



**NOAA
FISHERIES**

Northeast
Fisheries
Science Center

Incorporating Ocean Color Remote Sensing in Ecosystem Based Fisheries Management

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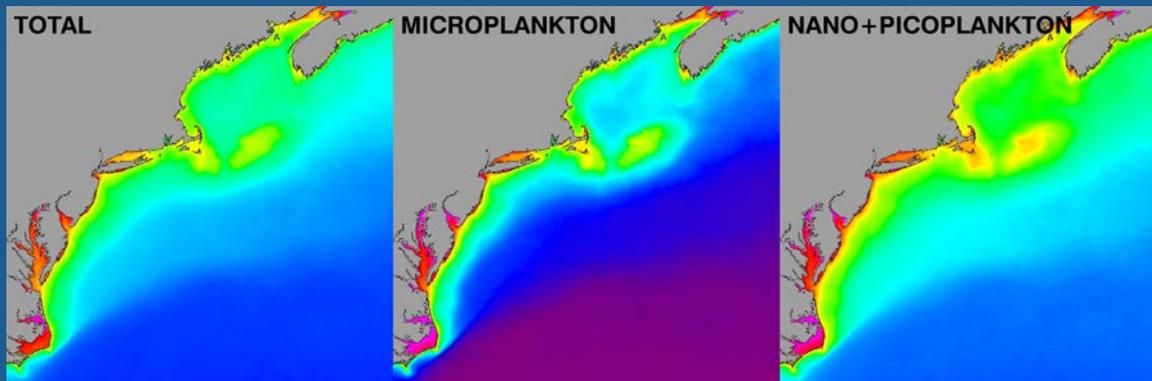
NOAA/NMFS/NEFSC

Ecosystem Based Management

- ❑ Within NOAA there is a strong focus on Integrated Ecosystem Assessments and Ecosystem-Based Approaches to Management, with an increasing emphasis on ecological forecasting.
- ❑ There is also an emphasis to monitor changes in the oceans and how climate changes impact phytoplankton species composition and the marine food web.
- ❑ In this context, there is a need for accurate, timely, consistent and fit for purpose ocean color data/products to support NOAA (NMFS, NOS, OAR) and related users with ongoing coastal, ocean and inland water applications, especially fisheries and broader living marine resource management.

Ocean color remote sensing

- ❑ Documenting, monitoring and forecasting the response of marine ecosystems to environmental variability and climate change
- ❑ Assessing biodiversity
- ❑ Biogeochemical cycling
- ❑ Connections between seasonal blooms (phenology) and recruitment
- ❑ Examining variations in functional groups/size class abundance and distribution patterns (temporally and spatially)
- ❑ Food-web structure and secondary/tertiary production

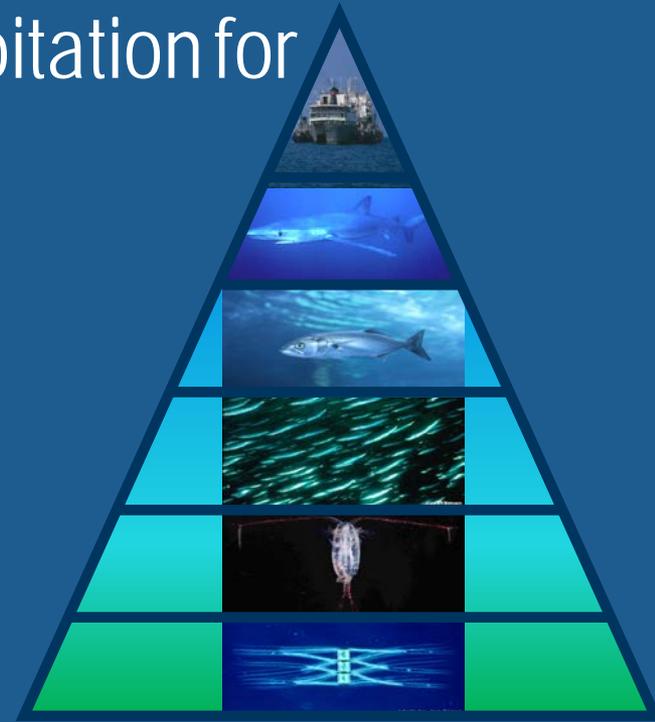


Ecosystem Production Potential

Goal: Use a bottom-up approach to determine fisheries production potential and exploitation for various ecosystem components.

- ❑ Benthos
- ❑ Benthivores
- ❑ Planktivores
- ❑ Piscivores

Question: How efficiently is primary production transferred to higher trophic levels?



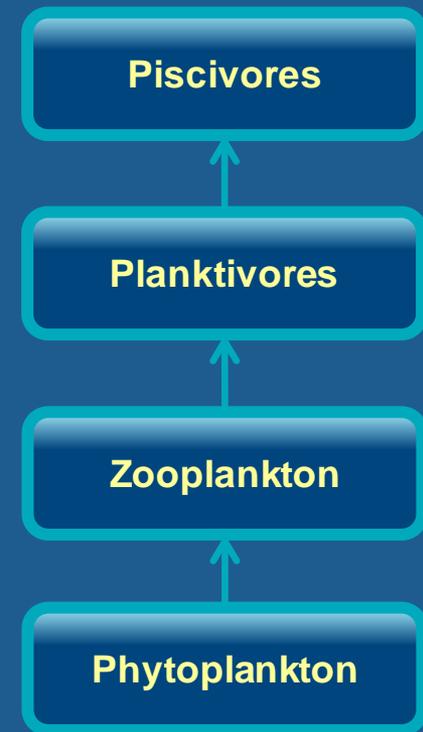
Ecosystem Production Potential - Historical

$$EPP = PP \cdot T^{TL-1}$$

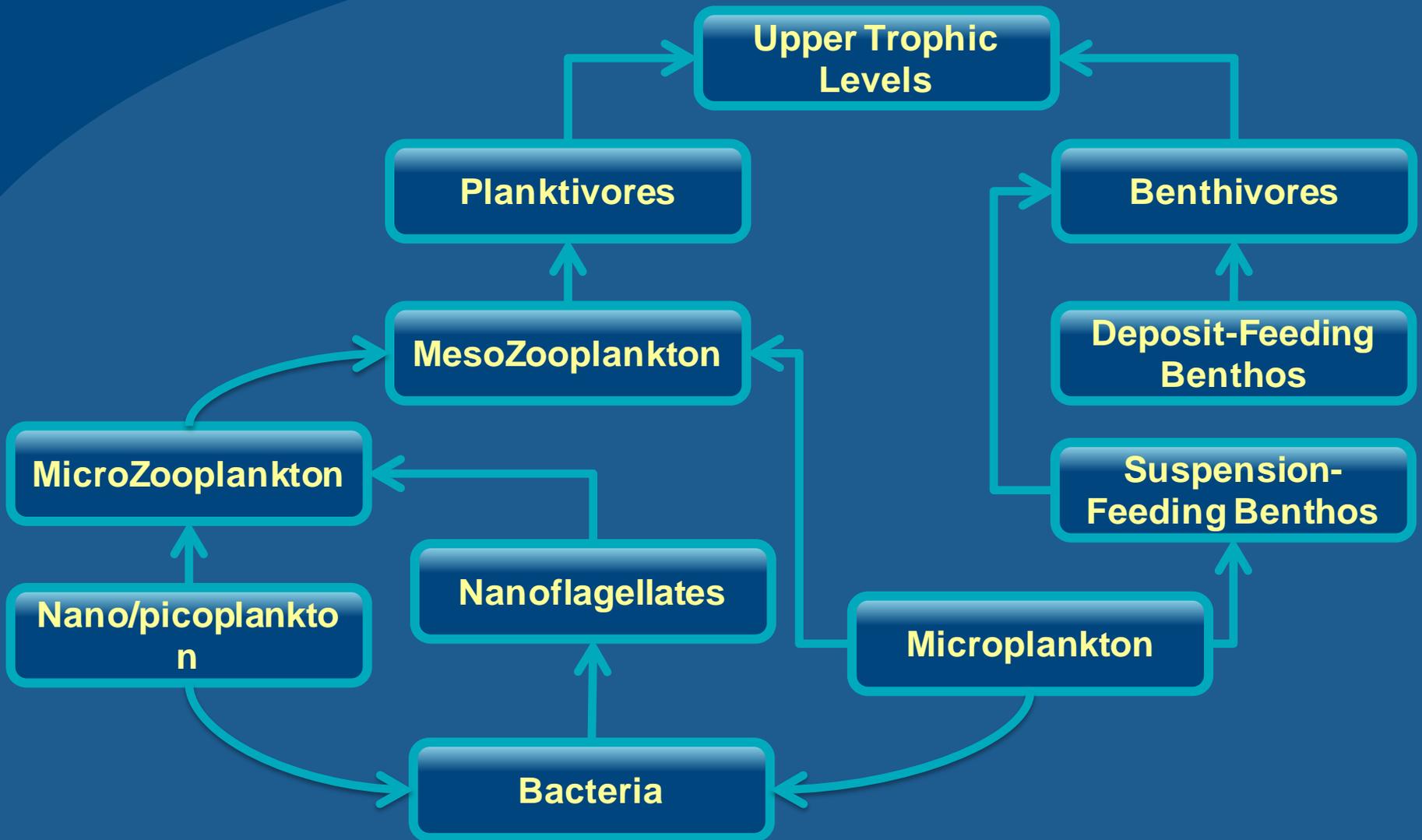
Where **EPP** is Ecosystem Production Potential,
T is the ecological transfer efficiency,
TL is the mean trophic level of the catch.

Historically, an exploitation rate of 50%
was assumed to be sustainable.

(Pauly, 1995 – Fisheries Research)



Ecosystem Production Potential - Model



Ecosystem Production Potential - Model

$$P_i = T \cdot P_j + A_i - F_i$$

Planktivores

Where P_i is Production at the i^{th} node,

T is the matrix of ecological transfer efficiencies,

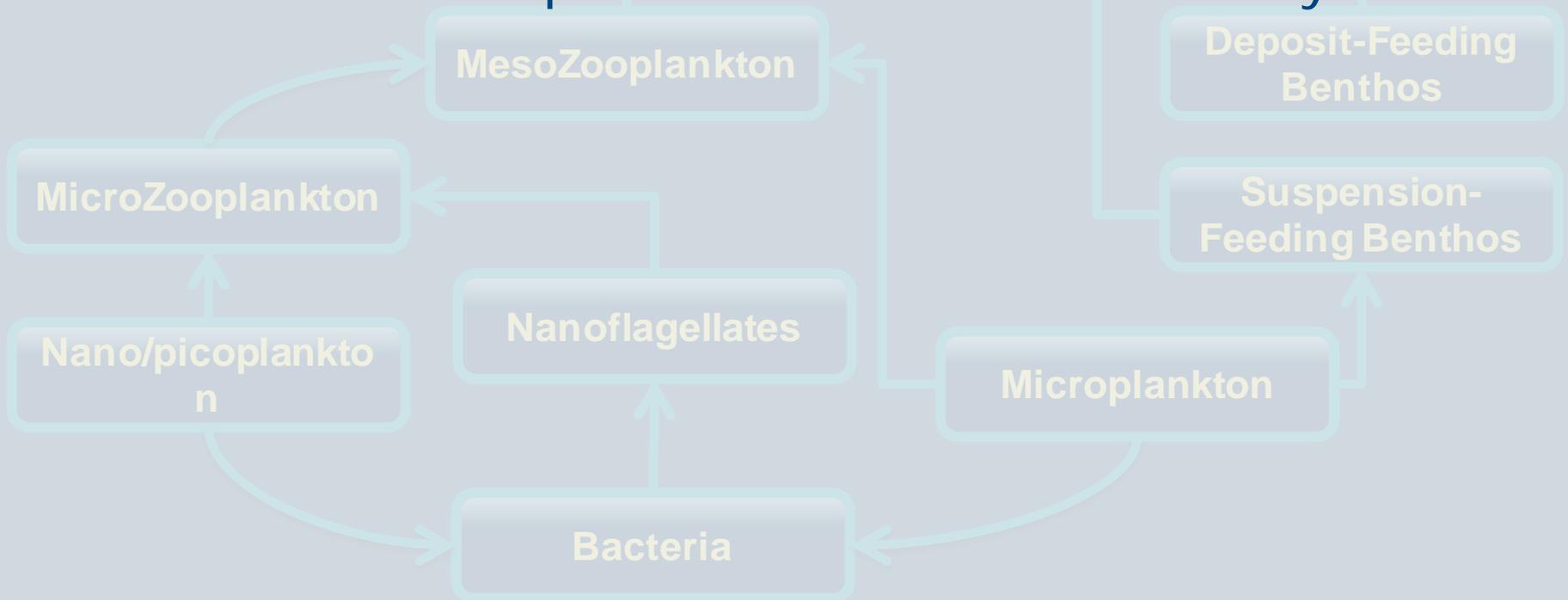
A_i is a vector of external inputs to the i^{th} node, and

F_i is a vector of losses from the i^{th} node.

Ecosystem Production Potential - Model

Proposed Ecosystem Limit Reference Point:

The total Exploitation Rate should not exceed the fraction of Microplankton Production in the System.

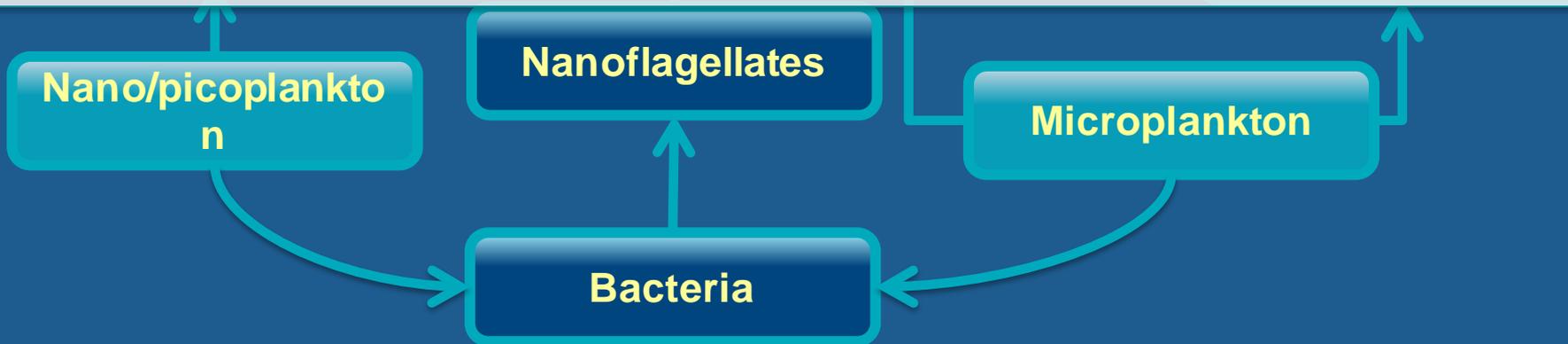


Ecosystem Production Potential - Model

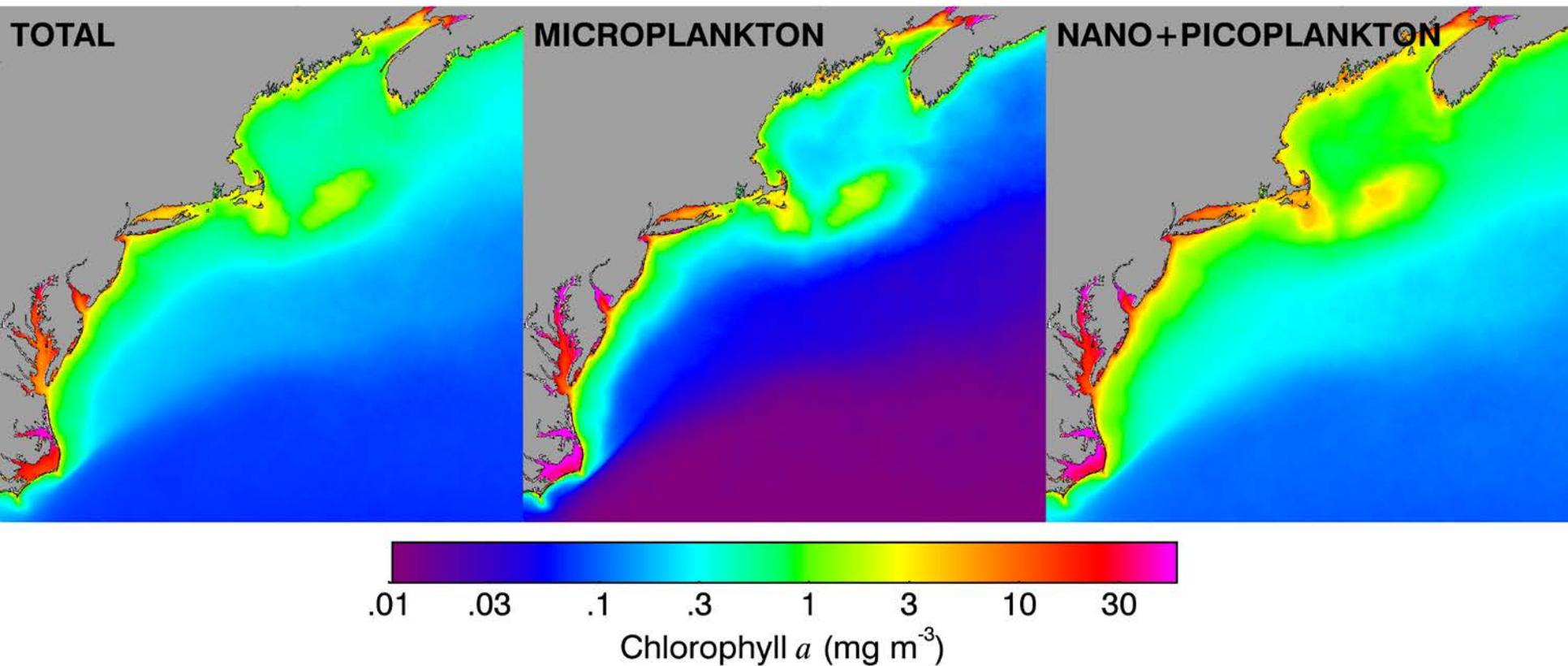
Proposed Ecosystem Limit Reference Point:

The total Exploitation Rate should not exceed the fraction of Microplankton Production in the System.

Use ocean color remote sensing to estimate the fraction of Microplankton Production.



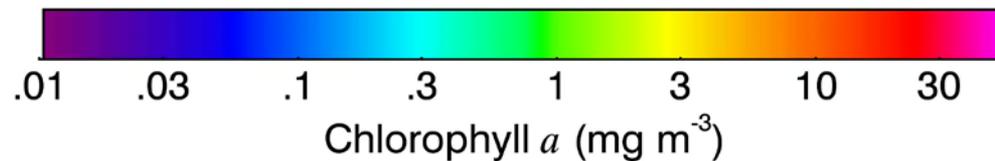
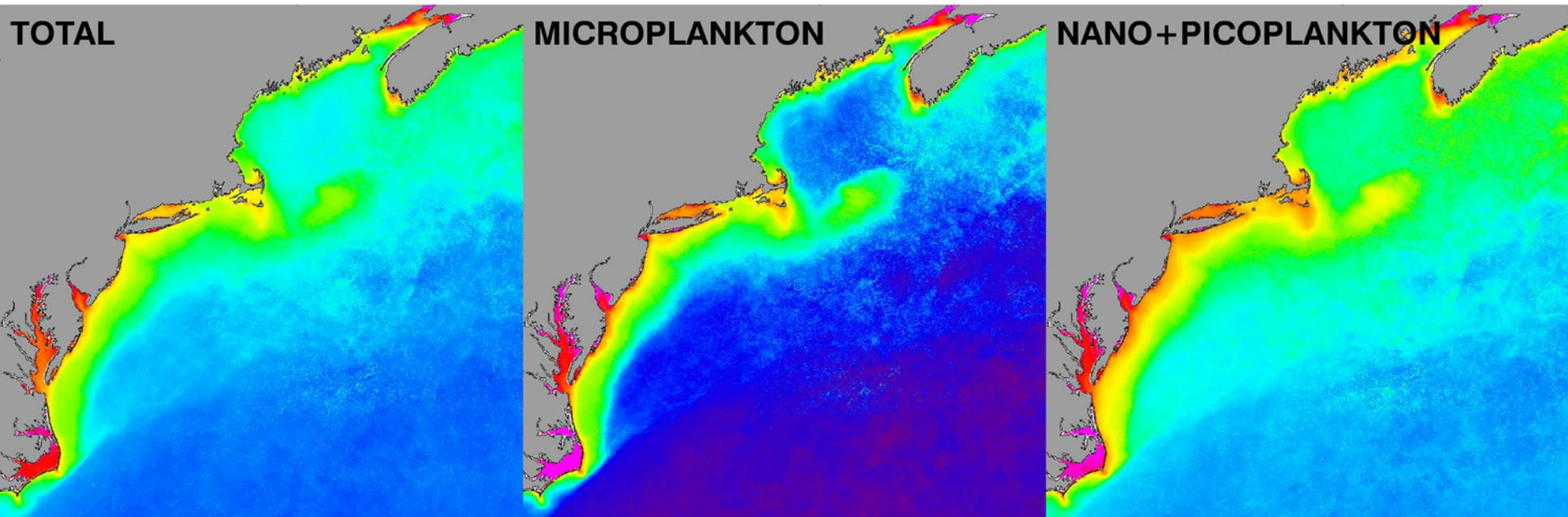
Phytoplankton size classes



Pan et al. 2008 & 2010

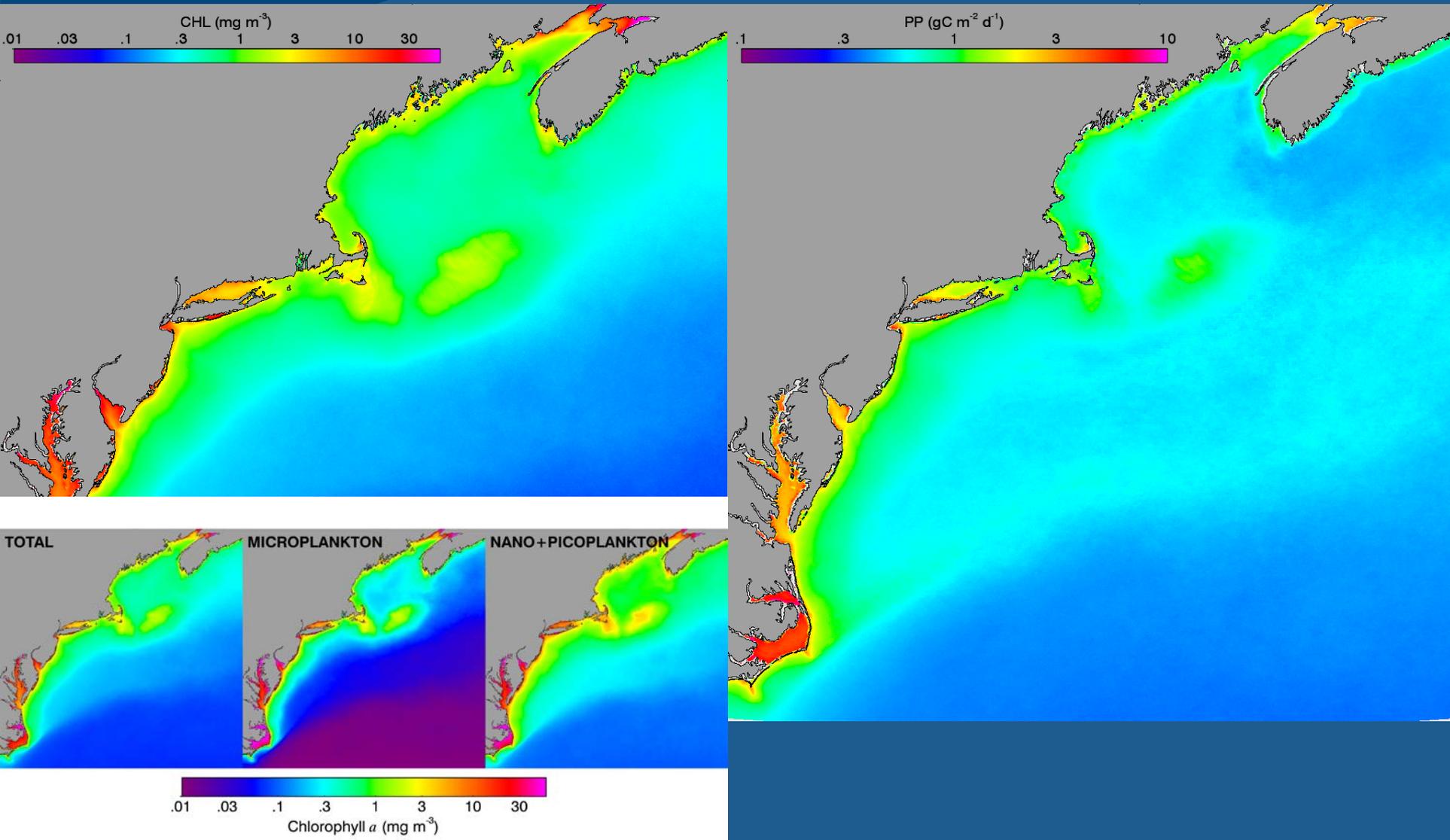
Phytoplankton size classes

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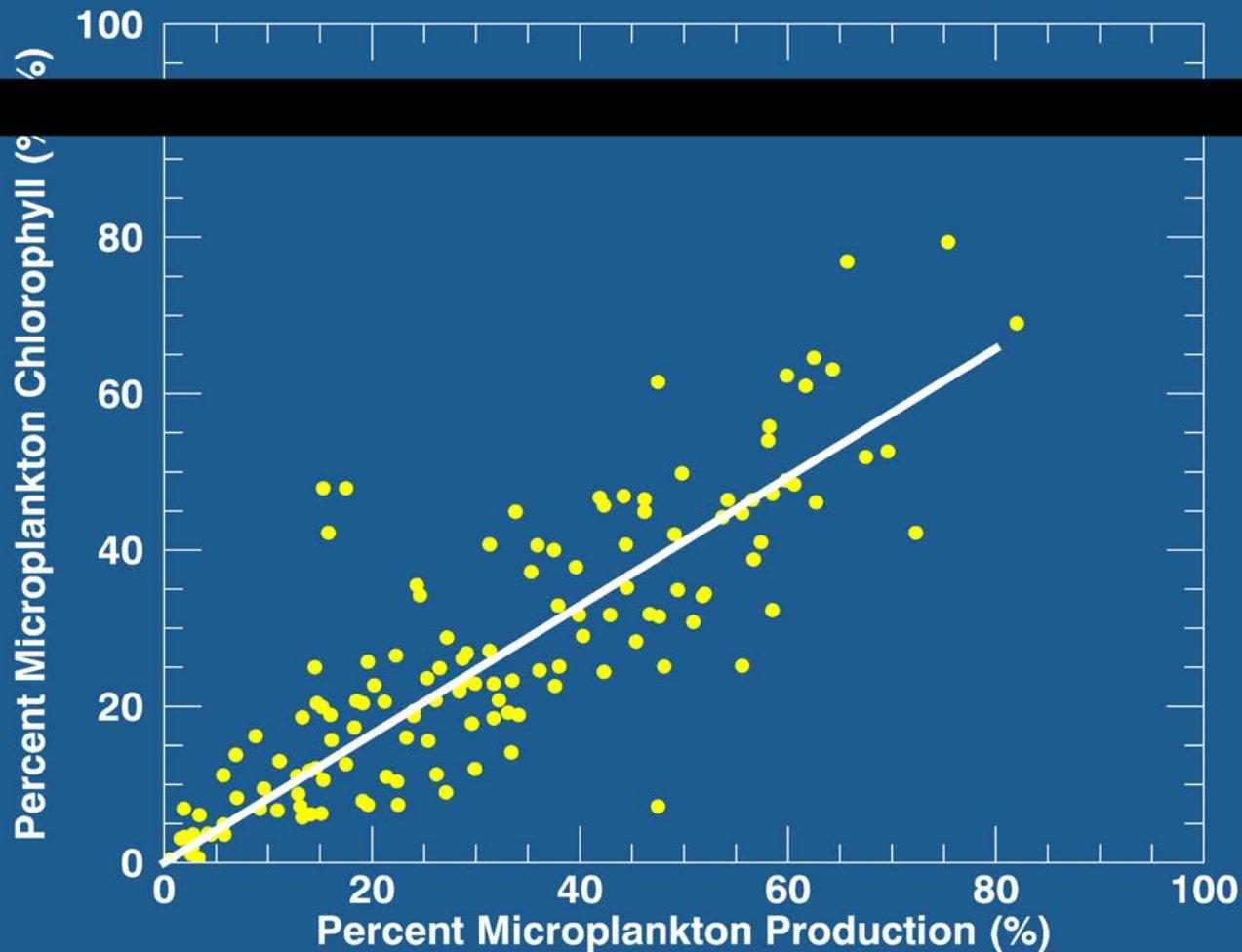


Pan et al. 2008 & 2010

Phytoplankton size classes

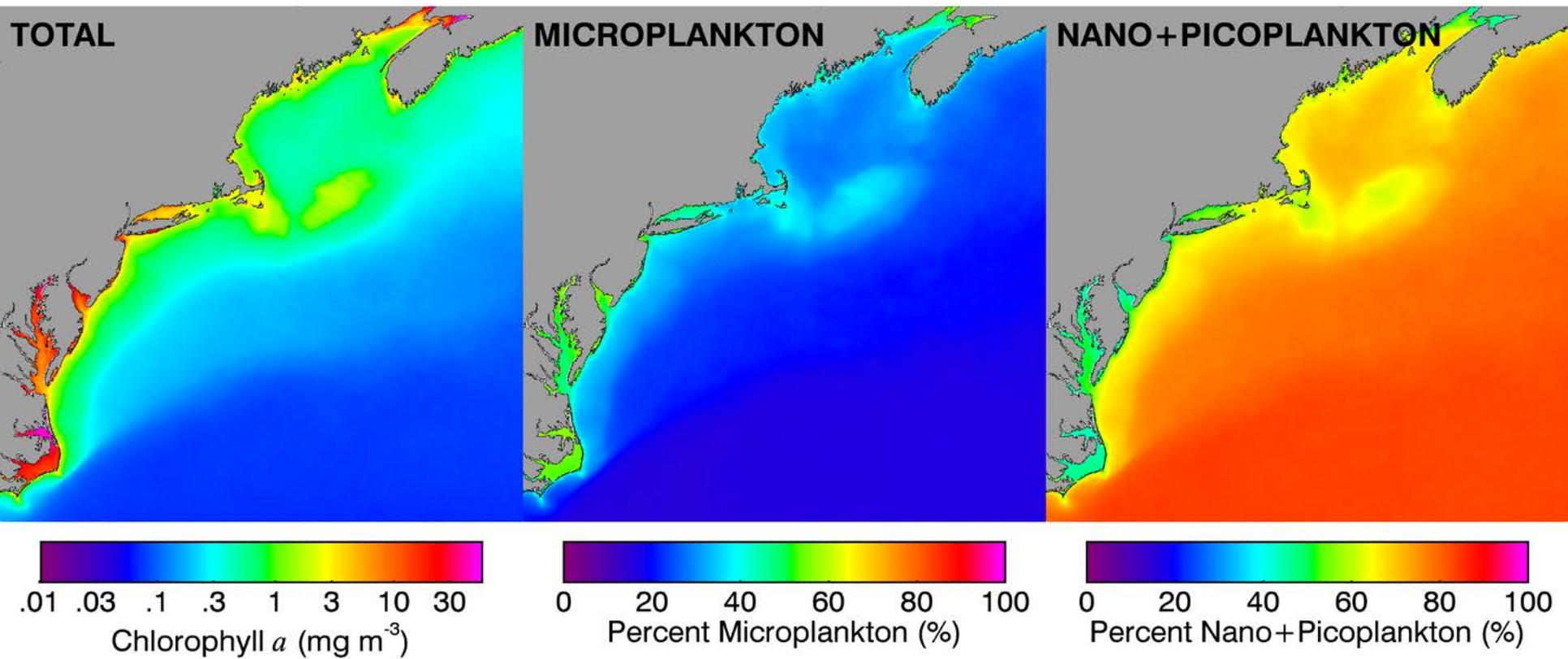


Size Fractionated Primary Production

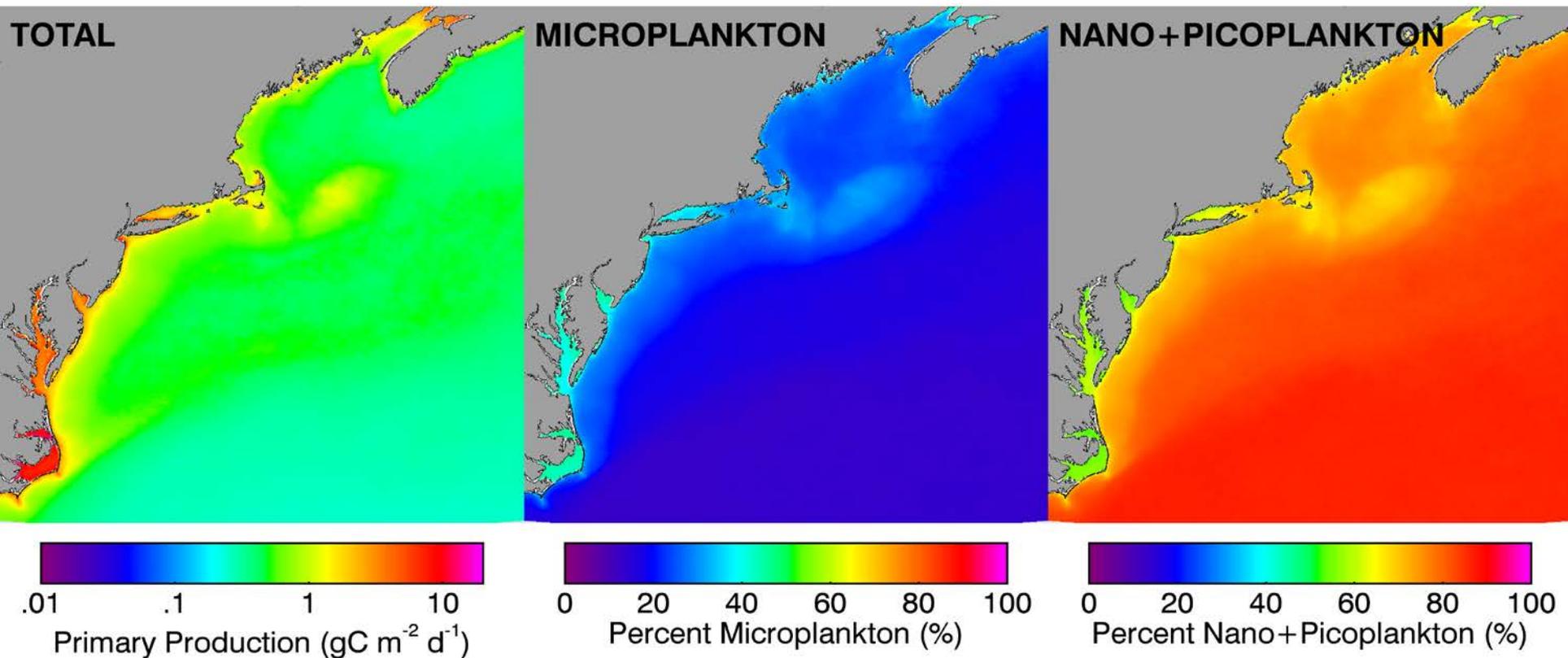


MARMAP - NEFSC

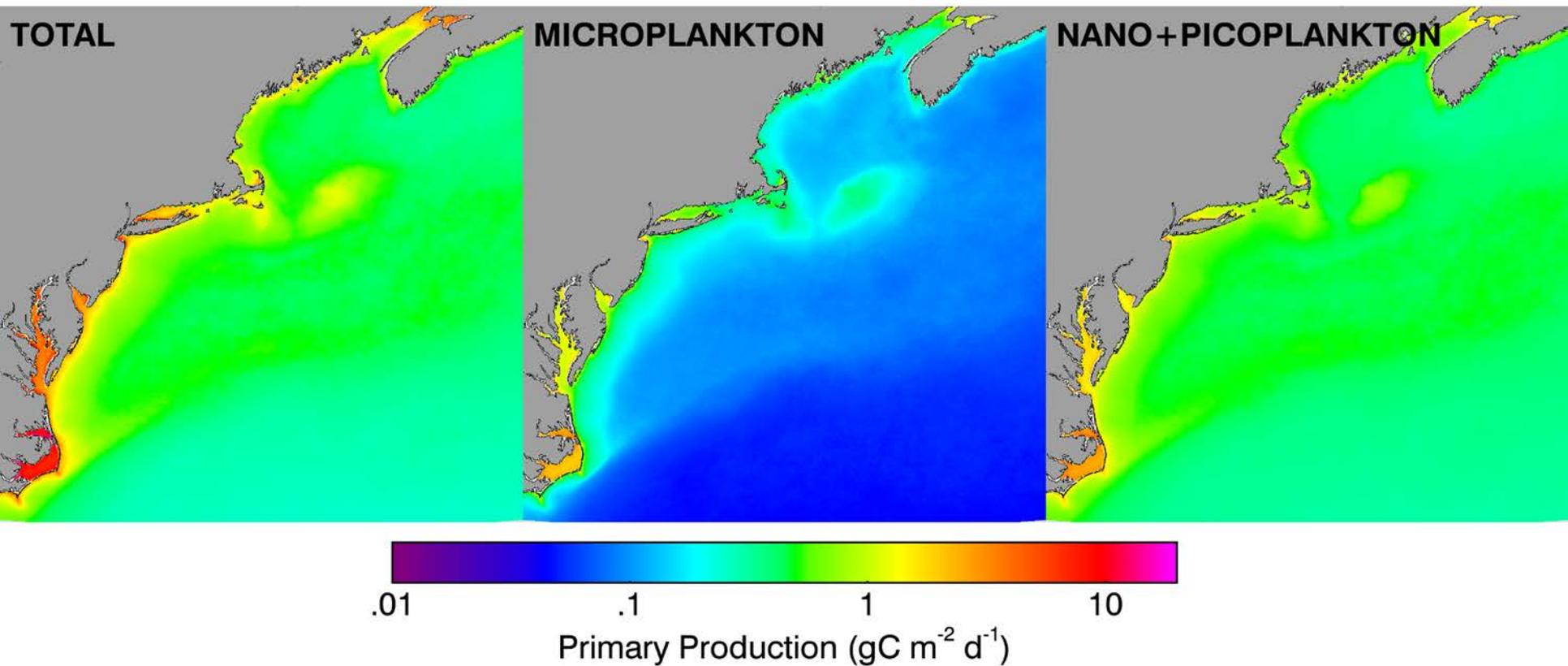
Size Fractionated Primary Production



Size Fractionated Primary Production

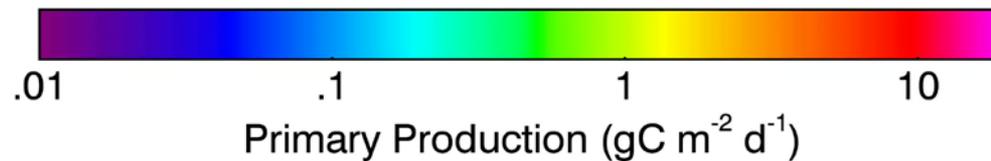
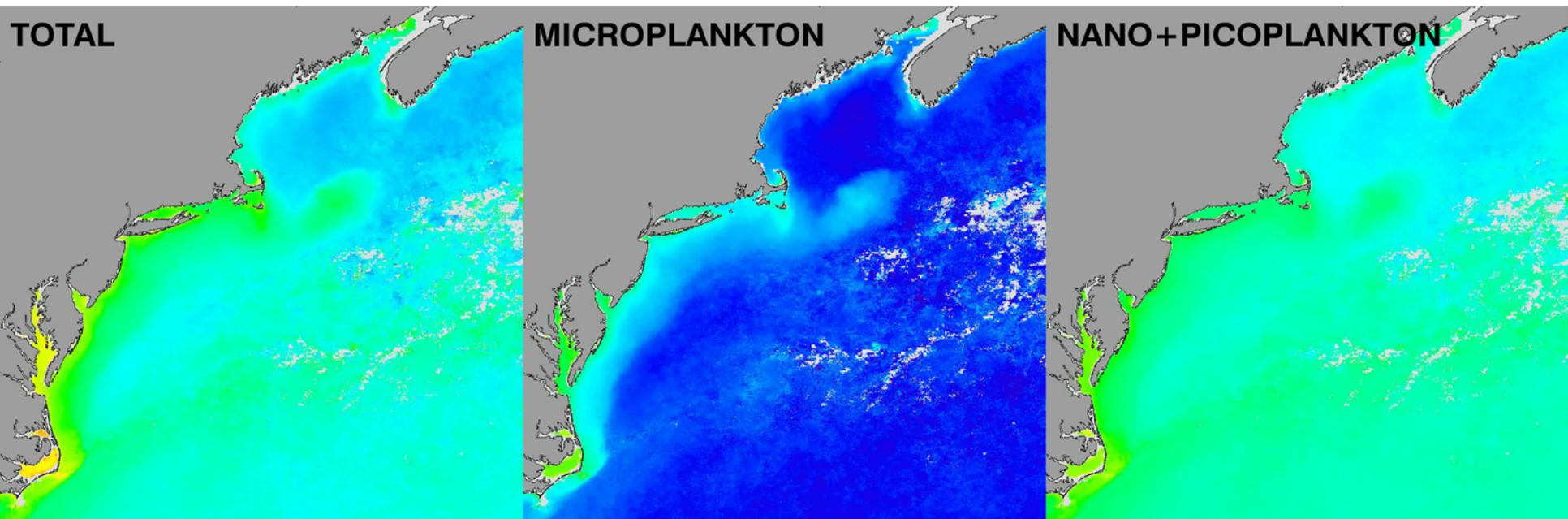


Size Fractionated Primary Production

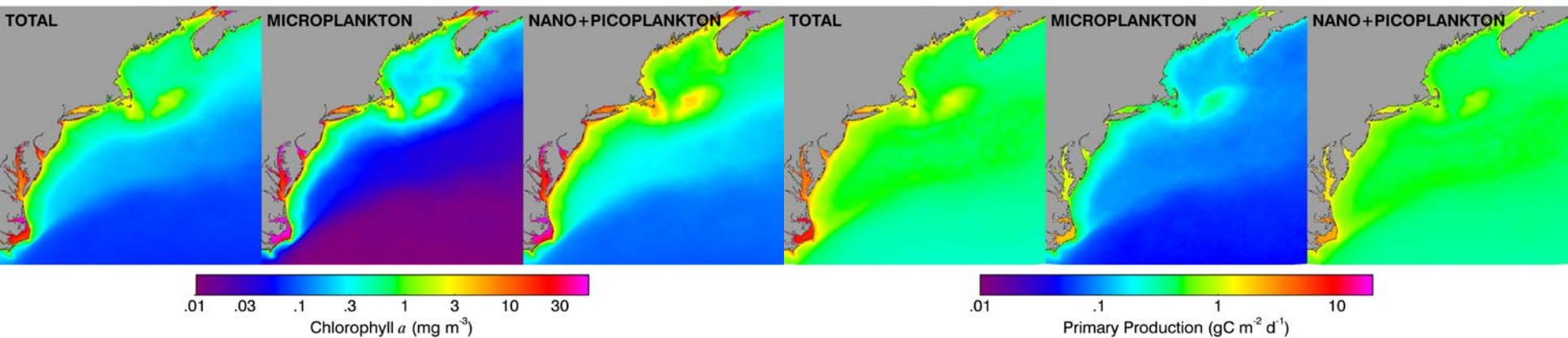
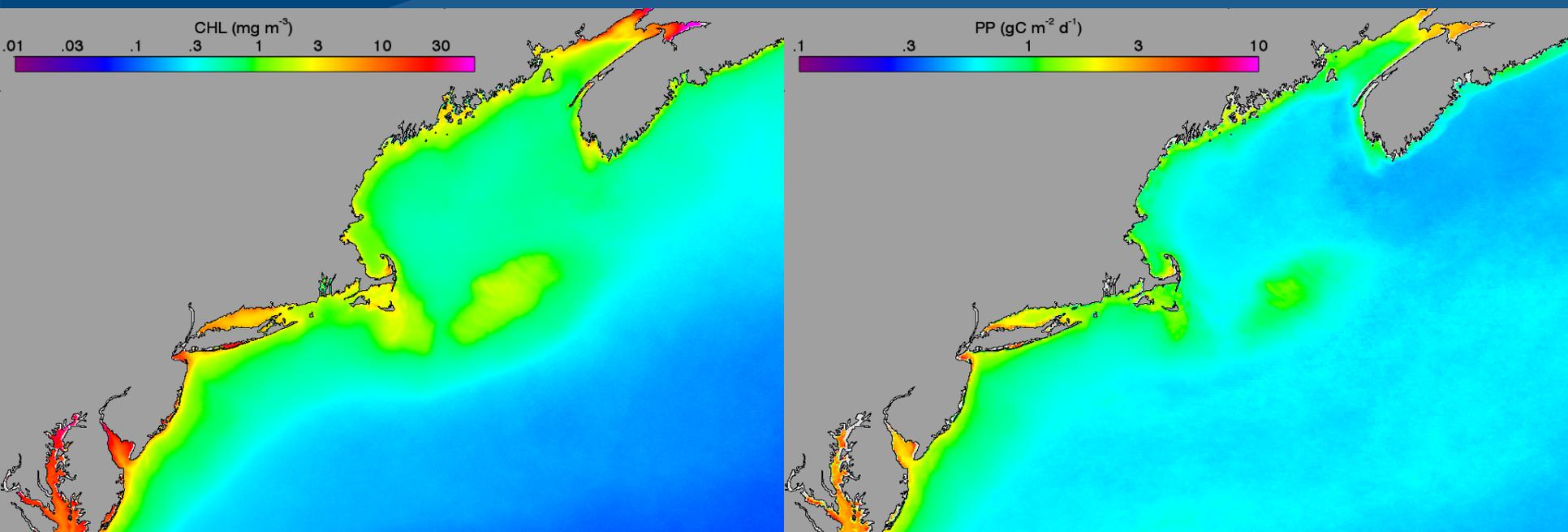


Size Fractionated Primary Production

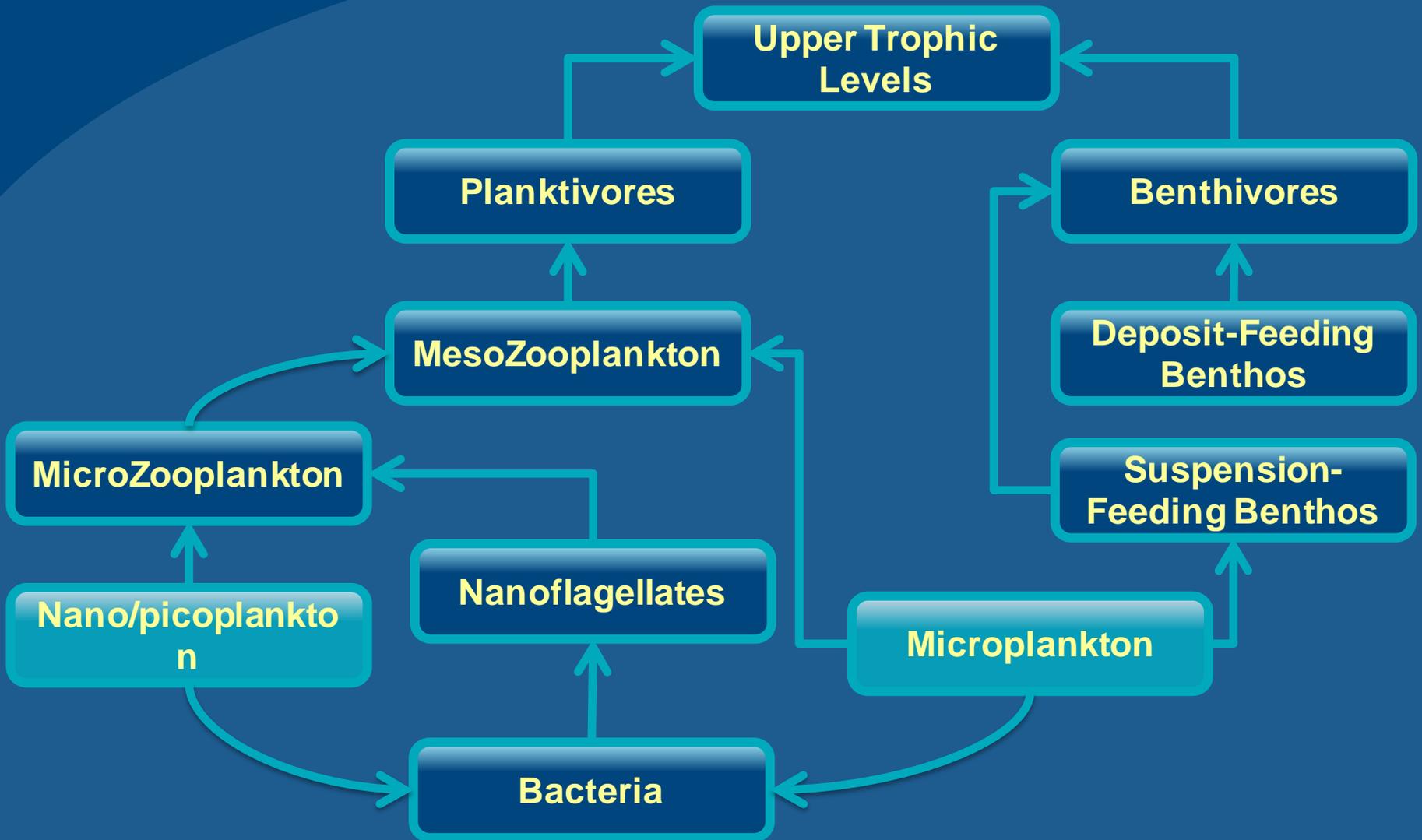
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Size Fractionated Primary Production

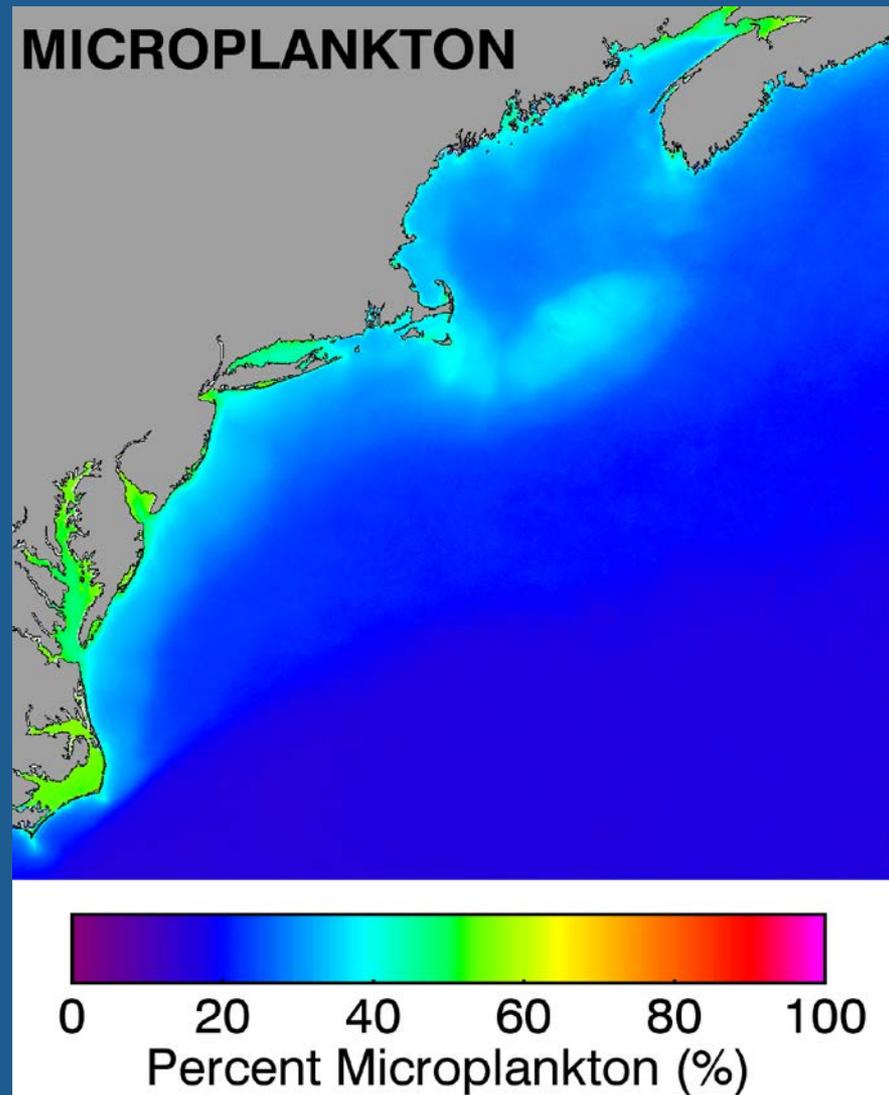


Ecosystem Production Potential - Model



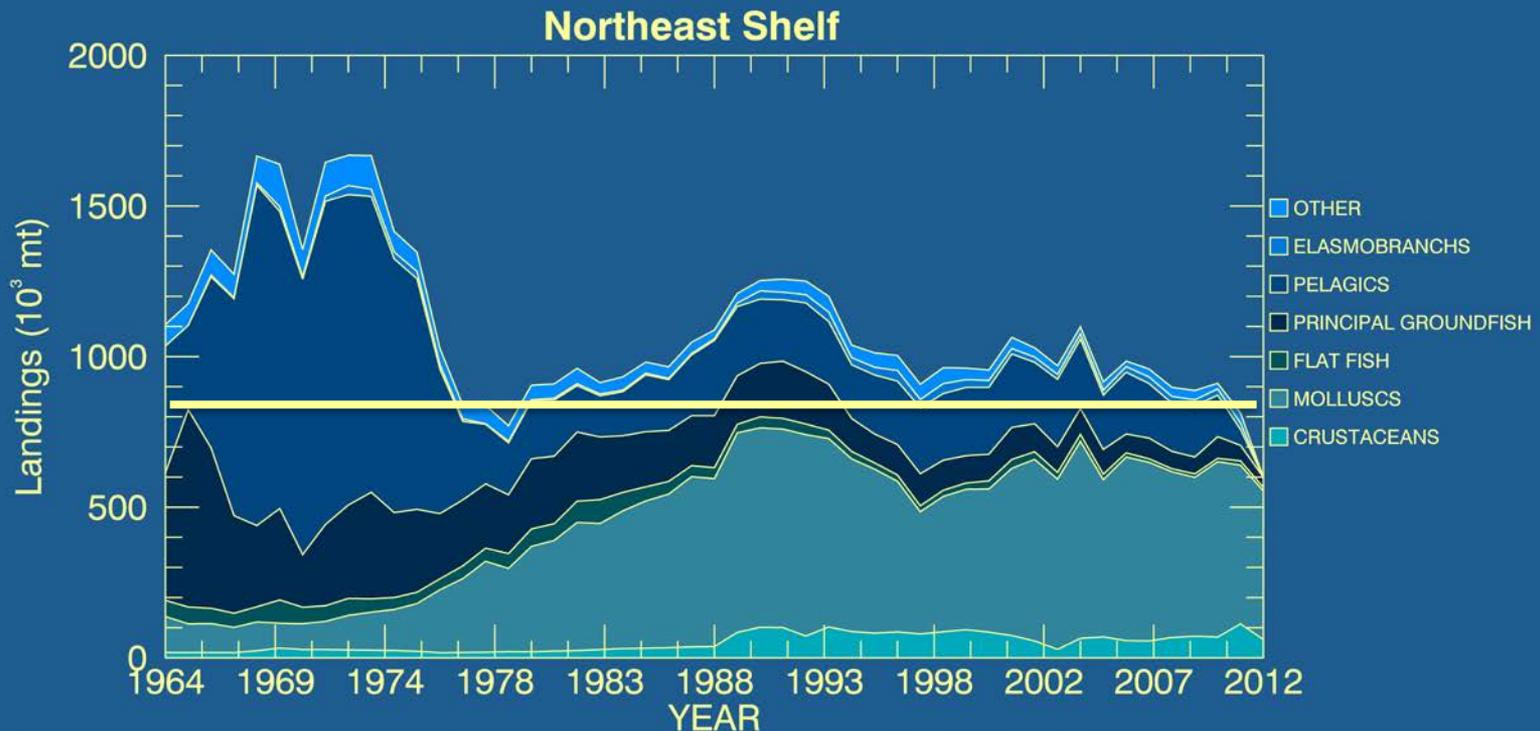
Summary

- The proposed ecosystem limit reference point is that the exploitation rate should not exceed the fraction of microplankton production in the system (~20-30%), which equates to **~825,000 t** of harvestable production.



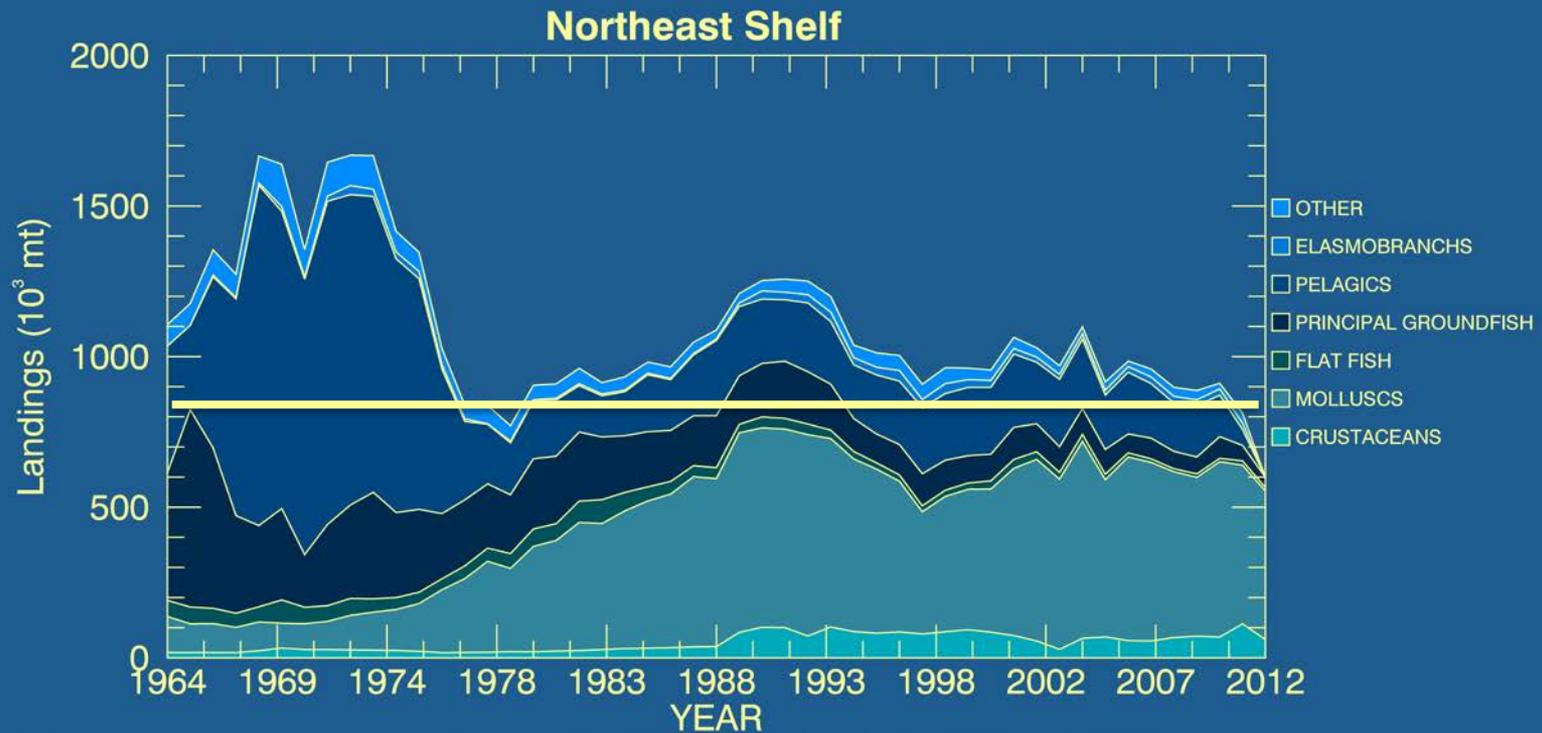
Summary

- Fishery removals exceeded recommended levels (~825,000 t) in the past, but are now close to estimates of sustainable extraction rates for the ecosystem as a whole.



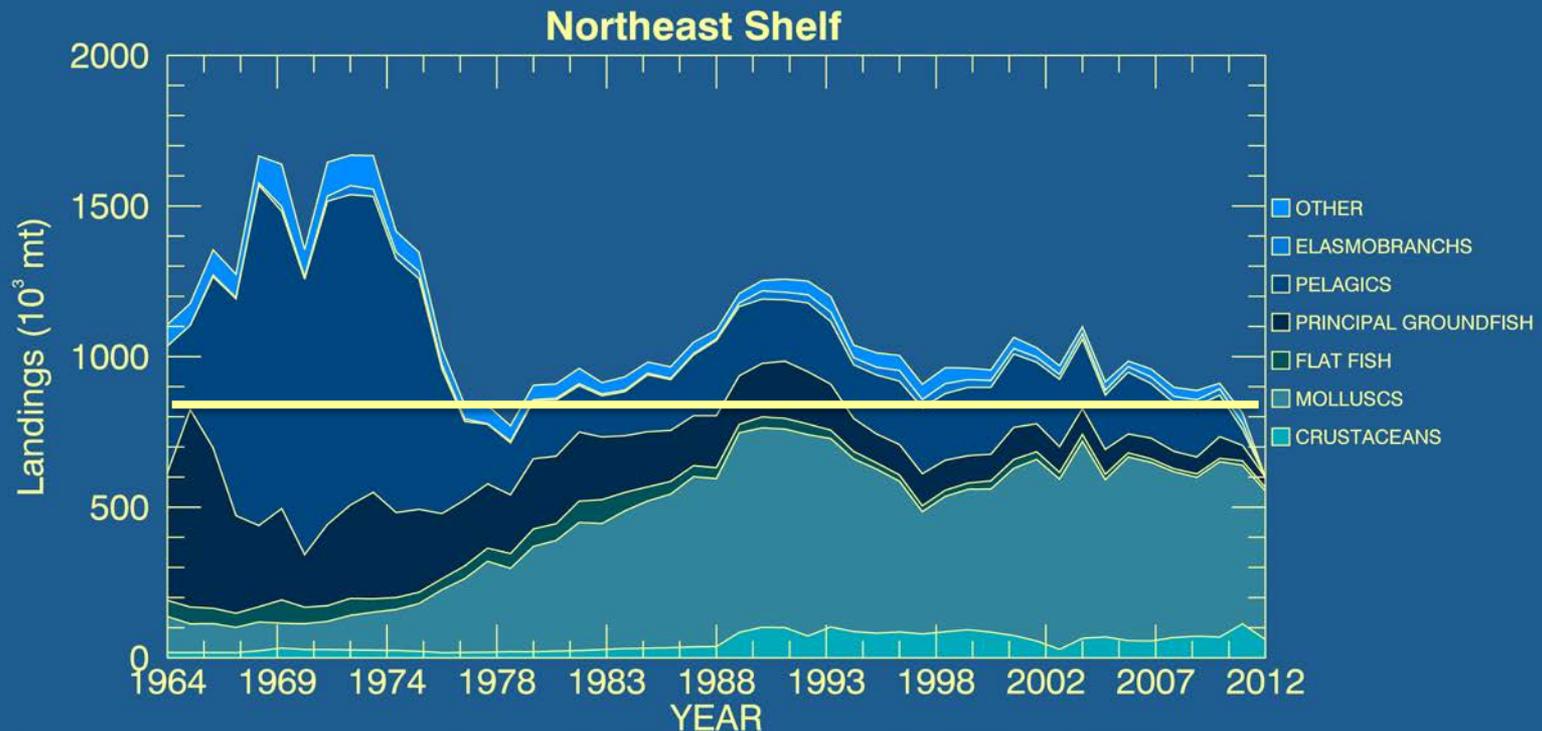
Summary

- Directed targeting of some species means that some functional groups are still at risk.



Summary

- A diversified catch will be necessary to create a more balanced harvesting policy.



Summary

- Changes in the phytoplankton community composition and/or rates of primary production will affect the community production and the overall fisheries yield of the system. Thus, there is an ongoing need for:
 - Climatological quality (preferably hyper-spectral) ocean color remote sensing data (RRSs, PAR, CHL, IOPs, Kd) to monitor changes in the phytoplankton community.
 - Improved algorithms for measuring phytoplankton functional groups/size classes on the continental shelf.
 - *In situ* validation data of phytoplankton pigments, primary production, and other related parameters.