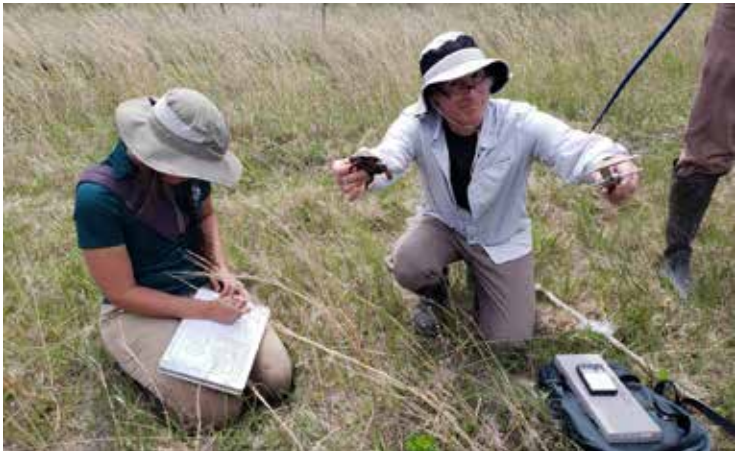


2021
WILDLIFE DIVERSITY
PROGRAM
ANNUAL REPORT



NC WILDLIFE RESOURCES COMMISSION
WILDLIFE DIVERSITY PROGRAM
ncwildlife.org/conserving





The North Carolina Wildlife Resources Commission's (NCWRC) Wildlife Diversity (WD) Program is housed within the agency's Wildlife Management and Inland Fisheries divisions. Program responsibilities principally include surveys, research and other projects for nongame and endangered wildlife species. Nongame species are animals without an open hunting, fishing or trapping season.

Dr. Sara Schweitzer, Assistant Chief, Wildlife Diversity Program
sara.schweitzer@ncwildlife.org; Wake County

Todd Ewing, Assistant Chief, Aquatic Wildlife Diversity Program
todd.ewing@ncwildlife.org; Wake County

Scott Anderson, Bird Conservation Biologist
scott.anderson@ncwildlife.org; Wake County

David H. Allen, Eastern Wildlife Diversity Supervisor
david.h.allen@ncwildlife.org; Jones County

Sierra Benfield – Aquatic Endangered Species Biologist
sierra.benfield@ncwildlife.org; Alamance County

John P. Carpenter, Eastern Landbird Biologist
john.carpenter@ncwildlife.org; New Hanover County

Alicia Davis, Alligator Biologist
alicia.davis@ncwildlife.org; Wake County

Katharine DeVilbiss, Central Region Aquatic Wildlife Diversity Biologist
katharine.devilbiss@ncwildlife.org; Granville County

Katherine Etchison, Mammalogist
katherine.etchison@ncwildlife.org; Buncombe County

Dr. Luke Etchison, Western Region Aquatic Wildlife Diversity Coordinator
luke.etchison@ncwildlife.org; Haywood County

Michael Fisk, Eastern Region Aquatic Wildlife Diversity Coordinator
michael.fisk@ncwildlife.org; Lee County

Sarah Finn, Coastal Wildlife Diversity Biologist
sarah.finn@ncwildlife.org; New Hanover County

Andrew Glen, Eastern Region Aquatic Wildlife Diversity Biologist
andrew.glen@ncwildlife.org; Alamance County

Gabrielle Graeter, Conservation Biologist/Herpetologist
gabrielle.graeter@ncwildlife.org; Buncombe County

Dr. Matthew Godfrey, Sea Turtle Biologist
matt.godfrey@ncwildlife.org; Carteret County

Jeff Hall, Partners in Amphibian and Reptile Conservation Biologist
jeff.hall@ncwildlife.org; Pitt County

Dr. Jeff Humphries, Eastern Amphibian and Reptile Biologist
jeff.humphries@ncwildlife.org; Orange County

Carmen Johnson, Waterbird Biologist
carmen.johnson@ncwildlife.org; Craven County

Brena Jones, Central Region Aquatic Wildlife Diversity Coordinator
brena.jones@ncwildlife.org; Granville County

Chris Kelly, Western Bird and Carolina Northern Flying Squirrel Biologist
christine.kelly@ncwildlife.org; Buncombe County

Allison Medford, Piedmont Eco-Region Wildlife Diversity Biologist
allison.medford@ncwildlife.org; Montgomery County

Dylan Owensby, Western Region Aquatic Wildlife Diversity Biologist
dylan.owensby@ncwildlife.org; Haywood County

Michael Perkins, Foothills Region Aquatic Wildlife Diversity Biologist
michael.perkins@ncwildlife.org; McDowell County

TR Russ, Foothills Region Aquatic Wildlife Diversity Coordinator
thomas.russ@ncwildlife.org; McDowell County

Andrea Shipley, Mammalogist (shared staff with Surveys & Research)
andrea.shipley@ncwildlife.org; Nash County

Mike Walter – Aquatic Endangered Species Biologist
michael.walter@ncwildlife.org; Alamance County

Kendrick Weeks, Western Wildlife Diversity Supervisor
kendrick.weeks@ncwildlife.org; Henderson County

Lori Williams, Western Amphibian Biologist
lori.williams@ncwildlife.org; Henderson County



Wood Stork



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Cover photos from top: Wildlife Diversity technician, Ben Dalton, poses with an adult Eastern Hellbender active on the stream bottom during breeding season snorkel surveys.; Second row: Kabryn Mattison (left) and Sea Turtle Biologist Matthew Godfrey process a Spotted Turtle during a monitoring project (Jeff Hall); Sierra Benfield and Mike Walter sort through contents from a suber sample for macroinvertebrates (Michael Fisk); Wildlife Diversity Technician, Kyle Shute, inspects a hibernating tricolored bat in a Caldwell County culvert. (Katherine Etchison); Bottom row: Stewards and Waterbird Team staff pose with one of the new AFSI signs at Emerald Isle (Carmen Johnson)

BIRDS



Northern Saw-whet Owl Surveys Conducted Using Songmeter Recordings

by: Christine Kelly/ Western Bird and Carolina Northern Flying Squirrel Biologist

North Carolina's tiniest owl, the northern saw-whet owl, got some attention in the first quarter of 2011. The saw-whet owl is state listed as Threatened, and the breeding population primarily inhabits the spruce-fir zone and high elevation hardwood forests. The first project focused on improving the survey technique for this species. Despite their diminutive size (males weigh as much as an American robin), they can have large territories. Thus, surveys to listen for them at night can be hit or miss, depending on where the owl is perched in its territory as the observer listens. To save some driving and sleep, N.C. Wildlife Resources Commission (NCWRC) staff turned to technology. Staff completed a trial run with Songmeter recording units that record passively for many nights. As with other bird surveys, the "multiple visits" that result from recording night after night increase the odds that a biologist will detect the bird if it is indeed present. These data are being analyzed and staff anticipate working passive recording surveys into their long-term monitoring strategy for this owl.



A Songmeter recording unit deployed in northern saw-whet owl habitat. (Christine Kelly)

(continued on next page)



A second survey employed conventional listening and audiolure surveys. In March, the bird crew conducted a “blitz” survey focused on northern hardwood forest in the southern mountains. The objective was to fill in distribution gaps and update some old records in the

NC Natural Heritage Program database. Johnny Wills, biologist with the Nantahala National Forest, helped the crew as they surveyed the southern Nantahalas, Unicois, and other massifs. Thus far, the only owl detected was at Albert Mountain in Macon County.

Finally, Haywood Community college students built and helped post nest boxes for saw-whet owls on William H. Silver Game Land in Haywood County. If used, these structures not only provide a home for the owl; they also will provide biologists with easy access to capture, band, and tag the owls for future tracking projects.



Left photo: Haywood Community College wildlife student, Rachael Hart, hangs a nest box for northern saw-whet owl at William H. Silver Game Land. (Christine Kelly)

Inset photo: Nest box for northern saw-whet owl (Christine Kelly)

Top photo: At the first tree selected for hanging a nest box, we noticed a fresh killed deer mouse on the forest floor. Could there be saw-whet owls here? (Christine Kelly)



Northern Saw-whet Owl Conservation Plan Begun

by Allison Medford, Piedmont Eco-Region Wildlife Diversity Biologist



Northern Saw-whet Owl (Shutterstock)

The new cohort of Species Conservation Plans (SCP) was assigned, including the Northern Saw-whet Owl (NSWO) Plan. The Piedmont Eco-Region Wildlife Diversity Biologist is learning about these owls in depth and, using Western Bird and Carolina Northern Flying Squirrel Biologist Chris Kelly as a well-spring of information, has started piecing together the SCP for North Carolina.

Researchers at UNC-Wilmington have expressed interest in expanding monitoring for NSWOs in the mountains, so the promise of new information about these elusive critters is on the horizon.

How YOU Can Support Wildlife Conservation in North Carolina

Whether you hunt, fish, watch, or just appreciate wildlife, you can help conserve North Carolina’s wildlife and their habitats and keep North Carolina wild for future generations to enjoy.

How? It's as easy as 1, 2, 3.

- 1 Donate to the Nongame and Endangered Wildlife Fund by checking Line No. 30 on your N.C. State Tax Form.
- 2 Purchase a Wildlife Conservation Plate, which features an illustration of a Pine Barrens Treefrog, for \$30, with \$20 going to the agency's Nongame and Endangered Wildlife Fund.
- 3 Donate to the Wildlife Diversity Endowment Fund, a special fund where the accrued interest — not the principal — is spent on programs that benefit species not hunted or fished. ncwildlife.org/donate





Barn Owl Project Updates

by: Allison Medford, Piedmont Eco-Region Wildlife Diversity Biologist

Thanks to a news release issued by the NCWRC, the Barn Owl Project had almost a dozen confirmed nests across the state. Young barn owls fledge in the spring, and nest box installation continued once structures were built and nesting had ceased. Biologists were excited about the influx of nest reports and appreciated the help from the public with this project. The barn owl project was launched to learn more about the distribution and abundance of barn owls throughout the state and how private landowners may be able to help conserve the species and enjoy their ecological benefits. Barn owls are particularly associated with open areas like those found in agriculture. They also eat a lot of rodents, especially when they



Barn Owl (Mark Medcalf)

are feeding a nest full of hungry chicks. And, they may not just be breeding in the winter and spring like most other owl species. Biologists are learning that they may nest year round depending on the availability of prey. Biologists have a lot to learn about barn owls in North Carolina, and they could not do it without an engaged public.

The Barn Owl Project progressed during the fall quarter with the start of fall nest monitoring. Cameras were posted on two sites — one on an active spring nest and one on a perching site near one of the nest boxes. NCWRC biologists hoped to get a sense of the owls’ fall activity using these cameras.

They have invested in temperature and relative light data loggers to give them a better sense of the temperature and light preferences of Barn Owl nests. They will use this information to tweak their nest box design to best mimic the “natural” nest sites (though, of course, these sites are in man-made structures or even other nest boxes; none of the known Barn Owl nests are in trees, rock shelves, rock outcroppings or other truly natural places).

In the winter quarter, they hoped to document any fall nests and install more nest boxes (right photo).



(Allison Medford)

Waterbird Team Prepares for Nesting Season by Posting Closure Signs

by Carmen Johnson, Waterbird Biologist

The Waterbird Team spent March preparing for the return of birds by posting closure signs on NCWRC-owned islands that are managed for the benefit of waterbirds. One additional site the NCWRC protects for nesting waterbirds is an area known as “the Point” at Emerald Isle. Through a partnership with the Town of Emerald Isle, the NCWRC protects nesting Least Terns and Wilson’s Plovers each year at the western end of the beach, and a stewardship group of local volunteers has formed to assist the Waterbird Team in monitoring the birds and maintaining the posting. Staff and stewards set up the enclosure each spring, and the stewards conduct regular checks to monitor how many birds are nesting at the site, any predation events or issues with trespass. In 2021, some new signs were introduced at the Point to help inform beach goers about ways they can share the shore with beach nesting birds. Developed by the Atlantic Flyway Shorebird Initiative (AFSI), these signs are intended to complement the signs state and federal agencies already use to mark nesting areas by providing information on the birds and how to help birds while enjoying the beach.



When visiting Emerald Isle in Carteret County, look for nesting waterbirds and these signs, developed by the Atlantic Flyway Shorebird Initiative.

A few common waterbird species that nest on North Carolina’s beaches



Stewards and Waterbird Team staff pose with one of the new AFSI signs at Emerald Isle (Carmen Johnson)



Least Tern



Black Skimmer



Common Tern



Piping Plover



Unoccupied Aerial Vehicles Assist Biologists with Wood Stork Nests Count

by Carmen Johnson, Waterbird Biologist

Each year, Wood Storks nest in the southeastern part of North Carolina, building large nests with sticks high in the trees of wooded swamps. The NCWRC's Waterbird Team annually conducts both ground and aerial surveys of these Wood Storks. In May, the team once again partnered with the Coastal and Estuarine Studies Lab from University of North Carolina Wilmington (UNCW) to complete UAV (unoccupied aerial vehicle) surveys of each colony. Mariko Polk, a PhD student, piloted the UAV, flying transects above the Wood Stork nests and taking photos at predetermined intervals. Once all the photos were collected, they were stitched together to provide a unique aerial view, allowing the Waterbird Team to detect nests not visible from the ground. Information gained from the UAV imagery and ground counts will be shared with landowners of the sites where these colonies are found, including Audubon NC, NC State Parks, and private individuals to aid management decisions.



Mackenzie Taggart, Ed Corey, Lane Garner, Carmen Johnson, Katie Sullivan, and Mariko Polk pose with UNCW's UAV, dubbed Moira Rose, after surveying the Wood Stork colony at Warwick Mill Bay in late May (UNCW CES Lab)



High resolution images are mosaiced together to give a complete view of the site. Photos can then be enlarged in order to count individual nests (UNCW CES Lab); Wood Stork with chicks in nest (Annika Andersson)



Piping Plover Nesting Season Ends with Below Average Results

by Carmen Johnson, Waterbird Biologist

After the piping plover nesting season ended, biologists wrapped up the annual Piping Plover Breeding Season Survey. Each season, NCWRC staff and partners survey all suitable nesting habitat, recording observations of pairs and individuals. Piping Plovers are ground nesters, making a shallow scrape in the sand that may be lined with fragments of shells. Because of this nesting habit, Piping Plovers face challenges from human disturbance, overwash and predators (including pets). In 2021, 40 pairs were detected in the state, and 17 chicks fledged (productivity of 0.43 fledglings/pair). This is below the average of 45.61 pairs and 24.4 fledglings since monitoring began in 1989, demonstrating the need for continued conservation efforts. The Atlantic population of Piping Plovers is federally listed as Threatened under the U.S. Endangered Species Act. NCWRC staff will continue to work with partners in North Carolina and throughout the Piping Plover's range to recover the species.



Adult male Piping Plover (top); Piping Plover nest with two eggs (Carmen Johnson)



Black Rail Surveys to Start Spring 2022

by Carmen Johnson, Waterbird Biologist

The Waterbird Team recently began planning for surveys of the federally threatened Eastern Black Rail that will begin in spring 2022. The Black Rail is a small, sparrow-sized, secretive marshbird, and it's estimated that only 40 to 60 pairs remain in the state. The decline is thought to be largely due to loss of habitat from sea level rise. Much still needs to be learned about the subspecies, and research is being carried out in several Atlantic and Gulf Coast states. The Waterbird Team is collaborating with Dr. Sue McRae at East Carolina University to learn more about the species on state lands and how to best manage for them.

Three sites along the North Carolina coast have been identified where the species has been detected within the past 10 years. Scouting trips were made to these sites in late 2021, with biologists looking at vegetation, water level, and microtopography that meet the needs of the species. Call-response surveys will be used this spring and summer at points with potentially suitable habitat in hopes of detecting the birds and will help the team to plan future work to learn more about the species.



Constance Powell makes notes on vegetation during a scouting trip in November 2021 (Carmen Johnson)



Black Rail (Agami Photo Agency); Potential Black Rail habitat (Carmen Johnson)





North Carolina Bird Atlas Off to a Great Start

by John Carpenter/Eastern Landbird Biologist

The [North Carolina Bird Atlas](#), one of the state's largest citizen scientist projects, officially launched in 2021! Over the last several months, the Atlas team has been busy hosting webinars with the birding community, developing a volunteer handbook, and refining survey strategies to estimate bird abundance and distribution across the state.

Birds are the most accessible form of wildlife for people to witness and observe, and crucial to the health of North

Carolina's wild, natural places. Yet, one in four birds has been lost since 1970 nationwide, an estimated total of 2.9 billion. The first step to reversing this trend is having a detailed picture of birds and what they depend on to be healthy in our state.

This can be achieved with the Atlas data collection efforts, which will occur through eBird.org/atlasnc. Volunteer participation was off to a great start with hundreds of survey



checklists submitted in just the first few weeks. This project will gather essential information about the current and future distribution and abundance of NC's birds and guide resources to help prevent listing species as endangered or even becoming extinct.



Since 1970, one in four birds has been lost — an estimated total of **2.9 billion!**

The NC Bird Atlas, officially launched in 2021, is the first step in reversing this trend.

More Than 16,000 Checklists Submitted to NC Bird Atlas So Far

by John Carpenter, Eastern Landbird Biologist

During the first few months of the NC Bird Atlas, over 600 volunteer birders submitted more than 16,000 checklists of bird surveys. NCWRC staff have already confirmed breeding for 166 species with data collected for greater than half of priority survey blocks.

A few highlights include the first record of a Cerulean Warbler for Person County, the first breeding record of Swallow-tailed Kite in Brunswick County, and a rare, confirmed nesting record for Loggerhead Shrike in Carteret County.

In addition, experienced seasonal technicians spread out across the state and conducted nearly 1,000 point count surveys. This separate dataset will allow the NCBA team to estimate densities for many species that breed in North Carolina.

In the fall, the NCBA team reviewed data and prepared for the winter. Most atlas projects focus on just the breeding season; however, staff will also examine the distribution and abundance of birds that spend the winter months in North Carolina.



Seasonal technicians for the NC Bird Atlas meet for training in Raleigh (top left). Highlights from submissions thus far include a rare, confirmed nesting for Loggerhead Shrike (top right) in Carteret County and a first-ever breeding record of a Swallow-tailed Kite in Brunswick County. (JP Carpenter)



Landowners Are Key Component of NC Birding Atlas' Future Growth

by John P. Carpenter, Eastern Landbird Biologist

A primary goal of the North Carolina Bird Atlas is to engage the public in conservation work. NCWRC staff expect this will be accomplished several ways, including increased awareness of avian conservation by private landowners. The importance of this group's participation in the atlas cannot be understated — over 85% of property in North Carolina is privately owned. The ability to access non-public land for the atlas is not only important to increase the data quality, but also provides safer, more productive places for agency technicians and volunteers to

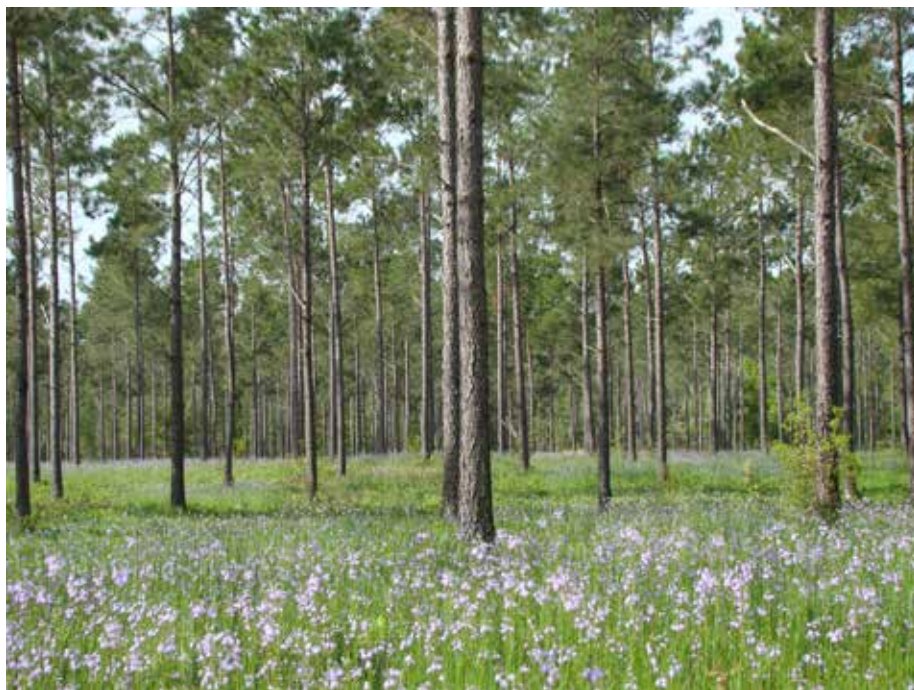
work and demonstrates support for the agency's mission.

During the fourth quarter of 2021, staff reached out to over 100 landowners and received permission to access over 73,000 acres of private property to survey birds for the benefit of the NCBA. These private landowners represent a vast array of interests: small single-family farms, non-profit organizations, timberlands and Limited Liability Companies.

Staff will continue to conduct this important outreach during the life of the project and are optimistic that the



number of positive interactions they've had with private landowners will continue to grow. With a little luck and some persistence, they hope many of these relationships develop into lifelong opportunities that will benefit all of North Carolina's wildlife.



Private property in Brunswick County, NC (JP Carpenter)



Nests in the West

by: Christine Kelly/ Western Bird and Carolina Northern Flying Squirrel Biologist

Golden-Winged Warblers

In the far western Cheoah Mountains (Graham County), NCWRC biologists found nine golden-winged warbler nests while conducting annual monitoring, mist-netting and banding within a regenerating forest. Golden-wings constructed nests on the ground adjacent to logged areas, which ranged in age from 4.5 to 15.5 years post-harvest. Two nests were on the brushy edges of fields that were former logging decks, and seven were along the brushy edges of interior roads bordering the logging units. Pictures of the nest sites and surrounding habitat will be added to a photo library guide that the Southern Appalachian Golden-winged Warbler Partners is developing to illustrate nesting and other habitat features. Biologists completed nest monitoring, including vegetation sampling, at the nest sites in the fall.

continued on next page



Top left, golden-winged warbler nest with eggs; Top right, a female golden-winged warbler incubating eggs; Bottom, a male golden-winged warbler (Christine Kelly)

Watch as biologists search [for golden-winged warbler nests](#)



Eastern Whip-poor-wills

In the central western mountains at DuPont State Recreation Forest (Henderson and Transylvania counties), biologists and NCWRC volunteer Alan Cameron found two Eastern whip-poor-will nests and several roost sites. 2021's pilot nest-searching project grew from Cameron's 2020 season contribution of trail camera footage showing whip-poor-will activity around the granitic domes in DuPont. The incredible footage, compiled by NCWRC into a [short video](#) (right), prompted further investigation in 2021. The whip-poor-will is listed in the NC Wildlife Action Plan as a Knowledge Gap species. The Partners in Flight Road to Recovery bird conservation effort to reverse avian declines lists the Eastern whip-poor-will as a priority due to a steep population decline (69% range wide since 1970). This decline translates to a loss of about 4.5 million birds over the past 50 years. Bird Conservation Region 28 (BCR28), which encompasses the Appalachian Mountains from southern New York to northern Alabama, has lost about 360,000 whip-poor-wills with approximately 90,000 birds remaining. Causes of decline are



Male whip-poor-will (Christine Kelly)



An incubating whip-poor-will simply closes her eyes to complete her camouflage (Clifton Avery)

not entirely known but threats include habitat loss and changes in private and public lands management on breeding, migration and wintering grounds. Eastern whip-poor-wills breed in eastern North American temperate forests and woodlands and winter in tropical

evergreen forests and dry forests. Biologists conducted the pilot survey in the spring to familiarize themselves with this species' habits and habitats, to fill in knowledge gaps, and assess feasibility of research in the future. Although the number

continued on next page



of nests found was lower than hoped for, the crew learned about nest phenology and habitat use, such as open areas with leaf litter and abundant cover nearby, and began honing a search image for nest and roost sites. Cameras and searching confirmed that whips indeed timed their first nest with the moon phase so that eggs hatched eight days before the May 26 full moon. This timing ensures optimal

brightly moonlit hunting conditions when whips are foraging for moths and beetles to feed the growing fledglings. Once fledged at just seven days of age, the semi-precocial chicks stayed under the vigilant care of the adult male while the female incubated a second clutch of two eggs. On several occasions, searchers found a trio of a dad with two fledglings roosting in thick vegetation not far from their nest sites.



A speckled, white whip-poor-will egg on leaf litter adjacent to a granitic dome (Alan Cameron)

Peregrine Falcons

Across the western mountains, biologists completed routine annual monitoring of peregrine falcon nests. One highlight this year was the first documented successful nesting attempt at Grandfather Mountain since 2008. Overall, biologists found pairs on territory at 15 sites in western North Carolina. Seven pairs nested successfully, rearing 12 nestlings.



Top: A peregrine falcon perched after a meal. Note the blood on its bill and face. (Christine Kelly) Right: Remains of a peregrine falcon nestling that died at approximately 3 weeks of age, just as its juvenile feathers were emerging. The cause of death is unknown. (Christine Kelly); Far right: Fortunately its two siblings survived. (Clifton Avery)



Zachary Lesch-Huie of The Access Fund and Mike Reardon of the Carolina Climbers Coalition point to the ledge where peregrine falcons attempted to nest at Big Lost Cove Cliff in Avery County in 2021.

Lynn Willis of High South Creative

Cameras and Climbers Answer Lingering Questions about Falcons

by: Christine Kelly/ Western Bird and Carolina Northern Flying Squirrel Biologist

Every year, biologists monitor peregrine falcons nesting on cliffs by watching them from afar through spotting scopes. To get a closer look, the NCWRC partners with rock climbers to access the ledges. These brief but exciting visits often answer a lot of questions staff couldn't answer from hours of watching through scopes. For instance, the climbers can see if the nest ledge is protected from the elements by an overhanging roof and if it is inaccessible to mammalian predators. Prey remains

found during these excursions tell biologists about the birds' diets. At Big Lost Cove, climbers from The Access Fund and Carolina Climbers Coalition discovered remains of blue jays and woodpeckers. They also found a rodent latrine in an adjacent ledge.

Climbers also help deploy cameras in nest ledges. In October, the Appalachian Mountain Rescue Team retrieved two cameras that were installed in a nest ledge in Rutherford County back in January and set up new

cameras. The goal was to better understand why this site suffers chronic nest failure. They found a few things: southern flying squirrels can access this ledge, which could result in egg predation. The falcons never laid eggs at this ledge in 2020 despite spending lots of time there. Though falcons mostly hunt birds, they will prey on bats and other mammals opportunistically. On two occasions, a falcon was pictured clutching a bat for its early morning breakfast. This

continue on next page



Joel McCombs of the Appalachian Mountain Rescue Team perches outside the peregrine ledge at Chimney Rock (Corey Winstead)



What is causing chronic nest failure among peregrine falcons?

A camera deployed on a nest ledge in Rutherford County provided biologists with at least one possible reason why this site suffers chronic nest failure: southern flying squirrels can access this ledge, which could result in egg predation.



A male peregrine falcon (foreground) tidies the “nest scrape” while the female (background) looks on. Notice the blue-gray and white coloring and smaller size of the male compared to the brownish-gray and cream coloring of the larger female

also brings to mind the question of whether there are enough prey in the Hickory Nut Gorge for nesting pairs to raise a family. And most surprising was camera documentation of a subadult female falcon in late winter and early spring that observers never saw from their spotting scopes. An adult female replaced her later in the season.

The remoteness of most of the peregrine falcon nest ledges in the mountains poses a challenge for powering

cameras and relaying images during the breeding season. This fall, the Carolina Climbers Coalition and NCWRC Wildlife Diversity Technician Clifton Avery deployed a camera in another peregrine nest ledge. This camera will transmit footage wirelessly to a home camera on the ground. The resident pair of falcons showed up on camera immediately, and the male set to work smoothing the nest “scrape” while his mate looked on.

Nest cameras are only useful at cliffs where the falcons return to the same nest ledge each year. At some cliffs, they rotate between ledges, making it a guessing game as to where to deploy a camera. Where nest cameras are a good option, biologists hope they will provide insight into causes of nest failure, turnover of individuals, and more. They can be the eyes and ears of biologists, and hopefully save staff time and thousands of miles of driving.

Ambiguity Between Warbler Species Cleared Thanks to Cooperative Project Between NCWRC and Partners

by John Carpenter, Eastern Landbird Biologist

Wayne's Black-throated Green Warblers were historically associated with the once vast Atlantic White Cedar forests that blanketed the Atlantic Coastal Plain from Virginia through the Carolinas. Wayne's Warbler, as it is colloquially referred to, is now a Species of Greatest Conservation Need in the North Carolina, South Carolina and Virginia Wildlife Action Plans. Surprisingly, the status of the Wayne's Black-throated Green Warbler as a true subspecies (*Steophaga virens*

waynei) depends largely on the taxonomic source one references. The Birds of the World series — a revered resource from the Cornell Lab of Ornithology — considers it subsumed by the nominate species, *S. virens*, which is commonly found throughout much of the Appalachian Mountains and into Boreal Canada. Avibase, on the other hand, list *waynei* as a subspecies, likely due to differing habitat preferences and apparently smaller bill. This ambiguity has recently been cleared up

through a cooperative project involving the NCWRC, Catawba College, Arkansas State University, and Penn State University. Using Whole Genome Resequencing (WGS), biologists have determined that Wayne's Black-throated Green Warblers are genetically distinct from birds that breed outside the Atlantic Coastal Plain. They hope this will help garner Wayne's Warbler, as well as the non-riverine swamp, bay, and pocosin habitats they use, more attention and conservation.



Black-throated Green Warbler (Jack R. Perry Photography)



Wayne's Black-throated Green Warbler in Croatan National Forest (J.P. Carpenter)

Biologists Assess Golden-winged Warbler Habitat in Cheoah Mountains

by: Christine Kelly/ Western Bird and Carolina Northern Flying Squirrel Biologist

In August 2021, NCWRC biologists returned to Graham County to measure habitat data around several Golden-winged Warbler nests. This work was done to see how habitat at the nine Golden-winged Warbler nests found in the Cheoah Mountains measured up with respect to typical and recom-

mended habitat characteristics outlined in the revised Golden-winged Warbler Conservation Plan. These nests were associated with two-age timber harvests ranging from five to 15 years post-harvest. One was located on the edge of a logging deck that had been converted to a wildlife opening, one on

the side of a closed permanent woods road, and seven along closed temporary roads. Vegetation data in nested 1-m, 5-m, and 11.2-m plots were collected using protocols from the Conservation Effects Assessment Protocols (CEAP). The map shows 11.3-m vegetation plots .

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Four of the Golden-winged Warbler nests, vegetation sampling plots at nests, and additional birds detected in the Cheoah Mountains (Graham County), 2021



In silviculturally derived management sites such as these, the Conservation Plan notes that most nest sites contain >50% forbs, and the Cheoah nests averaged 46.4% (Table 1). Woody cover is an important determinant of nest site selection, with typical Golden-winged Warbler nest sites containing some wood component, but the level never exceeding 70%. Woody cover at the nine Cheoah nests aver-

aged 21.9%. Golden-wings tend to select against sites with lots of grass cover, and the Cheoah nests had little grass (mean 8%).

Another feature of nest sites is approximately 13% open ground. At the Cheoah nests, open ground consisted of bare ground (0.5%) and leaf litter (10.3%).

Finally, blackberry can be an indicator of high-quality nest sites, but should occur in

small amounts, not exceeding 40%. Blackberry cover at the Cheoah nests averaged 6.1%. Overall, the nine nests fell within the range of desired habitat components known to be important to nesting Golden-winged Warblers, though caution should be used in interpreting these results as plots were restricted to the nests and not the surrounding management sites.

Table 1. Recommended habitat management targets for GWWA nests and results from nine nests in the Cheoah Mountains, NC in 2021, showing means and standard errors.

Habitat component	Desired habitat component ^a	9 nests in Cheoah Mtns, NC
Woody cover	5-50%. <70%	21.9% (5.9)
Forb cover	45-100%	46.4% (8.8)
Rubus cover	5-40%	6.1% (1.8)
Grass/sedge cover	5-25%, <45%	8.0% (2.4)
Open ground	13%	0.5% (0.5) bare ground 10.3% (2.8) litter
# Tall shrubs/5 m ^b	<5	0.88 (0.61)
Distance to forest edge ^b	39-230 m	24.2 m (6.4)

^aFrom the GWWA Conservation Plan. ^bFrom high quality nests in the CEAP project.



(Christine Kelly)

Left photo: In August, WDP biologists measured vegetation around the nest of this male Golden-winged Warbler “Dark Blue-silver Yellow” that was banded on May 6, 2021.

Right photo: Dark Blue-silver Yellow was spotted later helping his mate deliver food to their nestlings. The nest was along the side of a temporary road adjacent to a five year old harvest unit.



(Christine Kelly)



(Katherine Etchison)

Culvert and Bridge Surveys Offer New Opportunities for Winter Bat Data Collection

by Katherine Etchison, Mammalogist

Bat hibernacula surveys shifted focus from typical cave and mine sites to culverts this winter because of the potential risk of transmitting SARS-CoV-2 from humans to bats. The caves and mines originally scheduled to be surveyed this winter have tight passages where surveyors would have been close to bats for a

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A hibernating big brown bat in a McDowell County culvert. (Katherine Etchison)



prolonged time with little airflow. Culverts allow greater airflow than caves and require less time to survey, so these offered a lower risk option for monitoring hibernating bats. Additionally, targeted surveys of culverts during winter had not occurred in the mountains before, so this presented a new opportunity for data collection. Eighty-three culverts were surveyed in 12 mountain counties, yielding eight culverts with bat presence. Big brown bats were found in four culverts and ranged from one

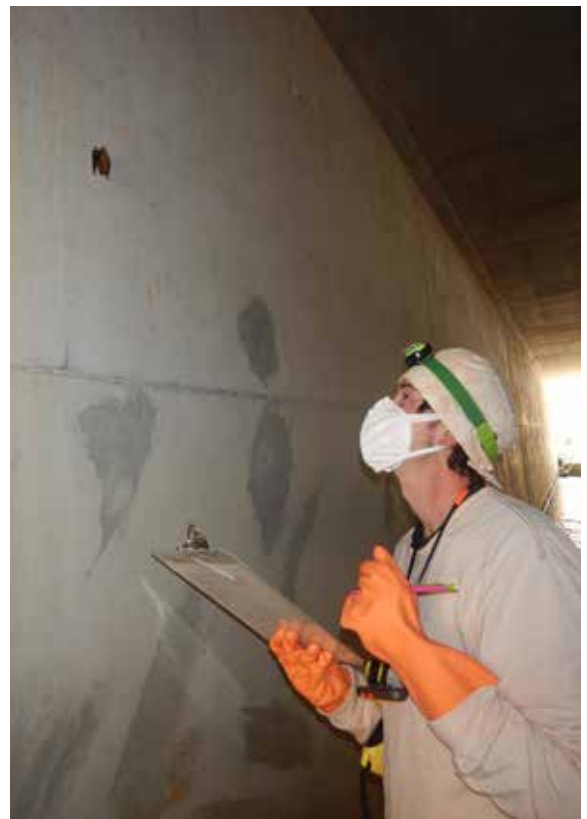
to seven individuals, single tricolored bats were found in two culverts, and single gray bats were found in two culverts late in the winter. Overall bat presence was low, which may be related to the many natural opportunities for bat hibernacula in the region.

Along with culverts, a few bridges were surveyed as temperatures climbed in March and bats returned to exposed roosts, like bridges. Highlights from these surveys included three gray bats found roosting in a bridge in Haywood County

where this endangered species had not been previously documented. Two Indiana bats were observed roosting under a different bridge in Haywood County, where this species was seen in May 2020. This endangered bat is seldomly encountered after experiencing population declines due to White-nose Syndrome in recent years. Although it wasn't the typical winter survey season, surveying these non-traditional winter sites allowed data collection to continue while presenting a low risk to bats.



Wildlife Diversity Biologist, Katherine Etchison, searches for hibernating bats in a Buncombe County culvert. (Joey Weber)



Wildlife Diversity Technician, Kyle Shute, inspects a hibernating tricolored bat in a Caldwell County culvert. (Katherine Etchison)



Staff Install Mine Gate to Minimize Human Disturbance to Bats at Crowder’s Mountain State Park

by Katherine Etchison, Mammalogist

An abandoned mine at Crowder’s Mountain State Park is sporting a new bat gate thanks to a team of cave gate installers, NC State Parks staff, and NCWRC staff. Bat gates are essential for providing passage for bats while preventing unauthorized human entry to a hibernaculum. Tricolored bats hibernate in the state park mine but are frequently subjected to human disturbance as evidenced by a well-worn unsanctioned footpath to the mine entrance. Hibernating bats often abandon a hibernaculum if disturbed frequently, so NC State Parks and the NCWRC recognized the need for a bat gate at this important site.

Building the gate when bats were not present was key to avoiding disturbance, so the team was careful to schedule construction after bats exited the mine in early spring. Biologists also surveyed the mine immediately before the survey to confirm the bats’ absence. The gate was fabricated on site over two days and required multiple on-foot trips carrying heavy equipment, iron and other materials.

Tricolored bat populations in western North Carolina have been greatly reduced by the fungal disease White-nose Syndrome and this species is now under review by the US Fish and Wildlife Service for potential listing. To make matters worse, the fungal pathogen that causes this deadly disease has been found in six Piedmont sites including the mine at Crowder’s Mountain

State Park. Preventing unauthorized entry into the mine will help reduce the likelihood of human-mediated transmission of fungal spores from this site.

Now that the bat gate is in place, only authorized entry using a key is possible. This hibernaculum will be monitored by NC State Parks and the NCWRC to provide vital tricolored bat population trend data.



Entrance to a mine on Crowder’s Mountain State Park before and after gate installation (Katherine Etchison)



Wildlife Diversity Biologist, Katherine Etchison, carries materials up to the mine entrance. (Ed Corey/NC State Parks)



Mistnetting Efforts Result in High Numbers of Bats at Several Sites

by Katherine Etchison, Mammalogist

In the fall, NCWRC biologists made the first sustained mist-netting effort since the onset of the COVID-19 pandemic. After the pause in mist netting during summer 2020, the NCWRC bat team and partners successfully completed all planned long-term monitoring sites. Partners from the U.S. Fish and Wildlife Service, the U.S. Forest Service, and NC State Parks collaborated to make sure the season went successfully. In addition, they successfully navigated new protocols around personal protective equipment used while working hands on with bats.

This netting season helped to fill in gaps in information as a result of the absent netting season of 2020. Notably, biologists captured high numbers of bats at several sites including one in Nantahala National Forest where 48 big brown bats were captured, the highest number recorded there. Additionally, one site at which 27 endangered Gray Bats were captured in 2018 again provided an opportunity to catch a relatively large number (10) in one night, one of which was originally banded in a neighboring state by the Tennessee

Wildlife Resources Agency. Unfortunately, there were no captures of a few species such as the Tri-colored Bat and Northern Long-eared Bat, both of which have experienced steep population declines due to white-nose syndrome (WNS). However, capture efforts at one site in Avery County again yielded Little Brown Bat captures this year, indicating that the species continues to be present at this site even though it too experienced steep population declines due to WNS.

“The Fat Bat Project”

In addition to long term mist-netting, the bat conservation team continued its collaboration on the Gray Bat project with

Indiana State University and began collaboration with Bat Conservation International on a national project dubbed “The Fat Bat Project.” As autumn approached, the NCWRC helped select and set up sites for a pilot study where UV lights are being set up to attract insect prey for bats to feed on before going into hibernation. Recent research has indicated that bats with higher fat stores going into winter are more likely to survive WNS, if infected. As a result, this project was developed with the goal of creating a scalable conservation solution, which could be rolled out across North America to help recover bat populations that have been decimated by WNS.



Little Brown Bat captured in Avery County (Kyle Shute)



Staff Secure Entry to Bat Mine before Winter Hibernation Began

by Katherine Etchison, Mammalogist

Each year, NCWRC staff visit an Avery County mine that serves as an important hibernaculum to several bat species to secure the site against unauthorized entry. Bats are sensitive to disturbance when hibernating, especially species susceptible to White Nose Syndrome, so preventing unauthorized entry during winter is key. Multiple trips were made

to the mine during October and November to make necessary repairs before bats returned to the mine to hibernate. A portion of the security fence was partially buried from a small landslide and further compromised by vandals, so additional posts were installed, and the fencing was removed and replaced. Weak areas of the security fence were also repaired, and

a damaged lock was replaced. A thorough search of the area was performed to ensure no other points of entry had been breached. Security cameras in the area were also maintained, and photos were turned over to law enforcement. A hibernaculum survey will be performed in January to monitor hibernating bats in the mine.



Western Wildlife Diversity Supervisor, Kendrick Weeks, repairing a gate outside the mine (Katherine Etchison)



Conservation Technician, Joe Tomcho, Western Wildlife Diversity Supervisor, Kendrick Weeks, and Wildlife Diversity Technician, Kyle Shute, repair the bat gate inside an Avery County mine. (Katherine Etchison)



Genetic Analyses of Eggshells Reveal Nesting Distances of Loggerheads

by Dr. Matthew Godfrey, Sea Turtle Biologist

Natal homing, which is the propensity for adults to return to the same location of their birth, has been a hallmark behavior of nesting female sea turtles since monitoring began over 50 years ago. Fundamental research involving genetics, satellite tracking and flipper tagging refined the scale of natal homing of a population

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A sea turtle volunteer holds an egg retrieved from a recently laid nest. The egg will be use for genetic analysis. (Jodie Owen)



to a few hundred kilometers. Current genetic analyses of eggshell samples from every known loggerhead nest laid between Virginia and northern Florida have shown that most loggerhead females lay their eggs within a span of a few dozen kilometers. A subset of turtles lay their eggs within several hundred kilometers, and a smaller number may venture even farther between

their nesting sites. For example, one nesting loggerhead in 2019 nested first on the northern Outer Banks of North Carolina at the end of May. Then, in mid-June, she nested just south of Jacksonville, Fla. She laid a third nest that same season in early July at Fort Fisher State Recreation Area in New Hanover County, NC. The total distance she traveled to lay these three nests is

unknown, but at minimum was >1400 km (870 miles). While this long-distance dispersal between nesting locations is relatively rare, it demonstrates some plasticity in the selection of nesting beach in this population of loggerheads, and suggests that individuals may be able to find new potential nesting locations made suitable for egg incubation due to changing climate conditions.



Map showing placement of three nests by an individual loggerhead sea turtle during the summer of 2019. These data were derived from genetic samples collected from each nest laid between Virginia and northern Florida.



Monitoring Sea Turtle Nesting Using DNA Eggshell Samples

by Dr. Matthew Godfrey, Sea Turtle Biologist

Since 2010, an eggshell sample has been collected from nearly every loggerhead sea turtle nest laid in Georgia, South Carolina and North Carolina, which is considered the range of the Northern Recovery Unit loggerhead population. The DNA fingerprints generated by the eggshell samples reveal the unique identities of all female turtles that lay their clutches in this region. Based on its eggshell sample, the loggerhead turtle nest laid on North Core Banks on June 27, 2021 was the first nesting activity documented by female loggerhead CC014164. However, the DNA sample provided a match in a different database

from a long-term, in-water monitoring project conducted along the southeastern United States. The turtle had been captured for research in 2003 near St. Augustine, Florida. The turtle's straight carapace length at that time was 27½" (70 cm). Incorporating average growth rates and minimum size at sexual maturity, biologists determined this turtle would be expected to start reproduction within 10 years. However, she was not observed nesting for nearly 20 years. It is possible that she experienced slower-than-average growth, or perhaps experienced delayed reproduction. Another possibility is that she started

nesting outside of the Northern Recovery Unit, but only recently moved to beaches within the area. Historical flipper-tagging data revealed that some adult female loggerheads can switch between nesting beaches as far apart as Cape Lookout National Seashore in North Carolina and Cape Canaveral National Seashore in Florida. It is thought that the Northern Recovery Unit loggerhead population split away from the Florida loggerhead population <20,000 yrs. ago, but there is increasing evidence that low level genetic exchanges across the two regional populations continue to occur.



An adult female loggerhead, on Cape Lookout National Seashore, found after she finished nesting but before she successfully found her way back to the ocean in the early morning (NPS - Cape Lookout National Seashore)



Did 2021 Set Record Season for Sea Turtle Nests? Time Will Tell.

by Dr. Matthew Godfrey, Sea Turtle Biologist

The nesting season for sea turtles in North Carolina spans early May through the end of August, with a peak in late June/early July. Although the start to the 2021 season was delayed relative to other years, by the end of June, 628 known sea turtle nests had been laid across the state's ocean coastline. This suggests there could be more than 1,200 nests laid for the whole season, making it one of the bigger seasons on record. The majority of nests have been laid by log-

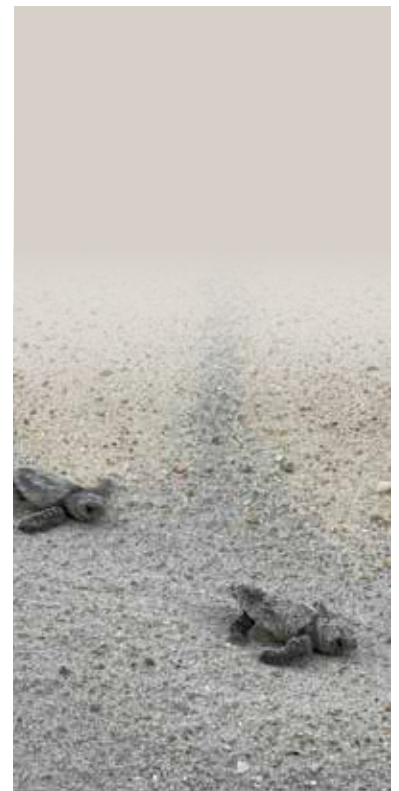
gerhead sea turtles, although to date there have been four nests laid by green turtles and six nests by Kemp's ridley sea turtles. Leatherbacks have not nested in North Carolina since 2018, and various nesting sites across the northwest Atlantic have reported a decline in nests laid by this species in the past several years.

The peak time for nesting sea turtles in North Carolina also marks the start of the emergence of hatchlings from nests laid earlier in the season.

The volunteers and cooperators who patrol the beaches daily to mark and protect sea turtle nests will now begin to keep watch for hatchling emergence events. When the nesting season finishes at the end of August, the volunteers and cooperators will continue to monitor nests throughout their incubation. This may require working into November, if late summer tropical storms have not interrupted the incubation of incubating nests.



Photo of nesting crawls made by two different loggerhead turtles during a single night on June 24 at Wrightsville Beach (Robert Kaess)



(Jodie Owen)



Using PIT Tags to Determine Sea Turtle Longevity

by Dr. Matthew Godfrey, Sea Turtle Biologist

How long do sea turtles live? The answer remains a mystery, largely due to the logistical challenge of designing a tag that remains attached to the turtle over years and decades. New information collected by sea turtle nesting beach projects provides some insight. In the last three nesting seasons in North Carolina, a combination of physical and genetic tags has revealed that eight loggerhead females have been actively laying eggs in North Carolina for at least 20 years. One turtle was first tagged with a metal flipper tag while attempting to nest on Camp Lejeune in June 1995. Metal tags applied to sea

turtles have a relatively high rate of failure after a few years, as is the case with this turtle, who was given new flipper tags in 2001. In 2003, she was also given a passive integrated transponder (PIT) tag in her left front flipper. PIT tags have a higher retention rate than metal tags but require a scanner to be recognized. Her genetic ID has also been documented through DNA analysis of a sample of fresh eggshell from her nests. These three sources of information combined have revealed that this turtle has continued to nest every few years in North Carolina and was last seen in 2019 while laying eggs on Bald

Head Island. Other turtles actively nesting on North Carolina beaches include a turtle first tagged in 1998, another in 1999, and five in 2002. The estimated minimum age of maturity for loggerheads in the NW Atlantic is 30-35 years, which means these tagged sea turtles are at least 50 years old. More precise estimates at this time are not possible, because tagging effort is low in North Carolina, and PIT tags were used only from the early 2000s. However, we expect greater understanding of sea turtle longevity as tagging efforts and genetic sampling continue.



*An adult female loggerhead nesting on Onslow Beach in Camp Lejeune, North Carolina
(Dr. Matthew Godfrey)*



The bog turtle is listed as Federally Threatened due to Similarity of Appearance (T(S/A)) to the northern population and state listed as Threatened in North Carolina.



A Glimmer of Hope in Bog Turtle Conservation

by Carl Jacobsen - Wildlife Diversity Technician

The bog turtle (*Glyptemys muhlenbergii*) is listed as Federally Threatened due to Similarity of Appearance (T(S/A)) to the northern population and state listed as Threatened in North Carolina. It has become evident in recent years that the species faces many of the same threats in the southern U.S. An

estimated 80-90% of bogs have been lost in North Carolina because of decades of land-use conversion. Bog turtle range in North Carolina is the Blue Ridge Mountains and upper Piedmont eco-regions, with records existing in eight river basins. Relatively few bog turtle populations remain, and most of those

appear to be in decline. The threats this species and their habitat – bogs -- face are numerous and include vegetative succession, vehicles, habitat loss and degradation, excessive predation, development and changes in the watershed and barriers to movement.

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With population declines and the number of threats the bog turtle faces, it can be overwhelming at times for those working to conserve the species. Fortunately, there are glimmers of hope and progress being made that keep them motivated and working hard to conserve this species. As part of some winter-time visits to assess habitat condition and determine habitat management needs at several bogs, WDP staff planned to visit a bog that has only ever had one adult turtle observed despite being discovered in the 1980s. An adult male was found in 2003 and none had been found since. On a cold snowy day in February 2021, a small group explored this bog (Figure 1), recording vegetation and habitat condition, as well as sketching out the beginning of a plan for habitat management. As they were walking around, Gabrielle Graeter, an NCWRC biologist, pointed down at beautiful sphagnum mats and said, “This over here looks like perfect nesting habitat.” Then five seconds later, Carl Jacobsen, a WDP Technician spotted a hatched nest! To his surprise, he spotted three relatively recently hatched eggs tucked into the sphagnum moss (Figure 2). Literally, everyone cheered. It was obvious the eggs hatched due to the spiral pattern of the remnant eggshell pieces. It was also evident that they were from the previous summer due to how intact and how little decomposition had occurred. In that one moment staff confirmed the recent presence of a breeding adult male, a breeding adult female and multiple hatchlings. With that discovery, the record for this location



Figure 1. View of one part of the bogs WDP staff visited in February 2021 in western North Carolina. (Carl Jacobsen)



Figure 2. Up-close view of the bog turtle nest and eggshell fragments discovered in February 2021. (Carl Jacobsen)

went from an almost 20-year-old one-turtle record to a present-day successful breeding population. There is much more to do to better understand the status of this population, but the evidence of young turtles gives them hope for this population given that many other populations have no evidence of nesting or young turtles. It was a good day in the field for bog turtle conservation!



Biologists Add New Tool to Conservation Tool Box to Help Bog Turtles

by Gabrielle Graeter, Conservation Biologist/Herpetologist

It has become evident in recent years that the species is as rare as the northern population and faces the same threats in the southern United States. An estimated 80-90% of bogs have been lost in North Carolina because of decades of land-use conversion. Relatively few bog turtle populations remain, and most of those are small and appear to be in decline. North Carolina is in danger of losing populations and genetic diversity.

Bog turtles are slow to rebound after detrimental impacts because they do not start breeding until they are 6 or 7 years old and only produce 1-4 eggs each year, if any. Unfortunately, the threats this species and their habitat — bogs — face are numerous. Major threats to bog turtles include vegetative succession, vehicles, habitat loss and degradation, predation, development and changes in the watershed, and barriers to movement.

Conservation of bog turtles is multi-faceted, can be site specific, and includes habitat management and restoration, land protection, collaboration with private landowners, and

protection from unnaturally high predation levels. NCWRC staff have recently added an additional tool to the conservation toolbox for helping this species — population augmentation via head-starting. Head-starting is the act of rearing wild hatchlings in protective enclosures before release at a less susceptible size, thereby reducing the high mortality of young age classes in the wild. Agency conservation partner Zoo Knoxville will incubate the eggs then rear the hatchlings for nine months before NCWRC staff release them back to their natal wetland.

NCWRC is initially focusing on a handful of conservation-owned lands that have had low nesting success. The goal is to stabilize and potentially grow these populations as part of a long-term, multi-faceted strategy to achieve species viability. Staff have been busy in the last month collecting egg clutches at these populations for head-starting (Figure 1). Thus far, staff have 17 clutches (total of 56 eggs) from five North Carolina sites that will be incubated at Zoo Knoxville from 2021-2022. Although this technique can augment the

population, habitat management, removing or mitigating barriers to movement, and addressing other threats will be necessary for the conservation of North Carolina's smallest and most habitat-specific turtle.



Figure 1. View into a bog turtle nest in the wild that has been partially uncovered (Gabrielle Graeter)



Bog turtle (Jay Ondreicka)



Recent Discoveries in a Bog Turtle Population Give Biologists Renewed Hope

by Gabrielle Graeter, Conservation Biologist/Herpetologist

Unfortunately, many remaining bog turtle populations in North Carolina are small and in decline. The threats they and their habitat face are numerous. Threats include development, changes in wetland hydrology, invasive and woody plants, busy roads and habitat fragmentation, predation, and more. NCWRC staff and partners are working hard to improve habitat conditions and improve the status of bog turtle populations at many of these sites.

At one population in western North Carolina, mark-recapture data analysis indicates the

population is in decline, with population abundance estimated to be eight turtles in 2015. Since then, two adults are known to have died. With extensive survey effort over the past few years, staff estimate that there are as few as four or five adult turtles remaining in this population. A scientific journal article by Shoemaker et al. (2013) concluded that for a bog turtle population to be viable over the long term, it must have at least 15 adult females, or approximately 30 adults. This focal population is far from meeting that minimum number. It is especially worrisome that only

one adult male has been detected over the last decade. With such a small population size, this population is prone to extirpation without immediate intervention.

Due to past land-use and current threats to this species, it can take a lot of effort to stabilize or increase a population. At this focal population, NCWRC staff and partners have made many efforts to protect the land, manage the habitat, and improve the status of the bog turtle population over the years. For example, the NCWRC purchased the land to help protect the habitat from further degradation, and staff have removed non-native invasive plants and woody vegetation to maintain the bog as open canopy. They have also used radio-telemetry to better understand the turtles' habitat use. In January 2018, a large-scale restoration project to address erosion problems, improve hydrology, and expand the size of the wetland was completed, thereby improving the amount and quality of the habitat at this site.

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The 9-month old bog turtle that was discovered during surveys at the focal population in summer 2021 (NCWRC)



In summer 2021, staff were elated to discover two previously undetected bog turtles at this bog, giving them new hope for this population. One was a juvenile turtle that had hatched the previous fall. With all the hard work staff have been doing to improve the habitat for the species, it was very exciting to know there has been recent nest success! They also captured a large 5-year-old male bog turtle that they had never seen before, which is fantastic given the shortage of breeding males. Biologists hope in the next couple of years he will be reproductively active and ready to contribute even more to the population! Despite these recent successes, there is still much to be done to help stabilize this population. By working closely with partners, prioritizing efforts, and taking effective on-the-ground action, biologists believe there is still hope for this bog turtle population and others.



NCWRC Conservation Biologist Gabrielle Graeter is elated to discover a 5-year-old male bog turtle at the focal population. (Gabrielle Graeter)

Bog Learning Network holds “Bogs & Brews” virtual meeting in December

by Gabrielle Graeter, Conservation Biologist/Herpetologist

The Bog Learning Network (BLN) is a consortium of scientists and land managers working to advance the restoration and management of Southern Appalachian Bogs. It provides a forum for sharing information and experiences about bog management and conservation and helps bog managers find resources and assistance. Strategies of the BLN include coordinating

protection efforts for Southern Appalachian wetlands, supporting on-the-ground conservation, facilitating and providing learning opportunities, and increasing BLN membership and outreach. Annual learning opportunities that the BLN offers include field trips and “work-and-learn” workdays, whereby a bog manager gets much needed assistance in the field with a project, and

simultaneously the participants learn about bogs and various bog management techniques.

When the pandemic began in early spring 2020, the Bog Learning Network’s (BLN) annual meeting, scheduled for April, was postponed indefinitely. The BLN steering committee waited until late summer 2021 to see if an in-person

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meeting would be possible but concluded that a virtual meeting would be the safest way to connect with members. Therefore, the BLN Steering Committee, on which NCWRC Conservation Biologist Gabrielle Graeter serves, planned the December 2021 “Bogs and Brews” virtual meeting.

The December 2021 virtual meeting was relatively short and held at the end of the day so people could have a “brew” of their choice (tea, coffee, beer,

etc.) and sit back and enjoy the meeting without worrying about getting “Zoom fatigue.” The meeting included updates from the BLN leadership and several sub-committee leaders, followed by a variety of interesting talks – illegal turtle collection, the influence of site history on bog turtle abundance, community classification of Kentucky’s bogs, and the use of native ferns as a biological control for an invasive plant species. During a session titled “Post-

cards from the Field,” several BLN members shared slides and talked for a few minutes each about an exciting project. The meeting was a great success – 111 people registered and at least 62 people attended the meeting live! Although it was not as good as meeting in person, the virtual format allowed the BLN leadership to share some important BLN updates, hear about recent work by several members, and connect with many of the BLN members.



In fall 2021, a Bog Learning Network Work-n-Learn workday was held with participation limited to 10 people for safety due to the pandemic. Here are the participants learning about the history of the wetland and property as well as the objectives for the workday.



Alligator Monitoring Continues in 2021

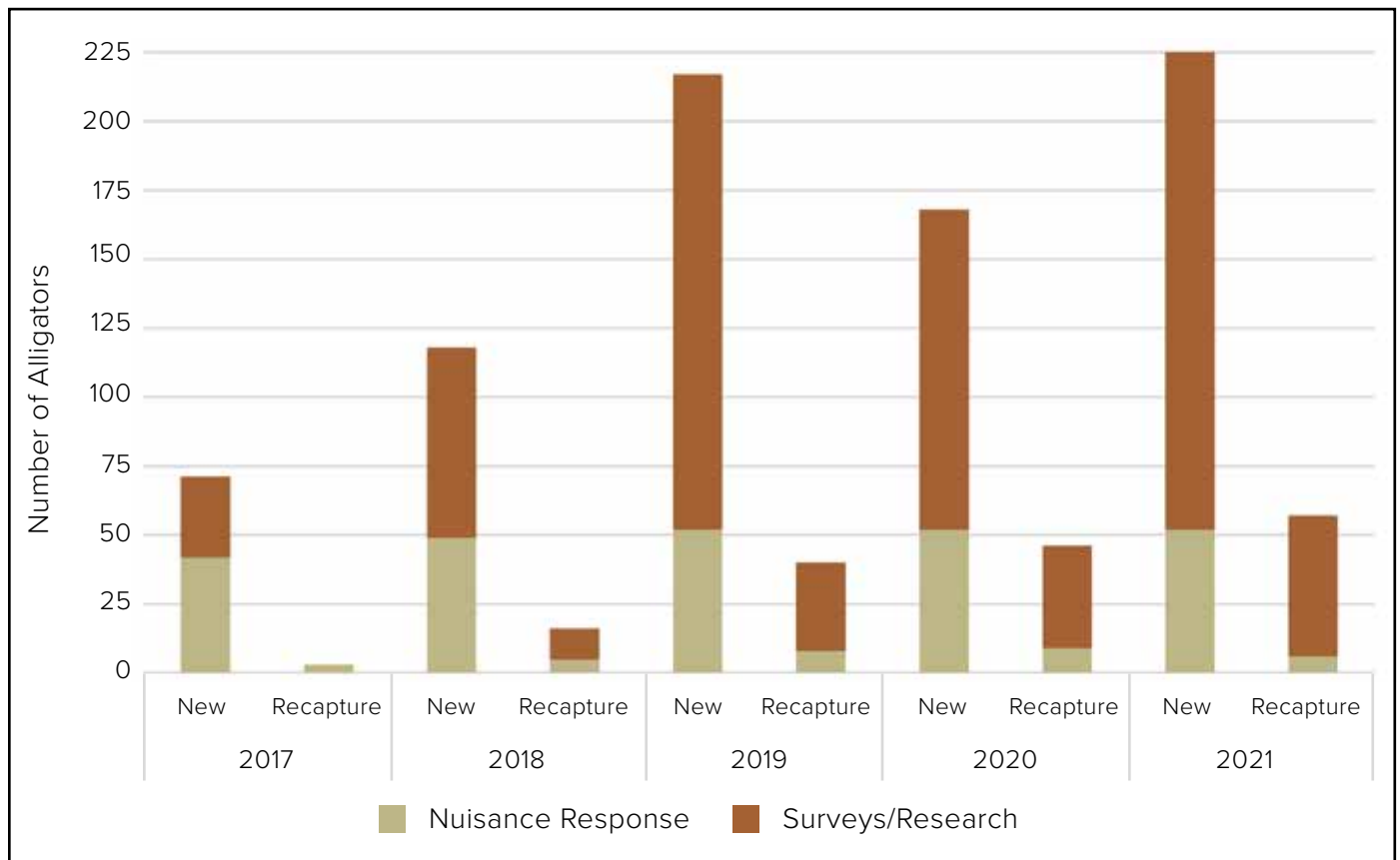
by Alicia Davis, Alligator Biologist

In spring 2017, NCWRC initiated a new marking and data collection protocol for all alligators handled by agency staff and permitted external handlers, including Alligator Control Agents, Jurisdictional Alligator Handlers, and scientific researchers*. First, every handled alligator is scanned to determine if it has already been tagged. Handlers mark all new captures with an internal Passive Integrated Transponder (PIT) tag, collect two tissue samples from

tail scutes, determine sex, take body size measurements, and record GPS coordinates of locations of capture and release. Measurements and locations are recorded for all recaptured individuals. To date, 800 wild alligators have been captured, marked and released in North Carolina using this method. Data were collected from 283 alligators in 2021, 57 of which were recaptured individuals that had been marked previously.

These data are of great benefit to the agency's alligator conservation efforts. Equipped with this information, biologists are able to learn more about growth rates and movements of individuals at different life stages, evaluate the effectiveness of various management practices, and identify communities that could benefit most from outreach programs with guidance on coexisting with alligators.

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Wild Alligators Captured, Marked, and Released in North Carolina by Year (2017-2021)

* Scientific researchers include Dr. Stephen Dinkelacker, Framingham State University and Dr. Scott Belcher, NC State University



In addition to data collection from live alligators, NCWRC began collecting data from all dead alligators in 2017. To date, data have been collected from 61 dead alligators, 53 of which were found dead. Of the 13 alligators that were found dead in 2021, three were hit by motor vehicles, one was inadvertently captured and drowned in a commercial pump, six appeared to have been illegally killed, and the cause of death for three alligators was not apparent. One of the six poached alligators was

found shot in a remote area where it had been relocated six months prior.

In rare situations in which alligators are found in locations far outside of alligator range, agency staff must assume that those individuals have been illegally kept in captivity. Due to concerns about potential disease introductions and/or habituation to being fed by humans, those individuals are not released into habitats that support wild alligator populations; rather, those individuals must be transferred to permanent

captivity or euthanized. Two alligators were euthanized in 2021 for these reasons. Within the range of natural alligator occurrence, one additional alligator was euthanized in 2021 due to severe injuries from a motor vehicle strike.

Femurs and other tissue samples were also collected from each dead alligator. In 2022, stored alligator femurs will be sent to a laboratory where growth rings in bone cross-sections will be analyzed in an attempt to age each individual.

Alligators Mortalities in North Carolina by year (2017-2021)

Mortality type	2017		2018		2019		2020		2021		Total Records
	New	Recap	New	Recap	New	Recap	New	Recap	New	Recap	
Euthanization	0	0	0	0	1	1	2	1	3	0	8
Found Dead	5	0	9	0	3	0	18	5	12	1	53
Total	5	0	9	0	4	1	20	6	15	1	61



NCWRC staff mark and collect data from all hatchlings found at nest sites. (Alicia Davis)



Two Protected Species Most Encountered During Snake Surveys

by Dr. Jeff Humphries, Eastern Amphibian and Reptile Biologist

2021 ended the seventh year of a mark-recapture study of selected snake species on the Sandhills Game Land in Scotland and Richmond Counties. The purpose of this study is to gather information about population size, population status (declines or increases over time), movements, growth and other aspects of the natural history of each species. Staff are targeting a mixture of snakes perceived as “rare” and “common” in the state. Survey methods include driving roads, walking habitat, and checking artificial cover throughout the year. Snakes are marked with PIT tags and scale marking. Over seven years,

NCWRC biologists have encountered 541 individuals of the six species targeted. Of note is the very small number of recaptures of any of the species. Differences in road mortality among the different species is becoming evident. Interestingly, two of the species that are considered Species of Greatest Conservation Need (Northern Pinesnake and Eastern Coachwhip) have been encountered the most during this study. This does not mean these species are not in need of conservation, but the high encounter rate specifically in the Sandhills is encouraging and likely a result of large areas of well managed habitat on the game land. This study

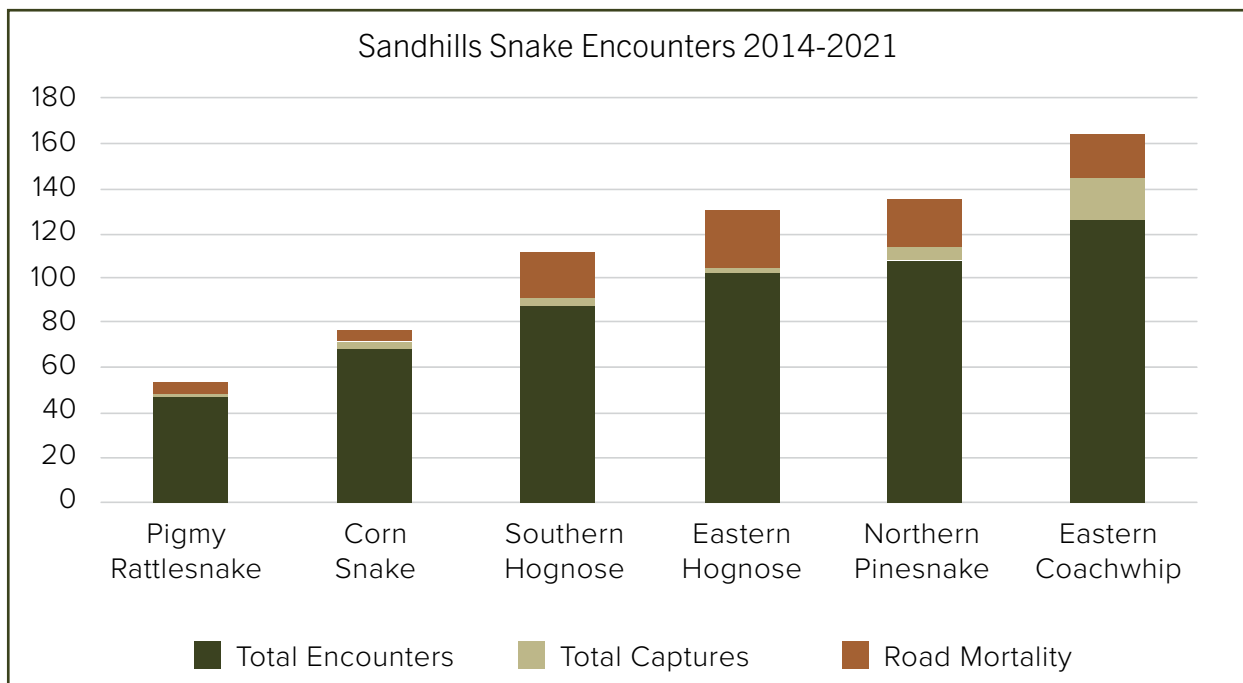
will continue for at least three more years and data will then be compiled and analyzed to provide a baseline for research and monitoring.



Northern Pine Snake (Jeff Hall)



Eastern Coachwhip (Jay Ondreicka)



Snake encounters over seven years in the Sandhills of North Carolina, including recaptures and road mortality.



AMPHIBIANS

(Jeff Hall)

Rainy Winter Yields Positive Results for “New” Isolated Wetlands

by Dr. Jeff Humphries, Eastern Amphibian and Reptile Biologist

In early 2021, NCWRC biologists working in the Sandhills spent considerable effort surveying for Species of Greatest Conservation Need (SGCN) such as Gopher Frogs, Eastern Tiger Salamanders and Mabee’s Salamanders. They have also continued to collect small portions of Gopher Frog egg masses for head-starting and translocation

of captive-reared juveniles. This past winter was extremely rainy compared to normal years and the high amount of precipitation presented an opportunity to search for isolated wetlands that may have been overlooked before. Indeed, several “new” wetlands were documented over the past few months on Sandhills Game Land. One of these wetlands is

being used by Tiger Salamanders for breeding and another “new” wetland is occupied by Mabee’s Salamanders (photo above). Discovering more isolated wetlands is important for documenting and monitoring SGCN species, assessing needs for wetland restoration, and directing management to maintain high quality habitat.



Staff Document 48 New Sites for Collinses' Mountain Chorus Frog

by: Lori Williams/Western Amphibian Biologist

In March 2021, Wildlife Diversity Program staff continued annual inventory and monitoring surveys for a state special concern chorus frog in the far southwestern counties (Cherokee and Clay). Formerly known as the Mountain Chorus Frog, in 2020 a research team led by Florida State University officially described the NC populations as a new species, naming it Collinses' Mountain Chorus Frog (*Pseudacris collinsorum*) with a distribution range that includes parts of Georgia, Alabama, and Mississippi. Fortunately, standard survey protocol of nighttime road cruising during wet or foggy conditions and stopping to listen for calling male frogs in breeding habitats is still suitable for the species. During the month of March, severe thunderstorms dumped several inches of rain on multiple occasions in southwestern NC, which may have created more ephemeral aquatic breeding habitats for Collinses' Mountain Chorus Frogs, thus aiding biologists' ability to detect them during surveys. Survey efforts were the most successful of any year since the beginning of the project in 2008. Out of 140 surveys

completed, 48 new sites were documented, the most ever in a single year. Out of the known sites surveyed, 38% had Collinses' Mountain Chorus Frogs, the highest percentage in recent years (2020: 21%; 2019: 35%; 2018: 29%). Notable new sites (n=6) occurred directly beside Highway 64 in Murphy, NC, a busy corridor through Cherokee County. One of these new sites is threatened because the small drainage pond the frogs are using is on a vacant lot for sale

in the middle of a heavily developed part of town.

Also noteworthy is the oldest historical record the NCWRC has for the species, a site originally found in 1949 where frogs were collected as museum specimens. Despite attempting to detect frogs since 2008 at or near this historic location (now, also in a heavily developed area), staff had always failed until this year. They finally had success in updating this long-standing, historic record.



Above: The newly described Collinses' Mountain Chorus Frog is a State Special Concern species found in the southwestern part of the state. (Lori Williams)



Left: A male Collinses' Mountain Chorus Frog calling from vernal pool habitat (Jonathan Micancin)



Biologists Deploy “Frogloggers” to Search for River Frogs

by Dr. Jeff Humphries, Eastern Amphibian and Reptile Biologist

During the second quarter of 2021, NCWRC biologists deployed automated recording devices (“frogloggers”) in a continued effort to detect the breeding calls of River Frogs in eastern North Carolina. This species was last found in the state in 1976, along the Lumber River near Maxton, and reasons for the apparent extirpation of the species are still unknown. River Frogs inhabit backwaters, sloughs and oxbows of blackwater rivers along the Atlantic and Gulf Coast throughout the Southeast. In North Carolina, they were historically known from several river systems in southeastern

North Carolina, though records were sparse, and the extent of their range before 1976 was poorly understood. Intensive surveys were performed in the 1980s and 90s using canoe and spotlight surveys, driving roads looking for frogs, and looking for schools of tadpoles at bridge crossings, but no River Frogs were found. In the spring, NCWRC staff deployed 13 frogloggers in remote locations along three rivers systems: the Black River, Lumber River and the Waccamaw River. The frogloggers are programmed to record 5 minutes every hour from sunset until sunrise from

May or June through early September. Analysis of calls from the recorders was conducted in the fall 2021.

Staff also coordinated with South Carolina Department of Natural Resources biologists to determine whether River Frogs still exist near the North Carolina border, which can be used to inform future survey locations in North Carolina. Collaborators have also discussed possible re-introduction of the River Frog to North Carolina riverine systems if work fails to detect the species after multiple years of exhaustive surveys.



Deploying an automated recording device next to an oxbow along the Lumber River in Robeson County (Dr. Jeff Humphries)



Ideal river oxbow habitat along a remote part of the Waccamaw River in Brunswick County (Dr. Jeff Humphries); inset photo: River Frog (Todd Pierson)



Biologists Find Elusive Salamander During Rainy Night Surveys

by: Lori Williams/ Western Amphibian Biologist

In June 2021, Wildlife Diversity Program staff conducted rainy night surveys for surface active salamanders, specifically targeting the Long-tailed Salamander, a Species of Greatest Conservation Need and newly proposed for state threatened status. Long-tailed Salamanders are arguably one of the rarest and most challenging salamander species to find in North Carolina, which may be due to small population sizes, a very

patchy, fragmented distribution within the state (and North Carolina being at the southern end of their range), and their reclusive behaviors and hard-to-reach habitats, often occupying rock outcrop and stream riparian zones within river corridors and gorges. Staff were not able to find the species at a known site in Watauga County where imminent bridge and road construction will destroy much of the habitat, but they were able

to update species records at another Watauga County site farther downstream in the Watauga River corridor. In northern Haywood County, nighttime surveys at a historical site in the Pigeon River corridor continued to be unsuccessful; staff have made several attempts to find the species in recent years, as the last confirmed observation was in 2009. However, the oldest Long-tailed Salamander record for the state is from museum

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Wildlife Diversity technician, Reed Rossell, searches rock outcrop habitat at night for the elusive Long-tailed Salamander in Haywood County. (Lori Williams)

collections in 1919, also in the Pigeon River corridor of northern Haywood County. There has been minimal effort to update that record, as the estimated location was assigned to the nearest town at that time and is in a developed area where habitat is not found. Staff spent time this spring scouting possible rock outcrops that were as close to the 1919 record as possible (within a few miles), and in two nighttime survey attempts, they were able

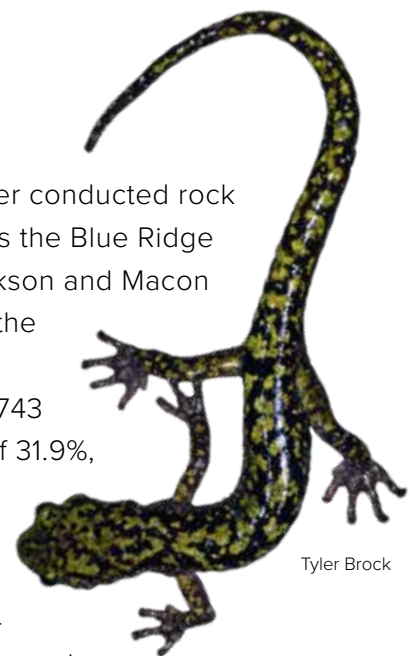
to find an adult Long-tailed Salamander each time. Photographs of the splotch patterns on the body and tail confirmed the individuals were different. The find is significant not only because they documented a new site for a rare species, but also because it represents the closest they may ever come to updating the oldest known record. It is encouraging to know the species has persisted in the general area for the last 100 years and counting!

Staff Document Highest Number of New Green Salamander Sites in a Single Season

by Lori Williams, Western Amphibian Biologist

In fall 2021, Wildlife Diversity Program staff and a longtime volunteer conducted rock outcrop surveys for state threatened Green Salamander that occupies the Blue Ridge Escarpment of western North Carolina (Henderson, Transylvania, Jackson and Macon counties). They completed the most surveys ever in a fall season for the species (n=743) at 462 individual rock outcrop sites and documented the highest number of new sites in a single season (n=41). Out of the 743 surveys, 237 had at least one Green Salamander for a success rate of 31.9%, almost identical to efforts in fall 2020 (736 surveys, 32.3% success).

As an important indicator of nest success, at least one hatchling Green Salamander was documented in 22 surveys at 19 individual rock outcrop sites. At just one site, they observed at least nine hatchlings on the rock surface and nine others climbing shrubs by their nest rocks



Tyler Brock

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at heights of more than 12 feet above ground. Other habitat used by hatchlings, yearlings, older juveniles and adults included not only the usual rock crevices and out in the open on bare rock but also on the rock surface under rock tripe and within moss, under bark pieces or other natural cover on top of rocks, and on mature trees and shrubs adjacent to rock outcrops.

Trees, and even tall shrubs like rhododendron and mountain laurel, next to rock outcrops, are critical for providing shade and keeping humidity and moisture at suitable levels for salamanders. It is established in literature the role trees and shrubs play for Green Salamanders, which are highly adapted to climb them, in terms of aiding dispersal and providing refugia and foraging opportunities, but biologists' actual observation of this unique habitat use is not very common.

In fall surveys, staff attempted to focus more on looking in trees and shrubs than in years past. In addition to hatchlings at several sites, they found four adults and older juveniles climbing trees, 6-8 feet high and up. On one occasion, an adult Green Salamander was observed 7 feet high, and 45 minutes later, it had climbed to over 12 feet high (and still climbing).

Staff will continue these critical population monitoring and inventory surveys for Green Salamanders yearly. Going forward, they will focus especially on learning more about habitat use by all age classes, hatchlings through adults.



A hatchling Green Salamander active on wet, bare rock. Note the blue coloring, as it can take many months to develop normal coloration. (Ben Dalton)



An adult Green Salamander climbing 12 feet high (and still going) a magnolia tree (Ben Dalton)



Juvenile Gopher Frogs Released at Newly Restored Wetland in Sandhills

by Dr. Jeff Humphries, Eastern Amphibian and Reptile Biologist

In collaboration with the North Carolina Zoo, NCWRC biologists continued to raise Gopher Frogs as part of a “headstarting” program. Gopher Frogs have become so rare on the landscape that headstarting — raising frogs from eggs to juveniles in captivity and releasing them into the wild — has become an important conservation tool. This year in the Sandhills in North Carolina, biologists raised and released 459 juvenile frogs. They collected small portions

of egg masses from a relatively stable population and released the frogs at a newly restored wetland for the second year in a row. If successful, this effort would be the first time a new population of Gopher Frogs has been created or restored in North Carolina. Increasing the number of populations or meta-populations is important for increasing the chances that this species remains part of the state’s fauna. Staff are monitoring the introduction using automated recorders to listen for

breeding adults and searching for egg masses during the breeding season. Since Gopher Frogs don’t reach sexual maturity until 2–3 years old, this winter and spring will be the first chance staff will have to determine if the introduction efforts are successful. If those efforts are successful, biologists plan to re-introduce frogs to other restored wetlands to improve populations and population resiliency across the frog’s range.



Releasing juvenile Gopher Frogs to a restored wetland in the North Carolina Sandhills (left); A headstarted juvenile Gopher Frog ready for release at a restored wetland (Michael Martin)



Good News and Bad News for Hellbender Populations in the Aftermath of Tropical Storm Fred’s Catastrophic Floods

by Lori Williams, Western Amphibian Biologist

In late summer, the remnants of Tropical Storm Fred dumped record amounts of rainfall and caused unprecedented flooding in western North Carolina that cost lives, destroyed homes and property, and resulted in untold damage to river ecosystems. Among the many questions of “what survived?” in the hardest-hit rivers in Haywood and Transylvania counties was the unknown effects on a sensitive, state-listed species, the Eastern Hellbender, especially since

the floods came just before its breeding season.

When the flood waters receded and rivers were safe to enter, Wildlife Diversity staff, partners and volunteers began the task of assessing habitat damage and monitoring the hellbender population as they have done for many years. They saw severe, and possibly lasting, damage to rivers with deep scouring of the river bottom, displacement and destruction of the large, flat boulders hellbend-

ers require, significant stream-bank erosion and loss of riparian vegetation and altering of stream channels. The number of fish and aquatic wildlife, including hellbenders, that perished in the floods is unknown. However, biologists do know that at least 11 live hellbenders were rescued in two river systems, with at least seven confirmed mortalities, although actual mortality numbers were likely much higher.

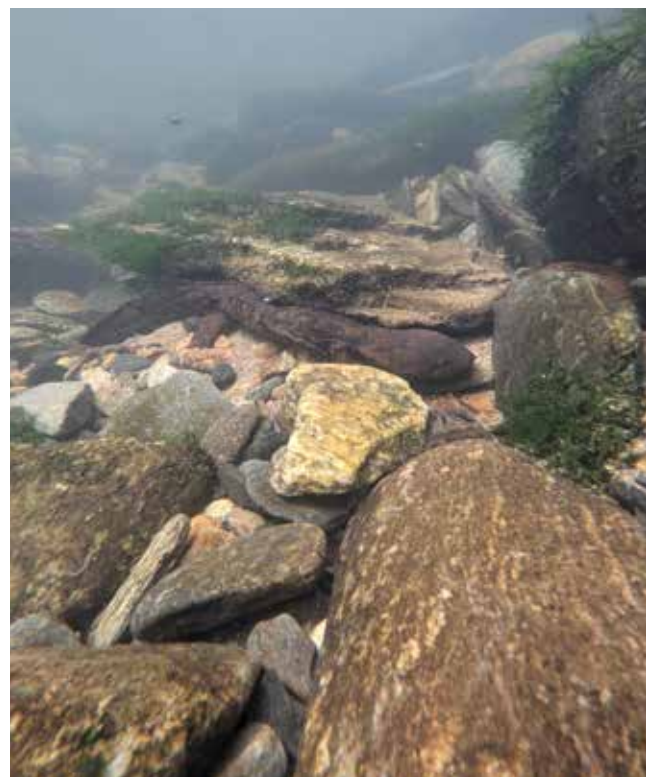
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Wildlife Diversity technician, Ben Dalton, poses with an adult Eastern Hellbender active on the stream bottom during breeding season snorkel surveys.





In good news, though, they did find adult hellbenders in comparable numbers to previous years, although actual breeding and nesting appeared to be down. Overall, for the breeding season snorkel surveys, staff completed 49 surveys with only 13 failing to document hellbenders. They covered eight counties and counted 278 animals (the most ever!), at least 70 of which were from one of the worst-hit rivers in the French Broad drainage, demonstrating the resilience of adult hellbenders. The impact on juvenile and larval hellbenders is unknown but may be revealed in the coming years with more monitoring efforts.



Clockwise from top left: The historic flood in August 2021 ravaged streambanks and deposited deep beds of dry cobble, altering stream flow (Lori Williams); During breeding season snorkel surveys in the best Eastern Hellbender populations, it is common to see two or more adults active on the stream bottom (Ben Dalton); An adult Eastern Hellbender found during breeding season snorkel surveys (Ben Dalton); Although nesting and breeding activity may have been down from previous years, Wildlife Diversity staff still observed a number of “denmaster” male Eastern Hellbenders guarding their nest rocks. (Ben Dalton)



Jeff Hall

NCPARC News: Winter Amphibian Surveys

by Jeff Hall, Partners in Amphibian and Reptile Conservation Biologist

Winter amphibian surveys were conducted across the Coastal Plain for target species such as Gopher Frog, Southern Chorus Frog, Ornate Chorus Frog, Mabee's Salamander and Tiger Salamander. Due to good amounts of winter rains, this period proved to be especially good for the Gopher Frog. Biologists detected Gopher Frog breeding activity, through visual searches for egg masses, in all five of the coastal populations, several of which had gone without signs of breeding for at least a year or more. In addition, in the Croatan population, there were two new breeding ponds detected.

Head-starting activities, involving rearing eggs up to metamorphosis, were initiated at three different Coastal Plain facilities for four different populations. Both the NC Aquarium at Fort Fisher, and the NCSU CMAST facility had participated previously, but this year a new partner was added: the Edenton National Fish Hatchery. Biologists at each facility hope to produce young Gopher Frogs that can then be released, in conjunction with NCWRC staff, back to their natal ponds.



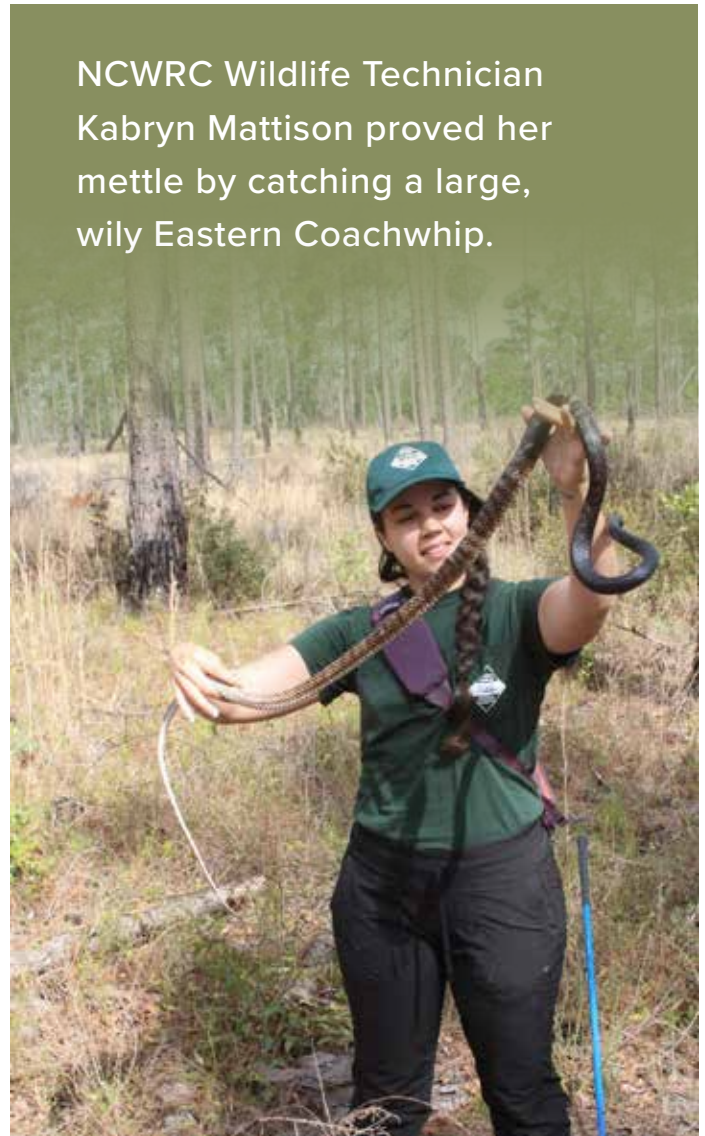


NCPARC News: Trail Cam Surveys “Capturing” Rattlers Continue

by Jeff Hall, Partners in Amphibian and Reptile Conservation Biologist

In 2021, NCWRC staff continued work using trail cameras to “capture” rattlesnake behavior and movements. Twenty-five different cameras were deployed for detecting Eastern Diamondback Rattlesnakes and Timber Rattlesnakes. These trail cameras continue to produce valuable images of these species, along with many others. During a site visit to replace batteries and SD cards for the cameras, NCWRC biologists had the opportunity to view rattlesnakes in habitat as well as other species of interest such as Eastern Coachwhip and Carolina Pigmy Rattlesnake.

In addition, NCWRC biologists were treated to a pair of Eastern Diamondback Rattlesnakes at one of the hibernation locations. Likely this is a breeding pair, and the images from the nearby trail camera may tell the tale.



NCWRC Wildlife Technician Kabryn Mattison proved her mettle by catching a large, wily Eastern Coachwhip.

Top photo: Trail camera installation for detecting Timber Rattlesnakes. Camera is attached to a tree on the right (red circle); Right photo: pair of Eastern Diamondback Rattlesnakes (Jeff Hall)





NCPARC News: Landowner Guidance to Protect Valuable Habitat

by Jeff Hall, Partners in Amphibian and Reptile Conservation Biologist

In the second quarter, staff visited several landowners and provided technical guidance on management of lands to benefit reptiles and amphibians. One of these landowner visits was to assess the property as habitat for the Carolina Pigmy Rattlesnake for possible enrollment in the Wildlife Conservation Lands Program. Staff were able to find one adult rattlesnake while on the property and are working with the landowner to provide management recommendations.

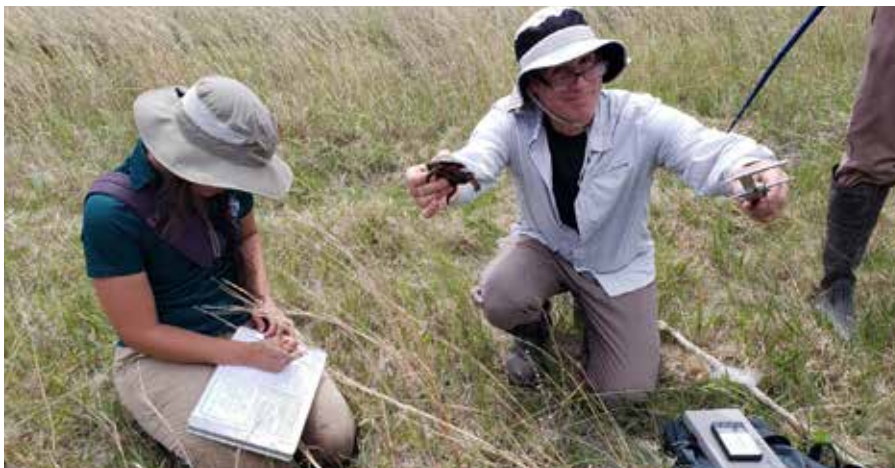


Carolina Pigmy Rattlesnake seen during visit on private land in Hyde County. (Jeff Hall)

NCPARC News: Spring Reptile Surveys Yield Several Listed Species

by Jeff Hall, Partners in Amphibian and Reptile Conservation Biologist

Spring reptile surveys included target species such as Bog Turtle, Spotted Turtle, Diamondback Terrapin, Mole Kingsnake, Carolina Pigmy Rattlesnake, Timber Rattlesnake, and Eastern Diamondback Rattlesnake. Staff conducted these surveys and some monitoring of known sites across the state. Additionally, trail cameras were retrieved from several locations targeted at rattlesnake hibernation sites. These images will be reviewed over the coming months.



Wildlife Technician Kabryn Mattison with Mole Kingsnake. Kabryn Mattison (left) and Sea Turtle Biologist Matthew Godfrey processing a Spotted Turtle during a monitoring project (Jeff Hall)



NCPARC News: Fall Upland Snake Surveys Especially Successful

by Jeff Hall, Partners in Amphibian and Reptile Conservation Biologist

Upland snake surveys during this quarter were especially successful including many SGCNs such as Carolina Pigmy Rattlesnake, Timber Rattlesnake, Southern Hognose Snake, Northern Pine Snake, and Eastern Coachwhip. Staff conducted

these surveys and some monitoring of known sites across the state. Records of these species continue to be extremely important to help direct conservation and restoration efforts on the lands that they call home.



From left, clockwise: Timber Rattlesnakes in a gestation site with numerous adults and recently born babies; Southern Hognose and Northern Pine Snake found during fall upland snake surveys (Jeff Hall)

NCPARC News: Rare Reptile Found During Late Fall Upland Surveys

by Jeff Hall, Partners in Amphibian and Reptile Conservation Biologist

During this final quarter of 2021, field highlights included upland snake surveys, Neuse River Waterdog surveys, and placement of monitoring devices. Upland snakes encountered during this quarter included Eastern Diamondback Rattlesnake, Carolina Pigmy Rattlesnake, Southern

Hognose Snake, Northern Pine Snake and Eastern Coachwhip. Surveys were conducted at numerous sites along the Coastal Plain and into the Sandhills. Additionally, through a contact with a private landowner in Pender County, staff were able to

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catch and photograph an Eastern Coral Snake. Records for this species are very few and far between so this was particularly rewarding. Neuse River Waterdog surveys were completed at seven Craven County historical sites. Unfortunately, the salamanders were only detected at one of the seven localities. Numerous automated audio recording devices (aka Frogloggers) were deployed for detection of winter-breeding anurans such as Ornate Chorus Frog and Gopher Frog. Trail cameras were installed to observe behaviors of rattlesnakes, most notably targeting the Eastern Diamondback Rattlesnake. Analysis of automated data will be ongoing in future quarters.



Eastern Coral Snake found in Pender County (Jeff Hall)



From top left clockwise: Eastern Diamondback Rattlesnake; Neuse River Waterdogs found at only one of seven historical sites in Craven County; Eastern Coachwhip (Jeff Hall)



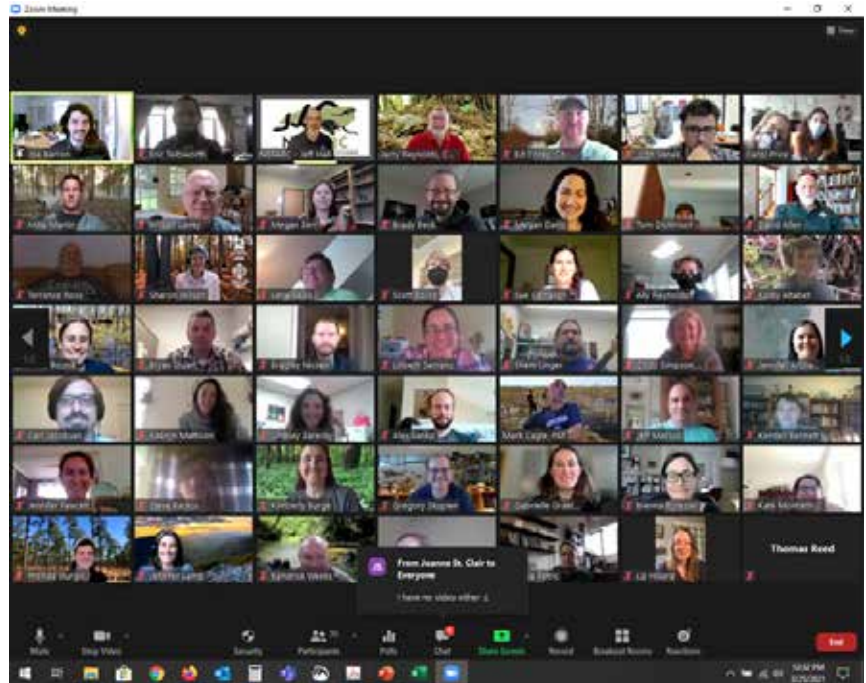
NCPARC News: 2021 Was the Year of Virtual Meetings

by Jeff Hall, Partners in Amphibian and Reptile Conservation Biologist

The 2021 NCPARC annual meeting was held virtually during the first over a two-day period. Over 110 participants registered for the meeting and viewed live presentations on topics ranging from Eastern Hellbender translocations to Bog Turtle site assessments to amphibian road mitigation projects and many others. Lots of positive feedback was received from participants who enjoyed the ability to attend the virtual meeting without constraints over travel. Future NCPARC meetings will likely be a hybrid between in-person and virtual options.

Several NCPARC groups met virtually during this same period including the Steering Committee and the Education and Outreach working group. Applications such as Zoom and Teams have proved invaluable in allowing these types of meetings to continue when in-person meetings were not possible. Although many in-person educational events were canceled, some NCPARC presentations were given virtually to groups.

In the second quarter, one NCPARC group met virtually — the Education and Outreach working group. Applications such as Zoom and Teams continue to



Screen capture during NCPARC annual meeting (Jeff Hall)

prove invaluable for facilitating meetings and presentations. Numerous in-person educational events were canceled, but staff provided many presentations on the conservation of reptiles and amphibians to several groups, including: Wingate College, UNC-Wilmington, NC State University, Croatan chapter of the Society of American Foresters, and the Eco Explorers group. In the third quarter, virtual meetings continued to be an important component of NCPARC working group functionality. Two working groups met virtually during this

quarter: Education and Outreach (EO), and Policy, Trade, and Regulation (PRT). The EO working group continues to find avenues for education about the conservation of reptiles and amphibians even through constraints of the pandemic, such as small neighborhood outreach events and virtual programs and workshops. The PRT working group has been reviewing various regulatory proposals involving venomous reptiles, snapping turtles, and listed species.



Dr. Luke Etchison

Sicklefin Redhorse Conservation

by: Dr. Luke Etchison/ Western Region Aquatic Wildlife Diversity Coordinator

It was a successful year for Sicklefins Redhorse, *Moxostoma* sp. (State Threatened), monitoring and egg collection in the Little Tennessee River Basin. Western Region Aquatic Wildlife Diversity biologists teamed up with colleagues from the US Fish & Wildlife Service, Eastern Band of Cherokee Indians, Duke Energy, and Tennessee Valley Authority to capture this sucker species that is endemic

to the Little Tennessee and Hiwassee river basins in western North Carolina and Northern Georgia. The Sicklefins Redhorse can only be caught in high numbers during its spring spawning run, when males and females congregate in shallow, swift shoals. The spawning period is very brief, so biologists attempt to time their sampling efforts when temperatures and water levels are just right.

This year biologists used boat electrofishing surveys to collect 99 Sicklefins Redhorse from the Little Tennessee River Basin. Survey locations included the Little Tennessee River downstream from Lake Emory Dam, the Oconaluftee River downstream from Ela Dam, the Tuckasegee River near Cullowhee, and the Tuckasegee

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River between the Oconaluftee River and Bryson City. The Little Tennessee River was the most productive site, and biologists collected an estimated 30,000 eggs from just five females. The eggs were fertilized on site before being transported to Warm Springs National Fish Hatchery in Georgia. After hatching there, the propagated Sicklefin Redhorse will be fed until they

reach sizes suitable for stocking. Stocking efforts will take place later in the summer/fall 2021 and will focus on areas in their native range where dams currently prohibit the Sicklefin Redhorse from occupying.

Biologists are also conducting a long-term mark/recapture study, which requires each fish to be implanted with a unique Passive Integrated Transponder

(PIT) tag. This monitoring effort provides additional insights into some of the Sicklefin Redhorse's basic biology such as population size, movement patterns, and lifespan. Nearly one-fifth of the fish captured in 2021 had been caught and tagged in previous years, including two fish that were originally captured in 2012.



NCWRC biologists collect data on a male Sicklefin Redhorse caught in the Little Tennessee River. (Dylan Owensby)



Biologists with NCWRC and US Fish & Wildlife Service capture Sicklefin Redhorse on a raft equipped with an electrofishing unit. (Dylan Owensby)



Staff Conduct Brook Lamprey Surveys to Determine Species Status

by Michael Fisk, Eastern Region Aquatic Wildlife Diversity Coordinator

The Wildlife Diversity Program staff conducted surveys for Least Brook Lamprey *Lampetra aepyptera* to collect data on the distribution and life history of this unique fish. To date, no targeted surveys for Least Brook Lamprey have occurred in North Carolina and little is known about their range and habitat use. This is largely due to their cryptic nature where juveniles spend 3–5+ years within sandy substrates, filter feeding on microscopic detritus. Once fully grown at 4–8 inches, they transform into adults and emerge from the substrate in February–March. Once emerged they do not feed, but spawn in shallow, gravel riffles and die soon afterwards. The spawning window is only a few weeks, which makes it difficult to survey for this species. In North Carolina, the species has been documented in small-to medium-sized tributaries in a few watersheds within the Neuse and Tar river basins, mainly in the Piedmont but some records exist in the Coastal Plain as well.

Objectives for the study were to document contemporary distribution for the species and describe their spawning habitat. In March, staff surveyed streams weekly in Wake and Johnston counties within the Neuse Basin by walking the banks, searching for spawning individuals.



Brook Lamprey in hand (Michael Fisk)

Least Brook Lamprey will congregate in shallow riffles, and 1–10+ individuals will excavate nests by removing gravel and fine sediments with their mouth and tail. This behavior makes it possible to conduct visual surveys for the species.

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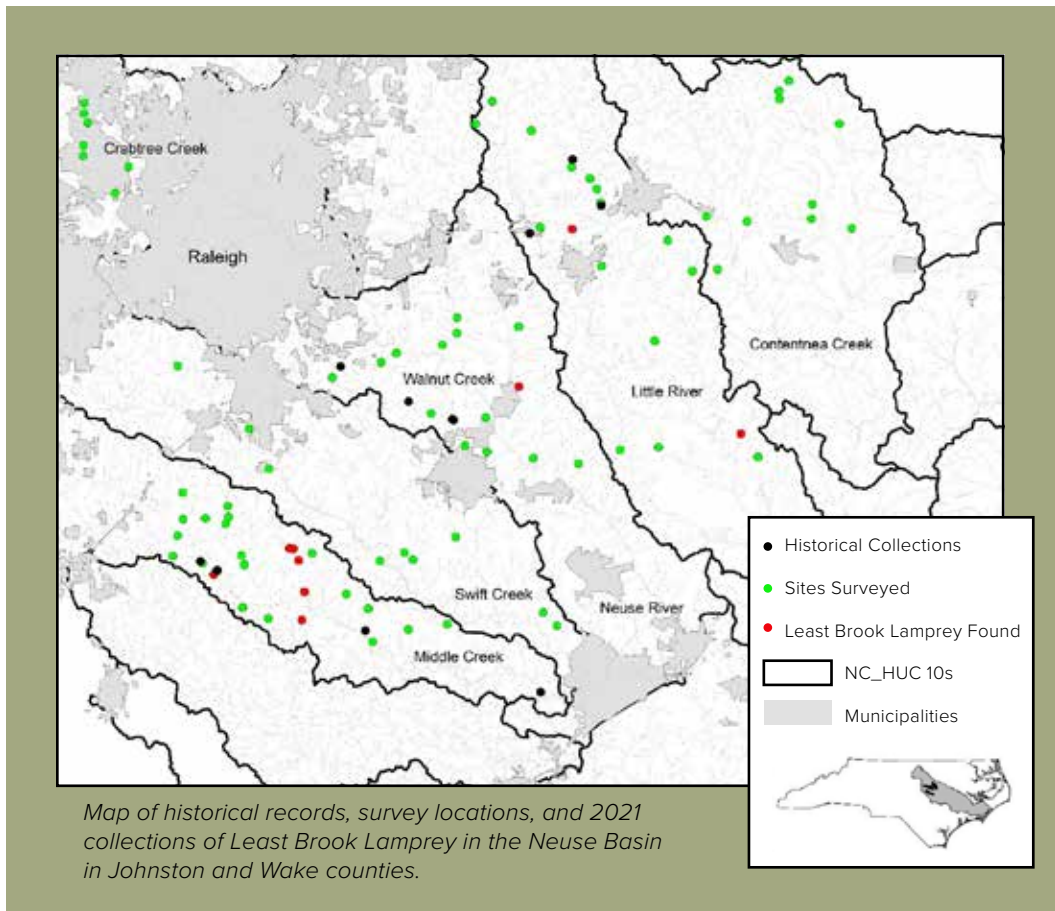
A total of 51 Least Brook Lamprey were observed from nine unique sites out of the 86 sites surveyed. Lamprey were found in the Middle Creek watershed most often, especially in Buffalo Branch and two other tributaries. Collections in the Little River watershed were only from two locations and one individual from each site. Eight of the nine locations where lampreys were observed were from new sites. Lamprey were observed nest building, staggng, and actively spawning in shallow, riffle hab-

itats, typically near the bank in the upstream portion of the riffle. Spawning aggregations ranged from two to 12 lampreys. Observations occurred from March 3–15. Surveys found that habitat in many of the historical collections and other stream reaches has been degraded from urban development in these two fast-growing counties, as well as beaver activity converting lotic habitats into more lentic conditions. Surveys will continue in 2022 focusing on the Tar River Basin and additional sites within the

Neuse Basin. These findings are an important step in this multi-year study to determine this species' status in North Carolina and to identify critical habitat for conservation efforts.



Brook Lamprey in shallow riffle (Michael Fisk)



Broadtail Madtom Surveys Conducted in Lumber River and Tributaries

by Katharine DeVilbiss, Central Region Aquatic Wildlife Diversity Biologist

Staff conducted site visits in the Lumber River and two tributaries, Shoe Heel Creek and Joes Creek, for the state listed Special Concern Broadtail Madtom, a rare, undescribed native catfish. They checked 40 small, artificial cover structures, informally named “madtom motels”, which were previously deployed at four localities, for occupancy

on two occasions. They found one Broadtail Madtom in a motel — the first since deploying the cover structures in 2019.

They also found several juvenile native catfish species utilizing the motels: Margined Madtom, Yellow Bullhead; and the non-native Channel Catfish. The number of occupied structures per site ranged from 0 to 6

out of 10 motels, with an average of 2.8 occupied motels. For comparison, during the previous site visit in May 2021, no fish were found occupying any of the cover structures.

Staff will continue to check motel occupancy on an ongoing basis and are planning additional future deployments and surveys.



Broadtail Madtoms captured in a net during surveys conducted in 2021 (Katherine DeVilbiss); an assembled “madtom motel” (NCWRC)



Staff Conduct Fish Surveys, Deploy Habitat Bags at Lake Waccamaw

by Brena Jones, Central Region Aquatic Wildlife Diversity Coordinator

NCWRC staff, in partnership with NC State Parks, have conducted annual standardized surveys since 2009 for three fish species of Greatest Conservation Need at multiple sites in Lake Waccamaw, including the endemic, federally Threatened Waccamaw Silverside. The mean number of Waccamaw Silversides collected per minute of seining (catch rate) at all sites combined has been highly variable over nine sampling years and was 3.2 fish/minute (fpm) of seining in 2021. This value has ranged from 1.82 fpm in 2017 to 23.5 fpm in 2009. Variability is expected due to the fish's schooling behavior, preference for open waters of the lake and varied sampling conditions. Waccamaw Killifish and Waccamaw Darters were also collected, suggesting that populations persist within Lake Waccamaw; however, numbers of Waccamaw Killifish were very low for the second year in a row.

Staff also deployed some artificial habitat bags, providing native mussel shells for cover, in an attempt to document Broadtail Madtom, a State Special Concern species, in the lake. This small native catfish, which has a genetically unique population in Lake Waccamaw, was rediscovered in the lake in 2019, not having been previously seen since 2002. They can be difficult to detect due to their diminutive size (rarely exceeding 65 mm or 2.6 in), so these bags will be checked periodically to determine if fish are using them or if modifications are needed.



Waccamaw Silversides (NCWRC)



Madtom habitat bag (Brena Jones)



MUSSELS

Macroinvertebrate casings attached to a mussel found during a survey (Michael Fisk)

Biologists Begin Study on Relationship Between Macroinvertebrates and Mussels

by Michael Fisk, Eastern Region Aquatic Wildlife Diversity Coordinator

Wildlife Diversity Program staff have initiated a new study to gain a better understanding of the relationship between aquatic macroinvertebrates and the success for imperiled, propagated mussel species. Macroinvertebrate communities are good indicators of long-term water quality. The

augmentation of existing populations and the reintroduction of propagated mussels back into their historical range depend on suitable physical habitat and water quality. Physical habitat can be visually assessed but water quality can fluctuate throughout the year and be impacted by acute

events that can go undetected in periodic monitoring events. Macroinvertebrates can recolonize habitats at a faster rate than mussels and can be used to describe current conditions within a given reach of water. By using a biological measure of site integrity and water

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MUSSELS

quality, biologists would have a better understanding of long-term stream conditions and would be able to make more informed decisions on mussel augmentations. The objectives of this study are to 1) describe macroinvertebrate assemblages in sites that support rare, imperiled mussels and sites that do not and 2) determine if any association between groups of insects (feeding group or taxonomic group) and rare mussels exists to help guide future

augmentations and surveys for imperiled mussel species.

In May and June, 12 sites were surveyed with suber samplers in reaches that have experienced declines in mussel diversity and abundance and in reaches where imperiled species still occur along with more diverse mussel assemblages. Samples were preserved in ethanol and will be identified down to the lowest taxonomic level. Once samples are identified and enumerated, indices

will be developed to compare between sites.

The anticipated results for this study are to develop indices that describe and rank mussel habitat over a wide range of habitats and conditions. Future surveys will be conducted to capture mussel sites under varying habitat and biological conditions to help determine the impacts of habitat and water quality on macroinvertebrate and mussel assemblages.



*Sierra Benfield and Mike Walter sorting through contents from a suber sample for macroinvertebrates
(Michael Fisk)*



Surveys in Little River Reveal Increase in Mussel Abundance

by Michael Fisk, Eastern Region Aquatic Wildlife Diversity Coordinator

Wildlife Diversity Program staff conducted snorkel surveys in the Roanoke River bypass channel in the summer to determine the long-term impacts of providing consistent water releases within the bypass channel on the mussel community. Roanoke Rapids Dam is in Halifax County and is operated by Dominion Power. It was constructed in 1955 and created a new channel for releases to flow through, bypassing the original river channel. This rendered the bypass channel, which is approximately .62 mile (1 km) long, largely dewatered,

except for dam spillage during high water events, test releases and local precipitation. As part of the hydropower relicensing agreement in 2005, Dominion Power began releasing water back into the bypass reach and was charged with conducting mussel surveys every seven years beginning in 2007. The NCWRC has completed these surveys each year.

In July 2021, eight surveyors spent 62.5 person hours over two days snorkeling through the bypass reach. They documented 10 species and found over 2,000 mussels (Figure 1).

This was a significant increase in mussel abundance compared to past surveys documenting <100 mussels in 2007, and <200 mussels in 2014.

The significant increase in mussel abundance was attributed to the Northern Lance, Eastern Elliptio and Eastern Lampmussel. These species comprised 97% of all mussels found. Live Roanoke slabshell and Triangle floater were documented in 2021, whereas, in previous surveys, only shells had been collected. Other notable species documented

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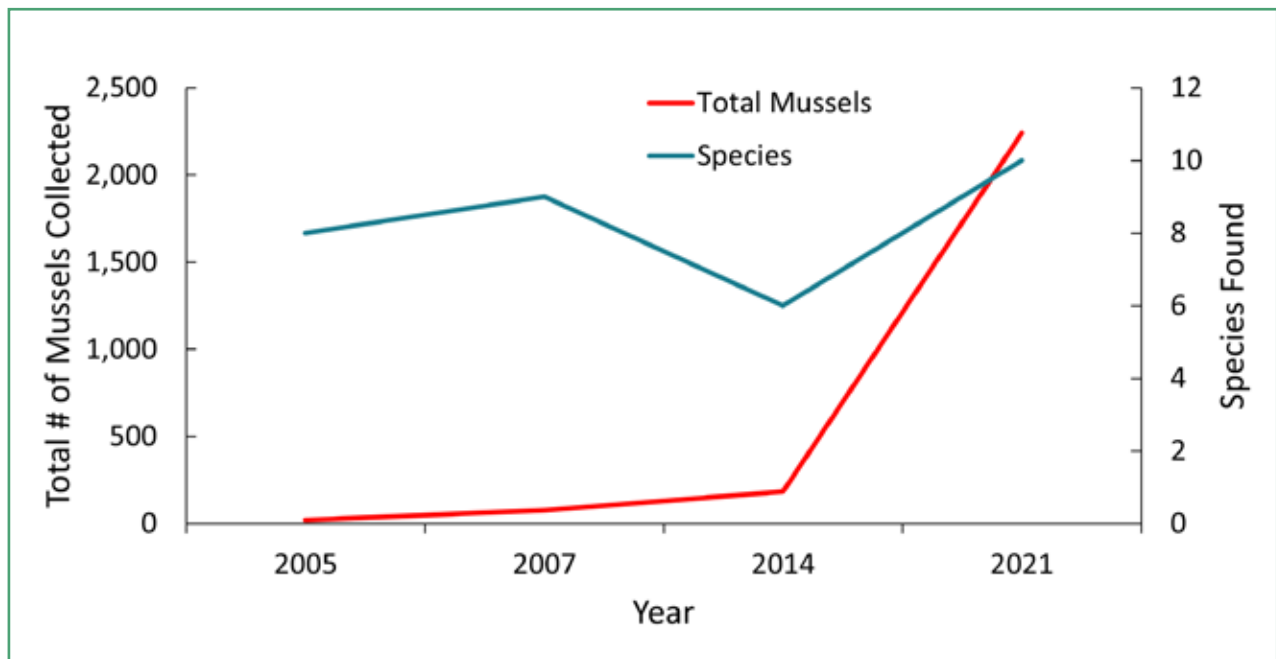


Figure 1: Mussels collected and species documented from 2005–2021 during surveys within the Roanoke bypass channel.



were the Alewife Floater, Tidewater Mucket and Eastern Pondmussel — all listed as state threatened in North Carolina.

This increase in abundance shows that mussels will repopulate an area when suitable conditions are provided although this is not a “quick fix.” Mussel repopulation unlike other taxa (e.g., fish) can take several decades to detect significant changes, and this time frame must be considered when evaluating restoration efforts. Staff will continue to survey the Roanoke bypass channel and evaluate its recovery.



Northern Lance encountered during 2021 survey in the Roanoke bypass channel (Rob Adams)

Biologists Search for Undescribed Mussel Species in Little River

by Katharine DeVilbiss, Central Region Aquatic Wildlife Diversity Biologist

NCWRC staff performed mussel surveys for an unknown, potentially new-to-science species in the Little River and tributary waters of the Pee Dee river drainage to gain valuable geographic range, habitat preference and behavioral information. Since their first discovery in a reach of the Little River in May 2019, individuals of this species were known exclusively from that one locality and one other locality 1.8 km upstream, found in June 2021. In the Little River, 23 surveys were performed, and another 26 in tributary waters including West Fork Little River, Densons Creek, Barnes Creek, Hannahs Creek, and Betty McGees Creek, in Randolph and Montgomery counties. Biologists detected 19 individuals of the unknown species over nine sites, increasing their known range to approximately 6.5 km of the Little River. None were detected during the surveys in other waterways. Search effort totaled 198 person-hours (p-h), for an average catch per unit effort of 0.09 individuals per p-h. Staff swabbed a subset of the found undescribed species for genetic material and took two individuals to the NCWRC Conservation Aquaculture Center in Marion, NC for ongoing life history studies.



Undescribed mussel species from Little River, Pee Dee basin (Katherine DeVilbiss)

In addition to the undescribed species, Species of Greatest Conservation Need (SGCN) detected included Brook Floater, a State Endangered species; Carolina Creekshell, a State Endangered species; Notched Rainbow, a State Threatened species; and, Savannah Lilliput, a Federal Species of Concern and State Endangered species. Staff biologists plan to continue surveys and studies in 2022 to further their understanding of this undescribed freshwater mussel species.



Tropical Storm Fred Assessments on Mussel Populations in Western NC

by: Dr. Luke Etchison, Western Region Aquatic Wildlife Diversity Coordinator

Historic and tragic flooding came to parts of western North Carolina on Aug. 17, 2021 as the remnants of tropical storm Fred drenched much of the region. The heaviest rainfall came to the high elevation ridges bordering Transylvania and Jackson counties, with some gauges reportedly receiving over 20 inches of rain in just 72 hours. The worst impacts were felt in Haywood County, where the dangerous flooding in the East Fork Pigeon River claimed the lives of six

people. This type of flooding has the power to roll over the substrate that lies on the stream bed, and potentially displace or kill benthic aquatic organisms. These animals are also likely to face exposure to pollutants from human waste, petroleum products, and many other toxic substances that might wash into streams during high flow events.

Of particular concern to biologists are the area's mussel populations, which already have very limited distributions. West-

ern Aquatic Wildlife Diversity biologists started post-flooding surveys as soon as water levels receded, focusing most of their time on sites that were known to be occupied by the Federally Endangered Appalachian Elktoe. Since most of the flooding was limited to the Nolichucky, French Broad, and Pigeon watersheds, snorkel surveys included the South Toe, Cane, French Broad, Little, Mills, and Pigeon (East Fork, West Fork, and mainstem) rivers.

From the limited number of sites that were searched, biologists were encouraged by what they saw. Although most of the rivers showed signs of bank erosion, riparian damage, and sediment scouring, the majority of sites still had populations of healthy mussels. These populations were typically located in refugia areas, which seemed to be less impacted by the high flows. The major exception was the East Fork Pigeon River, where a previously known small population of mussels could not be accounted for. The long-term impacts of this major flooding event are unknown, but biologists are hopeful that these aquatic ecosystems will quickly rebound.



A healthy Appalachian Elktoe found during post-flooding surveys in the West Fork Pigeon River in Haywood County (Dr. Luke Etchison)



Flooding damage on the East Fork Pigeon River in Haywood County (Dr. Luke Etchison)



CRAYFISH

Lindsey Zarecky, Greensboro Science Center

Staff Conduct Native Crayfish Surveys in Guilford County

Staff biologists visited four sites in July 2021 as part of ongoing efforts to update distributional records of native crayfish species. The sites were in Guilford County, specif-

ically targeting the known geographic range of the Greensboro Burrowing Crayfish, which is state listed as a species of Special Concern. Although the target species was not found,

individuals of the native *Cambarus* species *C acuminatus* complex were found in burrows at two of the sites.



Wildlife Diversity Program Staff Hold First In-Person Meeting in Years

by: Dr. Sara Schweitzer, Assistant Chief, Wildlife Diversity Program

In mid-December 2021, staff with the Wildlife Diversity Program had its first in-person meeting in years, conveniently slipping the meeting between Delta and Omicron variants of the SARS_Cov_2 virus, and we kept everyone safe and healthy. A few staff members joined virtually, so it was our first ever hybrid meeting of the Wildlife Diversity Program. The setting at Lake Norman State Park was perfect, with a great meeting room, exceptional views from the balcony, and super helpful staff. The unseasonably warm weather let us chat with one another outdoors, as well as hike and bird-watch.

After a welcome and fun ice breaker exercise, we reviewed the history of the Wildlife Diversity Program and marveled at the accomplishments of the last 38 years. David Allen, Eastern Region Supervisor, who has been with WRC for a bit more than 31 years, provided great insights into the development of the WD program. Unfortunately for us, he will retire at the beginning of April 2022; thus, we enjoyed hearing his reflections, as well as guidance for future work.

With his and others' suggestions in mind, we discussed the upcoming tasks associated with our major revision of the Wildlife Action Plan, our prioritization of Species Conservation Plan writing, and the need to update the Division of Wildlife Management's 2009 Strategic Plan. Reviewing the Strategic Plan generated much discussion on improvements to make relative to several goals, and new objectives to establish as we continue our efforts. The possibility of new funds from the Recovering America's Wildlife Act was incorporated into our discussion and generation of ideas.

A few ideas we'll work on include examining the organization of the WD program, increasing means of communicating

our work to various audiences, defining next steps for SGCN that have long-term survey data available, addressing unmet needs and data gaps, increasing efforts to conserve and better manage important habitats, and increasing inclusion and engagement with people through our program's activities.

Although our meeting lasted a full day, it went by quickly. We will work with the "what" ideas generated from this meeting to bring about purposeful, beneficial changes. Another meeting will help us tackle the "how" and implementation steps. Our work with the major revision of the WAP and efforts to bring RAWA to fruition will benefit from this meeting's discussions.



Wildlife Diversity Program staff met for the first time in years in December 2021.



The Wildlife Diversity Program

The Wildlife Diversity Program was established in North Carolina in 1983 to prevent nongame species from becoming endangered by maintaining viable, self-sustaining populations of all native wildlife, with an emphasis on species in decline.

More than 700 nongame animals call North Carolina home. Many nongame species, including mammals, birds, amphibians and reptiles, freshwater mussels and fish, are common and can be seen or heard in your own backyard. Other nongame animals, such as bald eagles and peregrine falcons, were, at one time, considered endangered, but now soar high in the sky, thanks to the work conducted by wildlife diversity biologists.

The men and women who work for the Wildlife Diversity Program are dedicated to conserving and promoting nongame wildlife and their habitats through a variety of survey and monitoring programs, species management, and habitat conservation or restoration projects. These programs and projects target nongame animals and their habitats, but game species — such as deer, turkey, mountain trout, and black bass — also benefit because they share many of these same habitats.

You can learn more about the many projects and programs conducted by wildlife diversity personnel on behalf of nongame and endangered wildlife by visiting ncwildlife.org/wdp.



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