Microbial Biodiversity in the Chesapeake Bay

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Biodiversity is variety of life

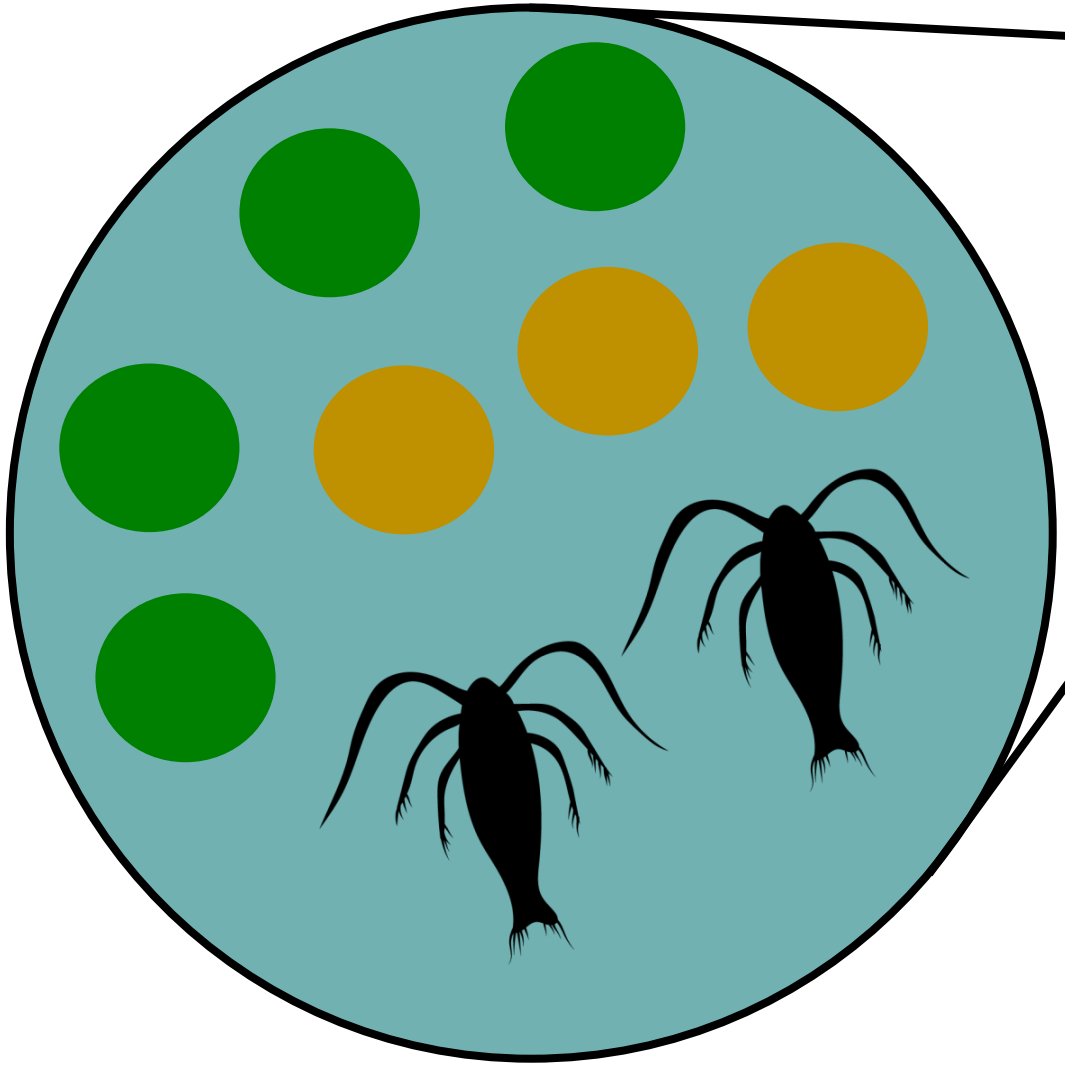
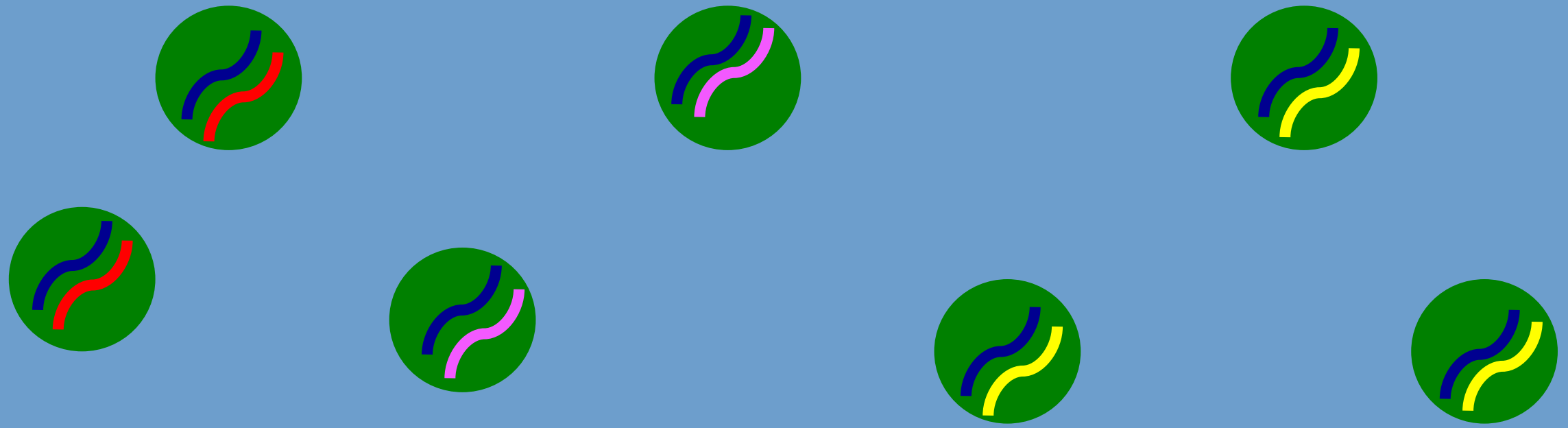


Photo: https://www.marylandhall.org/exhibitions/working-water-photography-jay-fleming

Biodiversity is important for ecosystem resilience



Resilience to short term disturbances such as a storm event

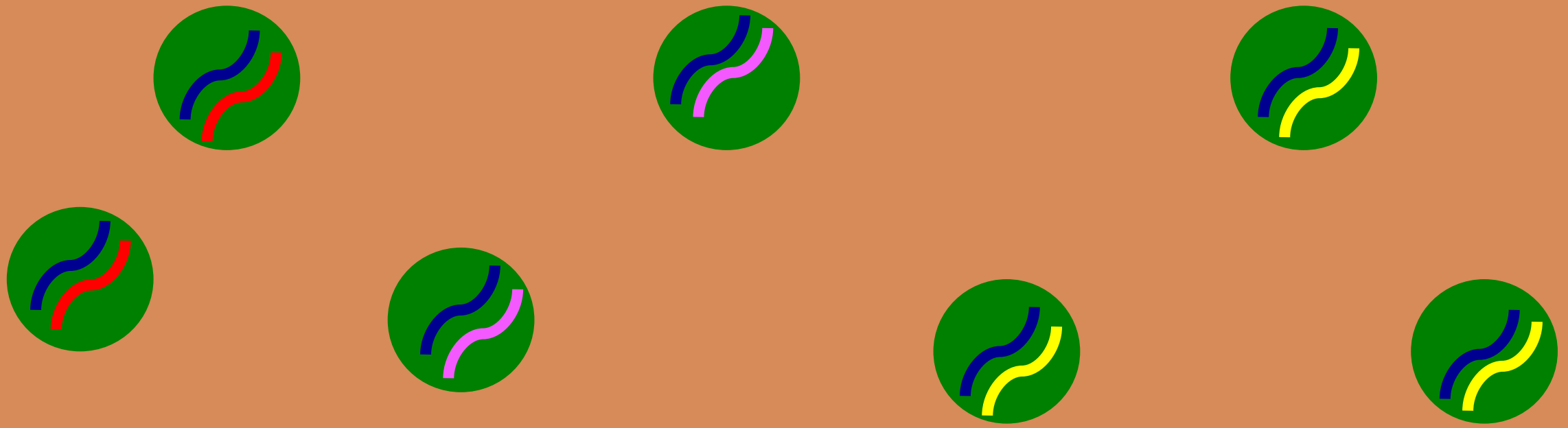
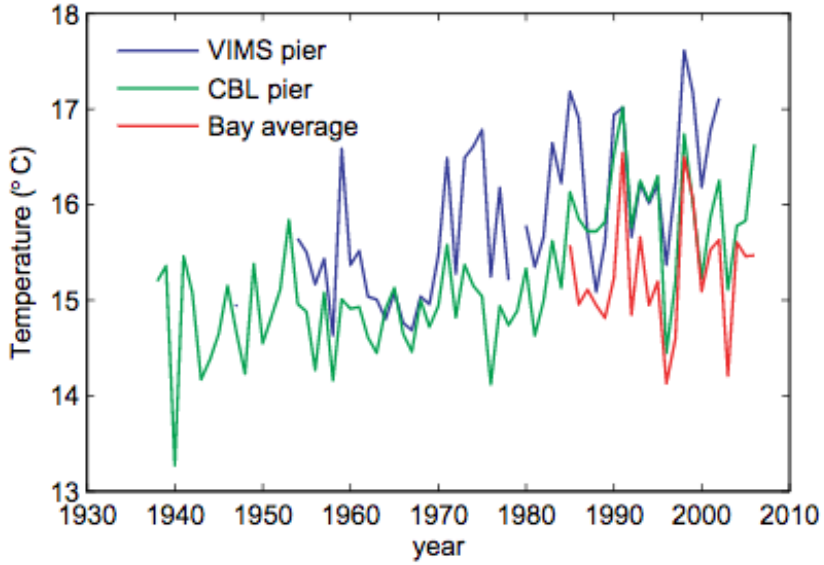
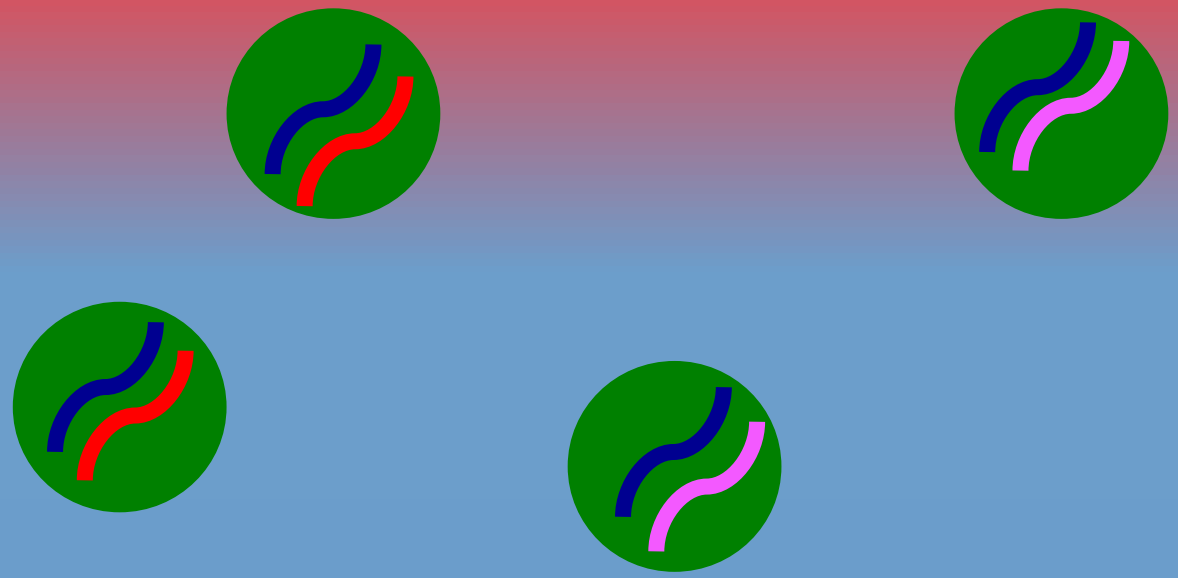


Photo: https://blogs.agu.org/mountainbeltway/2011/09/16/turbidity-in-chesapeake-bay/

Resilience to long term changes such as rising temperature





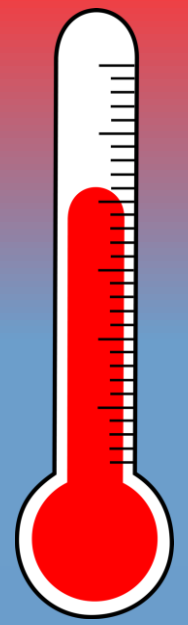


Figure: Najjar, R. G., et al. "Potential climate-change impacts on the Chesapeake Bay." *Estuarine, Coastal and Shelf Science* 86.1 (2010): 1-20.

Applications of Phytoplankton Biodiversity

Detect algal blooms

- Match ocean color with color of phytoplankton

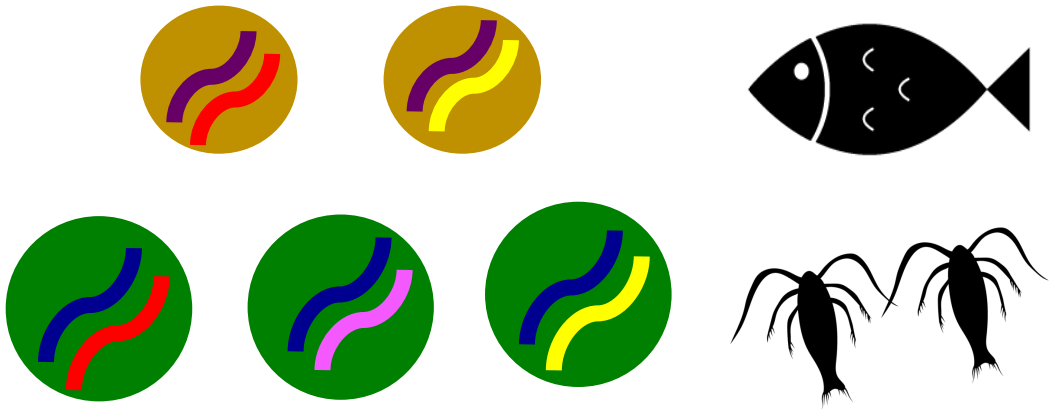
- Determine dominance of one species

Photo: https://caae.cals.ncsu.edu/research/harmful-algae/marine/

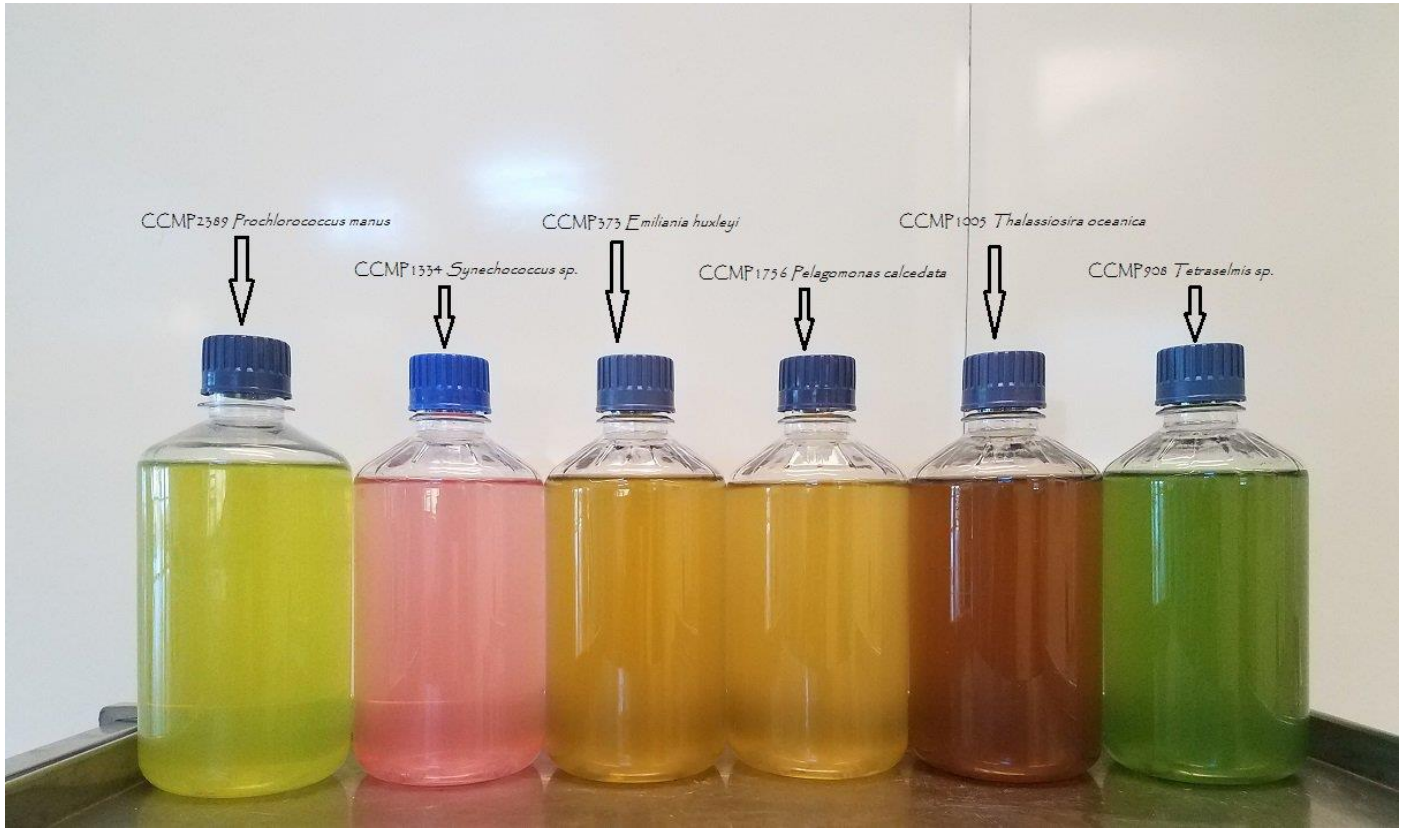
Infer ecosystem health

- Establish a relationship between satellite measurement and biodiversity

- Estimate species richness and relative abundance



Phytoplankton Biodiversity: taxonomic identification with pigments



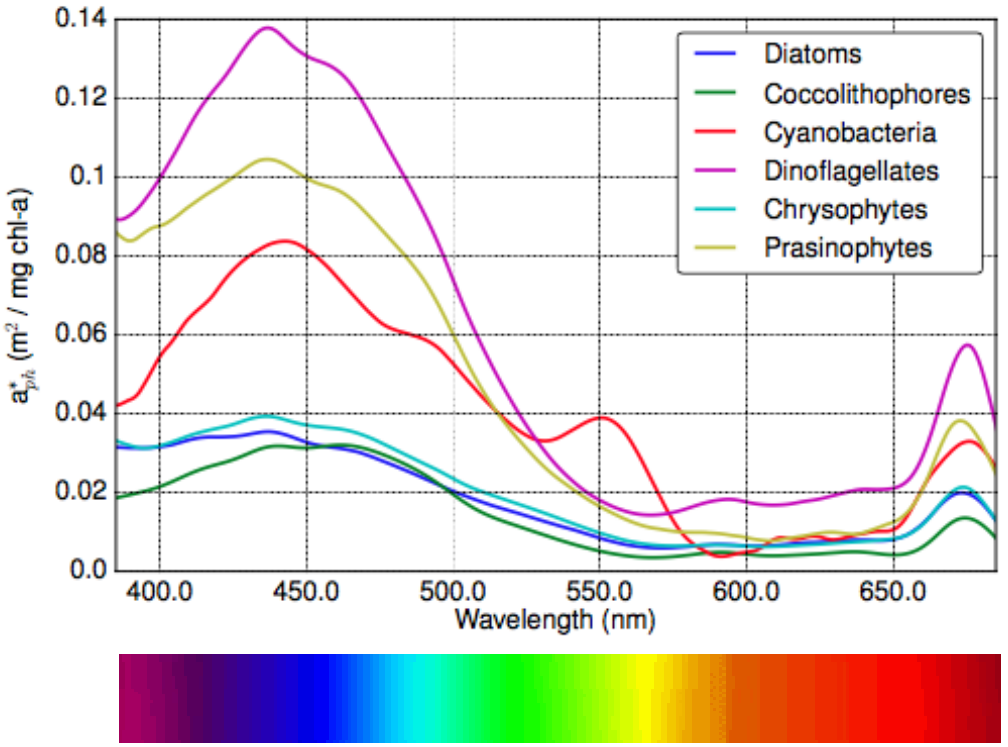


Photo: https://pace.oceansciences.org/gallery_more.htm?id=1594

Figure: Wolanin, A., et. al. "Investigation of spectral band requirements for improving retrievals of phytoplankton functional types." *Remote Sensing* 8.10 (2016): 871.

Monitoring Phytoplankton Biodiversity: Dominant algae based on pigment color

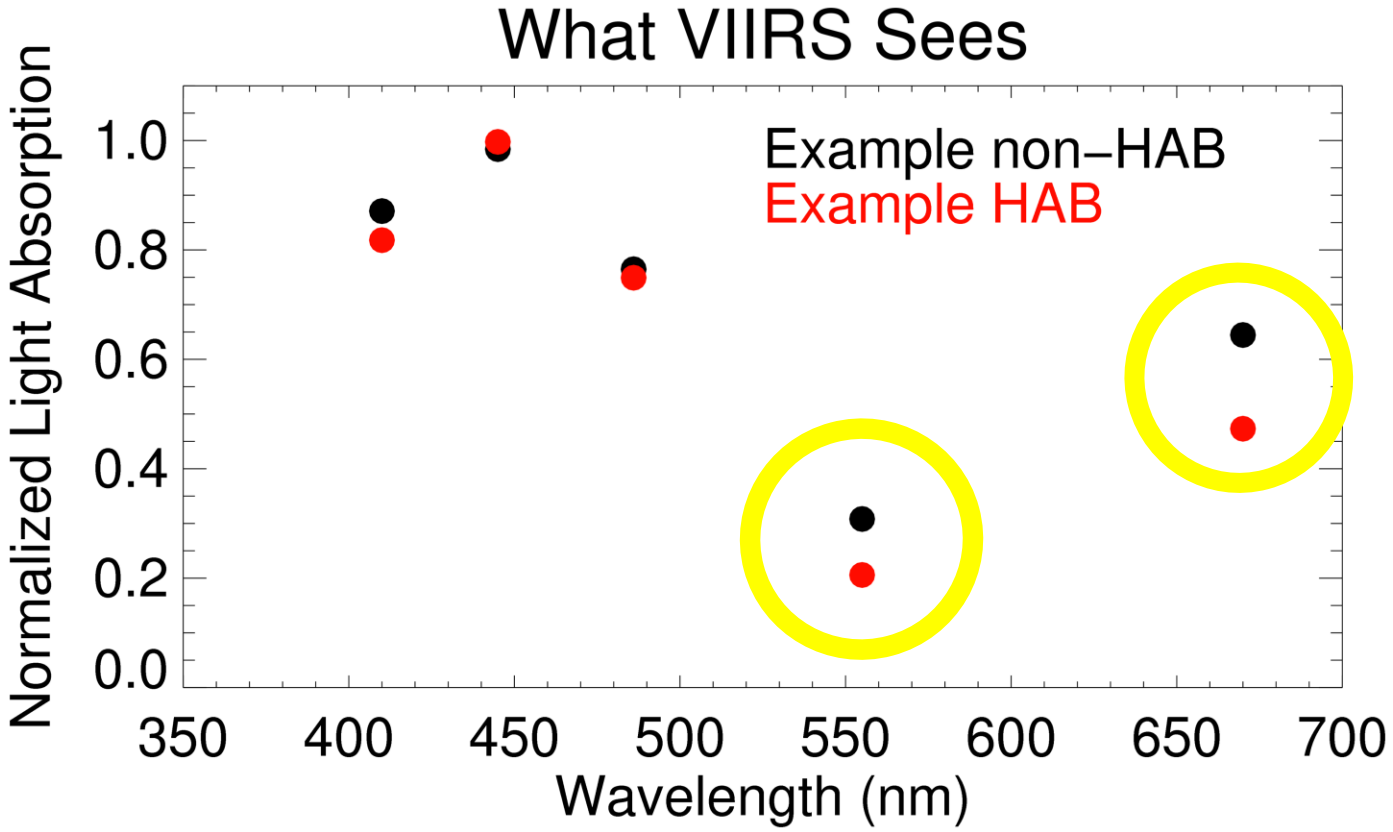


Figure: https://pace.oceansciences.org/about.htm#02

Photo: http://www.vdh.virginia.gov/environmental-epidemiology/harmful-algal-blooms-habs/alexandrium-monilatum-hab-in-lower-york-lower-james-rivers-and-chesapeake-bay/

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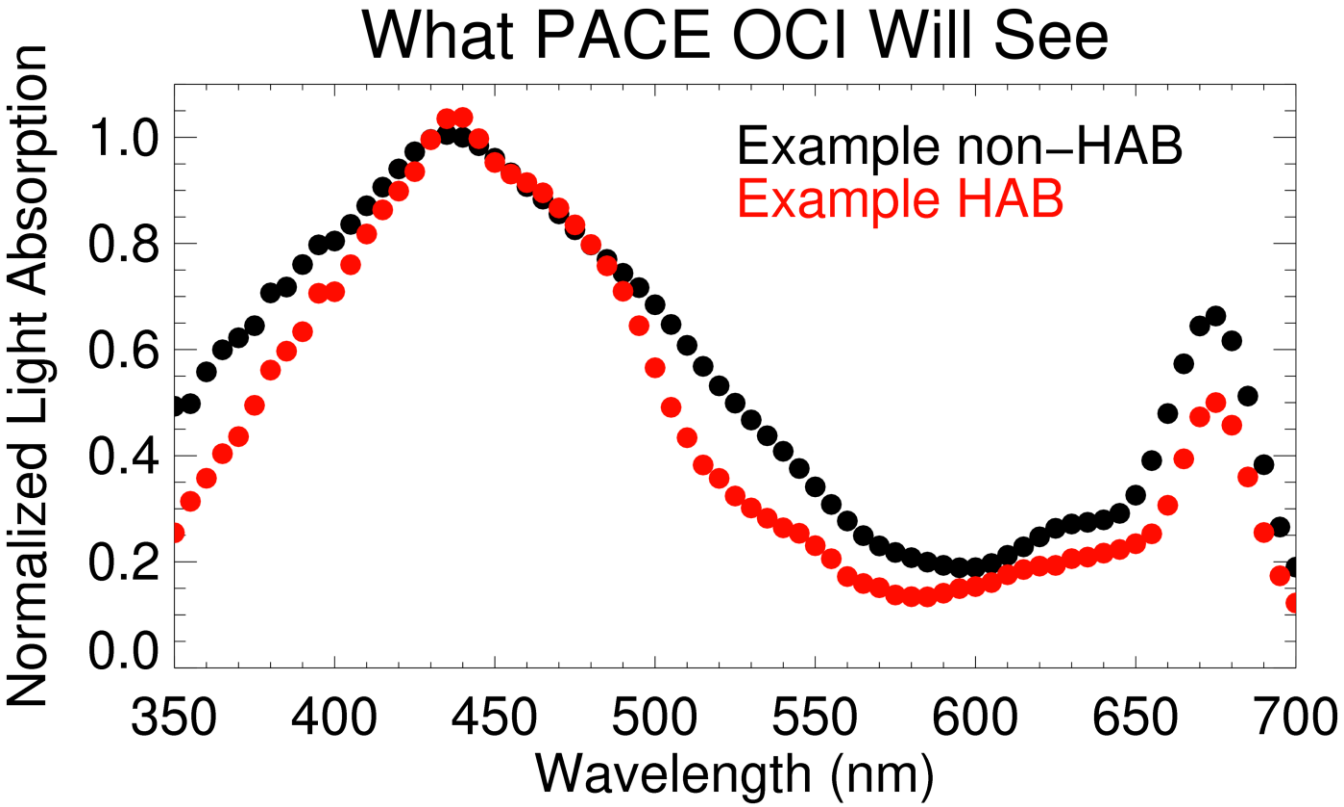

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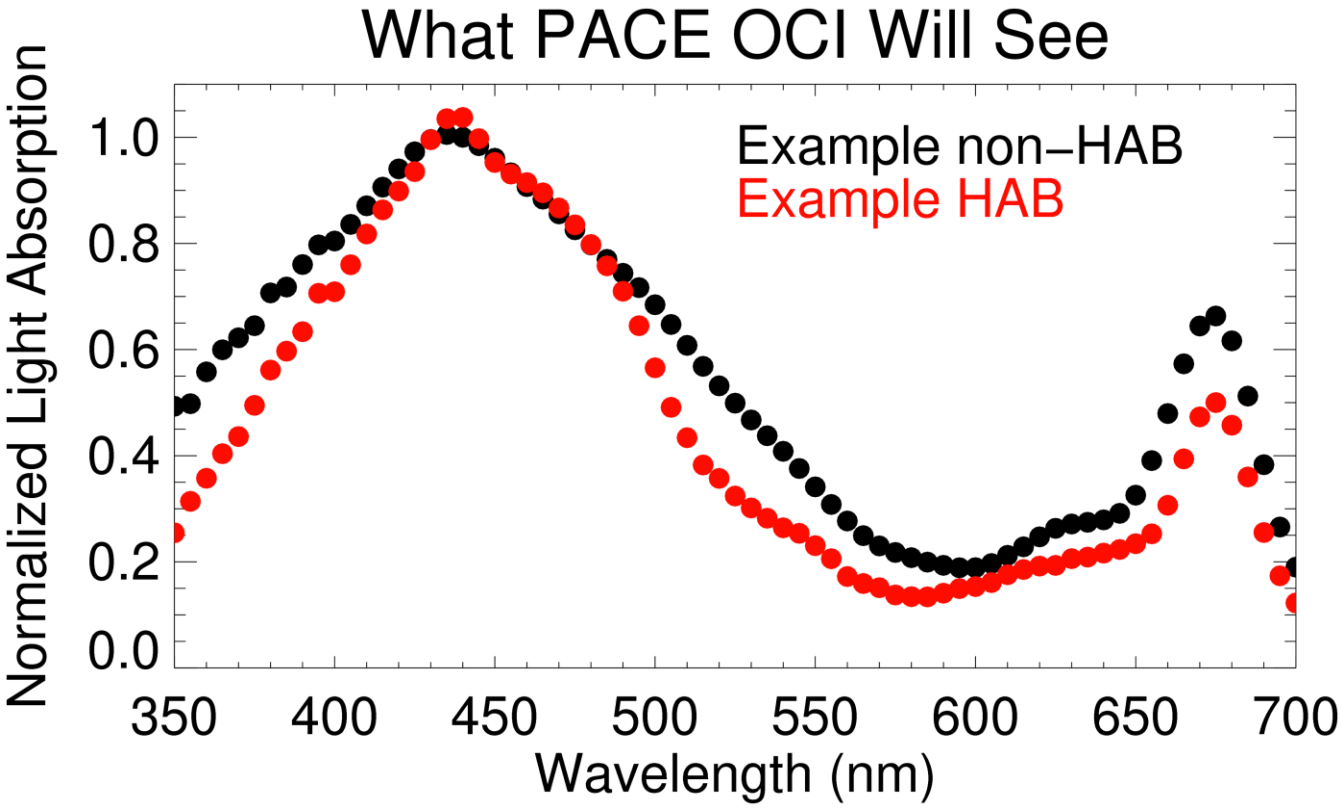

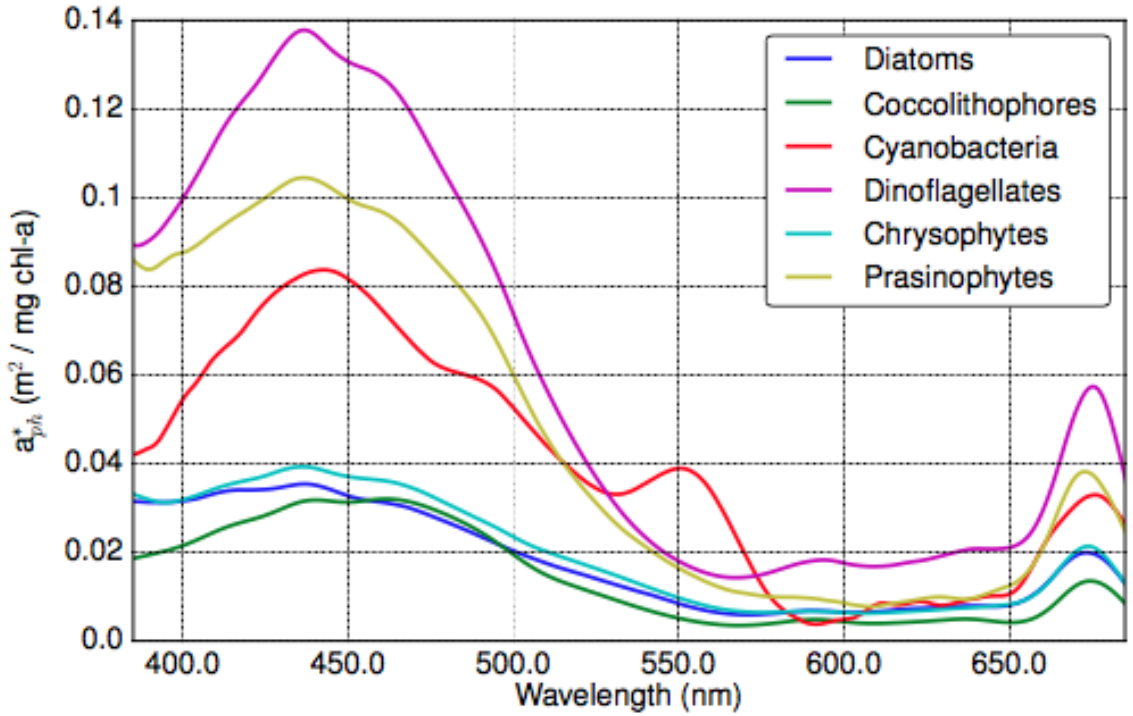

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Right: Wolanin, A., et. al. "Investigation of spectral band requirements for improving retrievals of phytoplankton functional types." *Remote Sensing* 8.10 (2016): 871.

Phytoplankton Biodiversity: taxonomic identification with genomics

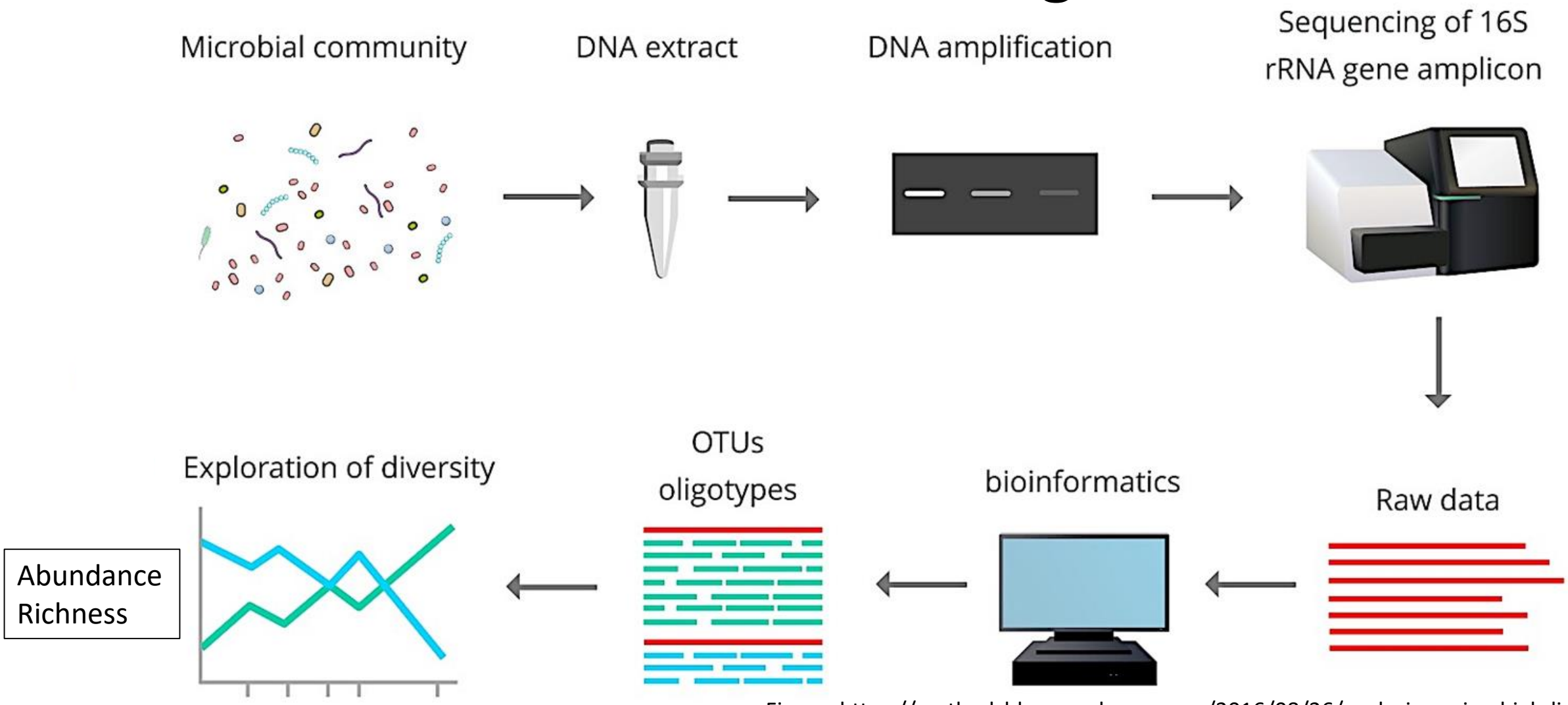

Figure: https://methodsblog.wordpress.com/2016/08/26/exploring-microbial-diversity/

Monitoring Phytoplankton Biodiversity: light attenuation as a potential proxy

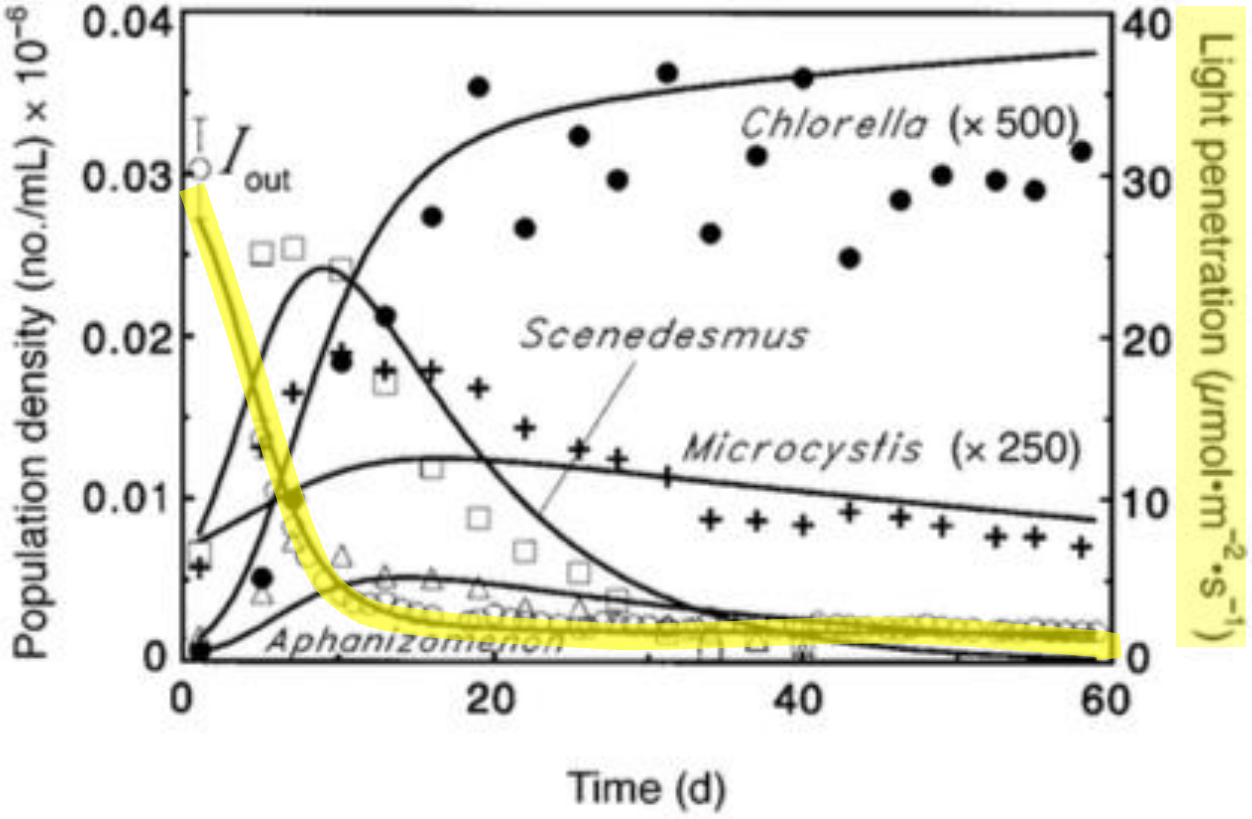

Figure: Huisman, J., et al. "Competition for light between phytoplankton species: experimental tests of mechanistic theory." *Ecology* 80.1 (1999): 211-222.

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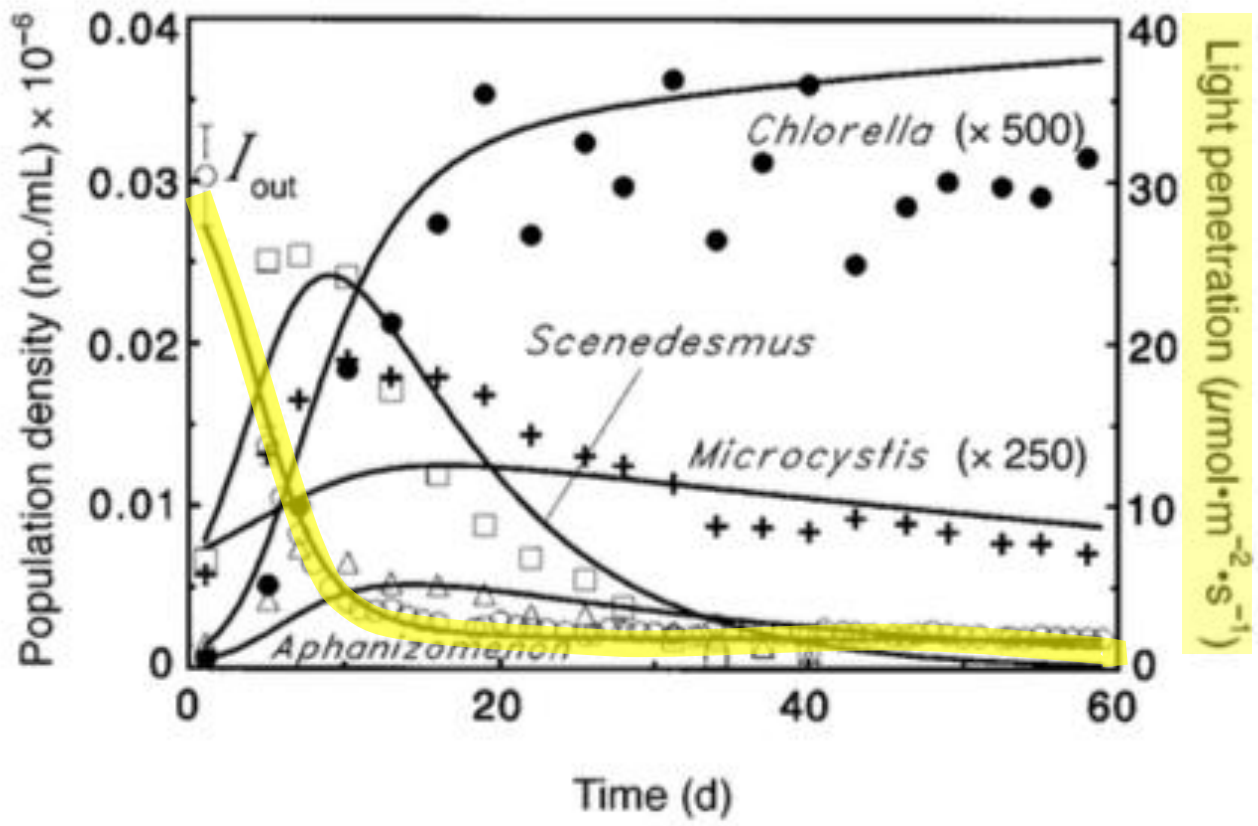

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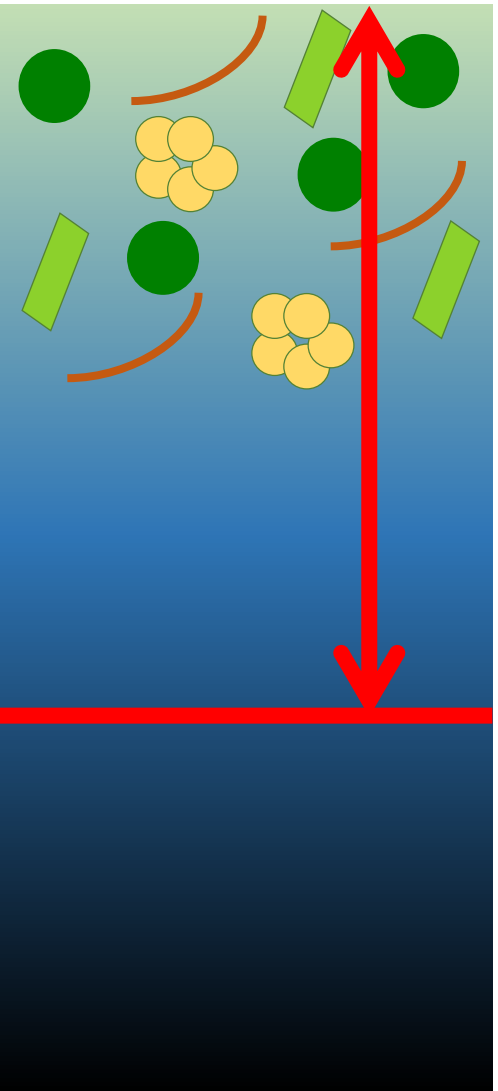
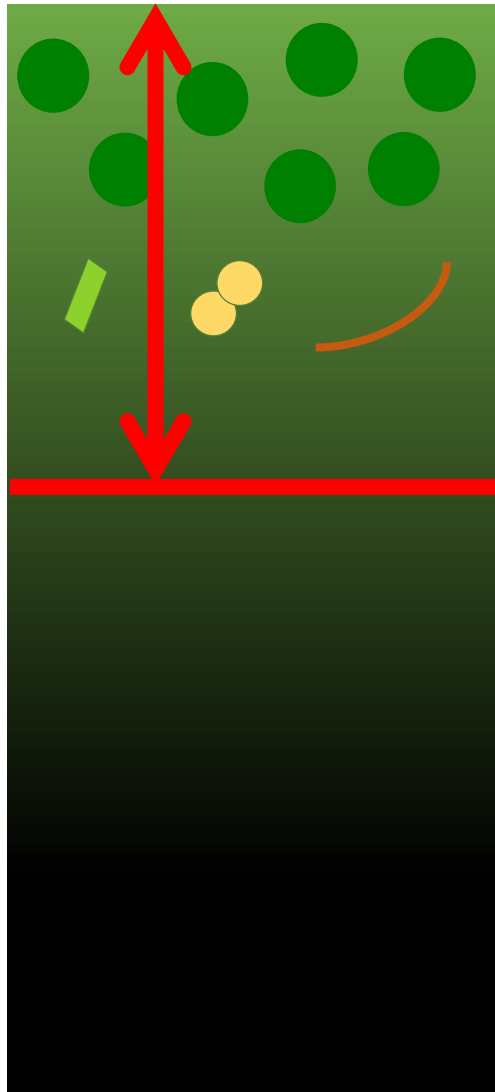


Z, attenuation depth

k_d, attenuation coefficient

$k_d = (1/Z)$



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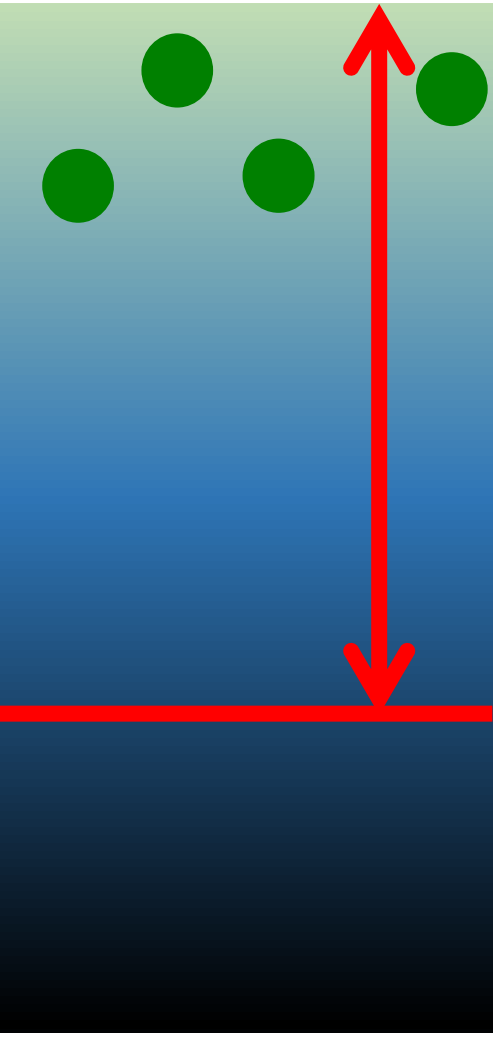
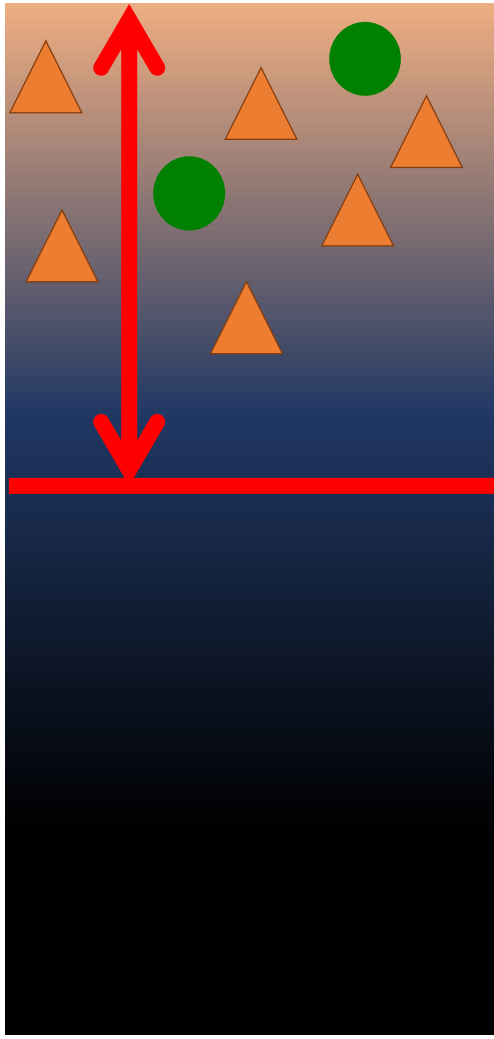
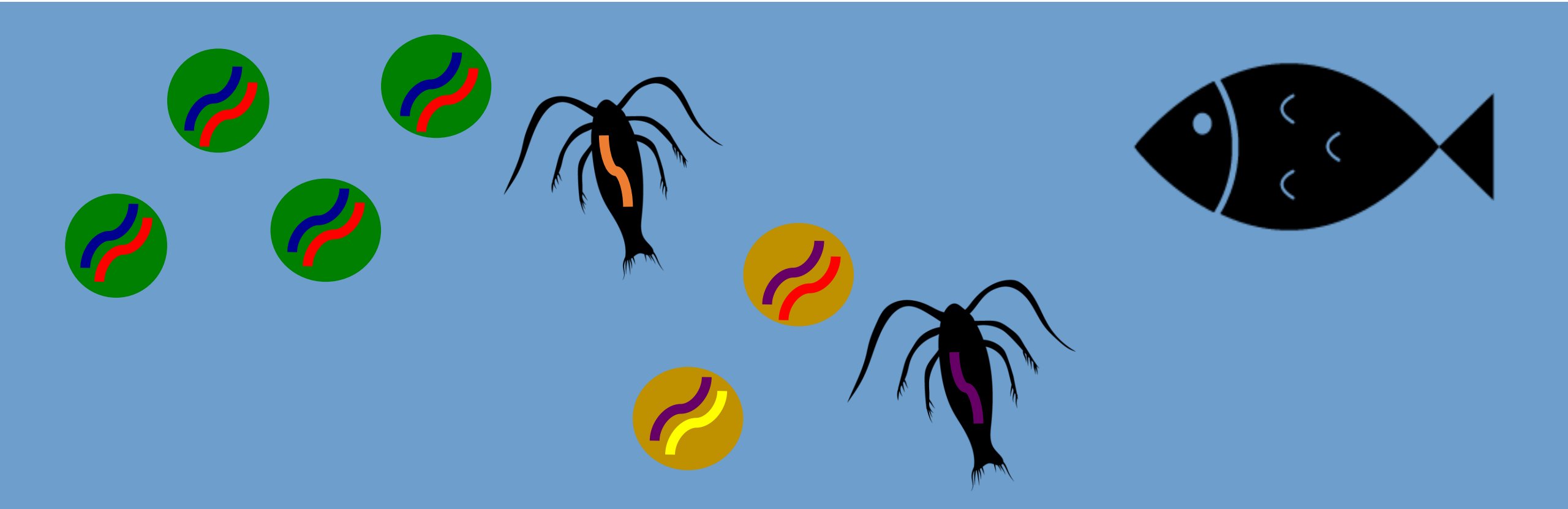


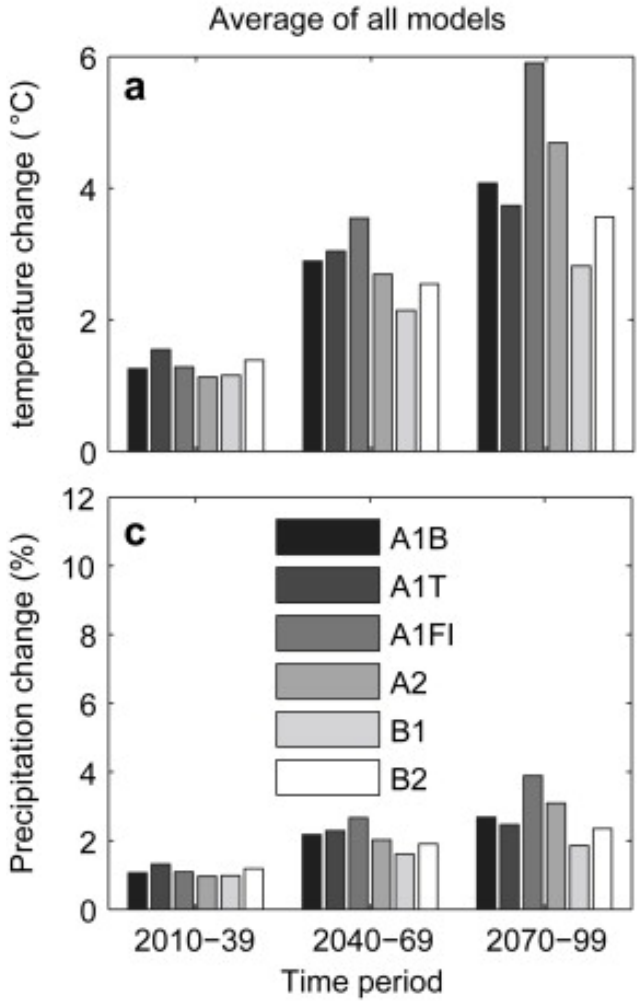


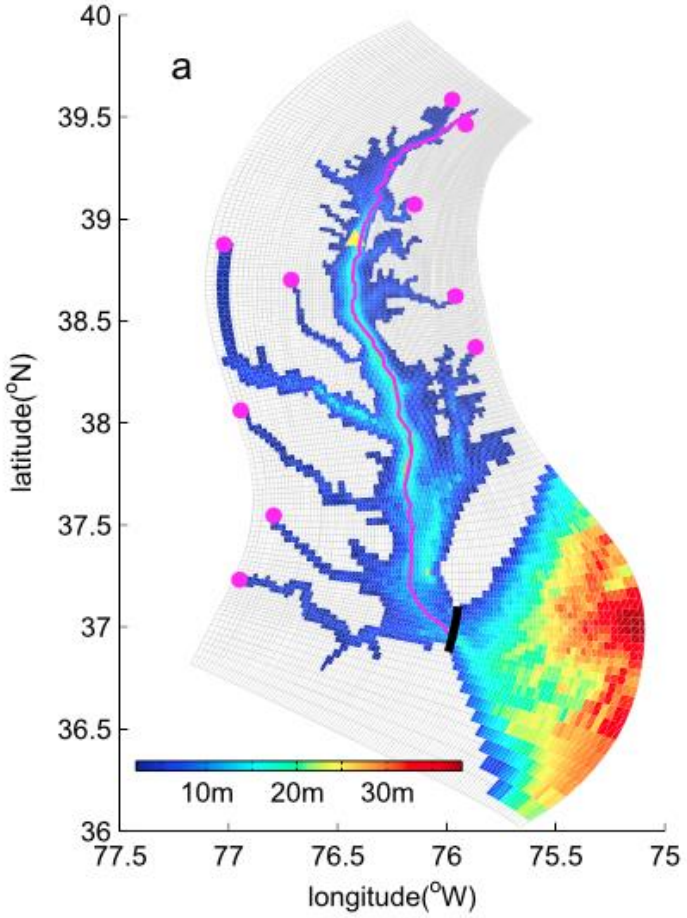
Photos: https://earthobservatory.nasa.gov/images/52169

Biodiversity and resilience are important for species interactions



Predicting biodiversity with models





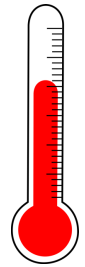
1. Include phytoplankton types in a model and associated ocean color satellite signal

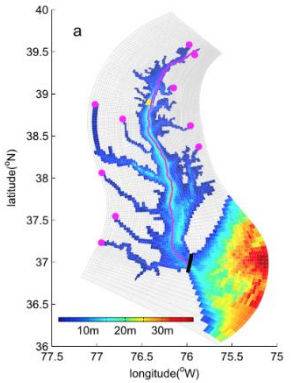
2. Incorporate relationship between light attenuation and biodiversity

Left: Najjar, R. G., et al. "Potential climate-change impacts on the Chesapeake Bay." *Estuarine, Coastal and Shelf Science* 86.1 (2010): 1-20.
Right: Feng, Yang, et al. "Chesapeake Bay nitrogen fluxes derived from a land-estuarine ocean biogeochemical modeling system: Model description, evaluation, and nitrogen budgets." *Journal of Geophysical Research: Biogeosciences* 120.8 (2015): 1666-1695.

Summary

- Biodiversity is important for ecosystem resilience
- Two applications monitoring phytoplankton biodiversity
  - Public Health: detecting algal blooms (dominance of one species)
  - Fisheries: develop a proxy for microbial biodiversity to assess ecosystem health (species richness and abundance)
- Models can help predict changes in biodiversity for different environmental conditions





Discussion

- How does biodiversity relate to your decision making?
- What do you want to know about biodiversity in the Bay? Spatial patterns, trends, predictions?
- Opportunities for collaboration

Contact: grace.e.kim@nasa.gov