

Monitoring water quality during aquatic transportation

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The transportation of live aquatic products is a necessary yet challenging process. Whether it's fry and fingerlings, broodstock or market fish, conditions must be kept at optimum levels. Fish and other aquatic products are harvested and moved within the farm and often travel long distances to customers, live fish markets, public waters for restoration, private recreational lakes, ponds and more. Similarly, larger brood fish must be transported to hatcheries for spawning. While the requirements for successful transportation can vary based on a host of variables, experienced farmers and contract fish transporters appreciate the importance of information to minimize loss through low oxygen conditions and temperature-

induced fish mortalities. Transportation is necessary for hatchery operations, but the experience can cause fatal levels of stress among fish. As Yanong & Francis-Floyd (2002) define it, stress in these scenarios is "a condition in which [the] animal cannot maintain a normal physiological state because of various factors adversely affecting its well-being."

Some stressors, such as the season and altitude, are beyond hatcheries' control, but must be considered as they affect overall water quality; similarly, factors like stress stemming from confinement, handling or individual travel tolerance are inevitable within the transportation process. However, there are still measures that transporters can take to effectively

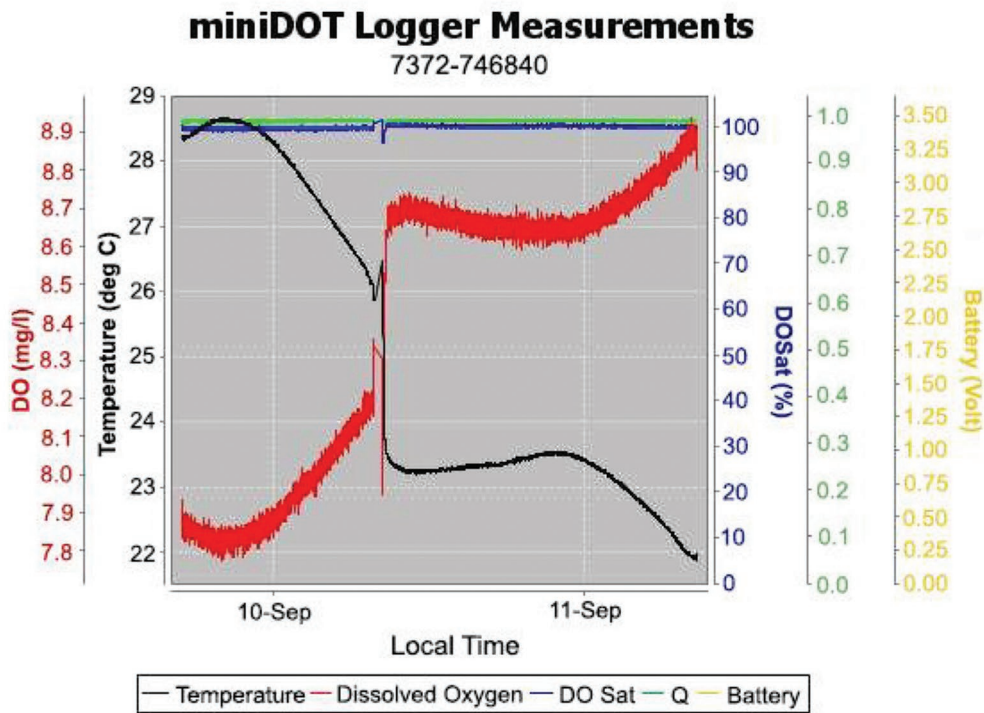


Figure 1. The program reads all the miniDOT Logger's data files in the selected folder. It concatenates these and presents the plot shown below.



Figure 2. Aquasend's miniDOT® Clear Logger records dissolved oxygen and temperature data.

minimize several stress-inducing variables. By maintaining optimal water quality and temperature throughout the transportation process, transporters can prevent these variables from contributing to the overall stress and possible subsequent fish death. Aquasend's miniDOT® Clear Logger is a water quality monitoring device that records dissolved oxygen and temperature measurements in real-time. By offering quick and accurate readings of oxygen level and water temperature, the miniDOT® Clear Logger arms transporters with the information they need to keep their aquatic products healthier for longer.

Qualities of healthy water

Dissolved oxygen

Dissolved oxygen (DO) is widely accepted as accurately indicative of water quality, specifically regarding its ability to support aquatic life. In their 2008 study, Onyia, Ladu & Onyia compared fluctuations in DO levels across several containers commonly used in fish transportation, citing a direct link between mortality rates and the depletion of DO. According to the United States Geological Survey's Water Science School, outside of biological activity, the three primary factors which determine DO levels are salinity, atmospheric pressure and water temperature. On a similar note, Wilson

(2010) explains in their discussion on DO that lower atmospheric pressure and water temperatures both correspond to higher levels of dissolved oxygen, while higher rates of salinity have been linked to decreased levels of DO.

Lethal DO levels for fish are typically between 1 and 3mg/L with minimal fish activity in this range. Wilson (2010) identified minimum DO levels to sustain the life of several fish species; for example, DO levels at 1 to 1.1mg/L resulted in death for juvenile catfish, adult catfish at 1 to 2mg/L led to a decrease in food intake, 50% of rainbow trout (6 months old) at 1.3 to 1.6mg/L experienced death, 50% of rainbow trout yearlings at 1.3 to 2.5mg/L experienced death, salmonids at less than 3.0mg/L resulted in death and brown shrimp at less than 0.7mg/L resulted in death. For normal levels of activity, DO levels above 3mg/L generally seem sufficient for many species (Wilson, 2010).

Temperature

Variables such as container population and length of time in transit can exacerbate stress levels and accelerate DO depletion, but temperature fluctuations can cause harmful disruptions despite careful consideration. Fish are poikilotherms and are unable to regulate their body temperature, making

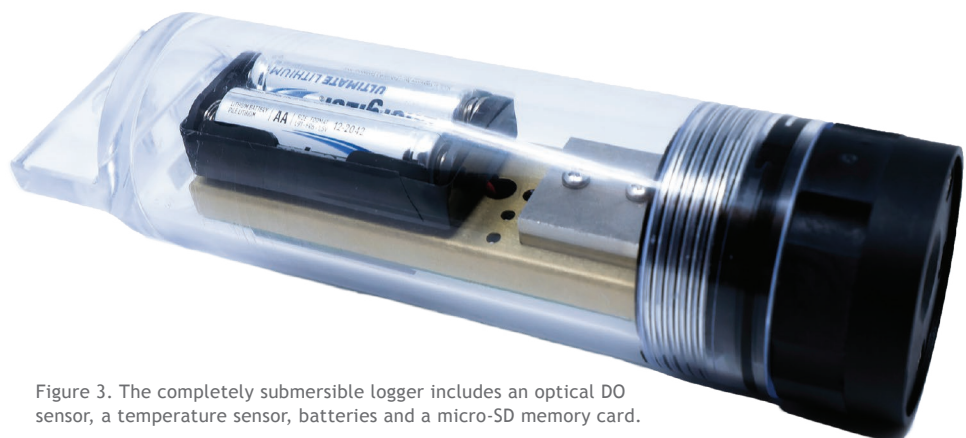


Figure 3. The completely submersible logger includes an optical DO sensor, a temperature sensor, batteries and a micro-SD memory card.

WATER QUALITY

water temperature especially critical to successful transportation outcomes (Harmon, 2009). Because ideal transportation temperatures are unique to a species and can change depending on the season of transport, a high degree of precision is required. For example, Piper (1982) recommends channel catfish be transported at temperatures of 7.7-10°C (45-50°F) in winter and 15.6-21.1°C (60-70°F) in summer. In that same study, Piper (1982) also recommended hauling striped bass at 12.8-18.3°C (55-65°F) to optimize fish health. Meanwhile, Yeager *et al.* (1990) found hybrid bass had better transportation results when tank water was cooled to <18.3°C (65°F). Because temperature fluctuations can occur relatively quickly and have the potential to be so impactful, real-time and reliable monitoring can allow transporters to make necessary adjustments to maintain optimal conditions.

How to make transport successful

Aquasend's miniDOT® Clear Logger is a valuable tool for aquatic product transporters and hatcheries who want to minimize losses and gain valuable insight. The miniDOT® Clear Logger is a completely submersible instrument that logs dissolved oxygen and temperature measurements. It has an internal LCD screen that displays real-time measurements to the user. To optimize data collection, the miniDOT® Clear Logger offers customizable time and sample intervals via a USB cable and software. The oxygen sensor is an optode

that measures dissolved oxygen concentration in water through a fluorescence method. These features allow users to view vital water quality data just by looking at the device to save valuable time if dissolved oxygen or the temperature dip below species optimal levels.

Not only does the miniDOT® Clear Logger allow for quick access to water quality data, but it also records all data throughout the entire transport which can be retrieved to provide a water quality report to the customer regarding transportation conditions. Aquasend focuses on product engineering to develop durable instruments that improve water quality with continuous monitoring to transform aquafarms and hatcheries worldwide. Aquasend's mission is to increase aqua farm and hatchery productivity by applying sensor, software and aquatic monitoring innovations while decreasing maintenance, labor costs and power consumption and measuring real-time transport conditions and ensuring water is measured in real-time.

References available on request

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