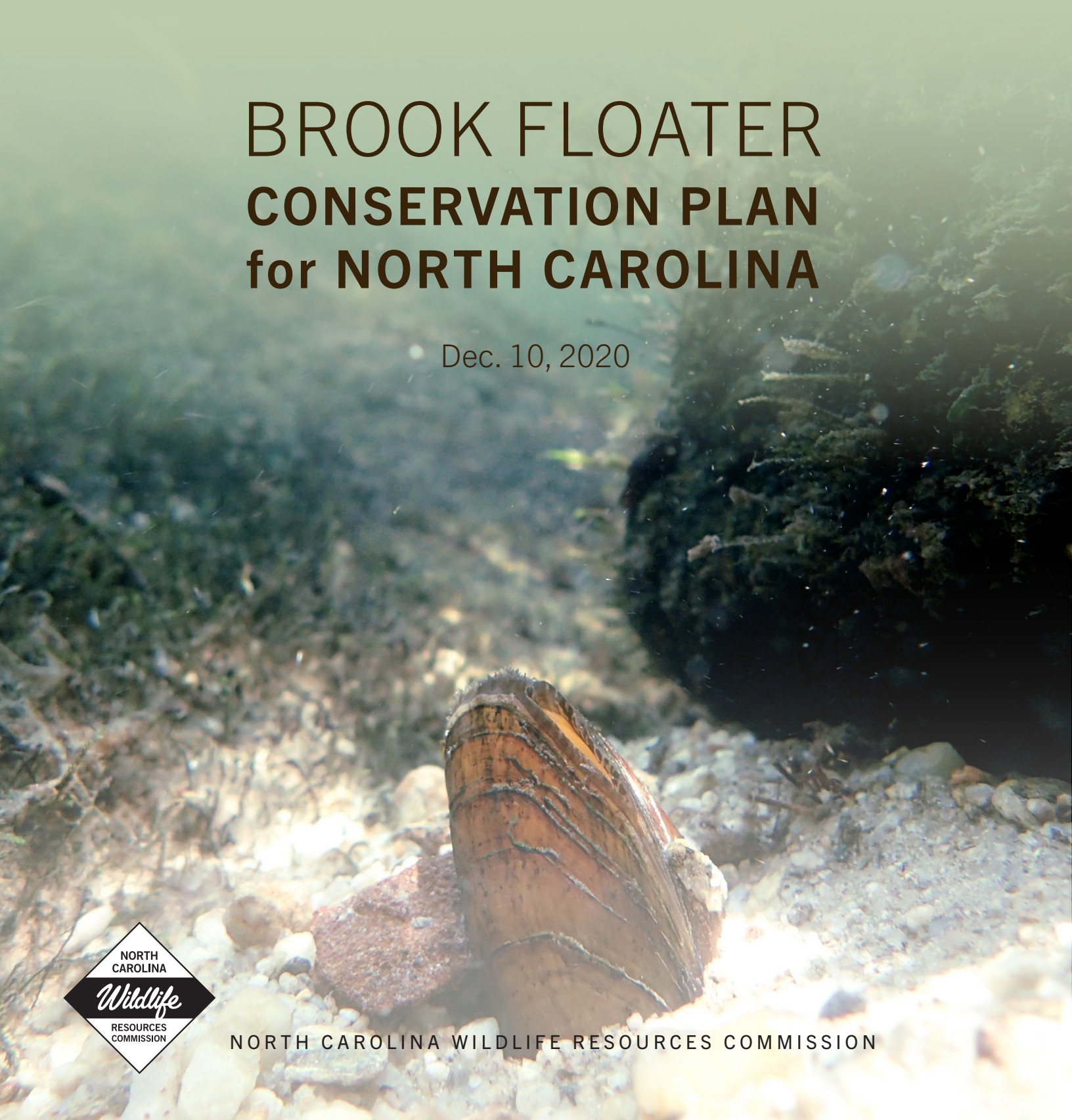
BROOK FLOATER
CONSERVATION PLAN for NORTH CAROLINA

Dec. 10, 2020



NORTH CAROLINA WILDLIFE RESOURCES COMMISSION

Brook Floater found in the Linville River

Brook Floaters from the Roaring River

Collecting tissue from a brook floater for genetic analysis

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Unless otherwise indicated, all photos by N.C. Wildlife Resources Commission

Table of Contents

Executive Summary

The Brook Floater (*Alasmidonta varicosa*) is a small mussel that is typically found in well oxygenated, free-flowing rivers and streams in gravel riffles along the Blue Ridge Escarpment and into the upper Piedmont. It is sporadically distributed in streams and rivers of the Atlantic coastal region, from Georgia north to Nova Scotia and New Brunswick (Canada). In North Carolina it is found in three river basins: the Catawba, Yadkin-Pee Dee, and Cape Fear. The most viable populations exist in the Upper Catawba and Upper Yadkin river basins, including the Linville River, Mulberry Creek, Johns River, Roaring River, Mitchell River, and the mainstem Yadkin River. Habitat loss and impaired water quality resulting from sedimentation (agricultural and urban runoff), nutrient loading, loss of riparian forests, sewage and industrial discharges, development and increased impervious surfaces, and watershed development all threaten the Brook Floater. To maintain Brook Floater populations, the N.C. Wildlife Resources Commission will support and contribute to permit reviews, current regulations, habitat protection and habitat management. The primary conservation strategy moving forward is to maintain the Brook Floater in the Catawba, Yadkin-Pee Dee, and Cape Fear river basins and reestablish populations where once extirpated. Currently in North Carolina there are 14 known populations, with varying degrees of viability. Within the next decade, the Wildlife Commission plans to reestablish six populations — three in each of the upper Catawba and Yadkin River basins. The ultimate goal in North Carolina is to maintain 20 viable populations, where a viable population is defined as one where multiple individuals and recruitment are observed over multiple years.

Biological Information

Description and Taxonomic Classification

The Brook Floater (*Alasmidonta varicosa*) is a small mussel, usually less than 70 mm in length. The shell is thinner towards the posterior margin and the mussel has a subovate or subtrapezoidal shape (Strayer and Jirka 1997). In North Carolina it is found in the three river basins: the Catawba, Yadkin-Pee Dee, and Cape Fear. It can be distinguished from other mussel species in the state by the raised (varicose) ridges on the posterior slope, a rayed (black or green) periostracum, and a bright orange foot.

Life History and Habitat

The Brook Floater is typically found in well oxygenated free-flowing rivers and streams in gravel riffles along the Blue Ridge Escarpment and into the upper Piedmont. It is predominantly a filter feeder consuming bacteria, algae, and plant and animal debris. Like almost all mussels, the Brook Floater requires a fish host to complete its life cycle. Identified fish hosts for the Brook Floater include: Blacknose Dace, Longnose Dace, Golden Shiner, Pumpkinseed, Slimy Sculpin, Yellow Perch, and Margined Madtom (Bogan 2002; Nedeau et al 2000; https://www.ncwildlife.org/Learning/Species/Mollusks/Brook-Floater#3029857-life-history). The species typically releases glochidia in February-April in North Carolina.

To complete its life cycle, the Brook Floater requires a fish host, such as this Pumpkinseed Sunfish.

Distribution and Population Status

The Brook Floater is sporadically distributed in streams and rivers of the Atlantic coastal region, from Georgia north to Nova Scotia and New Brunswick (Canada). In some states the Brook Floater appears to have experienced significant declines in population size. In North Carolina, Brook Floaters have been extirpated from several streams but are still found in three river basins: the Catawba, Yadkin-Pee Dee, and Cape Fear (Figure 1). The most viable populations exist in the Upper Catawba and Upper Yadkin river basins, including the Linville River, Mulberry Creek, Johns River, Roaring River, Mitchell River and the mainstem Yadkin River. Several populations have been discovered within the last seven years including the Catawba River upstream of Lake James in McDowell County, Roaring River in Wilkes County, and Mulberry and Buffalo creeks in Caldwell County. Roaring River and Mulberry Creek currently have the highest densities in each of the river basins. The populations of Brook Floater in the Uwharrie Mountains region may represent an undescribed species (Arthur Bogan, personal communication 2017). However, no definitive work on this population has been published so this population is still considered to be Brook Floater.

Until recently, surveys for the Brook Floater in North Carolina have been sporadic at best. Some initial mussel surveys by E.P Keferl in the late 1980s found the mussel in six streams — four in the Catawba River Basin and two

in the Yadkin-Pee Dee. Throughout the 1990s, surveys primarily by the NC Department of Transportation and the Wildlife Commission determined the range of the Brook Floater to be much larger than initially thought. In 1990, the first population was discovered in the Rocky River in the Cape Fear River Basin, but only one individual was observed. Throughout the 1990s the Brook Floater was still only known from 12 streams in North Carolina. In 1993, populations in Upper Creek and the Linville River in the Catawba River Basin were considered the best in the state (catch per unit effort [CPUE] 20.7 and 25.3 individuals per person-hour, respectively). Yet, regardless of river basin, the majority of observations in the 1990s were between one and three individuals and the average CPUE was 1.0. The highest density in any population was observed in 1998, in the Linville River (CPUE 31.5).

From 2000-2017 mussel surveys throughout North Carolina increased and more Brook Floater populations were discovered. By the end of 2009, 21 streams had known Brook Floater populations Still, CPUE was highly variable. The majority of sites ranged from one to three individuals and CPUE was usually less than one mussel per hour. The highest population numbers were observed in the Roaring, Yadkin and Mitchell rivers (CPUE 25.5, 14, and 13.8, respectively) in the Yadkin River Basin. From 2010-2017, more focused monitoring surveys were conducted for Brook Floaters. Over the past seven years, 16 streams have had recorded Brook Floaters in North Carolina. However, recent surveys have revealed new populations and larger distributions. Some streams have been found to have much higher densities than originally thought. The highest density population in North Carolina was discovered in 2015 in Mulberry Creek in the upper Johns River basin with CPUEs ranging from 38.3 to 48.0 at various sites. In 2011, a population was discovered in the Catawba River, extending upstream of Lake James for ~14 river miles. The population in the Linville River was considered to be small and only inhabited a two-mile reach upstream of Lake James, yet now the known range is extended 3 additional miles into the Linville River gorge. Prior to 2010, the population in the Roaring River was only known from one locality. Following surveys in 2014-2017, the population currently occupies ~24 river miles in the Roaring River watershed, and has consistently high CPUEs in the mainstem Roaring River and at various sites (CPUE=10.3, 11.7, 14.8 and 32.0).

Conducting mussel surveys

Recent surveys (2015-2017) have provided sufficient data to generate population estimates for Brook Floaters throughout their known range in the Upper Catawba and Upper Yadkin-Pee Dee river basins (Table 1, page 7). Population estimates were calculated using the following formula: $\mathbf{E = (n/A_s)A_o}$ where **E** = the population estimate; **n** = the number of animals recovered; $\mathbf{A_s}$ = a function of the number of sites surveyed, the mean length of surveyed sites, and the mean width of surveyed sites; and $\mathbf{A_o}$ = a function of the total segment length between sites with detected animals and the mean width of the segment (COSEWIC, 2009). Lower and upper estimates

Table 1. Population estimates of the Brook Floater (*Alasmidonta varicosa*) in the Catawba and Yadkin River basins in North Carolina. Values have been rounded to the nearest hundred.

Population		Estimated N
Catawba River Basin		
Catawba River (upstream of Lake James)		500-800
Linville River		600-1,100
Mulberry Creek		2,200-2,900
Upper Creek		200-300
Wilson Creek		900-2,300
	Total	4,400-7,400
Upper Yadkin-Pee Dee River Basin		
Mitchell River		900-1,400
Roaring River		3,400-5,500
Yadkin River (downstream of Kerr Scott)	*Total*	5,800-9,500
		13,600-21,800
	Cumulative Total	**18,000-29,000**

were determined by substituting total number of sites surveyed (lower estimate) and total number of sites where the species was detected (upper estimate). It is important to note that these estimates assume the area of occupied habitat is homogenous and thus the animals are uniformly distributed. The true Brook Floater population size is likely smaller. These numbers are most useful for providing possible comparative estimated values between surveyed populations.

The Wildlife Commission currently classifies the Brook Floater as Endangered. The NC Natural Heritage Program (NCNHP) categorizes the Brook Floater as S2, G3 – Imperiled. NCNHP defines "Imperiled" as, "Imperiled in North Carolina due to rarity or some factor(s) making it very vulnerable to extirpation from the state. Typically, 6 to 20 occurrences or few remaining individuals (1,000 to 3,000)." The NC Natural Heritage Program currently recognizes 17 confirmed occurrences in the state (Judy Ratcliffe pers. comm.). In 2010 the Center for Biological Diversity filed a petition with the US Fish and Wildlife Service (USFWS) to federally designate the Brook Floater as either Threatened or Endangered (US District Court for Washington, D.C. 2011). This resulted in a positive 90-day finding. The USFWS is now conducting a 12-month review for this species to determine if it merits listing as a candidate species. This review should conclude in 2019 (USFWS 2011).

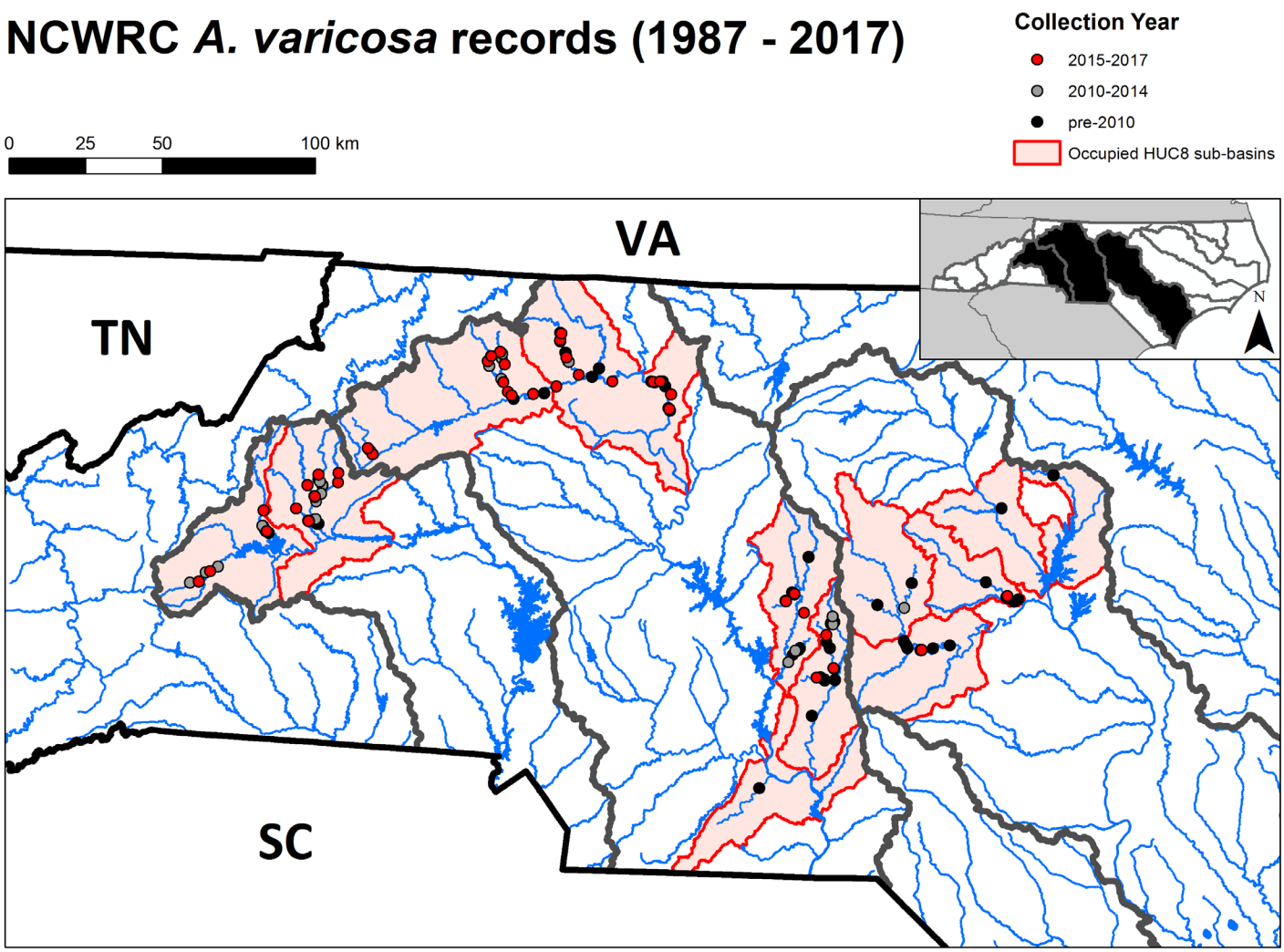
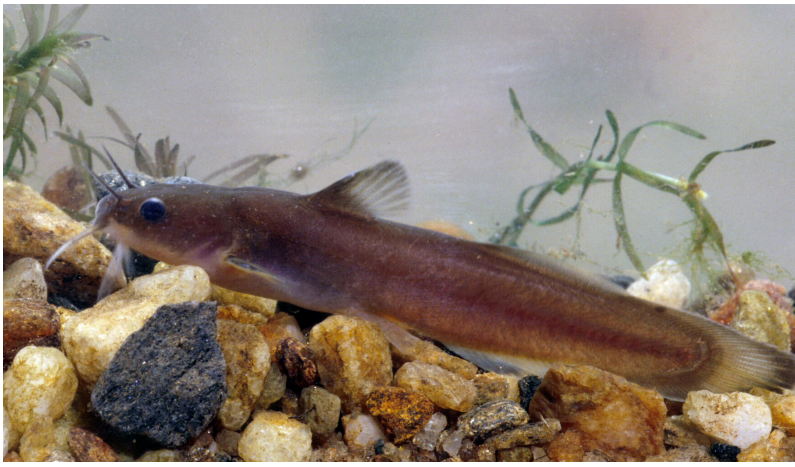


Figure 1. Distribution and collections of Brook Floaters in North Carolina

Historic and Ongoing Conservation Efforts

Historic efforts to conserve Brook Floaters have resulted, tangentially, through the Clean Water Act (1972), which limited pollution from point-source effluents, and from the creation of Pisgah National Forest, which provided water quality protection in the headwaters of the Catawba River Basin. Recent water quality protection in the Upper Catawba and Yadkin river basins have resulted from the purchase and/or expansion of Johns River Game Land, Stone Mountain State Park, Thurmond-Chatham Game Land, Mitchell River Game Land, and Pilot Mountain State Park. In addition, the following streams are either considered a High Quality Water or Outstanding Resource Water (HQW/ORW): Linville River, Warrior Fork, Wilson Creek, Mulberry Creek and Mitchell River. This designation is the highest level the state of North Carolina provides for water quality protection (NCDENR 2011). These designations confer stringent erosion and sediment controls, buffer widths, dictate the use of best management practices, and restrict new wastewater discharges.

Recently, researchers completed a host fish study for Brook Floater and found Margined Madtoms (*Noturus insignis*) to be the most suitable host in North Carolina (Eads 2008). This information provided the propagation tools to support ongoing efforts to conserve Brook Floaters via translocation and augmentation of extirpated populations such as the Catawba River downstream of Lake James, Upper South Fork Catawba River (Henry and Jacob Forks), and the Upper Yadkin River upstream of Kerr Scott Reservoir. Other recent efforts have focused on limiting vehicular traffic in streams occupied by Brook Floaters, biological assistance focusing on new HQW/ORW water quality classification in occupied rivers such as the Roaring River, technical guidance to land-protection organizations purchasing tracts of land adjacent to occupied streams, and initiation of a mark-recapture study in core populations in order to track temporal changes.



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Threat Assessment

Reason for Listing

Brook Floater was originally listed in North Carolina in 1977 as a Special Concern species. It was elevated to Threatened status in 1990 and listed as Endangered in 2001. These listings were believed to be based primarily on the increased trajectory of threats to recently discovered populations and recently extirpated populations (Judy Ratcliffe pers. comm.)

Present and Anticipated Threats

Habitat loss and impaired water quality resulting from sedimentation (agricultural and urban runoff), nutrient loading, loss of riparian forests, sewage and industrial discharges, development and increased impervious surfaces, and watershed development all threaten the Brook Floater (NCWAP 2015, COSEWIC 2009). In addition, existing populations are highly fragmented by impoundments, hydropower facilities, and stream crossings in all three currently occupied river basins (Nedeau 2008). Some of these threats have been abated or halted to some degree. There are no new large impoundments currently planned and point-source pollution of conventionally considered contaminants is reasonably regulated in North Carolina. However, it is anticipated that non-point source problems will continue in the future, and enforcement and compliance actions are

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Wildlife Commission biologists are working to ensure the long-term viability of the Brook Floater.

critical to maintenance or improvement of water quality. A class of emerging contaminants — including pharmaceutical, agricultural, and industrial byproducts that pass through wastewater facilities largely untreated and are often unregulated — pose a threat to many aquatic species. Some compounds act as endocrine disrupters. Others have poorly understood effects on aquatic life. These can reduce juvenile development or survival, and limit adult reproductive success, among other detrimental impacts (Adamson et al. 2017, Lee Pow 2016, Hinck et al. 2009, Gagné 2004). These pollutants may negatively affect both Brook Floater and host fish populations through multiple pathways.

Given the uncertainty in most models investigating the dynamics of aquatic ecosystems, it is difficult to predict with confidence the extent of effects of climate change on the Brook Floater. NCDENR (2010) states that climate change is likely to have a synergistic effect with other, more impending threats to these systems, such as development and removal of riparian vegetation. Additional system stressors may include increased magnitude and intensity of droughts, increased storm water runoff and resuspension of sediments during more frequent storms, and increased evaporation rates with increased temperatures, which also concentrate nutrients and slow their pathways through aquatic systems. These factors threaten both mussel and native host fish populations (Lynch et al. 2016). Very few specific climate change impact mechanisms have been identified, primarily due to the lack of focused study and standardized data sets. Further work is needed to understand the magnitude of potential effects.

CONSERVATION GOAL AND OBJECTIVES

Conservation Goal

Wildlife Commission biologists are working to prevent the extinction of the Brook Floater and ensure its long-term viability as a member of the fauna of North Carolina for the next 100 years. A viable population will be indicated by multiple individuals, numerous size-classes, a stable or increasing population, and recruitment over multiple years.

Conservation Objectives

Wildlife Commission biologists have developed a conservation strategy to maintain the populations of Brook Floater in the Catawba, Yadkin-Pee Dee, and Cape Fear river basins and reestablish populations where once extirpated.

Objectives include:

1. Maintain viable populations in at least seven locations in the Catawba River Basin. Four current populations include: Upper Catawba River, Linville River, Warrior Fork, Johns River (Wilsons Creek and Mulberry Creek). Reestablish three populations: Upper South Fork Catawba River (Henry and Jacobs Fork), Catawba River downstream of Lake James, and North Fork Catawba River (Armstrong Creek).
2. Maintain viable populations in at least 10 locations in the Yadkin-Pee Dee River Basin. Seven current populations include: Buffalo Creek, Roaring River, Mitchell River, Fisher River, mainstem Yadkin River, Uwharrie River (Barnes Creek and other small tributaries), Little River (Densons Creek), West Fork Little River (Uwharrie River and Little River populations may represent a currently undescribed species). Reestablish three populations: Upper Yadkin River mainstem, Elk Creek, and Reddies River.
3. Maintain viable populations in at least three locations in the Cape Fear River Basin: Deep River, Rocky River, and New Hope Creek.

CONSERVATION ACTIONS

Habitat Protection and Habitat Management

The N.C. Wildlife Resources Commission conserves Brook Floaters by protecting wide forested riparian corridors, minimizing construction and fill in the 100-year floodplain, using effective sediment and erosion control, and adequately managing storm water quality and quantity in development areas — actions that are essential to protect water quality and aquatic habitat for Brook Floaters. Staff will utilize the permit review process to minimize the effects of development on this and other aquatic species, generally following guidance provided in the Wildlife Commission's Guidance Memorandum to Address and Mitigate Secondary and Cumulative Impacts to Aquatic and Terrestrial Wildlife Resources and Water Quality (NCWRC 2002). Forestry activities should incorporate forest practice guidelines (FPGs) or best management practices (BMPs) as required by certifying organizations such as those of the Sustainable Forestry Initiative/Forest Stewardship Council/American Tree Farm System certification standards. This can help retain adequate conditions for aquatic ecosystems.

Wildlife Commission biologists conserve Brook Floaters by protecting wide, forested riparian corridors, which should be at least 100 feet for perennial streams.

Riparian buffers of at least 100 feet for perennial streams and 50 feet for intermittent streams will be recommended for most project settings. Where federally listed species are present, larger buffers and more stringent protection measures may be recommended. Where instream work is proposed, recommendations will focus on minimizing streambed

disturbance, such as working outside of live flows. Staff may also recommend that projects incorporate more stringent sediment and erosion control measures than are ordinarily required, such as stabilizing soils within five working days or seven calendar days, whichever is shorter, and using advanced settling devices. The Commission will evaluate recommending flow improvements in reaches where flow is regulated by upstream reservoirs such as the reach downstream of Kerr Scott Reservoir as the opportunity arises. The NC Division of Water Resources and several nongovernmental organizations are working toward resolving some water quality issues on the Rocky River. The Commission will support these efforts as necessary and appropriate.

The Commission will also support the addition of conservation lands in the Upper South Fork Catawba River sub-basin along the mainstem Catawba River downstream of Lake James, along Wilson Creek and the Johns River, in the Roaring River sub-basin, along the mainstem Yadkin River near Pilot Mountain State Park, and along the Rocky River in the Cape Fear basin. The Commission will also support expansion of the Mitchell River and Buffalo Cove Game Lands as appropriate.

The Commission should support dam removal as opportunities allow to reconnect populations or reestablish new ones. Examples of some of the highest priorities are provided: Patterson Dam on Buffalo Creek, Wilkesboro Dam on Reddies River, Rocky River Hydropower Dam on the Rocky River and Henry River Dam.

Population Management

Augmenting existing populations or establishing new populations in suitable areas can be a powerful tool for conservation. However, establishing new populations of a species that may become federally listed can be problematic because it can introduce regulations inherent in the Endangered Species Act. All management actions described below must be approved individually and separately from endorsement of this management plan by the Habitat,

Captive propagation — growing mussels in tanks before releasing them in the wild — will be one of the tools Wildlife Commission biologists use to conserve Brook Floaters in North Carolina.

Nongame, and Endangered Species (HNGES) Committee of the N.C. Wildlife Resources Commission. Before these actions take place, the HNGES may require tools that minimize regulatory burden such as Candidate Conservation Agreement with Assurances or Safe Harbor Agreement.

Utilize captive propagation and/or translocations to establish and augment populations of Brook Floater in the Catawba River downstream of Lake James, the Upper South Fork Catawba River (Henry and Jacob Fork), North Fork Catawba River, Upper Yadkin River upstream of Kerr Scott Reservoir, Elk Creek, Reddies River, and Fisher River. Establish connectivity and gene flow between existing and established populations by either translocating individuals or dam removal. Meta-populations can be reconnected to currently extirpated populations. All four populations in the Catawba River are isolated due to Lake James and its hypolimnetic discharge. These populations may need genetic augmentation to prevent inbreeding and boost outbreeding. The upper Reddies River is cut off from the Roaring and Yadkin River population by a dam. The water quality and habitat upstream of the dam has recovered, but Brook Floaters cannot reestablish naturally at that site. The only population upstream of W Kerr Scott Reservoir is isolated in Buffalo Creek. In addition, this population is bisected by the Patterson Dam which is currently breached and acts as a sediment release valve during random events. Populations in the Deep and (if extant) Haw River are also fragmented by dams. The Haw River is isolated from the rest of the Cape Fear River Basin by Jordan Lake, a large reservoir managed for hydropower generation and recreation by the US Army Corps of Engineers at B. Everett Jordan Dam. If suitable habitat and water quality are located, this could be a receiving system for reintroduction material. The Deep River has a chain of dams extending from Lockville Dam near Jordan Lake up to the headwaters at Oak Hollow Lake in the City of High Point. Opportunities to restore connectivity, particularly in the middle reach between Lockville Dam and Coleridge Dam, should be evaluated and pursued where appropriate.

Catawba River Basin

In 2018 Brook Floater propagation began at the Commission's Conservation Aquaculture Center. Pending approval by the HNGES, individuals from this cohort will be stocked in 2020 in the Upper South Fork Catawba River (Henry and Jacobs Fork) and/or in the Catawba River downstream of Lake James. We estimate initial stocking numbers at ~1,000 individuals per stream. These stockings should continue at a minimum of five years. In addition, translocated adults may be stocked in each target stream to increase the genetic viability of the reestablished populations. Selected stocking sites will be monitored yearly for success. By 2030, success or failure will be confirmed. These projects will be considered successful if multiple individuals are collected and there is evidence of recruitment into the population.

Depending on propagation success, excess individuals may be used to augment the Upper Catawba River Basin at selected, high quality sites. Additional individuals may be stocked in Armstrong Creek though reestablishing this population is currently the lowest priority.

Yadkin River Basin

In 2018, Brook Floater populations in the Upper Yadkin River, including Elk Creek, and the Fisher River will be augmented by individuals from the populations in Roaring and Mitchell rivers. We estimate translocating ~100 mussels per year for five years into high quality sites in the Upper Yadkin River, Elk Creek and Fisher River. Brook Floater propagation may also be implemented to augment these populations. However, this will follow propagation

efforts in the Catawba River Basin. Augmentation sites will be monitored for 10 years. In 2028, success or failure of augmented sites will be confirmed. These projects will be considered successful if multiple individuals are collected and there is evidence of recruitment into the population.

Following propagation in the Catawba River Basin and augmentation efforts in the Yadkin River Basin, Brook Floater propagation for the Reddies River may begin. We anticipate this occurring in 2028-2030.

Cape Fear Basin
More surveys and monitoring are needed within the Cape Fear River Basin to understand population levels, where suitable habitat exists, and where restoration could occur in the future.

Incentives (Tax break)

Wildlife Commission biologists will encourage private landowners in Brook Floater habitat to participate in the Wildlife Conservation Lands program. This program allows qualifying landowners whose property contains state listed species to get a property tax credit for implementing conservation actions.

Monitoring and Research

Mark-recapture studies in the Catawba and Yadkin river basins were completed in 2018 to establish baseline population levels. These surveys should be replicated on a defined schedule, along with general distribution surveys to track the range within specific streams. Particular attention should be paid to the Catawba River upstream of Lake James to determine if the population is starting to decline in that basin. In addition, the populations in the Fisher and Ararat rivers appear to have declined recently and have perhaps been extirpated. More distribution surveys are needed in these watersheds.

Population surveys in the Piedmont regions of the Cape Fear and lower Yadkin-Pee Dee should continue to identify better the extent of occupied reaches and abundance in these systems. The lower Rocky and Deep rivers in the Cape Fear basin both have large areas of potentially suitable habitat that lack survey coverage. The West Fork Little River should be investigated to document whether there are declines in the both habitat quality and mussel populations.

Conduct propagation research for long-term fish holding and mussel rearing at the Marion Conservation Aquaculture Center (MCAC).

Education and Outreach

Wildlife Commission biologists will work with Wildlife Education staff to promote education and awareness of the Brook Floater and efforts to conserve the species and its habitat. As part of this process, staff will develop and share outreach materials to help increase public awareness.

Regulations

Provisions of the Clean Water Act are often enough to protect Brook Floater populations. However, there may be instances where designation of Brook Floater Habitat as either High Quality Waters (HQW) or Outstanding Resource Waters (ORW) may be necessary. These designations will afford additional protection to the Brook Floater. In instances where this is necessary, the Wildlife Commission will support the NC Division of Water Resources in its assessments to determine if HQW or ORW designations are necessary and appropriate.

N.C. General Statute § 113 337 makes it unlawful to take, possess, transport, sell, barter, trade, exchange, export, or offer for sale, barter, trade, exchange or export, or give away for any purpose including advertising or other promotional purpose any animal on a protected wild animal list, except as authorized without a valid permit is currently prohibited under NC law and administrative code (15A NCAC 10I .0102). These restrictions are enforced by the N.C. Wildlife Resources Commission and violations are considered Class 1 misdemeanor (§ 113 337b).

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