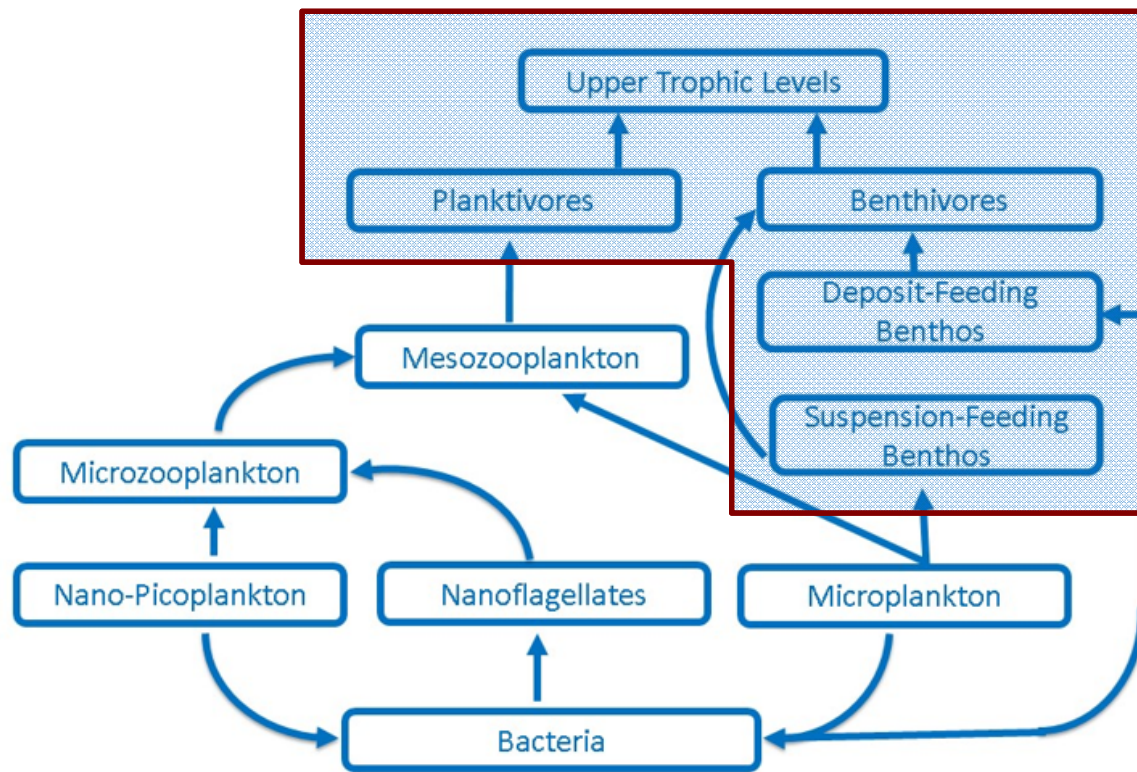
<http://www.st.nmfs.noaa.gov/copepod/time-series/us-50105/>



*Calanus finmarchicus* V-VI (N 100m<sup>-3</sup>)

EcoMon Gulf of Maine CPR line (Gulf of Maine)

## Trophic links - predators



# Feeding guilds

## Predators with common types of diets

| Guild               | Definition  |
|---------------------|---|
| Benthos             | Suspension and deposit feeders, principally crustaceans and mollusks              |
| Benthivores         | Predators of species in the benthos category                                      |
| Mesoplanktivores    | Predators of mesozooplankton, principally copepods                                |
| Macroplanktivores   | Predators of macrozooplankton, principally amphipods but including decapod shrimp |
| Macrozoo-Piscivores | Predators of macrozooplankton and fish  |
| Piscivores          | Predators of fish   |
| Apex Predators      | Typically large, fast moving predators that feed at the top of the food web       |





## Functional groups

| Common Name         | Species                              | Functional Group                     |
|---------------------|--------------------------------------|--------------------------------------|
| Spiny dogfish       | <i>Squalus acanthias</i>             | Demersal Piscivore<br>(Elasmobranch) |
| Winter skate        | <i>Leucoraja ocellata</i>            | Demersal Piscivore<br>(Elasmobranch) |
| Atlantic herring    | <i>Clupea harengus</i>               | Planktivore                          |
| Atlantic cod        | <i>Gadus morhua</i>                  | Demersal Piscivore                   |
| Haddock             | <i>Melanogrammus aeglefinus</i>      | Benthivore                           |
| Yellowtail flounder | <i>Limanda ferruginea</i>            | Benthivore                           |
| Winter flounder     | <i>Pseudopleuronectes americanus</i> | Benthivore                           |
| Atlantic mackerel   | <i>Scomber scombrus</i>              | Planktivore                          |
| Silver hake         | <i>Merluccius bilinearis</i>         | Demersal Piscivore                   |
| Monkfish            | <i>Lophius americanus</i>            | Demersal Piscivore                   |



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| Feeding guild             |  |                  |            |         |                       |                        |                      |           |             |                           |                |       |
|---------------------------|--|------------------|------------|---------|-----------------------|------------------------|----------------------|-----------|-------------|---------------------------|----------------|-------|
| Fishery                   | Value<br>Total biomass,<br>'000 mt<br># of Species | Apex<br>Predator | Benthivore | Benthos | Macro-<br>planktivore | Macrozoo-<br>piscivore | Meso-<br>planktivore | Piscivore | Planktivore | Planktivore<br>-Piscivore | Small<br>Shark | Total |
| Bottom trawl              | Biomass  |                  |            |         | 34.3                  |                        |                      | 569.1     |             | 0.0                       |                |       |
|                           | Species  |                  | 10         |         | 4                     | 7                      |                      | 10        |             | 1                         |                | 32    |
| Mid-water<br>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<br>recreational  | Biomass  |                  |            |         | 10.8                  |                        |                      | 569.1     |             | 0.0                       |                |       |
|                           | Species  |                  | 12         |         | 4                     | 6                      |                      | 10        |             | 1                         |                | 33    |
| Pelagic<br>recreational   | Biomass  |                  |            |         |                       |                        |                      | 5.6       | 50.8        |                           |                |       |
|                           | Species  | 4                |            |         |                       |                        |                      | 1         | 1           |                           |                | 6     |
| P. species<br>consumption | Biomass  |                  |            |         | 30.3                  |                        |                      |           |             |                           |                |       |
|                           | Species  |                  |            |         | 2                     |                        | 4                    |           |             |                           |                | 6     |
| Ecosystem<br>component    | Biomass  |                  |            |         |                       |                        |                      | 34.5      |             |                           |                |       |
|                           | Species  | 1                | 9          | 1       | 3                     | 3                      |                      | 4         | 1           |                           |                | 30 22 |

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| Feeding guild             | Groups of species having similar diets  |
| Functional group          | Species that are commonly caught together and have similar ecological characteristics   |
| Operating model           | A model that simulates a realistic ecosystem to test alternative management strategies  |
| Assessment model          | A model that estimates population size(s) and acceptable levels of catch to achieve desired outcomes                              |



## Trophic-based operating models

- Account for primary productivity and predation effects on managed species
  - Gut content observation and analysis -> estimate consumption
  - Relative population size of predators
- Censored models vs. holistic models
- Climate-driven structural ecosystem changes



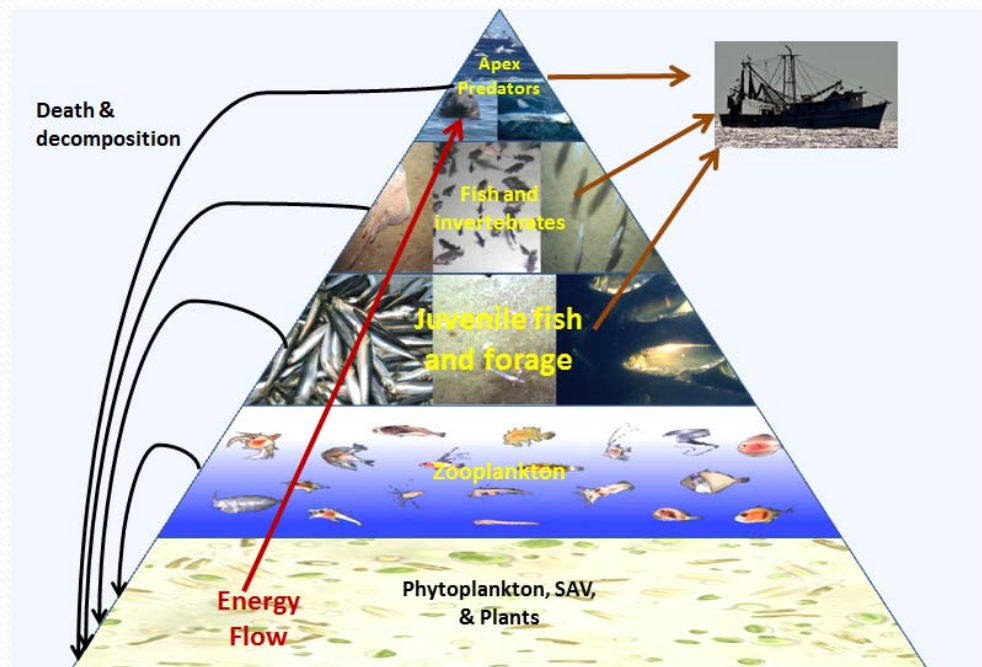
## Example Fishery Ecosystem Plan Conceptual Framework

- Account for trophic interactions
  - Multispecies ecosystem models (under development)
  - Focus on Georges Bank ecosystem
- ‘Functional group’ based catch limits (ACL)
  - Defines overfishing at ecosystem and guild level
- Overfished/depleted – actions to reduce risk to single species



# Term: Performance metrics

- Direct and indirect benefits to:
  - Commercial and recreational fishermen
  - Ocean users of various sorts
  - Ocean dependent communities





## **Fishery Ecosystem Plan Goals** **From Discussion Document I (April 2016):**

<http://s3.amazonaws.com/nefmc.org/Document-3-Draft-Fishery-Ecosystem-Plan-Outline.pdf>

*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 Strategic 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






## **Fishery Ecosystem Plan**

### **7 Operational Objectives**

1. Ecosystem and community/aggregate fishing mortality and or total catch is below established dynamic threshold (Strategic Objective 1)
2. Fishing-related mortality for threatened/endangered/protected species is minimized (could establish caps if desired)
3. Managed and protected species biomass is above established minimum threshold (Strategic Objectives 1 and 3)






## **Fishery Ecosystem Plan**

### **7 Operational Objectives**

- 4. Maintain ecosystem structure within historical variation, recognizing inherent dynamic properties of the system; Ecosystem structure includes size structure, trophic structure, and functional group structure. (Strategic Objective 3)
- 5. Maintain habitat productivity and diversity (Strategic Objective 4)
- 6. Habitat structure and function are maintained for exploited species





## **Fishery Ecosystem Plan**

### **7 Operational Objectives**

7. Minimize the risk of permanent (>20 years) impacts; e.g.
- a) Corals and sponges
  - b) Other vulnerable biogenic habitats
  - c) Coastal habitats vulnerable to Aquatic Invasive Species (AIS)
  - d) Vulnerable physical habitats (e.g. relict glacial gravel banks)

# Questions?

# Thank you

**NEFMC**  
**June 21, 2017**

