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An Evaluation of Known and Potential Sampling Techniques for Hellbender, *Cryptobranchus alleganiensis*

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ABSTRACT—Three known techniques, variations of visual search and capture by hand or nets, and two potential techniques utilizing electroshocking were evaluated for their effectiveness and efficiency in capturing hellbenders *(Cryptobranchus alleganiensis)* in the Allegheny River drainage, northwestern Pennsylvania. Under conditions of controlled sampling effort, the two electroshocking techniques accounted for 78.2% of the 87 individuals captured. Hellbenders appeared to exhibit no ill effects or differential displacement from electroshocking. Unlike the other techniques, the success of electroshocking was independent of the study site and time of day.

Key words: Population sampling techniques; electroshocking; hellbender; *Cryptobranchus alleganiensis*; Cryptobranchidae.

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INTRODUCTION

The hellbender *(Cryptobranchus alleganiensis)* was listed by Maryland authorities in 1972 as endangered in the state primarily on the basis of limited survey efforts which failed to document hellbender use of known habitat (Committee on Rare and Endangered Amphibians and Reptiles of Maryland, 1973). Prior to undertaking an intensive survey for the hellbender in Maryland, we decided that it was necessary to evaluate the effectiveness of different sampling methods under a variety of stream conditions. A technique or techniques would then be selected to minimize the possibility that failure to detect the presence of hellbenders was due to ineffective sampling procedures.

Hellbender populations have been sampled by several methods. Investigators such as Reese (1906), Smith (1907), Bishop (1941), Hillis and Bellis (1971), and Nickerson and Mays (1973*a*) captured specimens by overturning large flat rocks that are used for cover during daylight hours in streambeds (Nickerson and Mays 1973*b*). In most cases, potato rakes were used to move the larger rocks. Swanson (1948) noted that hellbenders could be collected by hand during periods of nocturnal activity along the stream bottom. Collection records of the Carnegie Museum of Natural History indicate that hellbenders have also been captured in riffles with the use of a seine.

Electroshocking techniques are widely used in fishery investigations (Hocutt and Stauffer, 1980), employing either alternating (AC) or direct (DC) current normally at 110 or 220 Volts. In a DC field, fish typically exhibit electrotaxis in which they are involuntarily attracted to the anode. Loss of equilibrium (electronarcosis) or death can occur if the voltage is high or specimens large (due to greater body resistance). Electrotaxis does not occur in an AC field, and specimens are more apt to be killed or stunned with long-term physiological effects. Additionally, AC fields are potentially more dangerous to humans and other animals. A good overview on the subject of electrofishing may be found in Northrop (1967). Electroshocking oftentimes results in the capture of amphibians and aquatic invertebrates. Thus, we felt that this method also may have potential in the capture of hellbenders.

Because of the need for both an effective and efficient sampling technique for use in population studies of hellbenders under a variety of stream habitat conditions, we evaluated the three previously used techniques and two techniques using electroshocking. The objectives of this study were to determine (1) the most effective and efficient sampling technique for hellbenders, (2) if the stream habitat or the time of day at which a technique is applied affects the results, (3) if a particular technique has a substantially greater displacement effect on hellbenders than another technique, and (4) if habitat disruption can be kept to a minimum.

STUDY SITES

Between 21 May and 6 July 1979, we conducted an evaluation of sampling techniques at three study sites in Crawford and Venango counties, northwestern Pennsylvania. These study sites were chosen on the basis of reported hellbender abundance in tributaries of the Allegheny River (Swanson, 1948; Hillis and Bellis, 1971) and field observations of suitable habitat. Site 1 was located in French Creek, Allegheny River drainage, at the Hayfield Township line bridge near the Abex Corporation on Route 19/Route 6, Crawford County, Pennsylvania. Site 2 was in Big Sandy Creek, Allegheny River drainage, on the Jon Voighton property, old Route 8, south of Franklin, Venango County, Pennsylvania. Site 3 was also in French Creek, Allegheny River drainage, at the Venango Borough bridge, junction of county road 20060 and Route 19/Route 6, Crawford County, Pennsylvania. A sample plot 200 m in length was delineated at each site. Widths varied from a maximum of 70 m at site 1 to a minimum of 15 m at site 2.

MATERIALS AND METHODS

Each sampling effort involved exactly one hour in order to achieve comparable results. The following techniques and procedures were used.

Search and seizure (A).—Three people work upstream from the downstream boundary of the sample plot, walking parallel paths approximately 1.5 m apart. Each one attempts to capture by hand or dip net hellbenders visible on the bottom.

Potato rake (B).—The same procedure is employed as above, except that any rock large enough to conceal a hellbender is overturned with a potato rake.

Electroshocking and dip nets (C).—Three people work upstream in parallel paths. The middle person hand tows a small, plastic boat carrying a 110-220 Volt AC/DC No-Brush Generator set at 110 or 220 Volts DC and grounded to the boat. A probe is used to electrify the water. The other two people capture stunned specimens with insulated dip nets.

Seine herding (D).—Field personnel begin at the upstream boundary of the sample plot. Two people cast a 3.2 mm mesh seine, measuring 1.5 m × 3.0 m, downstream approximately every 3 m. The third person kicks downstream toward the seine. Upon reaching the seine, it is quickly lifted by the other two field personnel.

Electroshocking and seine (E).—Field workers follow the same procedure as seine herding, except that the "kicker" handles the electroshocker, applying current to the water after each cast and kicks toward the seine while shocking.

Within a nine hour period during the day, each of the five techniques was used for one hour with a one hour interval between techniques within the same stretch of river. Techniques were rotated to a different time period every day over a five-day period, similar in design to a 5 × 5 Latin square. Therefore, each technique was applied once in each time period during the five days at a particular site. Sites were sampled for two non-consecutive five-day periods; site 1: 21–25 May, and 19–23 June; site 2: 4–8 June, and 26–30 June; and site 3: 11–15 June, and 2–6 July. From 21 May to 15 June 1979, the three study sites were sampled for five days each between 1500 and 2400

hours (DST). From 19 June to 6 July 1979, the sites were sampled for five days each between 0100 and 1000 hours (DST). Headlamps were used to locate hellbenders during nighttime sampling efforts.

Captured hellbenders were toe-clipped and returned to the stream at the point of capture. Toe-clip number, method of capture, and time of capture were recorded for each individual.

RESULTS AND DISCUSSION

Eighty-seven hellbenders were captured during the study. The success rates of the known sampling techniques (A, B, and D) were extremely low (Fig. 1). A viewbox might have improved the collecting efficiency of technique A. The two electroshocking techniques (C and E) were responsible for 78.2% of the hellbenders captured. Electroshocking in conjunction with dip nets (C) was the most successful sampling technique, accounting for 54.0% of all hellbenders captured. Approximately 24% of the hellbenders were captured by electroshocking downstream into a seine (E). No ill effects resulting from electroshocking were obvious in hellbenders captured by this procedure when compared to those captured by the other techniques. Rarely were they stunned to a point indicative of electronarcosis, rather they would either be attracted toward the anode or attempt to lethargically swim or move away from

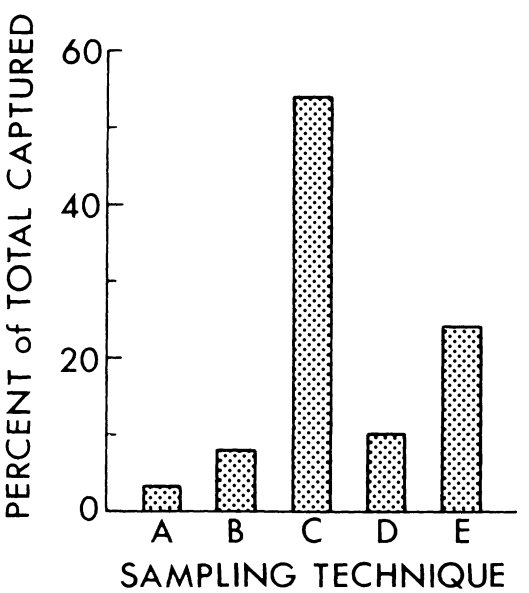

FIGURE 1. Numbers of hellbenders captured by each technique expressed as percent of total captured (N=87). Techniques are search and seizure (A), potato rake (B), electroshocking and dip nets (C), seine herding (D), and electroshocking and seine (E).

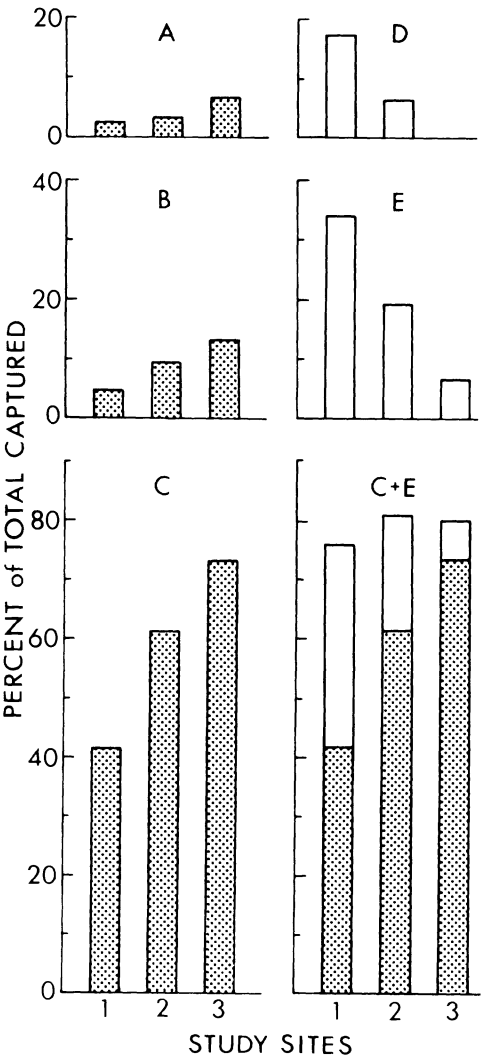

FIGURE 2. Number of hellbenders captured with each technique expressed as percent of total captured per study site. Sample sizes are 41, 31, and 15 for sites 1, 2, and 3, respectively. Techniques are search and seizure (A), potato rake (B), electroshocking and dip nets (C), seine herding (D), and electroshocking and seine (E).

the field. When the electrodes were removed, or after toe-clipped animals were returned to the stream, there was no apparent distress exhibited.

All techniques, considered individually, showed site-specific success rates (Fig. 2). The increase in percentage of captures per site shown by techniques A, B, and C was inversely related to the amount of riffle area per site. The riffle-pool-run ratio of sites 1 through 3 was 4-2-4, 3-3-4, and 2-3-5, respectively. Techniques D and E were most successful at the sites with the highest amount of riffle area. The first three techniques were conducted while walking upstream and depend on the workers' maneuverability and the bottom visibility. The latter two methods utilize downstream seine casting and require high flow velocity to be effective. The preferred habitat of the hellbender is the moderately deep, swift water area that occurs on the edge between riffles and runs (Bishop, 1941; Nickerson and Mays, 1973*a*). An accurate census of hellbender populations must be effective under both of these flow conditions. The combined results of techniques C and E were not affected by the riffle-pool-run ratio of the study sites.

The number of hellbenders captured during particular time periods was influenced by the technique in use. Search and seizure (A) was successful only at 0100 and 0300 hours (DST). Swanson (1948) noted that hand capture of hellbenders was most effective during darkness. The potato rake (B) was most successful between 1500 and 2000 hours and at 0500 hours (DST), within the period that hellbenders are known to use large rocks for daylight cover (Smith, 1907). Dusk and dawn are peak activity periods (Smith, 1907; Bishop, 1941). Noeske and Nickerson (1979) demonstrated that hellbender activity rhythms are biphasic under photoperiodic regimes with a large peak just after dark onset and a smaller peak after light onset. These activity peaks could have resulted in the success of seine herding (D) from 1900 to 2400 and at 0700 hours (DST). Electroshocking and dip nets (C) did not exhibit a clear pattern. The increased success rates of electroshocking and seine (E) at 2300 and 0700 hours (DST) could have been due to their biphasic activity rhythms. However, the combined results of the two electroshocking techniques were found to be independent of the time of day applied ($\chi^2 = 7.96$, df = 9, $P > 0.05$).

Hillis and Bellis (1971) observed that the average displacement of captured hellbenders was less than 10 m. Eleven of the hellbenders marked during our study were recaptured. About 73% of the recaptured individuals were initially captured using an electroshocking technique. All were recaptured within the 200 m sample plot. Based on recapture locations, no obvious differential displacement was noted due to electroshocking. The percentage of recaptures which were first captured by electroshocking did not differ greatly from the percentage of captures made by electroshocking overall (72.7% versus 78.2%). Released hellbenders sought out the nearest rock cover. In many cases, this cover had been recently overturned or moved during sampling efforts. Habitat disruption during sampling could be an important consideration, especially during the breeding season. Hellbenders lay eggs in late August or September (Smith, 1907). The disruption of nests under large rocks during this period could result in increased egg and larval mortality, cannibalism or predation. Electroshocking could probably be used effectively without physically disturbing nest sites. However, the effects of electroshocking on eggs or larvae are unknown.

In conclusion, the most effective and efficient technique for capturing hellbenders for population analysis was electroshocking in combination with dip nets or seine, depending on stream habitat conditions. Used together, the results from the two electroshocking techniques were apparently independent of the site and the time of day. Electroshocking was far superior than any other published method of sampling hellbender populations. It did not cause any obvious ill effects or a greater displacement in captured individuals. Although it could probably be used without significant habitat disruption, care should be taken during the breeding season to prevent possible harmful effects on eggs or larvae.

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