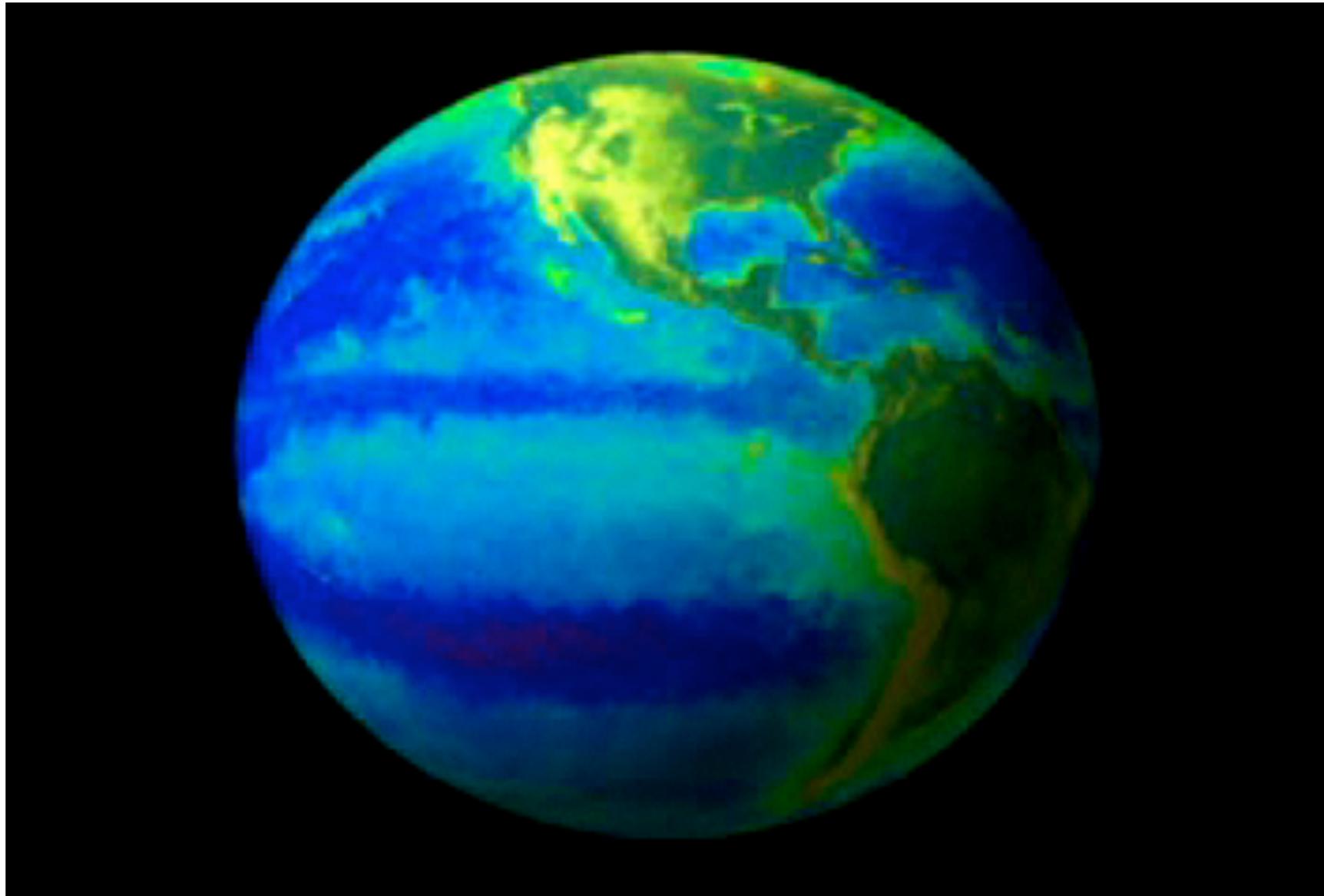


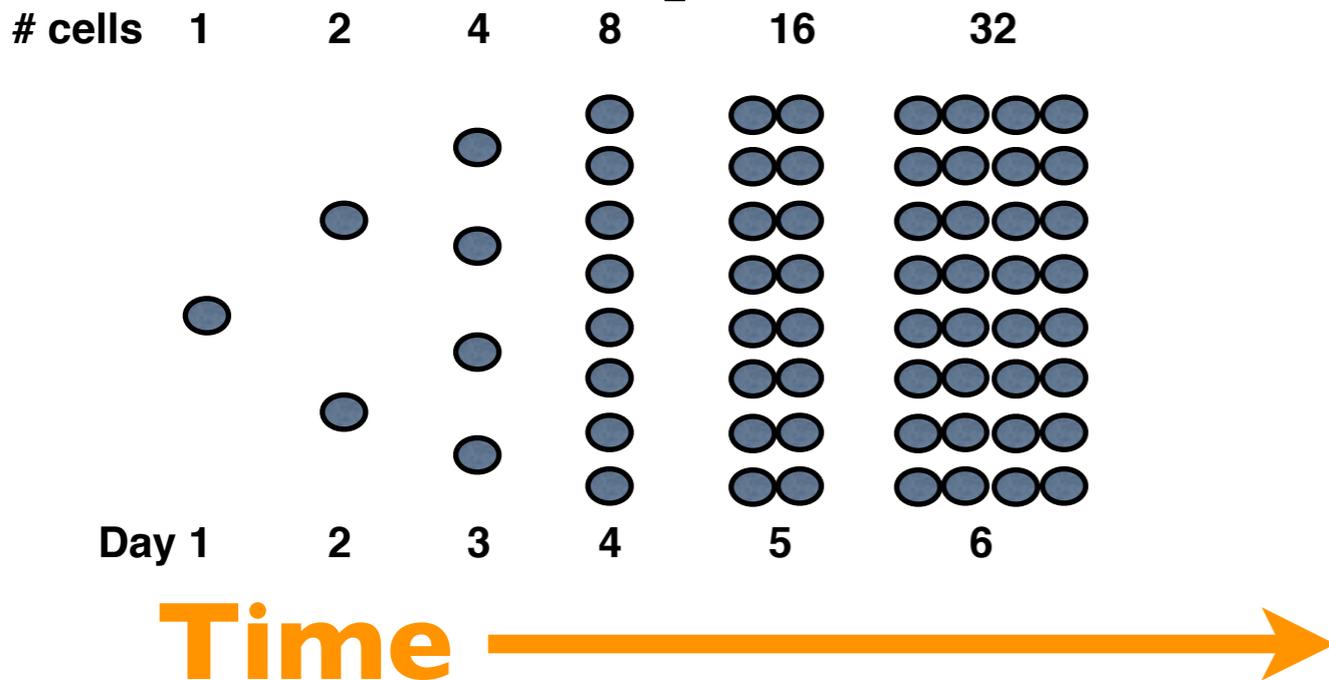
Patterns of Productivity II



Limitation by Nutrients (and Light!)

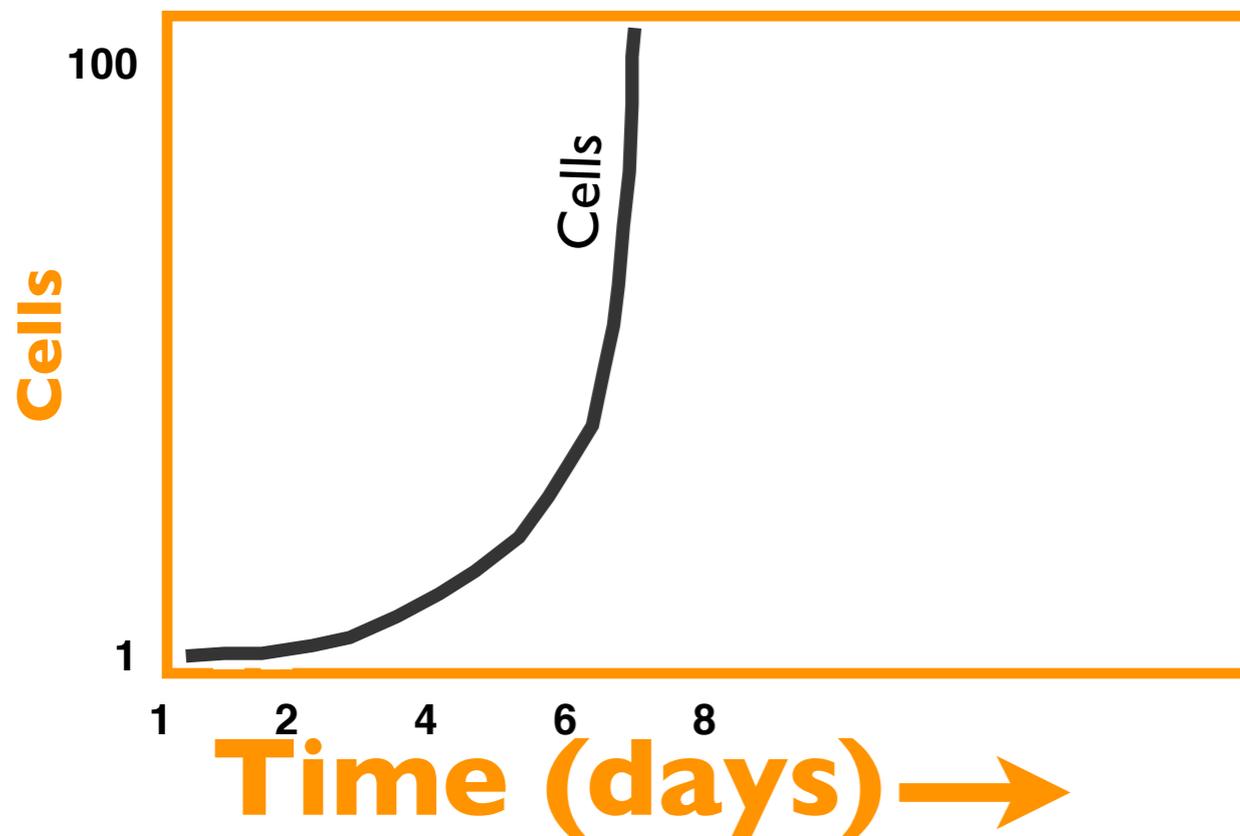
OCN 201 Biology Lecture 9

Exponential Growth



As cells grow, every cell divides into two new cells in each generation. This leads to exponential growth.

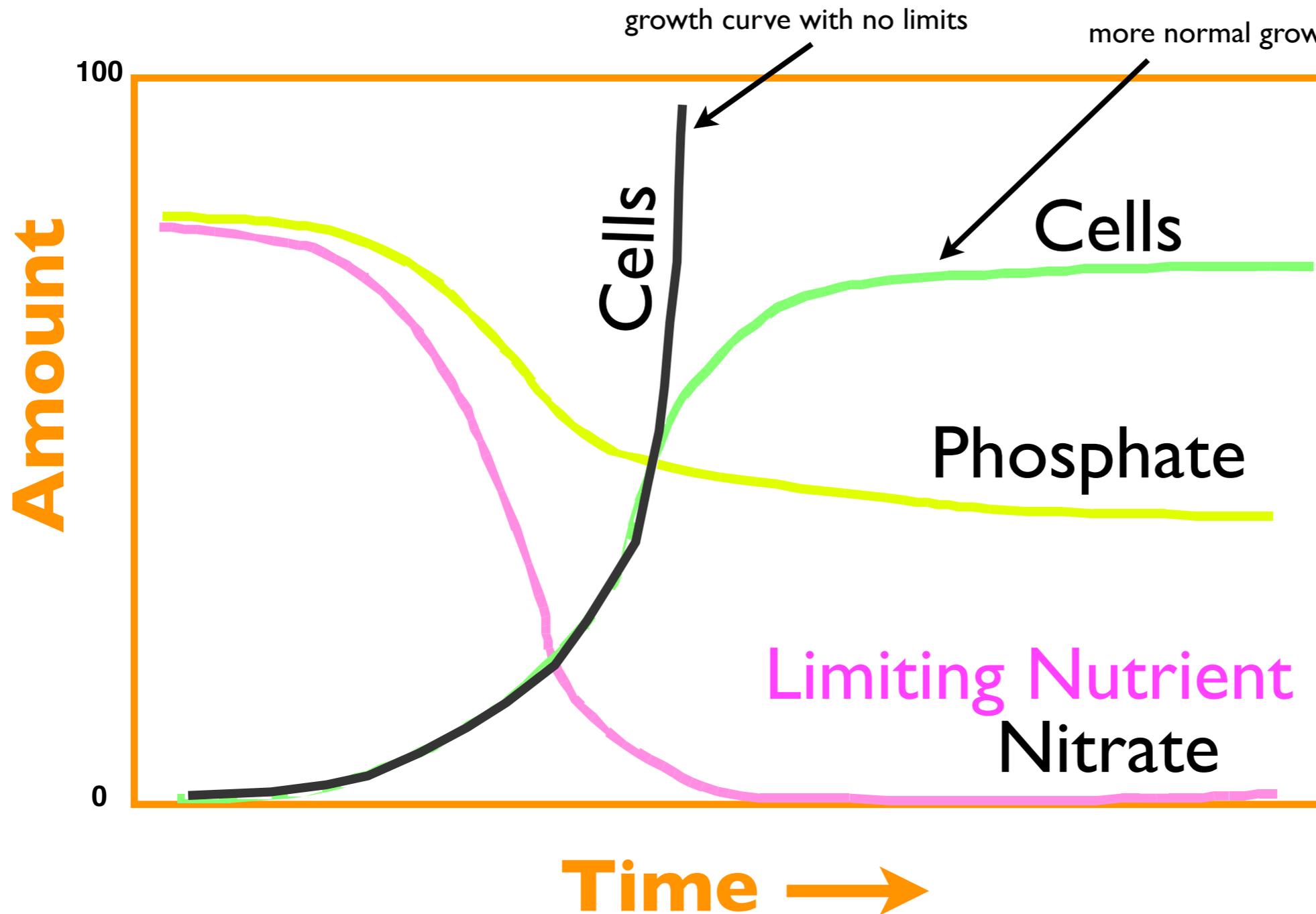
In this example, the cells are dividing once per day.



If you plot the number of cells over time, you can see that the population grows faster and faster

If nothing stopped its growth, a cell that divided once per day could grow from a one single microscopic cell to a population that fills the entire ocean in about four months!

Limiting nutrient



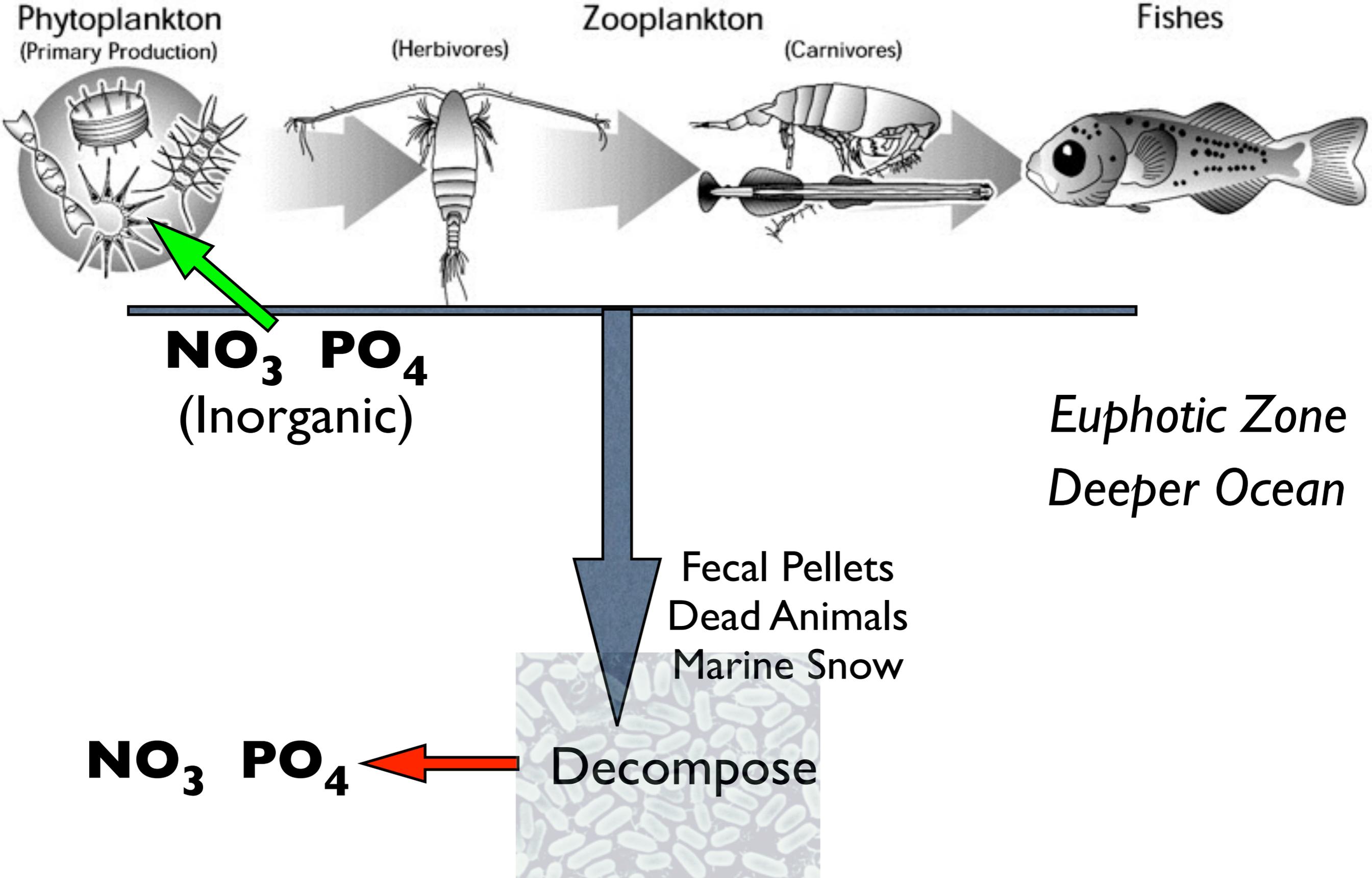
In this example, the cells used up all the nitrate (but not phosphate). With no more nitrate they can no longer grow, so nitrate is the limiting nutrient in this case.

Any nutrient has the potential to be limiting. It depends on how much of each nutrient is available relative to the organism's needs

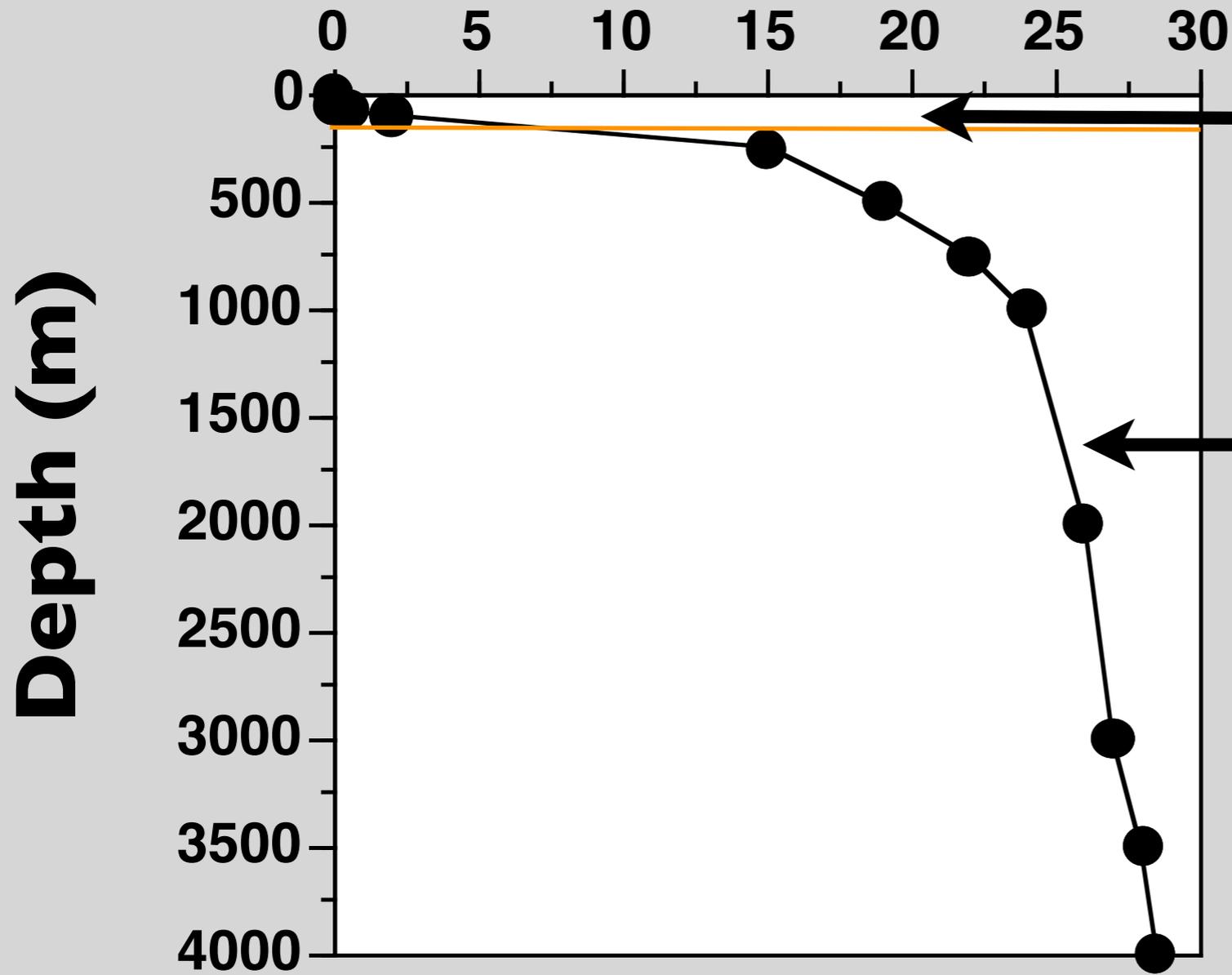
Nutrient Limitation

- With sufficient light, growth will continue until nutrients run out
- Limiting nutrient: the nutrient that runs out first

(Organic N & P)

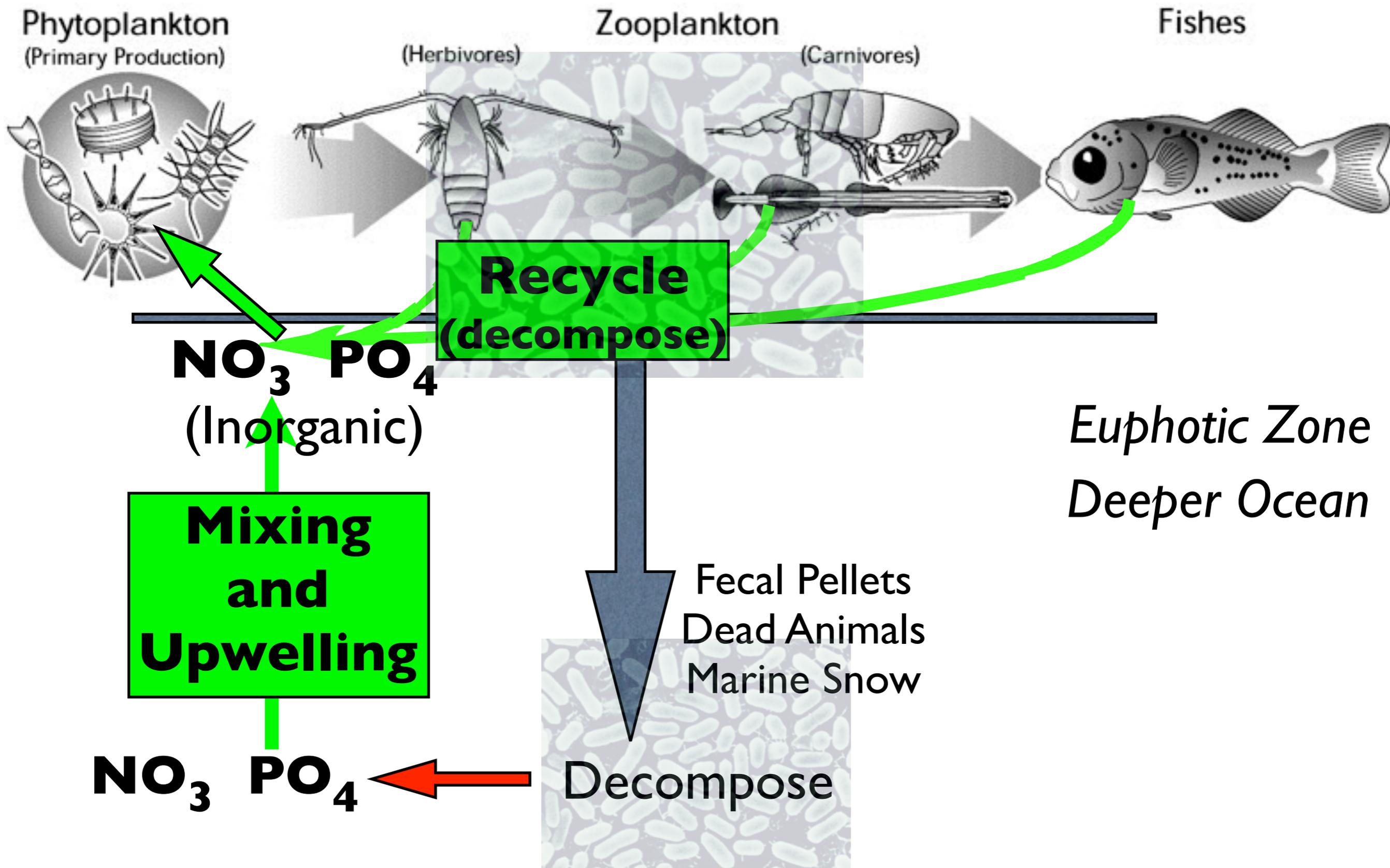


Nutrient Concentration



Nutrients depleted
in euphotic zone

Nutrients enriched
in deep water



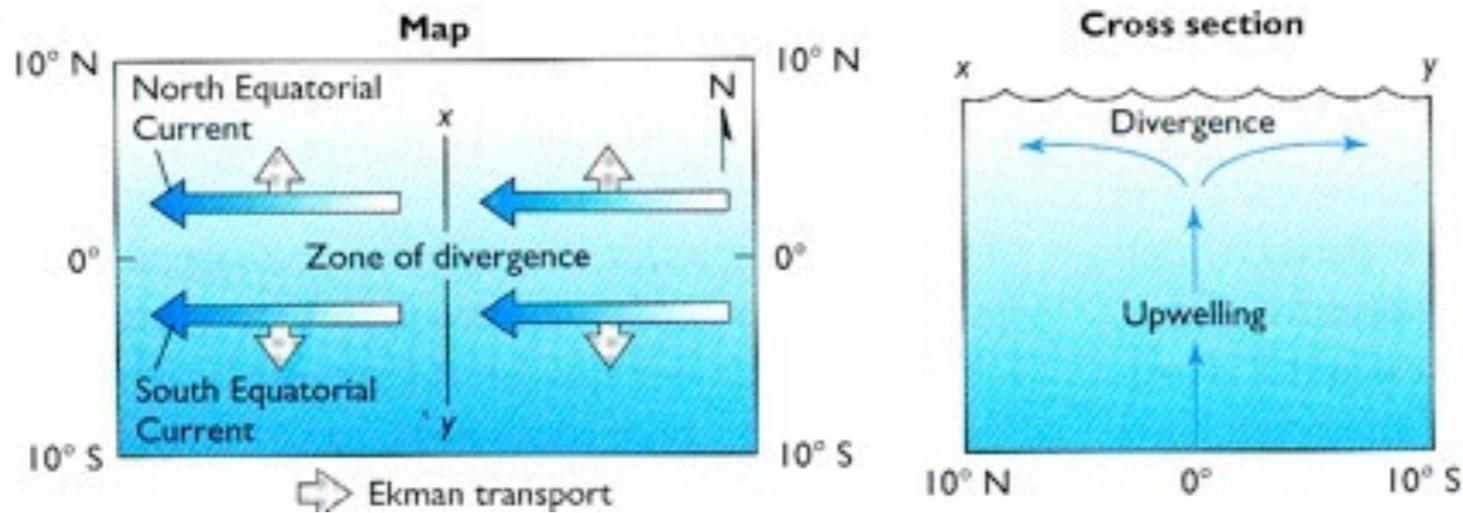
Modes of Production

- Regenerated Production: productivity based on nutrients that are **recycled** within the euphotic zone
- New Production: productivity based on nutrients **imported** (mixed or upwelled) into the euphotic zone

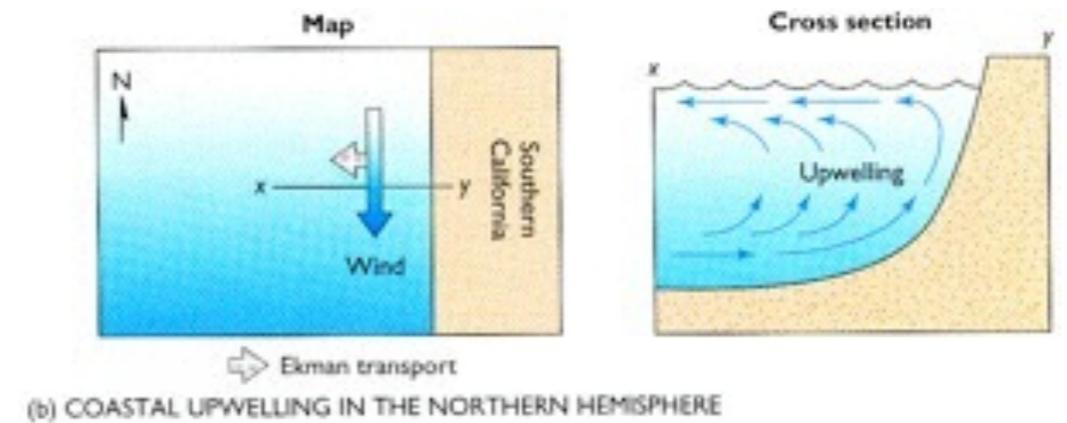
Source of New Production

- Mixing by storms, high winds
 - Strong density stratification inhibits mixing
 - Stratification greatest in the tropics
- Upwelling (coastal or equatorial)

Equatorial Upwelling

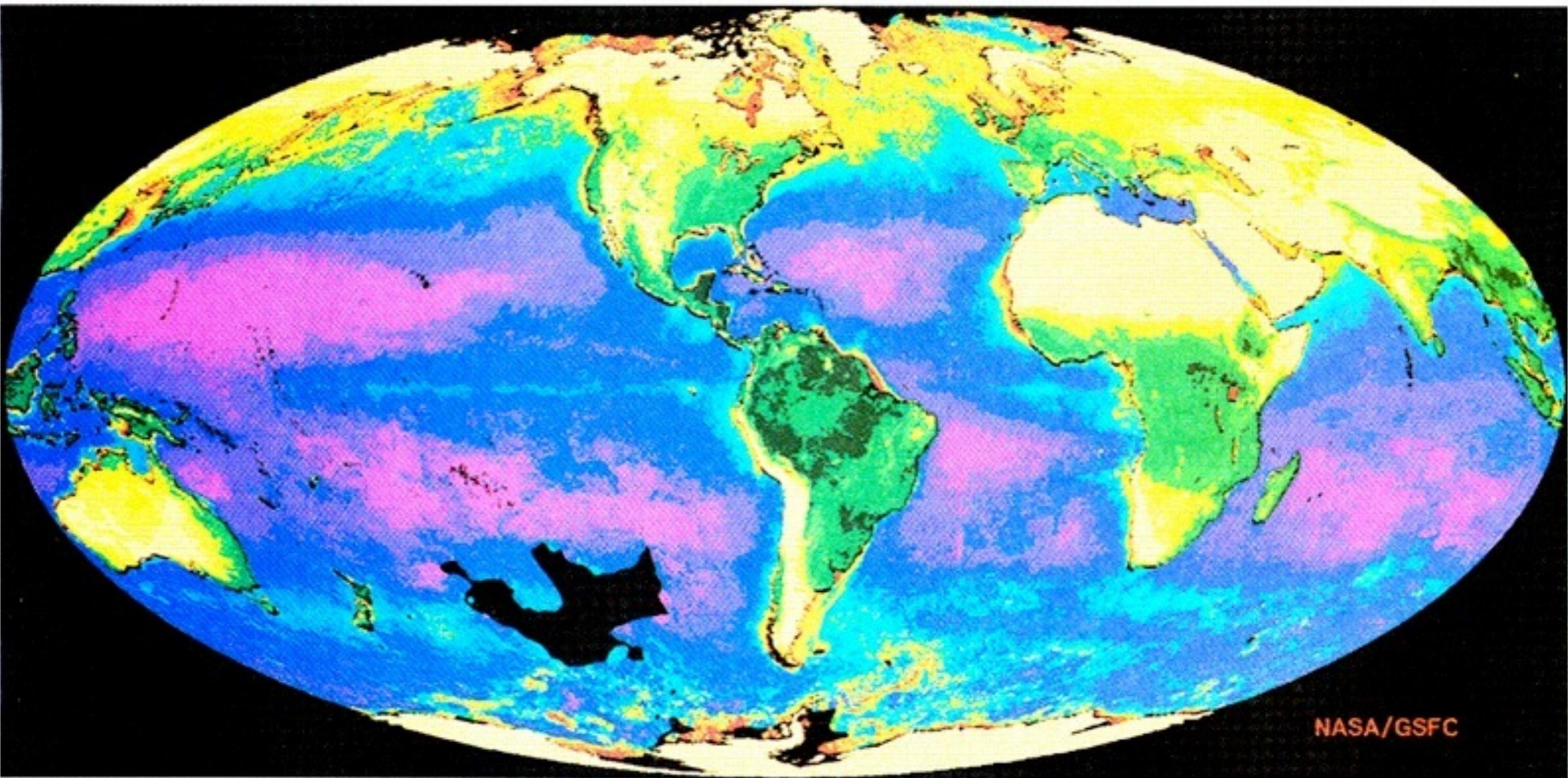


Coastal Upwelling

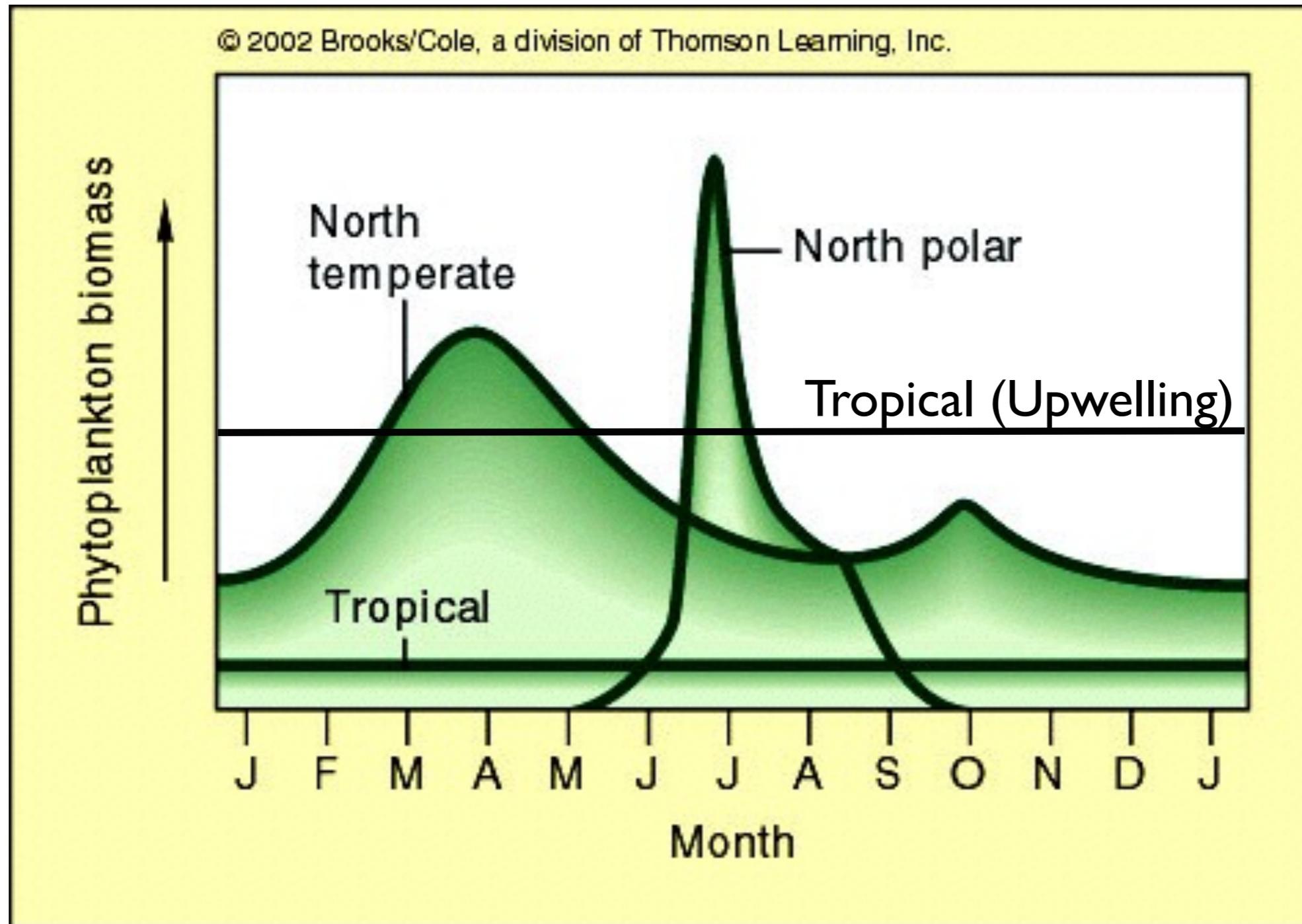


Key Concepts

- Nutrients are stripped from surface waters by photosynthesis and lost to deep water
- Areas with upwelling or deep mixing by storms are very productive because nutrients are brought back up into sunlit waters
- Areas with very little mixing or upwelling become nutrient limited and have low productivity **EVEN IF THERE IS LOTS OF LIGHT**



Seasonal Productivity



Productivity Patterns

- Tropics: Lots of sunlight, but low nutrients due to strong thermal stratification = persistently low productivity
- Equatorial upwelling: strong upwelling and lots of sunlight = persistently high productivity
- Temperate: Seasonal mixing of nutrients and moderate sunlight = spring bloom, small fall bloom
- Polar: High nutrients, but light limited except during summer = one major summer bloom