Ecology of larval Hellbender salamanders, *Cryptobranchus alleganiensis, in the* Great Smoky Mountains National Park

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Cryptobranchus alleganiensis

Introduction

The Hellbender (*Cryptobranchus alleganiensis*) is an aquatic salamander that can reach adult sizes over 29". Once common in Appalachian and Ozark streams in the eastern United States, populations of this giant salamander have waned in recent years (Trauth et al. 1993; Wheeler et al. 2003). Habitat loss, siltation, pollution, disease, human persecution, and exploitation are all suspected as major contributors to the decline (Nickerson and Mays 1973; Trauth et al. 1993; Nickerson and Briggler 2007).

Although C. alleganiensis can live 3-6 years before reaching sexual maturity (Smith 1907), little data has been collected on the habits and habitat of larvae and juveniles of the species due to low representation of these age classes (Pitt and Nickerson 2006). This knowledge, however, is crucial for conservation efforts of the species. Therefore, this study aims to expand knowledge of the ecology of larval Hellbenders and examine possible influences on larval abundance in Hellbender populations.


Study site on Little River-Great Smoky Mountains National Park

Methods

The Little River in the Great Smoky Mountains National Park (GSMNP) was chosen as a study site due to the high percentage of young Hellbenders in comparison to other rivers (Figure 1). During the summers of 2008 and 2009, skin diving in conjunction with rock turning was utilized to search for Hellbenders. Captured individuals were massed, measured, and marked if necessary. Adult and large juveniles were injected with Passive Implant Transmitter (PIT) tags, while larvae were marked with a unique coding system using Visible Implant Elastomer (Northwest Marine Technology). Stomach contents of larval Hellbenders were obtained by inserting small feeding syringes into the mouths and flushing stomachs with river water. The locations of each capture were marked using a GPS unit. Microhabitat parameters including water depth, water temperature, pH, salinity, conductivity, water flow, and gravel/rock size were measured at each capture site. Relative crayfish abundances were also noted.

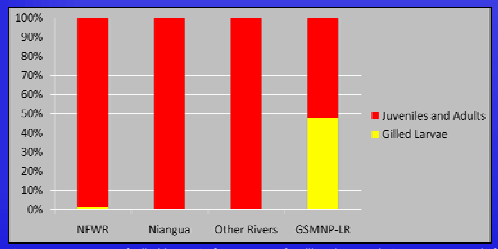

Figure 1. Percentage of gilled larvae in four groups of Hellbender populations. NFWR stands for North Fork of the White River (Missouri). "Other rivers" include the Spring River, Eleven Point River, Gasconade River, and Big Piney River (Missouri) (Taber et al. 1975; Peterson et al. 1988; Nickerson et al 2003).

Preliminary Results

During 2008 and 2009 a total of 40 Hellbenders were captured (Figure 2). Three adults were recaptured. Twenty gilled larvae are included in the sample. Stomach contents of nine larvae were obtained. Preliminary observation suggests that larval Hellbenders in the Little River are feeding primarily on aquatic insect larvae from the orders Ephemeroptera, Tricoptera, and Plecoptera. Gravel size under rock shelters of larvae was classified as cobble and pebble, and ranged from 11 mm to 180 mm. Crayfish relative abundance was low (min=0.015; max=0.160; mean=0.066). Ranges for additional larval habitat parameters are displayed below in Table 1.

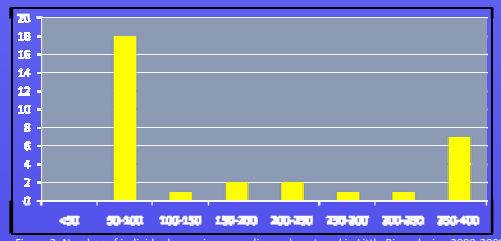

Figure 2. Number of individuals per size group (in mm) captured in Little River during 2008-2009.

Table 1. Microhabitat parameters of larval Hellbenders captured in the Little River during 2008 and 2009. Shelter size and water depth in mm, temperature in °C.

	Min	Max	Mean
Shelter size	145	1085	455.71
pH	6.8	7.4	7.02
Water Depth	250	748	459.06
Water Temperature	19.7	23.5	21.61


Larval Hellbender captured during 2008.

Acknowledgements

I'd like to thank the Reptile and Amphibian Conservation Corp, The Great Smoky Mountains Conservation Association, and the Cryptobranchid Interest Group for financial backing; The Great Smoky Mountain Institute at Tremont for food, housing, and volunteers; Philip Colclough and the Knoxville Zoo for support; and all of my other volunteers for their contributions. Thank you to Great Smoky Mountains National Park and Paul Super. Many thanks to my advisors, Dr. Max Nickerson and Dr. Perran Ross, for their input on this project.


Captured Hellbender being processed

Discussion

Several hypotheses have formed regarding the lack of Hellbender larvae captures, including survey methodologies, habitat structure, and survival (Nickerson et al. 2003). It seems probable that there are many causal mechanisms for the relative abundance of smaller age classes. Nickerson et al (2003) noted that age classes within the North Fork of the White River in Missouri demonstrated niche partitioning within habitat structure (Figure 3) and speculated that larvae avoid detection by hiding within the interstices of gravel, which the Little River lacks due to its bedrock character. My data demonstrate that larvae in Little River appear to utilize large rocks as shelter and do not display the same type of niche partitioning seen in other populations. It seems logical that if Hellbenders are more vulnerable to capture, they may be more vulnerable to predation as well. If higher predation rates on larvae exist in Little River, fewer larvae would be expected to survive to adulthood. Hellbenders do superficially appear to have niche partitioning with regards to food resources between larvae and adults in the Little River.

Low crayfish relative abundance could also be a contributing factor to the population structure. Crayfish represent the majority of adult Hellbender diets, although they prey on a variety of items including their own species. Based on crayfish relative abundance data, Little River may support fewer adults due to low prey base. Because all age classes appear to share similar habitat preferences within Little River, fewer adults could lead to more open niche space for smaller age classes and less direct predation by adults. To further examine this idea, I will compare body conditions of Hellbenders that inhabit areas with varying crayfish densities.

More study is needed on these and other hypotheses before the mechanism behind the high abundance of larvae in Little River can be determined. Future research should include larval movement, competition among different age classes, and survival/reproductive rates. These studies are needed to better understand Hellbender ecology, which is essential to successful conservation efforts.

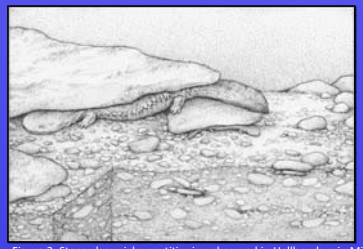
Figure 3. Stage class niche partitioning observed in Hellbenders in Missouri. Reprinted from Nickerson et al. 2003.

Larval Hellbenders appear to regularly feed on caddisfly and mayfly nymphs

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