Swimming Speed Performance of the Bigeye Shiner from the Ouachita River Drainage

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INTRODUCTION

Protection of small streams and their associated fauna are of major importance to land management agencies such as the U. S. Forest Service. Small streams provide habitat for endemic species in the Ouachita drainage such as the paleback darter (Etheostoma pallididorsum) as well as other more distributionally widespread species (Robison and Buchanan 1988). Some of the species that occur in small streams, while found in other areas as well, are nevertheless important components of the streams ecosystem.

Modification of streams can come in a variety of forms ranging from channel alterations to land use practices affecting stream runoff. Channel restrictions such as culverts can increase current velocities and reduce stream bottom roughness causing difficulty for small fishes moving upstream. Theoretically this could eliminate ephemeral spawning grounds as well as recruitment into ephemeral drainages when conditions were more favorable for fishes. The velocities which small fishes can endure and for what periods of time are of special concern in determiing impacts of structural stream alterations such as culverts.

A number of studies have been performed on the swimming abilities of larger fishes (eg. Thomas and Donahoo 1977; Buckley et al. 1985). Apparatus used in each of these studies appeared unsuitable for determining swimming speeds of fishes such as shiners. Much of the literature on small fishes related to swimming abilities often involve selection of habitats in an artificial stream by fishes rather than assessing ability of the fish to successfully negotiate a current of known velocity (eg. Matthews et al. 1990). In this study we determine the endurance of the bigeye shiner (Notropis boops) to select current velocities from low velocities to velocities which produce complete failure by the fish to negotiate.

MATERIALS AND METHODS

Layher and Ralston (1995) found significant differences between swimming performance of small fishes collected by seining and those collected by electrofishing. Consequently all fishes used in this study were collected by seining which was assumed to have no negative impact on the fishes swimming ability. Several collections of fishes were made in the Ouachita River and tributaries. These collections provided specimens which were housed in a controlled environment where oxygen and temperature were held relatively constant. Temperatures varied from 17.9 to 20.1 C and dissolved oxygen ranged between 6.0 and 7.0 mg/l.

Ralston and Layher (1997) described an ichthyonatometer, a device designed to allow the determination of either fish swimming endurance at a select velocity or the point at which a fish can no longer traverse the current. This device was used in this study. The device produces velocities from 0 to over 100 cm/sec. Six different velocities were used to assess the endurance of bigeye shiners: 26, 33, 36, 39, 46, and 53 cm/sec.

Prior to placing fish in the ichthyonatometer, water temperature in the tank of origin was compared to that in the swimming chamber reservoir to ensure no significant temperature difference. Fish were inspected upon removal from their aquarium for signs of disease or fungus. No fish were used that displayed any signs of ill health or incomplete caudal fins. Fish were allowed to acclimate to low flow levels in the chamber before velocity was gradually increased to the sesired level. Upon reaching the test velocity, time was recorded to the nearest second until the fish was exhausted or ten minutes had been successfully negotiated. One-hundred and twenty bigeye shiners were tested in the apparatus, 20 at each selected velocity. Fish were tested one at a time to avoid potential effects of flow alteration in the chamber. Percent failure at two minute intervals for each test veelocity were calculated.

RESULTS

Bigeye shiners were able to endure velocities up to 36 cm/sec for two minutes (Table I). Success rate dropped to 90 percent for two minutes when velocities reached 39 cm/sec. At 46 cm/sec 75 percent of the twenty shiners subjected to these velocities failed. No shiners could traverse velocities at 53 cm/sec for any time period.

Success rates of shiners at four minutes began falling at speeds of 33 cm/sec (Table I). However success rates remained high, 95 percent, through velocities of 36 cm/sec. At 39 cm/sec success fell below 50 percent. At 46 cm/sec only 05 percent of the fish could endure for four minutes.

As length of time the fish were subjected to various velocities increased, the percent of success declined (Table I), except for speeds up to 26 cm/sec at which fish easily endured for up to ten minutes. At 33 cm/sec all shiners could swim for two minutes. Success fell to 90 percent at ten minutes. A sudden decline in success occurred at 39 cm/sec with success rates falling from 90 percent for two minutes to only 05 percent at eight and ten minute duration trials. Success fell to zero after eight minutes at 46 cm/sec. No fish could swim for even two minutes at velocities above 53 cm/sec (Fig. 1). There was no significant difference in size of fish used between trials (T=0.996;P>T=0.423)(Table II).

DISCUSSION

Results of these endurance trials suggest that bigeye shiners can traverse higher velocities than sunfishes. No doubt body shape has a great influence on the success rates of endurance trials. Ralston and Layher (1994) reported that golden shiners (Notemigonus crysoleucas) exhibited dramatic declines in length of time the fish could endure at slightly higher water velocities.

Fishes such as these utilize substrate positioning less than darters or stonerollers and hence are probably more likely to be subjected to velocities in the water column. By subtracting velocity from endurance speed for a given time, one could calculate time needed to traverse a potential barrier such as restricted flow through a road culvert. By utilizing times and speeds in Table I, potential distance traveled at any velocity can be calculated. Data can also be used to estimate percentages of fish expected to be successful in such attempts.

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