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CONSERVATION STATUS OF HELLBENDERS (*CRYPTOBRANCHUS ALLEGANIENSIS*) IN ALABAMA, USA

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***Abstract.*—Hellbenders (*Cryptobranchus alleganiensis*) historically occurred in large numbers in the eastern United States, but they have undergone a considerable decline due to habitat modification and its subsequent effects on stream quality. To evaluate the Hellbender's current status in Alabama, we verified several recent anecdotal sightings of Hellbenders, and conducted 355 person hours of surveys and 31 trap nights in most historical collection localities and at several additional sites that we considered suitable for this species. We failed to find any Hellbenders during our survey. If Hellbenders still exist in Alabama, they represent relict populations that occur in very low population densities, and likely will be extirpated from the state in the near future. The apparent decline and possible extirpation of Hellbenders in Alabama is probably related to degradation of habitat and water quality resulting from large scale impoundments and land use patterns. As such, land use and water utilization practices will likely persist, and we recommend that conservation efforts intended for this species in Alabama be focused on other species, or on other areas of this species' range where conservation success is more feasible.**

Key Words.—Alabama, amphibian declines, conservation status, *Cryptobranchus alleganiensis*, population status

INTRODUCTION

The Hellbender (*Cryptobranchus alleganiensis*) is a large, fully aquatic cryptobranchid salamander found in cold, clear, rocky streams of the eastern United States (Conant and Collins 1991; Petranka 1998). Populations of Hellbenders have undergone an alarming decline during the past century, and they are therefore afforded protection in most states where they occur, and are considered near threatened by the IUCN Red List (Phillips and Humphries 2005; IUCN Red List, http://www.iucnredlist.org [accessed 28 May 2011]). Hellbenders reportedly are extirpated from some regions (e.g., areas of Indiana, Illinois, and Ohio; Williams et al. 1981; Phillips and Humphries 2005), occur only in small numbers in other regions (Williams et al. 1981; e.g., Maryland, Gates et al. 1985; regions of Ohio, Pfingsten 1990), and occur in stable, reproducing populations within a small fraction of their former range (e.g., West Virginia, Humphries and Pauley 2005; Georgia, Jeff Humphries unpubl. report; New York, Foster et al. 2009). Hellbenders are long-lived (living up to 30 years old; Taber et al. 1975), and thus a non-reproducing, aging population can persist for decades (Wheeler et al. 2003). The conservation of Hellbenders involves similar challenges as those exemplified by other imperiled species that exhibit similar life histories (e.g., turtles, Congdon et al. 1993, and freshwater mussels, Strayer et al. 2004; Wheeler et al. 2003). Therefore, conservation strategies employed for these groups may also be useful for the conservation of Hellbenders (Wheeler et al. 2003).

Northern Alabama represents the southernmost boundary of the Hellbender's range, with populations reported from several streams within the Tennessee River drainage (Mount 1975). Sizes of populations have never been estimated; consequently, historic abundance in Alabama is unknown. However, based on museum records (Auburn University Museum, AUM, and University of Alabama Herpetological Collections, UAHC, records; Mount 1975), Hellbenders were collected by turning rocks in at least 11 localities in five north Alabama counties from 1950–1979. However, by 1975 Hellbenders were already facing extirpation in Alabama (Mount 1975).

To date, no survey on population or distributional status of Alabama Hellbenders has been published (Cline 2004). We conducted visual encounter and trapping surveys from 2006–2010 in streams throughout northern Alabama to determine the conservation status of this species. We surveyed most historical collection localities, often multiple times, and several additional

TABLE 1. Collection effort and sites surveyed for Hellbenders (*Cryptobranchus alleganiensis*) in northern Alabama, U.S.A., 2006–2010. Dates refer to month/day/and year of survey, or the range of years during which surveys were conducted (e.g., the survey of George Cline and James Rayburn). Sites visited multiple times are indicated with multiple dates.

County	Stream	Site	Date(s)	UTM E	UTM N	Person hours	Trap nights
Colbert	Bear Creek	Bear Creek at Natchez Trace Pkwy	7/23/2010	399927	3836011	0	4
"	Cane Creek	Cane Creek Canyon Preserve	9/1/2008	426169	3831907	8	
"	"	"	7/18/2010	426169	3831907	6	
Franklin	Bear Creek	Bear Creek at Pleasant Site	2006–2007	402135	3821663	2	
"	Dismals Branch	Dismals Preserve	July 2006	428087	3798155	3	
"	"	"	5/8/2007	428087	3798155	3	
"	"	"	5/8/2007	428087	3798155	0	1
"	"	"	4/29/2010	428087	3798155	2	
"	"	"	4/30/2010	428087	3798155	8	
"	"	"	7/15/2010	428087	3798155	2	
"	Little Bear Creek	Little Bear Creek at State Rd 187	7/13/2008	419828	3806952	1	
"	"	"	7/13/2008	441303	3805103	1	
Jackson	Coon Creek	Coon Gulf	6/28/2007	621094	3844778	32	
"	"	"	6/29/2007	621094	3844778	4	
"	Estill Fork, Paint Rock River	Estill Fork at Freedom Baptist Church	2006-2007	575996	3863417	2	
"	Paint Rock River	Paint Rock River near Skyline WMA	7/1/2010	576241	3863240	2	
"	"	Paint Rock River 1.8 mi N County Road 20 on State Rd 65	"	568570	3848742	2	
Lauderdale	Bluff Creek	County Rd 14/Bluff Creek at Gravelly Springs	5/2/2010	416983	3860730	1	
"	Butler Creek	Butler Creek	8/19/2008	444223	3870261	10	
"	"	"	5/17/2010	444223	3870261	5.33	
"	"	"	5/18/2010	444223	3870261	5	
"	Cypress Creek	Cypress Creek at County Rd 16	8/18/2008	436435	3857568	16.25	
"	"	Wildwood Park	2006-2007	436383	3851509	10	
"	"	"	8/20/2008	436383	3851509	9.75	
"	"	Civil War Dam	2006-2007	435213	3852262	6	
"	"	Horseshoe Bend	"	435264	3852139	3	
"	"	Sharp's Mill	"	435541	3863083	10	
"	First Creek	Blowing Springs Cave Forever Wild Tract	10/20/2010	472293	3858329	2	
"	"	"	10/21/2010	472293	3858329	1.2	
"	Indian Camp Creek	County Rd 61 at Indian Camp Creek	7/12/2008	442576	3865647	1	
"	"	"	10/28/2010	442576	3865647	1	
"	Little Butler Creek	County Rd 61 at little Butler Creek	7/12/2008	443740	3871253	4	
"	"	"	7/23/2010	443740	3871253	4	
"	"	"	10/28/2010	443740	3871253	2	
"	"	"	10/29/2010	443740	3871253	0	5
"	Little Cypress Creek	County Rd 16 at Little Cypress Creek	7/12/2008	432758	3857649	2	
"	"	County Rd 8 at Little Cypress Creek	"	427847	3865779	4	
"	"	"	5/2/2010	427847	3865779	2	
"	"	"	7/23/2010	427847	3865779	2	
"	"	"	7/24/2010	427847	3865779	0	6
"	"	"	10/28/2010	427847	3865779	2	
"	"	"	10/28/2010	427847	3865779	0	5
"	Second Creek	Second Creek at State Rd 64	7/24/2010	469552	3869722	2	
"	Shoal Creek	Goose Shoals (Shoal Creek at County Road 8)	8/18/2008	445840	3868019	4	
"	"	Shoal Creek	8/19/2008	445840	3868019	25	
"	"	Goose Shoals (Shoal Creek at County Road 8)	7/23/2010	445840	3868019	0.25	
Limestone	Big Creek	Big Creek	5/1/2010	496209	3856626	4	
"	"	"	6/1/2010	496209	3856626	4	
"	Bluewater Creek	Bluewater Creek at U.S. Hwy 72	7/12/2008	462022	3857379	4	
"	"	Bluewater Creek at State Rd 64	7/24/2010	460548	3868458	0	6
"	Elk River	Elk River at TN border	7/23/2010	497927	3871996	0.25	
"	Limestone Creek	Limestone Creek	7/12/2008	512170	3832298	2	
"	Piney Creek	Piney Creek	7/12/2008	510597	3831755	0	
"	Sugar Creek	Sugar Creek at State Rd 99	7/24/2010	485794	3866859	0	4
Madison	Brier Creek	Brier Fork at Bell Factory	2006-2007	546949	3853343	6	
"	Flint River	Flint River at Three Forks	"	547258	3853520	4	
"	"	"	5/1/2010	547258	3853520	8	
"	"	"	7/1/2010	547258	3853520	6	
"	"	Flint River at U.S. Hwy 72	5/1/2010	551167	3844476	8	
"	"	Flint River at Sulphur Springs	2006-2007	545318	3864209	4	
"	"	"	7/1/2010	545318	3864209	25	
"	"	"	10/29/2010	545318	3864209	2	
"	"	Bloucher Ford	2006-2007	548057	3859180	4	
"	"	Horseshoe Bend of Flint River	"	548236	3854271	2	
"	Hurricane Creek	Hurricane Creek SE New Market	"	556074	5859854	2	
"	Mountain Fork, Flint River	Mountain Fork of Flint River at New Market	"	552377	3863634	2	
"	"	"	5/1/2010	552377	3863634	6	
"	"	Mountain Fork of Flint River at Old Mountain Fork Rd	2006-2007	554331	3864012	2	
"	"	"	"	553266	3863854	2	
"	"	"	7/25/2010	554331	3864012	1	
"	West Fork, Flint River	West Fork of Flint River at Fisk	2006-2007	539069	3868796	2	
"	"	"	5/1/2010	539069	3868796	8	
"	"	"	7/25/2010	539069	3868796	4	
"	"	"	10/29/2010	539069	3868796	1	
Marion	Bear Creek	Bear Creek, State Rd 13	5/1/2010	435330	3791957	1	
"	"	Bear Creek, State Road 241 to U.S. Hwy 43; canoe survey	7/16/2010	433797	3793143	16	
Morgan	Baker Creek	Baker Creek	5/1/2010	495777	3829263	8	
"	Ginhouse Branch	Ginhouse Branch, Wheeler NWR	7/12/2008	511615	3823047	4	

localities and streams we deemed suitable for Hellbenders based on habitat descriptions in Mount (1975) and Petranka (1998). In addition, we verified several recent, anecdotal reports of Hellbenders from other biologists in Alabama. Our goal was to match or exceed the collection efforts used by previous researchers in other parts of the Hellbender's range and compare our findings to these studies as a means to determine the species' current population status. Our data were used to classify the status of Hellbenders in Alabama into one of three conservation status categories, adapted from studies of freshwater mussels (Brim Box and Williams 2000; Strayer et al. 2004): (1) extirpated (zero Hellbenders found); (2) relict (few adults found; few dead individuals found); or (3) stable (several Hellbenders of many size classes found, including evidence of current reproduction).

MATERIALS AND METHODS

We contacted biologists and stream ecologists who lived or conducted surveys within the Hellbender's historical range within Alabama and asked them to provide information on Hellbender occurrences. We investigated several unvouchered sightings, and when possible, we deposited specimens and/or photographs at AUM. Here, we report only verified sightings with supporting physical evidence (photographs or specimens).

We conducted timed visual encounter surveys of historical and newly designated sites during summer 2006–2007 (113 person hours), summer 2008 (88 person hours), and spring–fall 2010 (154 person hours; Table 1). Most surveys consisted of at least two people wading through shallow rocky creeks looking for large flat rocks. When a rock was located, one person would lift it, while the other stood downstream with a dip net and reached under the rock to sweep animals into the net. We often used Peavey hooks to lift rocks that were too large to lift by hand, as recommended by Soule and Lindberg (1994), and in most cases the researcher who searched under the rock wore a mask and snorkel. Most surveys took place in streams shallow enough to warrant this method for surveying and re-surveying localities, and it was not necessary to attempt diving (e.g., Nickerson and Krysko 2003). Rock turning is a recommended (Nickerson and Krysko 2003) and common Hellbender collection method (Foster et al. 2008). In addition, at several historical localities (Table 1) we set flat funnel traps baited with canned tuna, bass-tuna-crayfish mixture, or fish oil in water at least 2 m deep (Foster et al. 2008). Most trapping was conducted at sites where Hellbenders were recently encountered, and in a few cases traps were set in lieu of rock turning surveys due to the lack of large rocks available to search.

RESULTS

Verification of unvouchered reports.—During the study

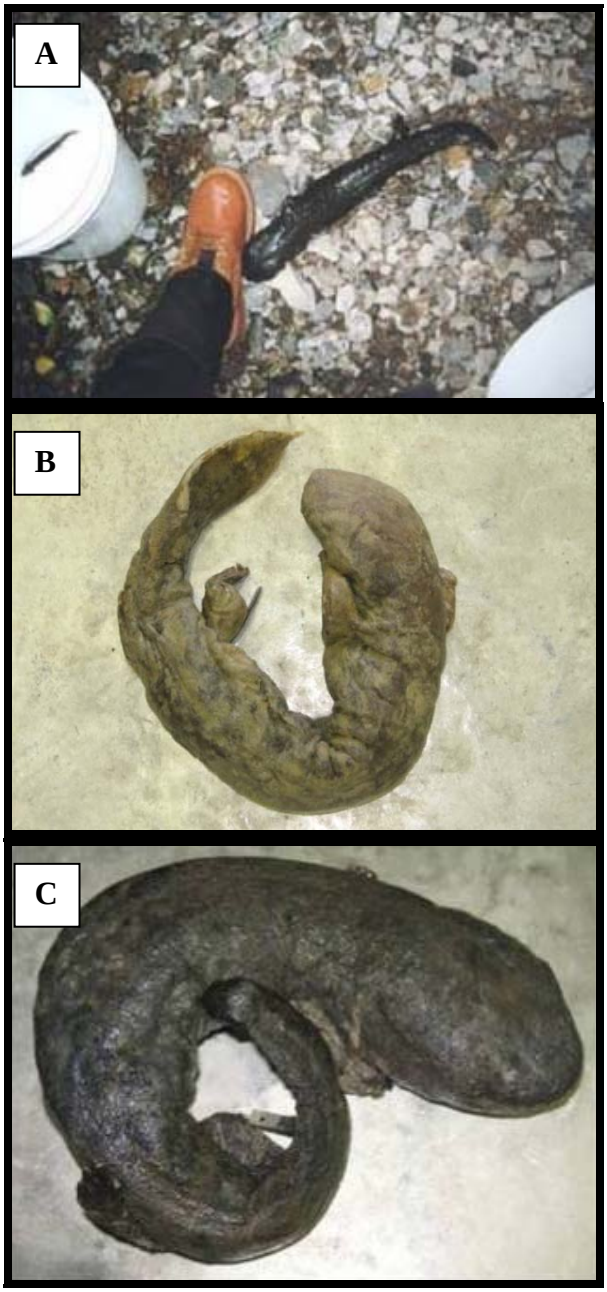

FIGURE 1. The last known Hellbenders (*Cryptobranchus alleganiensis*) encountered in Alabama. A) Hellbender captured alive during fish surveys in Madison County, Alabama in 1999; B) Hellbender found dead in Cypress Creek, Lauderdale County, Alabama in 2004; C) Hellbender found dead in Dismals Canyon, Franklin County, Alabama in 2006. (A photographed by Jeff Powell; B and C photographed by Sean P. Graham)

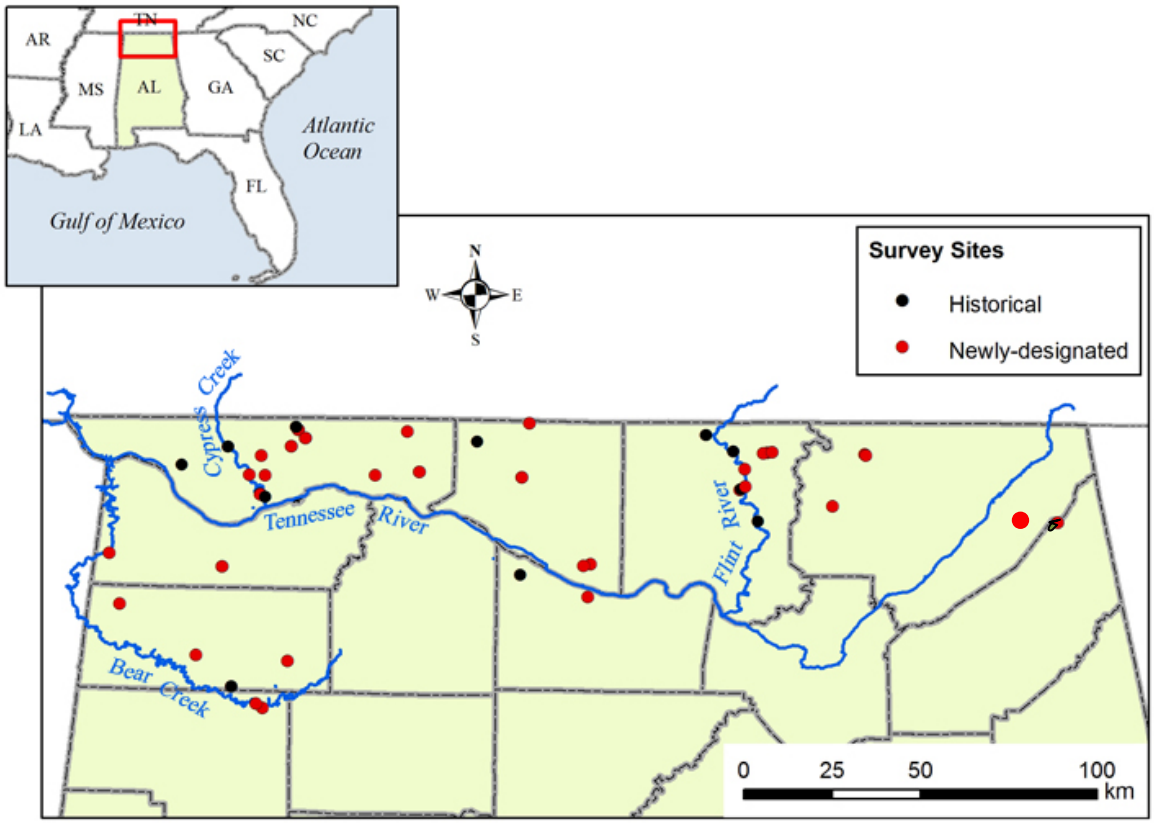

FIGURE 2. Map of sites surveyed for Hellbenders (*Cryptobranchus alleganiensis*), with important streams indicated. Sites surveyed where Hellbenders were collected historically indicated by black dots; newly-designated sites indicated with red. Some sites were in close proximity to each other and may appear as a single dot. Grey boundaries indicate counties.

period, several recent Hellbender sightings were confirmed and available specimens and photographs were deposited in the Auburn University collections. A 1990 newspaper clipping with a photograph of a Hellbender and its captor served as a photographic voucher for the first county record of this species in Limestone County, Alabama (Graham et al. 2009). A photograph of a Hellbender (AUM AHAP-D 252; Fig. 1a) encountered alive in 1999 by stream ecologists in a Madison County tributary of the Flint River was vouchered and deposited in the AUM digital photo archive. Another 30 cm snout-vent-length (SVL) specimen (AUM 37995; Fig. 1b) found dead in Cypress Creek, Lauderdale County, Alabama, was collected in 2004 by Tom Haggerty (University of North Alabama), and donated to AUM on request. Finally, a 38 cm SVL specimen (AUM 38598; Fig 1c) found dead in 2006 in Franklin County, Alabama, was deposited in AUM during this study.

Survey.—We conducted 355 total person hours of visual encounter (rock turning) surveys at 45 sites and 29 streams in eight Alabama counties (Fig. 2). Eight sites were surveyed twice, four sites surveyed three times, two sites surveyed four times, and two sites surveyed six times (Table 1). These included sites in the Flint, Lower Elk, Paint Rock, Bear Creek, and Cypress Creek sub basins of the Tennessee River drainage in Alabama. Sites re-surveyed were streams with relatively high habitat suitability based upon habitat descriptions (Mount 1975; Petranka 1998; Fig. 3), or sites where Hellbenders were recently encountered (see above). Also, we concentrated trapping at localities with recent Hellbender records within streams for a total of 31 trap nights. During the surveys, we did not encounter a Hellbender.

DISCUSSION

Unfortunately, baseline data are unavailable to enable thorough comparison between our survey effort and past

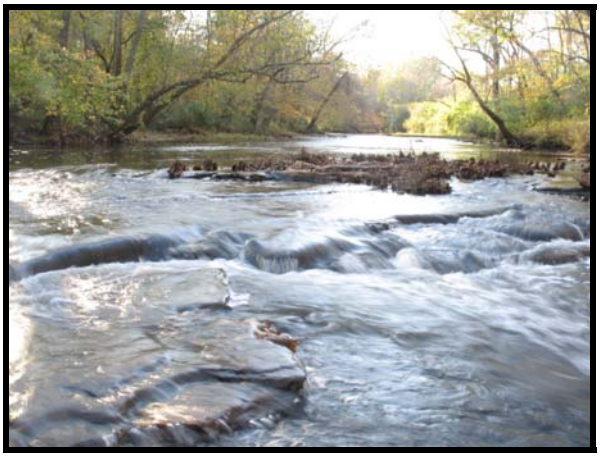

FIGURE 3. Flint River at Sulphur Springs, Madison County, Alabama. Several sites in northern Alabama, such as this one, appear to have suitable substrate and water quality to support Hellbenders (*Cryptobranchus alleganiensis*). (Photographed by Sean P. Graham)

attempts to locate hellbenders in Alabama. However, museum records give an indication of the former abundance of this species in Alabama. Twenty-seven hellbenders were collected from 11 sites in five northern Alabama counties prior to this survey (AUM and UAHC records). Nine Hellbenders were collected from a single locality in Madison County, Alabama, during a two hour search in 1967 (number of collectors unknown; UAHC records), and five Hellbenders were collected by three observers in a single day from the same locality in 1970 (search time unknown; Tom Yarbrough, unpubl. field notes). Similarly, five Hellbenders were collected during a class field trip at one locality in one day in Lauderdale County, Alabama in 1968 (number of person hours unknown; AUM records). In the above cases, the salamanders were permanently removed and preserved. We are unsure if additional Hellbenders were encountered and released during these collection trips, and it is impossible to determine encounter rates from the above information. However, the museum records suggest the possibility that Hellbenders were fairly common in northern Alabama in the recent past, and the current survey indicates that this is no longer the case. The likely time period when the decline of Hellbenders in Alabama took place (e.g., 1970s–1980s) corresponds with the timing of Hellbender declines documented in other areas (Wheeler et al. 2003).

Our results are similar to the results of studies that have documented declines in freshwater mussels in Alabama; because freshwater mussels are long-lived and require excellent water quality and natural substrate regimes to reproduce, low-density populations consisting only of old adults can persist for some time before they become completely extirpated (e.g., relict populations, Brim Box and Williams 2000; Strayer et al. 2004). Similarly, studies that have documented declines in Hellbenders have demonstrated a shift in the age distribution of populations to larger proportions of old adults (Wheeler et al., 2003), and our results may describe the logical next phase of decline and extinction for Hellbenders after this shift to an aging population. We found no living Hellbenders despite conducting extensive surveys. The two most recently (2004 and 2006) encountered Hellbenders in Alabama were found dead, suggesting that populations in Alabama should at best be considered 'relict populations.' This echoes Mount's (1975) assertion that continued habitat degradation in Alabama would eventually lead to the extirpation of Hellbenders in this state.

It should be noted that Foster et al. (2008) recommended trapping as the most effective method for establishing the presence of Hellbenders, and our trapping effort did not meet their recommended minimum effort required to determine their presence using this technique (e.g., 100 trap nights per site). However, our survey effort matches or exceeds that of other studies conducted in other parts of the Hellbender's range, which have been used to monitor populations or to determine baseline or continued status (Phillips and Humphries 2005). For example, Nickerson et al. (2002) encountered 0.25–0.65 Hellbender individuals/h in streams of Great Smoky Mountains National Park and considered this evidence of low population densities. However, in less than a month of surveying, they encountered 39 Hellbenders and a nest (Nickerson et al. 2002). Historical survey data from the White River drainage in Missouri indicate 1,142 Hellbenders were encountered during 750 person hours of effort in 1969 (1.52 individuals/h), and 269 Hellbenders were encountered during 108 person hours of effort (2.49 individuals/h) in 1970 (Nickerson and Mays 1973). A recent survey of this drainage documented 138 Hellbenders in four streams surveyed for 197 person hours (1.08 individuals/h; Phillips and Humphries 2005), and a study in New York documented 123 Hellbenders during ca. 300 person hours of rock turning surveys (ca. 0.41 individuals/h; Foster et al. 2009).

Like Mount (1975), we speculate that the primary cause of the rarity of Hellbenders in Alabama is due to the damming of free-flowing rivers and streams in this area. Historically, the Tennessee River supported an unparalleled freshwater mollusk and fish fauna (Lydeard and Mayden 1995; Neves et al. 1997; Warren et al, 1997; Williams et al. 2008). The Tennessee River is now impounded throughout its entire 300 km Alabama reach, and this led to the elimination and/or endangerment

of an entire freshwater fauna (Neves et al. 1997; Warren et al. 1997; Williams et al. 2008), including Hellbenders (Mount 1975). For example, only 30% of the 91 species of freshwater mussel species known historically from the Tennessee River are known to have reproducing populations, while the rest are considered relic, endangered, extirpated, or extinct (Neves et al. 1997). The Tennessee River in Alabama has one of the highest levels of fish species richness and endemism in the United States, and simultaneously exhibits one of the highest levels of fish imperilment in the Southeast (Warren et al. 1997).

Hellbenders were also not detected in several smaller, non-impounded streams with seemingly suitable habitat that previously supported Hellbender populations (Fig. 3). Jeff Humphries (unpubl. report) found a correlation between Hellbender abundance and land use patterns that affect stream quality in Georgia Hellbender streams. Hellbender abundance was positively correlated with the percentage of forest buffer along streams, which presumably has cascading effects on stream siltation and water temperatures (Humphries, unpubl. report). Fewer Hellbenders were found in streams that had less forest buffer and were, therefore, warmer and more turbid (Humphries, unpubl. report). Although data on percentage of forest buffer around northern Alabama streams are lacking, streams once occupied by Hellbenders have been heavily impacted by agriculture, urbanization, and related water quality degradation (Tsegaye et al. 2006), and thus if the factors identified by Humphries (unpubl. report) also impact populations in northern Alabama, they could explain their current rarity. Finally, if population densities were already low in Alabama when previous museum collections took place, it is possible that over-collection may have played a role in the decline of Hellbenders (see Nickerson and Briggler 2007).

In summary, our most optimistic view for Hellbenders in Alabama is that they may still occur in very small numbers in the state and that this species is in imminent danger of extirpation. Factors impacting water quality in Alabama appear to be related to large scale water impoundment projects, human population growth, and land use patterns (Tsegaye et al. 2006), and are not likely to be ameliorated in the near future. Restoration efforts intended for this species may be better focused on other species, or on other areas of the Hellbender's range where conservation efforts have a better chance for success. For example, conservation effort would be more beneficial for other herpetofaunal species with a need for additional population assessments (e.g., Black Warrior Waterdogs, *Necturus alabamensis*), with a better chance for preservation or recovery (e.g., Red Hills Salamanders, *Phaeognathus hubrichti*), or on property acquisitions to secure large stream buffers in areas of the Hellbender's distribution where stable populations still occur (e.g., the Southern Appalachians).

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LITERATURE CITED

Brim Box, J., and J.D. Williams. 2000. Unionid mollusks of the Apalachicola Basin in Alabama, Florida, and Georgia. Bulletin of the Alabama Museum of Natural History 21:1–143.

Conant, R., and J.T. Collins. 1991. A Field Guide to Reptiles and Amphibians, Eastern and Central North America. Houghton Mifflin Company, Boston and New York, USA.

Cline, G.R. 2004. Eastern Hellbender, *Cryptobranchus alleganiensis alleganiensis*. Pp. 20–21 *In* Alabama Wildlife Vol. III: Imperlied Amphibians, Reptiles, Birds, and Mammals. Mirarchi, R.E., M.A. Bailey, T.M. Haggerty, and T.L. Best (Eds.) The University of Alabama Press, Tuscaloosa, Alabama, USA.

Congdon, J.D., A.E. Dunham, and R.C. Van Loben Sels. 1993. Delayed sexual maturity and demographics of Blanding's Turtles (*Emydoidea blandingii*): Implications for conservation and management of long-lived organisms. Conservation Biology 7:826–833.

Foster, R.L., A.M. McMillan, A.R. Breisch, K.J. Roblee, and D. Schranz. 2008. Analysis and comparison of three capture methods for the Eastern Hellbender (*Cryptobranchus allageniensis allageniensis*). Herpetological Review 39:181–186.

Foster, R.L., A.M. McMillan, and K.J. Roblee. 2009. Population status of Hellbender salamanders (*Cryptobranchus alleganiensis*) in the Allegheny River drainage of New York State. Journal of Herpetology 43:579–588.

Gates, J.E., R.H. Stouffer, J.R. Stauffer. 1985. Dispersal patterns of translocated *Cryptobranchus alleganiensis* in a Maryland stream. Journal of Herpetology 19:436–438.

Graham, S.P., S.K. Hoss, R.D. Birkhead, D.A. Steen, C.K. Ward, and R.H. Mount. 2009. One hundred and one new county records for Alabama amphibians and reptiles. Herpetological Review:40:367–371.

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.

Lydeard, C., and R.L. Mayden. 1995. A diverse and endangered aquatic ecosystem of the southeast United States. Conservation Biology 9:800–805.

Mount, 1975. Reptiles and Amphibians of Alabama. Auburn Printing Company, Auburn, Alabama, USA.

Neves, R.J., A.E. Bogan, J.D. Williams, S.A. Ahlstedt, and P.W. Hartfield. 1997. Status of aquatic mollusks in the southeastern United States: a downward spiral of diversity. Pp. 43–85 *In* Aquatic Fauna in Peril: The Southeastern Perspective. Benz, G.W., and D.E. Collins (Eds.). Southeast Aquatic Research Institute, Special Publication 1. Lenz Design & Communications, Decatur, Georgia, USA.

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*. Applied Herpetology 4:207–226.

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., K.L. Krysko, and R.D. Owen. 2002. Ecological status of the Hellbender (*Cryptobranchus alleganiensis*) and the Mudpuppy (*Necturus maculosus*) salamanders in the Great Smoky Mountains National Park. Journal of the North Carolina Academy of Science 118:27–34.

Nickerson, M.A., and C.E. Mays. 1973. A study of the Ozark Hellbender *Cryptobranchus alleganiensis bishopi*. Ecology 54:1164–1165.

Petranka, J.W. 1998. Salamanders of the United States and Canada. Smithsonian Press, Washington, D.C., USA.

Pfingsten, R.A. 1990. The status and distribution of the Hellbender, *Cryptobranchus alleganiensis*, in Ohio. Herpetological Review 21:48–51.

Phillips, C.A., and W.J. Humphries. 2005. *Cryptobranchus alleganiensis*, Hellbender. Pp. 648–651 *In* Amphibian Declines: The Conservation Status of United States Species. Lannoo, M. (Ed.) University of California Press, Berkeley, California, USA.

Soule, N., and A.J. Lindberg. 1994. The use of leverage to facilitate the search for the Hellbender. Herpetological Review 25:16.

Strayer, D.L., J.A. Dowling, W.R. Haag, T.L King, J.B. Layzer, T.J. Newton, and S.J. Nichols. 2004. Changing perspectives on pearly mussels, North America's most imperiled animals. Bioscience 54:429–439.

Taber, C.A., R.F. Wilkinson, and M.S. Topping. 1975. Age and growth of Hellbenders in the Niangua River, Missouri. Copeia 1975:633–639.

Tsegaye, T., D. Sheppard, K.R. Islam, A. Johnson, W. Tadesse, A. Atalay, and L. Marzen. 2006. Development of a chemical index as a measure of in-stream water quality in response to land-use and land cover changes. Water, Air, and Soil Pollution 174:161–179.

Warren, M.L., P.L. Angermeier, B.M. Burr, and W.R. Haag. 1997. Decline of a diverse fish fauna: Patterns of imperilment and protection in the Southeastern United States Pp. 105–164 *In* Aquatic Fauna in Peril: The Southeastern Perspective. Benz, G.W., and D.E. Collins (Eds.). Southeast Aquatic Research Institute, Special Publication 1. Lenz Design & Communications, Decatur, Georgia, USA.

Williams, J.D., A.E. Bogan, and J.T. Garner. 2008. Freshwater Mussels of Alabama and the Mobile Basin in Georgia, Mississippi, and Tennessee. University of Alabama Press, Tuscaloosa, Alabama, USA.

Williams, R.D., J.E. Gates, C.H. Hocutt, and G.J. Taylor. 1981. The Hellbender: a nongame species in need of management. Wildlife Society Bulletin 9:95–98.

Wheeler, B.A., E. Prosen, A. Mathis, and R.F. Wilkinson. 2003. Population declines of a long-lived salamander: a 20+ - year study of Hellbenders, *Cryptobranchus alleganiensis*. Biological Conservation 109:151–156.

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