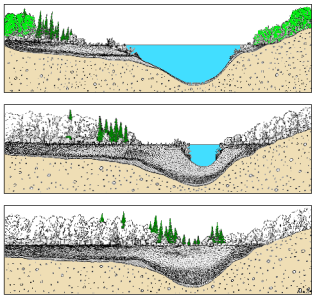
Eutrophication

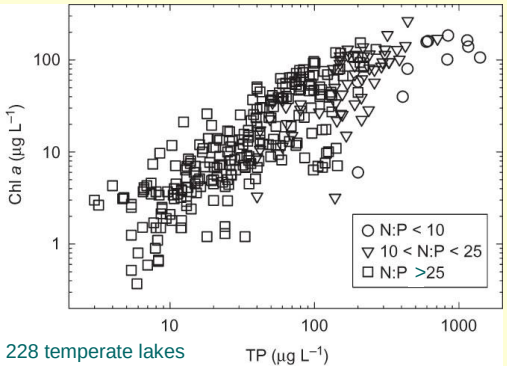
What's all the fuss?

Natural and cultural processes of eutrophication

- Classical view of natural eutrophication in lakes
- However,
  - Many large lakes may be oligotrophic for much of their history (what type mostly?)
  - Small, acidic lakes, too
- The real issue is cultural eutrophication



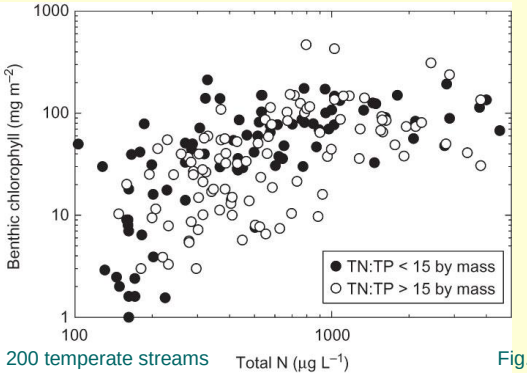
Nutrient-algal biomass relationships in **lakes**



228 temperate lakes

Fig. 18.6

Nutrient-algal biomass relationships in **streams**



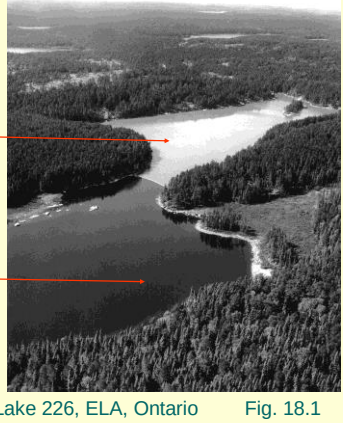
200 temperate streams

Fig. 18.11

Whole-lake experiments

Science, 1974

David Schindler



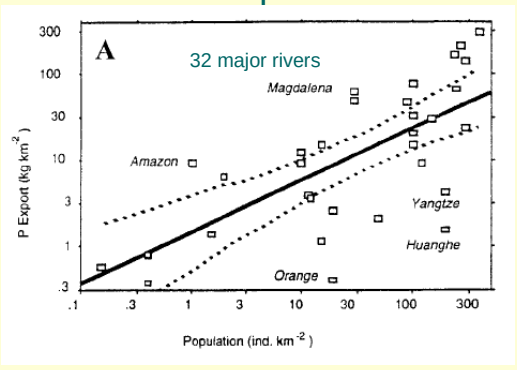
Lake 226, ELA, Ontario

Fig. 18.1

Why does nutrient pollution resulting in algal blooms matter?

- Taste and odor problems
- Blooms of toxic algae (e.g., ?)
- Aesthetics and money
- Oxygen problems (bacteria?)
- Fish kills

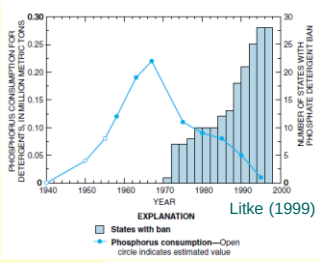
World P export vs….us



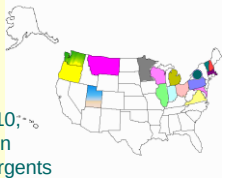
Caraco (1995) in Anderson et al (2002)

One off-shoot

- In 1994, US greatly limited P in laundry detergents through a voluntary ban by the industry after many states had outlawed P use
- Dishwasher detergents have recently (2010) been targeted, but many complain of poor cleaning action



Litke (1999)



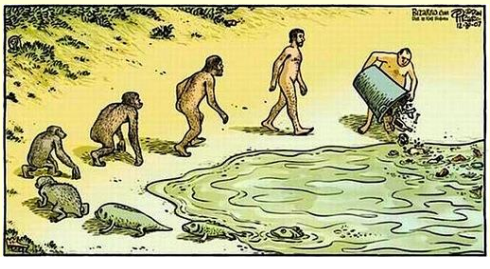
As of 15 July 2010, 17 states ban P in dishwasher detergents

Solutions

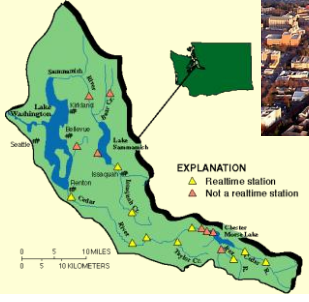
- Reduce nutrients
  - Shrink fertilizer usage
  - Divert and treat sewage
  - Remove them
    - Dredging
    - Harvesting biomass
    - Use nutrient cycling (for some elements)
      - Maintain and restore riparian zones and wetlands
        - Do not bypass
    - Creatively use geomorphology

Two case studies of eutrophication

- Lake Washington
- Lake Trummen

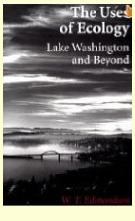


Lake Washington

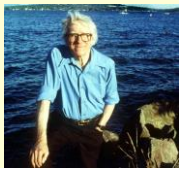


Lake Washington/Stinko

- Noticed shift to eutrophic algal species
- Sewage diverted from Lake Washington in 1960's
- Cyanobacteria dropped out--eventually
- Were able to control trophic state before hypolimnion went anoxic
  - Why such a concern from a limiting nutrient /redox perspective?



W.T. Edmondson (1916-2000)



Effect of nutrient control in Lake Washington

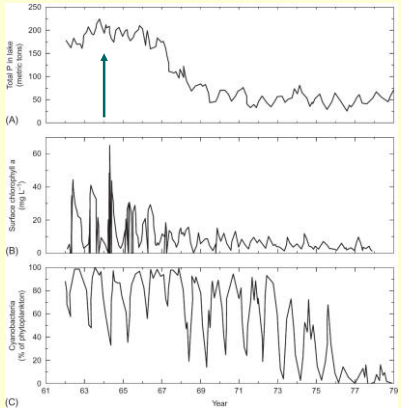
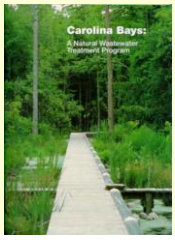


Fig. 18.14

Nutrient removal and wetlands

- Wetlands can serve as nutrient sinks or filters
- How are N & P "removed" from water entering wetland?
  - Any differences?
  - Possible solutions?
- Will all wetlands work as nutrient filters?
  - Why or why not?
- What about Carolina bays?



Nitrate removal and riparian zones

- The importance of intact zones and flow paths

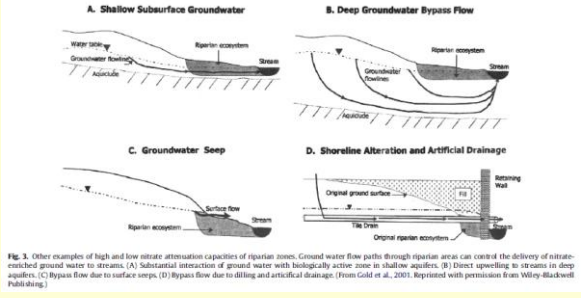
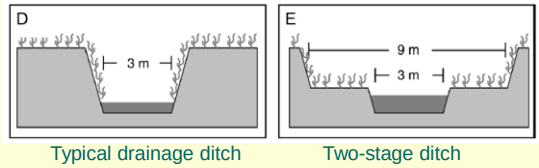


Fig. 3. Other examples of high and low nitrate attenuation capacities of riparian zones. Ground water flow paths through riparian areas can control the delivery of nitrate-enriched ground water to streams. (A) Substantial interaction of ground water with biologically active zone in shallow aquifers. (B) Direct upwelling to streams in deep aquifers. (C) Bypass flow due to surface seeps. (D) Bypass flow due to dilling and artificial drainage. (From Gold et al., 2001. Reprinted with permission from Wiley-Blackwell Publishing.)

Ranalli & Macalady (2010)

Nitrate removal & agricultural "streams"



Typical drainage ditch Two-stage ditch

Floodplain restoration enhances denitrification and reach-scale nitrogen removal in an agricultural stream

Sarah S. Roley,[1,3] Jennifer L. Tank,[1] Mia L. Stephen,[1] Laura T. Johnson,[1,4] Jake J. Beaulieu,[1,5] and Jonathan D. Witter[2]

[1]Department of Biological Sciences, University of Notre Dame, Notre Dame, Indiana 46556 USA
[2]Department of Food, Agricultural, and Biological Engineering, Ohio State University, Columbus, Ohio 43210 USA

Ecological Applications, 2012