Enhancing the Sustainability of Bonefish Fisheries through Research on the Sublethal Consequences of Recreational Angling Practices

A Bonefish and Tarpon Unlimited Research Project

Background: Although the bonefish is clearly an important icon of the recreational fishing industry (Photo 1), there is little known about the effects of different angling practices on these fish. At present, there are only three studies that explicitly examine issues associated with the effectiveness of catch-and-release strategies for bonefish. Two of these studies provide information on hooking mortality, and one study provides some information on post-release behavior. Neither study, however, provides an assessment of the sub-lethal physiological effects of catch-and-release angling. Although knowing the number of fish that die as a result of catch-and-release angling is essential for basic fisheries management activities, other, sub-lethal effects can reduce the biological fitness of angled individuals. There is clearly a need to understand how bonefish respond to catch-and-release strategies. Evidence suggests that some local populations are experiencing declines in abundance and shifts in size structure. Conservation-minded anglers (including members of Bonefish and Tarpon Unlimited) and guides are looking to fisheries managers and scientists for catch-and-release guidelines to use with bonefish. At present, bonefish anglers are forced to rely upon catch-and-release findings from studies done on other species with the assumption that they are applicable to bonefish. This approach fails to recognize the species-specific and fisheries-specific differences inherent in recreational angling and provides only a temporary solution until additional research on bonefish has been conducted. In early 2007, Bonefish and Tarpon Unlimited provided a research grant to support our research on the sublethal effects of angling on bonefish. The research team was lead by Dr. Steven Cooke (fish ecology and conservation physiology), Dr. Cory Suski (fish physiology), Dr. Andy Danylchuk (fish biology), and Dr. Tony Goldberg (fish health and veterinary medicine). In February 2007, our team embarked on a research expedition to Eleuthera, The Bahamas where we worked at the Cape Eleuthera Institute. Beyond the team leaders, an additional 16 research staff (primarily graduate students and technicians) participated in the expedition. The purpose of this report is to provide a brief summary of our research activities to date including the presentation of some preliminary findings. Team members are currently developing comprehensive reports detailing all research findings.

Photo 1. Dr. Goldberg stalks bonefish on the flats of Eleuthera.

Approach: Using block nets, we captured approx. 150 adult bonefish in the waters of south Eleuthera. During all experiments, water temperatures ranged from 21 to 25C. Fish were temporarily held in pens (see photo 2) prior to transport to the laboratory facilities at Cape Eleuthera Institute.

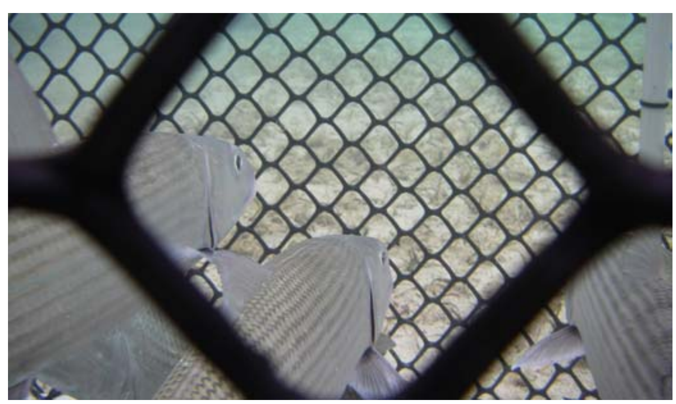

Photo 2. Bonefish in holding pen.

Question 1. What is the short term (minutes) stress response of bonefish? Knowledge of species-specific response to stress is necessary for understanding the fundamental biology of different species and can also yield information relevant to catch-and-release fisheries. After fish were netted, we sampled individual fish from periods ranging from 1 min through to 45 min post capture. Although this was not an angling-induced stressor, our intent was to document short term stress responses in a large number of fish (hence netting was appropriate). This information was needed to refine catch-and-release studies. Fish were individually netted from the holding pen and placed into a water filled trough. Blood samples were obtained from the caudal vessels of fish using vacutainers (see photo 3).

Photo 3. Michael Donaldson (M.Sc. student) uses a vacutainer to collect a non-lethal blood sample while the fish is held in a water-filled trough

Physiological analyses were conducted in the field using portable diagnostic tools (see photo 4).

Photo 4. Field diagnostic tool for assessing stress.

Although we examined a large number of physiological parameters (ions, hematocrit, hemoglobin, glucose, etc), for the purpose of this summary, we will focus on blood lactate. Lactate is an anaerobic metabolite that is associated with high intensity exercise. Lactate is one of the most robust metrics for assessing magnitude of physiological disturbance as well as recovery rates.

Our short term post stress assessment revealed that following "stress" of net capture, lactate levels exhibited a rapid rise, apparently reaching near maximal values within approx. 10 min (Fig 1). The lactate levels observed for bonefish and the time course trends following stress are similar to those patterns observed in other teleost fishes.

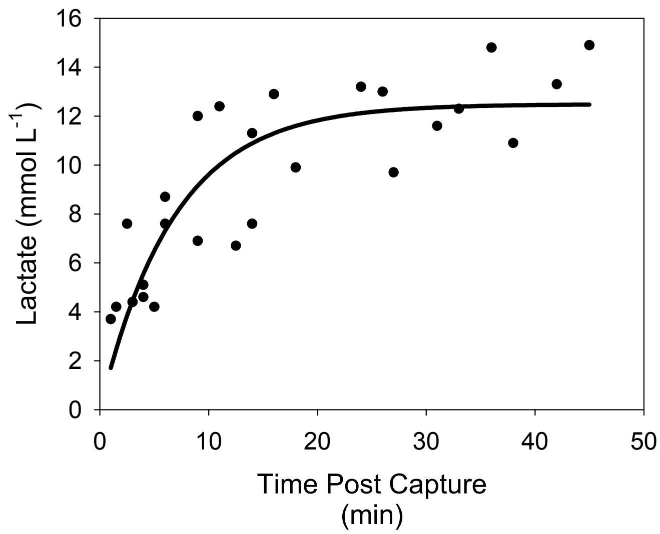

Fig 1. Short term stress response of bonefish following capture in a net. Fish were sampled between 1 and 45 minutes after capture.

Question 2. What are the physiological recovery dynamics of bonefish following 4 mins of exercise? We also wanted to ascertain the magnitude of physiological disturbances that occur in bonefish following a bout of exercise that replicated an angling event, and how long it takes for bonefish to recover from these disturbances. These experiments were conducted in the laboratory and involved first acclimating fish to laboratory conditions for 48 hours and then holding them in individual chambers to assess recovery after 4 minutes of exhaustive exercise (Photo 5). Results showed that 4 minutes of forced exercise (similar to what would be expected in an angling event) resulted in a 13-fold increase in plasma lactate, but this disturbance returned to resting levels after 4 hours of recovery (Fig 2).

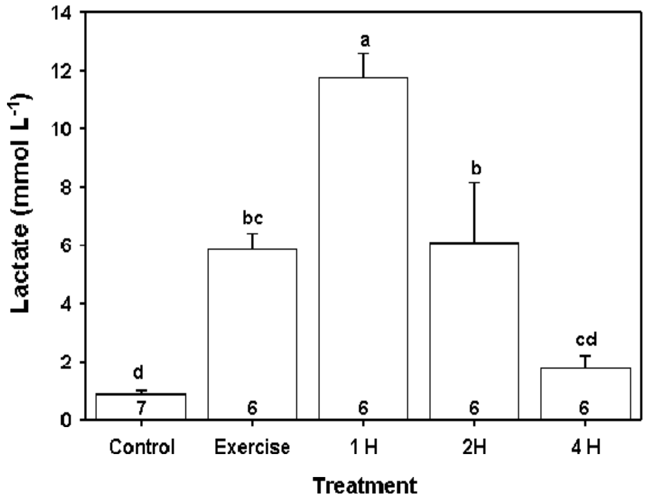

Fig 2. Recovery profile of bonefish following 4 mins of exercise. Sample sizes are at the bottom of the bars. Dissimilar letters indicate statistically significant differences. All values are means and error bars represent standard errors.

These data suggest that following a "typical" bonefish angling event at moderate water temperatures, recovery occurs reasonably quickly.

Photo 5. Fish were held in individual chambers continuously supplied with sea water for laboratory physiological studies. Here, Dr. Suski prepares to sample a fish.

Question 3. How do the physiological disturbances vary if the intensity of the exercise event varied and if air exposure was coupled with exercise, and also if this variation would influence the time for bonefish to recovery? We replicated the experiments conducted in Question 2. However, we only sampled fish immediately following the stressor and two hours after stress. This sampling protocol enabled us to assess differences in recovery relative to different angling stressors. One minute of exercise resulted in a small increase in blood lactate that was not different from resting values (Fig 3). If bonefish were air exposed following exercise, even just for 1 minute, their ability to recover from exercise was slowed compared to fish that were not air exposed. Additionally, 3 minutes of air exposure following exercise resulted in elevated lactate concentrations and prolonged recovery times. In fact, there is no evidence of recovery for fish in the 4 minutes exercise and 3 minutes of air exposure treatment group despite the fact that at 2 hours, fish exposed to just 1 min of exercise are recovered (Fig 3).

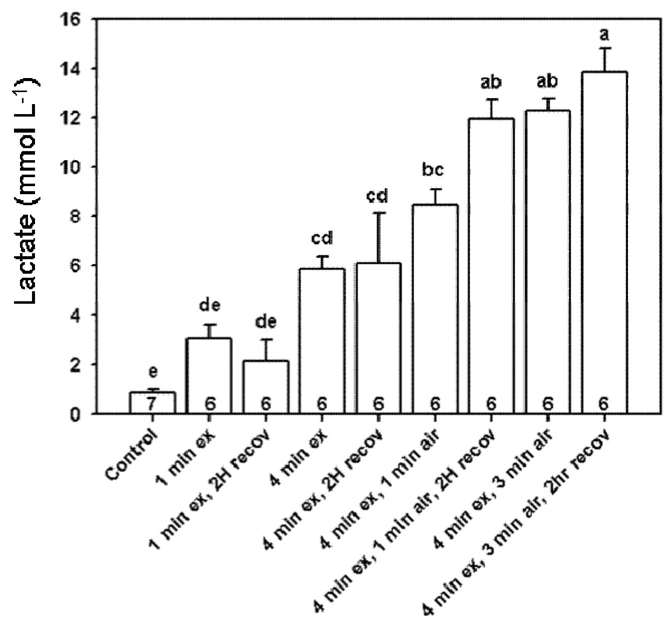

Fig 3. Stress response and recovery (at 2 hours) for bonefish relative to different exercise and air exposure durations. All stress responses and recovery values are paired (e.g., 1 min ex = values sampled immediately following exercise; 1 min ex, 2H recov = fish in the same treatment sampled 2 hours after the stressor was applied). Dissimilar values represent statistically significant differences. Sample sizes appear at the bottom of the bars. All values are means and error bars represent standard errors.

These findings highlight the negative consequences of air exposure on bonefish. In addition, shorter angling durations are associated with more rapid recovery rates. Efforts should focus on attempting to reduce or eliminate air exposure at intermediate temperatures as it appears to be the factor (when applied post exercise) that is prolonging recovery and increasing disturbance. Furthermore, from a practical perspective it is easier to minimize air exposure than it is to reduce the angling duration.

Question 4. In the wild, does angling duration influence post-capture physiological status? For this aspect of the study, we angled fish until they could be landed by an angler without assistance from research staff. Fish were then immediately sampled for blood as above. Lactate levels increased with the duration of the angling event (Fig 4). Interestingly, larger fish also took longer to land. Hence, it is not possible to determine if the elevated lactate levels we observed were related to size of fish, the duration of the angling event, or a combination of the two activities. Future research will focus on evaluating size specific responses of bonefish to stress.

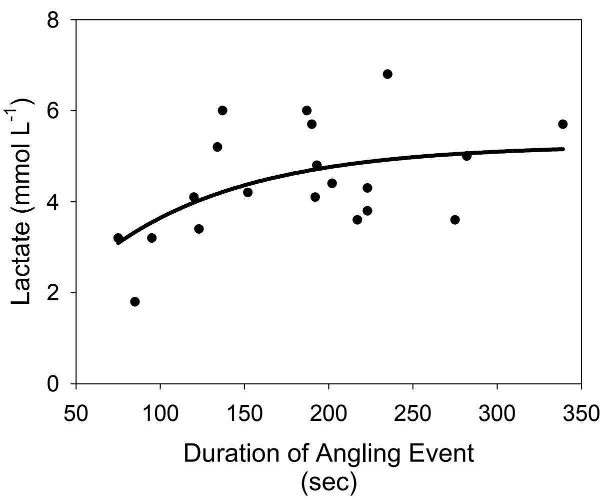

Fig 4. Post angling lactate levels relative to the duration of the angling event.

Question 5. How does the physiological condition of individual bonefish change pre and post angling? This study involved experimentally angling fish that were sampled immediately before and after the angling event. Angling was conducted in the ocean. All bonefish experienced elevations in lactate between pre and post angling levels. This proof of concept study revealed that for the first time (in any catch-and-release study), it was possible to assess how individual fish responded to stress (from resting to after angling in a field environment; Fig 5). Also relevant to this finding is that it provides the context for future field studies that will evaluate the relationship between individual physiological status and post release behavior and survival.

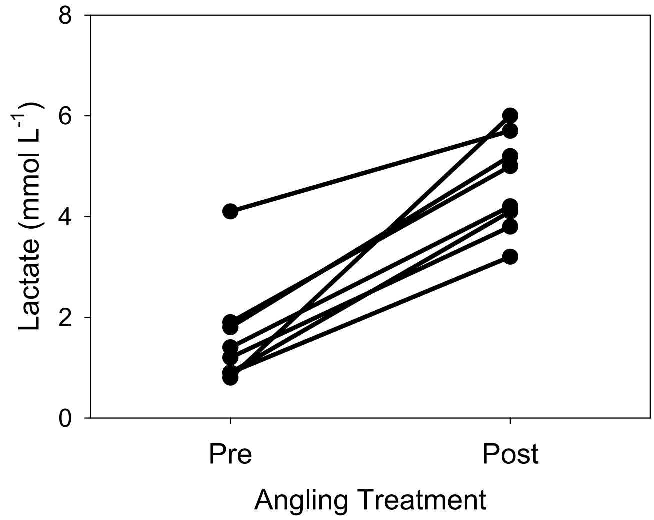

Fig 5. Lactate levels of individual bonefish from pre and post angling conditions. Paired t-tests revealed that the pre and post values were significantly different.

Summary: Collectively, these findings represent the first comprehensive assessment of bonefish responses to different catch-and-release angling stressors. These findings will help to refine future experiments. In addition, this work reveals that air exposure should be minimized. Future questions include: 1. Does physiological status influence post-release survival? and 2. How does water temperature influence stress in bonefish?

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