"A TIME TO BE BORN AND A TIME TO DIE"

A Discussion of Some of the Causes of Fish Mortality.

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As the saying goes, there is a time for everything, each in it's own season. Late winter/early spring seems to be the season most often chosen by nature to eliminate the weak, the infirm and the unlucky from wild fish populations.

As fish enter the winter, many things take place, one of which is that their normal food supply becomes unavailable to them. Being "cold blooded" reduces, but does not eliminate, a fish's need for food during the winter. Most fish have empty stomachs during this time, which they would fill if the opportunity arose to do so. It is for this reason that ice fishing produces the best catch rates of the year.

WINTER KILL

Winter is a period of starvation stress for all wild fish. Some have entered the winter with more reserves of fat and vital nutrients, others with less. As winter progresses, snow accumulates on the ice and, depending on the year, lasts for varying lengths of time. At some point, the accumulation of snow is sufficient to shut off sunlight. Pond plants need sunlight to renew the oxygen supply, which is continually used by the living organisms of the pond. Once the snow blocks the sunlight, a count down clock begins. The number of days and hours that are on the clock is determined by many factors, not all of which are clearly understood.

Certain factors are clear, however. Among these is the volume of water in the pond. At the time ice forms on the pond, oxygen has been generally distributed throughout the water column by the fall turn over. The turn over accomplishes much the same things as breathing. In the case of the pond, it breathes once in the fall, and once again in the spring.

Therefore, when our clock starts the count down until the oxygen runs out, there will be more oxygen available in a deep lake than in a shallow one. In Illinois, a pond 8 to 10 feet deep over 1/4 of its area is deep enough to withstand most winters. It's not that simple though. If it were, many more lakes would undergo winterkill than actually do. Other factors enter in, such as the amount of accumulated organic matter, leaves, dead aquatic weeds and so forth, which are slowly decaying under the ice.

Also involved is a simultaneous rise in carbon dioxide from ordinary respiration of fish, plants, and bacteria, as well as in hydrogen sulfide, a poisonous gas , which is a product of bacterial respiration in the absence of oxygen. The fish, being cold in the winter, do not require a lot of oxygen to maintain life. However, if the oxygen drops low, if the carbon

dioxide (which acts as an anesthetic to fish) rises to an anesthetic level, and hydrogen sulfide rises to a mildly poisonous level, the fish are hit from three different directions at once, and winterkill, the first of the causes of dead fish in the spring, occurs. In a very long, cold winter, the problem will be particularly widespread and severe.

Another cause of death in spring and fall related to the cold is the fact that some fish in Illinois are living near or beyond the northern limit of their range. One fish living near the northern limit of its range is the gizzard shad. Many Illinois ice fisherman are familiar with watching gizzard shad dying under clear ice, while they are catching bluegill that are perfectly healthy. If the ice was cloudy, the fish may die without being observed and become frozen in the ice. When the ice melts in the spring these fish are released. It is not possible to determine when they died.

Several factors are at work in these mortalities. Prolonged cold is one, where water temperatures less than 34°F penetrate deeper than normal. These die-offs seem to occur more in shallow lakes when the population is unbalanced and consists of many old and few young fish. These stresses combine and at ice out or shortly thereafter, disease, nature's population control mechanism, sweeps through the ranks of the shad and thins them out. Often, a parasite called *Plistophora cepedianae* and a bacterium, *Aeromonas hydrophila*, in a combined infection, kill the fish. The numbers of dead and dying fish can be dramatic. As the ice goes out, many thousands of gizzard shad can line the shore in windrows.

Before we leave the cold of winter behind, we should mention it as the cause of mortality of a couple of introduced species which have become familiar to Illinois anglers. One, the threadfin shad, is introduced in Illinois because its tremendous potential for reproduction and small size make it ideal forage fish for predators like largemouth bass and crappie. The threadfin shad is so far north of its natural range that the cold of late fall in Illinois (45°F) is lethal to all threadfin in the state, with the exception of those protected by the heated water produced by electric power generating plants. The second species, redear sunfish is an import from the southeastern U.S. The northern limit of its range runs right through Illinois, at about the level of Bloomington. North of this line it becomes very difficult, if not impossible, to permanently establish redear populations. The die-offs are not spectacular and are seldom noticed because the fish generally don't live through their first winter, due to the prolonged cold.

EARLY SPRING MORTALITIES

Now that the ice is off and the late winter/very early spring die-offs are over, it is time for the water to warm rapidly with the breezes of spring.

Before going on, a discussion of stress and its role in fish disease is in order. Perhaps this relationship was best illustrated by what Dr. Stanislas Sniezko (the father of fish pathology in America) called the Polish 3 ring circus, represented by the 3 circles shown in Figure 1.

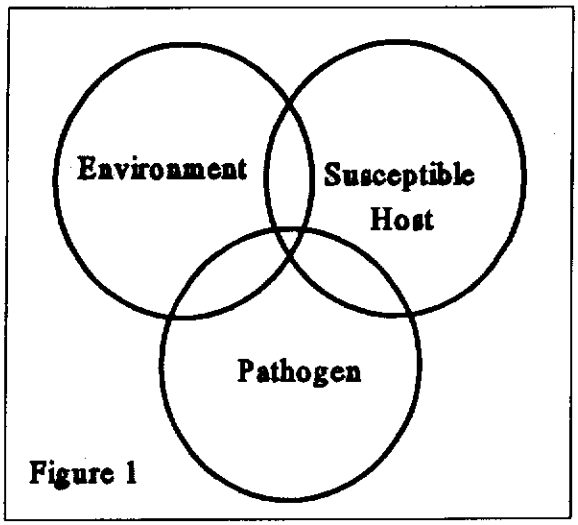

Figure 1

As long as these three factors were in balance, one with the other, no disease occurs, even though the disease organism and the susceptible host exist side by side. When a stress is placed on this system such as poor nutrition for the host or a bad environment, the system becomes unbalanced, and disease is the result.

Back to our pond fish population just after ice out. Having undergone the stress of winter starvation and perhaps some conditions under the ice that were not quite winterkill, now comes a period of rapidly rising temperatures. The bacteria present are capable of responding to the rising temperatures quicker than the fish, which must repair the damage the cold did to their immune systems.

On top of this, the mature fish of the pond have another stress operating as well. They must prepare for spawning. The repairs of the normal wear and tear of winter are sacrificed to the production of sex products. To help the fish overcome these long term stresses, hormones called cortisols are produced. Paradoxically, while helping the fish cope with these stresses, cortisols also suppress the immune system.

COLUMNARIS DISEASE

The result is one of the most common cause of telephone calls to the Illinois Department of Natural Resources in the spring, columnaris disease. Caused by soil bacteria called Flexibacter columnaris, which are always present, this disease is stress mediated. The worse the stress, the more fish affected.

Columnaris disease occurs in ponds and lakes in springtime Illinois, when water temperatures reach about 70°F. Most often, the greatest number of seriously affected fish are the biggest bluegill present, followed by crappie and large bullheads. Usually,

largemouth bass and channel catfish are little affected in the wild, although columnaris is their major disease in a hatchery or fish culture situation.

The sores or lesions caused by this disease are often on the head, in the mouth and on the gills. Channel catfish fingerlings typically show "saddle back" lesions behind the dorsal fin. The mouth may appear yellow, eroded and fungused, although there is no fungus involved. The gills often have a brown, rotten looking place on the filaments, usually at the base of the gill arch and usually only on one side. With bluegill, there may be sores on the sides which are roughly circular, with the scales in the center loose, bloody, and easily removed with the point of a pencil.

Affected fish in a lake situation will hang near the surface and be blown about by the wind. They are found in the shallows, often laying on their sides. Though these fish are still alive, they are unresponsive, unaware of your approach, and do not react to shadows cast over them. They are easily caught by hand and struggle weakly, if at all.

LOSS PATTERNS

The question is often asked, "How do I tell a fish kill due to disease from one caused by pollution?" There are two things that distinguish a fish kill caused by an environmental catastrophe such as pesticide poisoning from one due to disease. These are the pattern of the kill, and the numbers of species affected.

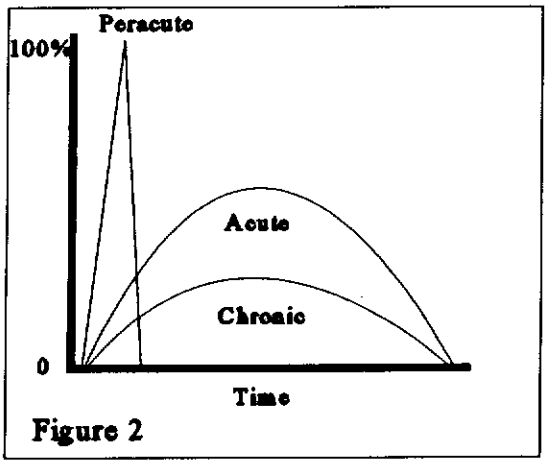

Figure 2

There are three types of loss patterns, illustrated in Figure 2. The first is peracute, representing an environmental catastrophe, in which all types of fish present die within 24 to 48 hours. There are numerous causes, such as pesticide runoff or loss of oxygen in the water. Whatever the reason, the pond temporarily will not support fish life.

The second type is the acute loss pattern, in which 80 to 90% of the fish present die within 5 days. If many kinds of fish are dying, one should suspect environmental problems. If only one or two kinds of fish out of many kinds present are dying, then a disease, possibly a bacteria or virus should be suspected.

The third type is the chronic loss pattern, in which often only one species of fish is dying, though many species may be present. Fish die at the rate of 10 to 20 a day and the losses go on for many days, sometimes weeks. This type of loss pattern is often due to a mildly

pathogenic bacteria or a parasitic protozoan disease.

A typical scenario of a pesticide fish kill (peracute) starts with a pond with no apparent problems. Usually, there is a 1 to 2" rain with a lot of runoff. The following morning, all the fish in the pond are up, dead and dying. This type of kill often happens in the spring and early summer, during the season for applying insecticides to crops.

Occasionally farm pond fish kills take place, due to pesticide run off which is in low enough concentration that strange effects occur. Fish deaths caused by pesticides are dose related. If by chance, the dose is low enough, sometimes only small fish are killed and the larger ones are unharmed. Occasionally just the opposite happens, when a heavy rain occurs just after pesticides are applied, the dose that the pond receives is so large that secondary kills occur. Not only are all the fish killed, but when the turtles eat the dead fish, they contain so much pesticide that the turtles are killed too.

Sometimes, very odd things have happened related to pesticide use on the farm, such as the fish kill which once took place because cattle had rubbed on pesticide soaked burlap bags and then decided to go wading in the pond!

A typical natural kill, one caused by columnaris disease, almost always occurs in a lake rather than a stream. The losses of fish start slowly, with a few affected individuals appearing at first, gradually working to a peak over a period of days and then tapering off gradually. It occurs in the spring when the water temperature is about 65-70°F, shortly before or during spawning time. Usually, the largest, sexually mature angling sized bluegill and/or crappie will be affected, with few if any smaller fish appearing in the kill. Although many other species of fish may be present, usually none of them are sick or dying.

In the case of the natural disease kill, there is usually nothing that can be done, often because the losses are minor and would not justify the expense of treating the sick fish. Indeed, there is often no practical way to get the drug inside the fish where it would do some good. Columnaris disease may affect from 50 to several thousand fish, depending on the size of the lake and the severity of the outbreak. The fish populations are almost never seriously affected and the disease will pass of its own accord as the first spring spawning period passes and water temperatures begin to stabilize.

SUMMER KILL

As the summertime water temperature rises above 80°F, other, less common "natural" causes of death in fish can occur. Natural is in quotes because there is some question as to how often this type of kill would happen without the activities of man to help it along.

Many ponds and lakes in Illinois are quite fertile, due to the natural fertility of the prairie

soils on which they are built. This fertility is often artificially increased by runoff of excess fertilizer from adjacent crop land. These ponds support large stands of aquatic plants, including both the tiny, one celled ones which give the water its' green color and the larger ones which float in stringy mats or have leaves, stems, flowers, and seeds.

Usually, even this is not enough to cause a problem, unless barn lot drainage, rich with animal manure reaches the pond. It also happens if the pond is being used for aquaculture, with a ton or more of catfish per acre of water, being fed 60 lbs. of feed a day for example. The greatly increased fertility supports abnormally high populations of plants, animals, and insects. Commonly, there are many more pounds of each per acre of water than would found in nature.

Life in this fertile environment goes on at a fever pace, until the clouds cover the sun. In a situation like that just described, two or three cloudy days in a row cause a collapse of the heavy population of one celled plants and animals. They all die suddenly and the bacteria in the pond, already at abnormally high levels, abruptly are presented with a bonanza of dead one celled animals and plants to decompose. Since most plants are dead, there is very little renewal of the dissolved oxygen. The pond bacteria use oxygen at a furious rate and the oxygen level in the pond water quickly drops to a level at or near zero.

Usually, the first indication of a problem that the pond owner has is that he visits the pond early one morning to find that all the fish have come to the surface gasping and struggling.

Seldom, if ever, will one of these "summer-kills" kill <u>all</u> the fish in the pond. The small fish, usually bluegill and green sunfish an inch or so long, and any bullheads present will survive. Typically, all largemouth bass and channel catfish are suffocated.. When this happens, the best thing to do is to apply a fish toxicant to remove the survivors and start over again with a balanced stocking of largemouth bass, bluegill (70%), redear (30%), and channel catfish fingerlings.

Once a summer-kill starts, it is usually too late to do anything except watch the fish die, since most pond owners are not equipped to deal with this problem. Indeed, if the wrong aeration equipment is used, it may actually <u>lower</u> the dissolved oxygen, making matters worse than they might have been. As with all events in nature, there are degrees of severity with which each event occurs. Occasionally, the conditions which set up a summer kill are only severe enough to place the fish under heavy stress, but the dissolved oxygen doesn't go to zero and cause an immediate kill.

This situation can occur in some of our medium sized rivers with centers of population and industry along their courses. During late summer drought, an increasing and substantial fraction of the flow of these streams is contributed by sewage treatment plants and industrial effluents. As the water's temperature rises, its' oxygen holding capacity goes down. The diluting effect of rainfall runoff is absent, due to dry weather. This

results in increasing concentrations of wastes from sewage, industrial, and agricultural sources. The bacteria in the water, presented with an increasing concentration of food and favored by rising temperatures, respond by demanding increasing amounts of oxygen.

At some point, there is too little oxygen available for the fish and heavy stress occurs. Seven to ten days following the stress event, fish disease breaks out, often among the channel catfish, which are particularly sensitive to low oxygen stress. Depending on the year, this can involve a few or many thousands of fish, dead, dying, or sick and covered with sores.

This kind of kill is another "natural" one, in quotes because there is no one source of pollution that one can point the finger at and say, "they did it!" Instead, it is the sum of man's activities along the river that are responsible. Without the alterations in the environment that mankind causes, this kind of fish death would seldom, if ever, take place.

STRESS DUE TO HANDLING AND TRANSPORT

Lastly, there is one more common cause of fish death in ponds which should be discussed. It is not what one would characterize as natural, but it occurs often enough to warrant discussion here. This involves fish death following stocking. Most often this occurs with channel catfish, because this species is a popular fish to supplementally stock into existing fish populations.

If the fish stocked begin to die anywhere from immediately to about a week following the stocking, the pond owner has some pretty good circumstantial evidence that the fish were heavily stressed before or during shipment to the pond. Most often, these fish die of bacterial or parasitic disease or both. There is usually nothing that can be done to save these fish because there is no practical way to deliver drugs to them or withdraw the drugs following treatment.

The diseases which the recently stocked fish suffer will usually be self limiting and will probably not spread to the fish already in the pond. The resident fish have not been under stress, and will probably have little difficulty resisting most disease organisms.

The final cause(s) of fish mortality that will be discussed falls under the category Miscellaneous Mysterious Maladies (MMM). Let it first be said that fish never die without a reason. Sometimes though, it is very difficult to find out what that reason is! Occasionally, the cause is almost unique, and may never be repeated. If a knowledgeable observer is not present when it happens, the cause of death may never be known.

Often, one can only tell that an MMM is in progress when, of many types of fish present in the lake, only one is dying. The concerned citizen calls the Department of Natural Resources and is instructed to place dying fish on ice and rush them to the pathology lab.

The pathologist then finds no bacteria, no viruses, no parasites, no toxins, no environmental problems, no changes from normal in the tissues. In fact, occasionally the fish look as though they ought to be alive. They just aren't!

All the answers to the question "What killed this fish?" are not known, but we continue to try to learn.

RWH