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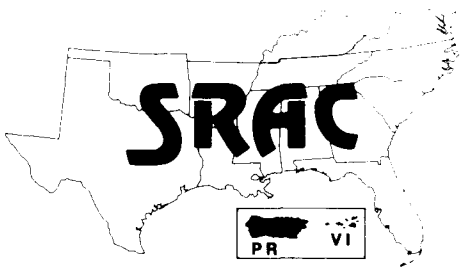

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Pond Aeration

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Oxygen in ponds comes from two sources--photosynthesis and diffusion from the air. The most important source is photosynthesis which is the process plants use for manufacturing food. In the presence of sunlight, plants (especially algae) add oxygen to water as a by-product of photosynthesis. At night, no oxygen is produced, but respiration of algae, fish and bacteria continues to remove oxygen from the water. Most of the time there is a desirable balance between how much oxygen is produced and how much is used, but under some conditions, the balance can be upset, and the oxygen concentration becomes low enough to stress or kill fish.

The amount of oxygen in pond water can vary considerably from pond to pond and from hour to hour. Typically, however, oxygen concentrations are lowest at dawn and highest during late afternoon.

The amount of oxygen water can hold is dependent upon atmospheric pressure, salinity and temperature. Water can hold less oxygen as altitude increases. However, this is usually of little importance in the Southeast. Salinity is not important for most freshwater fish producers.

The most important factor is water temperature. As temperature increases, water can hold less oxygen.

Most low oxygen problems occur from June through September. The reasons for this are:

- water can hold less oxygen as it becomes warmer;
- respiration rates of both plants and animals increase with the warmer water, so more oxygen is used;
- summer's still, hazy or cloudy days may reduce the amount of oxygen produced; and
- large amounts of feed given to fish at this time of year result in large quantities of fish waste which create a higher demand for oxygen.

Causes of oxygen depletion

The most common oxygen problem occurs when consumption by respiration exceeds the amount of oxygen produced through photosynthesis and diffusion from the air. Algae grow in large quantities as a result of heavy fish feeding. As the quantity of algae increases, it accumulates closer and closer to the surface to gather sunlight and increasingly shades the lower depths. As a result, most of the oxygen is produced near the surface, leaving a large volume of water below the first 2 to 4 feet deficient in oxygen production. Eventually, oxygen produced during the day is less than the demand for oxygen during the night, resulting in possible death or undesirable stress on fish.

Another type of oxygen depletion occurs when algae die suddenly. When algae die, not only does the pond lose its source of oxygen but the decaying algae use considerable amounts of oxygen. All causes of sudden algae die-offs are not fully understood, but it is known that die-offs can occur after pond treatments with certain chemicals and herbicides.

Predicting natural algae die-offs is difficult. However, they are often associated with surface algae scums and very heavy algal "blooms." When a die-off occurs, the green water often becomes streaked with gray, black or brown. The color of the water may eventually become totally brown, gray, black, milky or clear. A distinct foul smell may also be noticeable.

The third and most serious kind of oxygen depletion is referred to as a "turn-over." During hot summer weather, surface water becomes less dense as it absorbs heat and it floats

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over a cooler, more dense layer of water. All the oxygen is produced in the warmer layer and the two layers may not mix for weeks at a time, especially in deepwater ponds. Eventually, all the oxygen is used up in the lower, cooler layer. A cool snap or a thunderstorm with wind and hard rain can cool the warm surface water making it heavy enough to sink and mix with the oxygen-deficient bottom layer. The net result is a dilution of the oxygen and an increase in the demand for oxygen from dissolved minerals and decaying organic matter. To complicate these problems, the algae usually die at the same time. "Turn-overs" cause the most catastrophic fish kills in ponds.

Measuring oxygen concentrations

Oxygen concentrations can be measured using inexpensive chemical kits ($40) or electronic oxygen meters ($200-$1,000). A chemical kit is suitable as a backup, as a check on electronic devices, or when fewer than three ponds are involved. It takes several minutes to test oxygen in a pond using the chemical test, and results are relatively difficult to read by artificial light at night. Electronic measuring devices, on the other hand, allow the fish farmer to quickly measure oxygen in many ponds during the night.

Monitoring dissolved oxygen

Ponds in which fish are fed should be monitored for oxygen at least twice daily, at daybreak and nightfall, during summer and early fall. Higher evening oxygen readings and correspondingly lower morning oxygen readings from day to day, or low evening readings, usually warn of future problems. Keep a chart of daily oxygen readings to help detect developing water quality problems.

Oxygen monitoring may have to be done continually during darkness throughout the summer if stocking and feeding rates are high. No season of the year is totally immune from low oxygen problems so oxygen should also be monitored periodically during cooler months.

Two methods have been used to project oxygen concentrations at sunrise. The first is based on the fact that, in general, dissolved oxygen concentrations decrease during the night at approximately the same rate from dusk to dawn. The rate may vary from night to night so readings taken one night don't necessarily apply to predictions for oxygen decline during following nights.

Here's how to use the projection method of predicting nighttime oxygen depletions:

1) Mark vertically on graph paper a line representing dissolved oxygen concentrations from 0 to 20 parts per million (ppm). Horizontally mark a line with the time of night beginning at dusk. Use one graph for each pond.

2) Measure the dissolved oxygen in each pond around dusk and plot it on the graph at the time the reading was taken.

3) Return to the same place in the pond 2 to 3 hours later and plot the new oxygen reading on the same graph.

4) Draw a line using a straight edge between the two plotted readings, and extend the line to a point that crosses a vertical line drawn from dawn. Where those lines cross is the concentration of oxygen expected at dawn.

5) If the predicted oxygen concentration at dawn is less than 3 ppm, then action can be taken to begin emergency aeration before 3 ppm is reached.

This method is a tool which producers can use to make management decisions; it doesn't work in all situations. The best example of when it does not work is the case of an algae die-off. Algae die-offs will cause sudden, unpredictable oxygen depletions and must be monitored closely to prevent fish kills.

Another method to predict low dissolved oxygen was developed from actual records on fish farms. It has been shown that when dissolved oxygen in a pond at dawn is 5 ppm or more and dissolved oxygen at dusk is more than or the same as the day before, no oxygen depletion occurs during the following night or morning. But when dissolved oxygen at dawn is less than 5 ppm and dissolved oxygen at dusk is less than the day before, an oxygen depletion can be expected during the night.

The techniques described above are only tools to help predict oxygen problems that occur under "normal" conditions. Neither method can be used to predict oxygen depletions which are caused by algae die-offs, turn-overs, or other unusual circumstances.

Aeration requirements for ponds

Oxygen requirements in ponds can vary greatly. A commonly used rule of thumb is to use 1 horsepower/surface acre with an aerator rated at least 2.5 lbs O_2/hp per hour. This assumes normal oxygen cycles during the day and night, healthy fish, and maintenance of minimum oxygen levels above 2 to 3 ppm. However, an excessive algae buildup or sudden algae die-off can create a much greater than normal demand for oxygen. Fish, standing crops and maximum daily feeding rates also influence the aeration requirement.

Sick fish and high concentrations of nitrites, ammonia or carbon dioxide can also increase the need for additional aeration. In these situations, additional capacity can be provided by portable aerators to prevent fish losses which may occur either immediately or as delayed deaths caused by disease. Also, power outages or mechanical breakdowns can shut down any unit. For these reasons, mobile aerators with high standard oxygen transfer rate (SOTR) ratings are also needed for emergency or stand-by use. For most farm situations, one portable aerator

for every three to four ponds is adequate. If aeration requirements exceed that supplied by available equipment, then ponds with the fastest falling oxygen levels should be aerated first.

Placement of aerators

Recent research has shown that the most effective placement for fixed electric paddlewheel aerators is midway along the longest side of a pond with the discharge of the aerator directed toward the middle of the pond. In this position, the aerator directs water perpendicular to the long side, developing circulation that reaches most areas of the pond. Placement of this type aerator in a corner of a pond and directing water diagonally across the pond provides poor circulation. Locating fixed aerators in the middle of a pond levee will incur a higher installation cost and may be inconvenient when aerators are needed in conjunction with harvesting operations near water supplies.

Portable aerators should be used before fish are stressed to the point that they cannot reach the aerated area. The best location to place an aerator before they are seriously stressed will usually be in the part of the pond with the highest oxygen concentration because that is where the fish will be found. If two aerators are needed to keep fish alive, then they should be operated alongside each other so that if one aerator cuts off, the other aerator can hold fish until the problem is remedied. Fish will panic and move to other oxygen-less areas of the pond in search of more oxygen if a single aerator cuts off during a severe oxygen depletion.

If fish are severely stressed from low oxygen and cover the surface of the pond, aerators should be placed in the area of highest fish concentrations in an attempt to aerate as much of the pond as possible and attract fish to the aerator. Fish will usually go to the shallow end of a watershed pond in search of higher oxygen and fresh water. Be prepared to operate an aerator in shallow water to attract fish to this area. Fish also will tend to move out onto the banks when oxygen is very low. Bankwasher aerators are effective in aerating along the shoreline so that relief is quickly provided to fish near shore.

Maintenance and safety

All types of equipment require occasional maintenance and repair to ensure longer life and dependability. Information and instructions for recommended maintenance should be obtained from the manufacturer or dealer when an aerator is purchased. Check the warranty and keep all records of purchase for later use.

Several types of aerators have pillow bearings that require frequent greasing. This is important for normal operation of equipment and protection of the bearing. Some bearings have a self-greasing device that reduces this task. All engines and motors should be maintained as recommended by the manufacturer. Electric motors should be protected from splashing, and all drive shafts should be checked periodically for proper alignment. Differentials in tractor-powered paddlewheel aerators should be checked for water and drained and re-serviced if water is found.

Check water depth of paddlewheel blades and adjust so that the unit is level and depth is proper. Tractors used to power aerators should be fueled and ready for operation when needed. A good maintenance program is important because the loss of a tractor or aerator during an emergency can result in high fish losses.

Safety is another important consideration. Hazards include tractor use on narrow levees, operating PTOs and moving gears, and the use of electricity near areas of activity and water. Make certain all safety guards on tractors are in place and in good condition, especially on PTO shafts and stub gear. Perform any inspection or service only after equipment is shut down. Refuel only when engine is not operating and is cooled down. Make sure that tractor operators are experienced, especially when equipment is used on levees and around ponds. When using tractors to relocate or place aeration equipment, set brakes securely and block wheels.

Handle fuel with caution:

- Do not smoke around fuel.
- Use a vent on fuel storage tanks, and make sure that tanks are properly grounded.
- A fuel filter should be located in the fuel line between the fuel tank and engine.

For electrical safety:

- Do not drive over live wires.
- Make sure that power is shut off at the control box before any maintenance work is done.
- Use qualified electricians to install wiring.
- Place exposed wiring in conduits to prevent rodents from damaging the wiring.

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