

Eutrophication



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Eutrophication

■ Definition

- The increase in organic matter leading to the over enrichment of a system

■ Organic Matter created by primary producers

- Phytoplankton or Algae
- Feed on CO₂, Sunlight, and
- Nutrients, the limiting factor

Major Eutrophication Locations

■ Gulf of Mexico

- Second Largest Hypoxic Zone (no Oxygen) in the World
- Low Oxygen Concentrations extend over 7,000 square miles
- 25% of the US Commercial Fishing Industry

■ 65% of United States Estuaries



Other Major Locations

- Black Sea
- Baltic Sea
- Chesapeake Bay
- Long Island Sound



Primary Nutrients

■ Nitrogen and Phosphorus

- Major Sources vary by Location

Long Island Sound

60% of nitrogen load from wastewater of NYC

Chesapeake Bay

25% of N and P loads from point sources

Mississippi River

10% of N and 40% P from point sources

Non Point Sources

- Erosion of soil
 - Major phosphorus additions
- Agricultural Runoff
 - Manures and fertilizers
- Atmospheric Deposition
 - Fossil Fuel Combustion



Aquatic Interaction

- Phytoplankton Nutrient Consumption
- Phytoplankton Community Change
 - Dinoflagellate
 - Cyanobacteria
- Unconsumed Phytoplankton
 - Fall to Bottom Waters

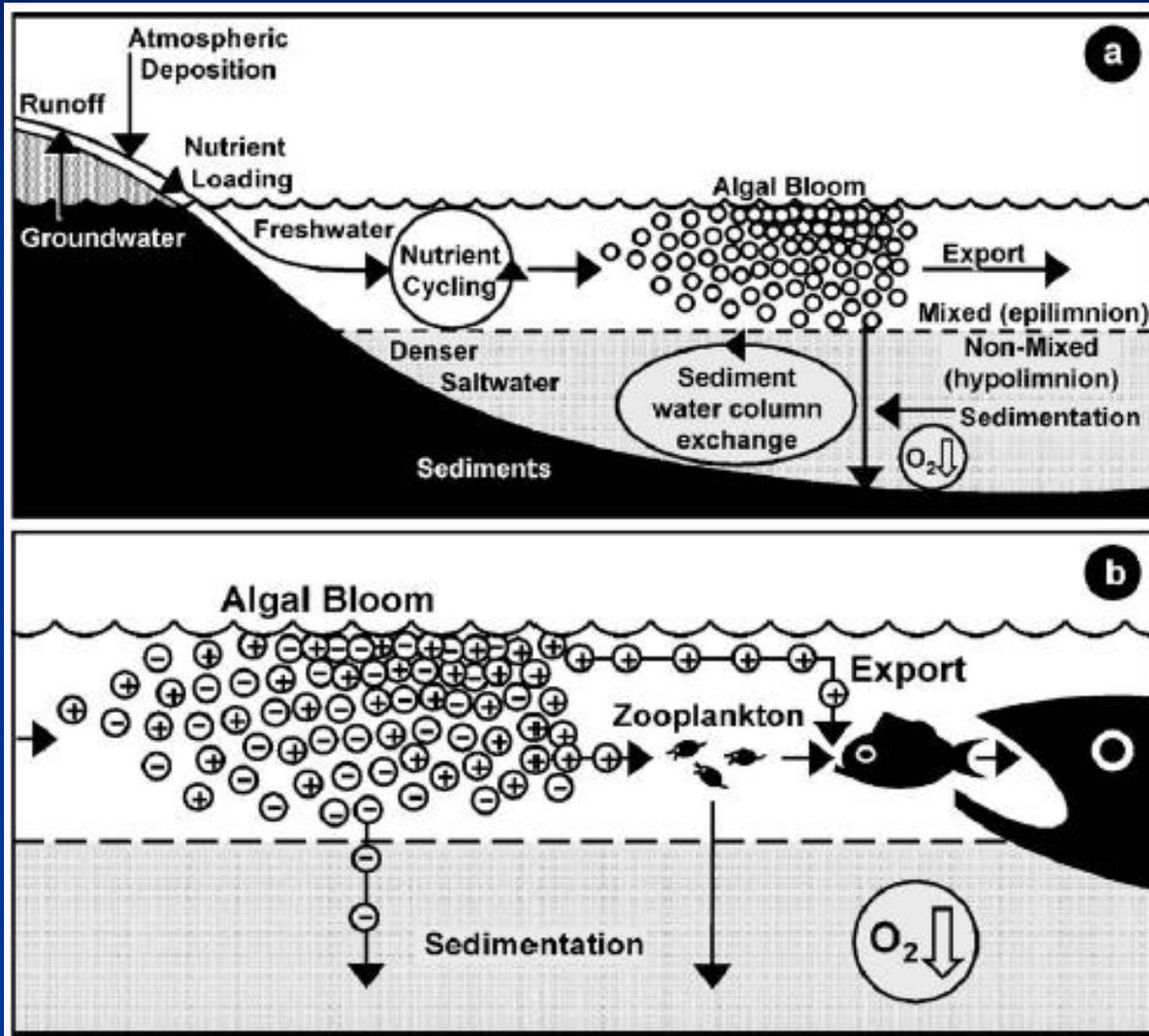


Aquatic Interactions

- Microbes Breakdown
Phytoplankton
 - Use Oxygen during
Process



Aquatic Interactions

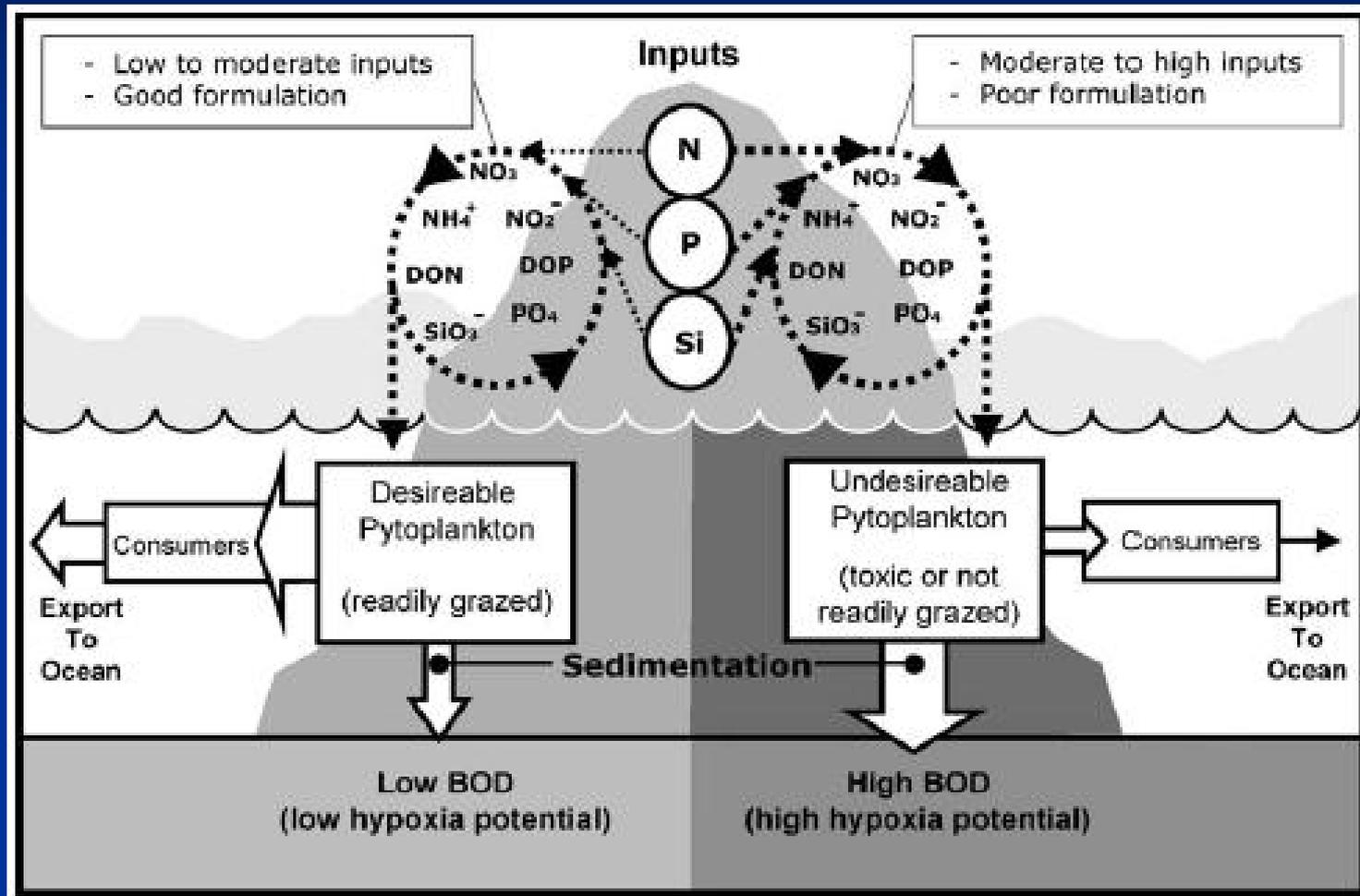


Aquatic Interactions

- Massive Algae Blooms
 - Block Light to Plants Below
Habitat for Smaller Species is Destroyed



Aquatic Interactions



Major Physical Parameter

- Discharge Rate
 - Residence Time
 - Oxygen Replenishment
 - Break Stratification



Interactions Result

- Oxygen Depletion by Microbes
- Blooms Blocking Light
 - No Food or Oxygen
 - Mobile Organisms Move
 - Stationary Organisms Die



HAB

■ Harmful Algae Blooms

- Unconsumed Blooms
- Toxic Blooms

- Can Cause Death to

Fish

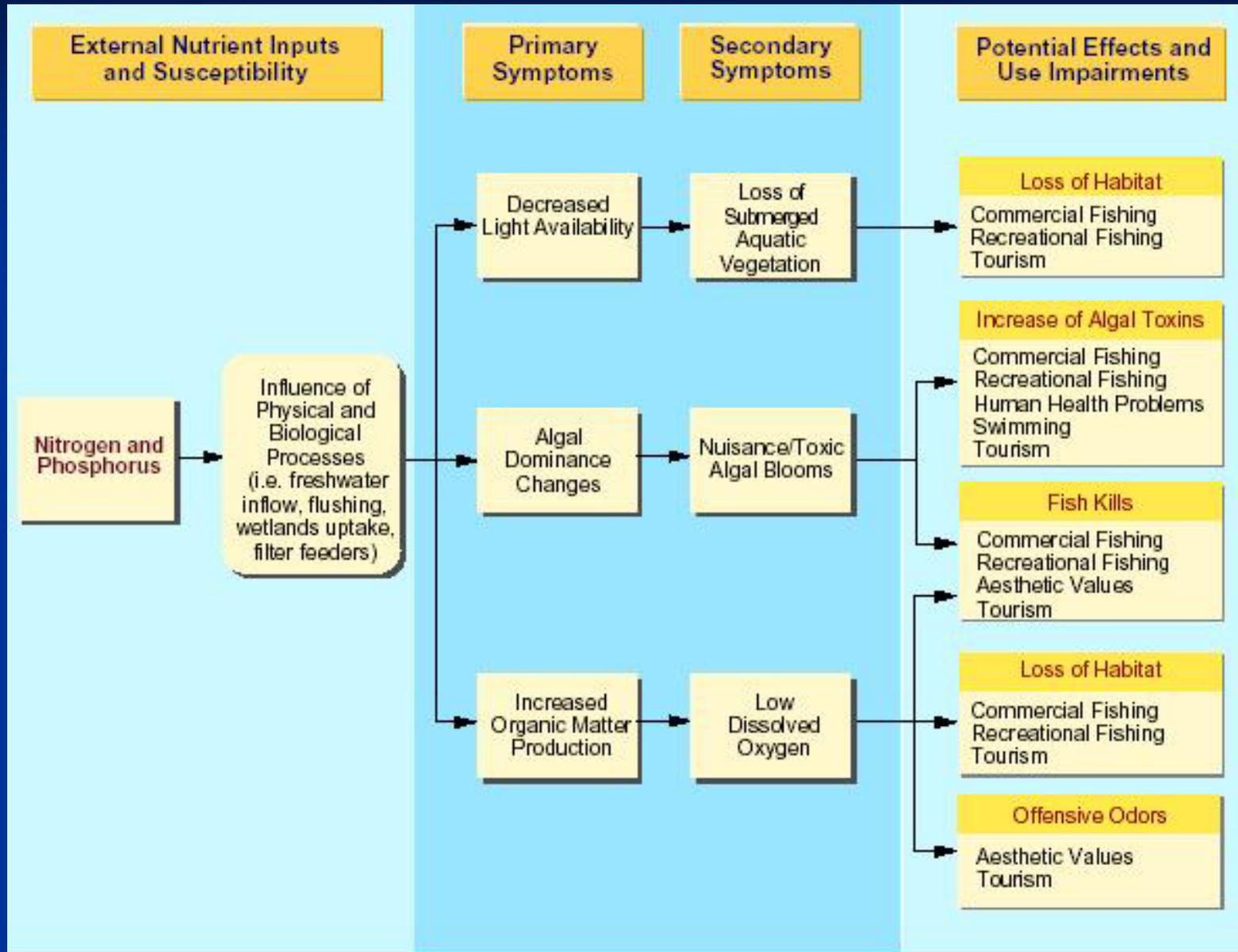
Sea Birds

Aquatic Mammals

Also Death or Illness to
Humans



Effects of Eutrophication



References

- Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando, D.G.G. Farrow. (1999) National Estuaries Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries. National Oceanic and Atmospheric Administration. Silver Springs, MD.
- Carpenter, S.R., N.F. Caraco, D.L. Correll, R.W. Howarth, A.N. Sharpley, V.N. Smith (1998) Nonpoint Pollution of Surface Waters with Phosphorus and Nitrogen. *Ecology Applications* **8**, 559.
- Environmental Protection Agency. (2000) Deposition of Air Pollutants to the Great Waters. *Third Report to Congress*. U.S. Government Printing Office, Washington DC.
- Howarth, R.W., G. Billen, D. Swaney, A. Townsend, N. Jaworski, K. Lajtha, J.A. Downing, R. Elmgren, N. Caraco, T. Jordan, F. Berendse, J. Freney, V. Kudeyarov, P. Murdoch, and Z. Zhou-Liang. (1996) Regional Nitrogen Budgets and Riverine Nitrogen and Phosphorus Fluxes for the Drainages to the North Atlantic Ocean: Natural and Human Influences. *Biogeochemistry* **35**, 75.
- National Research Council. (1993) Soil and Water Quality: An Agenda for Agriculture. National Academy Press, Washington, DC.
- Nester, E.W., Anderson, D.G., Nester, M.T., Pearsall, N.N., Roberts, C.E., Jr. (2004) Microbiology, A Human Perspective. McGraw-Hill, New York, NY.
- Nixon, S.W. (1995) Coastal Marine Eutrophication: a definition, Social Causes, and Future Concerns. *Ophelia* **41**, 199.
- Paerl, H.W., Ausley, L.W., Bales, J.D., Buzzelli, C.P., Crowder, L.B., Eby, L.A., Fear, J.M., Go, M., Peierls, B.L., Richardson, T.L., Ramus, J.S. (2001) Ecosystem Impacts of 3 Sequential Hurricanes the US's Largest Lagoonal Estuary, Pamlico Sound, NC. *Proceedings of the National Academy of Science, USA*. **98**, 10, 5655.
- Paerl, H.W. (2005) Assessing and Managing nutrient-enhanced eutrophication in Estuarine and Coastal Waters: Interactive effects of Human and Climate Perturbations. *Ecological Engineering* **26**, 40.
- Pinckney, J.L., H.W. Paerl, M.B. Harrington, K.E. Howe (2001) The Role of Nutrient Loading and Eutrophication in Estuarine Ecology. *Environmental Health Perspectives* **109**, 5, 699.
- Rabalais, N.N., R.E. Turner, D. Justic, Q. Dortch, W.J. Wiseman, Jr., and B.K. Sen Gupta. (1996) Nutrient Changes in the Mississippi River and System Responses on the Adjacent Continental Shelf. *Estuaries* **19**, 386.
- Rabalais, N.N., (2002) Hypoxia in the Gulf of Mexico: Causes, Effects, and Environmental Effects. Statement to the United States Commission on Ocean Policy. March 7.
- Turner, R.E., and Rabalais N.N. (2003) Linking Landscape and Water Quality in the Mississippi River Basin for 200 Years. *Bioscience* **53**, 6, 563.

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Questions?