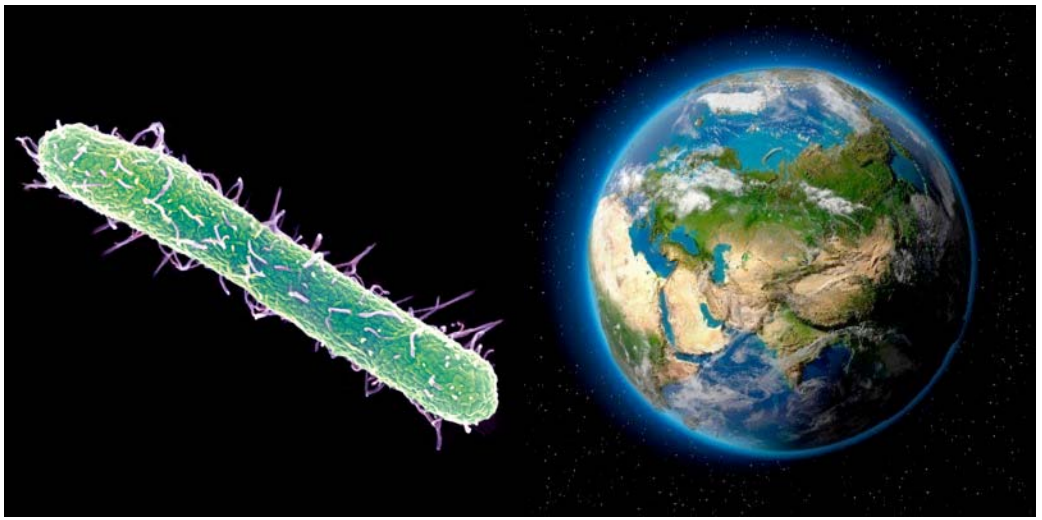
From the Very Large to the Extremely Small: Including Microbiology in Climate Models



Blaire Steven

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The Connecticut Agricultural Experiment Station

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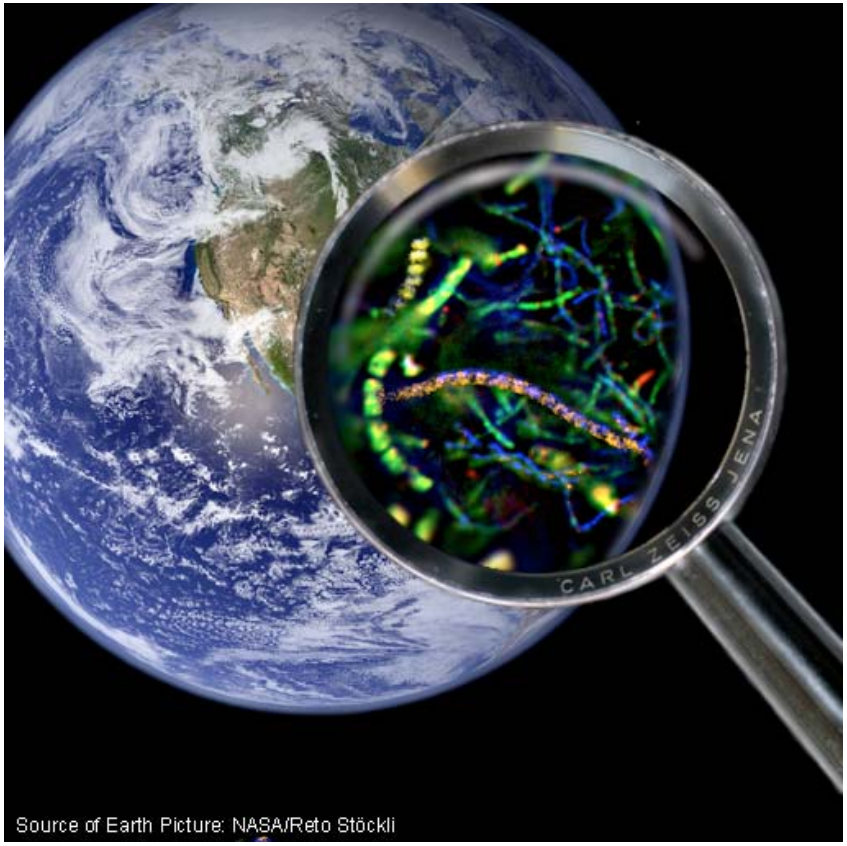
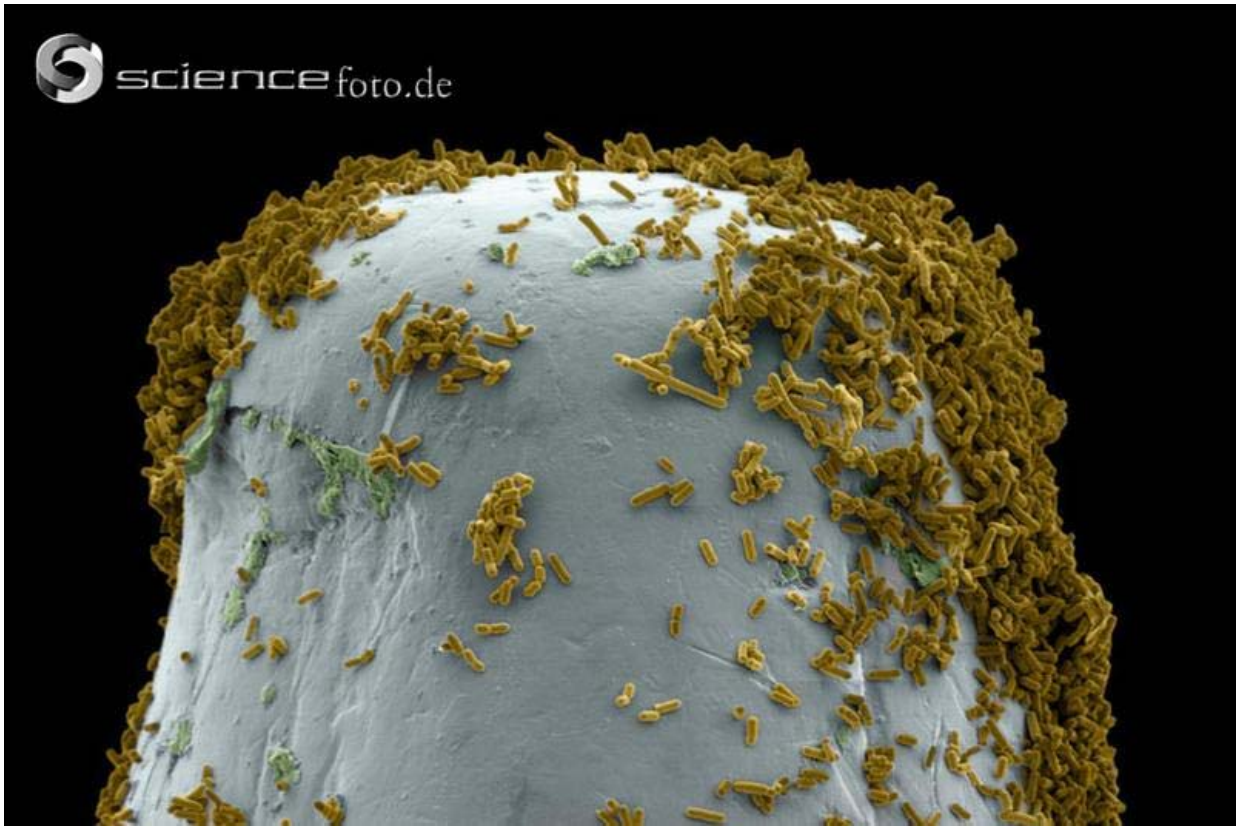
What is microbial ecology?

The study of microorganisms and the physical, chemical, and biological conditions influencing them



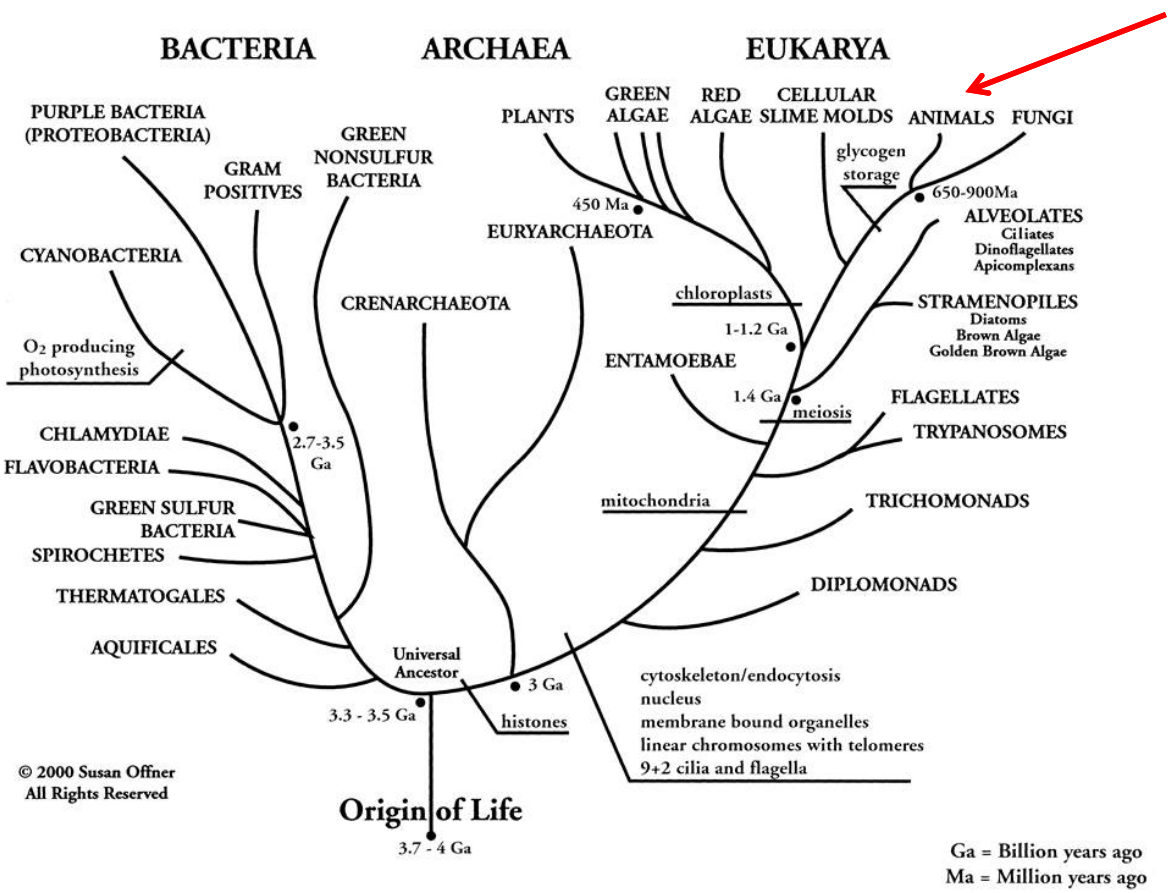
How small are microorganisms really?

The average bacterial cell is 1 um in length or about 25,000 bacteria lined end to end = 1 inch.



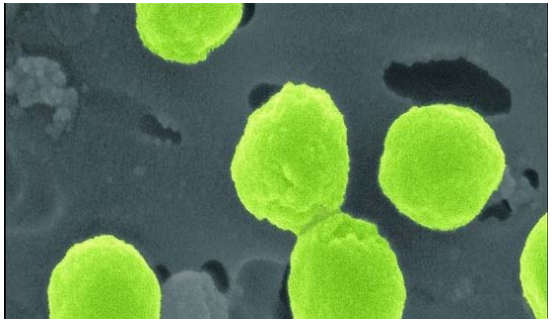
The diversity of microbial life

The vast majority of life is microscopic.



But seriously, microbes can't affect the planet?

The oxygen atmosphere
2.5 billion years ago oxygenic photosynthesis produced the oxygenated atmosphere we enjoy today



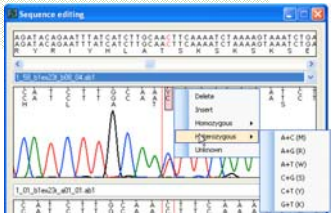
***Prochlorococcus* and modern oxygen**
Prochlorococcus is the single most abundant phototroph in the ocean and is single handedly responsible for 50% of atmospheric oxygen production

Atmospheric methane
Microorganisms (methanogenic archaea) are the only organisms capable of biogenically producing methane.
Methane is 20X more potent than CO_2 as a greenhouse gas

How do you do microbial ecology?

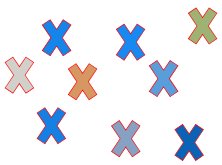
Primarily through genetics

Sample → Extract DNA → Genetic Analysis



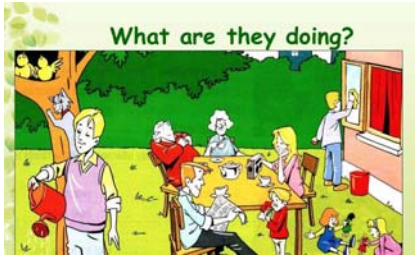
Targeted sequencing

Polymerase Chain Reaction



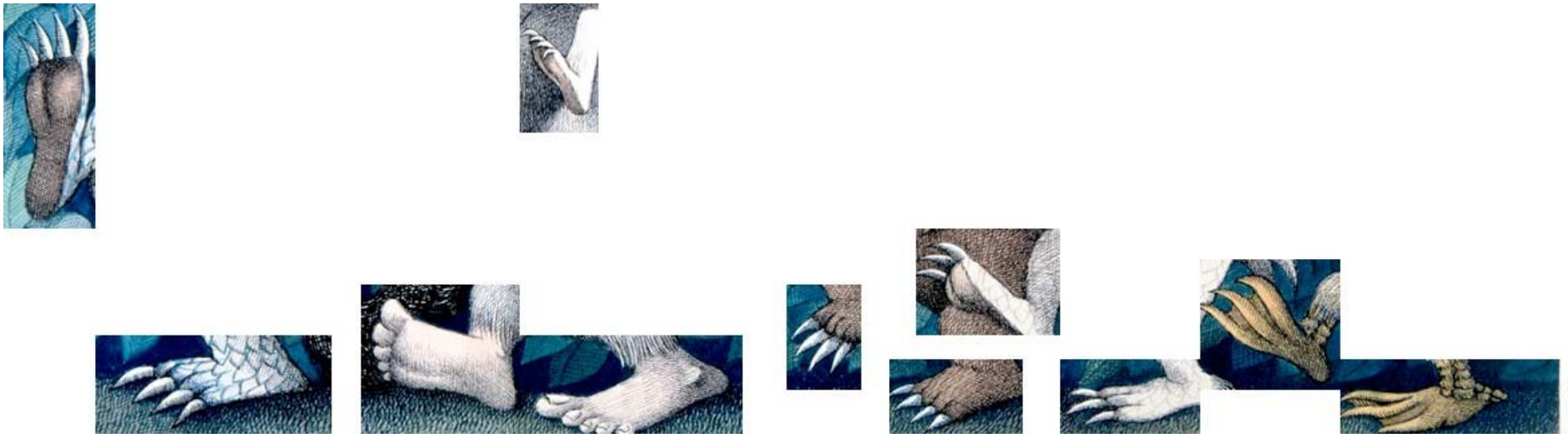
Shotgun sequencing

Direct Sequencing



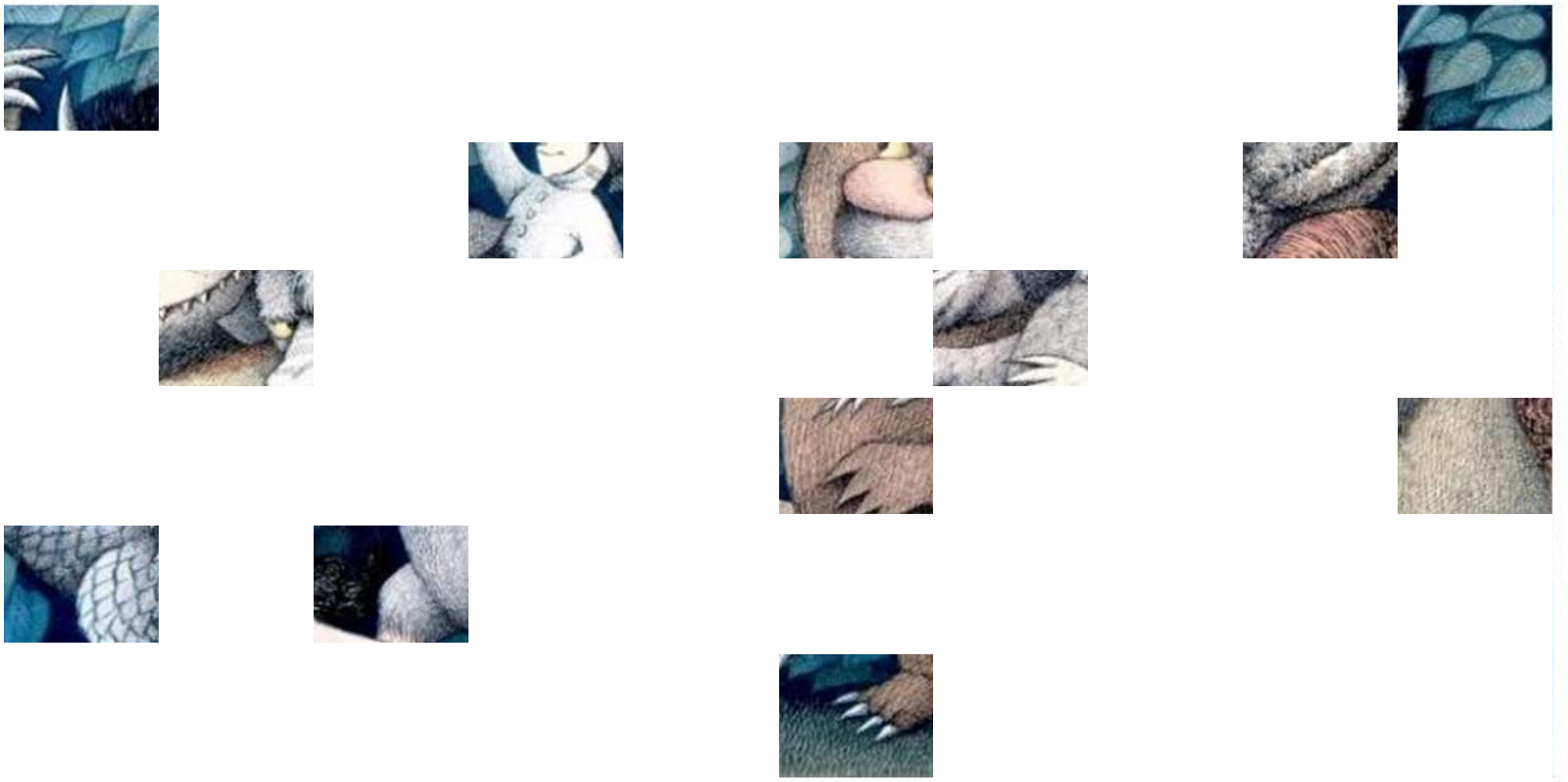
How about an analogy?

Phylogenetic sequencing



How about an analogy?

Shotgun metagenome sequencing



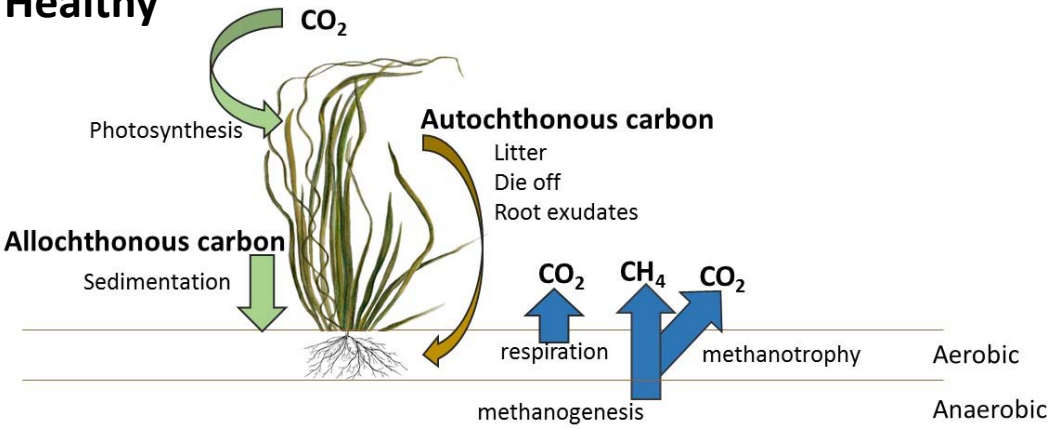
How about an analogy?

Even perfect sequencing is still just a snapshot

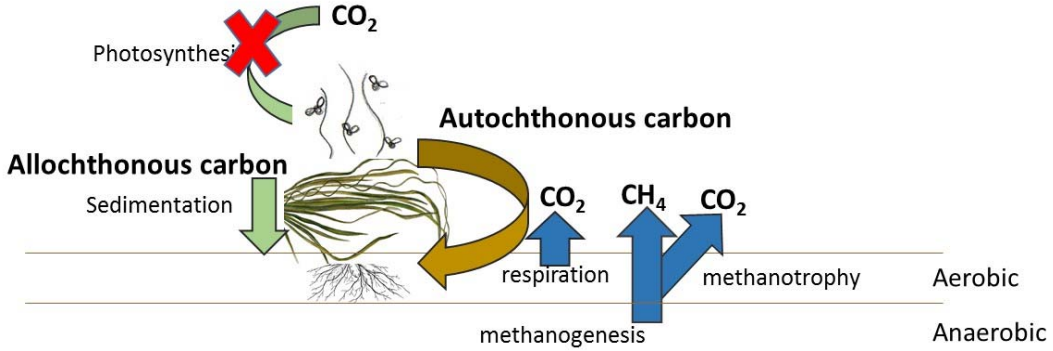
Now for some research

Sudden Vegetation Dieback (SVD) in Connecticut's coastal wetlands

Healthy



SVD



Hammonasset State Park, CT

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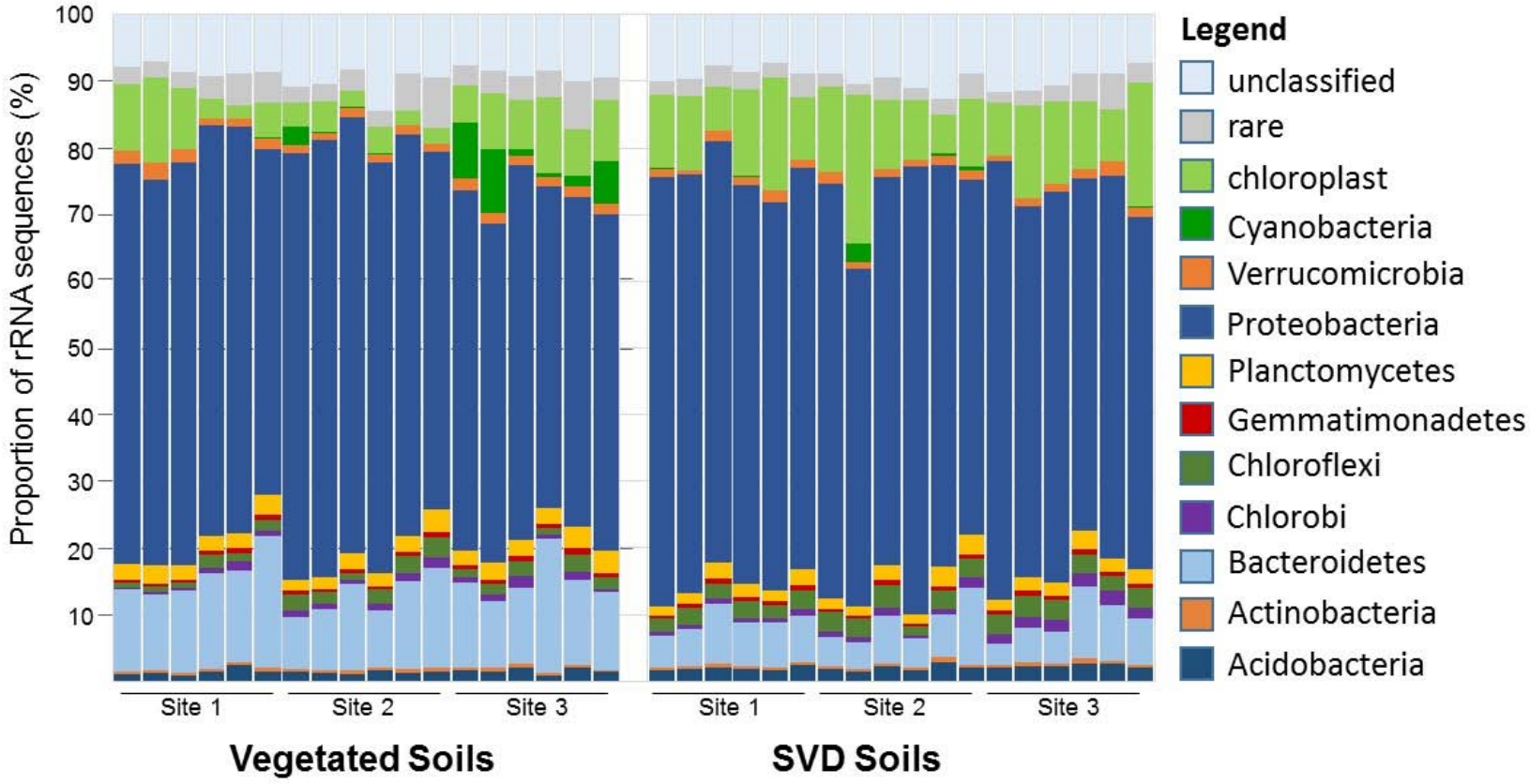
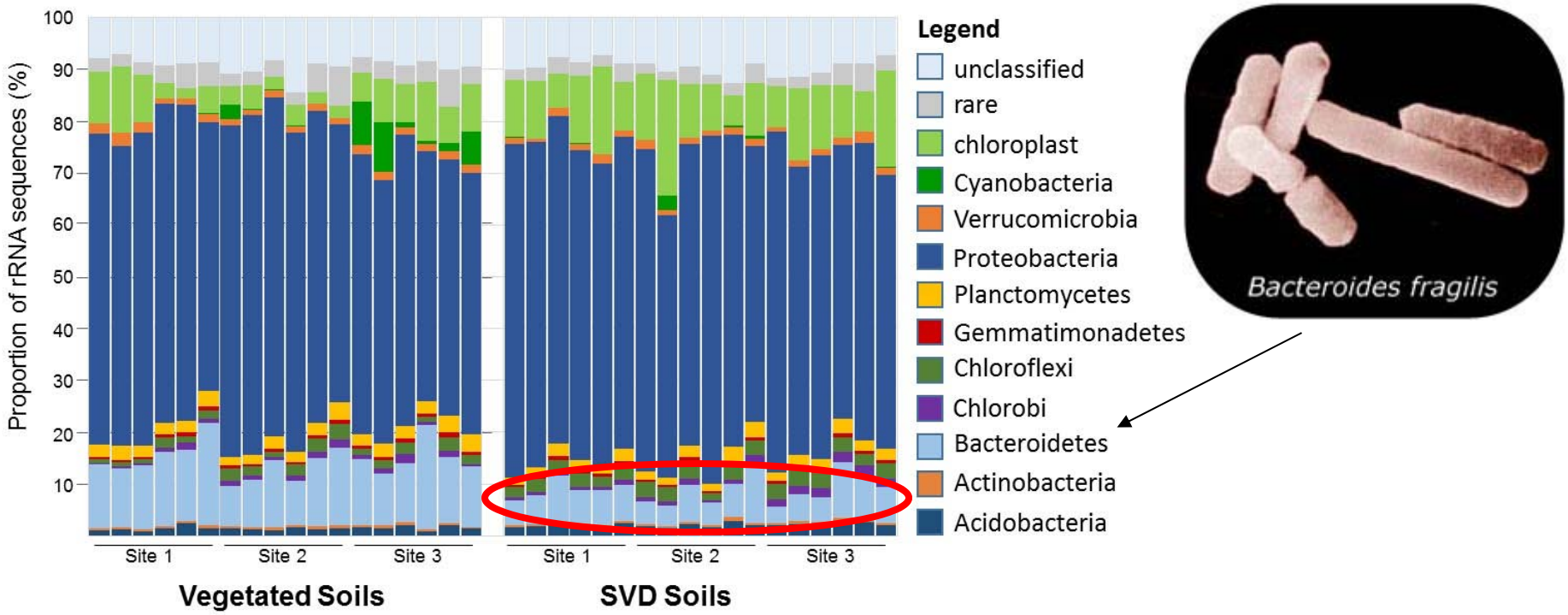
Now for some research

SVD alters the composition of the soil bacterial communities



SVD in Connecticut's Coastal Wetlands

Decreased populations of *Bacteroidetes*



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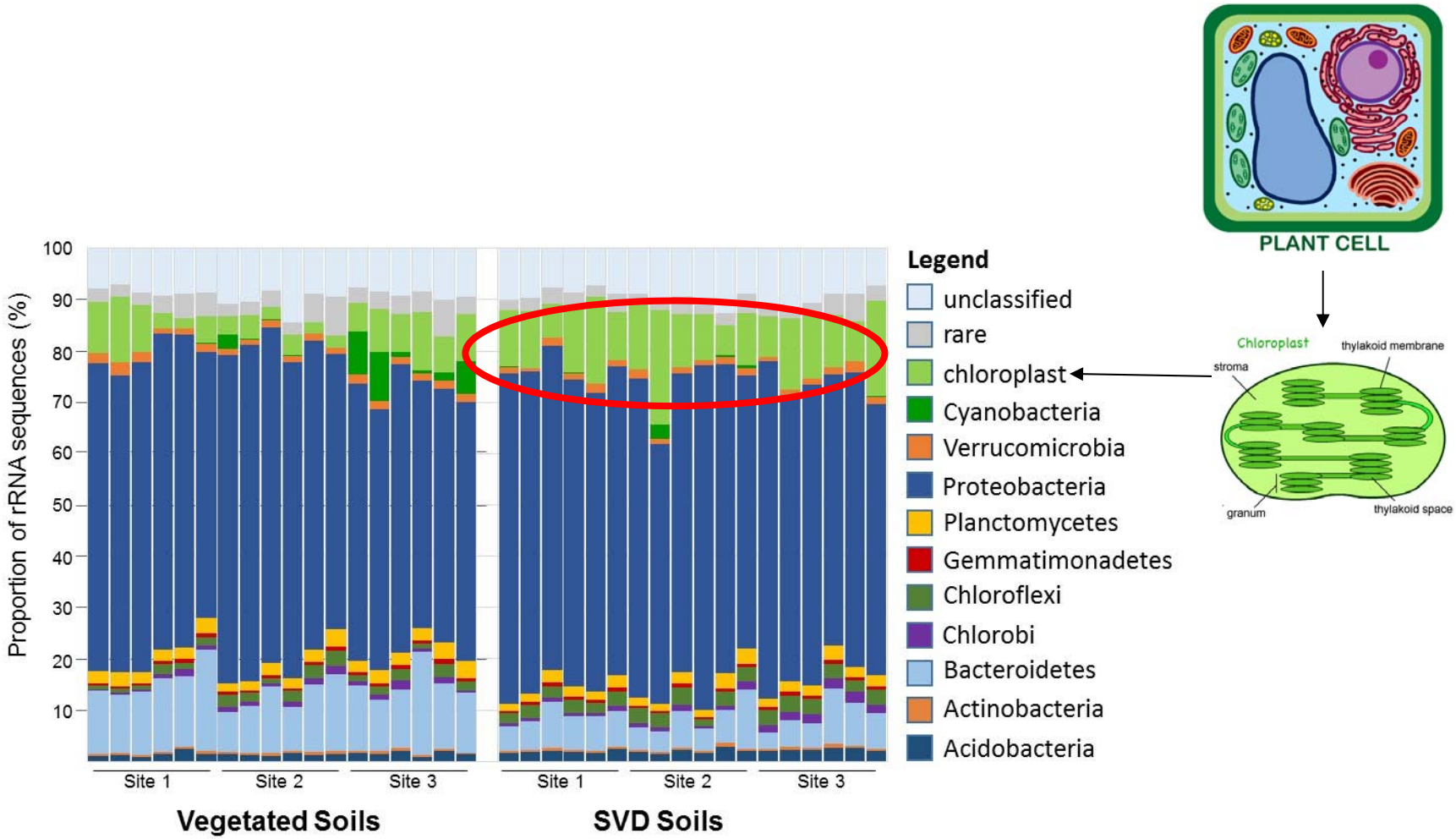
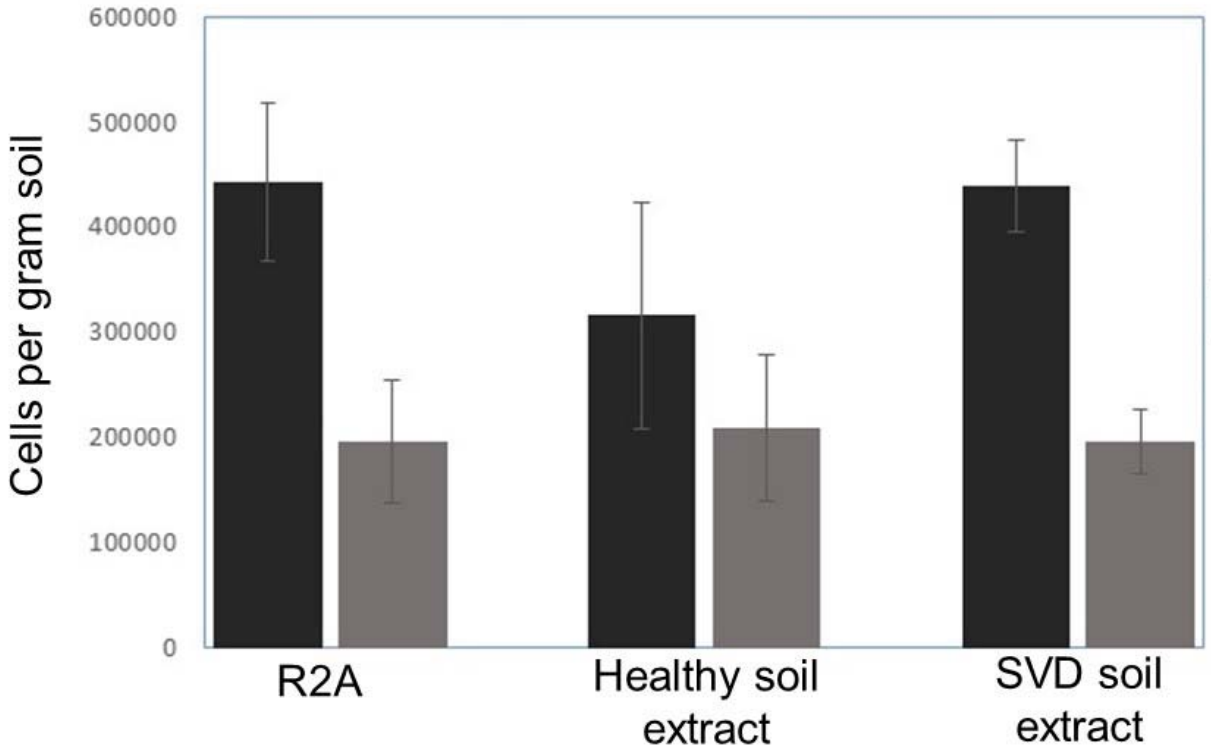
SVD in Connecticut's Coastal Wetlands

Increased populations of chloroplasts



SVD in Connecticut's Coastal Wetlands

Culturing bacteria from the soil



Healthy soil

SVD soil

Freshwater Algal Blooms

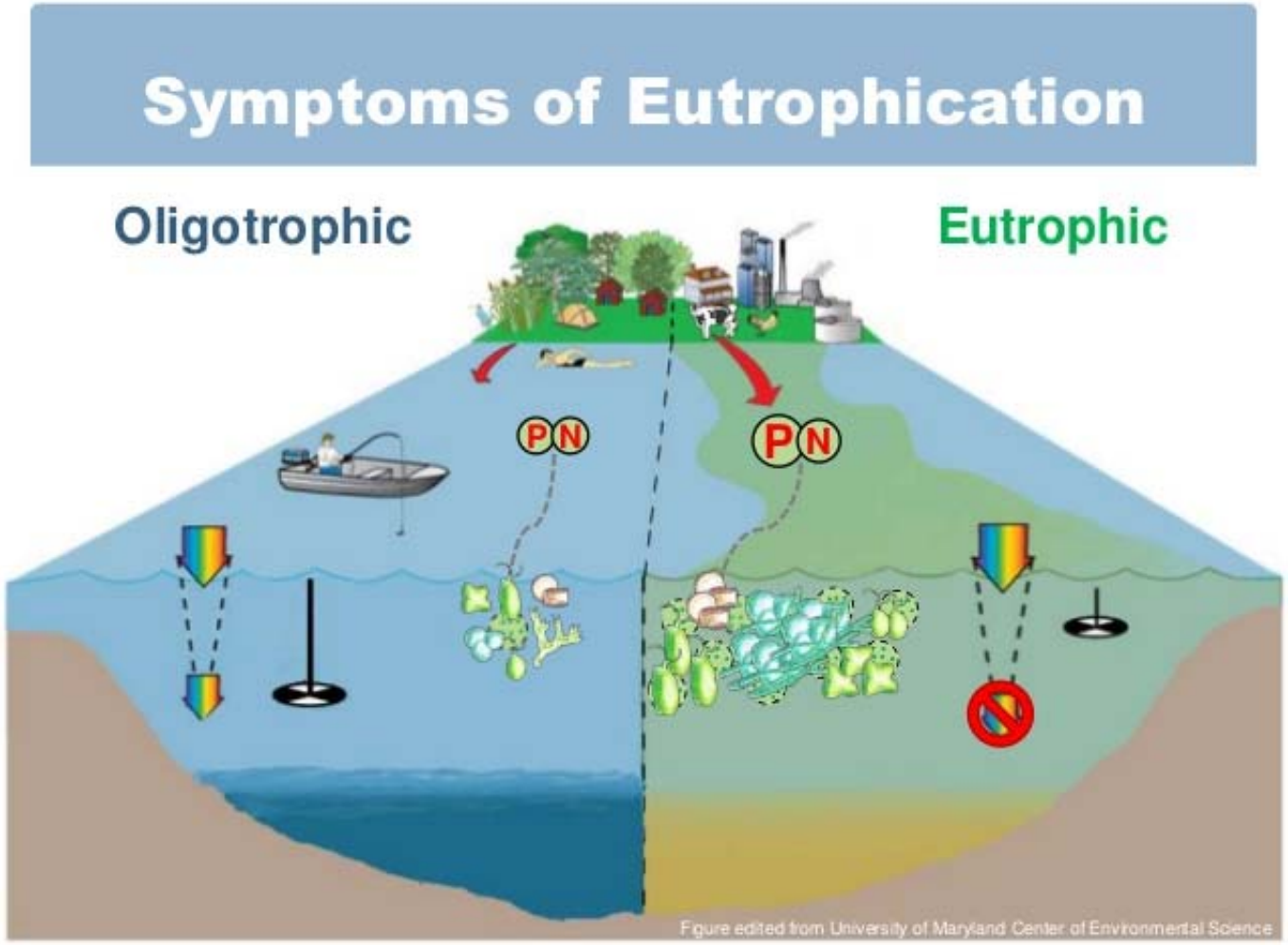
A blight on Connecticut's freshwater resources

Candlewood Lake, CT

or a potential health hazard

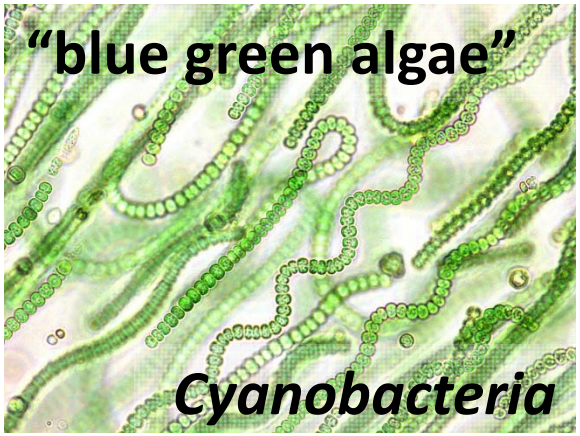
Freshwater Algal Blooms

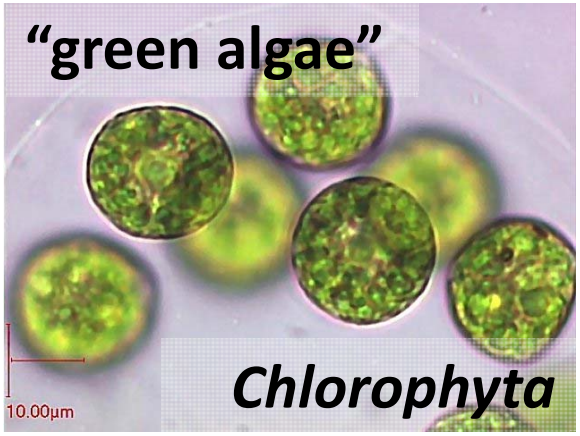
What causes a bloom?

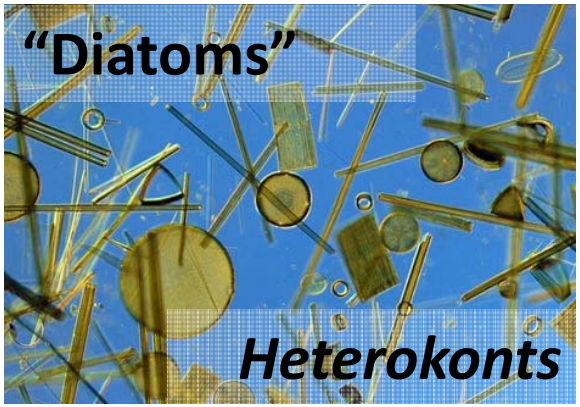


Freshwater Algal Blooms

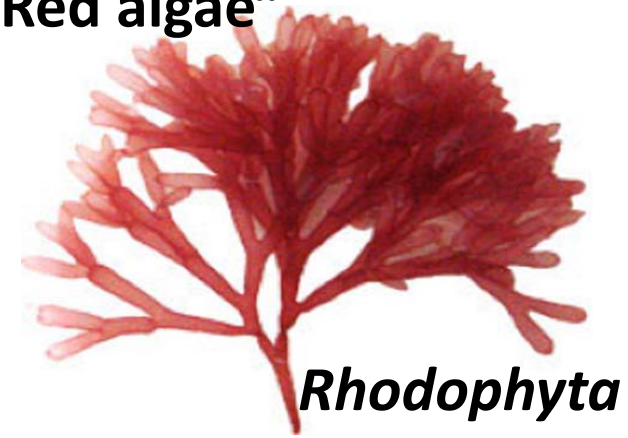
What exactly is “algae”?





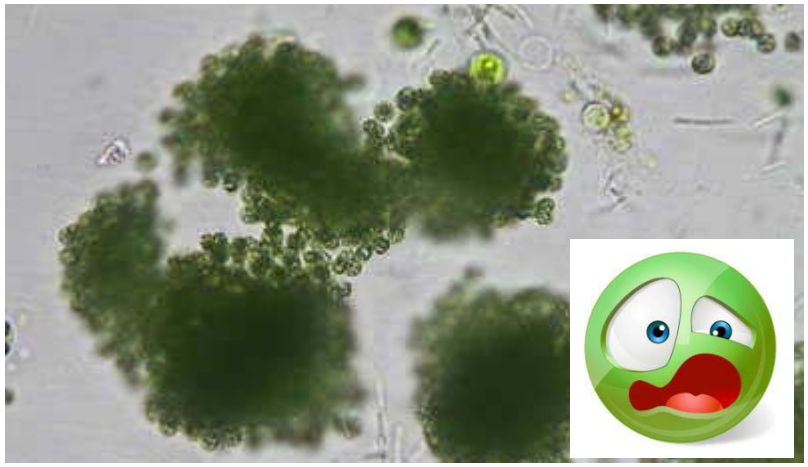


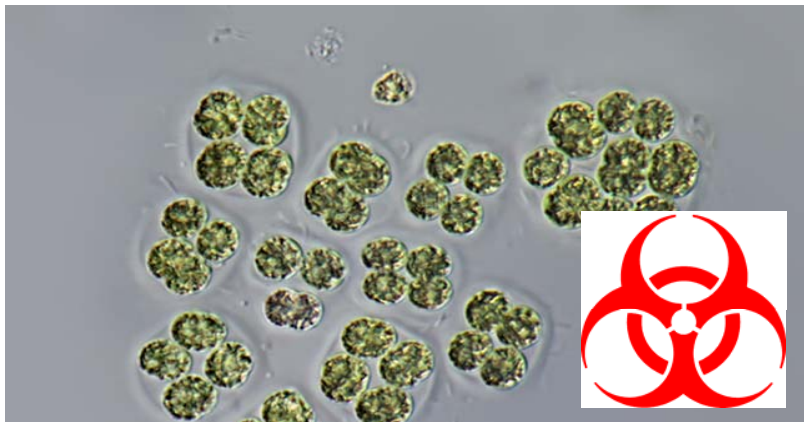
“Red algae”



Freshwater Algal Blooms

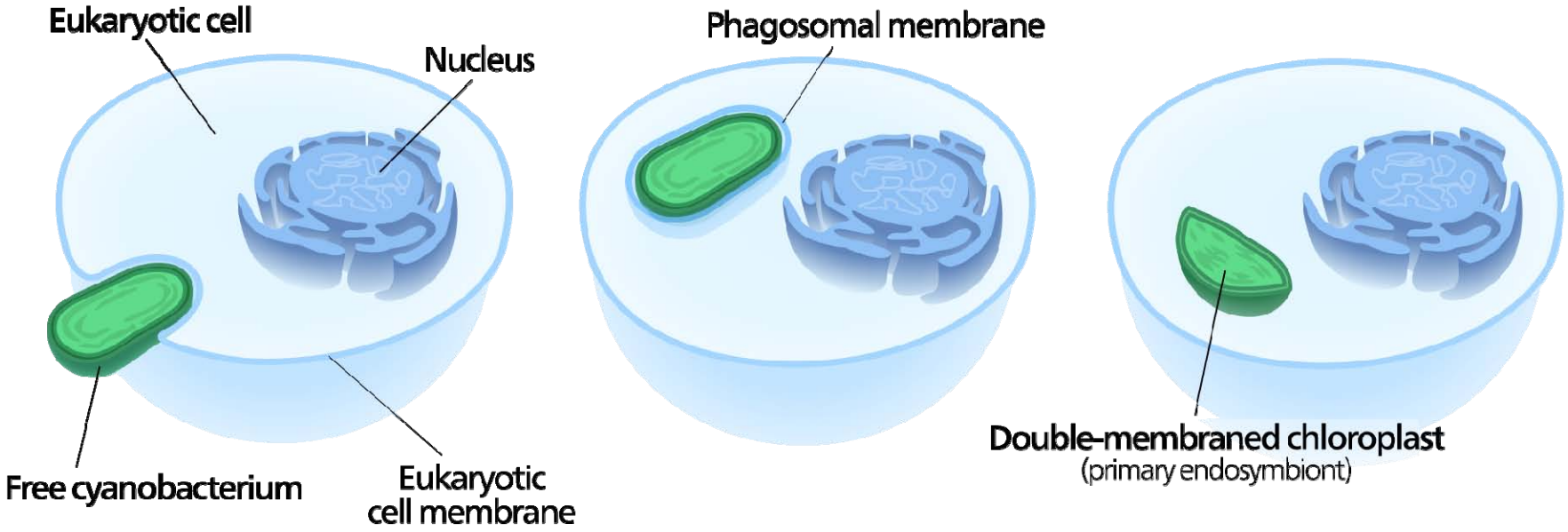
Identifying a harmful algal bloom





Freshwater Algal Blooms

Evolution and molecular biology to the rescue



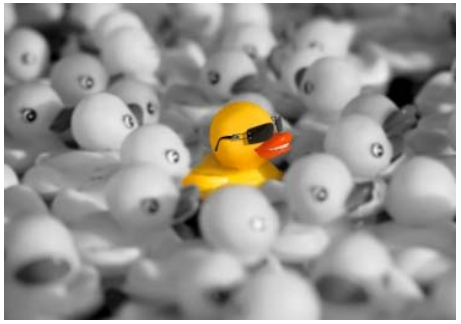
Freshwater Algal Blooms

But why is a molecular based survey better?

Standardization
All researchers can perform the experiment the same way

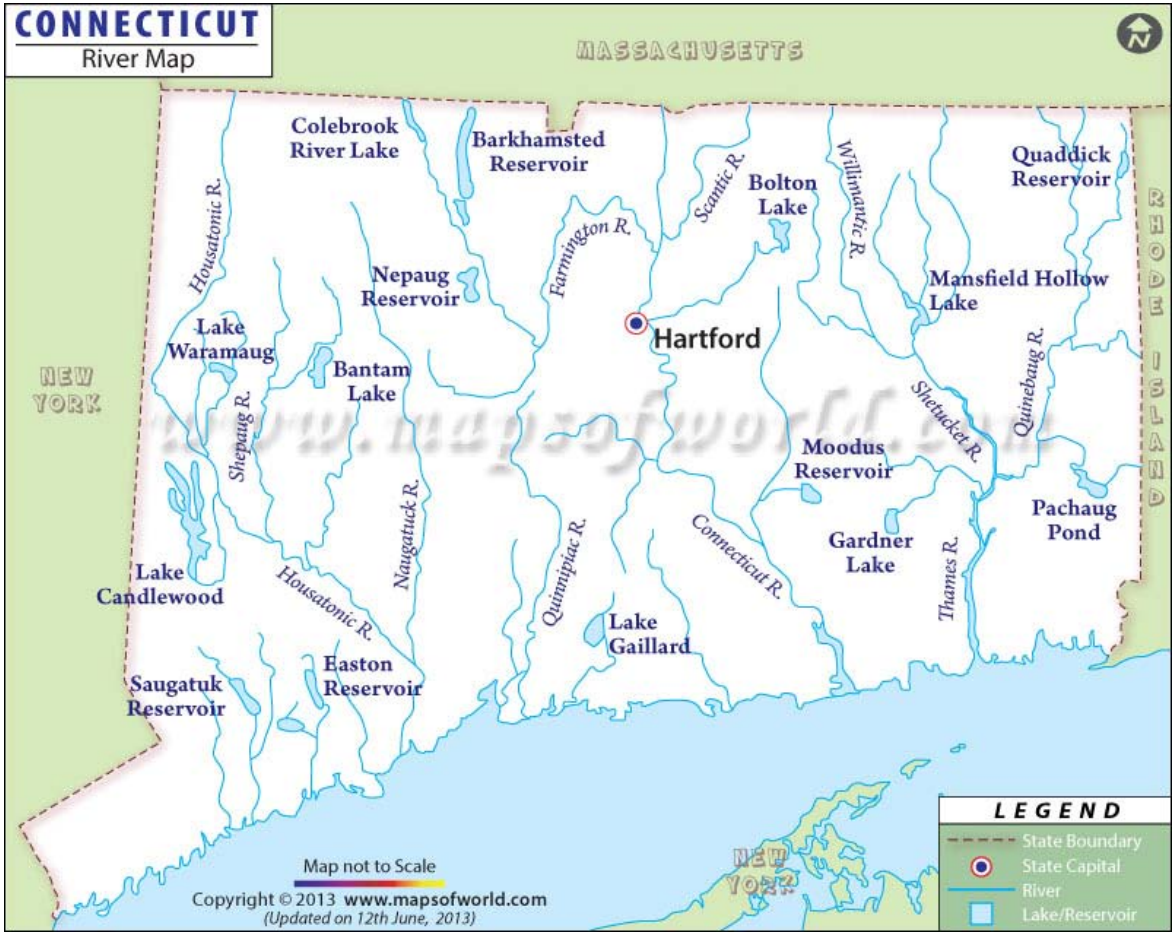
Sharing
Data can be made publically available

Replication
All experimental results look the same



Sensitivity
Can find the rare occurrences

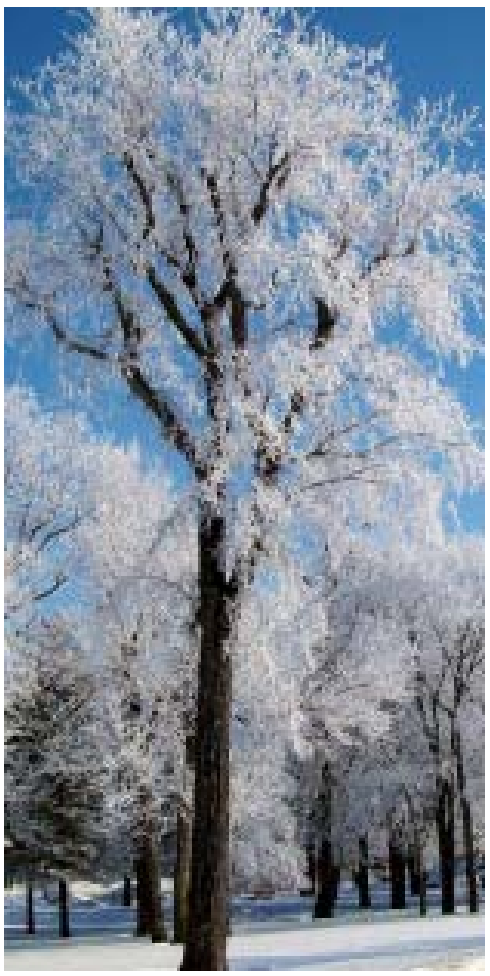
Freshwater Algal Blooms

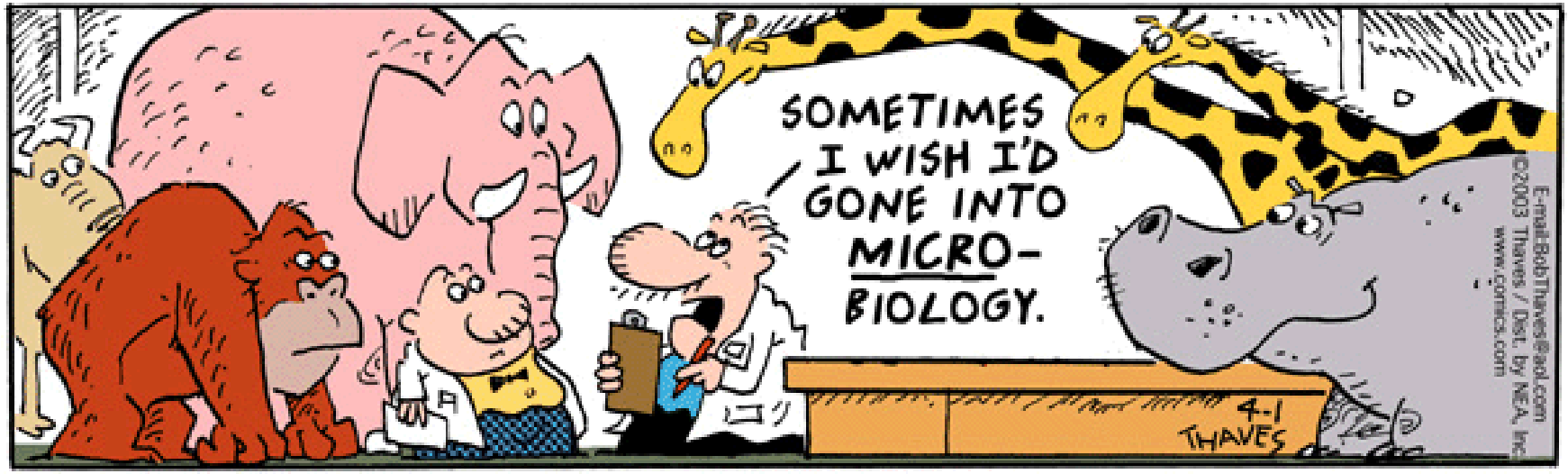


In Summation

Microorganisms play important roles in virtually every ecosystem on Earth. A better understanding of the microbial world around us will help develop climate models, environmental remediation, health, and agriculture.





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