Phytoplankton Functional Types in Marine Services

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NOAA/NMFS/NEFSC

NOAA FISHERIES
Northeast Fisheries Science Center

Christopher Brown, Paul DiGiacomo, Michael Fogarty, Evan Howell, Veronica Lance, Antonio Mannino, Christopher Melrose, Michael Novak, Jeffery Polovina, Chris Proctor, Heidi Sosik, Menghua Wang, Jeremy Werdell

International Ocean Colour Science Meeting 2015

PFT/PSC Data within NOAA

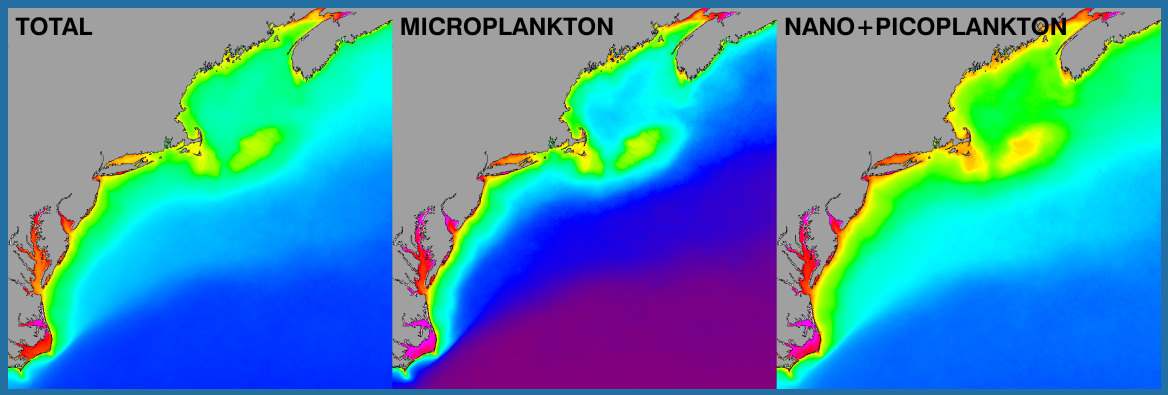
- Within NOAA there is a strong focus on Integrated Ecosystem Assessments and Ecosystem-Based Approaches to Management, with an increasing emphasis on ecological forecasting.

- 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 PFT and PSC 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.

PFT/PSC Data within NOAA

- Documenting, monitoring and forecasting the response of marine ecosystems to environmental variability and climate change
- Assessing biodiversity
- Biogeochemical cycling
- Examining variations in PFT/PSC abundance and distribution patterns (temporally and spatially)
- Food-web structure and secondary/tertiary production



Current Activities and Opportunities

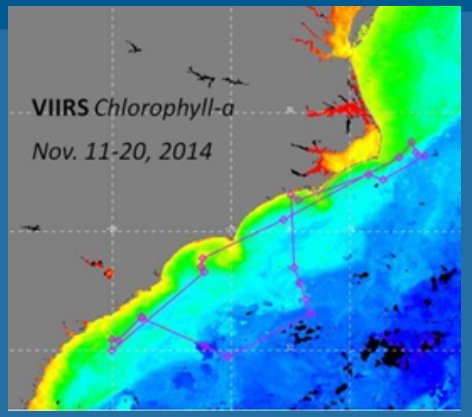
NOAA Satellite Services (NESDIS):

- The Center for Satellite Applications and Research (START) is actively working with users to develop PFT and PSC products to support coastal, oceanic and inland water application and management needs.
- VIIRS Cal/Val Cruises (annual ?)
  - November 2014
  - October 2015
  - Additional opportunities in Chesapeake Bay and other regions

NOAA Fisheries

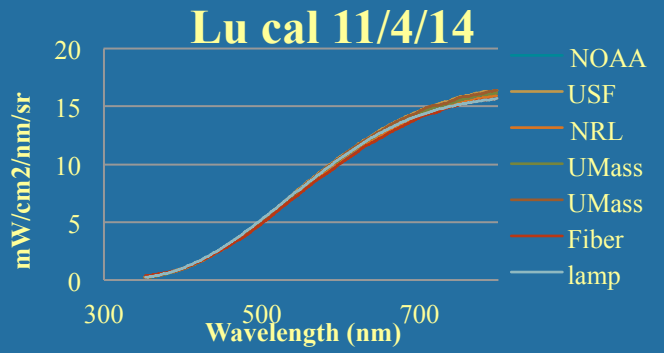
- NEFSC EcoMon Surveys & Collaborations (Jon Hare)

VIIRS Cal/Val Cruise



11-21 November 2014 – NOAA Ship Nancy Foster:

- 4 US Agencies, EU-JRC, 6 Universities
- 10 days, 23 stations, 11 VIIRS matchups, 4 profiling radiometers, 2 floating radiometers, 6 above-water radiometers
- Several validation measurements including:
  - Water-leaving radiance
  - Aerosol
  - Optical Depth
  - Chlorophyll
  - IOPs
  - Phytoplankton Physiology
  - Carbon
  - Total Suspended Matter

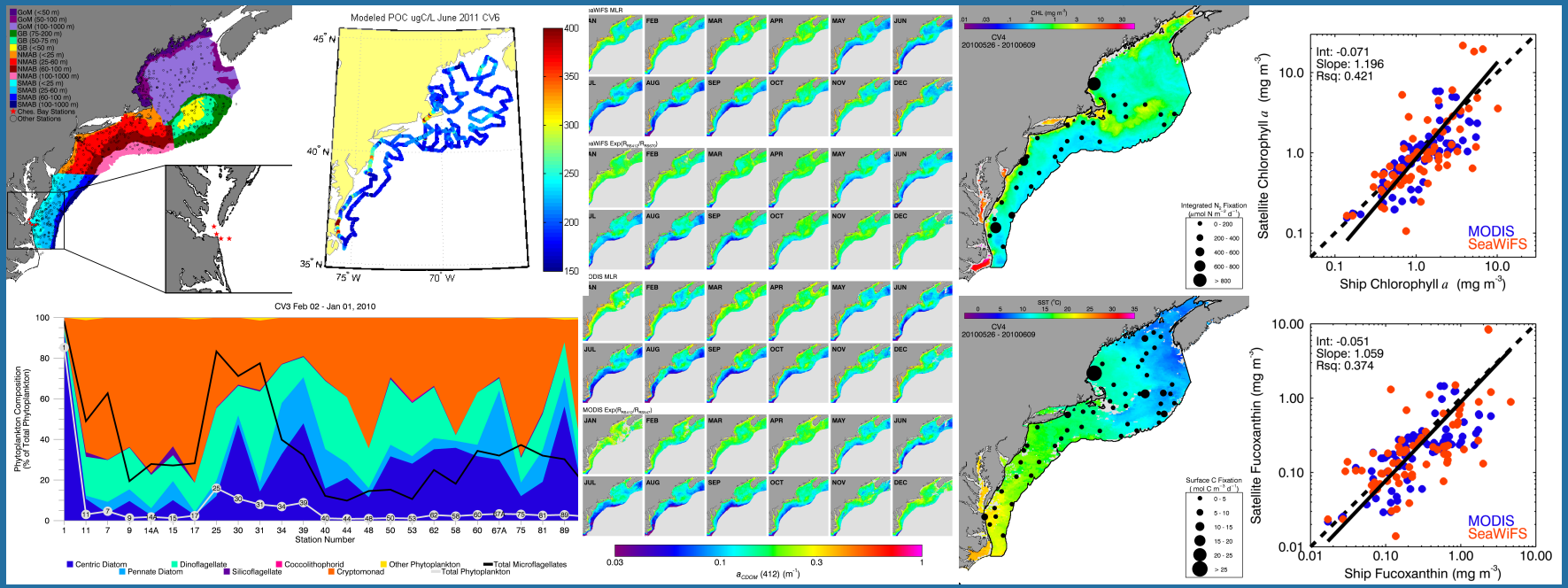


October 2015 – Menghua Wang or Paul DiGiacomo

Ecosystem Monitoring Cruises (NEFSC)

CliVEC (NASA) - Antonio Mannino (NASA), Margaret Mulholland (ODU), Kimberly Hyde

- 7 NOAA Northeast Fisheries Ecosystem Monitoring cruises (2009-2012)
- 612 Stations
- Carbon, Nitrogen Fixation, Nutrients, HPLC Pigments, Primary Production, Phytoplankton Taxonomy (SeaBASS)



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IOPs – NASA Ocean Ecology Laboratory (Jeremy Werdell)

- NOAA Northeast Fisheries Ecosystem Monitoring cruise (2012)
- NOAA Northeast Pelagic Survey (Pisces 2013)
- AOPs, IOPs, POC, DOC, Suspended Particulate Matter, HPLC Pigments
  - Including some size fractionated IOP samples

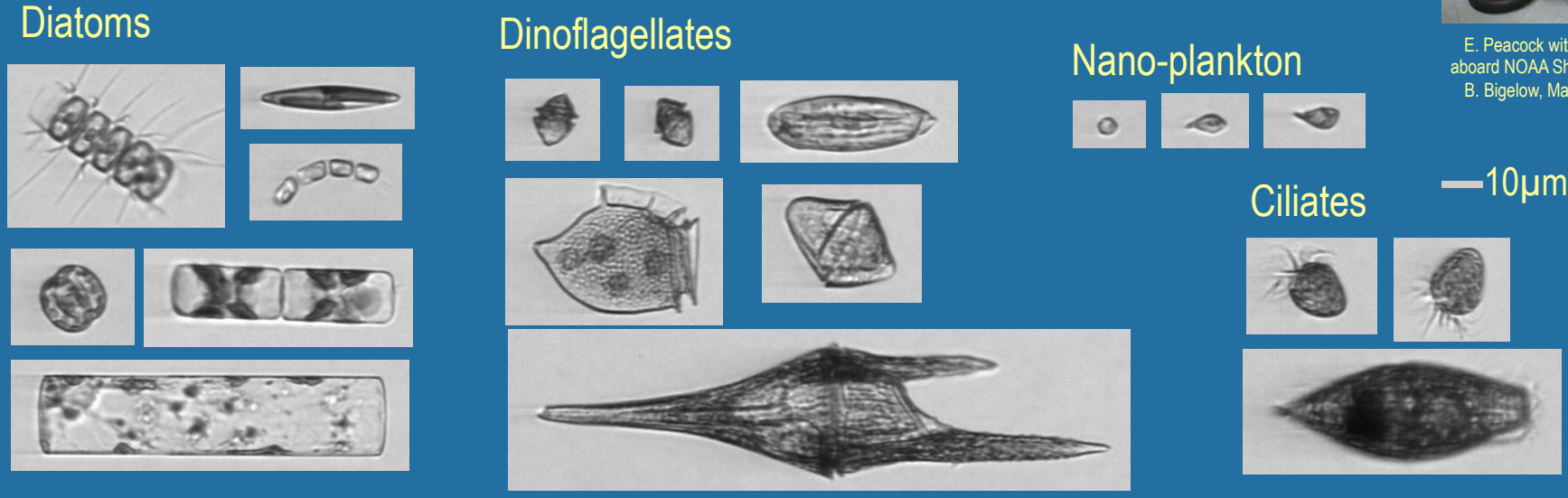



Ecosystem Monitoring Cruises (NEFSC)

Imaging Flow Cytobot – Heidi Sosik (WHOI)

- 4 NOAA Northeast Fisheries Ecosystem Monitoring cruises (2013-2015)
- Continuous underway sampling of automated imaging-in-flow cytometry.
- > 4 million images showing high spatial variability in relative abundance of plankton groups including diatoms, dinoflagellates, nanoplankton, and ciliates
- Open Data Access: http://ifcb-dta-whoi.edu/

E. Peacock with IFCB aboard NOAA Ship Henry B. Bigelow, May 2015



Example cell images from May 2015 ECOMON cruise

Sosik et al. / WHOI

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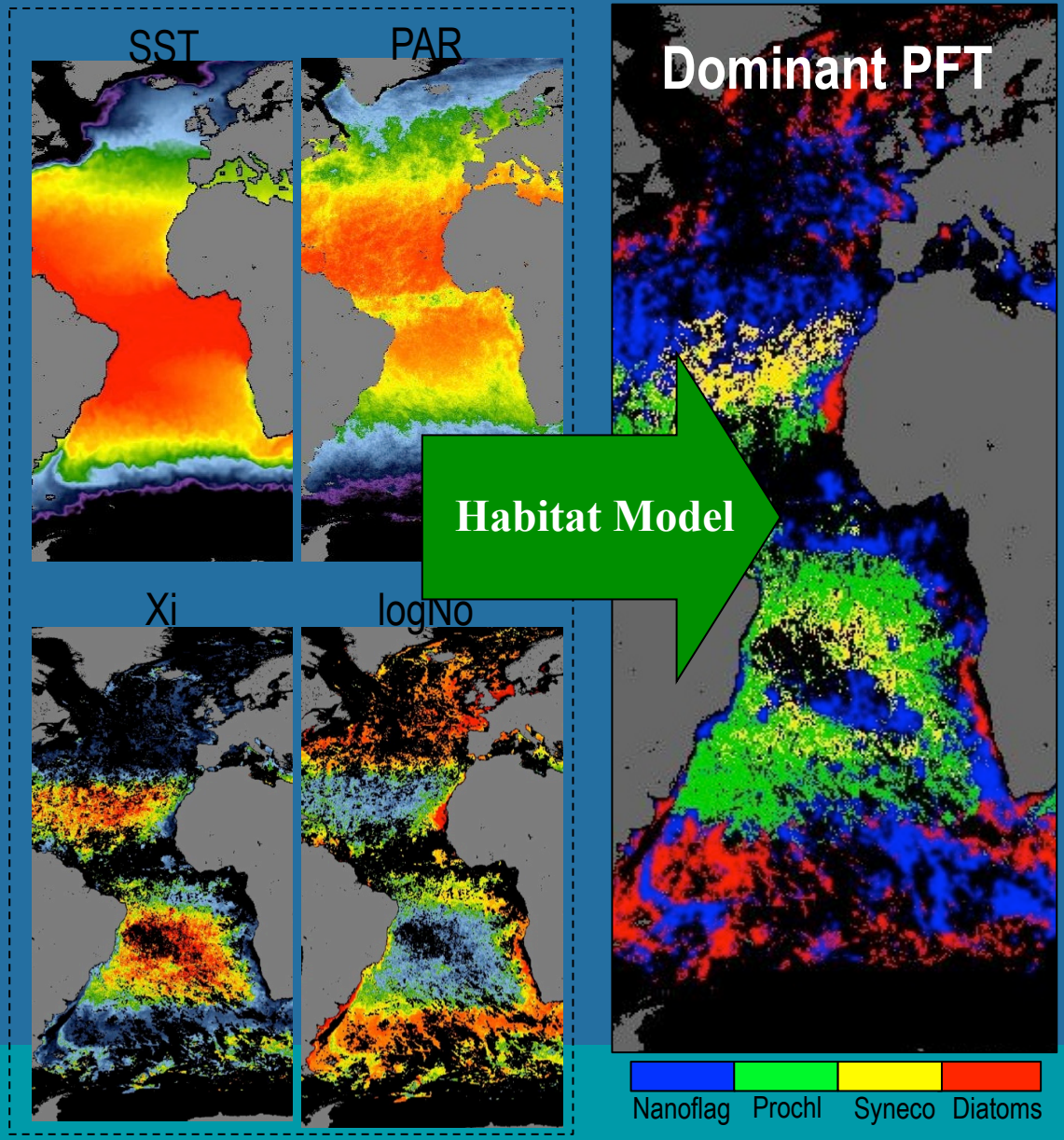
Other NOAA Data – Jon Hare (NOAA/NEFSC)

- Laser in situ scattering transmissometer (LISST) measures volume concentration of suspended particles between 2.5-500 μm, which can be used to estimate size fractionated biovolumes and size spectra. – Christopher Melrose (NOAA)
- Nutrients & CTD (NODC)
- Continuous Plankton Recorder (CPR)

Predicting PFTs Using Habitat Models

Using a statistical habitat model with satellite- and model-derived input variables (e.g. SST and PSD) to generate maps of probable distribution of Diatoms, Nanoflagellates, Synechococcus, and Prochlorococcus.

Tim Moore (UNH) &
Chris Brown (NOAA)



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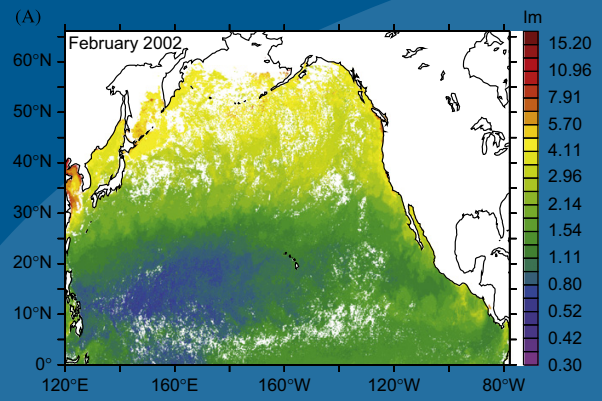
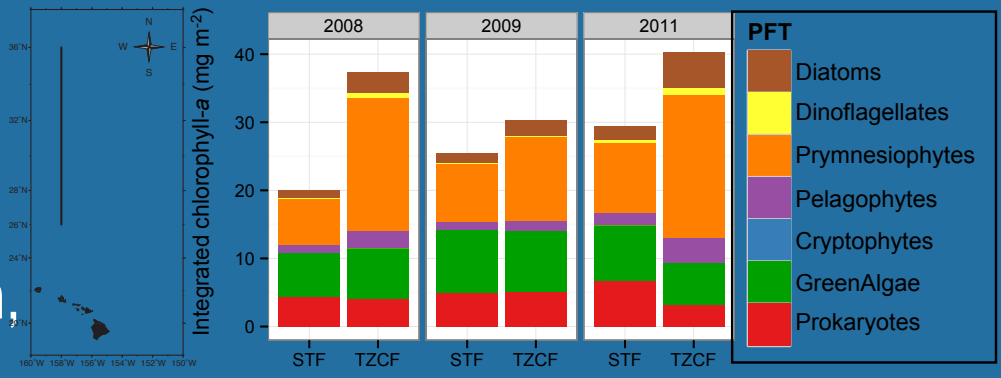
PSC/PFTs - Climate and Higher Trophic Levels



Polovina & Woodworth (DSR 2012)

Measuring phytoplankton cell size to monitor climate impacts in the equatorial and subtropical Pacific. Observed changes in cell size during El Niños (smaller) and La Niñas (larger) likely impact energy transfer to higher trophic levels. (Jeffery Polovina – NOAA/PIFSC)

Phytoplankton are being monitored at the North Pacific subtropical and chlorophyll transition zone fronts, which are key foraging grounds for migratory species including swordfish, sea turtles, sea birds and elephant seals. (Evan Howell – NOAA/PIFSC)



Howell, et al. (Progress in Oceanography, in press)

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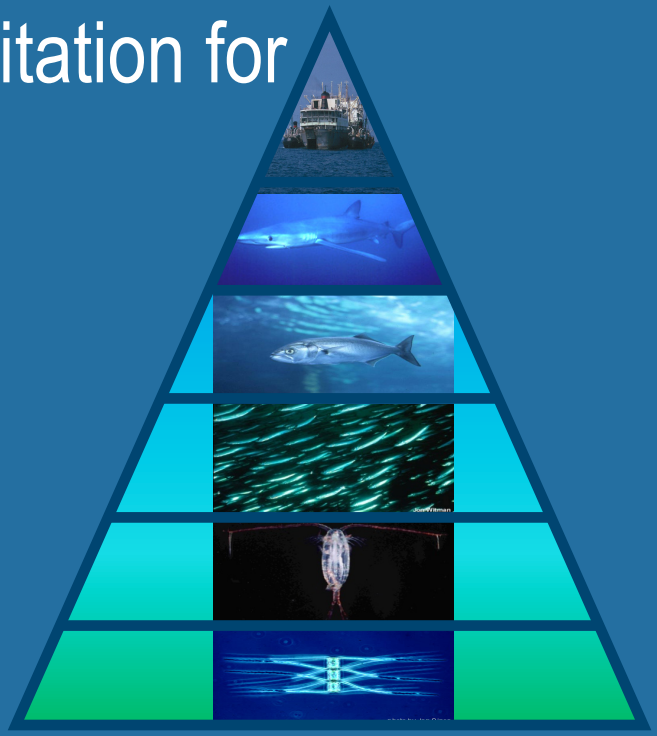
PSC Application in Fisheries

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

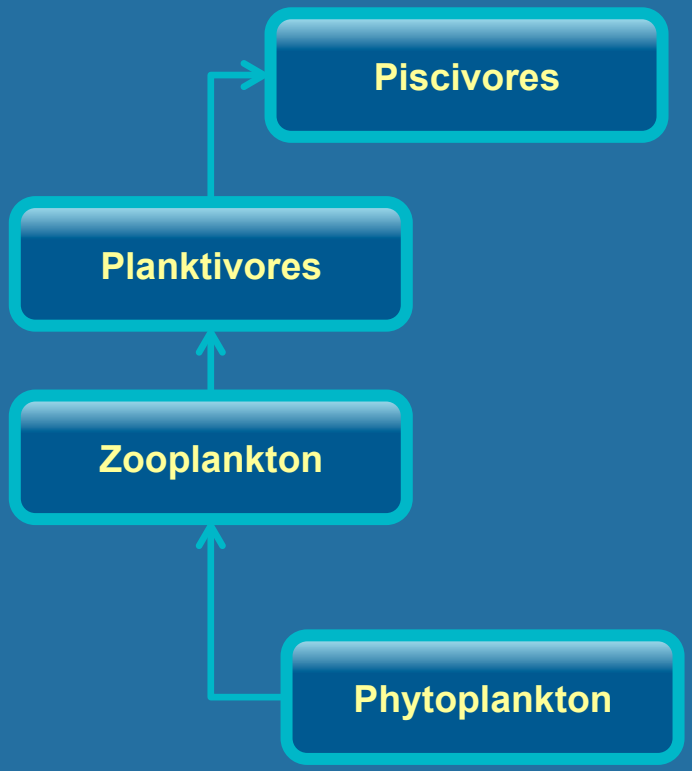
- Benthos
- Benthivores
- Planktivores
- Piscivores



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

PSC Application in Fisheries - Historical

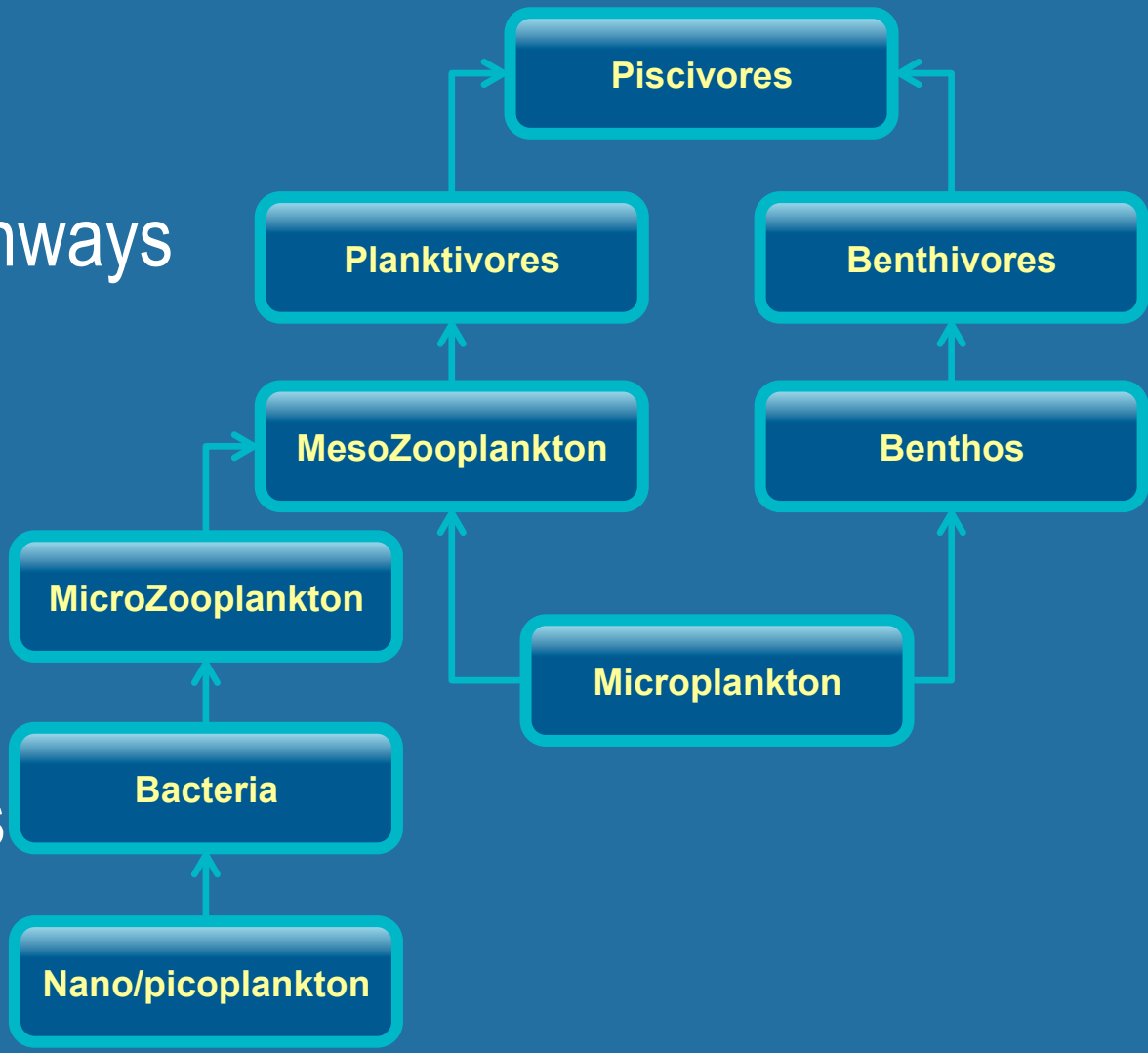
- Potential yield estimates ranged from 115-200 million tons.
- Total primary production
- Inferred ecological transfer efficiencies (10%)
- Assumed mean trophic level of the catch



Kestevan & Holt (1955)
Graham & Edwards (1962)
Schaefer (1965)
Ricker (1969)
Ryther (1969)

PSC Application in Fisheries - Updated

- Benthic component
- Two Production Pathways
  1) Direct grazing
  2) Microbial loop
- Ecological transfer efficiencies from network flow models



PSC Application in Fisheries - 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%).
- Fishery removals exceeded recommended levels in the past, but are now close to estimates of sustainable extraction rates for the ecosystem as a whole.
- Accurate measurements of fractionated primary production are necessary to maintain sustainable extraction rates.
- Shifts in the phytoplankton community will affect the community production and the overall fisheries yield of the system.

PFT/PSC Data within NOAA - Summary

- **NOAA Research and Modeling**
  - PFT/PSC Habitat Modeling
  - Affects of Climate Change on phytoplankton composition
  - Food Web Modeling
- **Need for accurate PFT/PSC & production**
  - Continental Shelf (Fisheries management)
  - Size fractionated production (Food web modeling)
  - Ecosystem affects of climate variability
- **Opportunities for data collection**
- **Resources for data distribution**