Influence of Depth and Retrieval Speed on Yellow Perch Barotrauma Recovery Time in Winter

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Physoclistous fish are often affected by barotrauma because the swim bladder is not connected to the esophagus. Barotrauma is increasingly being used in assessing mortality in fish brought from deep water. Barotrauma is the physical damage that occurs because of the over inflation of the gas bladder resulting from a rapid decrease in ambient pressure. The two important factors influencing barotrauma effects are water depth and decompression. In this study, two experiments were conducted on yellow perch (*Perca flavescens*) at three depth locations on Grace Lake, Bemidji, Minnesota. Fish were measured for barotrauma recovery time (s) following capture by hook and line. Barotrauma recovery time was considered as the time for the individual to swim below the ice. Over the course of the study 88% of the individuals recovered in less than 3 seconds at 3.0 m, 72% at 4.5 m, and 37% at 6.0 m. Barotrauma recover time differed significantly by depth (p-value < 0.01). In contrast, the recovery time at the two retrieval speeds were similar (p-value = 0.86). This study will help further understand how freshwater physoclistous fish are affected by barotrauma, even at shallow depths.

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Introduction

Barotrauma is the physical damage caused by over inflation of the gas bladder resulting from a decrease in ambient pressure as the fish is caught in deep water and brought to the surface. Barotrauma is known to be a main contributor for mortality in both marine and freshwater fishes (Bartholomew and Bohnsack 2005). The rapid reduction in pressure, as the fish is retrieved through the water column, often leads to barotrauma and has been documented for many freshwater and marine fishes (Bartholomew and Bohnsack 2005). Past studies have mainly focused on deep bodies of water because barotrauma is more prevalent as a fish is retrieved from deeper water. In recent years, more studies are being done involving shallow bodies of water and barotrauma has been documented to occur at depths as low as 3.5 m (Shasteen and Sheehan 1997). Even when barotrauma occurs in shallow waters, it can cause internal injuries, bulging of the eyes, protrusion of the gas bladder through the mouth, bubbles in eyes and fins, and formation of gas bubbles in the organs.

The effects of barotrauma can prevent the fish from returning to the depth of capture and make it susceptible to mortality (Keniry et al. 1996). Predators, motorboat props, and wave action can be significant causes of mortality to fish suffering from barotrauma (Keniry et al. 1996). Predation is the most common cause of death for fish with signs of barotrauma (Morrissey et al. 2005).

Physoclistous fish (e.g., families Centrarchidae, Percidae, and Moronidae) are exposed to the effects of barotrauma because the swim bladder is free of the gut forcing the fish to slowly expel the excess gases through the blood stream. Yellow perch (*Perca flavescens*) are physoclistous fish often found in water depths ranging from 1 to 11 m during the winter (Isermann et al. 2005). Recreational fisheries in inland waters have had few studies done that help better understand the effects of barotrauma in yellow perch (Radomski 2003). Recreational anglers primarily harvest yellow perch 254 mm or larger and few (5.4%) harvest fish below 170 mm (Isermann et al. 2005). As a result, large numbers of yellow perch are caught and released indicating that barotrauma has the potential to affect large numbers of fish in inland lakes.

Past studies have found that the depth a fish is captured at can influence how much a fish is affected by barotrauma, but often minor effects like the time needed for a fish to recover and descend to the capture depth are ignored. Decompression is a common theme in marine research (Bartholomew and Bohnsack 2005), however, it is relatively untested in shallow inland waters. Decompression is when the angler allows the fish to adjust to pressure changes by holding the fish at a depth for a certain time and consecutively moving to shallower depths until the fish reaches the surface. The effects of compression can easily be manipulated in an experiment by varying the retrieval speed of the fish at the time of capture. When decompression is used by fisherman in marine waters barotrauma effects decreased suggesting a similar strategy could be influential in the survival of physoclistous fish in small freshwater lakes. Therefore, the objectives for this experiment were to determine if depth at capture and retrieval speed have an influence on yellow perch barotrauma recovery time in small inland waters.

Methods

Three locations were chosen based on depth (3.0, 4.5, and 6.0 m) at Grace Lake, Bemidji, Minnesota. The yellow perch sampled during this study were all collected between 7-16 February 2015. The fish were captured inside a portable CLAM (Bigfoot XL2000, CLAM, Medina, MN) ice house shelter heated with a Sunflower heater (Tank top heater, Mr. Heater, Cleveland, OH). The temperature inside the icehouse was not recorded. All fish were captured through a 0.25 m ice hole by hook and line on a plain lead weight hook with wax worms (Pyralidae). The fish were all captured with a Guide Series Classic rod and reel combo (Guide Series Classic, Gander Mountain, Wilmot, WI). The three sample depths were located by using digital sonar (Marcum LX 7, Marcum Technologies, Minneapolis, MN). Three holes were used for this experiment at each location with two holes for angling and one for the digital sonar to decrease the chance of losing fish.

To address the first objective (influence of depth on yellow perch barotrauma recovery time) 60 fish (20 at each depth) were captured over the span of three days. Upon capture the fish were measured for total length (mm) and marked by cutting a small portion (approximately 13 x 13 mm) triangle off of the bottom half corner of the caudal fin to insure no fish were sampled twice during the study. Fish were handled for 10 s or less and were released head first into the hole in the ice. The head first method is commonly used to give the fish an advantage at making its way below the ice and ultimately returning to the capture depth (Malchoff and MacNeill 1995). The barotrauma recovery time was measured for each fish with a stopwatch. The recovery time was considered to be the time for the individual to swim below the ice.

To address the second objective (influence of retrieval speed on yellow perch barotrauma recovery time) 30 fish were captured at each of two different retrieval speeds (1 rotation/s and 2 rotations/s). The fish for the second objective were all captured at 4.5 m due to more fish being prevalent at that depth at the time of the study. The fish were measured, marked, and released the same way as in the first objective. The retrieval speeds were alternated between each fish captured.

Data collected for both objectives were found to be non-normally distributed so either Kruskal-Wallis (objective 1) or Wilcoxin Mann Whitney U (objective 2) tests were used. For all statistical tests an alpha level of 0.05 was used.

Results

Over the course of the study 240 fish were caught at depths ranging from 3.0 to 6.0 m. The average barotrauma recovery time increased as depth increased primarily from 4.5 to 6.0 m. (Figure 1). The median barotrauma recovery times increased by 1 for each depth interval (1 s at 3.0 m, 2 s at 4.5 m, and 3 s at 6.0 m). The Kruskal-Wallis test determined a significance (Chi-squared = 47.1, df = 2, p-value < 0.01) between the three depths suggesting that depth has an influence on barotrauma. The majority of fish recovered in less than 3 seconds at 3.0 (88%) and 4.5 m (72%) while only 37% did so at 6.0 m.

Barotrauma recovery time averaged 4.43 s at 1 rotation/s and 5.10 s at 2 rotations/s (Figure 2). There was no evidence to suggest that there was a difference in recovery times between the two retrieval speeds (W = 461.5, df = 1, p-value = 0.86). There were no obvious signs of barotrauma effects except the protrusion of the gas bladder through the mouth which was found in 28% (n = 68) of the fish captured at 6.0 m. There were three recaptured fish that were immediately released because they had been previously captured. All fish recovered in less than one minute and no fish died as result of immediate effects of barotrauma during this experiment.

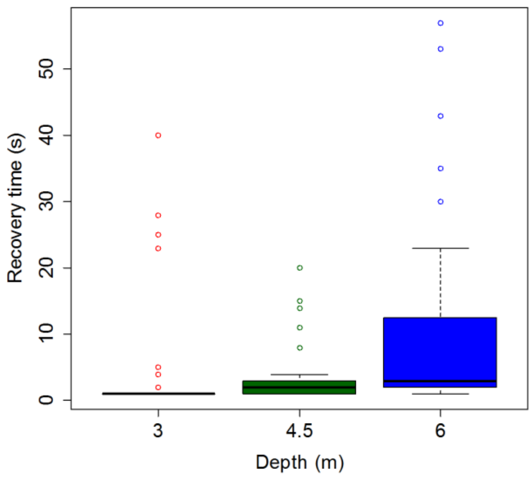

Figure 1- Distributions of barotrauma recovery times for yellow perch captured at 3.0, 4.5, and 6.0 m from Grace Lake, MN between 6-17 February 2015.

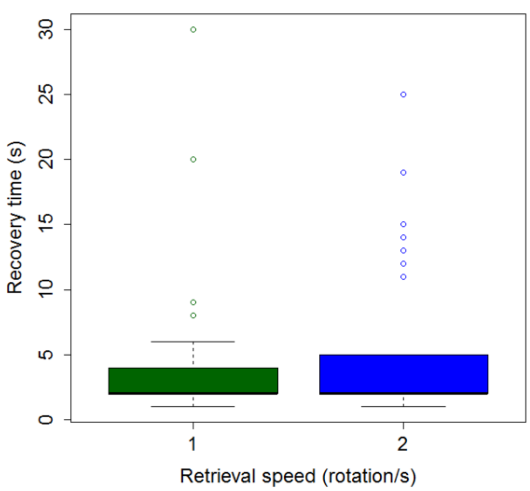

Figure 2- Distributions of barotrauma recovery times for yellow perch captured at 4.5 m with a retrieval speed of 1 rotation/s and 2 rotations/s. Yellow perch were captured from Grace Lake, MN between 6-17 February 2015.

Discussion

Arlinghaus et al. (2007) indicated that barotrauma is a main contributor to mortality of fish captured from extreme depths. The results from this study were similar to other studies (Feathers and Knable 1983; St. John and Syers 2005) in that barotrauma effects increased with depth. Preliminary signs of barotrauma in this study were found at depths of 4.5 and 6.0 m. Schreer et al. (2009) found signs of barotrauma as low as 6.1 m in the St. Lawrence River. External signs of barotrauma have been found in as low as 3.5 m (Shasteen and Sheehan 1997). In this study the signs of barotrauma were relatively low to nonexistent until 6.0 m (average recovery times of 3.10 s at 3.0 m, 2.78 at 4.5 m, and 9.43 s at 6.0 m).

Capture depth has been reported to heavily influence mortality of angled fish with higher mortality rates occurring for deepwater captures (Bartholomew and Bohnsack 2005). For physoclistous fish to make a relative change in depth, they must either go through decompression or recompression. Physoclistous fish cannot expel gas directly from their gas bladder and can only transfer gas through the circulatory system. This can cause a lot of problems for fish that are directly released into marine or freshwater environments because it takes a while for physoclistous fish to remove excess gas from the gas bladder to the external environment.

To our knowledge the European perch (*Perca fluviatilis*) is the only species in the Percid family where research involving the effects of depth change has been previously conducted. The European perch can only handle a change in 20% of the initial depth before barotrauma effects like gas bladder protrusion through the mouth occur (Lagler et al. 1977). Lagler et al. (1977) reported that as depth increased, the barotrauma recovery time increased due to the higher percentage change in initial depth upon capture. At 10.6 m yellow perch are found to have a high risk of barotrauma. At 10.0 m the risk is 50% and increases to 90% at 15.0-17.5 m (Schreer et al. 2009). In this study, recovery times at 3.0 m and 4.5 m were similar. This could be due to the fact that a few fish in 3.0 m that were hooked deep within the mouth. Future studies may need to consider severity of injury from hook as a factor that influences barotrauma recovery time.

The two retrieval speeds tested in this study were found to result in similar recovery times which are contrary to past studies that found decompression to be helpful (Keniry et al. 1996). The two retrieval speeds were chosen because 2 rotations/s is a common retrieval speed used by ice anglers in Minnesota and 1 rotation/ s was half of that speed. It was thought that a slower retrieval speed would help with the decompression of the fish and ultimately decrease the effects of barotrauma, however, a slower retrieval speed could decrease fish capture rate. The retrieval speed could possibly be significant at a depth of 6.0 m where barotrauma recovery time was found to be significantly different than the shallow water depths tested. Future research should attempt to determine if slower retrieval speeds can have a measureable effect at depths greater than the 4.5 m depth tested in this study.

The cut mark on the caudal fin could have affected the barotrauma recovery time making it harder for the fish to swim, but was the easiest way to measure, mark, and release the fish within 10 s. There is still a need for a better understanding of the barotrauma effects in fresh water systems and under what circumstances they occur. However, the information provided by this research should help recreational anglers understand that even in shallow waters fish can be affected by barotrauma.

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