

Observations of Interspecific and Conspecific Cover-Object Sharing by Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) in a Pennsylvania Stream Section with Limited Cover-Rock Habitat

Amber L. Pitt^{1,*}, Sean M. Hartzell², Jamie L. Shinskie³, and Reiley Robinson²

Abstract - *Cryptobranchus alleganiensis* (Hellbender) are large aquatic salamanders native to cool, high-quality streams and rivers in the eastern US. Hellbenders inhabit areas that have large, flat cover rocks with open space underneath for sheltering and breeding. Reports of Hellbenders sharing cover with conspecifics and fish are rare, suggesting Hellbenders will displace other organisms from shelter rocks. In a tributary of the North Branch Susquehanna River in Pennsylvania, at least 17% (but possibly 26%) of Hellbenders we observed during surveys shared cover rocks with conspecifics, and 17% shared cover rocks with fish, including *Cottus* sp. (sculpin), *Noturus* sp. (madtom catfish), and *Anguilla rostrata* (American Eel). We suspect these observations may be attributable to a paucity of available cover rocks at this site and may increase the likelihood of ecological interactions among Hellbenders and with other organisms.

Cryptobranchus alleganiensis (Sonnini de Manoncourt and Latreille) (Hellbender) are large (up to 74 cm total length), fully aquatic salamanders native to cool, high-quality and highly oxygenated streams in the eastern US (Nickerson and Mays 1973, Petranka 1998). A typical feature of Hellbender habitat is the presence of large, flat cover rocks with open space underneath, which are used for shelter and breeding habitat by this species (Hillis and Bellis 1971, Nickerson and Mays 1973, Rossell et al. 2013). Hellbenders have been observed underneath cover rocks with conspecifics during the fall breeding season when males will compete with other males for cover rocks used as nesting habitat (den sites), and females will enter den sites guarded by males to lay eggs (Bishop 1941, Nickerson and Mays 1973). Post-breeding males will also guard eggs and larvae from predators (Bishop 1941, Nickerson and Mays 1973) and may associate with larvae for a period of time (Groves et al. 2015). Hellbenders are typically not observed with conspecifics under cover outside of observations associated with reproductive activities and seasons (but see Bodinof Jachowski and Hopkins 2013), which last a few weeks from late August through early September in northern populations of this species (reviewed by Nickerson and Mays 1973). The paucity of published observations reporting conspecific cover sharing outside of the breeding season suggests that Hellbenders are typically territorial and compete with and displace conspecifics (Hillis and Bellis 1971, Humphries and Pauley 2005, Nickerson and Mays 1973, Rossell et al. 2013). Hellbenders are well-known to consume smaller conspecifics (Groves and Williams 2014, Nickerson and Mays 1973), suggesting cannibalism may be a contributing factor.

Likewise, reports of other vertebrate species co-occupying cover rocks with Hellbenders appear to be rare. Nickerson and Mays (1973) reported single occurrences of *Ictalurus*

¹Environmental Science Program, Trinity College, 300 Summit Street, Hartford, CT 06106. ²Division of Environmental Services, Pennsylvania Fish and Boat Commission, 595 East Rolling Ridge Drive, Bellefonte, PA 16823. ³Pennsylvania Department of Military and Veterans Affairs, Fort Indiantown Gap National Guard Training Center, Building 26-151 Tomstown Road, Annville, PA 17003. *Corresponding author - amber.pitt@trincoll.edu.

punctatus (Rafinesque) (Channel Catfish) and *Ambloplites rupestris* (Rafinesque) (Rock Bass) underneath cover rocks with Hellbenders. *Necturus maculosus* (Rafinesque) (Mudpuppy) have also been occasionally observed sharing rocks with Hellbenders (Bishop 1941, Nickerson and Mays 1973). Because Hellbenders may consume smaller vertebrates, such as fish and other salamanders (Bishop 1941, Nickerson and Mays 1973), it is likely that the few reports of smaller vertebrates observed co-occurring under cover rocks with Hellbenders represents predator avoidance by prey. It is possible that larger fishes may compete with Hellbenders for shelter space and prey organisms, which could explain the paucity of these observations. Alternatively, the paucity of observations of Hellbenders sharing cover with other vertebrate species might be attributed to survey technique or protocol rather than avoidance. For instance, many researchers survey for Hellbenders by snorkeling and lifting rocks (Nickerson and Krysko 2003) and non-focal species may have an opportunity to escape or may be disregarded in pursuit of Hellbenders. Nonetheless, given the paucity of these reports in the literature, these observations are important to consider in order to broaden our understanding of Hellbender ecology.

While surveying a tributary of the Susquehanna River, PA, to assess the population status of *Cryptobranchus alleganiensis alleganiensis* (Sonnini de Manoncourt and Latreille) (Eastern Hellbender), we observed instances of conspecific and interspecific cover-object sharing which have rarely been reported for this species. During 2015, 2016, and 2024, we searched for Hellbenders at 2 sites, each ~200 m in length, separated by unsuitable habitat, and located within the lower reaches of a middle-order tributary of the North Branch Susquehanna River in eastern Pennsylvania. We selected the 2 sites based on availability of cover objects. We have restricted location information as this species is designated as a “species of greatest conservation need” by the Pennsylvania Fish and Boat Commission, and Hellbender populations are vulnerable to illicit collection (Nickerson and Briggler 2007). During June and July 2015, we surveyed the further downstream of the 2 sites 11 times for the presence of Hellbenders using snorkeling and rock-lifting surveys as described by Nickerson and Krysko (2003). We specifically noted observed conspecific and interspecific co-occupancy as part of our protocol, as had been done by Nickerson and Mays (1973). We measured, pit-tagged, and released all individuals captured. We captured and released a total of 12 individuals during this survey period, consisting of adult and sub-adult individuals.

At least 2, but possibly 4, of the 12 Hellbenders were sharing a cover object with a conspecific, and 3 Hellbenders were sharing cover with fish as follows. On 6 June 2015 at 13:54, we captured 2 Hellbenders of unknown sex (one measuring 45.7 cm and the other 31.4 cm total length [TL]) that, based on proximity to the cover rock and lack of detection during a visual scan of the broader area prior to lifting the cover rock, appeared to both have been located under a rock 54 cm length by 36 cm width, though the smaller individual was first observed and captured just outside of the cover of the rock immediately after the capture of the larger individual. Given the proximity to the cover rock and our assessment of the area prior to lifting the rock, it is unlikely, though not impossible, that the individual would have been previously undetected if it had not been co-occupying the space under the lifted cover rock. The larger individual had a bite mark in its tail and 2 scars on its head, likely from another Hellbender. On 25 July 2015 at 13:52, we captured 2 Hellbenders of unknown sex (one measuring 40.4 cm and the other 38.8 cm TL) under a cover rock 32 cm length by 15 cm width. The smaller individual had a few bite marks, likely of Hellbender origin based on bite size and shape, on its tail. The larger individual had a small scar on its head. During these surveys, we also observed 2 instances in which an adult Hellbender shared

a cover rock with *Cottus* sp. (sculpin) and 1 instance where an adult Hellbender shared a cover rock with *Noturus* sp. (madtom catfish). We also conducted surveys utilizing the same techniques in the more upstream site on 2 occasions in May 2016 and captured a total of 6 individuals varying from larvae to adults. Of these, 2 Hellbenders were observed sharing a cover rock, and none were observed with fish. Specifically, on 18 May 2016 at 11:47, we captured 2 Hellbenders of unknown sex (one measuring 35.7 cm and the other 29.7 cm TL) under a cover rock 90 cm length and 70 cm width. On 9 July 2024, we returned to the more downstream site to re-evaluate the status of the Hellbender population. We observed 5 Hellbenders (all sub-adults) during our 1-day survey. While lifting 1 large cover rock, we observed a sub-adult Hellbender present underneath the rock with a single *Anguilla rostrata* (Lesueur) (American Eel). Unfortunately, both animals escaped capture and thus measurement, but were visually estimated to each be ~30 cm in total length. No Hellbenders were observed sharing cover with conspecifics during our 2024 survey.

As summarized above, reports of Hellbenders sharing shelter with conspecifics outside of the breeding season and with other vertebrates appear to be uncommon. Of 23 total Hellbenders observed during our surveys of this study stream, at least 4 (~17% of the total), but possibly 6 (~26% of the total), were occupying cover rocks with another Hellbender, and 4 (~17% of total) were occupying cover rocks with fish. We speculate this may be attributed to a limited availability of cover rock at this site, which may increase the probability of Hellbenders co-occupying cover with other organisms. During our 2015 surveys, we noted that cover rock in this stream appeared to be qualitatively more limited than other streams we have surveyed for Hellbenders within other portions of their range, and during our 2024 survey, we noted that cover rock was less abundant than previously observed. We hypothesize that this may be attributable to rocks being dislodged and washed downstream during major flooding events (which this area has experienced in recent years) and/or due to their removal by people in order to build structures, which has occurred elsewhere in Hellbender habitats (Unger et al. 2017). Hellbenders have been declining or have undergone range restrictions throughout much of their range (Briggler et al. 2007) including populations in the Susquehanna River basin (Pitt et al. 2017), and the degradation of habitat, including sedimentation or removal of cover rocks, is one of several factors that have been implicated in the decline of Hellbender populations (Briggler et al. 2007, Unger et al. 2017).

The co-occurrence of small, benthic fishes under cover rock such as sculpins and madtom catfish may benefit Hellbenders by increasing availability of prey; however, it is possible that small fishes may also prey upon Hellbender eggs and larvae. The co-occurrence of larger fishes and conspecifics under cover may be detrimental if there is competition for space and prey items and could increase the risk of Hellbender mortality by cannibalism. Future behavioral studies may be able to further evaluate interactions among Hellbenders and with co-occurring organisms under cover rocks in the context of negative or positive ecological interactions. Additionally, future studies could explicitly document and report observed conspecific and interspecific co-occupancy as part of their protocol and use other techniques such as underwater cameras or borescopes to elucidate if interspecific cover-sharing by Hellbenders and other vertebrates is more common than revealed by more traditional snorkeling and rock-lifting surveys.

Acknowledgments. We thank Joseph Tavano, Rachel Johnson, Cody Pavlick, Eric Wahlman, Shane McLaughlin, Anna Maria Imwalle, Kathy Gipe, Josh Brown, Lydia Delp, Jarren Uplinger, Sam Hall, Dean Stavrides, and Soren Meyers for assistance during field surveys. Financial support was provided by Bloomsburg University of Pennsylvania and Trinity College. This work was approved by the Pennsylvania Fish and Boat Commission (Scientific collectors permits #2015-01-0154, #2016-01-0146, #2016-01-0430, and #2024-01-0312) and the Institutional Animal Care and Use Committees

A.L. Pitt, S.M. Hartzell, J.L. Shinskie, and R. Robinson

of Bloomsburg University of Pennsylvania (Protocols 122, 141-R) and Trinity College (Protocol B-88-24). The findings and conclusions in this note are those of the authors and may not necessarily represent those of the Pennsylvania Fish and Boat Commission.

Literature Cited

- Bishop, S. 1941. The Salamanders of New York. New York Museum Bulletin No. 324. New York State Museum, Albany, NY. 365 pp.
- Briggler, J., J. Utrup, C. Davidson, J. Humphries, J. Groves, T. Johnson, J. Ettlign, M. Wanner, K. Traylor-Holzer, D. Reed, V. Lindgren, and O. Byers (Eds.). 2007. Hellbender population and habitat viability assessment. IUCN/SSC Conservation Breeding Specialist Group, Apple Valley, MN. 46 pp.
- Bodnof Jachowski, C.M., and W.A. Hopkins. 2013. *Cryptobranchus alleganiensis alleganiensis* (Eastern Hellbender) aggregate behavior. *Herpetological Review* 44:292.
- Groves, J.D., and L.A. Williams. 2014. *Cryptobranchus alleganiensis alleganiensis* (Eastern Hellbender) cannibalism. *Herpetological Review* 45:108–109.
- Groves, J.D., L.A. Williams, and S.P. Graham. 2015. *Cryptobranchus alleganiensis alleganiensis* (Eastern Hellbender) larval/adult association. *Herpetological Review* 46:70–71.
- Hillis, R.E., and E.D. Bellis. 1971. Some aspects of the ecology of the Hellbender, *Cryptobranchus alleganiensis alleganiensis*, in a Pennsylvania stream. *Journal of Herpetology* 5:121–126.
- Humphries, W.J., and T.K. Pauley. 2005. Life history of the Hellbender, *Cryptobranchus alleganiensis*, in a West Virginia stream. *American Midland Naturalist* 154:135–142.
- Nickerson, M.A., and J.T. Briggler. 2007. Harvesting as a factor in population decline of a long-lived salamander, the Ozark Hellbender, *Cryptobranchus alleganiensis bishopi* Grobman. *Applied Herpetology* 4:207–216.
- Nickerson, M.A., and K.L. Krysko. 2003. Surveying for Hellbender salamanders, *Cryptobranchus alleganiensis* (Daudin): A review and critique. *Applied Herpetology*. 1:37–44.
- Nickerson, M.A., and C.E. Mays. 1973. The Hellbenders: North American Giant Salamanders. Milwaukee Public Museum Publications in Biology and Geology, Milwaukee, WI. 106 pp.
- Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian, Washington, DC. 587 pp.
- Pitt, A.L., J.L. Shinskie, J.J. Tavano, S.M. Hartzell, T. Delahunty, and S.F. Spear. 2017. Decline of a giant salamander assessed with historical records, environmental DNA, and multi-scale habitat data. *Freshwater Biology* 62:967–976
- Rossell, C.R., Jr., P. McNeal, D.P. Gillette, L.A. Williams, S.C. Patch, and A.G. Krebs. 2013. Attributes of shelters selected by Eastern Hellbenders (*Cryptobranchus a. alleganiensis*) in the French Broad River Basin of North Carolina. *Journal of Herpetology* 47:66–70.
- Unger, S.D., L.A. Williams, J.D. Groves, C.R. Lawson, and J.W. Humphries. 2017. Anthropogenic associated mortality in the Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*). *Southeastern Naturalist* 16:N9–N13.