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Note

Injury and short term mortality of benthic stream fishes – a comparison of collection techniques

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Abstract

Small benthic fish such as darters are frequently collected for stream inventory purposes or to document habitat use, with the intent of releasing the fish unharmed following enumeration. The purpose of this study was to examine the injury and short term mortality (8 d) of greenside darters captured by live wire pot trapping and electrofishing, using two different settings (80Hz, 6ms and 60Hz, 6ms). Two different electrofishing techniques were used, spot electrofishing and sweep electrofishing. Short term mortality was highest for fish collected in live pot traps. Abrasion from the wire traps appeared to remove scales and irritate the skin. By the conclusion of the study, 74% of the fish caught in live pot traps were dead from fungal lesions. Greenside darters captured by all electrofishing methods exhibited low short term mortality (<10%). The only initial mortality, hemorrhaging and spinal damage, occurred for fish collected using 80Hz, 6ms sweep technique, although the short term mortality was still far less than that observed among trapped fish. The spot electrofishing technique resulted in no injury, with either of the settings. Live trapping produces little initial mortality, and thus may be wrongly viewed as a safe alternative for the collection of threatened benthic stream fishes, compared to electrofishing. We suggest that researchers studying small fish in warmwater systems use caution when collecting and handling fish for subsequent release.

Introduction

Small benthic fish such as darters are often difficult to sample in lotic systems (Hendricks et al., 1980). Although population estimates are uncommon for such species, they are frequently collected for stream inventory purposes or to document habitat use, with the intent of releasing the fish unharmed following enumeration. Many darter populations have been recognized as threatened and afforded different forms of state/provincial or federal protection. It is necessary to monitor these populations and investigators assume that the collection and enumeration procedure is having negligible effects on the survival of the fish.

A variety of different sampling techniques have been used to collect or observe darters. Direct underwater observations by divers (Keenleyside, 1962; Northcote & Wilkie, 1963) are useful for documenting habitat use, but are not always appropriate for enumerating fish. In some cases, the efficiency of active gears such as seines may be limited due to unembedded substrate, variable flow conditions and dense cover (Bunt et al., 1998). Such conditions are common in southern Ontario, requiring that alternative sampling techniques be employed to collect benthic species and to document habitat use.

Live trapping is one of the primary methods available for investigating habitat use and conducting biological inventories of stream dwelling fish (Bagenal, 1978). Live wire pot traps are commonly used in lentic environments for providing detailed information on the microhabitat use of small fish. Such traps have also been used unmodified (Bunt et al., 1998), or modified slightly (Culp & Glozier, 1989) for similar application in lotic environments. Lotic environments require traps that are capable of functioning without collecting too much debris under different flow conditions and in a diversity of microhabitats (Gammon, 1976).

Electrofishing is also one of the most commonly used methods for collecting darters in streams despite difficulties associated with their behavior and morphology (Larimore, 1961). Biologists collecting fish for enumeration purposes or population estimates often work upstream while moving the anode in an sweeping motion (Bohlin, 1989; Reynolds, 1996). Electrofishing has also been used as an effective method for habitat characterization in shallow, fast-flowing water with large diameter substrates (Heggenes et al., 1990). When documenting habitat use, the anode is often placed adjacent to homogenous habitat type and the anode is slowly drawn away (Hearn & Kynard, 1986). Micro-habitat use for captured fish is then recorded from the position where the fish was first observed rather than the point of collection in order to minimize the displacement biases associated with galvanotaxis (Gatz et al., 1987).

Although these collection techniques are being commonly used to collect some threatened darter species, very little information exists on the injury and short term mortality associated with live pot traps and electrofishing. Numerous studies on the effects of electrofishing on salmonids have been published, but there is still a lack of examples dealing with warmwater non-game species. Virtually no information is available on the effects of live wire pot traps on injury or short-term mortality.

The purpose of this study was to examine the injury and short term mortality of a small benthic darter species captured by live trapping and electrofishing. In this paper, we differentiate not only between electrofisher settings (frequency and pulse width) but between spot-electrofishing and sweep electrofishing techniques.

Methods

For this study we used greenside darters (*Etheostoma blenniodes*) which have been demonstrated to be easily captured downstream of the Mannheim Weir (43° 25′ N, 80° 25′ W) on the Grand River, Ontario (Bunt et al., 1998). The nature of the study precluded the ability to obtain a control group. Greenside darters occupy substrates with large unembedded cobble, which are difficult to seine (Bunt et al., 1998).

All fish were captured from similar riffle sections with large unembedded cobble and boulder substrates on June 9th, 1997. Mean water depth ($\pm$ 1 SEM) was 25.27 cm $\pm$ 1.78. Water temperature at time of collection was 22 °C, and varied by up to 2 °C during the time that fish were held in enclosures. During the collection period, conductivity was 541 μS cm^{-1}. Fish ranged in total length from 45 mm to 63 mm, and the mean lengths between groups were not significantly different (ANOVA, $p > 0.05$).

Two unbaited pot traps with 5 mm wire mesh (Gee Minnow Trap, Cuba Manufacturing, New York) were set in 30 cm of water among large unembedded cobble for 1 h. The traps were removed from the water, opened, and the fish were placed in a large cooler.

A backpack electrofisher (Mark VII, Smith Root Inc., Washington) with a gel cell battery was used for all electrofishing collections. Preliminary experiments indicated that 380 volts was required to collect darters in the Grand River. The unit was operated by the same individual for the entire collection period. Fish were collected with a 5 mm mesh net before being transported into a cooler located on the stream bank. We compared two different electrofishing settings (80Hz, 6ms and 60Hz, 6ms) and two different electrofishing techniques (spot electrofishing and sweep electrofishing).

Spot electrofishing involved operating the anode as described by Hearn & Kynard (1986). The electrofisher was operated for no more than 3 s for each spot-electrofishing sample. Sweep electrofishing involved moving upstream while systematically sweeping the anode back and forth in an effort to cover a large area. The electrofisher was operated for up to 10 s at a time. Observations on the behavior of fish as they were electroshocked and the duration required for fish to recover were noted. Fish were examined for evidence of irregular swimming, loss of scales, frayed fins, external hemorrhaging and flaring of the gills.

After either being removed from the trap or from the electrofishing net, fish were treated in a similar manner. Twenty-five fish from each treatment were randomly removed from the cooler using a small dip net and placed in enclosures secured in the river. Fish were monitored constantly for the first 2 h and then once daily for an 8 d period. Each day, moribund individuals were removed and observations on the behavior of remaining fish were recorded. The incidence and extent of fungal growth on fish was also described. Post mortum examinations were performed using a dissecting microscope.

Results

Trapping

Fish caught in traps showed no evidence of hemorrhaging or spinal injuries before being placed in the enclosures. However, the fish did have slightly frayed fins, some scale loss, and associated abrasions, especially around the caudal region. No moralities were observed within the first several days of observation. On day 3, more than 50% of the fish in the enclosures were showing signs of saprolegnian growth on the caudal region. The lesions were initially gray-white in colour, with a cotton-wool like appearance. By day 4, fungal growth had progressed anteriorly and caused death when it reached the opercular area (see Figure 1). By the conclusion of the study, 74% of the fish caught in live pot traps were dead, and all of the remaining individuals had fungal growth gradually progressing anteriorly, which would have likely become terminal. Although the results are pooled, each of the 4 enclosures exhibited the same patterns of mortality.

Spot Electrofishing 60Hz, 6ms

Fish collected by this method and with this setting oriented quickly to the anode and were captured within 3 seconds. All fish recovered within several seconds of being removed from the current. Thirty five fish were collected using this method, of which 25 were held for observation. None of the 35 fish died initially, nor exhibited any obvious hemorrhaging. Similarly, no evidence of spinal damage was visible. Short term mortality was very low (4%), with only one mortality occurring on day 6 (Figure 1).

Spot Electrofishing 80Hz, 6ms

Results for this treatment were similar to the other spot electrofishing settings (60Hz, 6ms). Fish responded to the electrofisher in a similar manner, and of the 28 fish captured, no initial mortality was observed. Among the 25 fish held, short term mortality was low, with only 2 fish dying on day 6 of observation (8%) (Figure 1).

Sweep Electrofishing 60Hz, 6ms

Fish were more difficult to sample with this method than with spot electrofishing, using either of the two settings. Fish appeared to exhibit fright bias (Bovee & Cochnauer, 1977) when the electrofisher was operated. Fish were observed to react to the field. However, fish were often able to escape prior to succumbing to the effects of galvanotaxis. Forty-two fish oriented towards the anode and were collected, among which no initial mortality was observed. Slower recovery times were noted for fish collected with this technique and setting. No fish exhibited burns, hemorrhaging or obvious spinal damage. Of the fish held for observation, 2 fish died after being held for 24 h (8%) (Figure 1). No other moralities occurred over the study period.

Sweep Electrofishing 80Hz, 6ms

This electrofishing technique and setting produced the greatest initial mortality, with 4 of the 44 (9%) fish electroshocked not recovering. Most of the fish collected with this technique and setting exhibited symptoms of tetanus which included flared gills and rigid musculature. Recovery following electrofishing was observed to be the longest for this treatment (> 15 s). All of the fish that died initially had burns between the posterior margin of the head and posterior to the spiny dorsal fin. One of the initial moralities also exhibited hemorrhaging around the gills. Three fish, one of which died initially, had obvious spinal damage with crooked spinal alignment and inability to use posterior musculature. The two remaining fish with spinal damage died after being held 5 d (Figure 1). No other short term moralities were observed.

Discussion

Short term mortality was highest for fish collected in traps. Abrasion from the wire traps appeared to remove scales and irritate the skin. The warm stream conditions facilitated the rapid growth of water mould, which eventually killed fish collected by this method. It has often been noted that saplrolegnian infections of fish are frequently associated with wounds and lesions and that handling or any traumatic damage to the skin may predispose them to infection (Wolke, 1975; Richards, 1978; Neish & Hughes, 1980). These conditions can disrupt the mucous covering on the surface of the fish which is though to serve as a barrier and possess some antifungal action (Willoughby, 1969). Tiffney (1939) reported that macroscopic injury to fish skin greatly increased the chance of fungal infection. Most researchers who collect darters in similar traps would not suspect that such high short term mortality

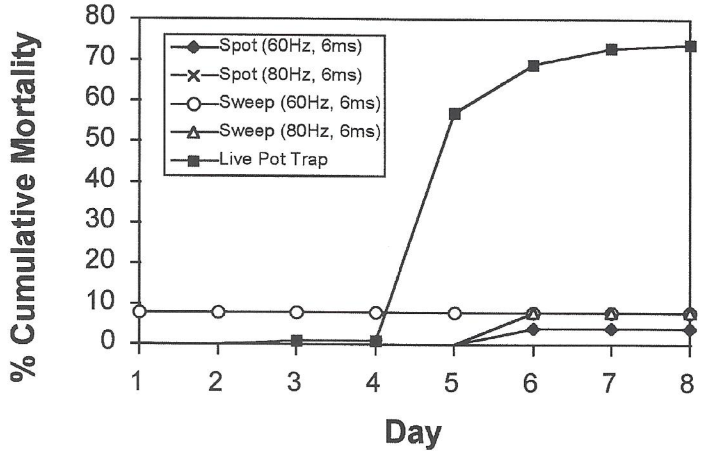

Figure 1. Short term mortality among greenside darters collected using two different electrofishing techniques and settings ($n = 100$) and live trapping ($n = 100$).

would result from this apparently humane, passive and unobtrusive capture technique.

The effects of electrofishing on the injury and short term mortality of fish have been investigated thoroughly for many salmonids, but few examples exist for warmwater species. Greenside darters captured by all electrofishing methods exhibited low short term mortality (< 10%). The only initial mortality, hemorrhaging and spinal damage, occurred for fish collected using 80Hz, 6ms sweep technique, although the short term mortality was still far less than that observed among trapped fish. The spot electrofishing technique resulted in no injury, with either of the settings. This may suggest that the duration that fish are shocked (only 3 s for spot techniques) affects injury and short term mortality. Fish which were collected with the sweep technique were shocked for up to 10 s, and required longer periods to recover.

Whaley et al. (1978) investigated the lethality of electroshock among fantail darters (*Etheostoma flabellare*) and bluegill (*Lepomis macrochirus*) in an aquarium equipped with two plate electrodes. Mortality was low when fish were shocked for less than 15 s, but increased progressively with duration of exposure. Mortality was also highest at the frequency which they describe as giving good electrotactic response. We found similar results, in that the most injurious setting was the higher frequency (80Hz) and for the longest duration (sweep, up to 10 s) resulting in burns, gill flaring and spinal damage.

Despite the less controlled circumstances with *in situ* investigations and experiments, the results are more directly applicable to field collections of wild fish. Whaley et al. (1978) suggested that, because of the enforced orientation of the fish parallel to the electric field, the rectilinearity of the field induced by electrode plates, and the confinement of the field within the plastic aquarium, their data were not directly applicable to field conditions.

The effects of live trapping small fish in wire traps has not been previously reported in the literature. We suggest that researchers studying small fish in warmwater systems use caution when collecting and handling fish for subsequent release. Live trapping produces little initial mortality, and thus may be wrongly viewed as a safe alternative for the collection of threatened fishes, compared to electrofishing. The effects of live trapping could likely be minimized by using traps made out of alternative materials (Culp & Glozier, 1989). Alternatively, researchers may consider coating wire minnow traps in plastic or rubber in order to smooth sites of abrasion.

The biological effects of electrofishing are beginning to be more widely studied for groups other than salmonids, and this will be useful for providing guidance to those wishing to collect threatened stream fishes. In situations where the effects of a collection technique are unknown, we suggest that researchers use unobtrusive methods such as snorkeling or videography for monitoring relative abundance and microhabitat use of small threatened fishes.

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