Understanding Lakes

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BIOLOGICAL DIFFERENCES

Populations of algae and the animals that feed on them are lower in oligotrophic lakes because (nutrient concentrations. Thus the water remains clear. Decay of the relatively small amount of c matter in oligotrophic lakes does not completely deplete the hypolimnetic supply of dissolved o Therefore, lack of oxygen does not restrict animals from living in the hypolimnion of oligotrophi(Lake trout, for example, require cold, well-oxygenated water and primarily live in the hypolimnio oligotrophic lakes. Minnesota's oligotrophic lakes are found in the northeast region of the state, infertile soils are covered with mixed conifer forests.

Extremely deep oligotrophic lakes such as Lake Superior and Lake Tahoe have hypolimnia that r completely saturated with oxygen the entire year. However, many moderately deep lakes (with maximum depths greater than about 30 meters) may develop anoxia in the lower hypolimnion d late summer but may still be classified as oligotrophic because of their very low nutrient concentrations, low algal abundance, and relatively high transparency (high secchi depth). Thes may have a two-story fishery, with warm and cool water fish in the epilimnion and metalimnion a cold water fish (such as trout) in the cold, oxygen rich portion of the hypolimnion. The cold-wat fishery is therefore very sensitive to increased inputs of organic matter from sewage or erosion (external inputs), and to increased algal and macrophyte production (internal inputs) due to eutrophication since these factors will accelerate the rate and extent of hypolimnetic oxygen de in the summer.

Algae or macrophytes grow so thickly in some eutrophic lakes that light penetrates only a short distance and nutrients below that depth are not assimilated. As discussed earlier, phosphorus is typically the limiting nutrient in freshwater lakes, meaning that the plants deplete all available phosphorus before depleting other nutrients. In a hypereutrophic lake, algae may become so ab that they suffer from self-shading. In those cases, photosynthesis is limited by light rather than nutrients. When a great abundance of phosphorus is available in a lake, nitrogen may become lir In such lakes, certain species of blue-green algae that can fix atmospheric nitrogen have a clear competitive advantage and frequently become dominant. They dominate the algal community u another nutrient, or usually light, becomes limiting. In many infertile lakes in northeastern Minne: both phosphorus and nitrogen may be extremely low during midsummer. Since most sources of point source or nonpoint-source pollution involve increased inputs of **both** N and P, these lakes extremely sensitive to such pollution, irrespective of which is technically "most" deficient.

Eutrophic lakes show wide seasonal changes in their biological and chemical conditions. Because great amount of organic matter produced in these lakes, the decay rate is high in the hypolimni causing oxygen to be depleted. Therefore, eutrophic lakes frequently show a complete loss of dissolved oxygen below the thermocline during summers. Clearly, fish and most other animals c: live in the hypolimnion of such lakes. Warm-water fish that can live in the epilimnion, however, c quite productive. Bass, panfish, northern pike, walleye, carp, and bullheads thrive in many of Minnesota's eutrophic lakes. Complete or nearly complete oxygen depletion below the thermocl may also be a common feature of many moderately deep (10 to 30 m) mesotrophic lakes, if de enough to stratify throughout the summer. Therefore, virtually complete anoxia below the therı does not necessarily mean that the lake is eutrophic.

> Ice Lake, one of our WOW lakes, is an example of a mesotrophic lake that becomes anoxic below the thermocline in the summer, (see Ice Lake section) as is Hale Lake, a somewhat less productive lake immediately downstream of Ice Lake. Both are ~16-18 meters deep.

Another oxygen-related problem in eutrophic lakes is winterkill. A dense snow cover over the ic reduces light penetration and keeps oxygen-producing photosynthesis from occurring. The high organic content of the water, however, provides considerable food for the decomposers. If the decomposers succeed in using all the available dissolved oxygen, a fish kill can occur.

In certain cases, a winterkill may lead to a more balanced fishery and possibly even improved wa quality. Fish that survive a winterkill will have reduced competition for food for a period of time may grow faster and to a larger size. Fewer small fish reduces predation on the larger zooplankt such as the water flea, *Daphnia sp.,* leading to increased zooplankton grazing on algae and a res increase in water clarity. This general scheme, involving fishery manipulations to reduce the abu of zooplanktivorous fish, has been termed biomanipulation, and is being tried in many urban lak where it is economically impractical to reduce nutrient inputs enough to significantly reduce alg these situations the offending fish may be removed by intense stocking of gamefish, by intensi netting and trapping, or even by poisoning the entire fishery and starting over with greatly redu planktivores.

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