Understanding Lakes

TROPHIC STATUS

Since the early part of the 20th century, lakes have been classified according to their trophic st "Trophic" means nutrition or growth. A eutrophic ("well-nourished") lake has high nutrients and plant growth. An oligotrophic lake has low nutrient concentrations and low plant growth. Mesotr lakes fall somewhere in between eutrophic and oligotrophic lakes. While lakes may be lumped in few trophic classes, each lake has a unique constellation of attributes that contribute to its tro status. Three main factors regulate the trophic state of a lake:

1.Rate of nutrient supply

- Bedrock geology of the watershed
- Soils
- Vegetation
- Human landuses and management

2.Climate

- Amount of sunlight
- Temperature
- Hydrology (precipitation + lake basin turnover time)

3.Shape of lake basin (morphometry)

- Depth (maximum and mean)

- Volume and surface area
- Watershed to lake surface area ratio ($A_w : A_o$)

Trophic status is a useful means of classifying lakes and describing lake processes in terms of tl productivity of the system. Basins with infertile soils release relatively little nitrogen and phosph leading to less productive lakes, classified as oligotrophic or mesotrophic. Watersheds with rich organic soils, or agricultural regions enriched with fertilizers, yield much higher nutrient loads, re in more productive, eutrophic (even hyper-eutrophic) lakes.

Eutrophication, the progress of a lake toward a eutrophic condition, is often discussed in terms history. A typical lake is said to age from a young, oligotrophic lake to an older, eutrophic lake. Geological events, such as glaciation, created lakes in uneven land surfaces and depressions. Th landscapes surrounding lakes were often infertile, and thus many lakes were oligotrophic. Event some of the shoreline and shallow areas supported colonizing organisms that decomposed unconsolidated materials into reasonably fertile sediments. Active biological communities devel and lake basins became shallower and more eutrophic as decaying plant and animal material accumulated on the bottom. Shallow lakes tend to be more productive than deep lakes, in part because they do not stratify, thereby allowing nutrients to remain in circulation and accessible plants. They also tend to have a smaller lake volume, so nutrient loading from their watershed h larger impact. There are undoubtedly exceptions to this typical progression from oligotrophy to eutrophy,where geology, topography, and lake morphology caused eutrophic conditions from th start.

This concept of lake aging has unfortunately been interpreted by some as an inevitable and irre process whereby a lake eventually "dies." In fact, many oligotrophic lakes have persisted as suc the last glaciation and some ultra-oligotrophic lakes, such as Lake Tahoe may have been unproc for millions of years. Furthermore, research in paleolimnology has provided evidence that contra the idealized version of a lake becoming more and more eutrophic as it ages. Studies of sedime cores have suggested that the algal productivity of Minnesota lakes actually may have fluctuate great deal during the past 12 - 14,000 years (the period since the last glaciation). Changes in c and watershed vegetation seem to have both increased and decreased lake productivity over th period. Some lakes probably experienced high rates of photosynthesis fairly soon after glacial re and then became less productive until recent times. It is also possible that water sources for so lakes have changed over the past thousands of years through diversions of stream flow, for exa In such cases water supplies to a lake (and therefore nutrient supplies) could have changed, lea changes in the lake's productivity.

However, lakes may be culturally eutrophied by accelerating their natural rate of nutrient inflow. occurs through poor management of the watershed and introduction of human wastes through septic systems. Such changes may occur over periods of only decades and are reversible if anthropogenic nutrient loading can be controlled. In the 1960s this was a serious issue, exempli the hyper-eutrophic condition of Lake Erie. Although it was pronounced "dead," it eventually re to less eutrophic conditions, when major point sources of phosphorus were controlled in the ea 1970s (by spending millions of dollars to build advanced wastewater treatment plants).

In North America, most of the problems associated with the direct discharge of domestic waste have been successfully mitigated. Now the regulatory focus is on the much more difficult proble controlling non-point sources (NPS) of nutrient pollution such as agricultural drainage, stormwa runoff, and inadequate on-site septic systems. NPS pollution is particularly difficult to address b it is diffuse, not attributable to a small number of polluters, and associated with fundamental ch in the landscape, such as agriculture, urbanization and shoreline development.

An excellent discussion of the factors and issues relating to natural versus cultural eutrophication is a paper called:

The Algal Bowl- A Faustian View of Eutrophication, (by J.R. Vallentyne, 1972, Federation Proceedings, Vol 32 (7), pp1754-7. American Society of Biological Chemists Symposium on Man and his Environment at the 56th Annual Meeting of the Federation of American Societies for Experimental Biology, Atlantic City, NJ, USA, April 10, 1972).

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