Algal Blooms: eutrophication and the health of our lakes

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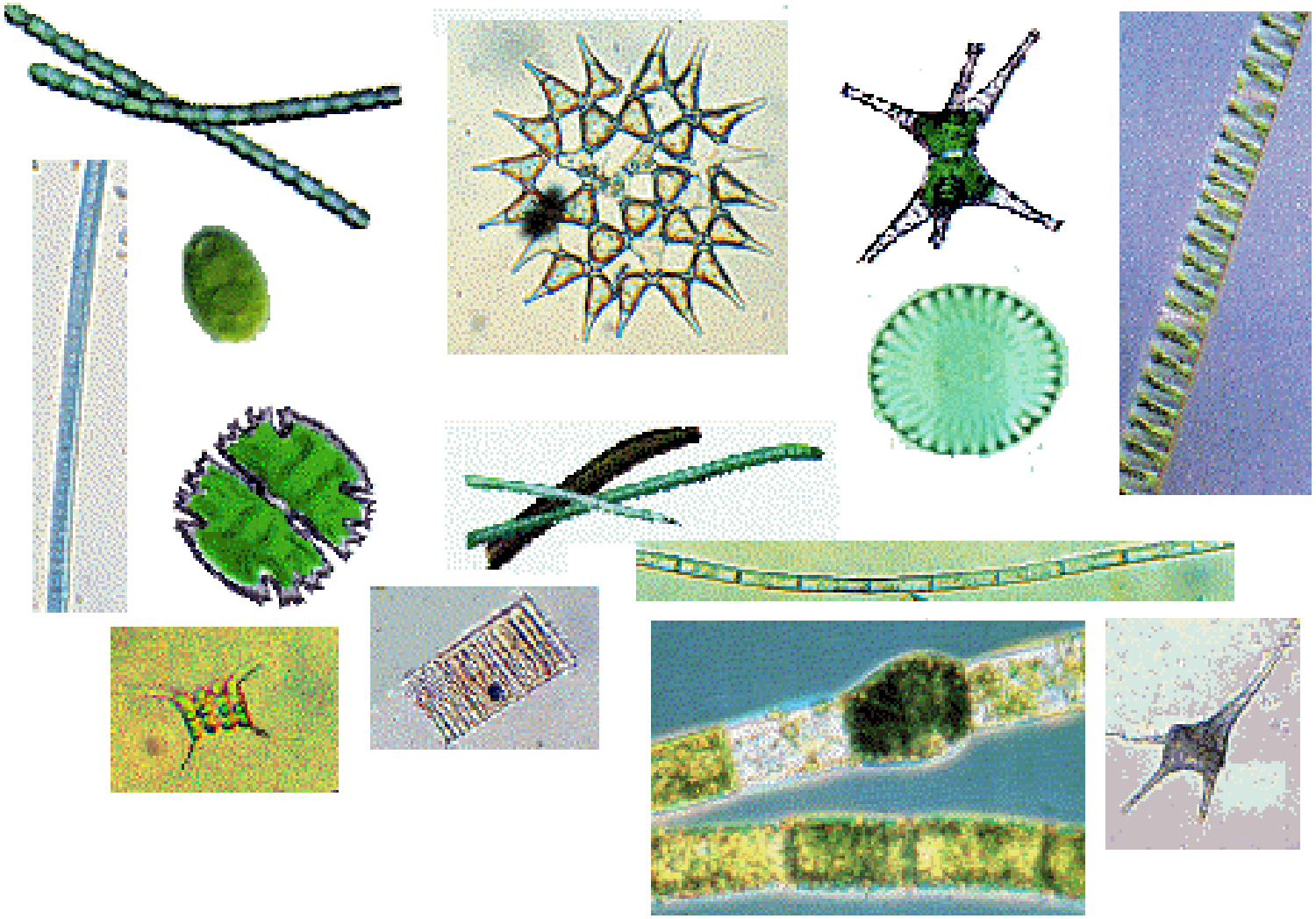
IISD Experimental Lakes Area

What is eutrophication?

What are phytoplankton (algae)?



http://ksuweb.kennesaw.edu/

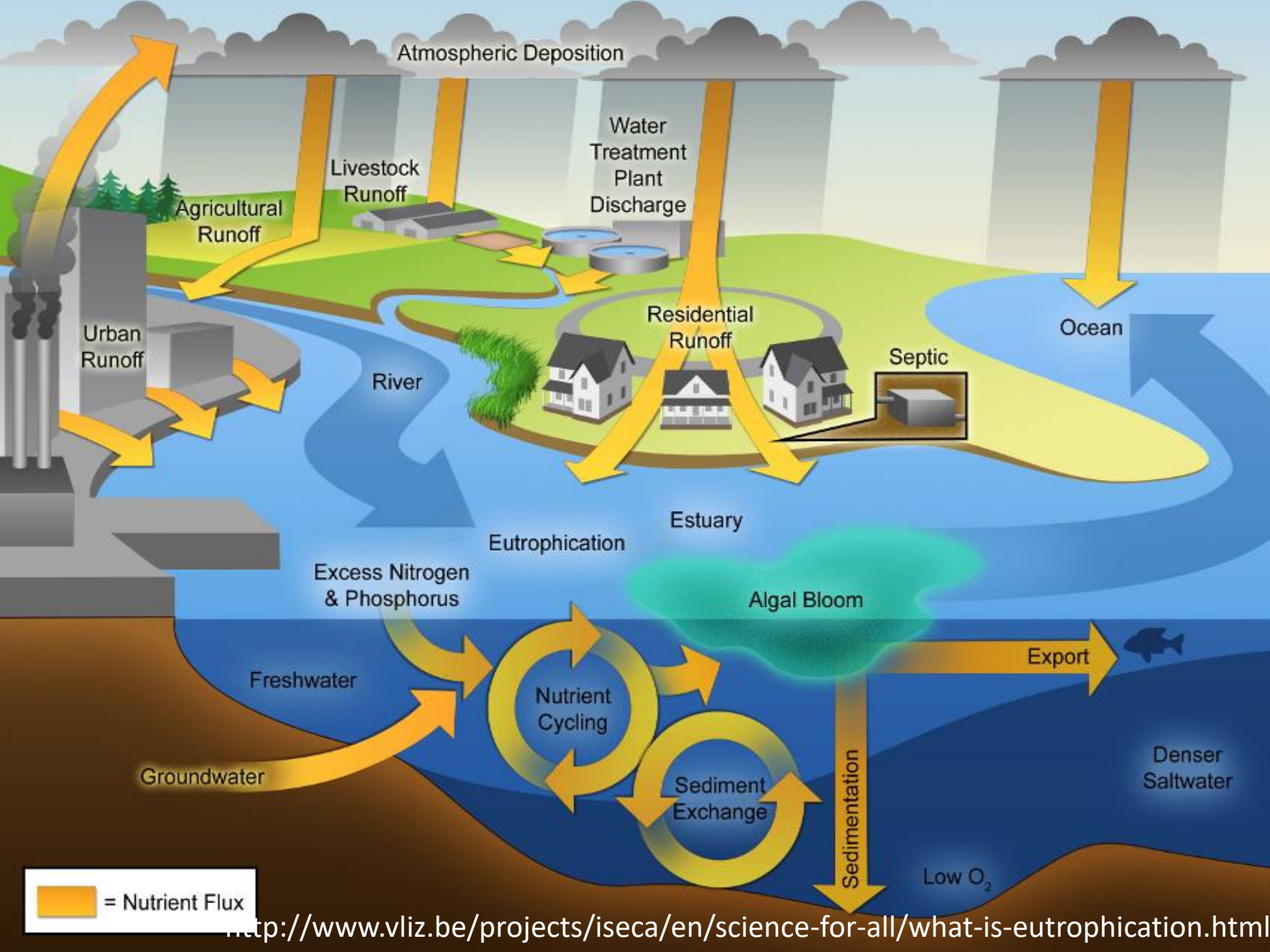
Cultural Eutrophication

Over-fertilization of waterbodies with nutrients from human activities

Photo Credit: Google Images

Poll: what are the most important human sources of nutrients to lakes? Can select more than one

- Fossil fuels
- Sewage treatment plants
- Fertilizer (agriculture)
- Agricultural feed lots
- Detergents
- Storm drains
- Pharmaceuticals
- Plastics



http://www.vliz.be/projects/iseca/en/science-for-all/what-is-eutrophication.html

Why is eutrophication a problem?

- Toxic algae may become prevalent
- May cause taste problems in drinking water
- Algal blooms degrade recreational use (e.g. beach closures, aesthetics)
- Often associated with other water quality problems *(E. coli*)
- Water treatment is expensive


Toledo Times

News Business Community Sport Weather

700 square mile toxic algae bloom on Lake Erie
Water shortage hits again!

Monday October 7 Toledo OH

Satellite images show that the toxic algae bloom on Lake Erie now covers an area of 700 square miles.

These water shortages have become virtually an annual event and there is no plan at Federal, State or City level to effectively deal with it.

Despite repeated undertakings from government officials at all levels there appears to be no

Poll – How do you think eutrophication may affect fish?

- Eutrophication can kill fish
- Eutrophication may increase fish numbers and growth
- Eutrophication may change fish species composition
- Eutrophication may affect concentrations of contaminants such as mercury
- All of the above

Eutrophication and fish

- Algae are the base of the aquatic food web, so moderate increases in their abundance may increase fish production
- Increases in fish growth rates can actually help to decrease concentrations of some contaminants, such as mercury
- If algae become too high, they may cause decreases in oxygen in deep waters that lead to fish kills
- Changes in fish habitat may cause shifts in species composition
- Some algae may affect the taste of fish

Research on eutrophication at the IISD-Experimental Lakes Area

Our mission

To conduct ecosystem-based research that improves our understanding of human impacts on the environment and provides science-based solutions for clean water and healthy ecosystems

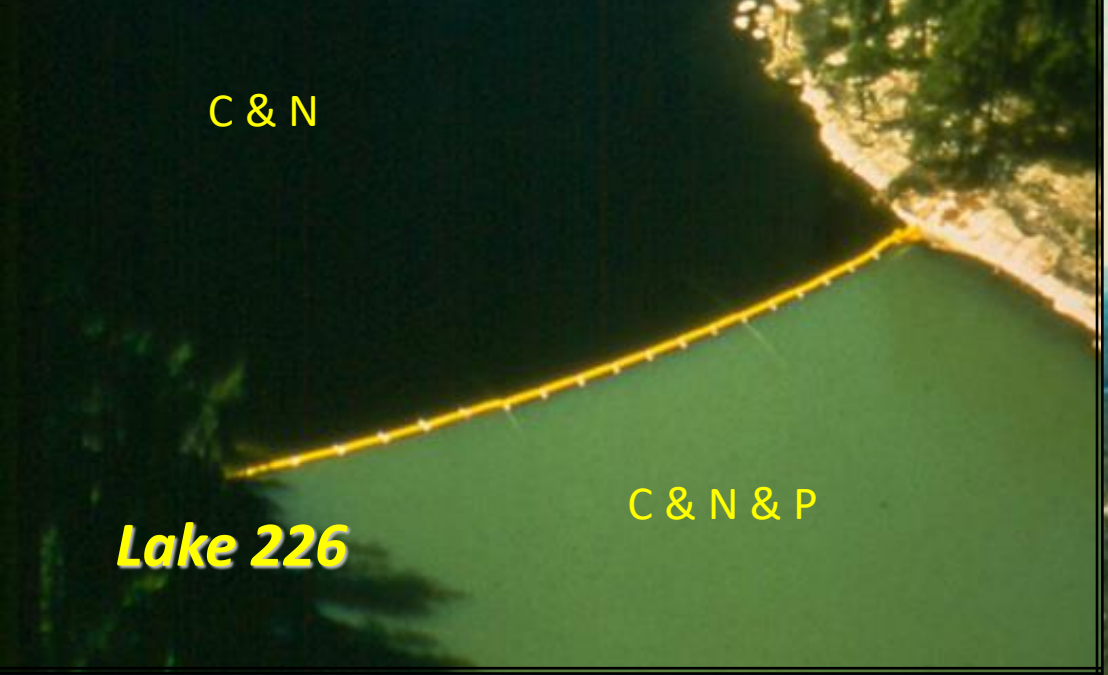
Why is the IISD-ELA unique?

- ***<u>Ability to conduct whole-ecosystem experiments</u>***
- Globally unique long-term (54 years) comprehensive data set on freshwater

Picture: Lauren Hayhurst

What are the most important nutrients contributing to eutrophication?

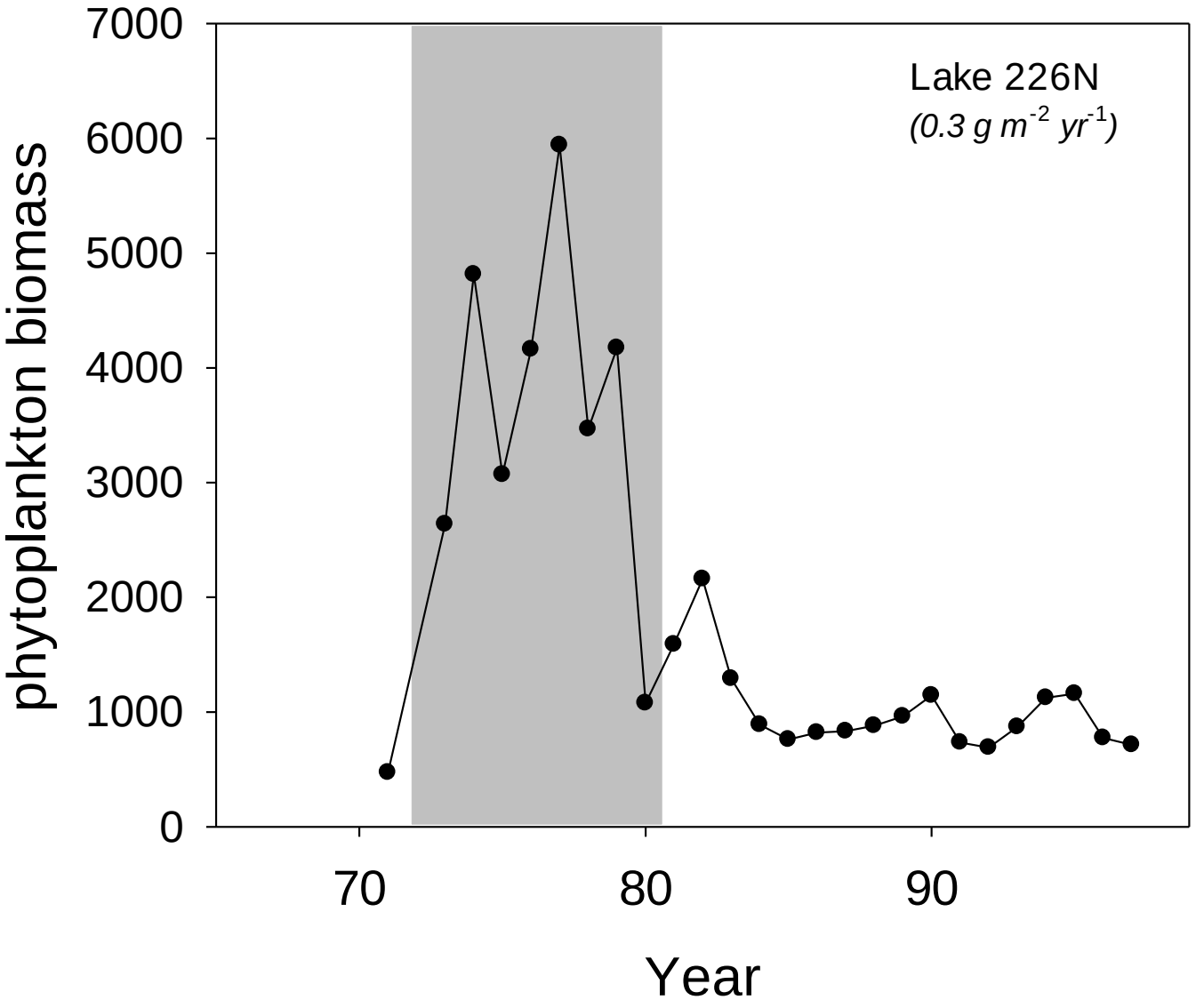
- Algae need many different nutrients to grow
- The nutrient in least supply relative to demand is known as the “limiting nutrient”

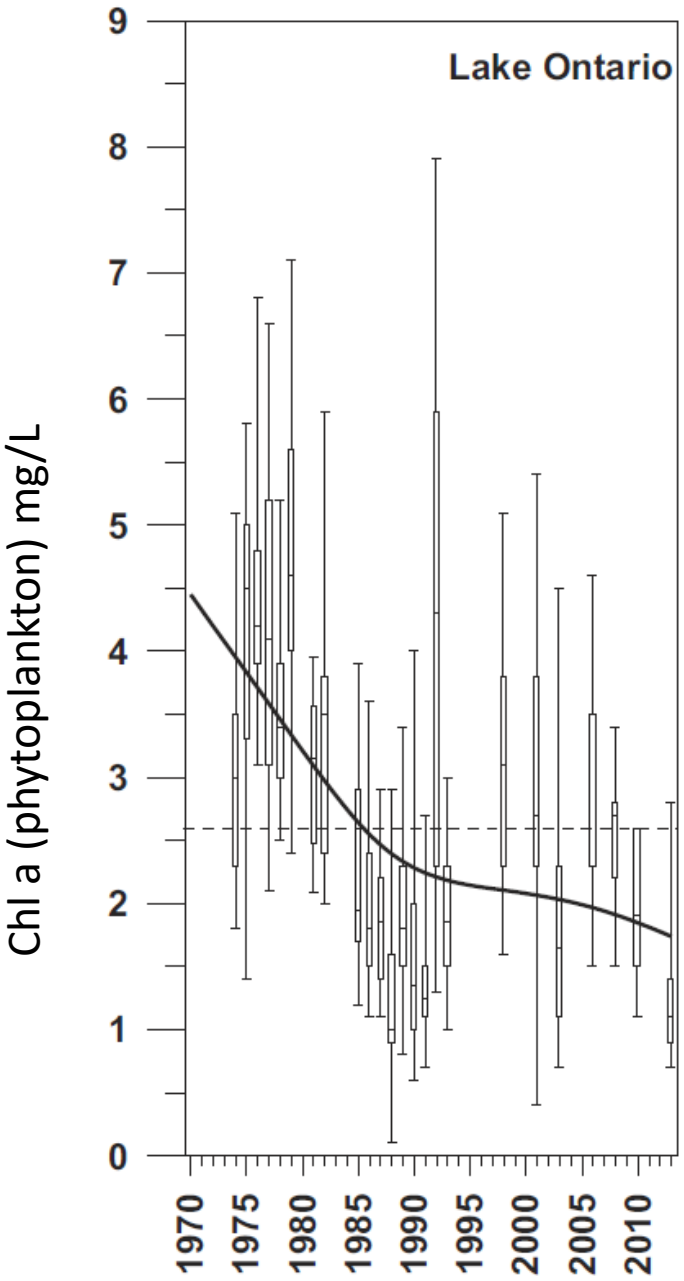

C & N
C & N & P
Lake 226


Lake 227
N & P


Lake 226

Reducing phosphorus inputs led to rapid recovery at ELA



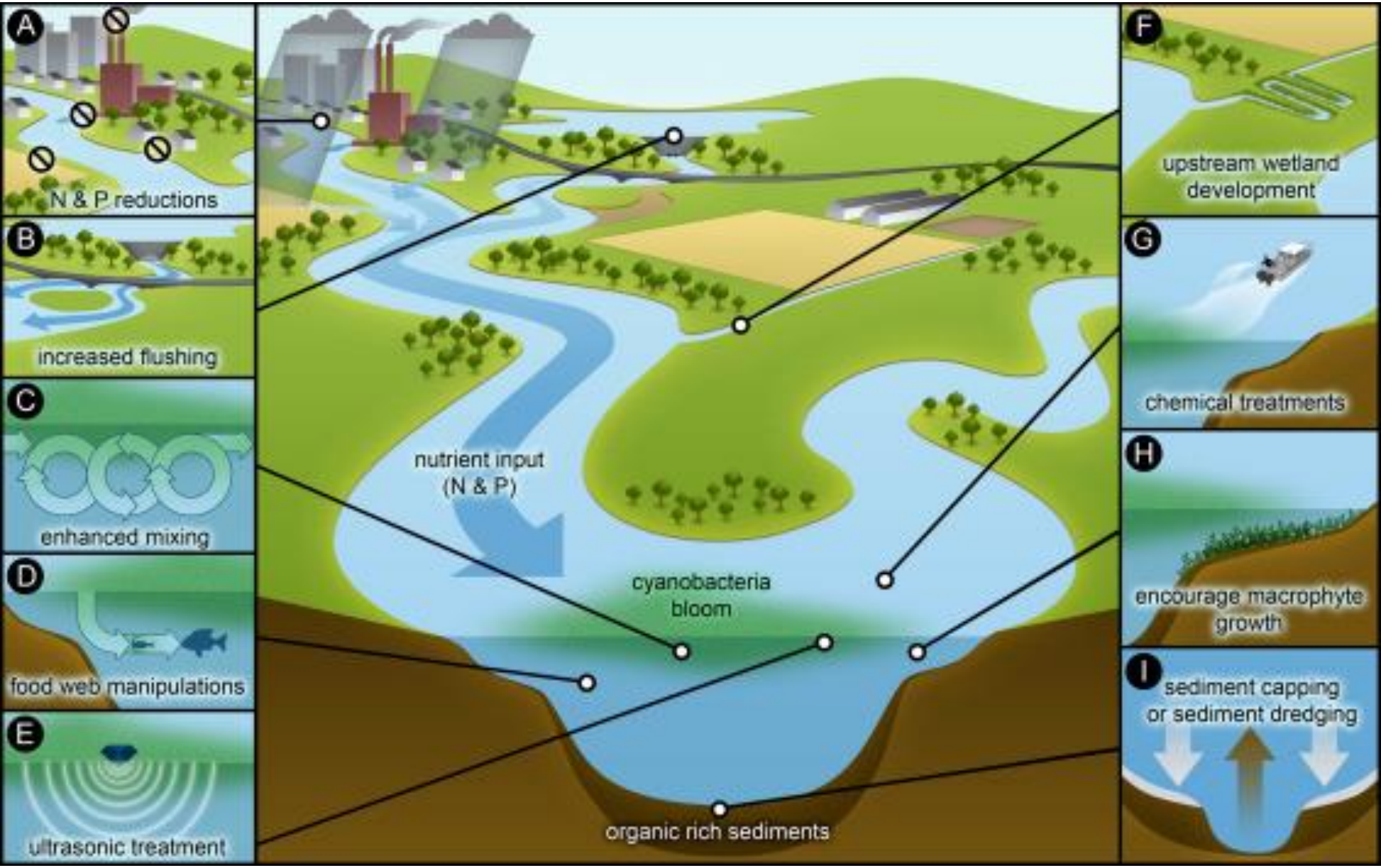


Based on research at ELA, it is our belief that nutrient reduction efforts should focus on phosphorus

Reductions of phosphorus have resulted in recovery of many lakes worldwide.

Problems may persist in some lakes, however, because of diffuse inputs and sediment recycling

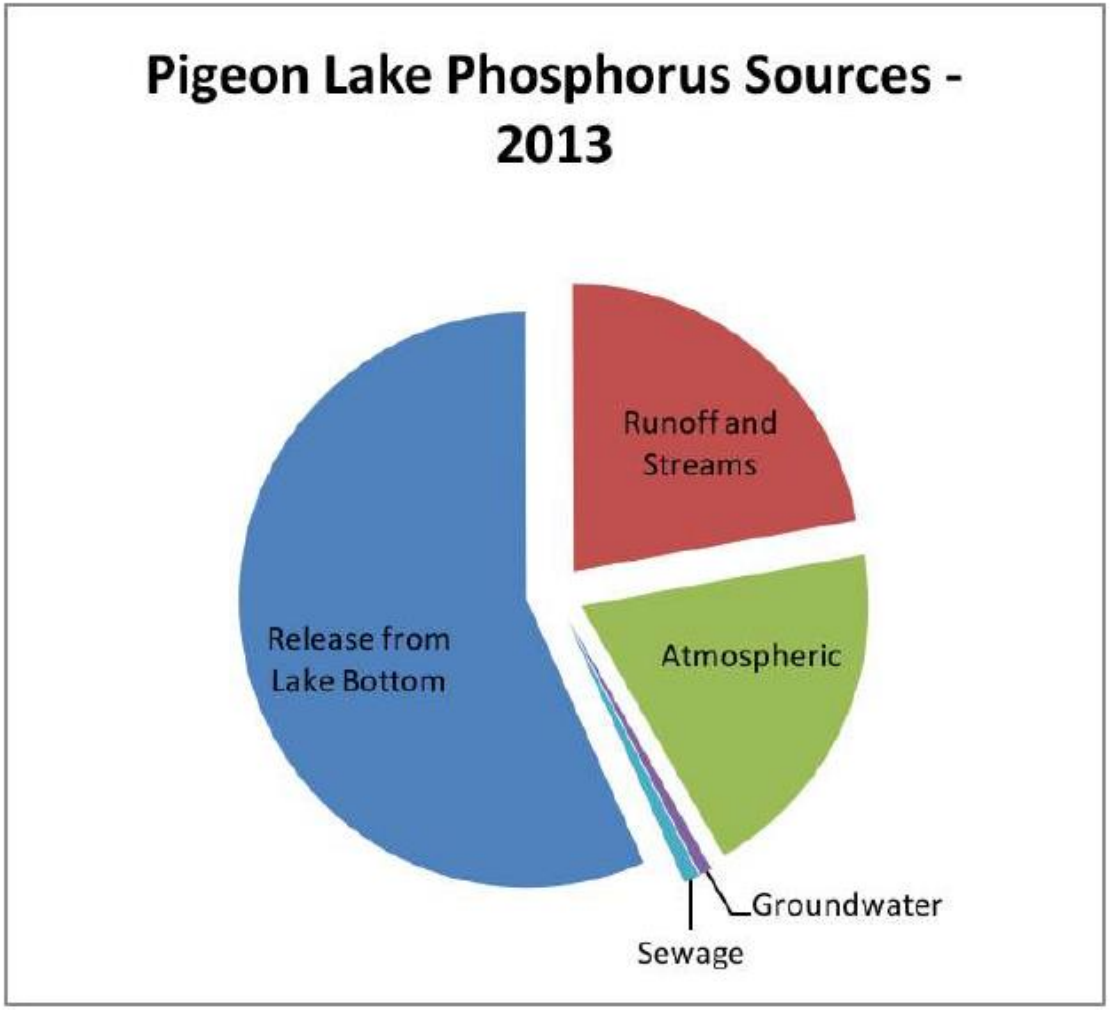
Solutions



Paerl et al. 2016 Harmful Algae 54: 213-222

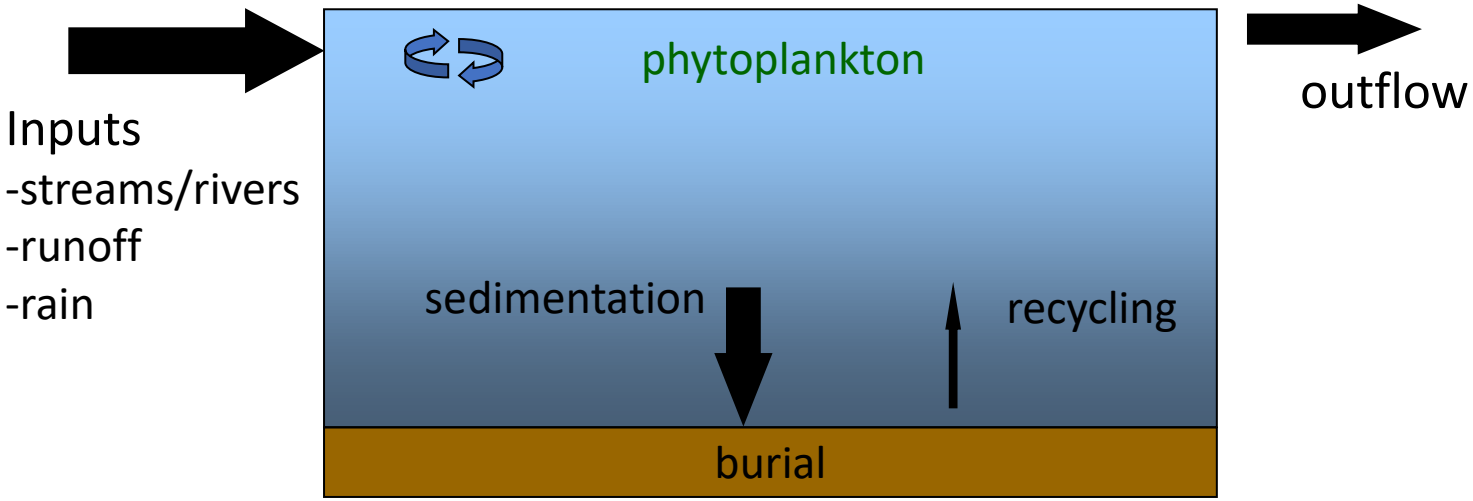
Lake sediments and eutrophication

FIGURE 4: Phosphorus Sources in 2013



Pigeon Lake Watershed Management Plan 2018

Lake sediments and eutrophication



- P is taken up by phytoplankton or attaches to other particles that settle to the lake bottom - this is one of the main ways that P is removed from lakes
- P in lake sediments may be released back into the lake – this is called "internal loading"
- Internal loading may be an important source of P for phytoplankton and may approach external loading inputs
- Internal loading varies among lakes and can slow recovery following reductions of external nutrient inputs

Sediment recycling

- Internal loading is not a new source of P – it is legacy P derived from past external sources that is being recycled
- As a result, remediation efforts that seek to reduce internal loading can only have a short-term effect (<10-15 yrs).
- Long-term control of eutrophication must include efforts to reduce external inputs

How might climate change affect eutrophication?

- Climate change is likely to make eutrophication problems worse
- Undesirable blue-green algae proliferate in warmer waters
- Changes in precipitation will affect the delivery of phosphorus to lakes
- Decreases in ice cover will affect the length of the growing season

PIGEON LAKE WATERSHED ASSOCIATION

https://www.plwa.ca/donate

Things you can do

- Maintain septic systems
- Avoid the use of detergents and soaps with phosphates
- Avoid the use of fertilizers on lawns
- Agricultural fertilizer treatment needs to match the demands of crops
- Avoid draining of wetlands and maintain a buffer strip of vegetation along shorelines
- Support Pigeon Lake Watershed Association

THANK YOU!

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Recent research on eutrophication at ELA: What is the role of nitrogen?

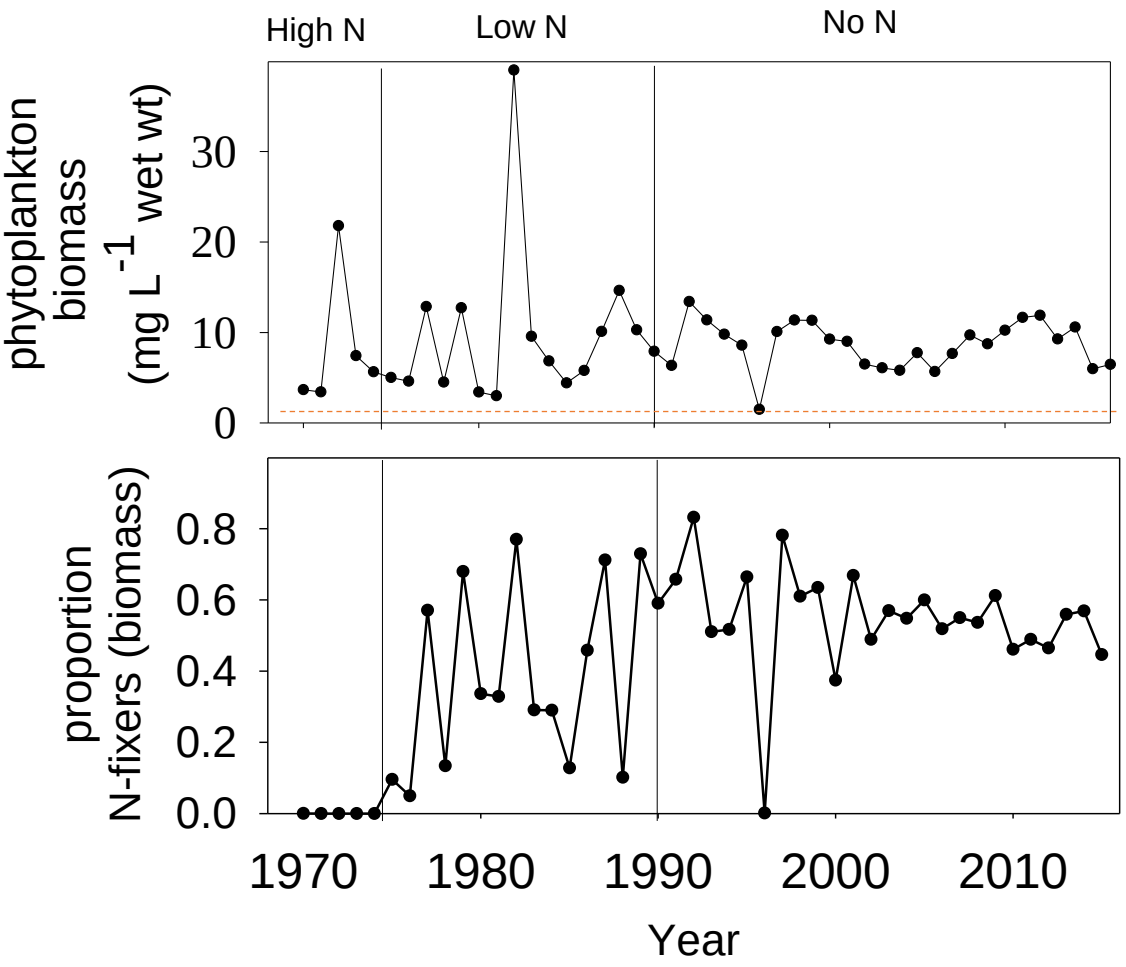
Is it necessary to reduce loadings of P alone or N and P together to remediate culturally eutrophied lakes?

Why does it matter?:

Billions of dollars are spent annually on efforts to control eutrophication

Dual nutrient management is more expensive than P-only approaches. The high costs of dual management may discourage action or deflect resources away from P-only approaches that may be just as effective

Reductions of N while keeping P loading high: Lake 227 example



Reductions of N with high P loading did not affect total algal biomass

Changes in N:P strongly affected algal species composition

Conclusion: focus efforts on reductions of <u>phosphorus</u>

When might it be important to decrease nitrogen?

- Cases where direct N-toxicity from ammonia or nitrate may be a problem (groundwater)
- Estuaries and the oceans? Evidence for N limitation in these systems is also based on short-term small scale studies
- Relationship between N and algal toxins?