

WHERE DID ALL THE O2 GO?

By David Jones, KHA

Whether you have a big Koi Pond filled with show stoppers or something more modest, the main ingredient – water – needs some extra attention during these hot summer days. A “Red Flag” should go up for any fish keeper as air temperatures hover at the century mark, and pond temperatures reach 85F. Higher temperatures create changes in water parameters; the most troubling are swings in the amount of Dissolved Oxygen (D.O.) in the water which can become life threatening for our fish. Let’s review some back-ground facts about D.O. and some ways to improve our water quality during summer.

Maximum D.O. is dependent on water temperature and atmospheric pressure. Here are some numbers to put it in perspective: The air that we breathe has 21% oxygen, which translates to 210,000 parts per million (ppm). As the atmospheric air presses down on the surface of our ponds, only a miniscule amount of oxygen diffuses into the water to become D.O. At a pond temperature of 50F, oxygen saturation is 11.5 ppm, at 70F it’s 9.0 ppm, and at 90F, the most oxygen that water can take up is 7.5 ppm. In reality, as the pond goes through its diurnal cycle (daylight/dark), D.O. amounts are less. The dilemma here is that warmer water can’t hold as much oxygen, but the fish and other pond organisms need more oxygen due to higher metabolism. Here is the D.O. “User Group” that take oxygen out of the pond:

- Higher water temperatures cause fish to have a higher metabolism, be more active, eat more food, create more solid waste and ammonia, and grow more. Their need for more O2 is - 24/7
- Nitrifying bacteria in the biofilter use O2 during the conversion of ammonia into nitrates. – 24/7
- Biological Oxygen Demand (BOD) – O2 to feed the bacteria that break down mulm, uneaten food, fish slime coat, decaying plant and algae materials, feces and other solid waste. – 24/7
- The “respiration” process of photosynthesis in plants and algae *consumes lots of O2 at night.*
- Overcast weather, thunderstorms and other “Low Pressure” events decrease D.O. – Any time.

Looking over that summary, you can see that most of the pond’s oxygen demand is steady over 24 hrs. However, the high oxygen demand of plants and algae during darkness will create a significant low in D.O. in the early morning. In fact, oxygen starvation on summer mornings is a leading cause of fish deaths. So, to be good fish keepers, we must add oxygen to our ponds to supplement that provided by the atmosphere. The most effective way to do this is to stir up the water to provide more interaction between the air and the water – just like nature does with wind and waves. Here are some man made and “natural” ways that add D.O. to a pond:

- Design elements such as pond surface area, waterfalls, streams, trickle and shower filters, spray bars, venturis, fountains, and anything that brings water molecules in contact with the air. 24/7
- Pumped air through airstones, diffusers, and air lifts brings deeper water to the surface. 24/7
- The process of Photosynthesis in plants and algae produces O2, *but only during daylight hours.*
- Clear skies and “High Pressure” atmospheric conditions. Mostly good weather during summer.

Yes, we can and must use all possible means to add D.O. to the pond, but we still have to be aware of the possibility of very low D.O. in the early morning. How can we tell if our pond is about to run low on oxygen? We can measure D.O. with a test kit or meter, or we can observe the fish for abnormal behavior. Our fish get stressed when D.O. is low – they may not eat, they may show red streaks in their fins, they may have their mouths open and gill covers flared and spend more time at the surface and near the waterfall – the only areas where D.O. is higher in the morning, - then return to deeper water as photosynthesis increases D.O. later in the day. If you see these behaviors - your D.O. may be borderline.

How much oxygen do our fish need? Well, the more oxygen in the water, the happier and healthier your Koi will be. Although they can survive for periods at lower levels, approximately 5 ppm is considered a minimal level for D.O. It should also be noted that a Koi's gill can only extract about 80% of available O₂.

Now that we have all the background material, think about this possible scenario in your pond.

It's the peak of summer, the water is 85F. There have been several overcast days, which have cut down on photosynthesis. The pond is slightly overstocked, and the fish are off their feed a little - maybe it's the heat. It's been a couple of weeks since you flushed your filter or backwashed your Bubble Bead, but you plan to do that and a water change next weekend. Your waterfall and aeration are working fine. The TV weatherman is calling for possible thunderstorms and a low pressure front passing through during the night. When you wake up in the morning, the electricity is off. The storm knocked out a transformer and you've had no electricity for 3 hours. You look out at the pond and see a sickening sight – a few Koi are floating, the others are gasping at the surface. **Oxygen Starvation! What happened here?**

- Cloudy days diminished O₂ production from photosynthesis – creating a reduced D.O. situation.
- The stocking density was too high! - Too many fish competing for insufficient D.O.
- Overdue maintenance let sludge and mulm build up in the pond/filters – creating a higher B.O.D.
- Koi off their food or acting different is a sign of stress – a possible harbinger of chronic low D.O.
- Power went out when D.O. was lowest - need emergency generator or backup battery air supply.

What could you have done differently? Consider these measures to avoid running out of O₂:

- No overcrowding! Keep fish levels realistic, reduce your numbers.
- Reduce B.O.D. by keeping everything clean.
- Keep a watchful eye on fish behavior, especially during overcast, stormy, or low pressure days.
- Add more filtration and aeration with a trickle tower or shower filter. They add lots of O₂.
- Have some sort of automatic emergency power – a generator or batteries running air pumps.
- Be aware that treatments with Formalin or PP will reduce D.O. Even salt does to a lesser degree.

As an emergency measure, you can add Hydrogen Peroxide (3%) at a rate of 1 quart per 1000 gallons. It's H₂O₂ which is water with an extra oxygen molecule. Avoid direct contact with fish when spreading around pond full strength, or dilute first. The additional oxygen effects of H₂O₂ last up to 4 hours.

Summary. Through the effects of photosynthesis, the amount of D.O. in ponds is a bell shaped curve with the maximum amount at dusk, and the least amount at dawn. Keep your pond clean. Maximize aeration. Watch your fish - changes in behavior can be the tip off for low D.O. Have an emergency plan

Increasing the amount of oxygen in the water is the BEST thing you can do for your fish!