Environmental Transport and Fate

Chapter 5 – Water Quality in Lakes

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Water quality issues in lakes and reservoirs:

1. Excessive acidity
   Cause: acid precipitation (incl. in catchment basin)
   Effect: dwindling fish population

2. Excessive nutrient input
   Cause: agricultural runoff of excess fertilizer along feeding streams
   Effect: excessive growth of low forms of vegetation, algal blooms

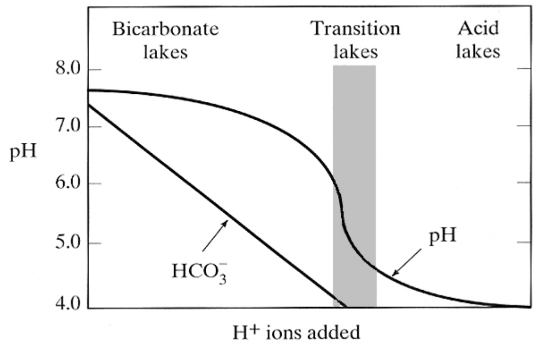
3. Heavy metals
   Cause: leaching from mine tailings
   Effect: poisoning of drinking water supply, fish kill

4. Excessive sedimentation
   Cause: poorly designed reservoir, soil erosion along feeding streams
   Effect: gradual basin filling and eventual disappearance of lake

Acid precipitation

Sulfur in coal → SO_2 in fumes → H_2SO_4 downwind → acid rain and snow

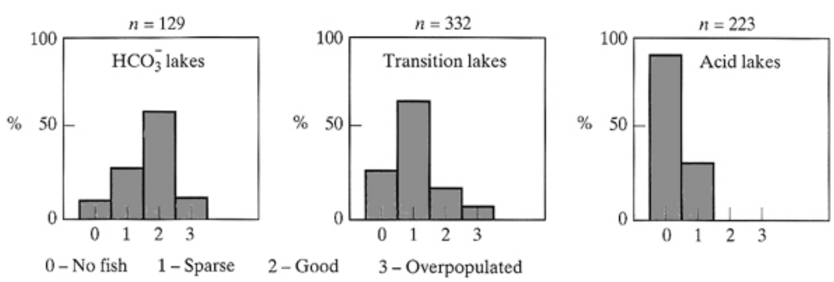
Acid buffering by bicarbonates, if limestone or other form of calcium is present



(Masters, 1997)

$$H^+ + CaCO_3 \rightarrow Ca^{2+} + HCO_3^-$$

Fish population degrade as acidity increase.



Frequency histograms of fish status for 684 Norwegian lakes categorized as bicarbonate, transition, or acid lakes (Wright, 1984 – Taken from Masters, 1997)

Figure 4.15 Regions in North America containing lakes that would be sensitive to potential acidification by acid precipitation (shaded areas), based on bedrock geology (USEPA, 1984; based on Galloway and Cowling, 1978).

With their granite bedrocks (silicon based, no calcium), New Hampshire lakes are sensitive to acid precipitation.

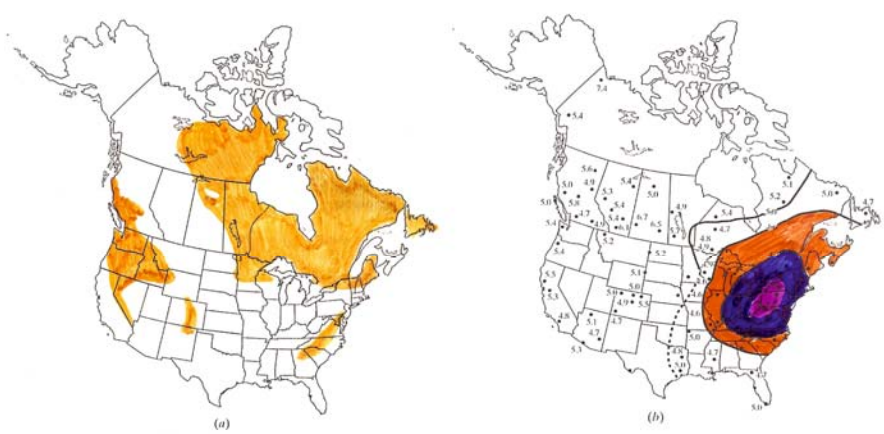
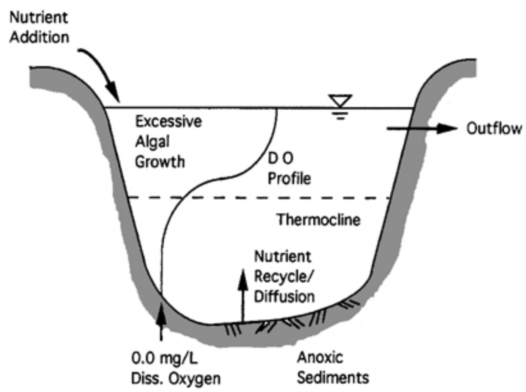


FIGURE 5.25 (*a*) Regions in North America containing lakes that would be sensitive to potential acidification by acid precipitation (shaded areas), based on bedrock geology. (EPA, 1984, based on Galloway and Cowling, 1978); (*b*) pH of wet deposition in 1982. (Interagency Task Force on Acid Precipitation, 1983)

(Taken from Masters, 1997, page 219)

Lake eutrophication



(Schnoor, 1996, page 186)

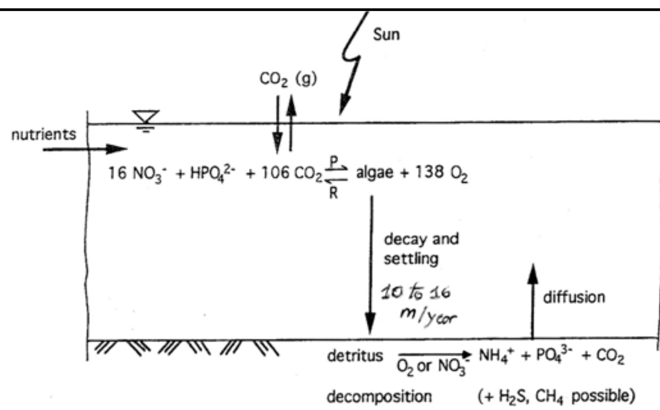


Figure 5.2 Regulation of the chemical composition of natural waters by algae.

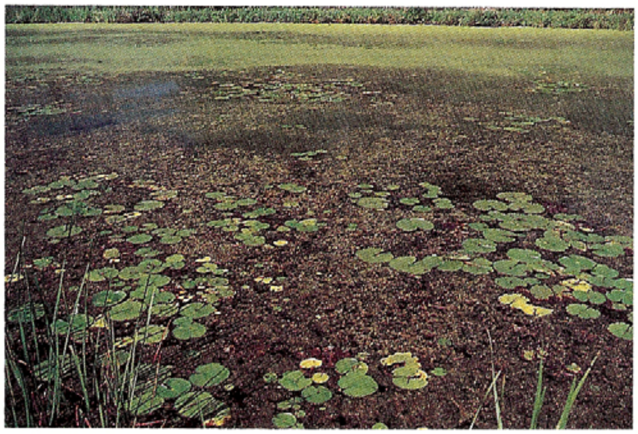
(Schnoor, 1996, page 188)

$106\ CO_2 + 16\ NO_3^- + HPO_4^{2-} + 122\ H_2O + 18\ H^+ +$ trace elements ... $\longrightarrow$ $\dfrac{[N]}{[P]} = \dfrac{16\times 14}{1\times 31} = 7.2$

- If N-to-P ratio falls below 7.2, nitrogen is in shorter supply than phosphorus and is the limiting nutrient
- If N-to-P ration is higher than 7.2, phosphorus is in shorter supply than nitrogen and is the limiting nutrient.

<u>Action</u>: Work to reduce the nutrient in least supply, *i.e*. the limiting nutrient.

Example of a eutrophic lake



Eutrophic lake. Nutrients from agriculture and domestic sources have stimulated growth of algae and aquatic plants in this lake. This reduces water quality, alters species composition, and lowers recreational and aesthetic values of the lake.

(From Cunningham & Saigo, 1997)

Another quality issue:

Excessive sedimentation

Koorawatha dams (early 1900s) : arch dams built for railway water supply (Australia). (Photos by Hubert Chanson, University of Queensland, Brisbane, Australia)