AQUAGUIDE

MISSOURI DEPARTMENT OF CONSERVATION

Pond Turnover

What is it?

Turnover is the gentle, natural mixing of pond and lake waters. It is caused by changing temperatures in surface waters brought on by the progression of the seasons. In Missouri's continental-temperate climate, most ponds and lakes turn over in both the fall and the spring. Turnover occurs in the fall when surface waters cool, and in the spring when they warm-up again.

Water

The density and weight of water change with its temperature. Like most other liquids and gasses, cold water is both heavier and denser than warm water. Water has one unique property, however. It is most dense and heavy at 39^{0}F (4^{0}C). As water cools and approaches 32^{0}F (0^{0}C), its molecules actually expand and form the crystalline structure of ice. Ice floats because it is both lighter and less dense than the warmer 39^{0}F (4^{0}C) water beneath it. It is this unique property which makes it possible for aquatic life, including fish, to over-winter in streams and rivers, ponds and lakes. If water's weight and density were greatest at 32^{0}F (0^0), ponds, lakes, streams and rivers would become solid ice!

Annual Cycle of Ponds

Your pond has four stages in its annual cycle. As you might expect, these stages parallel the four seasons of the year. They are:

- Summer stratification
- Fall turnover
- Winter stratification
- Spring turnover

Summer stratification: During the summer, ponds "stratify" into three layers of water with differing temperatures, densities, and levels of dissolved oxygen. Because of these differing physical properties, they do not readily mix. Of the three, temperature is the most readily measured parameter and for this reason this summer process is often known as "thermal stratification."

The uppermost level, known as the epilimnion, is composed of warm, lighter water. This zone is well oxygenated because of its constant contact with the atmosphere (wind action) and because of oxygen produced by the aquatic plants found there. The temperature of water in this layer increases throughout the summer. The depth to which the epilimnion reaches depends on the clarity of the pond's waters and the terrain in which it is located. As summer progresses, however, the epilimnion typically shrinks in size. Regardless, almost all fish are found in this top layer of your pond.

The middle layer of water is known as the thermocline. It is a transitional layer where the water temperature drops at least 0.5^0F for each foot of increasing depth. Swimmers in ponds with established thermoclines often note this layer of rapidly changing water temperature. The thermocline also is a transitional layer for dissolved oxygen levels. It is deeper and further removed from the atmospheric oxygen than the uppermost epilimnion. Also, because of the depth, light penetration is limited and plant growth is restricted which in turn limits photosynthetic production of oxygen. Fish may use this zone to escape the higher temperatures of the epilimnion, but the reduced oxygen levels mean that they return rather quickly to the oxygenated upper layer.

The lowest layer of pond water during summer is referred to as the hypolimnion. Its waters are the coolest and densest of the three zones. In fact, water temperatures in this layer typically range from 54^0F to 59^0F (12^0-15^0C) even during the hottest summer months. The epilimnion and thermocline, however, seal the hypolimnion from any contact with the atmosphere. Since it is the deepest layer of water in the pond, little light penetrates to it and plants which produce oxygen can not live here. Decomposition of plants and animals which sink to this depth and the decay of organic material which washes into the pond rapidly uses all the dissolved oxygen found in the hypolimnion. By mid-July this layer may be completely devoid of oxygen. Fish can not survive in the hypolimnion so there is little point in fishing the bottom of the pond in the summer.

Fall turnover: As temperatures drop toward 50^0F in the fall, the epilimnion cools and becomes both more dense and heavier. This cooler, more dense water sinks and fall winds stir the epilimnion which gradually erodes the thermocline. Eventually, the pond waters become uniform in density and temperature. This leads to a complete mixing of the water column which is known as "fall turnover." This mixing can happen literally overnight and sometimes leads to noticeable changes in the color, taste, and odor of the water. These changes are due to the pond-wide circulation of decaying particles of organic material and gasses which accumulated in the hypolimnion all summer. Over time, the freely circulating water becomes thoroughly oxygenated from the surface to the deepest part of the pond. Fall turnover opens the entire pond's volume to fish and they may be found throughout the water column.

Winter stratification: As winter approaches, water in the pond reaches its point of maximum density at 39^0F. A layer of colder, less dense water soon forms on top of the deeper 39^0F water. Eventually, this colder water reaches 32^0F and a layer of ice forms on the top of the pond. This gradual separation results in a pond which has colder water on top of warmer water. This process is sometimes known as "inverse stratification." Early in the winter you may expect to find fish in the warmer water on the pond's bottom. As the winter goes on, the water at the bottom of the pond becomes depleted of oxygen from the decay of organic material just as it does in the summer. Fish move higher in the water column as the winter progresses. A "winter kill" of fish may result if heavy snowfalls block light penetration through the ice and oxygen levels are depleted. Clearing snow from the pond to permit light penetration may help avoid a "winter kill."

Spring turnover: Each spring the ice melts and the sun and seasonal breezes warm the top layer of cold, less dense water. Eventually, this upper layer of water reaches 39^0F, becomes heavier, and sinks. Soon the pond achieves a uniform temperature and density throughout the water column and it becomes well mixed. This second period of mixing in the annual temperature cycle is known as "spring turnover." The entire pond has good levels of dissolved oxygen and fish can be found at all depths.

Factors Affecting Pond's Cycles

Obviously, no two ponds are exactly alike. Some ponds stratify strongly during the summer and some remain well-mixed from top to bottom. Others never, or seldom, have an ice cover and don't experience winter stratification. Some of the factors which modify your pond's annual cycle are identified below.

Climate: Ponds in northern Missouri tend to have well developed periods of winter stratification. Ponds in the southern part of the state may have only brief periods of winter stratification. In fact, mild winters in Missouri's Bootheel may result in well mixed ponds from the fall turnover to the start of summer stratification. Regardless of where they're located, prolonged periods of high winds may destratify ponds several times each year.

Depth: The depth of your pond has a lot to do with its annual stratification cycle. Shallow ponds may never truly stratify, or do so for only brief periods of time. They are warmed or cooled to uniform temperatures quite quickly and are readily mixed by high winds. Deeper ponds, on the other hand, tend to establish pronounced and stable stratification patterns.

Topography: Ponds located in open, windy sites may turn over at any time of the year only to restratify as soon as the wind drops. Conversely, ponds in deep, narrow valleys, or those protected by forest land, may stratify and remain quite stable throughout the summer.

Pond size: Small ponds experience fall and spring turnover for briefer periods than do large ponds, or lakes. Small ponds may circulate for only a few days, but large ponds and lakes may circulate for several weeks, or longer.

Management Implications

Turnover, as we've seen, is a complex, but natural, process affecting all ponds to some degree. Some of the management implications of turnover include the following.

Water supply: Livestock may be "put-off" by the taste of water from ponds experiencing fall or spring turnover. An alternate source of water to get you through these brief periods probably isn't necessary. Treatment plants for municipalities which draw water from ponds and lakes may have to adjust their chemical treatments and change filters more often during periods of turnover. Despite the plant operator's best efforts, smell and taste complaints could be a seasonal happening during turnover.

Fish: As discussed previously, fish can be found at different levels in your pond at various times of the year. Summer stratification restricts fish to the epilimnion and thermocline. During fall and spring turnover, fish are found throughout the water column. In winter, fish initially are found near the warmer bottom waters. As the winter progresses, and oxygen levels in the deepest waters are depleted, fish move up in the water column. Knowing where fish are, and are not, can help increase the success of your fishing trips.

Fish habitat: Adding artificial habitat like cedar trees or Christmas trees to ponds that lack natural habitat is a good practice. Your efforts will be rewarded if your knowledge of the annual cycle of ponds, and where fish are located, leads to the installation of the habitat in areas where it can be used. Brush piles placed in deep water will only be useful for brief periods following fall and spring turnover. Habitat placed in shallow 4-6 foot water depths, on the other hand, will be available to fish year-round. Habitat placed at a variety of depths is a good strategy for successful fishing throughout the year. For more information on using cover see the Aquaguide *Fishing in a Barrel.*

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