Bonefish Transportation: If You Have To Do It, Here's How

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Photos by Cory Suski

Oxygen is something that is critical for life, but is typically not something that we think about as we go about our day. As you stand on the flats on a calm morning and take a deep breath prior to fishing, you probably think more about fresh air, open spaces and fish than oxygen. But just like humans, bonefish have specific oxygen requirements that need to be met to keep them happy, healthy and vigorous.

When we interact with bonefish through angling, we have the potential to impact their access to oxygen, which is something that frequently goes unnoticed. This article summarizes recent BTT-supported research that examined the effect of adding supplemental oxygen to livewells on bonefish prior to release.

Previous research has shown that angling is essentially exercise for fish and can result in changes to their physiology – their heart rate goes up, they consume a great deal of energy, and they also produce wastes such as lactate, similar to what we would produce if we were exercising. Recovery from this exercise can take anywhere from two to four hours depending on the amount of exercise that is done, and is a process that consumes energy. More importantly, the extent of these physiological changes can impact the likelihood that fish are captured by a predator after being released, with tired fish less capable of avoiding predator attacks.

To minimize the likelihood of predator attacks on fish after release, anglers may choose to hold fish in livewells for short durations so the fish can recover and/or to allow the angler to move to a better location (fewer predators) before releasing the fish. Similarly, bonefish caught during live-release angling tournaments can be held in livewells prior to the weigh-in, and this holding period can last for several hours.

During any situation where live fish are held in tanks or confined spaces, oxygen concentration in the water is something that should be considered, especially since fish take up oxygen from the water as they breathe. Since treatment of bonefish prior to release is an important component of a successful catch-and-release fishery, with BTT funding we set out to answer the questions: What dissolved oxygen concentration do bonefish need? Can bonefish have too much oxygen? What happens if oxygen concentrations fall?

Our research aimed to quantify the physiological and behavioral impacts of dissolved oxygen, which is the amount of oxygen in the water available to fish and other organisms. We performed two separate experiments: one held bonefish in water at different oxygen concentrations to identify upper and lower limits and the other exercised fish to replicate angling, then recovered them in water with different oxygen concentrations and sampled blood to measure how their rate of recovery was influenced by oxygen concentration. The goal of this research was to identify oxygen concentrations that should be maintained in livewells that will allow bonefish to recover from angling in the least amount of time with the fewest sub-lethal effects, allowing them the greatest probability of post-release survival.

The behavioral portion of the study was conducted at the Cape Eleuthera Institute (CEI) on the island of Eleuthera, The Bahamas, and consisted of placing fish into individual containers that replicated livewells. These containers were supplied with normal seawater, water that had low oxygen, and water that had been over-oxygenated. The low-oxygen environment replicated real-life angling situations where bonefish had been placed in a livewell without flow-through, so that the bonefish had consumed most of the oxygen in the container. The over-oxygenated environment replicated situations that may arise through the unregulated use of oxygen-infusion systems that supply dissolved oxygen to livewells. The normal seawater treatment served as a control, and replicated a situation where bonefish were held in a livewell with a flow-through system that was left running constantly to provide a continuous stream of fresh seawater.

When fish were held in these different oxygen concentrations, the frequency of gill ventilations was counted—this essentially is a measure of breathing rate for the fish and indicates how hard they are working to obtain oxygen.

After 30 minutes of exposure to the livewell with no flow-

through, there was a two-fold increase in the rate of opercular beats for bonefish relative to fish held in the livewell with a flow-through system. This suggests that the fish likely were becoming oxygen deprived in the low-oxygen situation, and needed to work harder and pass more water over their gills to obtain oxygen.

In contrast, bonefish exposed to water that was over-oxygenated (livewell with an oxygen system) showed a significant drop in ventilation rates relative to fish held in seawater. Although at first blush this might seem a good thing, it turns out it is not. For fish, one of the cues that stimulate them to pass water over their gills is an absence of oxygen in the water. Therefore, holding fish in over-oxygenated water likely reduced this stimulus for them to ventilate their gills, causing a reduction in ventilation rates. While this wouldn't seem to be a large negative consequence, gill ventilation helps remove wastes such as carbon dioxide. Therefore, the reduced ventilation rate of bonefish in the over-oxygenated water caused an accumulation of waste products that can impair recovery.

The blood physiology portion of the study was also conducted in the Bahamas and involved exercising bonefish for four minutes to replicate angling, and then allowing them to recover for either two or six hours in the same containers as the behavior study. This design allowed us to quantify how different concentrations of oxygen either facilitated or impaired recovery.

Results showed that recovery from exercise was slowed by low oxygen conditions compared to regular seawater. Similar results were observed for fish recovered in water with high oxygen compared to normal seawater, with over-oxygenated water causing physiological disturbances that persisted for several hours.

The blood experiment results complement the behavioral study results, and show that flow-through livewells are better for holding bonefish than are non-flow-through livewells and livewells with supplemental oxygen. Any time that fish are held for extended periods of time in closed containers of water, it is imperative that oxygen concentration of the water be considered.

For those who are able or desire to measure these things, this means that recommended dissolved oxygen concentrations during holding remain between 4 mg/L and 8 mg/L (normal seawater dissolved oxygen concentrations are typically around 6 mg/L). Continuous use of livewell flush pumps and/or the continuous addition of fresh seawater to holding tanks should be sufficient to maintain this oxygen concentration.

It is important to point out that the measurement of oxygen in water is extremely simple and straightforward. Dissolved oxygen meters are relatively inexpensive (many models are available for well below $400) and will reliably inform anglers, managers and tournament organizers what the concentration of oxygen in any holding tank is, thereby removing any speculation or uncertainty regarding water quality, especially during long-term holding.

The next time you are on the flats and take a deep breath after a challenging fight with a bonefish, think about the fact that you are constantly acquiring oxygen and that the fish is doing the same as it swims away.

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