Engaging North Carolina's Trout Anglers and Other Stakeholders to Help Conserve Eastern Hellbenders

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Abstract: The eastern hellbender salamander (*Cryptobranchus alleganiensis alleganiensis*) is a protected species of concern in North Carolina as well as in several other states. Despite long-term efforts by the North Carolina Wildlife Resources Commission (NCWRC) and cooperating partners to improve understanding of hellbender status in the state, census of all known and potential populations is lacking. The species' dependence upon clean, cold, well-oxygenated water restricts its distribution to North Carolina's Blue Ridge Ecoregion, overlapping much of the state's trout fishery. This overlap presented an opportunity for the NCWRC to educate trout anglers about hellbender conservation while also offering a chance to supplement existing data of the spatial and temporal distribution of the salamander by enlisting angler help. In 2013, an advertisement within the Public Mountain Trout Waters' portion of the North Carolina Inland Fishing, Hunting and Trapping Regulations Digest initiated direct outreach on hellbender conservation needs to trout anglers. This advertisement complemented NCWRC's summer 2007–summer 2017 outreach efforts to a variety of stakeholders including anglers, recreationists, and landowners that included posters, streamside signage, in-person programming and information tables, popular articles, and a nine-minute online documentary. These combined efforts resulted in 207 hellbender encounter reports from stakeholders, with 127 specifically from anglers. These data represent observations in 56 streams across 17 counties, with seven reports from waters that lacked previous knowledge of hellbender occurrence. Reports originated both from private ($n = 117$) and public land ($n = 90$). The encounter method reported most often was incidental observation ($n = 165$). Much work remains relative to hellbender conservation, but managers should consider exploring similar resource overlaps to collect valuable distribution data, help prioritize locations for monitoring efforts, and promote conservation messages.

Key words: outreach, river, amphibian, fishing, citizen science

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Eastern hellbenders (*Cryptobranchus alleganiensis alleganiensis*) are large, secretive, aquatic salamanders that require relatively clean, cool, and well-oxygenated streams and rivers (Hillis and Bellis 1971, Williams et al. 1981). The species' historical range includes the Appalachian Mountains from northeast Mississippi to New York and through the upper Midwest states of Ohio, Indiana, and Illinois (Ohio River, Tennessee River, Cumberland River, and Susquehanna River drainages) with a disjunct population in the Ozark Mountains in Missouri (Missouri River drainage) (Petranka 1998). A disjunct, endangered subspecies, the Ozark hellbender (*Cryptobranchus alleganiensis bishopi*) also occurs in the Ozark Mountains, both in Missouri and Arkansas (Petranka 1998).

Throughout its historical range, eastern hellbenders have experienced widespread declines and extirpations (Gates et al. 1985, Pfingsten 1990, Mayasich et al. 2003, Wheeler et al. 2003, Foster et al. 2009, Burgmeier et al. 2011, Graham et al. 2011, Keitzer et al. 2013, Quinn et al. 2013, Pitt et al. 2017). This salamander can grow quite large (>0.6 m), is long-lived (>30 years), and slow to mature (age 6–8 years), thereby increasing the vulnerability of low-density populations and/or those with low reproductive success (Petranka 1998, Briggler et al. 2007, Unger et al. 2013). Hellbenders are considered bioindicators of aquatic ecosystem health because they are intolerant of poor water quality (i.e., pollution or sedimentation); water quality and habitat degradation issues often result from a lack of riparian or catchment forest cover as a result of current and/or past land use practices in the watershed (Mayasich et al. 2003, Keitzer et al. 2013, Pugh et al. 2016, Jachowski et al. 2016, Nickerson et al. 2017, Jachowski and Hopkins 2018). Other threats include dams or other barriers to movement, habitat disturbance from intensive recreational use (e.g., moving rocks, building dams), intentional harm, illegal harvest or over-collection, and an overabundance of predators, pathogens, and parasites (Nickerson and Mays 1973, Williams et al. 1981, Gates et al. 1985, Mayasich et al. 2003, Philips and Humphries 2005, Briggler et al. 2007, Nicker-

son and Briggler 2007). The main predators of larvae and juvenile hellbenders are fish, wading birds, snakes, and turtles, while predators of large adult hellbenders include river otters (*Lontra canadensis*), raccoons (*Procyon lotor*), and humans (Nickerson and Mays 1973, Philips and Humphries 2005, Briggler et al. 2007, Hecht et al. 2014).

Hellbenders require abundant large, unembedded, flat boulders to use as shelters and as nest sites. Larvae and large juveniles require cobble beds (Nickerson and Mays 1973, Nickerson et al. 2003, Rossell et al. 2013). Primary food sources for larval and small juvenile hellbenders include aquatic insects, other stream invertebrates, as well as other aquatic salamanders (Hecht-Kardasz et al. 2013, Augustine et al. 2016). Adults and larger juveniles eat mainly crayfish but also small cyprinids, snails, worms, other invertebrates, frogs, and salamanders (Nickerson and Mays 1973, Peterson et al. 1989, Groves and Williams 2014, Augustine et al. 2016, Hecht et al. 2017). Hellbenders also scavenge for discarded bait, carrion, and in some instances harvested trout on in-stream stringers (Townsend 1882, Nickerson and Mays 1973, Nickerson and Krysko 2003).

In North Carolina, hellbenders are identified as a Species of Greatest Conservation Need (SGCN) in the North Carolina Wildlife Action Plan and are protected from harm, collection, possession, or sale as a Special Concern Species (NCWRC 2015). A violation constitutes a Class I misdemeanor with a discretionary fine and up to 120 days in jail. The eastern hellbender was recently petitioned for federal listing under the Endangered Species Act in 2010, with a finding that protection may be warranted pending status assessment (USFWS 2011).

Misconceptions about hellbenders persist widely in western North Carolina and elsewhere, particularly among the angling public. Though unfounded and often exacerbated by the animal's uncharismatic appearance (e.g., slimy skin, beady eyes, large size, writhing motions), common perceptions are that hellbenders harm trout populations, are venomous or poisonous, ruin fishing gear, and are bountied (Nickerson and Mays 1973, Reimer et al. 2013, Mullendore et al. 2014, Perry-Hill et al. 2014, Baker 2017). These misconceptions contribute to the negative attitudes toward hellbenders and historically led to untold numbers of the animals being killed (Nickerson and Mays 1973). Despite a protected status, some people still deliberately harm or kill hellbenders when found in North Carolina; resource managers routinely hear reports of intentional harm or in some cases find direct field evidence. Trout anglers are the most likely user group to encounter hellbenders due to hook-and-line captures or through incidental observation of animals active in the water. Therefore, the angling public represents the highest-priority target audience for engagement to help change attitudes and foster hellbender conservation. Other stakeholders who see hellbenders on occasion, although likely not as frequently as anglers, include recreationists (people using streams for recreational activities other than fishing) and private landowners (people with streamside properties).

Similar to hellbenders, trout resources of North Carolina are located within the state's Blue Ridge Ecoregion, where cold waters support populations of either native brook trout (*Salvelinus fontinalis*) or exotic brown trout (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*). The North Carolina Wildlife Resources Commission (NCWRC) manages the bulk of these resources via its Public Mountain Trout Waters program (PMTW) that encompasses 26 counties and approximately 8,500 km and 870 ha of lotic and lentic waters, respectively, and includes all 17 counties within the hellbender's North Carolina range (Figure 1). Through PMTW, the NCWRC focuses on the enhancement of self-sustaining trout populations and utilization of stocked trout to provide recreational opportunities. Although populations of self-sustaining brown trout and rainbow trout are numerous and an emphasis of NCWRC management, the agency also devotes considerable effort towards conservation of brook trout, a North Carolina SGCN (NCWRC 2015).

In 2014, the NCWRC found that approximately 149,000 anglers fished for trout in PMTW and had an estimated total economic impact to North Carolina's economy of US$383 million (Responsive Management 2015a). Anglers were willing to travel considerable distances (average = 136 km one direction), with two of the top three counties of residence for North Carolina trout anglers being within urban-Piedmont centers: Wake and Mecklenburg counties (Responsive Management 2015b). Furthermore, of the seven

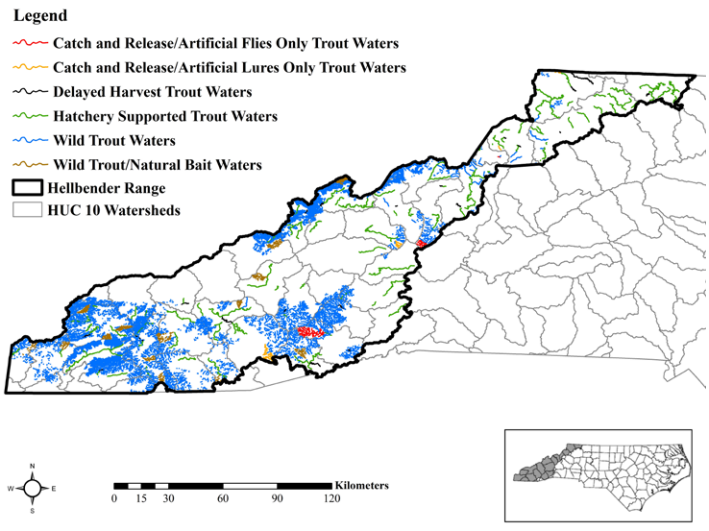

Figure 1. Streams in the Public Mountain Trout Waters program within the western North Carolina range of eastern hellbender (*Cryptobranchus a. alleganiensis*).

PMTW classifications, the two which were managed via seasonal stockings (Hatchery Supported Trout Waters and Delayed Harvest Trout Waters) were fished most frequently (Responsive Management 2015b).

The resource overlap between trout fisheries and hellbender populations provides an outreach and engagement opportunity for anglers, as well as other stakeholders, to further hellbender conservation. Herein, we provide a retrospective look at our approach to increase hellbender public awareness, with a targeted effort directed towards trout anglers. Specifically, our goals included the following: to dispel misconceptions and change angler behavior toward hellbenders; to increase the public's awareness of hellbender life history, conservation issues, and role in a healthy aquatic ecosystem; and to engage a variety of stakeholders in an informal citizen science effort to improve hellbender distribution data and conservation in North Carolina.

Methods

Outreach

From 2010–2017 we conducted 15 in-person outreach efforts, opportunistically and as scheduling allowed, at local river festivals, landowner or civic group meetings, or public education events across seven of the 17 counties within the hellbender's North Carolina range. Those counties not represented with in-person outreach either did not host events we could attend or had events on conflicting dates when agency staff or volunteers were time-constrained. Event locations were within sub-basins of the Nolichucky, upper French Broad, upper New, and Watauga rivers. The first event occurred in 2010 with partners from the North Carolina Zoological Park and New River State Park. At this and subsequent events, NCWRC staff, partners, and volunteers manned an information table with a live, captive-raised, hellbender display and a costumed hellbender mascot. The hellbender costume, courtesy of the North Carolina Zoological Society, was an original product of industrial arts students and staff at Randolph Community College in Asheboro, North Carolina. During in-person outreach, we engaged visitors in conversation about hellbender life history facts and habitat needs, dispelled misconceptions, discussed typical angler encounters, and handed out our contact information, as well as asking the public, especially trout anglers, to report their observations. We estimate that events drew 30–600 attendees.

In print media, from 2007–2017, at least 36 articles were published in local, state, and regional newspapers, popular magazines, and newsletters highlighting North Carolina's hellbender natural history, conservation issues, and requests for additional observations from the public. In 2012, the NCWRC published a hellbender article in its magazine, Wildlife in North Carolina (>50,000 subscribers), with a hellbender photograph on the front cover for the first time ever (Beane 2012). Since 2013, the NCWRC has included a print advertisement in the agency's annual North Carolina Inland Fishing, Hunting and Trapping Regulations Digest, directly targeting trout anglers and asking them to report encounters to the agency and to release hellbenders unharmed if caught.

Starting in 2014, NCWRC media staff and partners produced a 279×432-mm poster and signage to educate anglers and other stake holders. Partnering with the U.S. Forest Service, we printed and began distributing 2,500 hellbender posters ($1,000 cost) to the public, and NCWRC Inland Fisheries Division staff produced 300 152×229-mm polyethylene angler signs ($771 cost) for streamside posting in three river basins to date. The signs and posters targeted outreach to anglers specifically, asking them to report hellbender encounters to the agency, report violations (i.e., hellbender harm or collection), and what to do when a hellbender is caught on hook and line. Signs were posted streamside on the same tree or object as the NCWRC's PMTW regulations signage in the Hiwassee River, upper French Broad River, and upper New sub-basins. Posters were handed out at public events, installed in information kiosks at popular fishing and recreation areas in the Pisgah National Forest and Nantahala National Forest (National Forest), and given as display items to local businesses and fishing or river guides.

Digital media outreach efforts began in 2012 with an updated hellbender species profile on the NCWRC's public website, subsequent media releases, electronic newsletters, and blog posts on the agency's social media accounts. In fall 2014, partners at Freshwaters Illustrated released a nine-minute digital documentary filmed in North Carolina on hellbenders and threats to the species entitled "The Last Dragons," accessible online and featured at various outdoor film festivals and screenings in western North Carolina and across the nation (Freshwaters Illustrated 2014). A combined NCWRC Facebook and blog post in summer 2017 reached more than 15,000 and 50,000 people, respectively, setting the agency's all-time record number of "hits" on its social media pages (J. Owens, NCWRC, personal communication).

Public Reports

NCWRC western region field staff and administrative staff in the agency's headquarters began receiving an increasing number of hellbender reports from anglers and the general public starting in 2011–2012. These communications consisted of text messages, phone calls, emails, or in-person verbal accounts. Often, photographs and/or video clips taken with cell phones and/or underwater cameras were also shared with staff. We responded to these reports through email, text messages, and phone calls to thank the

observer, verify the encounter, and gather as many details as possible including the date, location (with GPS point or other distinct landmark), method of the encounter, and what the person saw. When we could confirm with certainty that the observation was indeed a hellbender, with photos or videos shared or enough details on body size, shape, or behavior given by the observer to leave no doubt, we documented it as a record for the State's database and added the site to the State's species distribution map.

We categorized the person making the report based on his/her activity at the time of the encounter. If people reported catching or seeing a hellbender while fishing, we classified that report as an "angler" source. People who mentioned they were wading, swimming, snorkeling, canoeing, kayaking, tubing, or engaging in some other activity were categorized as "other recreationists." If people did not give enough details for us to determine if they were fishing at the time, we documented the source of their report in the "other recreationists" category by default. We distinguished landowners from recreationists if they said the encounter occurred on their own property and sorted those reports into a "private landowners" category.

Data Analysis

From reported GPS points, distinct landmarks such as roads or bridges, details gleaned from conversation with observers, and aerial imagery, we plotted actual or approximate encounter sites on maps using ArcGIS (ESRI, Redlands, California, version 10.5). This geospatial information allowed us to examine property ownership and trout fishery regulation status at each location. Descriptive data summaries, including means, standard deviations, and percent frequencies, were obtained using Rcmdr package, v. 2.4-1 in R, v. 1.1.383 statistical software (The R Foundation for Statistical Computing, Vienna, Austria).

Results

From 1992–2017, 194 individuals reported a total of 207 hellbender observations to the State, as recorded in NCWRC and/or North Carolina Natural Heritage Program databases. We did not have an ability to determine whether people reporting from the same stream or site on different dates may have seen the same animal; however, no two people reported observations from the same site, same day, so the likelihood that multiple people duplicated reports any given day is low. The mean (SD) number of reports per year, all years pooled that had a report, was 9.86 (12.63). Prior to most of our engagement efforts (pre-2010), we received a total of 29 reports with a mean (SD) of 2.23 (1.58) per year. After concerted outreach began in 2010, we had 178 public reports with a mean (SD) of 22.25 (12.91) per year. The 178 reports received since 2010 is an increase of over six times over the previous total, whereas the annual mean is an increase of almost 10 times (Figure 2). Anglers provided 127 reports across all years for 61.35% of the total number received. Other recreationists provided 73 observations for 35.27% of the total. Private landowners contributed seven reports, or 3.38% of the total (Figure 3). Ninety (43.48%) hellbender encounters occurred on public lands including National Forest, National Park Service, North Carolina State Park, NCWRC Game Land, or municipal or right-of-way properties. National Forest reports were the most numerous for federal lands. The public generated 117 (56.52%) reports from private properties (Figure 4).

Encounter method was classified most often as an incidental

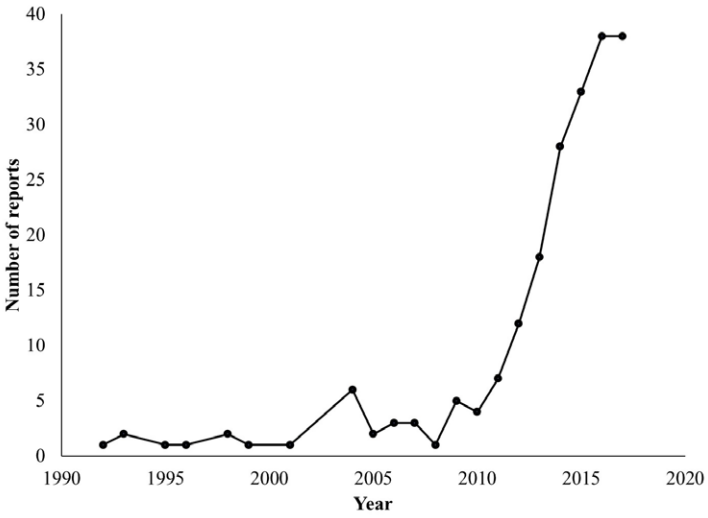

Figure 2. Number of verified eastern hellbender (*Cryptobranchus a. alleganiensis*) public reports in western North Carolina by year, all sources pooled; concerted outreach efforts began in 2010.

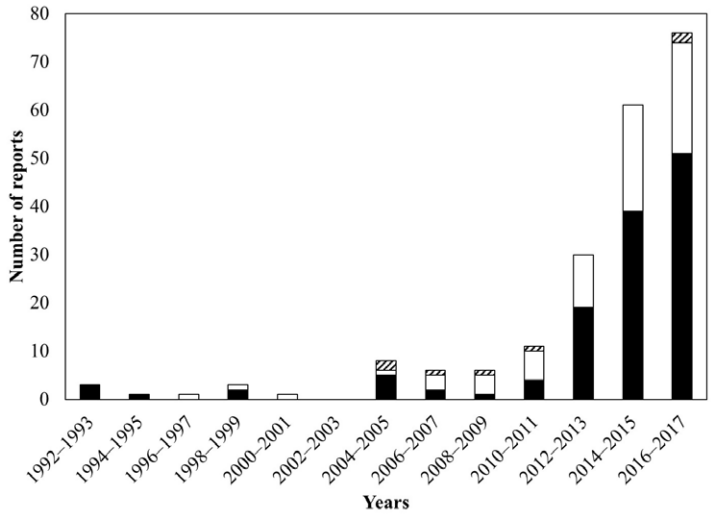

Figure 3. Number of verified eastern hellbender (*Cryptobranchus a. alleganiensis*) public reports in western North Carolina by year and source; black bars represent anglers, white bars represent other recreationists, and striped bars represent private landowners.

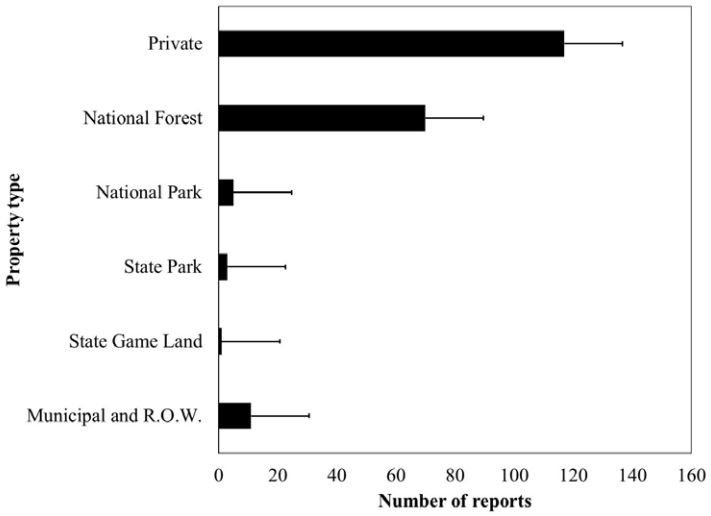

Figure 4. Number of verified eastern hellbender (*Cryptobranchus a. alleganiensis*) public reports (with standard error shown) in western North Carolina by site property type.

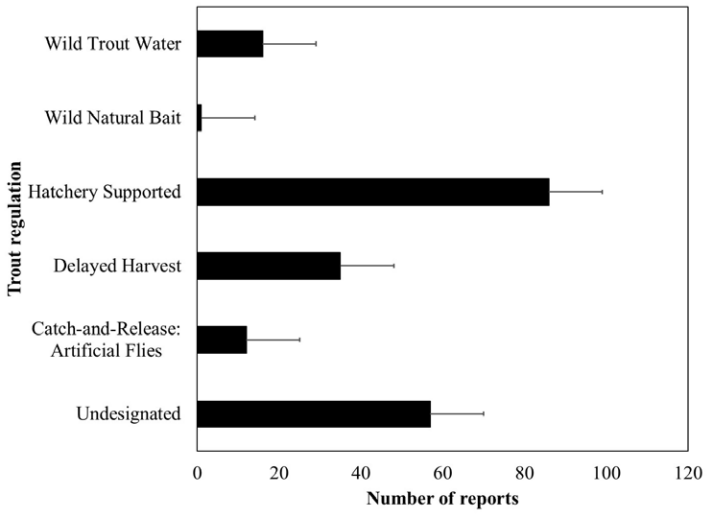

Figure 5. Number of verified eastern hellbender (*Cryptobranchus a. alleganiensis*) public reports (with standard error shown) in western North Carolina by site Public Mountain Trout Waters classification.

observation with 165 (79.71%) reported: anglers reported 91, other recreationists reported 67, and private landowners reported seven. Hook and line captures of hellbenders by anglers totaled 28 (13.53%). Anglers provided seven (3.38%) encounters of netting hellbenders while fishing. An angler also made one (0.48%) report of an incidental capture with a minnow trap. Recreationists specifically had six (2.90%) observations while snorkeling or wading.

The public reported hellbender encounters across a variety of PMTW streams as well as those not within the program. Sites within Hatchery Supported Trout Waters generated the most observations at 86 (41.55%), whereas sites not in the PMTW program numbered 57 (27.54%). Other categories represented included Delayed Harvest Trout Waters, Catch and Release/Artificial Flies Only Trout Waters, Wild Trout/Natural Bait Waters, and Wild Trout Waters (Figure 5).

The distribution of reports was widespread and included all HUC 6 river basins (Gulf of Mexico drainages, west of the Eastern Continental Divide) in western North Carolina within the hellbender's range. Likewise, all nine of the HUC 8 sub-basins within the hellbender's range were represented. Of the 45 HUC 10 watersheds within the hellbender's range, public reports represented a total of 31 (68.89%). The total number of streams represented was 56 including seven new streams (across four sub-basins) that were previously unknown to have hellbender occurrence. The total number of individual sites within streams was 129.

Our largest western North Carolina river basin, the French Broad-Holston, dominated reporting numbers with 132 (63.77%). Reports by sub-basin matched some of the areas where our most robust hellbender populations still occur: upper French Broad with 75 reports (36.23% overall) and Nolichucky with 44 reports (21.26% overall). The upper New sub-basin produced 33 reports (15.94%) and is another area where healthy populations remain. The upper Tennessee sub-basin was similar with 31 reports (14.98%), while the middle Tennessee-Hiwassee was the most poorly represented basin with 11 reports (5.31%) (Table 1).

Table 1. Number and percent composition of verified eastern hellbender (*Cryptobranchus a. alleganiensis*) public reports by western North Carolina HUC 6 river basin and HUC 8 sub-basin.

Basin	Number of reports by basin (% of total)	Sub-basin	Number of reports by sub-basin (% of total, % of basin)
French Broad-Holston	132 (63.77)	Upper French Broad	75 (36.23, 56.82)
		Nolichucky	44 (21.26, 33.33)
		Pigeon	4 (1.93, 3.03)
		Watauga	9 (4.35, 6.82)
Kanawha	33 (15.94)	Upper New	33 (15.94, 100.00)
Upper Tennessee	31 (14.98)	Tuckasegee	13 (6.28, 41.94)
		Lower Little Tennessee	9 (4.35, 29.03)
		Upper Little Tennessee	9 (4.35, 29.03)
Middle Tennessee-Hiwassee	11 (5.31)	Hiwassee	11 (5.31, 100.00)
TOTAL	207 (100.00)		207 (100.00, 100.00)

We received accounts of 10 dead hellbenders during this project. Two mortalities were results of intentional harm (e.g., stake through the body and a gunshot). At least five were possible accidental mortalities from recreational activities or fishing (i.e., excessive struggle with hook and line or injuries). Apparent cause of death included broken necks and jaws, internal injuries and bleeding from the mouth, and blunt force trauma from being stepped on

or crushed. The possible causes of the remaining mortalities were undetermined.

We were unable to quantify the number of times the general public mentioned seeing specific outreach materials, where they heard about reporting hellbenders, or how many people said their attitude and behavior had changed as a result of what they had learned. However, all of our methods (print and digital media, signs and posters, and in-person events) were mentioned more than once, with the regulations digest advertisement and the agency's social media posts, blogs, or electronic newsletters mentioned the most often as the main driver of angler response. Occasionally, people said they heard about hellbenders from more than one source. Others said they received word-of-mouth information in their peer groups about releasing hellbenders unharmed and about reporting encounters. Some anglers mentioned that they did not harm a hellbender they caught because they learned of its legal status and that its presence in the river was a good sign. Many anglers and recreationists extended gratitude for the agency's hellbender conservation efforts.

Discussion

Our retrospective look at our engagement efforts with trout anglers and the general public revealed that outreach is well worth agency, partner, and resource professionals' time. We still have significant conservation challenges in western North Carolina waterways with habitat degradation, dams and barriers to movement, poor water quality, and pollution, among other things. Pollution is most notably sedimentation from road construction, residential and commercial development, poor land use practices in watersheds such as steep slope development and agriculture without adequate riparian buffers, and discharge or drainage from quarries and mines. Another emerging threat in the region, though perhaps not as widespread, is an increasing recreational pressure on animals and habitat (e.g., rock moving). Despite these and other hellbender conservation challenges, the pronounced increase in the number of reports we received once we started to communicate directly with anglers was encouraging and may indicate movement away from misconceptions and undesirable behaviors when people encounter hellbenders. In a survey of Indiana residents, Reimer et al. (2013) found that providing the public with even a small amount of hellbender information, particularly conveying its rarity, uniqueness, and local connection, resulted in an increase in positive perceptions of the animal and support for its conservation. Likewise, in both Missouri and Indiana, other researchers discovered how attitudes (positive or negative view of hellbenders) are closely tied with intended behaviors (e.g., whether to release hellbenders unharmed, kill them, collect them) (Mullendore et al. 2014, Perry-Hill et al. 2014).

The variety of outreach materials and media we used to help disseminate information surely reached a wider audience than if we had relied on fewer sources. Researchers in Indiana who surveyed landowners about hellbenders found similar benefits in a variety of outreach sources (Mullendore et al. 2014). Word-of-mouth information about the hellbender's protected status and ecological role, delivered through angling peer groups or extended family, is particularly encouraging because people are more likely to act in accordance to information they receive from friends and family (e.g., releasing hellbenders unharmed).

The distribution of hellbender encounters overlaps popular mountain fishing and recreation areas, particularly within Pisgah National Forest. The sheer number of people fishing and recreating in certain "hot spots," coupled with diurnal activities of some of our more robust hellbender populations and their natural foraging behaviors (e.g., scavenging or being attracted to live bait), increased the odds of a chance encounter between people and hellbenders. Ideally, NCWRC and cooperating partners can use this information on hellbender observations in popular fishing spots to further counter the falsehood that hellbenders harm trout populations. In many instances, our most robust hellbender populations coexist with our most popular and heavily fished trout populations, and the common factor is high-quality habitat with clean, cool, well-oxygenated water, available shelter, and abundant food sources that hellbenders and trout both need.

The number of detailed reports we received have provided us with valuable species distribution information throughout the hellbender's range in North Carolina. This information allowed us to update historical site data as well as identify new sites (i.e., stream reaches) within previously known hellbender streams and new, individual streams that we did not know had hellbenders at all. Some of these hellbender-occupied sites and streams could have remained unknown to us because they are on private land, are in hard-to-survey areas, or are streams we simply have yet to survey. Reports from anglers and the public also help shape our survey and research priorities, in some cases influencing where we conduct field work, and allowing us to be more efficient and effective in conservation efforts. Moreover, although we did not have an explicit goal of generating relative abundance data at any spatial scale, we can use our results to supplement existing monitoring and research efforts focused on examining abundance and population trends in North Carolina.

From the distribution of public reports, it is clear that certain areas of the mountain region need more targeted outreach (e.g., middle Tennessee-Hiwassee basin and Pigeon, Watauga, lower Little Tennessee, and upper Little Tennessee sub-basins). We re-

ceived few reports from those waterways, either because people do not know to report encounters (or are choosing not to) or because there are simply not many observations of hellbenders in those systems. The former suggests we need to boost outreach in the poorly represented communities to increase public awareness of hellbender conservation, dispel myths, and solicit angler help. Likewise, researchers in Missouri and Indiana found that residents in general, and regardless of familiarity or intended behavior with the animal, are just not likely to take the time or be willing to report hellbender encounters to government agencies (Reimer et al. 2013, Mullendore et al. 2014, Perry-Hill et al. 2014). A reluctance to report observations to the NCWRC or other official may indeed be responsible for some of the poorly represented counties and waterways in our dataset, particularly where we know we have stable hellbender populations and human-hellbender encounters are likely occurring. However, few reported encounters in certain waterways could reflect inherently poor and declining hellbender populations (e.g. Pigeon sub-basin) or those where we suspect more recent declines (e.g., upper Little Tennessee sub-basin) (L.Williams, NCWRC, and J. Groves, retired, NC Zoological Park, unpublished data). Nonetheless, in general, reports from the public may serve as an index for overall species status in North Carolina.

Although there were more individual report locations off National Forest properties, waters with a high encounter rate overlap our more robust hellbender populations in the state. We are fortunate in North Carolina to have the headwaters of major drainages (e.g., French Broad River, Watauga River, New River, and Hiwassee River) within our state and in most cases originating on protected, forested uplands of our National Forest system in North Carolina. Watersheds within a predominantly forested landscape are directly linked to healthier and more sustainable hellbender populations (Freake et al. 2017, Pitt et al. 2017, Jachowski and Hopkins 2018).

The reports and evidence that intentional harm to hellbenders still occurs is disturbing, yet we can use this information to guide continued engagement efforts as we strive to change perceptions of hellbenders. While we only received two such reports, the very nature of these acts makes it unlikely that the perpetrators would volunteer that information or kill or harm hellbenders where others can see and report that behavior to state officials (Mullendore et al. 2014). These occurrences are likely underreported and would be extremely difficult to quantify, but our hope is that by spreading unbiased, sound information and encouraging peer-to-peer outreach, we can diminish those instances (Reimer et al. 2013, Perry-Hill et al. 2014).

Accidental mortality of hellbenders from fishing or recreational activities in streams (e.g., rock moving or dam building) also occurs, and we are beginning to document those examples more frequently in North Carolina (Unger et al. 2016, Unger et al. 2017). We intend to continue to educate resource users about the habitat degradation and the risk moving large shelter rocks can pose for hellbenders and other aquatic species by producing additional materials to distribute such as a tri-fold, color brochure on hellbender life history facts and a brochure with a "don't move the rocks" message. We can also continue to urge anglers, through print and digital media or other free take-home products distributed at in-person events, to do all they can not to harm hellbenders caught accidently on hook and line, including cutting them loose quickly to prevent excessive struggle or grave injuries. Residents surveyed in Missouri and Indiana indicated they were more likely to remove the hook or cut the line to release the hellbender if they valued nongame wildlife in general and did not have preconceived, negative ideas about hellbenders that would influence antagonistic behavior towards them (Perry-Hill et al. 2014). In that regard, agencies and partners should consider doing more to raise public awareness of all nongame fish and wildlife in aquatic systems.

As our effort demonstrated, there can be value within the intersection of diverse natural resource focal areas (e.g., hellbender conservation and trout angling). We feel this speaks to what many resource managers know relative to the complexities of the natural world we work with: everything in nature is somehow connected. This larger sense of connectivity can often be overlooked as we focus on our specialized tasks (e.g., aquatic salamander management or trout management). However, it might be those commonalities that have the highest chance of success in advancing the conservation of sensitive creatures such as hellbenders. Similar to the salmonids that occupy these systems, hellbenders have rigid habitat requirements. Historic loss of, and continued threats to, habitats have impacted hellbender (and trout) populations negatively and pose considerable risk for long-term viability. Although this challenge exists, there is an opportunity to benefit both trout and hellbenders by pursuing the commonality of required, suitable habitat.

Protection and enhancement of trout habitat is important to trout anglers and is a key focal area of NCWRC trout management (NCWRC 2013). Anglers may not be as familiar with the life history requirements of hellbenders as we would like for them to be, but there is a general understanding of habitat requirements to support a trout fishery. As such, there is a real opportunity for resource managers to convey the message relative to habitat that what is good for trout (clean, cold, and oxygenated water) is good for hellbenders as well and reiterate that hellbenders do not harm trout populations, but rather both are part of a healthy stream ecosystem. Highlighting this linkage may help to increase awareness of sensitive animals; plus, it could work to supplement efforts fo-

cused solely on trout by showing added value of those endeavors to support a larger system conservation outcome.

Hatchery Supported Trout Waters and Delayed Harvest Trout Waters are the two most commonly fished classification types in PMTW (Responsive Management 2015b). Not surprisingly, we received a large number of hellbender observations from these waters (44.55% were from Hatchery Supported Trout Waters alone). In the end, these waters would not be in PMTW if habitat conditions did not support trout seasonally, but we would also not have received the number of hellbender observations from anglers if they were not aware of the need or reporting process. There is more work to be done to improve both aquatic habitat and hellbender awareness, but this study has highlighted the potential of promoting such connectedness to aid in the conservation of one of the State's SGCN.

In the future, we plan to continue multi-method engagement with anglers, recreationists, and private landowners indefinitely, and despite the foreseeable challenge of agency staff and volunteer time constraints, we plan to seek opportunities for expanding outreach and citizen science efforts in underrepresented communities. For example, many of the more rural communities in western North Carolina have a rich natural history where locals may feel a sense of pride, cultural identity, or family heritage tied to their local waterways. Often, individuals in these communities who have a deep affinity for their backyard streams or favorite fishing spots have witnessed how local waterways have changed over time. These are the individuals needed to engage with conversations about hellbenders and trout and what makes a healthy river. If we can utilize this sense of local pride or ownership, we may discover new conservation allies and further our goals in the long run.

Similarly, private landowners are an under-utilized resource for generating hellbender observation reports. We received few reports from that sector of the public, although in our last ten years of field work, we have spoken to many long-time residents of streamside property that anecdotally described hellbender encounters from decades past or in their youth. These landowners often possess an intimate knowledge of their stream reach and indicate how hellbenders were much more abundant in the past than now. Reaching out to more private landowners might reveal more information on local population declines, or extirpations, as well as lead to habitat restoration opportunities in the future. Furthermore, engaging private landowners could provide a chance to discuss water conservation and land management measures that landowners could do to reduce sedimentation, and protect stream water quality, hellbenders, and habitat (Mullendore et al. 2014).

Our research shows the value in engaging a wide array of partners and using a multitude of creative measures to spread a conservation message, and regarding hellbenders, the collective consciousness does seem to be changing positively in some communities. As we found, there are opportunities for natural resource managers to identify conservation commonalities, such as trout and hellbenders, that might be outside of typical work plans or daily activities. However, we have shown that collaboration across natural resource disciplines and diverse partnerships can promote awareness and aid in conservation. We encourage others to look for similar opportunities among disciplines to help strengthen their natural resource management efforts.

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