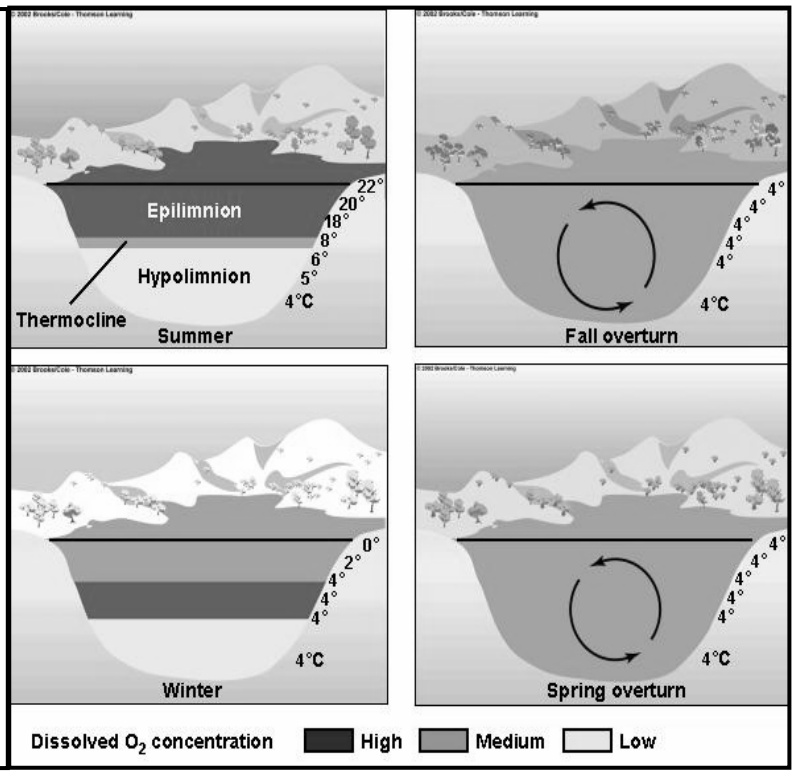
The lakes in the Winnebago Pool are all classified as shallow lakes. Typically, shallow lakes behave much differently than deeper water lakes that we may be accustomed to seeing in Wisconsin. Shallow lakes are generally characterized by depths less than 25 feet (7.6 m), large surface area to volume ratios, and frequent mixing. Our understanding of shallow lake dynamics is poor. Shallow lakes have typically been mismanaged in Wisconsin with the results being habitat and water quality degradation.

The diagram at the right shows a typical deep-water lake and the annual cycle of *thermal stratification* and *overturn*. Shallow lakes like Winnebago, Butte des Morts, Poygan, and Winneconne are consistently mixed and resemble, year-round, the spring or fall overturn phases that deep-water lakes progress through.

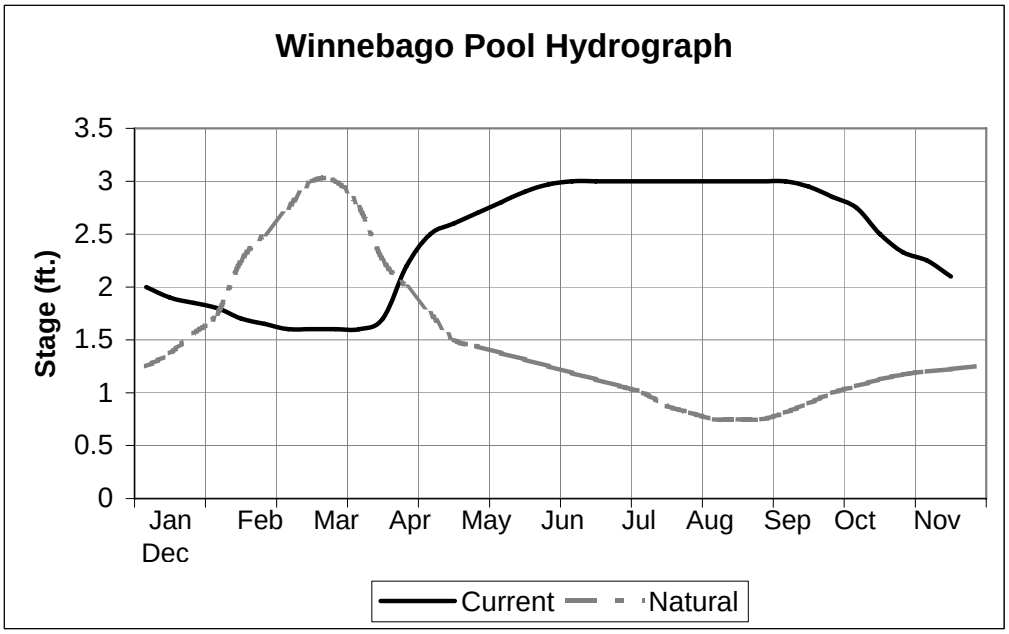
Credit: Figure from G. Tyler Miller's *Living in the Environment*, 13th edition. Brooks/Cole Publishing, Thompson Learning.



Lakes left to fluctuate naturally, without influence of a dam or other artificial water control structure, will go through a predictable sequence of water level conditions. Spring snowmelt raises water levels up to typically their highest levels of the year. Levels slowly recede through the summer months due to increased evaporation and lower precipitation amounts. Levels again begin to increase in the later fall and early winter months. Of course, fluctuations will occur throughout the year as rainy periods and dry spells occur but the general pattern is followed.

Many lakes have water levels managed for boating or some other cultural need like power generation, resulting in artificially high summer levels. Dams located in Neenah and Menasha control the Winnebago Pool water levels. Built in the 1850's, the dams

raised the water levels by about 2.5 feet initially and another 0.5 feet with subsequent modifications. On the Pool lakes the natural ecological balance is upset and the result is a loss of aquatic plant habitat and poor water clarity. This artificial water level management on shallow lakes is just one example of a management practice that can have detrimental impacts to habitat and water quality. The hydrograph below illustrates the water level management cycle currently in place on the Winnebago Pool and compares it to a lake without a water level control structure.



Winds, even light winds, can easily create rough conditions on the lakes. The long *fetches* typical of the Pool lakes lead to frequent mixing of the lake water, which reduces the amount of time the lake water column is stratified. This mixing also stirs up bottom sediments and releases stored nutrients which feed algae blooms, both of which add up to decreased water clarity. Suspended sediment decreases the penetration of light into the water, which minimizes the growth of aquatic plants.

Healthy aquatic plant communities have adapted to natural water level fluctuations. Water levels, if maintained for cultural uses such as navigation, take many of these plants out of the natural timing condition, the result being the inability for the plants to grow and reproduce. Wild rice and bulrush are good examples of this need for natural lake level fluctuation. Both plants are very sensitive to water level fluctuation timing and live in shallow water areas. Rice requires a specific water level during a critical growth phase called the floating leaf stage. Water levels too high or too low prevent growth and the end result is loss of wild rice beds. Bulrush seeds are another example. As the primary means of bulrush bed expansion, the seeds need exposure to heat and drying in order to germinate. In this case stable high levels retard seed germination and reduce rush habitat.

A major consequence of reduced rooted plants, like bulrush and wild rice, is the creation of favorable conditions for algae growth. Algae compete with rooted aquatic plants for available light and nutrients. At one time the Pool lakes were plant dominated, but unnaturally high water levels have changed all that. When rooted plants are “upset”, the algae will take advantage of the nutrients and space now made available to them. With lake levels controlled by dams, algae are winning the battle of the plants in the Winnebago Pool. All the lakes now favor algae growth, and are considered to be algae dominated.

The artificial management of water levels, especially high summer levels, has dramatically decreased the ecological quality of the Pool lakes. Cane beds on the Pool lakes continue to decline, water clarity is low, and wetland loss has been extreme. Wildlife and fish species diversity and abundance decreases—fewer teal, fewer pike, fewer shorebirds, greater turbidity, less balance. That is the story on the Winnebago Pool. Can that change? Yes, but only with a public willing to accept change when it comes to water level management.

The lakes are like aquatic "gardens" and they will grow plants regardless of whether or not we have a good understanding of them. Managing for a healthy balance, based on understanding, is the challenge.

Definitions

THERMAL STRATIFICATION—The vertical temperature stratification of a lake which consists of: (a) the upper layer, or *Epilimnion*, in which the water temperature is virtually uniform; (b) the middle layer, or *Thermocline*, in which there is a marked drop in temperature per unit of depth; and (c) the lowest stratum, or *Hypolimnion*, in which the temperature is again nearly uniform.

OVERTURN—(1) The sinking of surface water and rise of bottom water in a lake or sea that results from changes in temperature that commonly occur in spring and fall. (2) One complete cycle of top to bottom mixing of previously stratified water masses. This phenomenon may occur in the spring or fall, or after storms, and results in uniformity of chemical and physical properties of water at all depths.

EPILIMNION—The warm upper layer of a body of water with thermal stratification, which extends down from the surface to the *Thermocline*, which forms the boundary between the warmer upper layers of the emilimnion and the colder waters of the lower depths, or *Hypolimnion*. The epilimnion is less dense than the lower waters and is wind-circulated and essentially homothermous.

THERMOCLINE—(1) The region in a thermally stratified body of water which separates warmer oxygen-rich surface water from cold oxygen-poor deep water and in which temperature decreases rapidly with depth. (2) A layer in a large body of water, such as a lake, that sharply separates regions differing in temperature, so that the temperature gradient across the layer is abrupt. (3) The intermediate summer or transition zone in lakes between the overlying *Epilimnion* and the underlying *Hypolimnion*, defined as that middle region of a thermally stratified lake or reservoir in which there is a rapid decrease in temperature with water depth. Typically, the temperature decrease reaches 1°C or more for each meter of descent (or equivalent to 0.55°F per foot).

HYPOLIMNION—The lowermost, non-circulating layer of cold water in a thermally stratified lake or reservoir that lies below the *Thermocline*, remains perpetually cold and is usually deficient of oxygen.

FETCH—(1) The distance traveled by waves in open water, from their point of origin to the point where they break. (2) The distance the wind blows over water or another homogeneous surface without appreciable change in direction.

Definitions courtesy of the North American Lake Management Society (NALMS). www.nalms.org/glossary/glossary.htm