Physiology, Behavior and Survival of Angled and Air Exposed Largemouth Bass

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Introduction

Catch-and-release (C&R) angling is an increasingly common leisure activity as well as a form of recreational fisheries management throughout the world. The fundamental assumption of C&R is that the majority of the individuals survive with negligible long-term consequences. However, there is much literature that suggests that considerable mortality can occur following C&R events despite the belief that the fish appear in good condition at the time of release. Recently, a number of studies have been conducted to assess the sublethal physiological consequences of angling-related stress on individual fish. In particular, prolonged air exposure and high water temperature, as well as their interaction (Gingerich et al. 2007; White et al. 2008), are regarded as dominant stressors that may influence fish survival (Cooke and Suski 2005).

In North America, and indeed much of the world, largemouth bass (*Micropterus salmoides*) are one of the most important game fish. They also represent a species in which many of the angled fish are released. Anglers target largemouth bass for various reasons, including as a part of competitive angling events where fish experience a suite of physiological and where mortality rates can exceed 50%. To date, however, there have been no studies that have attempted to link the individual physiology of largemouth bass with their post-release behavior and fate in a catch-and-release context. Therefore, by coupling telemetry and non-lethal biopsy, for the first time, this study evaluated the combined effects of air exposure duration and water temperature on fish physiology and their post-release behavior and survival using largemouth bass as a model.

Methods

Study animals and sampling

Experiments took place at the Queen's University Biological Station on Lake Opinicon, Ontario. This study was partitioned into two water temperature groups (Cool = 15.1 ± 0.5°C, N = 27; Warm = 21.3 ± 1.1°C, N = 31) with a total sample size of 58 largemouth bass. Within each temperature group, individual fish were placed into one of three air exposure groups (Control = 0 sec., Low = 179 ± 95 sec., High = 598 ± 195 sec.). Fish were angled and landed within 20 sec and immediately placed in a water-filled trough where a blood sample was obtained from the unanestetized fish by caudal puncture (Photo 1). Lactate and glucose concentrations were quantified on-site using commercially available meters and a plasma sample was frozen in liquid nitrogen for later analysis of ions [Na+, K+, and Cl-] and aspartate aminotransferase [AST], an enzyme indicative of tissue damage.

Photo 1. Lisa Thompson and Michael Donaldson acquire a blood sample from a largemouth bass using the caudal puncture technique

Each fish was randomly assigned an air exposure treatment duration and following treatment, was then placed in a monitoring tank for 30 minutes during which opercular rate, equilibrium loss, and time to regain equilibrium were observed and recorded.

A second blood sample was obtained following the 30 minute monitoring period and blood was processed as above. Immediately after the second blood sample, a micro radio telemetry tag (less than 2g tag mass) was externally attached to each fish (no anesthesia) prior to being released at a common site (Photo 2).

Photo 2. The release of a micro radio tagged largemouth bass

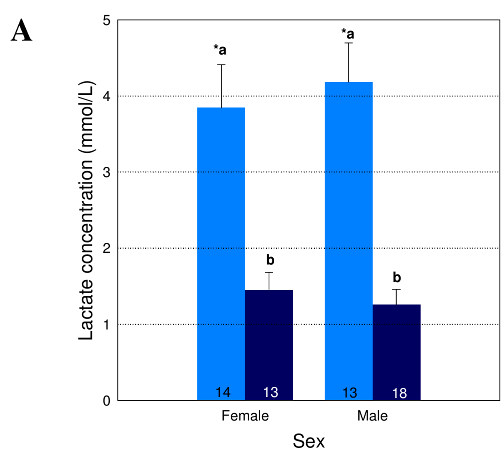
Each fish was tracked until it left a pre-determined area (approx. distance = 350m) from the release site in order to monitor post-release behaviour and mortality (Photo 3).

Photo 3. Dr. Robert Arlinghaus and Thomas Klefoth track the released largemouth bass in Lake Opinicon

Results

Baseline physiology

Baseline lactate, glucose and AST were significantly elevated at a water temperature of 15.1℃ as compared to at 21.3℃ (Figure 1A,B,C). An interaction effect existed between sex and water temperature for lactate concentrations (Figure 1A).



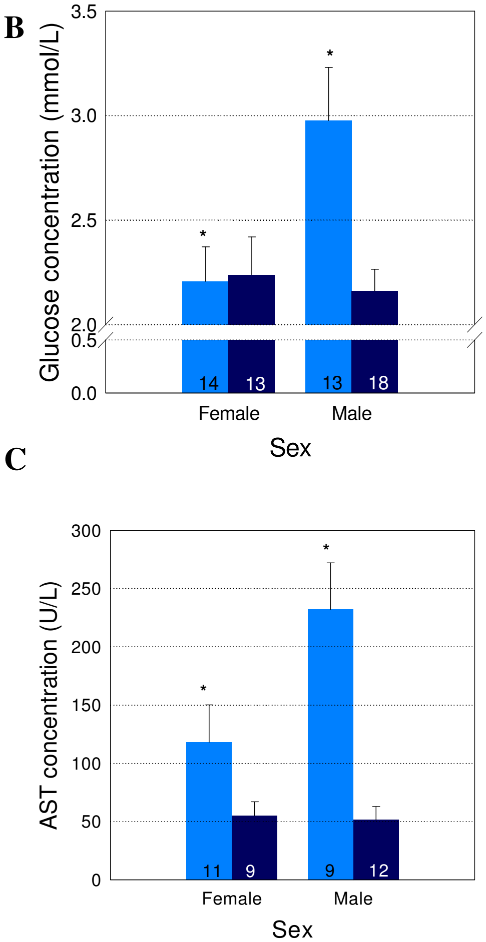


Figure 1. Mean baseline lactate (A), glucose (B) and AST (C) concentrations at water temperatures of 15.1 ± 0.5℃ (light blue) and 21.3 ± 1.1℃ (dark blue)

Behavioural responses

All control fish maintained equilibrium throughout the entire experiment while all fish exposed to high durations of air exposure lost equilibrium for a minimum of 2 sec. and a maximum of 1800 sec. (Figure 2). Fish at 15.1℃ exposed to low duration of air exposure look a significantly shorter period of time (max. = 240 sec.) to regain equilibrium than fish at a water temperature of 21.3℃ (max. = 1200 sec.) at the same duration of air exposure.

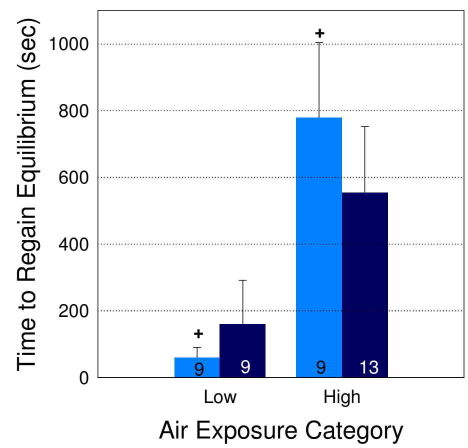


Figure 2. Time to regain equilibrium for fish exposed to low and high durations of air exposure at water temperatures of 15.1 ± 0.5℃ (light blue) and 21.3 ± 1.1℃ (dark blue)

At 15.1℃, the opercular rate decreased with increasing air exposure, while at a water temperature of 21.3℃ the opercular rate was intermediate for controls, highest in the low air exposure group and lowest in the high air exposure group. In all instances, air exposure had a significant effect on the opercular rate of the largemouth bass.

Physiological responses

The physiological response to air exposure was inconsistent across water temperature and air exposure groups. Regardless of the air exposure duration, the mean change in lactate and AST concentrations were significantly lower at 15.1℃ compared to at 21.3℃ (Figure 3A,C). Conversely, fish in different water temperature groups did not have significantly different mean glucose concentrations; however, fish in different air exposure groups did. Generally, the mean change in glucose concentrations was highest in the low air exposure group, with the greatest change in glucose concentrations occurring in the low air exposure group at 21.3℃ (Figure 3B). Ion status varied inconsistently with air exposure and water temperature. However, in general, the change in sodium ion concentrations increased with increasing air exposure and water temperature, while the potassium ion concentrations decreased in both water temperature groups at high air exposures. The change in Cl^- concentration following air exposure was significantly lower at 15.1 ℃ than at 21.3 ℃ (Figure 3D).

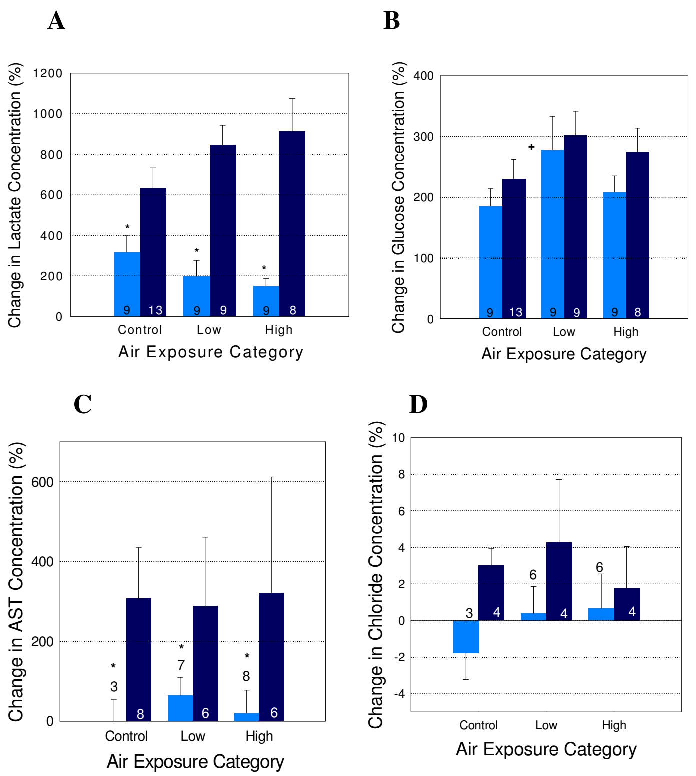


Figure 3. Mean percent change in lactate (A), glucose (B), AST (C) and chloride (D) concentrations following air exposure at water temperatures of 15.1 ± 0.5 ℃ (light blue) and 21.3 ± 1.1 ℃ (dark blue)

The time that it took for the fish to leave the release site ranged from a minimum of 1 hour to a maximum of 73 hours. Although not statistically significant, fish exposed to long periods of air exposure at 21.3 ℃ took longer to leave the release site than fish exposed to short periods of air exposure at 15.1 ℃ (Figure 4).

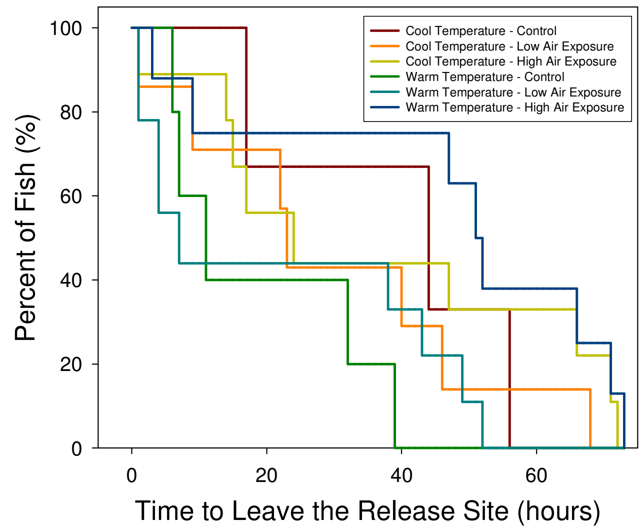


Figure 4. The time taken for largemouth bass in each air exposure and water temperature category to leave the release site

Discussion

The results of this study demonstrate that the combined effects of air exposure and water temperature can result in changes in the physiology and behavior of largemouth bass in a catch-and-release context indicative of welfare impairments. Although no mortality was observed in this study, it is possible that replicating this study at higher water temperatures would induce mortality, particularly for fish exposed to longer durations of air exposure. The water temperatures used in this study (15.1 ± 0.5 ℃ and 21.3 ± 1.0 ℃) were reasonably moderate and were well below the optimal temperature (e.g., the temperature at which largemouth bass experience optimal performance) and far below temperatures that would exceed the thermal tolerances of largemouth bass. The fact that some of the physiological indicators in this study yielded results that were inconsistent with predictions may reflect the considerable inter-individual and inter-sexual variation in baseline physiology. This, however, does not mean that exposing largemouth bass to air for periods of up to 15 minutes is consistent with good fisheries practice in a catch-and-release context. Even short durations of air exposure may lead to sublethal physiological disturbances (summarized in Cooke and Suski 2005) compromising the well-being and welfare of the fish (Arlinghaus et al. 2007a; Cooke and Sneddon 2007). We urge all anglers to adopt a risk averse strategy and eliminate or minimize air exposure (e.g., by using barbless hooks, unhooking fish in water, having pliers or unhooking devices accessible; Cooke et al. 2001; Arlinghaus and Hallermann 2007). At higher water temperatures, even short durations of air exposure could lead to mortality in bass or other species. However, there is still a paucity of catch-and-release research on the interactive effects of different stressors across a broad range of water temperatures.

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