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Mary Anne,
This is an excellent paper.
Shows a good grasp of concepts
and interrelationships.
Thank you,
Dr Morgan

FISH

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Fish

The eutrophication of a lake is accompanied by a rapid succession in the fish community. Freshwater fish in general are fairly tolerant of changes in food abundancy. They have a diverse diet, some even being omnivores. With the outset of eutrophication, food availability is increased, and the fish community will thrive. However, conditions will soon become unfavorable if not checked. Decomposition increases rapidly under these conditions, and the oxygen source will be depleted or at best limited to only certain areas of the lake. Trout, salmonids, and coregonids (white fishes) are often eliminated in such lakes. They are replaced by a more tolerant fish, accustomed to warmer water. These may be omnivores, such as carp, which is seen in great quantity in St. Mary's Lake, a very eutrophic habitat.

SOME ARE EQUALLY RESTRICTED, AT LEAST TO FOOD CLASSES.

Another problem with eutrophication is that it affects the littoral zone. Some fish, like the Pumkinseed Sunfish, inhabit weedy waters. In general, lakes high in macrophytic growth are better fishing areas, as evidenced by the fisherman on Tenderfoot Lake. The larger fish, such as the Walleye, and Largemouth Bass, found in Tenderfoot, feed on smaller fish. The smaller fish, like the sunfish, feed on the insects or crustaceans found among the weeds. Some may feed on even smaller fish from the minnow family, such as the Golden Shiner. These in turn feed on algae and zooplankton or tiny animals.

A more serious effect of changing vegetation relates to the reproductive habits of the various fish. The spawning ground may be gravel or sand, which would disappear under increased eutrophication. It is this changing littoral zone, and

the increase in organic debris which reduces the survival of young. Even under good conditions a Bluegill female, for example, may have only a few young survive from thousands of eggs layed at one spawning. Bluegill, even so, are widely distributed as a result of stocking. At UNDERC, Lakes Mullahy and Ward were stocked with Bluegill. These are very alkaline lakes with a pH around 9 or 10. Their specific conductance is accordingly high, both over 100. In addition to the Bluegills, there were Sunfish - also stocked. These fish do well in such alkaline waters, considering that at a pH of 8.5 conditions begin to be dangerous.

THE BLUEGILL IS A SUNFISH.

In less alkaline water, under 9.0, but still with a high specific conductance, the number of species present increases. The lakes in this category are Inkpot, Kickapoo, Morris, Plum and Tenderfoot. Northern Pike, Yellow Perch, Muskellunge and Walleye are found in almost every one. The Yellow Perch do well even in lakes with a pH of 5.0 or higher. There are Yellow Perch in Bergner which has only a pH of 5.5. This species must therefore be tolerant of a greater fluctuation in pH. They can also withstand both soft and hard water with only one difference. In the soft water lake such as Roach, they tend to have soft skeletal elements. Another characteristic of Yellow Perch is that they do favor cooler waters, and are therefore found farther North. They go deep during the day, and are found in the shallows at night.

After a certain point a eutrophic lake will become either a marsh or a bog. On the UNDERC property there are a considerable number of bogs or dystrophic lakes. These are characterized

by low-moderate productivity, high organic matter, reducing conditions in the hypolimnion which leads to high nutrient release, and a low pH. From here a lake usually goes to extinction. Few organisms thrive under these conditions. Only one or two of the bogs at UNDERC had any type of fish community. At pH's lower than 4.5, fish usually disappear.

A bog has very little oxygen, and what it does have is usually concentrated in the first two meters. If an organism can't stay up in this area he will be lost forever. A bog lake is generally very deep, dropping off sharply to 80 feet, in the case of Tender Bog. Under these circumstances, it is not likely to turnover. So although there is a high nutrient release in the hypolimnion, these nutrients are never brought up to where they can be used. Bogs are often darkly stained with low light penetration below 2 or 3 meters. Only moderate photosynthesis can go on in such a lake. It is understandable then that the fish community would be only poorly represented in a bog. What species there are are usually small, such as ombrae and mudminnows. Umbra = mudminnow Although these species can go below the O_2 deficit line, in order to reproduce, they must develop a system which will keep the eggs in oxygenated water. Species which lay their eggs along the bottom would never survive. Perch are found in Hummingbird Lake, having come in by way of the drainage system, at times of high water. They are however, unable to effectively reproduce and their presence is only temporary.

Fish have a tremendous effect on a lake system. If their numbers are great enough, they can determine the shape of the zooplankton, and in turn the phytoplankton communities.

In UNDERC lakes this effect was quite evident in our studies of the plankton community.

Going from a lake habitat to a stream, the major difference is that a stream has a current. When we sampled Tenderfoot Creek we caught a variety of the smaller fish species, shiners and chubs mostly. From Morris and Bergner the size and types of fish caught were much different. Only large Northern Pike, Perch and Bluegills were captured in our nots. One obvious reason was that we used only large mesh gill nots. In the stream, the seines had much smaller mesh. Sampling methods have an enormous effect on the results.

Looking at the stream itself, there are advantages to being small. A stream as it meanders through an area, creates alternately pools and riffles. The riffles are shallow areas where the current is faster. Small animals have developed characteristics which allow them to stay in the riffles for reproductive purposes. Here the fish predation is lowest, and the habitat is fairly stable since the riffles do not move. Fish, however, are restricted to the pools. Even in the pools the velocity is differnet at different levels. Organisms distribute themselves according to this layering. The deeper the pool, the stiller the water is the rule. It is in the very deep pools that the large fish are found. Otherwise the fish found in a stream are small. They are in many ways at the mercy of the current. So much of Tenderfoot Creek is so shallow that a large fish would be trapped if forced there by the current. A small fish would be able to navigate these areas without difficulty. It is evident why technique is important.

some are beautifully adapted for fast water.

Using our sampling methods, we caught only the small fish, the larger ones remaining in the pools.

2. Morris has an interesting problem. Several years back it was stocked with Northern Pike. Since then this species has more than taken over the lake. Morris is a relatively small lake, with only a few deep spots. They have greatly reduced the food supply, stunting their growth. In general they should grow as long as 2 to 4 feet, but instead after 4 years they are only 20 inches.

The Northern Pike is an excellent predator, darting after frogs, ducklings or other fish. They feed on smaller fish, but the small teeth of their palate and tongue can be flattened if they need to swallow a larger fish. The Northern Pike are at the top of the food chain, and at the bottom is the phytoplankton. These are the primary producers, using light as their energy source. The phytoplankton of Morris are primarily colonial or cells with spines. In this form ingestion by zooplankton becomes more difficult. Zooplankton are size specific. Each species can filter through only the smaller particles. Large, colonial forms will therefore escape predation.

Zooplankton are preyed upon by the smaller fish, such as the minnows. Minnows are found in Morris lake although we never caught any. These small fish also prey on insects and crustaceans. They are therefore found among the weeds, feeding during the daytime. It is evident from the zooplankton community that the fish predation is heavy. In a fish lake all the larger zooplankton - Cladocerans and Copepods are picked off first.

This leaves only the rotifers and smaller cladocerans and copepods. This is what we see in Morris. Bosmina are one of the smallest cladoceran, so their presence is understood.

If the minnows are having problems, then their predators, the Northern Pike, must be too. In such an overpopulated lake, each individual is stunted, weighing only a fraction of what he could weigh at that point.

The biggest problem in Morris is that most of the fish are the same age. Four years ago was the best spawning year, and the population grew accordingly. Since then they have been competing for food. In addition to the Pike, Perch were caught in Morris. Only large Perch were captured, again maybe because of the mesh used, but more likely because there are only large Perch in the lake. These Perch are probably 4 or more years old, having developed at the same time as the Pike. Any smaller Perch, under the circumstances would not have a chance to grow. The predaceous Pike would pick them off before they mature.

Morris is an overstocked lake, containing large Perch and poorly fed Northern Pike. It'll be a while before the numbers are reduced enough to allow ea h species to grow to its fullest capacity. Our efforts at alleviating this situation will only have a minimal effect. Even species down to the planktonic level have felt the effect of this overpopulation.

Sources

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