



Extension FactSheet

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Understanding Pond Stratification

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Many of Ohio ponds and lakes undergo a regular yearly process known as thermal stratification. A pond that is thermally stratified simply means that there is a noticeable temperature gradient as the water gets deeper. You may have noticed this in summer while swimming. If your pond is stratified, you will notice the deeper water around your lower legs is noticeably colder than the surface water. Stratification is not a major concern, but it can contribute to pond management problems if specific circumstances arise. An understanding of pond stratification can be valuable in helping you manage your pond effectively.

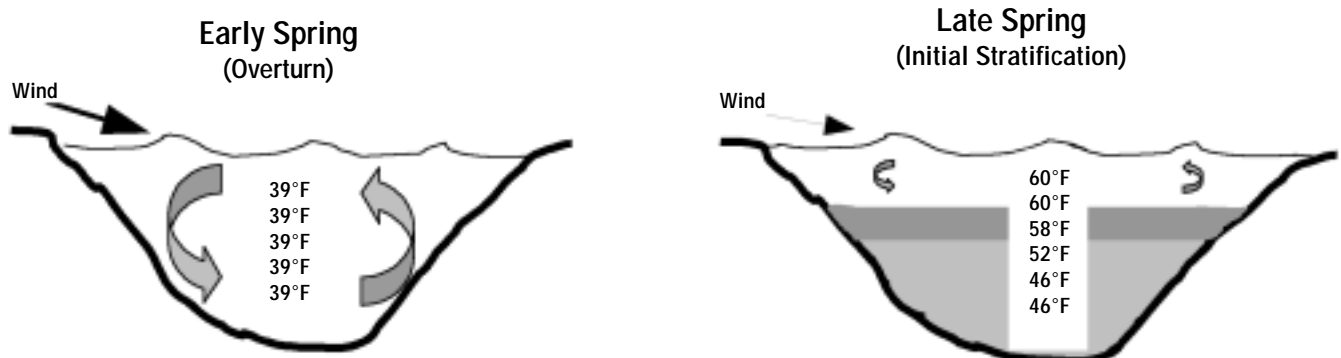
The Stratification Process

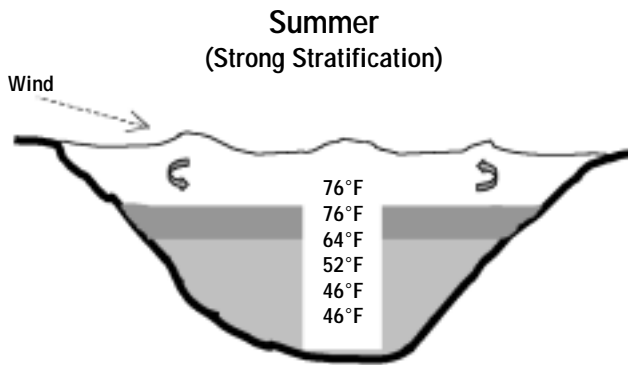
Normal thermal stratification of a pond, if it is to occur, generally begins in May or early June and ends in September or early October. Ponds can stratify because water attains maximum density at 39°F. It becomes less dense (lighter in weight) both above and below 39°F. Soon after the ice melts in the early spring, the water temperature

throughout the pond rises to 32°F. Winds blowing across the pond's surface cause the water to pile up on the downwind side. The water moves downward, across the pond bottom, to the upwind side. The entire pond begins to circulate from top to bottom, maintaining a uniform temperature. As long as winds are strong enough, the pond temperature will remain uniform, even as the pond begins to warm during spring. This is a period known as "spring overturn."

As spring advances and the weather warms, there is typically a period of little or no wind and circulation is reduced substantially. The surface waters warm quickly, causing the initial thermal stratification to develop. In some years, stratification may be destroyed if high winds occur, only to redevelop when speeds decrease again. If wind remains low, the stratification will strengthen and become harder to destroy.

During summer, the temperature differential between the warm, upper layer (called the epilimnion) and the colder, bottom layer (the hypolimnion) increases. Normal

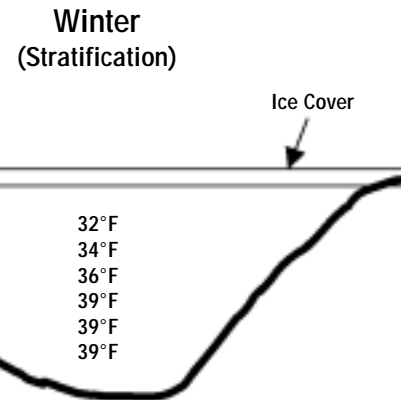




summer wind and weather conditions cannot cause the two layers to mix, and the pond will remain stratified until fall. Between the epilimnion and hypolimnion is a relatively thin layer of water called the thermocline. This layer is characterized by a rapid decrease in temperature.

As summer wanes and fall begins, water temperatures in the warm, upper layer begin to cool. As the upper layer cools to approximately the same temperature as the lower layer, thermal stratification disappears as wind can now mix the two layers together. This is known as “fall turnover” and is considered to have occurred when temperatures are the same from the surface down to the deepest area of the pond.

As fall progresses into winter, water cools to 39°F and below, the colder upper layer becomes less dense. This causes the pond to become stratified again. However, in winter the colder water is near the surface rather than at the bottom. Occasionally, strong winds will break up winter stratification for a few days. It will reform once calm weather returns. Often a layer of ice forms, sealing the pond surface and preserving the stratification until ice-out. Little mixing occurs during winter.



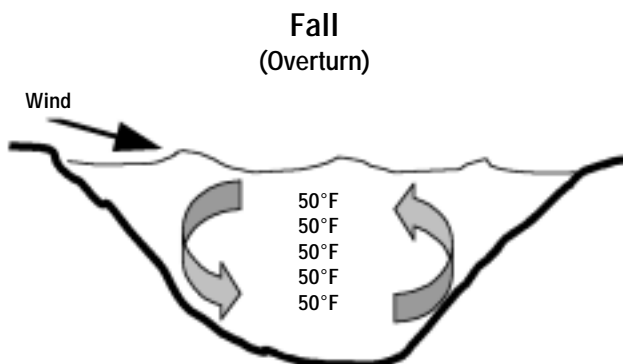
Factors Affecting Pond Stratification

Not all ponds undergo stratification. Shallow ponds (< 8 ft deep) often do not stratify because even moderate summer and winter breezes can keep the pond completely mixed. Conversely, deep ponds (> 12 feet) almost always stratify. Winds are rarely strong enough to prevent thermal stratification from forming.

Pond location also plays an important factor in whether a pond will stratify. Ponds that are located in open areas are subject to all the wind’s energy and rarely stratify. Only the very deep ponds (> 16 ft) stratify in open areas. Conversely, even shallow ponds that are well protected from wind will stratify.

Weather patterns also influence whether a pond stratifies or not. Calm, hot summers can cause virtually all ponds to stratify in summer whereas cooler, windy summers prevent stratification in many ponds except the deep or well-protected pond. Differences in weather between summers is why a pond may stratify one year but not the next. Occasionally, summer stratification can be “broken up” during a major rain event in which a large volume of cold rain water causes the pond to prematurely overturn. This can lead to catastrophic summer fish kills (see Ohio State University Extension Fact Sheet A-8-01, *Winter and Summer Fish Kills in Ponds*).

Pond owners can also prevent stratification from occurring. Small ponds that are aerated extensively often do not stratify because aeration keeps the pond in a continuous circulation and prevents differences in temperature from forming. The same level of aeration in larger ponds and lakes may not prevent stratification. In these instances, additional aeration may be required. Should pond stratification be prevented with aeration? That depends on the management goals of the pond owner. Pond owners should learn the pros and cons of aeration, consider their goals, and then make an informed decision.



Additional Pond Management Information

Placing Artificial Fish Attractors in Ponds and Reservoirs; Ohio State University Extension Fact Sheet A-1.

Pond Measurements; Ohio State University Extension Fact Sheet A-2.

Controlling Filamentous Algae in Ponds; Ohio State University Extension Fact Sheet A-3.

Chemical Control of Aquatic Weeds; Ohio State University Extension Fact Sheet A-4.

Muddy Water in Ponds: Causes, Prevention, and Remedies; Ohio State University Extension Fact Sheet A-6.

Ohio Pond Management; Ohio State University Extension Bulletin 374

Controlling Weeds in Ohio Ponds; 41 minute videotape. VT50.

Visit your county office of Ohio State University Extension for copies of these resources.

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