Consumption of Juvenile Bull Trout (*Salvelinus confluentus*) by Larger Conspecifics During an Electrofisher Sampling Event

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Electrofishing is an effective capture method often used for fish sampling in streams and lakes. An electric current is produced in the water between a cathode and anode; fish caught in the electric field are temporarily "stunned" for easy netting. The behavioural and physiological effects of electrofishing on fish have been the subject of much research (Reynolds 1996; Nielsen 1998). Some studies have detected feeding and growth reductions (Mesa & Schreck 1989; Thompson et al. 1997), altered blood parameters and cardiac function (Bracewell et al. 2004; Schreer et al. 2004), muscular hemorrhages (Schill & Elle 2000), spinal damage (Sharber & Carothers 1988), and mortality (Habera et al. 1996; Henry & Grizzle 2006). Other studies, such as Schneider (1992) and Barrett & Grossman (1998), failed to detect mortality or growth effects that were significantly different from those on control fish.

In spite of the potential for injury in individual fish, population-level effects may be small in relation to natural mortality and growth variability (Schill & Beland 1995; Habera et al. 1996; McMichael et al. 1998) and electrofishing remains in common use. Nevertheless, it is generally recommended that power settings (voltage and amperage) be adjusted to the minimum required to achieve adequate samples for the size of fish and water conductivity in the sampled area (Reynolds 1996).

Two spawning bull trout in a British Columbia river. Photographer: James Baxter

Given the numerous studies documenting sub-lethal effects, it is often assumed that the stressful effects of electrofishing last hours or days (Reynolds 1996); however, published observations on the resumption of feeding activity are rare. This article provides an observation of very rapid resumption of feeding in juvenile bull trout (*Salvelinus confluentus*). This has important practical implications for field sampling.

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Methods

The Halfway River, a fifth order tributary of Arrow Lakes Reservoir in southeastern British Columbia, was sampled by electrofishing on 12 September 2007 as part of a larger study of juvenile habitat and stream residence. This tributary is one of several that provide spawning and juvenile rearing habitat for adfluvial bull trout from the reservoir. The sampled reach had a relatively steep gradient with substrate comprised mainly of boulder and cobble ranging from 0.3 to 1 m diameter. One person operated the backpack electrofisher (Smith-Root Model 12-B) while a second person netted fish and carried the capture bucket. Output of the electrofisher was set at I-5 (60 Hz at 6 ms). The river has low conductivity (22-30 µS/cm; hardness as $CaCO_3$ 6.5 mg/l), and it was necessary to increase the voltage setting on the electrofisher from 300 V to 600 V soon after starting in order to effectively draw fish to the anode. In total, about 300 m of stream was sampled between 0800 and 0900, concentrating on habitats near the stream margin. Stream water temperature was 7° C. Captured fish reacted typically to electrofishing: being attracted quickly to the anode, they lost control of their swimming ability and exhibited galvanonarcosis (Smith-Root Inc. 1998). Stunned fish were netted and added to a white plastic bucket (28 cm inside diameter, 40 cm height) where they floated on their side for a few minutes before regaining equilibrium. Water depth in the bucket was about 8 cm, and the bucket was in almost constant motion as sampling proceeded upstream over rough substrate, with the bucket in hand of the netting crew member.

Observations

About halfway through the sampling, an age 0 bull trout was captured and added to the capture bucket that already contained two other age 0 bull trout less than 60 mm fork length (FL), and three larger juvenile bull trout (111–138 mm FL). When the stunned age 0 fish was added to the bucket, it floated on its side initially as all captured fish did. Before it could recover, one of the larger juveniles seized and held it by the pectoral fin. Then, perhaps stimulated by the attack of the first, a second large juvenile seized a recovered age 0 fish by the pectoral fin. At first it seemed possible that the fins might have been accidentally inhaled by the larger fish, however, after a few seconds the first juvenile adjusted its grip to position the smaller fish headfirst into its mouth and began to swallow. In an attempt to discourage this, the water in the bucket was swirled by hand and a rock was added to the bucket to give the smaller fish something to hide behind. The hand swirling caused the second attacking juvenile to release its prey, but the first continued to swallow over the next few minutes until the caudal fin was inside its mouth. The consumed age 0 fish (53 mm FL) was regurgitated dead later when the larger juvenile (116 mm) was removed from the bucket for sampling.

Discussion

Observations of rapid recovery of feeding behaviour following capture by electrofishing are rare in the fisheries literature, and an observation of feeding while still in a moving capture bucket has not yet been reported (to our knowledge). However, such activity could be undetected. Mesa & Schreck (1989) conducted a comprehensive study using field and lab experiments with cutthroat trout (*Oncorhynchus clarki*) and found that a period of 3 – 4 hours was required for 50% of the fish to return to a seemingly normal mode of behaviour compared to undisturbed trout after electrofishing, anesthetization, and marking in natural streams. However, the response was variable among stream sections and some fish returned to apparently normal behaviour shortly after release. In their accompanying artificial stream experiment, fish were already feeding one hour after electrofishing and marking (the time of first observation), but at a reduced rate compared to the pre-treatment level. Mesa and Schreck (1989) also observed, importantly, that the stress effect of electrofishing alone was less than electrofishing plus handling, as indicated by plasma cortisol concentrations.

Our observations of bull trout predation in the sample bucket are consistent with those of Mesa and Schreck (1989) in showing that salmonids can recover and begin feeding again very quickly after exposure to an electric field when the recommendations of Reynolds (1996) are followed. Our observations extend those of Mesa and Schreck (1989) by showing that bull trout feeding can begin even before a sampling event is completed, while fish are still in the holding container. Juvenile bull trout appear to be opportunistic in their feeding, with fish as small as 65 mm exhibiting piscivory, including cannibalism (McPhail & Baxter 1996; Ben-James 2001). The stress of electrofishing cannot be assumed to prevent feeding soon after, and if recovery occurs while fish of varying sizes are held in close proximity, smaller individuals can be consumed by larger fish during the sampling. This has potential to bias population assessment including age class and size distributions, population estimates for smaller fish, and length-weight relationships for larger fish. Furthermore, bull trout are rare over much of their distribution. In British Columbia, the species is blue-listed as a species of special concern (Haas & Porter 2001), and in the United States several populations are listed as threatened under the Endangered Species Act (Lohr et al. 2000). In such cases, the prevention of unnecessary mortalities during sampling events is even more important. We recommend that fish of differing sizes be segregated using different containers, or dividers if in the same container, during electrofishing for bull trout or other piscivorous species to ensure smaller fish are not consumed prior to processing.

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