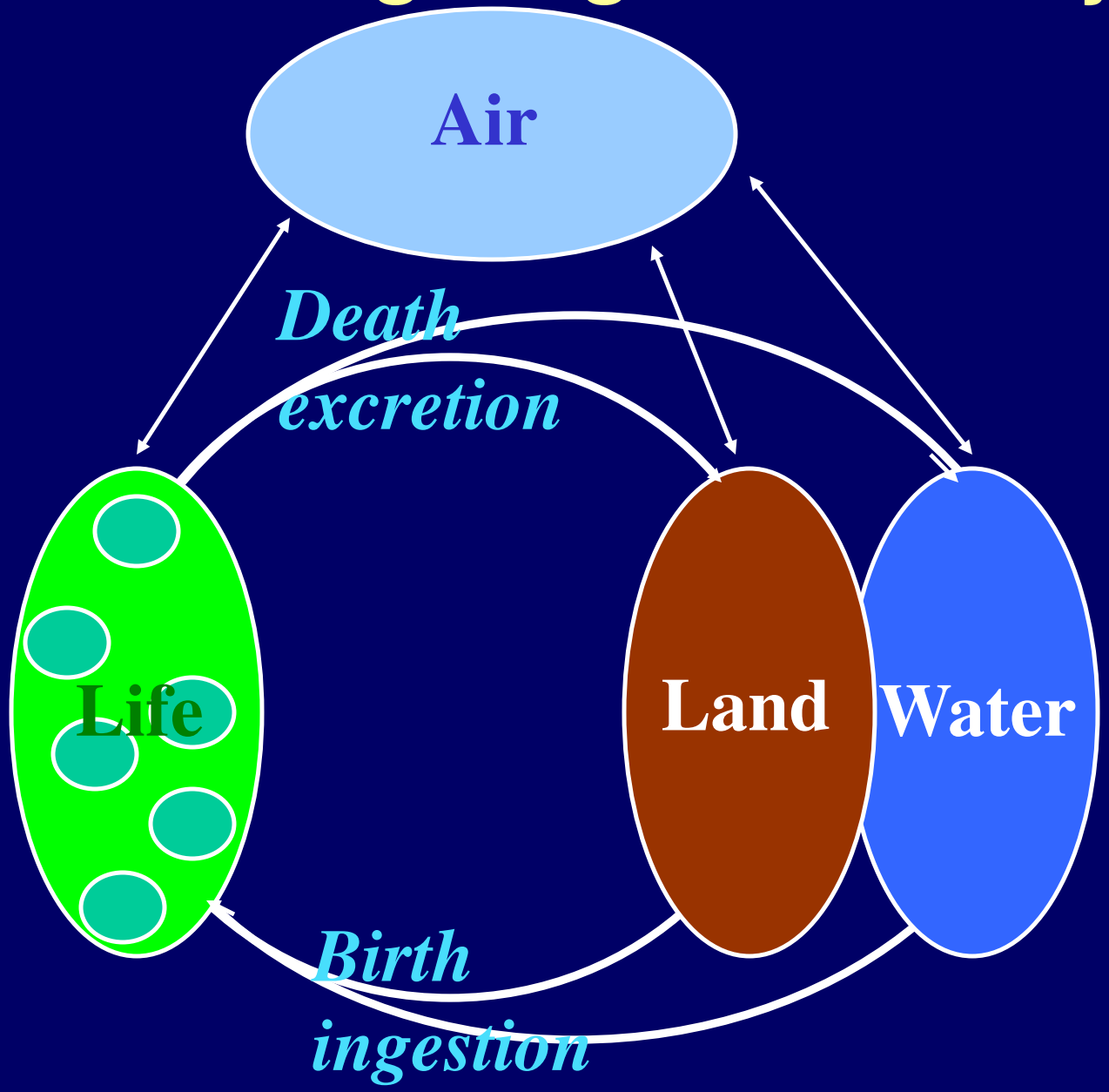
NIO
understanding the seas

Importance of Biogeochemistry in Biological Oceanography

M. DILEEP KUMAR
National Institute of Oceanography
Dona Paula, Goa 403 004

Understanding Biogeochemistry



How did BGC begin?

Origin of Earth: 4.5×10^9 *years ago*

Primitive air: N_2, H_2O, CO_2, H_2, H_2S

Life: 3.5×10^9 *years ago*

Photosynthesis

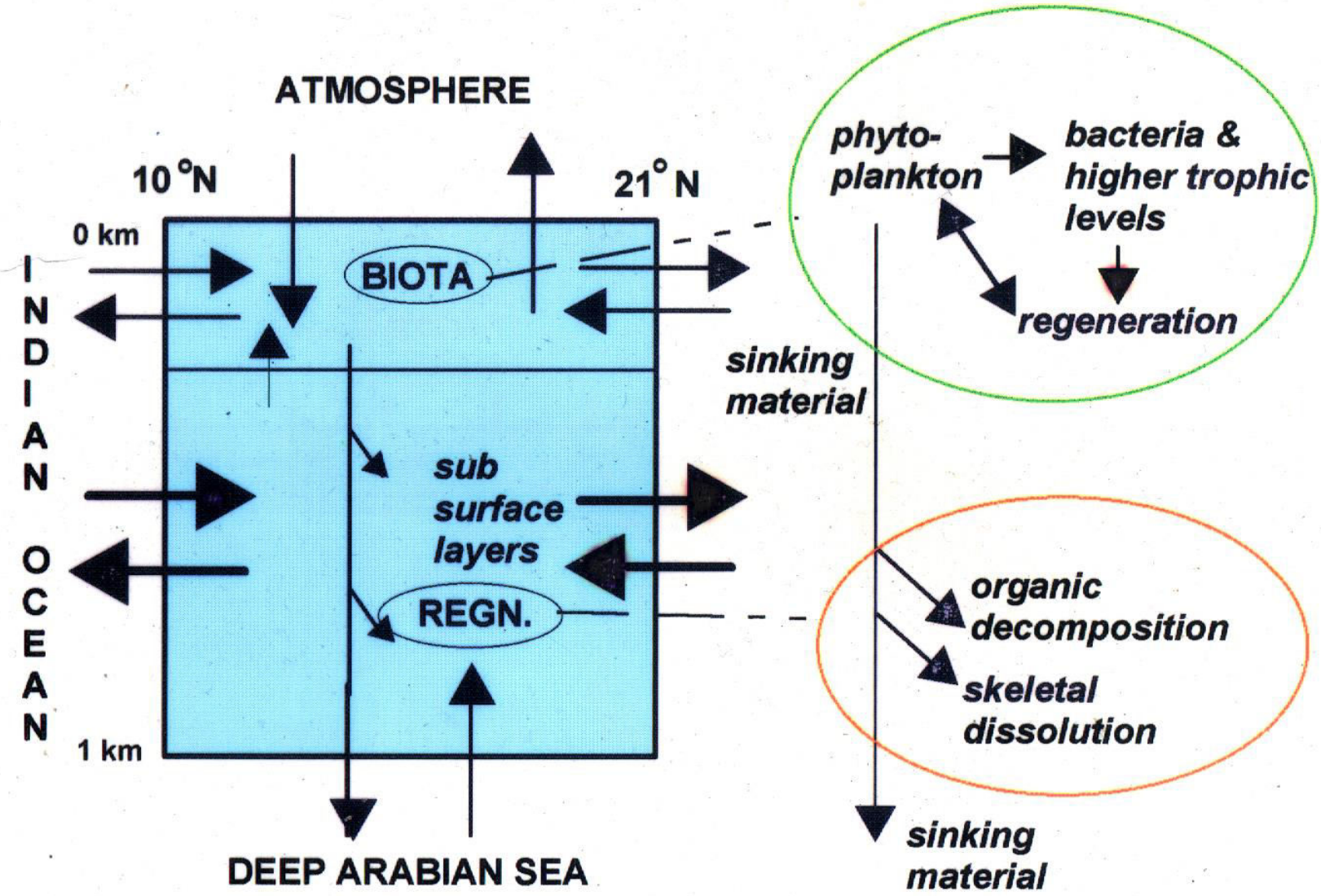
$$2H_2S + CO_2 = (CH_2O) + 2S^o + H_2O$$

$$CO_2 + H_2O = (CH_2O) + O_2$$

Present air: N_2, O_2

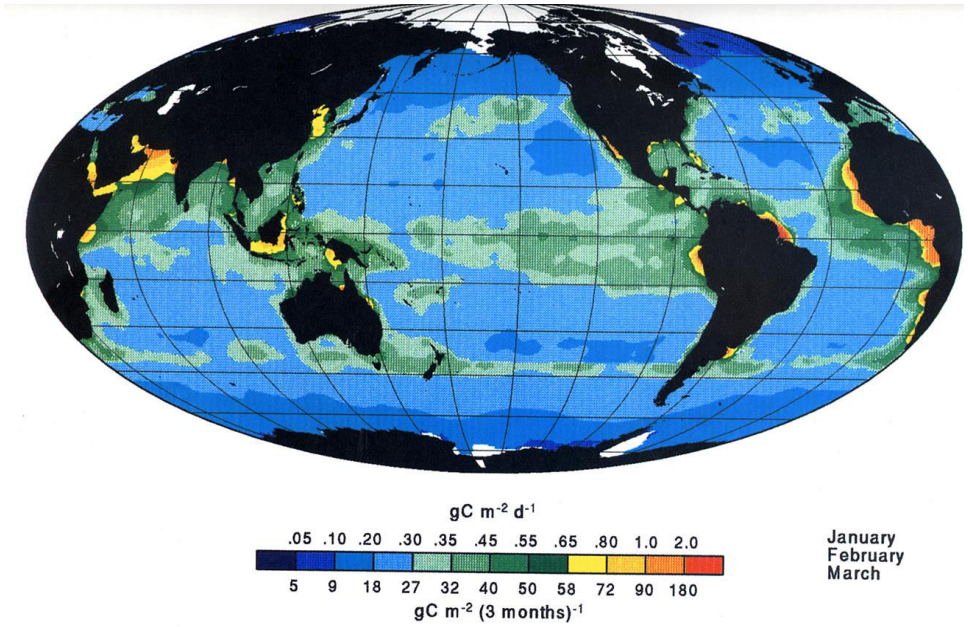
diverse life sustaining planet !!!

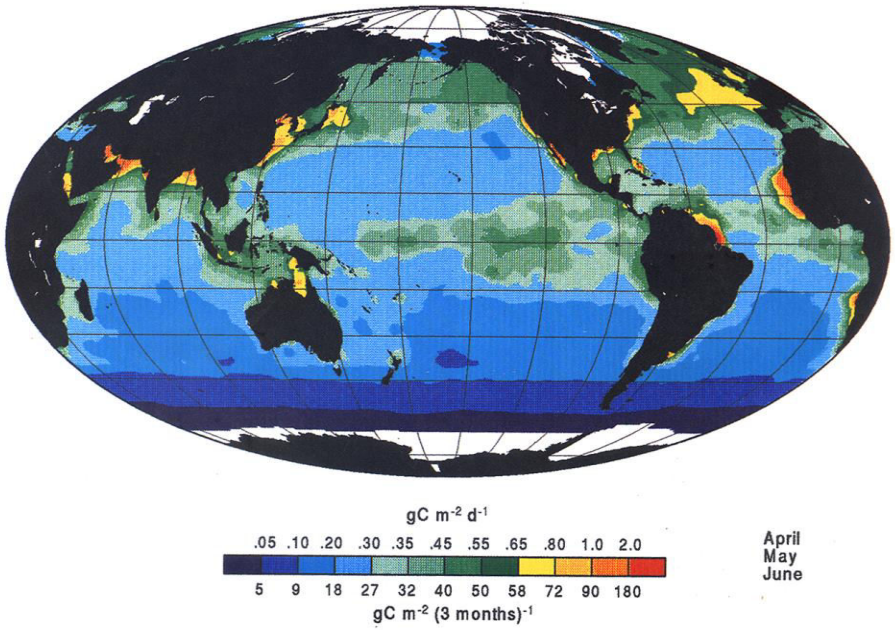
Ocean Biogeochemical Cycle

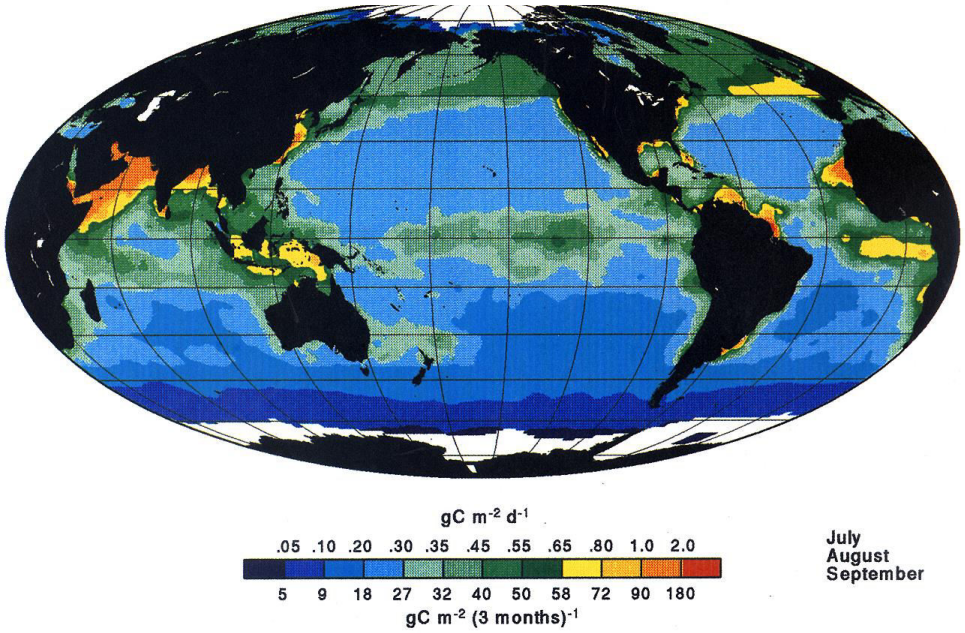


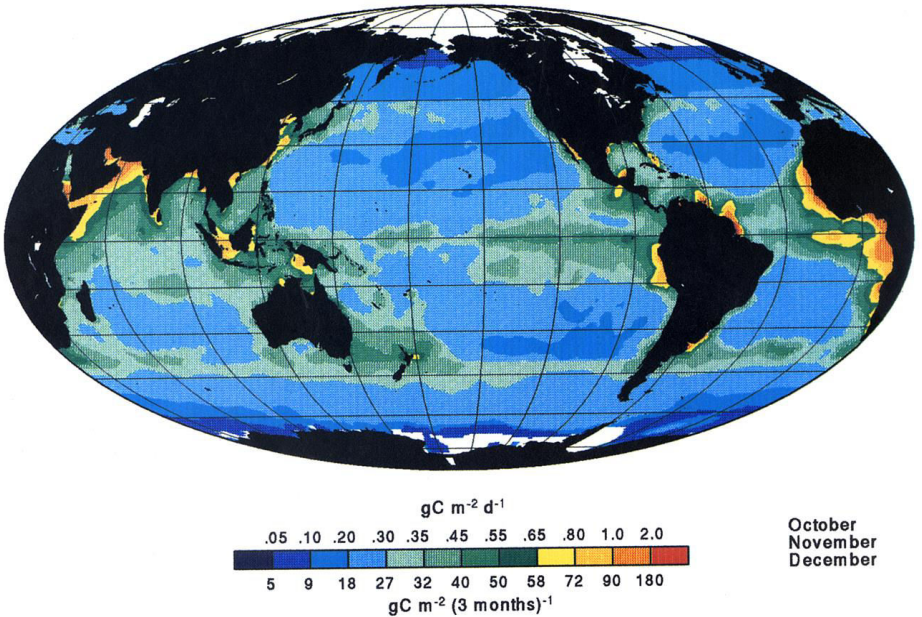
Global Primary production

Behrenfeld and Falkowski, 1997









Synthesis of Organic matter

CO_2 + H_2O + Energy + Nutrients
= Organic matter + O_2

Photosynthesis

CO_2 + H_2O + Energy = CH_2O + O_2

Abundant in the ocean are CO_2 and water.

WHAT LIMITS THE SYNTHESIS OF ORGANIC MATTER? **Nutrients**

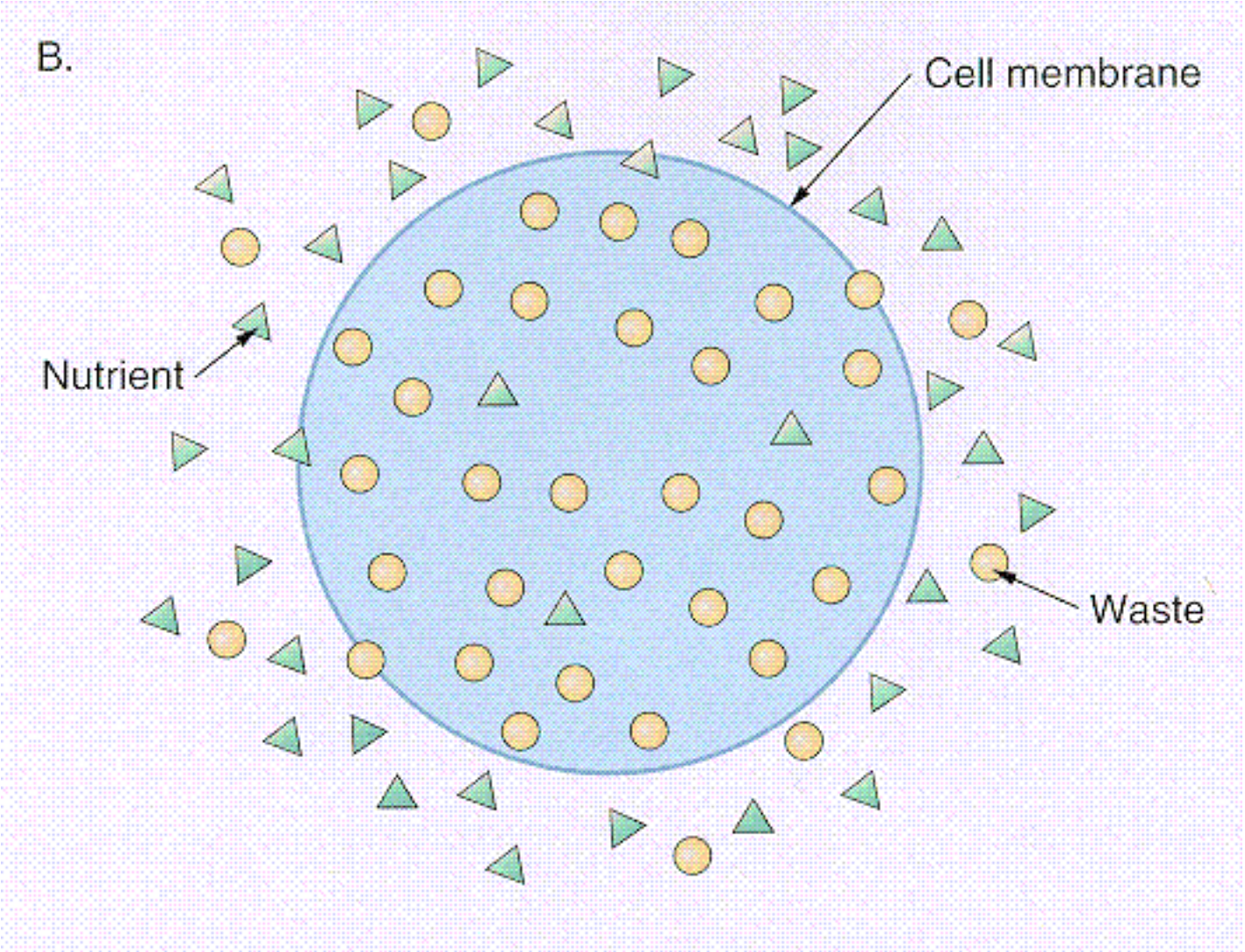
What are these nutrients?

Essential ingredients in building materials required for cell functioning and bioenergetics

Nitrogen, phosphorus, silicon, Iron etc.

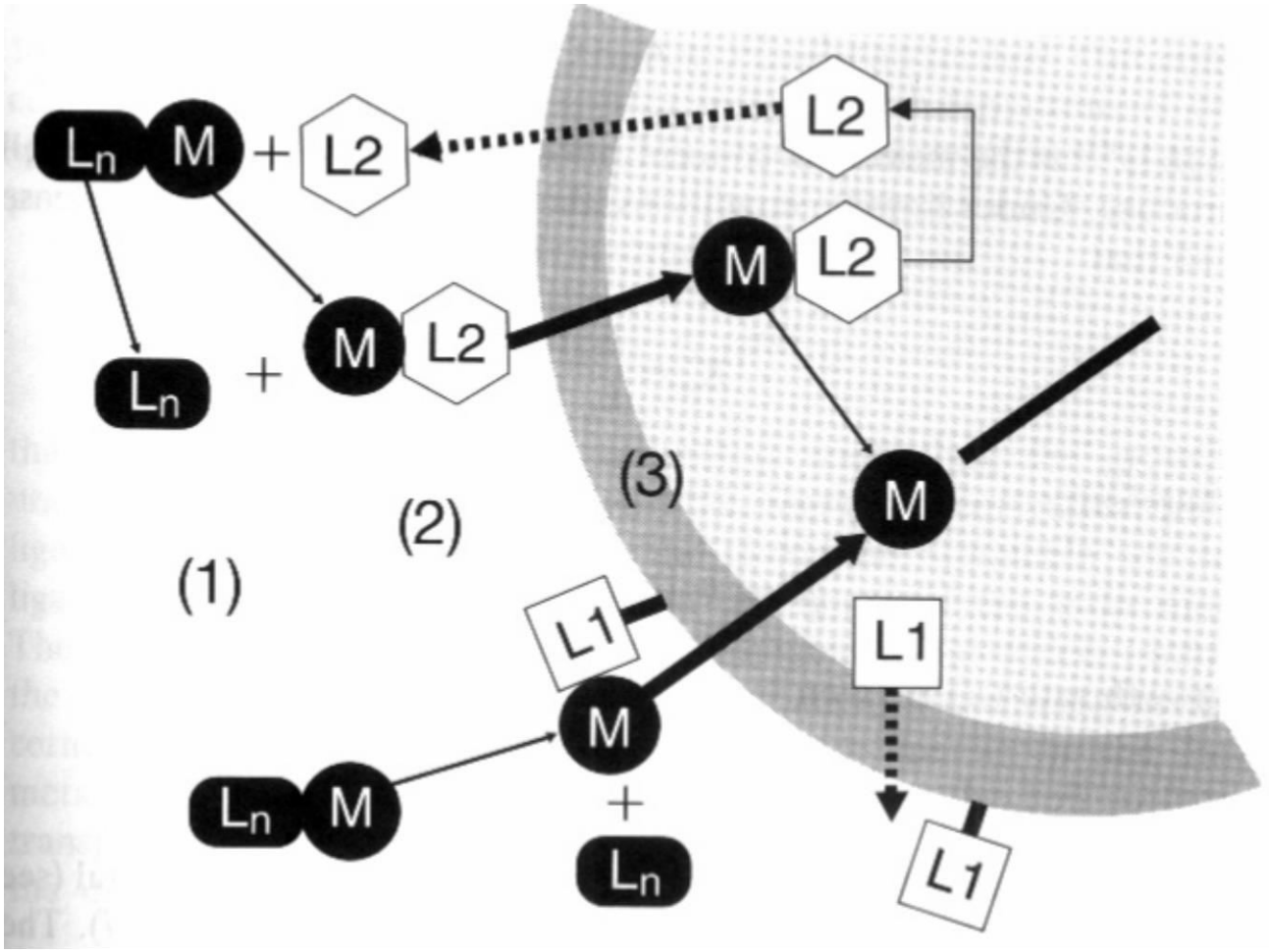
Nutrient uptake: Diffusion

molecules move from high to low concentrations

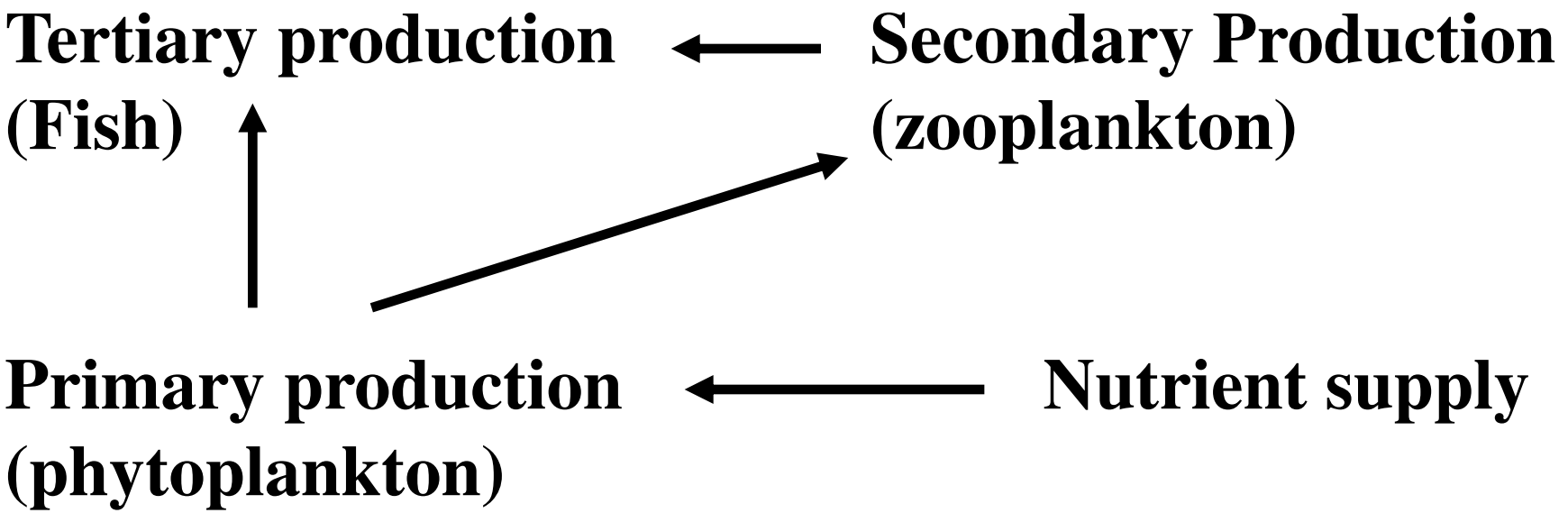


http://dusk.geo.orst.edu/oceans/PPT/23.Product_Ecol10.ppt

Diffusion/Complexation/Scavenging/absorption



Speciation controls bioavailability of metals



Quality & quantity of resource matters!

Relative availability of N, P and Si facilitates dominanance of certain groups of primary producers in the surface ocean

C:N:P = 106:16:1

…that determines the nature and variety of the following food chain…

N and Si are the most competing in determining the dominant groups of primary producers

Nutrient	Dominant Group(s)
N & P	Chl-a producing
DON	Cyanobacteria, dinoflagellates
N	Cyanobacteria
Si	Diatoms

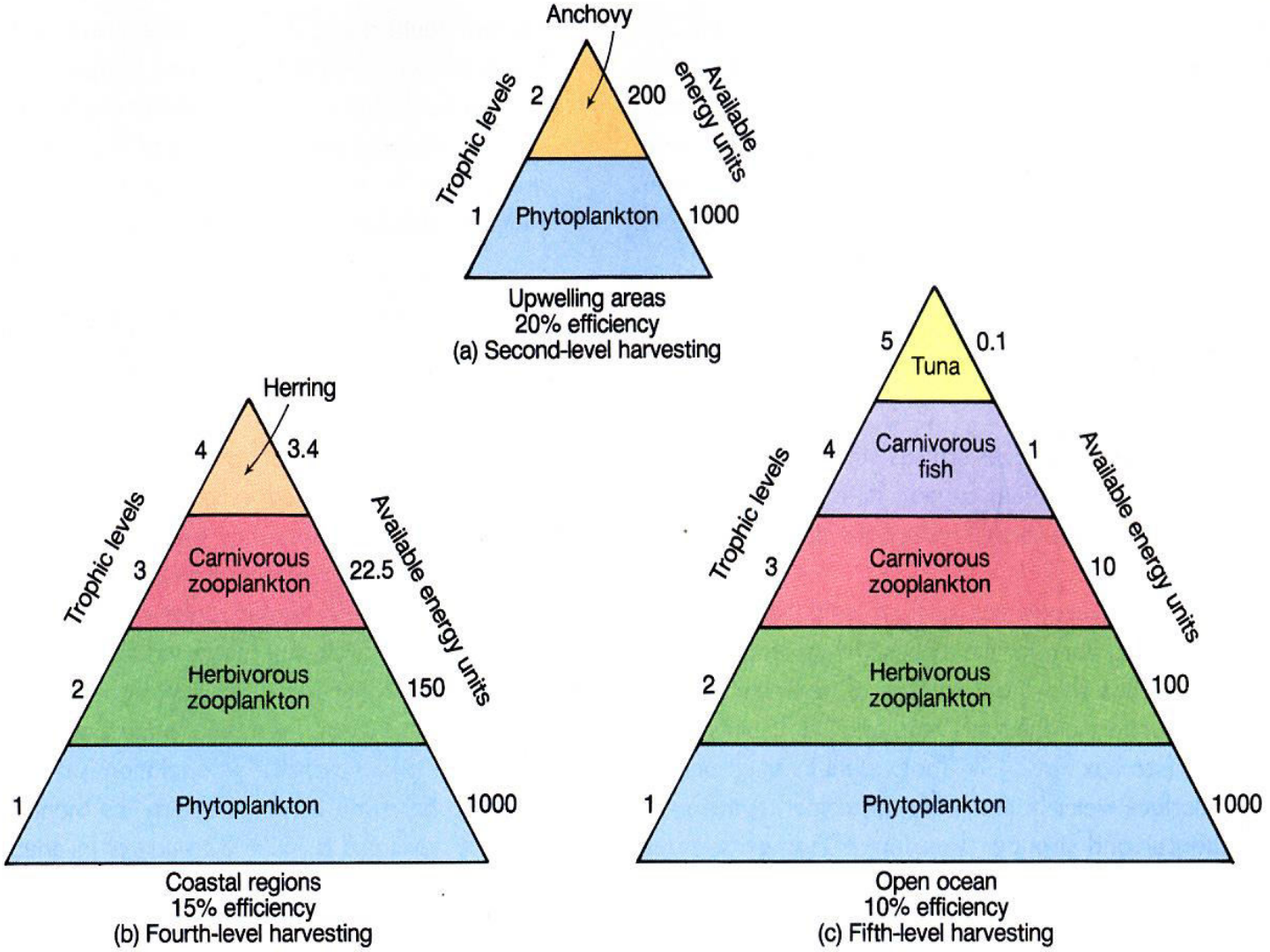
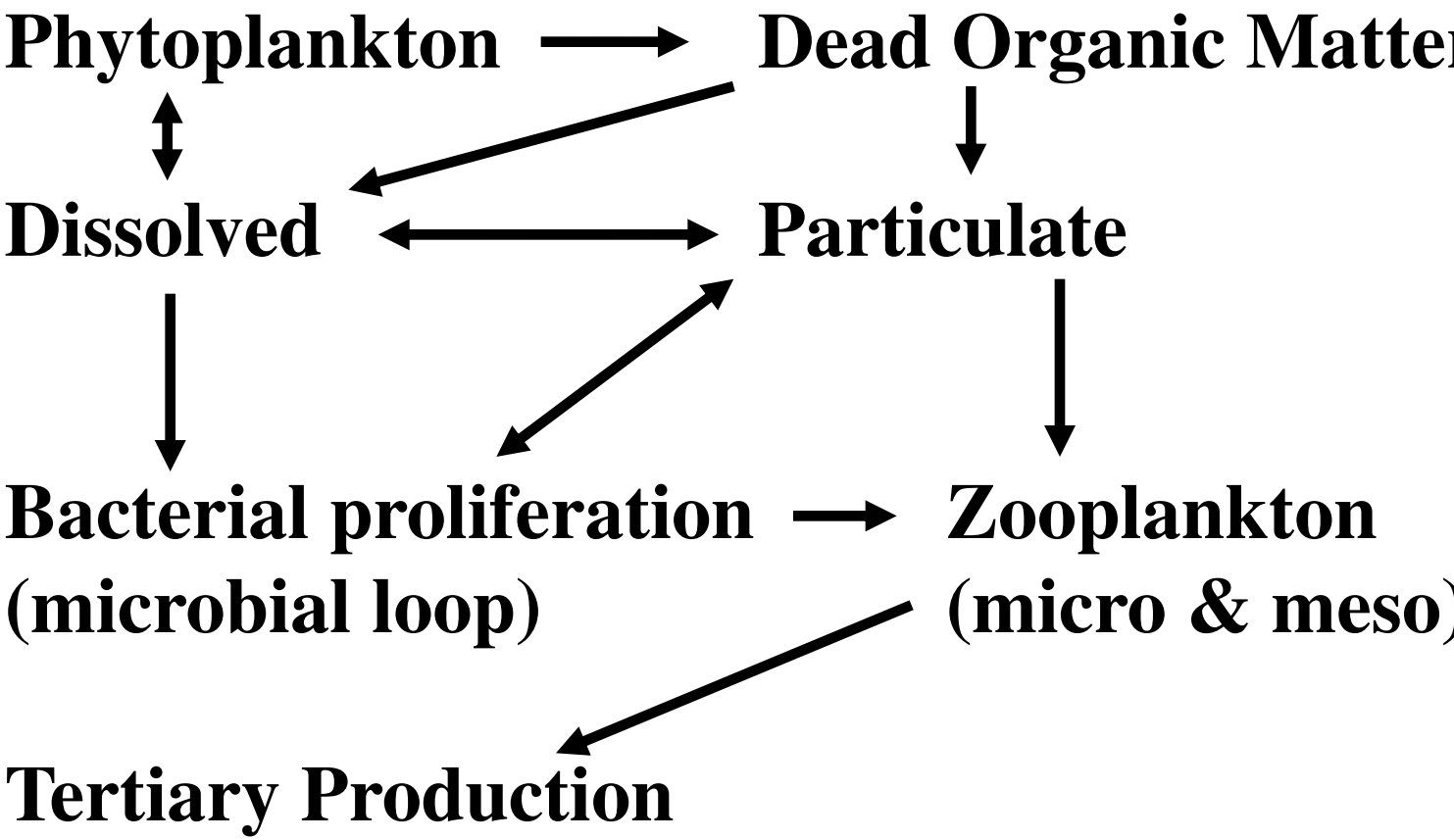


Figure 14.14

Trophic level efficiency varies among (a) upwelling areas, (b) coastal regions, and (c) the open ocean. The number of trophic levels and the level at which humans harvest differs with location.

How is 90% energy lost between trophic levels?



Quality & quantity of resource matters!

Key role of microbes in ocean carbon turnover

Carbon fixing cyanobacteria
to
Organic Carbon decomposing heterotrophs

Heterotrophic bacteria (aerobic): remineralization

$CH_2O + O_2 \text{ ----> } H_2O + CO_2$

or

sink

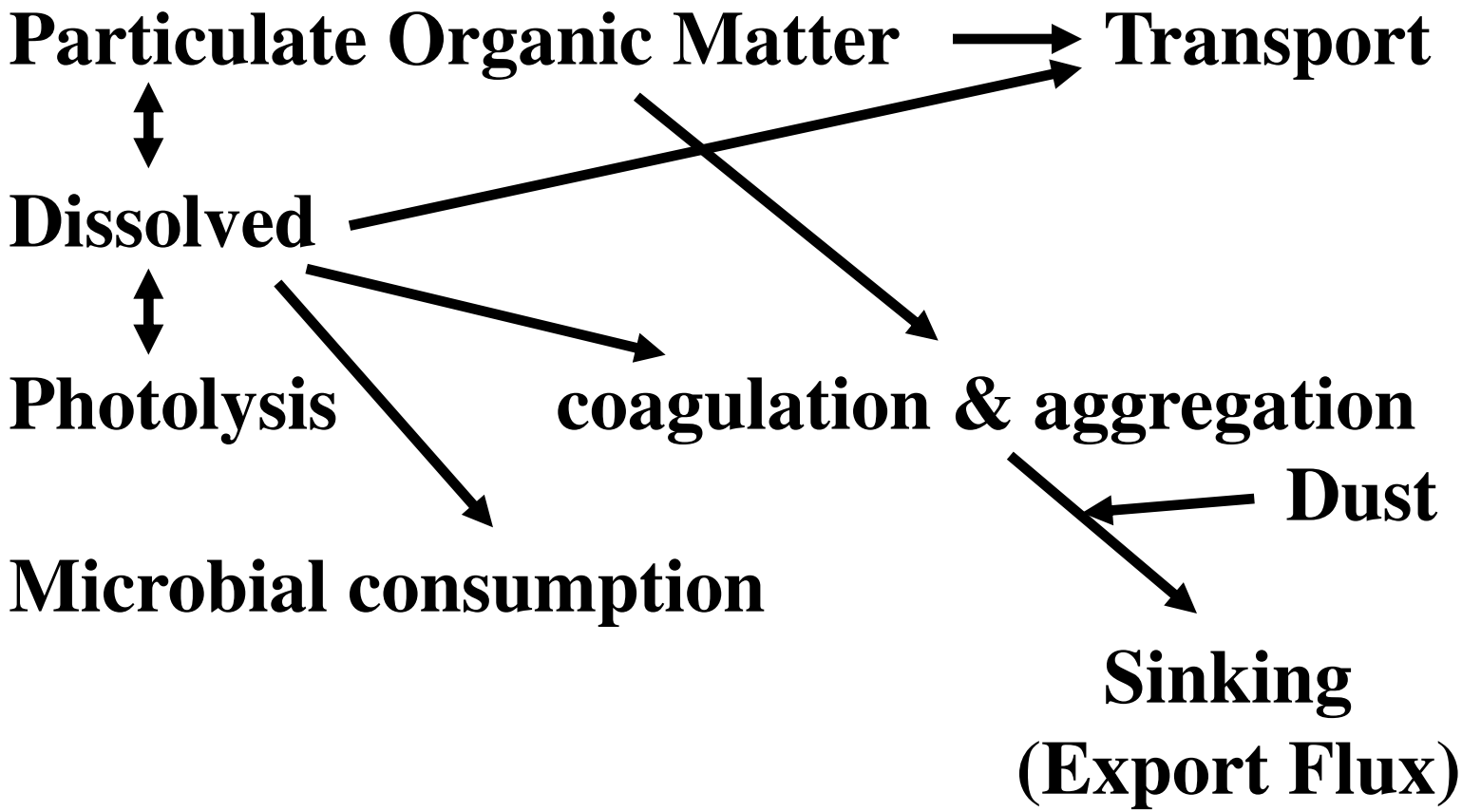
DOM + O_2 ----> bacterial biomass + CO_2 + H_2O

microbial loop link

PHYTOPLANKTON

HIGHER TROPHIC LEVELS

Loss of Organic Matter from ocean

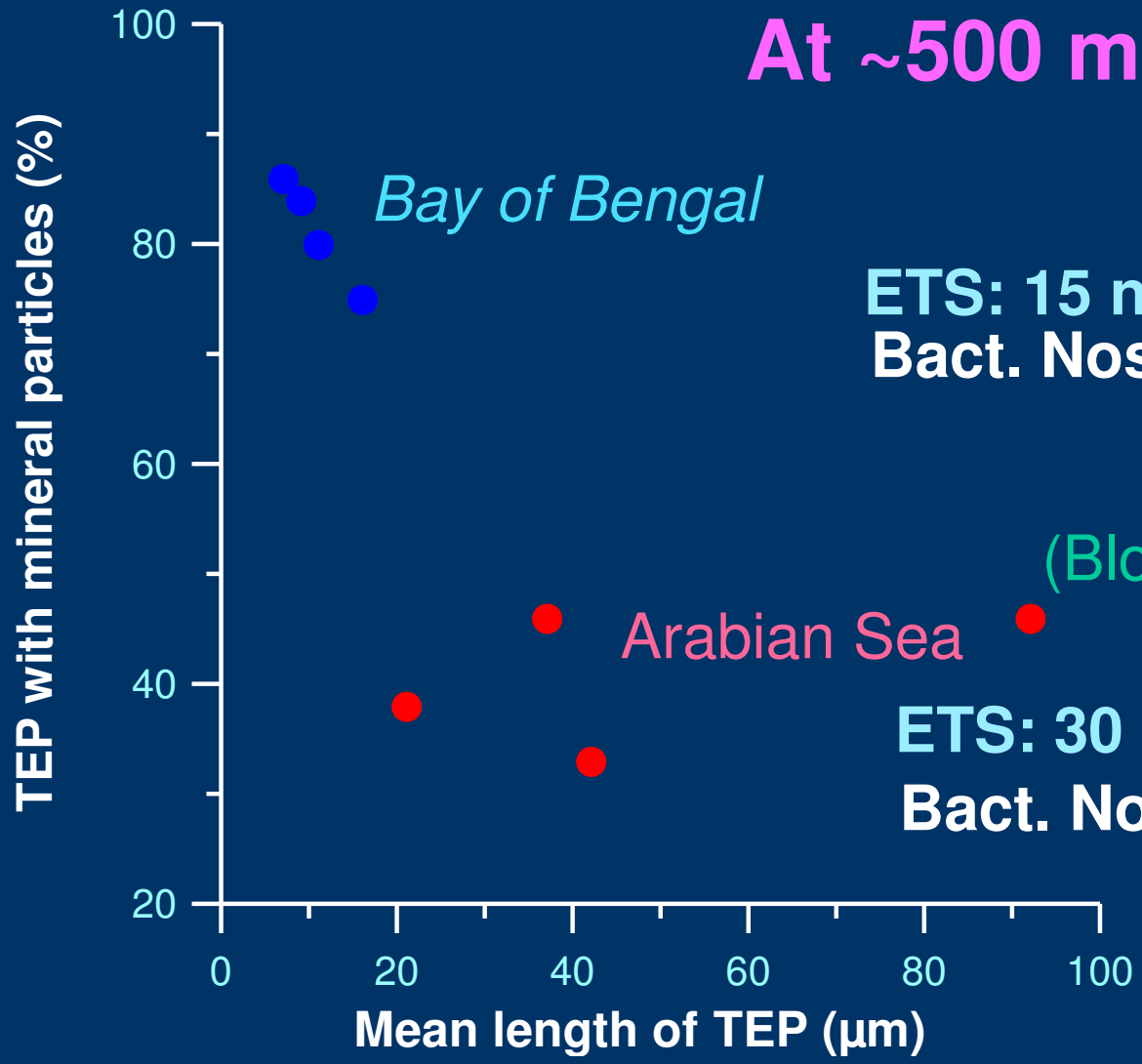


Sinking material fluxes

SINKING FLUXES IN DEEP WATERS

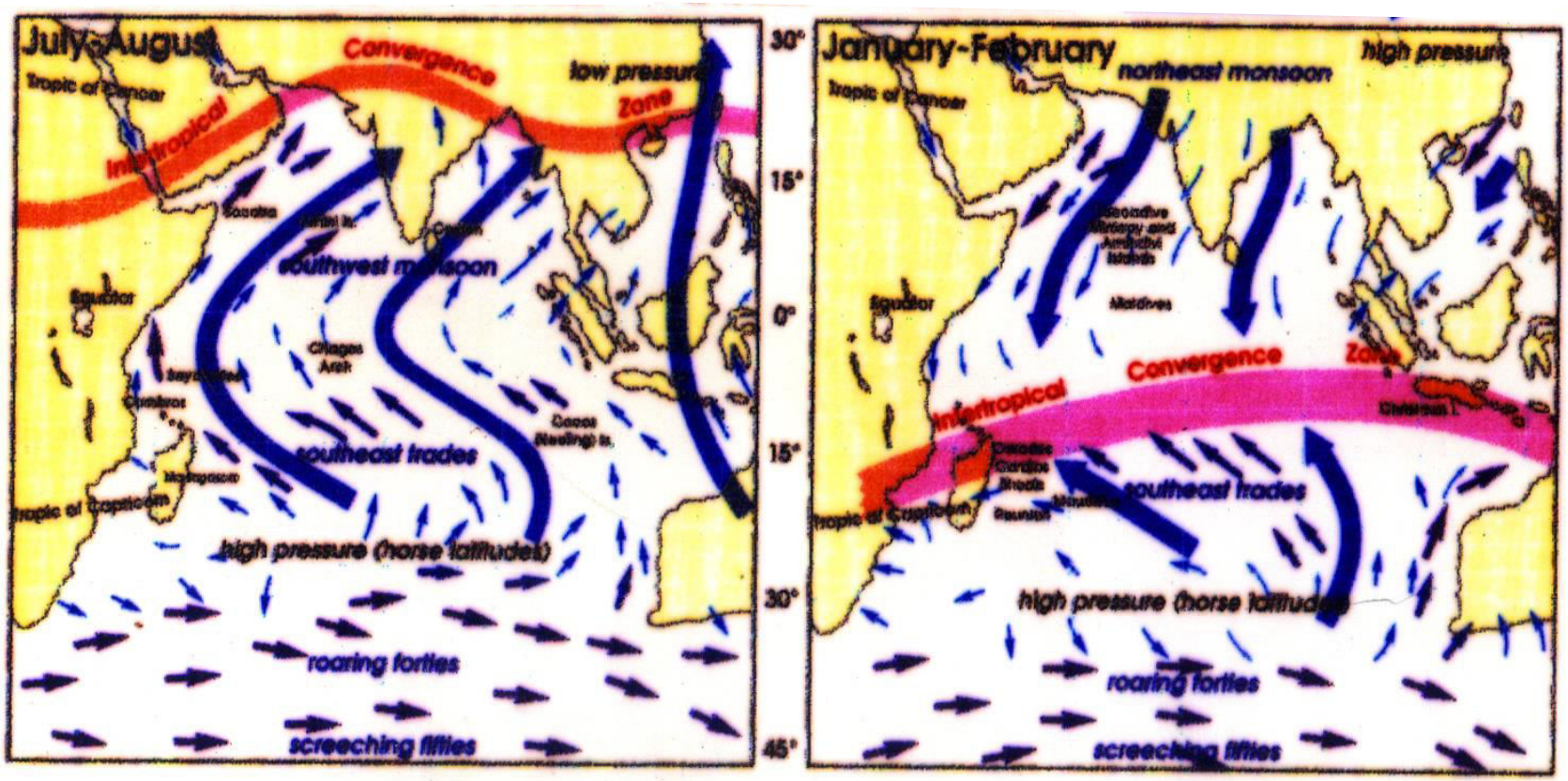
	Org – C	CO_3 – C	Lithogenic
		g / m^2 / y	
ARABIAN SEA (NAIR et al., 1989)			
WEST (60°, 30′E)	1.80	2.28	2.64
CENTRAL (64°, 45′E)	1.53	2.10	3.05
EAST (68° 45′E)	1.56	1.43	5.40
BAY OF BENGAL (ITTEKKOT et. al., 1991)			
NORTH (17°26′N)	2.65	1.29	27.96
CENTRAL (13°09′N)	2.61	2.03	14.70
SOUTH (04°26′N)	2.04	2.22	8.56

Transparent and mineral particles

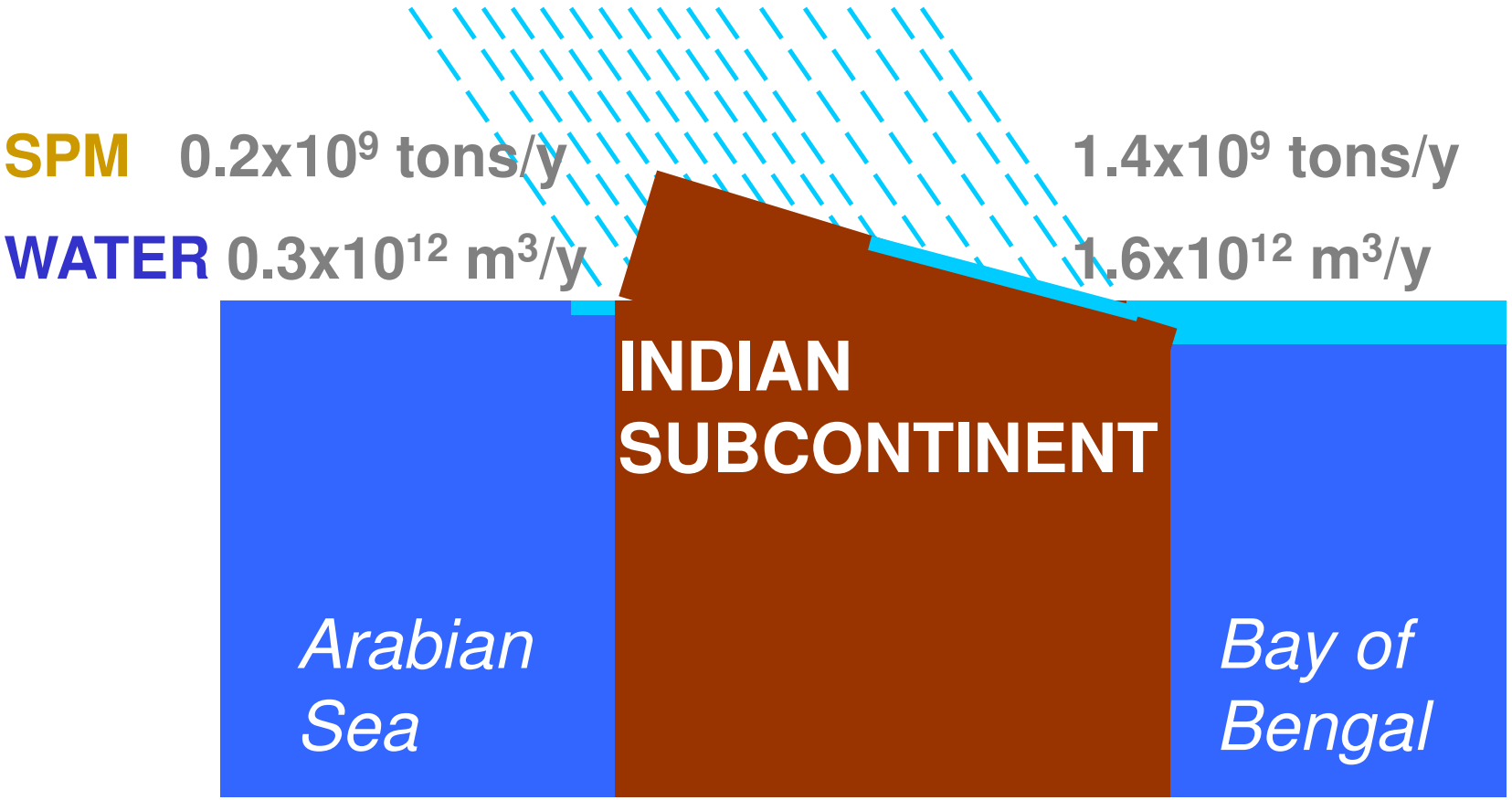


NIO

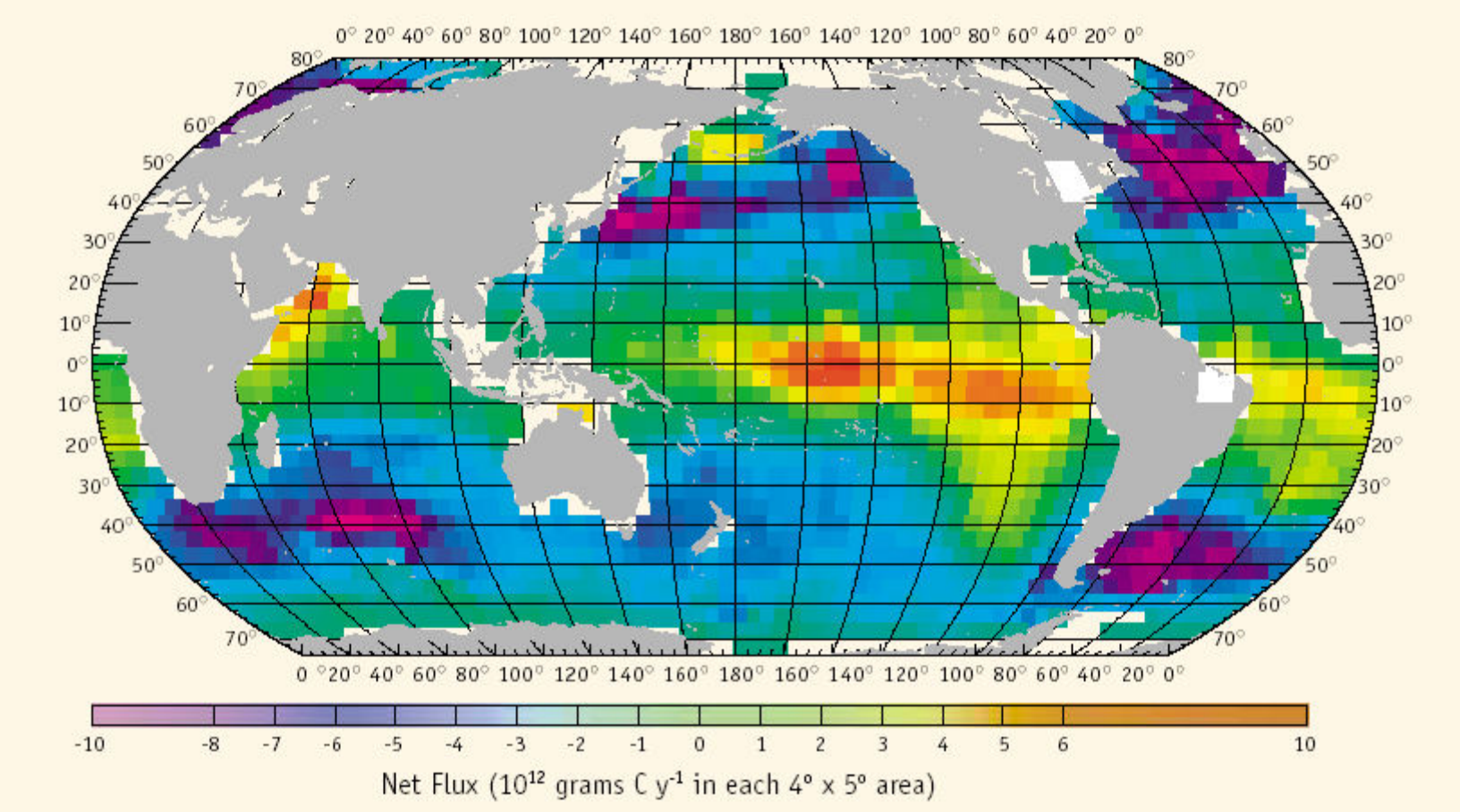
Monsoon forcing: North Indian Ocean



Different river discharges



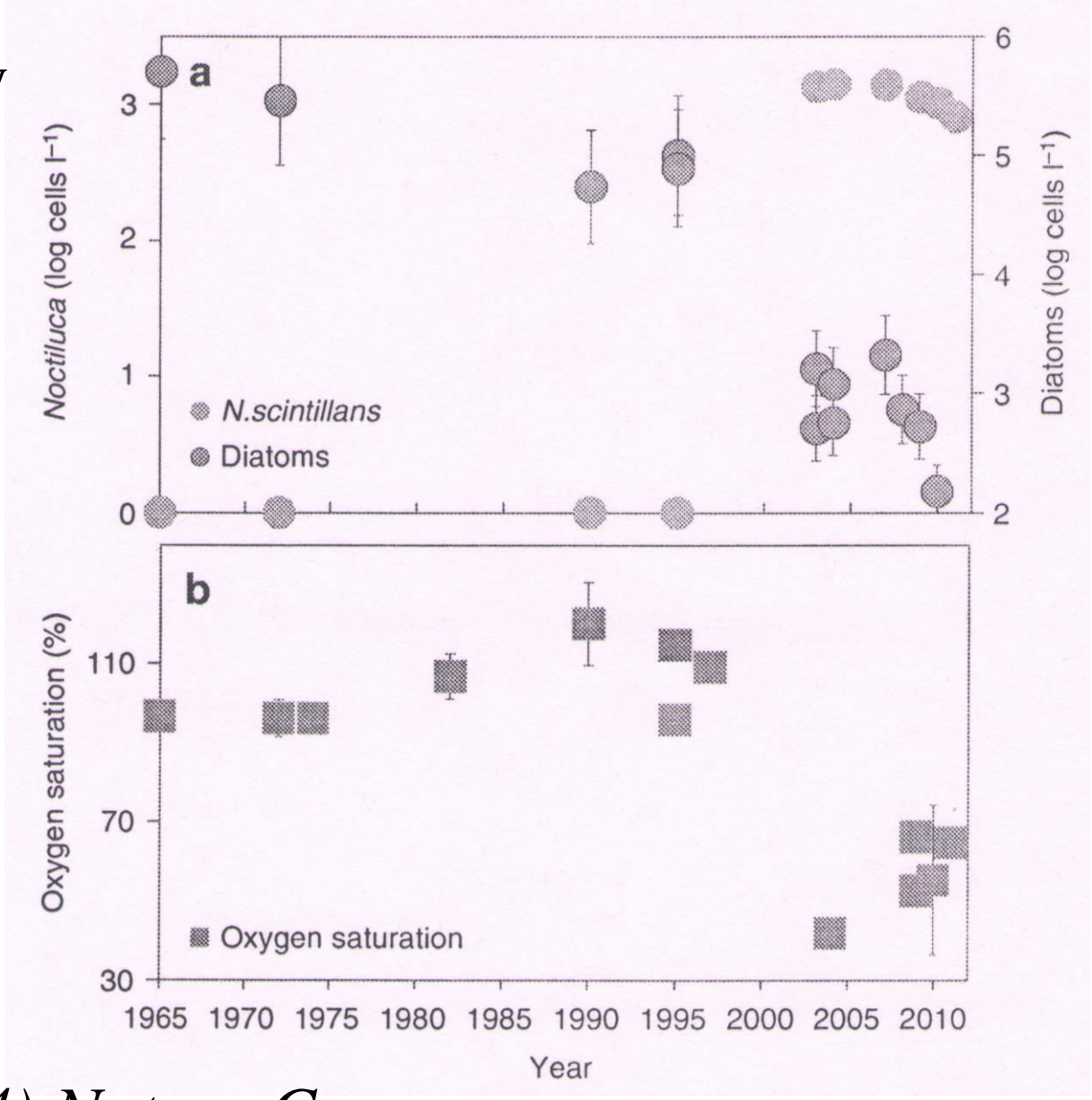
Sea-to-air fluxes of carbon dioxide



Changing Environment and shifting Ecosystems

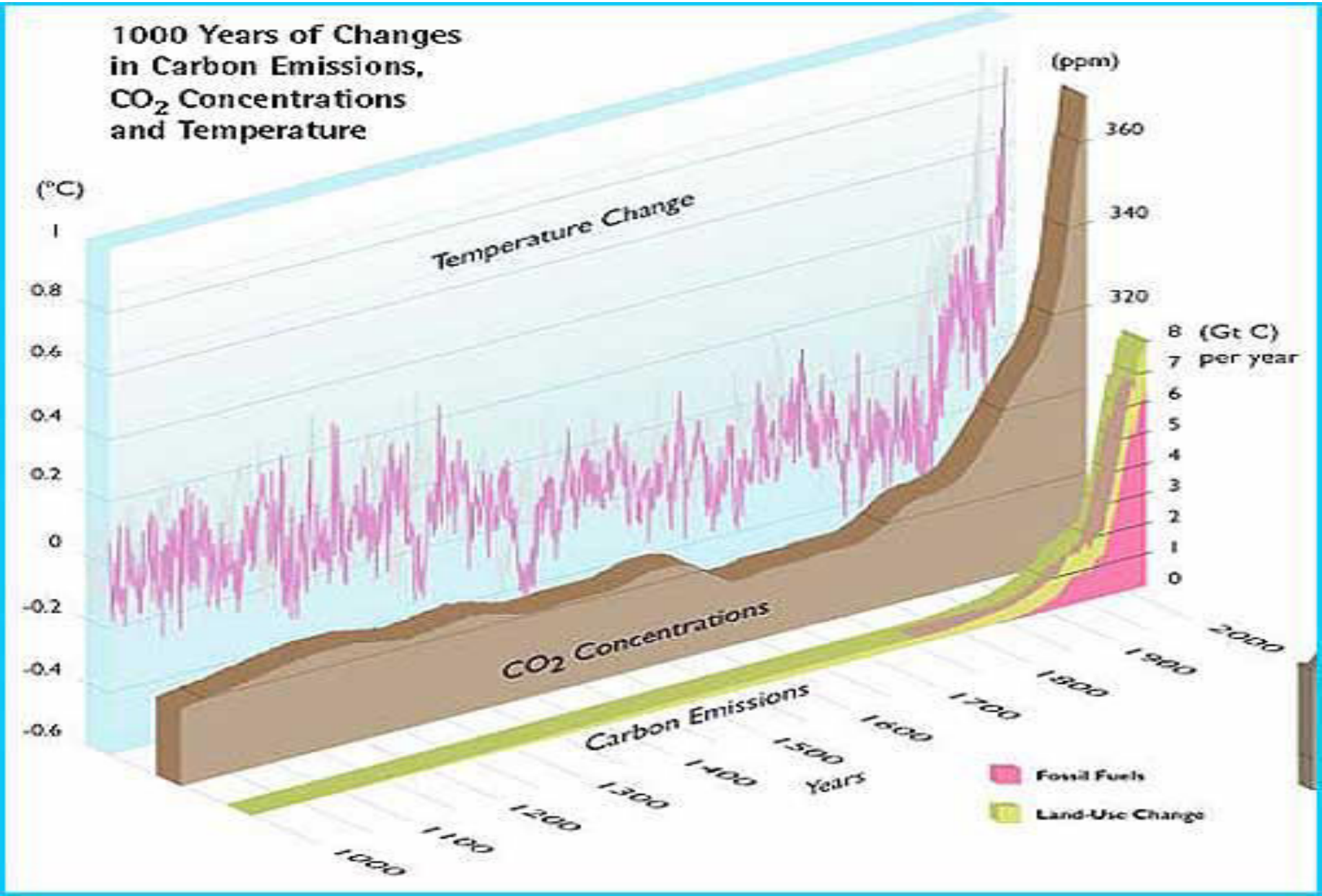
Oxygen deficiency Facilitates *Noctiluca* Blooms!

Threat to Fishery resources along west coast of India?



Gomes et al. (2014) Nature Comm.

Global Temperatures *vs* Atmospheric CO2 *vs* CO2 Emissions by Humans – Last 1000 Years



Thank You !