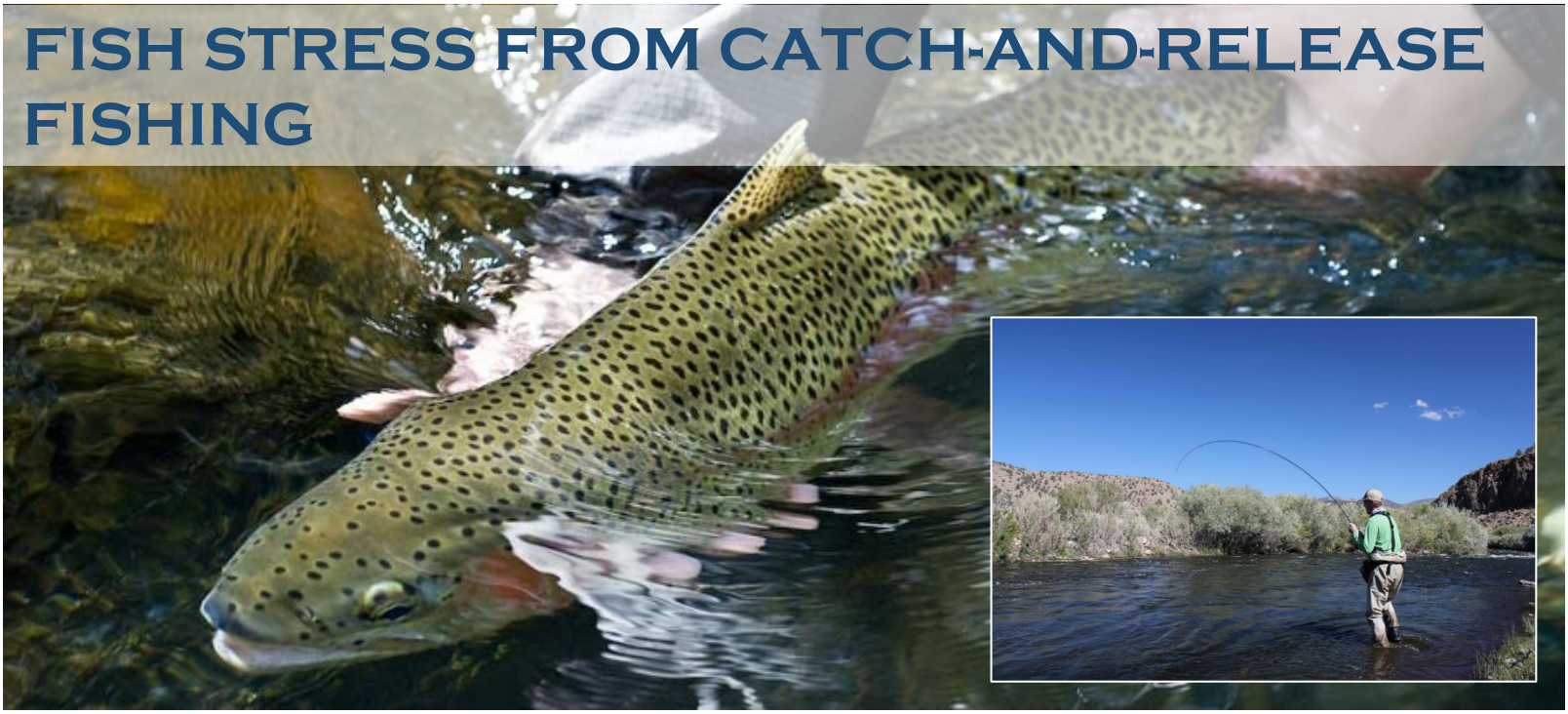
FISH STRESS FROM CATCH-AND-RELEASE FISHING



Introduction

Fish are stressed when caught by anglers due to capture, handling, and air exposure. When fish are harvested for consumption these stressors are, of course, irrelevant. However, anglers often practice catch-and-release so that fish may be caught again, and fishery managers use regulations that require release of some fish of a given size or species to improve or conserve populations. Even when fish are alive at the time of release, the stress to a fish from being caught and released can result in delayed mortality, reduced reproductive success, or increased vulnerability to predation (Figure 1). To ensure that catch-and-release practices effectively return caught fish to the population, researchers have studied both lethal and sub-lethal stresses from catch-and-release fishing. An analysis of blood is the most common tool used to measure fish stress, where cortisol (stress hormone) and glucose and lactate (metabolites) levels are used to measure primary and secondary stress responses; cardio-respiratory responses have also been used (Cooke et al. 2013). These studies of fish stress due to angling have helped to understand what factors determine whether a fish dies after it is released, the recovery profile of survived fish, and how the physiology and behavior of survived fish changes and how those changes affect recruitment and mortality within populations (Cooke and Schramm 2007). Angling duration and air exposure often have the largest influence on fish stress and can be controlled by anglers and reduced through facilitated recovery.

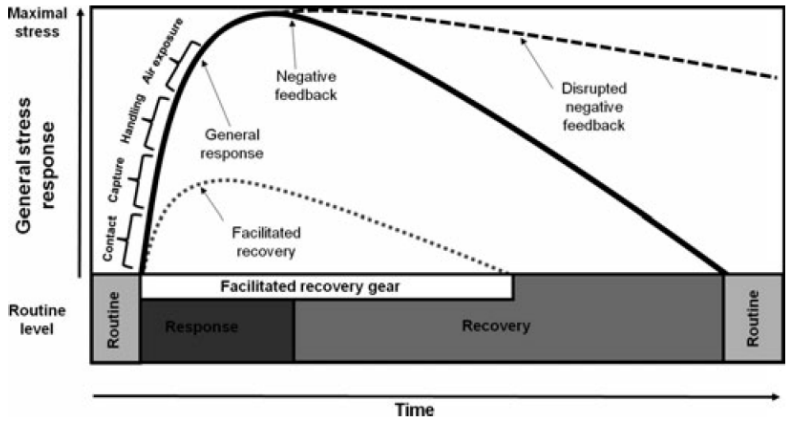


Figure 1. Schematic of general stress response from fish capture. Negative feedbacks can result in reduced reproduction or increased predation risk. Facilitated recovery can reduce stressors using facilitated recovery gear. From Cooke et al. (2013).

Angling Duration

Physiological changes occur due to burst exercise when a caught fish tries to avoid capture, and the amount of stress experienced is largely related to the duration that a fish is angled. In other words, a fish that is retrieved immediately experiences much less stress than one that is played to exhaustion. A substantial portion of exhaustively played fish may die immediately or during the recovery period after release. Some studies show this number to be as high as 89% (Muoneke and Childress 1994). In a study of rainbow trout, Meka and McCormick (2005) found that plasma cortisol levels (a blood indicator of stress level) began to increase beyond base levels after 2 to 3 minutes of a fish being angled and handled for hook removal (Figure 2). Cortisol levels continued to increase with angling and handling times for up to six minutes, the maximum time observed for the study. In general, the magnitude of physiological disturbance during angling can increase at sub- or supra-optimal temperatures, be greater for larger fish, and be greater for fish that have not fed recently (Cooke et al. 2013).

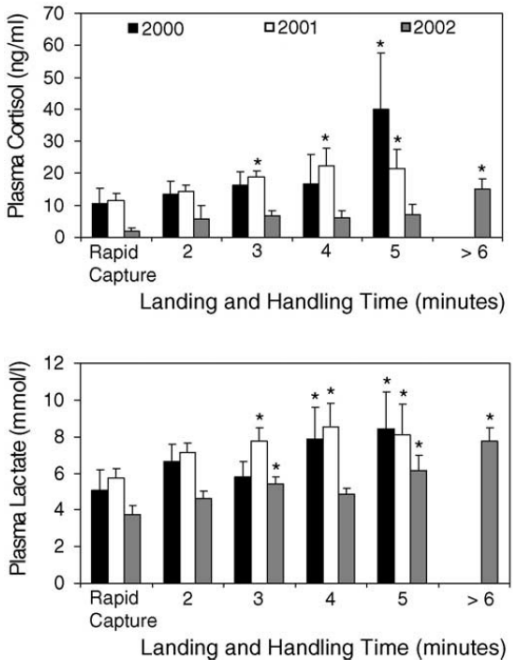


Figure 2. Cortisol and lactate levels from rainbow trout angled for different durations. From Meka and McCormick (2005).

Duration of Air Exposure

When fish are retrieved by anglers they are often held out of water for hook removal, measurement, and photographs. During this period of air exposure the exchange of oxygen at the gills is largely inhibited, causing an additional stress beyond what occurs during angling. A study by Queen's University (Kingston, Ontario) scientists found that rainbow trout survival after being exercised (simulation of being caught) was 88%, but survival decreased to 62% when fish were exposed to air for 30 seconds after exercise and survival decreased further to only 28% after 60 seconds of air exposure (Ferguson and Tufts 1992). Blood chemistry analysis indicated there to be substantial stress during air exposure that could ultimately influence whether a released fish survives through a recovery period.[1] In another study, SUNY-Potsdam scientists found that brook trout exposed to air after 30 seconds of chasing (simulated angling) showed no decrease in swimming performance with 60 seconds or less of air exposure but swimming performance decreases by 75% with air exposures of 120 seconds (Figure 3; Schreer et al. 2005). Although no mortalities were observed during this particular study, the scientists concluded that fish exposed to air for more than 60 seconds could be more

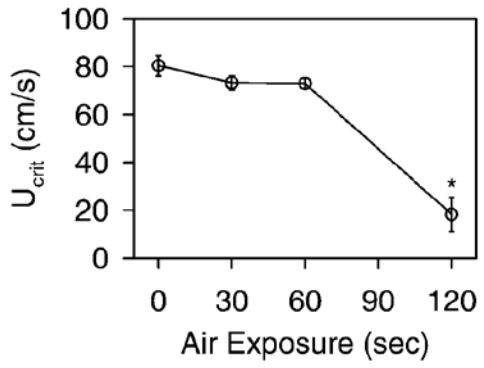


Figure 3. Critical swimming speed of brook trout after air exposure. From Schreer et al. (2005)

[1] In more technical terms, air exposure resulted in trout having larger extracellular acidosis, greater blood lactate concentrations, higher retention of carbon dioxide in the blood, whereas oxygen tension and hemoglobin:oxygen carriage were reduced by over 80%.

vulnerable to predators or be displaced in lotic environments because of their decreased swimming ability.

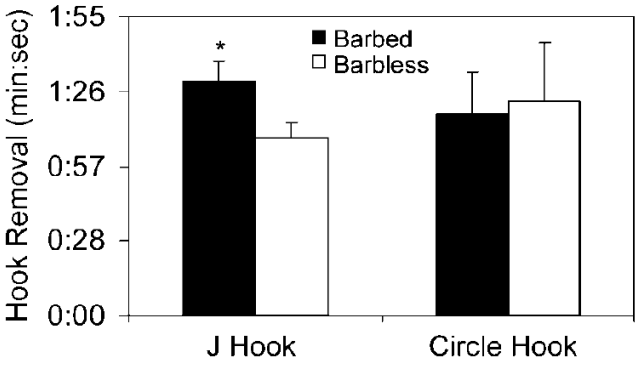


Figure 4. Time taken to remove barbed and barbless J-hooks and circle-hooks from rainbow trout. From Meka (2004).

The length of time a fish is exposed to air after being caught is partially determined by the length of time taken to remove a hook. One study found that novice anglers required more time to remove hooks than experienced anglers, and that barbed hooks took longer to remove. That same study reported that circle hooks injured less rainbow trout than j hooks and barbless j hooks, but circle hooks were less efficient for landing fish (Figure 4; Meka 2004). Fewer fish were injured when caught by fly fishing than spin-fishing, and novice anglers injured more fish overall. Some gears are designed to reduce handling injury during hook removal, such as rubber-coated nets void of knots. However, in some cases the equipment used to reduce the effects of fish handling during hook removal can cause additional fish injury. For example, mechanical lip-gripping devices are often used to hold fish by the mouth during hook removal to minimize scale and mucous (slime) loss that occurs when fish are held by the body or in nets. However, these devices have been shown to cause damage to mouth tissues (80 to 100%) in some species (Danylchuk et al. 2008), so anglers should use caution when using such devices and minimize time that fish are held vertically, which can damage internal organs.

Facilitated Recovery

Fish are often released into the water soon after the hook is removed and a photo is taken. However, sometimes a facilitated recovery is beneficial to enhance survival. One often used method is for stream anglers to hold the fish in slowly moving water while water flows through the mouth and across the gills, thus aiding gill ventilation, until the fish swims away. A recent study showed that an inexpensive portable recovery mesh bag used to hold sockeye salmon caught by anglers (and exposed temporarily to air) in flowing water resulted in 20% higher survival (Figure 5). A concurrent survey of anglers revealed that they would use this more involved method of recovery given that it did in fact improve fish survival (Donaldson et al. 2013). Other gears that increase water flow across the gills to aid in ventilation, such as holding tanks with water pumps, may also aid in fish recovery and survival. However, the science of facilitated recovery is still relatively new, many methods have not been evaluated scientifically, and ultimately any gear must be practical in order to be adopted by anglers.

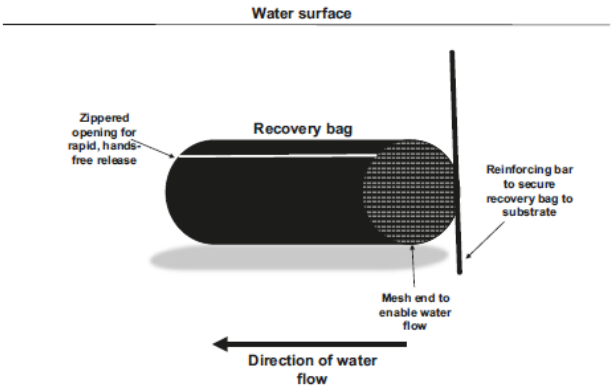


Figure 5. Example of facilitated recovery gear available to anlgers to help increase survival of caught-and-released fish. From Donaldson et al. (2013).

Summary

It makes sense that fish that are played longer and held out of water longer will experience more stress, and the more stress experienced by a fish the more likely it is to die when released. To reduce stress, scientists have recommended some general guidelines for catch-and-release angling (Cooke and Suski 2005):

1) minimize angling duration (the time a fish is played and handled for hook removal)
2) minimize air exposure (15-20 sec) by removing hooks with the fish in water and photographing fish quickly
3) use barbless hooks and artificial lures/flies
4) use rubber nets void of knots that protect fish scales and mucous
5) avoid angling during extremes in water temperature

Many of these guidelines are already practiced by educated anglers that retrieve fish quickly, leave them in water during hook removal, use barbless hooks, and photograph fish quickly before releasing them, ultimately keeping fish out of the water for no more than 15-20 seconds. Anglers also limit fishing during warm summer periods when trout are stressed (management agencies sometimes close fisheries during these warm periods). These behaviors by educated anglers have helped substantially to reduce fish stress from catch-and-release fishing, thus increasing the chance those fish will live to be caught again.

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Authorship and Further Information

Dan Dauwalter, Ph.D. | ddauwalter@tu.org | 208-345-9800 | 910 Main Street, Suite 342, Boise, Idaho 83702