



ROBUST REDHORSE CONSERVATION PLAN for NORTH CAROLINA

Dec. 10, 2020



NORTH CAROLINA WILDLIFE RESOURCES COMMISSION



On the river in search of adult Robust Redhorse



Placing a PIT-tag in adult Robust Redhorse for tracking purposes



Robust Redhorse fry in an aquarium at McKinney Lake Fish Hatchery, located in Richmond County



Collecting eggs from a female Robust Redhorse



Juvenile Robust Redhorse shortly before being released into the Pee Dee River



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Executive Summary

The Robust Redhorse (*Moxostoma robustum*) is a large member of the sucker family (Catostomidae). It is currently listed as endangered by North Carolina, where it exists in low numbers only in the lower Pee Dee River below Blewett Falls Dam. Habitat loss and blockage resulting from dams and extreme fluctuations in flow from hydropower operations historically endangered Robust Redhorse. Introduced species such as Flathead Catfish also threaten Robust Redhorse. To conserve Robust Redhorse, N.C. Wildlife Resources Commission biologists will enhance the populations below Blewett Falls through captive propagation and stocking. Commission staff will also explore avenues such as a Candidate Conservation Agreement with Assurances that will create opportunities to stock Robust Redhorse in other areas of its historic range such as the Pee Dee River below Lake Tillery.

Female Robust Redhorse collected from the Pee Dee River. The fish was weighed, measured, PIT-tagged and released back into the river.



Biological Information

Description and Taxonomic Classification

The Robust Redhorse (*Moxostoma robustum*, Cope 1870) is the largest sucker species native to the Carolinas, exceeding 700 mm total length (TL) and 8.4 kg (RRCC 2006). Distinguished by large, fleshy, plicate lips with a generally straight posterior margin, adults and juveniles are bronze to golden, with large scales and heavy, molariform pharyngeal teeth. The caudal fin is red; other fins are often also similarly colored and males develop large tubercles on their head, snout, anal, and caudal fins during spawning season (Cope 1870).

The species was described from the Yadkin River in North Carolina by Cope (1870), but the name *Moxostoma robustum* was then mistakenly applied to another sucker species for over a century until the collection of two fish from the Savannah River (GA/SC) and the Pee Dee River (NC) in the early 1980s. Additional captures in 1991 in the Oconee River (GA) and further investigation of nomenclature applications led to correction of these errors (Bryant et al. 1996). Mitochondrial and nuclear DNA analyses have revealed that the North Carolina population in the lower Pee Dee River is genetically distinct from other Robust Redhorse population units (Darden and Tarpey 2014, Wirgin et al. 2001, Wirgin 2002).

Life History and Habitat

Robust Redhorse are large, relatively long-lived fish, with a maximum reported age of 27 years, reaching sexual maturity at four to five years in males and five to six years in females (Darden and Tarpey 2014). Adults aged using scale annuli ranged in estimated minimum age from eight to 16 years old. This indicates a long window of potential reproductive activity, even with known uncertainty margins in this methodology (Jenkins 2007, Grabowski et al. 2008, Straight and Freeman 2013).

A freshwater potamodromous species, adult Robust Redhorse move upstream within rivers during the spring to spawn on clean gravel shoals (Grabowski and Isely 2006, Fisk 2010). These migrations can exceed 100 river kilometers (km), but populations are restricted by barriers such as hydropower dams and by habitat availability (Grabowski and Isely 2006, Fisk 2010, Fisk et al 2013). In North Carolina, the species inhabits the Pee Dee River below Blewett Falls Dam to the state line (Figure 1, page 7) and is currently known to use only two primary spawning shoal complexes near confluences with major tributaries. A split in migration behavior type has been observed in this population. One subgroup remained local to the Piedmont reach of the river year-round, while the other moved long distances downstream to overwinter in deeper habitats in the Coastal Plain of SC (Fisk 2010).

Robust Redhorse feed on insects and mollusks, using their large pharyngeal teeth to crush the shells of snails and mussels. They have been observed to feed on large quantities of exotic Asian Clams (*Corbicula fluminea*) and even young fish appear adaptable in their prey selection (Freeman et al. 2002). It is unknown, however, whether exotic species have any negative dietary or metabolic effects.

Extensive mark-recapture and radio telemetry studies have revealed that adults can show a high degree of spawning shoal fidelity, with individuals captured in spawning condition on the same shoal in multiple years (Fisk 2010, Grabowski and Isley 2006, Ely and Zimpfer 2013, Straight and Freeman 2013). Adults aggregate in April through May, when water temperatures range from 16-24 degrees C (Grabowski and Isley 2006, RRCC 2006). Spawning usually consists of a "triad," two males on either flank of a female in areas of medium to high current velocity (Freeman and Freeman 2001, Straight and Freeman 2013), and fertilized eggs are deposited in interstitial spaces among gravel substrates. Larvae hatch after roughly a week, remaining in the gravel for an additional one to two weeks before emergence into the water column (Fisk et al. 2013, Jennings et al. 2004, Looney and Jennings 2004).

Little is known about the juvenile life history of Robust Redhorse, as few wild individuals have been collected despite a wide array of sampling across habitats and seasons. The reason for the difficulty in collecting immature fish is unknown, but this data gap exists in all three states. Recent telemetry data from hatchery-propagated juveniles in the Pee Dee River indicates the ability to rapidly travel long distances (over 100 km; J. Gibbons, SCDNR, personal communication).

Distribution and Population Status

Robust Redhorse are endemic to Atlantic Slope river systems in the southeast. While they may have once been more widely distributed, they are currently found in the mainstems of the Oconee, Ocmulgee, and Ogeechee rivers of the Altamaha basin in GA; the Savannah and Broad rivers of the Savannah basin in SC/GA; the Wateree and Broad rivers of the Santee basin in SC; and the Pee Dee River in NC/SC (Figure 2, page 8). The North Carolina population is restricted to the unimpounded reach of the Pee Dee River below Blewett Falls Dam and represents the northernmost extent of the species. No individuals have been collected from any upstream reaches in North Carolina upstream of Blewett Falls Dam, including the type locality, since the time of description (RRCC 2014).

Population levels are low across the entirety of its range and it is listed as State Endangered in North Carolina. Targeted sampling of spawning adults has occurred in the Pee Dee River during the spring since 2005, with a break to reduce population disturbance from 2010 to 2013. Additional surveys over a larger area of the watershed have been conducted since 1999. Including the single individual captured in 1985, 193 Robust Redhorse have been collected to date, of which 30 were identified as males, 55 as females, with the remainder being immature.

All animals are PIT-tagged to track recapture rates and model population size. Recapture rates among and within years have ranged from 25% in 2005 (total annual captures n=8) to 68.4% in 2016 (n=19), with a mean of 44.3%. A population estimate of breeding adults in the Pee Dee has been generated for each sampled year since 2006 using the software package MARK, with associated confidence intervals (Figure 3, page 8). Parameters are generated via the Cormack-Jolly Seber open population model and through 2016, estimates ranged from 31 (95% CI 23-39) in 2013 to 52 (95% CI 39-65) in 2008. However, in 2017 that estimate dropped to 18, driven by the capture of only one

Robust Redhorse are endemic to Atlantic Slope river systems in the southeast. In North Carolina, they are found only in the Pee Dee River.

new (previously untagged) adult of seven collected. However, the population estimate was back up to 62 in 2018. An additional seven juveniles between 350-480 mm were captured, along with six 2-year-old propagated juveniles stocked in November of 2016. Regardless, this population lingers at an extremely low level and, as documented natural recruitment is also very low, is at a high risk for further endangerment and extirpation without continued proactive conservation measures.

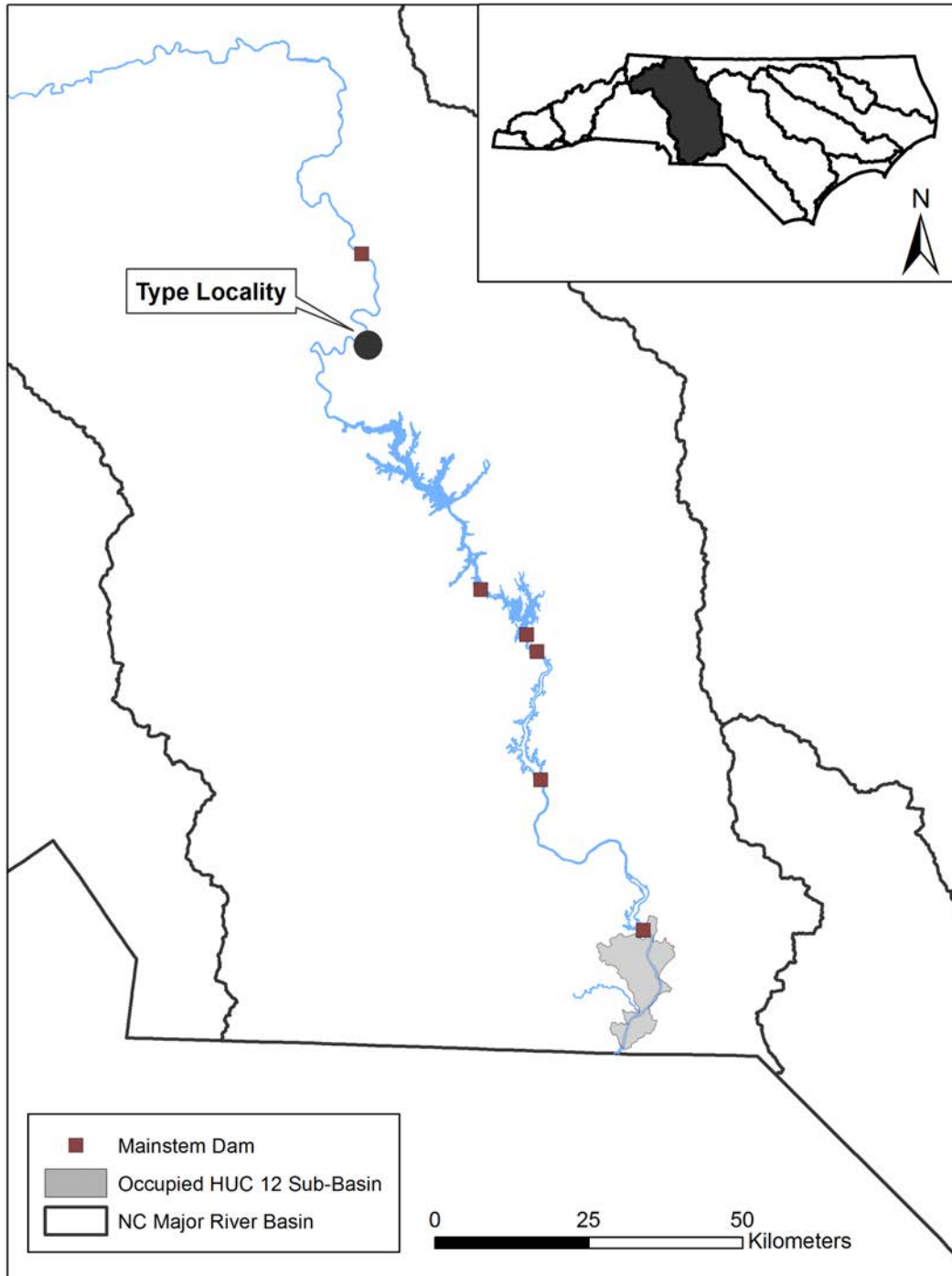


Figure 1. Range and type locality of Robust Redhorse in the Yadkin-Pee Dee River in NC.

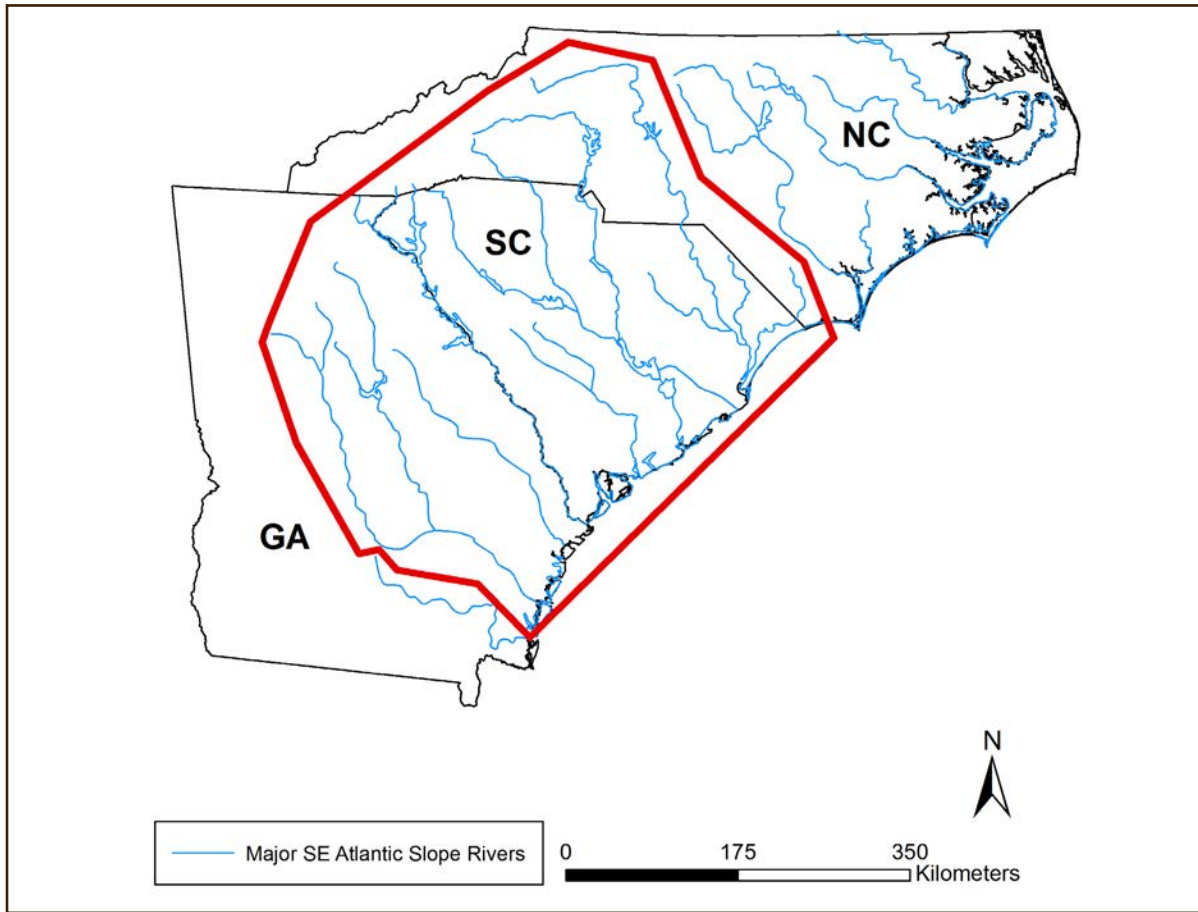


Figure 2. Historic range of Robust Redhorse in Atlantic Slope Rivers of the southeast as indicated by the red outline.

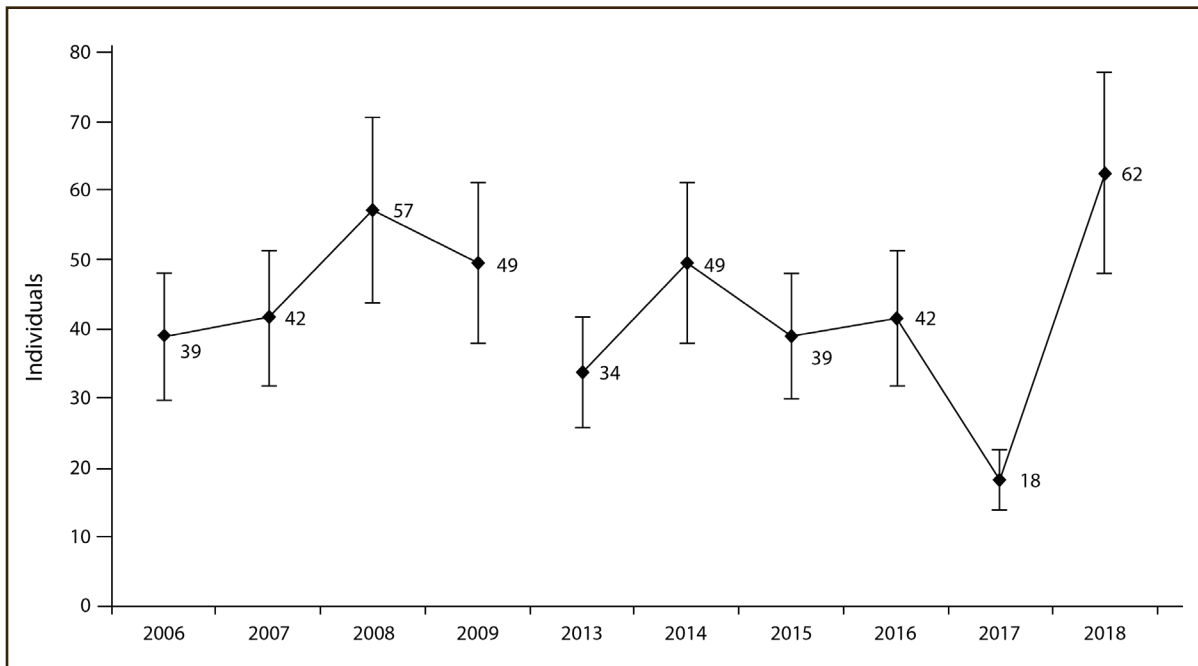


Figure 3. Annual adult breeding population estimates for Robust Redhorse on Pee Dee River spawning shoals in NC. Error bars represent 95% confidence intervals. Gap from 2010-2013 represents years spring sampling was not conducted.

Historic and Ongoing Conservation Efforts

The N.C. Wildlife Resources Commission is a member of the Robust Redhorse Conservation Committee (RRCC), a partnership formed in 1995 through a signed Memorandum of Understanding (MOU) between stakeholders across the species' three-state range — North Carolina, South Carolina and Georgia (RRCC 2010). Fellow members include federal and state natural resource agencies, GA Power, Duke Energy, SC Electric and Gas, and the SC Aquarium. Additional cooperators include universities such as NC State University and the University of Georgia, as well as the NC Museum of Natural Sciences. The RRCC has been a proactive and effective collaboration, with the goals of implementing research and conservation, enhancing recruitment in existing populations, and re-establishing the species in suitable habitat within the historic range. In addition, the group provides educational materials and resources describing the Robust Redhorse and the significant accomplishments of the RRCC on a dedicated website at <http://www.robustredhorse.com>. Following the MOU, the RRCC produced a Robust Redhorse Conservation Strategy document (Nichols 2003), encompassing protocols and actions to achieve conservation goals, a Policy outline to guide consistency across regions and activities (RRCC 2002), and a Habitat Restoration Management Plan to identify threats and potential opportunities (RRCC 2006).

The Yadkin-Pee Dee Technical Working Group (TWG) consists of a subgroup within the RRCC focused on research, conservation, and management of the Pee Dee River population of the Robust Redhorse. Chartered in 2002, the TWG additionally coordinates propagation and augmentation activities in the basin and collaborates with the larger RRCC (YPD TWG 2002).

Riparian lands adjacent to the critical North Carolina spawning areas of Robust Redhorse are protected in part via ownership by the Wildlife Commission and Duke Energy. A significant portion of these properties have been incorporated for conservation management into the Commission's Game Lands program, which includes provisions for restoration of native habitats.

Due to the significant influence of the operation of Blewett Falls Dam on the hydrology of the Pee Dee River downstream and subsequent effects on the quality and availability of Robust Redhorse spawning habitat, cooperative conservation partnership with Duke Energy Progress (Duke Energy) has been a vital component of species management and survival. During the most recent cycle of Federal Energy Regulatory Commission (FERC) relicensing, new minimum flow schedules were developed for both the Blewett Falls and Tillery Dam (the next dam upstream) projects. License issuance was significantly delayed following the 2006 filing, finally granted in 2015, but Duke Energy began voluntarily providing higher minimum spawning flows (1,200 cubic ft per second [cfs]; required minimum at the time was 150 cfs) for a 30-day period in the spring of 2009, which was then extended to a year-round minimum in 2011 whenever possible. Beginning in January 2012, even greater spring minimum flows were provided through the end of May each year, with graduated reductions over a span of weeks to mimic natural seasonal flows. Duke Energy has also installed systems at both Blewett Falls and Tillery dams to improve dissolved oxygen concentrations in tailwaters and monitoring has documented improved compliance with state standards (FERC 2015; T. Styer, Duke Energy, personal communication).

To augment existing populations and establish new ones, mitigating risk of local extirpations pushing this rare species closer to extinction, captive propagation and stocking of young fish has occurred in all three states.

Gametes collected from adult fish on the North Carolina spawning shoals were propagated in split batches — half at the Wildlife Commission's McKinney Lake Fish Hatchery and the remainder at SC Department of Natural Resources' (SCDNR) Dennis Center, using a protocol developed by the USFWS to minimize genetic risks and avoid excessive depletion of gametes available for wild spawning. Phase I (6 months old) fingerlings were stocked into the Pee Dee River at two locations on either side of the state line in November of 2014 and 2015, while Phase II (18 months old) juveniles were stocked at the same sites in November 2016. All Phase II fish were fitted with unique PIT tags and 30 (15 from each hatchery) were given surgically implanted VEMCO sonic tags, which are tracked using static receivers already deployed in the lower Pee Dee River to monitor Atlantic Sturgeon (*Acipenser oxyrinchus*) and Shortnose Sturgeon (*Acipenser brevirostrum*). An additional 50 fish were held back at each hatchery to attempt growout to sexual maturity. There were no propagated juveniles spawned in 2016 or 2017 because there were not sufficient quantities of gametes in captured adults to meet the mating design criteria. All propagated year-classes are genetically traceable using fin clip material collected from the parent fish.



Robust Redhorse juveniles were released into the Pee Dee River at two locations on the North Carolina/South Carolina state line in November 2014 and 2015.

Six of the Phase II fish were recaptured near spawning shoals during spring sampling in April and May 2017 and 26 of the 30 VEMCO-tagged fish were relocated within a few months of release. This suggests some successful short-term survival as well as innate habitat orientation, despite development in hatchery ponds. Recently completed genetic analyses indicate that two juveniles captured in 2016 and seven from 2017 were products of the stocked 2014 year-class (D. Ferrae, SCDNR, personal communication). Seven of these nine fish were captured on or near spawning shoals during spring sampling and it is possible that they or their cohorts may successfully recruit into the breeding population between 2018 and 2020.

Discussions are ongoing toward proposed reintroduction of the Robust Redhorse into the 30-km reach below Tillery Dam, following indications from a habitat suitability modeling study that the species could inhabit this reach at the minimum release flows (Fisk et al. 2014). The Commission is exploring the possibility of establishing a Candidate Conservation Agreement with Assurances to facilitate the stocking of Robust Redhorse in the reach below Tillery Dam.

Threat Assessment

Reason for Listing

The Robust Redhorse was listed as Endangered in North Carolina in the late 1990s due to its extremely restricted range and small population size, along with a decline in numbers stemming from habitat loss, movement barriers, historical overfishing and the introduction of exotic piscivores (NatureServe 2017). It is currently petitioned for listing by the US Fish and Wildlife Service.

Present and Anticipated Threats

This species has been the focus of intensive study across its range for several decades; a library of annual reports, technical publications, research articles, theses, dissertations, and press releases discussing threats, as well as life history, management actions, policy and conservation, is available on the dedicated RRCC website at <http://www.robustredhorse.com/h/reportpubs.html>. This list is updated periodically by executive members of the RRCC. The following is a summary of threats.

The Robust Redhorse is currently restricted from any expansion upstream in the Pee Dee River by the presence of Blewett Falls Dam, a large hydro-power dam operated by Duke Energy, precluding any natural recolonization of historic range. The dam hosts six turbines, impounding a 12-mile-long, 2,866-acre reservoir with a 900-foot tailrace. Operation of the dam also altered the natural flow regime, which is significant to a species which uses seasonal cues from water temperature and flow to trigger spawning aggregation. Under the previous FERC license, issued in 1958, generation occurred following electricity demand and releases from upstream reservoirs, with a year-round required minimum flow of 150 cfs and a typical generation flow of 7,200 and 9,200 cfs, creating significant fluctuations, changing over a matter of hours, in quantity of submerged habitat available on a daily basis (FERC 2015). Previous peaking schedules also created artificial low water events after eggs were laid in the spring, resulting in suspected losses due to egg desiccation, loss when the next pulse of water washed away eggs with reduced adhesion properties into unsuitable habitat, or reductions in hatch success and larval development (Fisk et al. 2013, Weyers et al. 2003). In recent years, Duke Energy has voluntarily provided ecologically beneficial spring release flows as a partner in the Robust Redhorse Conservation Committee and Yadkin-Pee Dee Technical Working Group. Beginning in 2015, the new FERC license also includes provisions for increased minimum release flows both year-round and during spring migration and spawning.



Blewett Falls Dam (Photo: Wikipedia)

Sedimentation due to both in-channel erosion and particles carried by runoff presents multiple challenges, including destruction of spawning habitat when gravel beds are covered, impaired larval development, egg mortality (Jennings 2010, Jennings et al. 2004) and reduction of prey base. These effects are exacerbated by factors such as increases in impervious surface in upstream portions of the watershed, more frequent or larger storm events and bank destabilization (e.g. forested buffer removal or livestock/vehicle access).

Water quality has also been heavily impacted by runoff containing agricultural and industrial chemical pollutants, nutrients, and emerging contaminants such as pharmaceuticals and endocrine-disrupting compounds. The latter act on fish as they develop and can result in an intersex condition, where an individual has both male and female gonadal tissue. A recent nationwide study found the highest proportion of intersex Largemouth Bass (*Micropterus salmoides*) in the lower Pee Dee River, sympatric with Robust Redhorse (Hinck et al. 2009). Details of effects, including magnitude of reproductive impact and other sublethal complications, are still largely unknown for this predominantly unregulated class of pollutants, but the likelihood of negative effects on Robust Redhorse is high, as mechanisms of deleterious impacts have been documented in other species (Lee Pow 2016, Gagné 2004). Contaminant analysis of ova from a single large adult female Robust Redhorse from the Pee Dee River revealed concentrations several orders of magnitude higher than tissue from other species, indicating potential for maternal inheritance alongside environmental exposure (Penland 2017).

Exotic species with high population levels sympatric with the Robust Redhorse include Flathead Catfish (*Pylodactis olivaris*), an aggressive predator shown to reduce native fish populations (Ashley and Rachels 1998, Pine et al. 2007), Blue Catfish (*Ictalurus furcatus*), which are also piscivorous when large (Edds et al. 2002), Smallmouth Buffalo (*Ictiobus bubalus*) and Common Carp (*Cyprinus carpio*) which are both abundant potential space and resource competitors, along with non-native mollusks such as Asian Clam (*Corbicula fluminea*) and Japanese Mystery Snail (*Cipangopaludina japonica*), whose effects are not yet known. Predation poses a direct risk to juveniles and probability of encounter is high as both species of large exotic catfish occur almost ubiquitously in the Pee Dee River below Blewett Falls Dam and continuing into South Carolina. Egg and larval predation on gravel

Flathead Catfish are aggressive predators that can reduce native fish populations.



beds could also have a disproportionate impact to that felt by other species due to the extremely low numbers of successfully spawning Robust Redhorse, where the loss of a single nest could represent a significant segment of that year-class.

Another risk for this small population is loss of genetic diversity leading to bottlenecks and loss of response plasticity in the face of a complex, changing environment. Population-level analyses suggested that the Pee Dee River supports high levels of gene diversity and low inbreeding coefficients (Darden and Tarpey 2014), but there was evidence of a “long term gradual population decline as well as a recent moderate population bottleneck.” With continued low recruitment levels and potentially high possibility of matings between siblings or other closely related fish, these trends will continue to multiply. If this metric of population health declines, the species becomes less resilient to changes in its ecosystem and more susceptible to stressors such as disease, parasites and pollutants. Darden and Tarpey (2014) estimated a retention of 90-92% of genetic diversity retained over 100 years at current calculated population estimate levels ($n = 38-55$), with a 64-69% loss in allelic richness, with the caveat that the rate of loss increases precipitously at the low end of confidence intervals ($n = 20$).

Climate change effects have the potential to negatively impact Robust Redhorse spawning success via increased water temperatures and changes to seasonal rainfall and flow patterns (Lynch et al. 2016, NCDENR 2010). Water temperatures above 27 C exceed thermal tolerances of eggs, larvae and fry (Jennings et al 1998), conditions already observed near the end of May and early June in the Pee Dee River. Adults may also migrate at times not conducive to spawning success or fail to migrate at all if flow timing is altered or reduced by drought (Ely and Zimpfer 2013). Similarly habitat quality and quantity will be reduced if less water is available (Fisk 2010). Additional effects of climate change potentially compounding on other concurrent environmental stressors include resuspension of sediments during more frequent storms, concentration of nutrients and slowed transport pathways through increased evaporation rates, algal blooms, fish kills and other productivity shifts (NCDENR 2010). The precise mechanisms and outcomes of climate change impacts have not yet been identified in most cases, primarily due to the lack of focused research and standardized data sets (Lynch et al. 2016) and further work is needed to inform an effective management response.

Conservation Goal and Objectives

Conservation Goal

Wildlife Commission biologists are working to prevent the extinction of Robust Redhorse, with particular focus on Robust Redhorse in the Pee Dee River. To reach this conservation goal, biologists need to ensure the long-term viability of Robust Redhorse as a member of the fauna of North Carolina for the next 100 years. A viable population will contain multiple individuals, numerous age-classes, and recruitment over multiple generations.

Conservation Objectives

Wildlife Commission biologists have developed a conservation strategy to maintain the population of Robust Redhorse in the Pee Dee River and expand its current range into the next upstream reach below Tillery Dam. Objectives include:

1. Maintain a viable population of Robust Redhorse and high genetic diversity ($\geq 90\%$ of current levels; Darden and Tarpey 2014) in the Pee Dee River below Blewett Falls Dam. Genetic diversity is defined in Moyer and Darden (2014).
2. Reestablish a population of Robust Redhorse in the Pee Dee River between Tillery Dam and Blewett Falls Reservoir.
3. Increase numbers and recruitment in the Robust Redhorse population below Blewett Falls Dam.

Conservation Actions

Habitat Protection and Habitat Management

The Wildlife Commission will continue cooperative efforts with Duke Energy to maintain adequate dissolved oxygen concentrations in dam tailwaters, as well as manage riparian lands for protected native forested buffers. The Commission will work with partners in the Yadkin-Pee Dee TWG to continue improving understanding of contaminant loads and effects in the river. The TWG will also engage other stakeholders where appropriate to improve compliance with existing water quality regulations if needed and to investigate the efficacy of proposing new or modified regulations.

Protecting habitat integrity, including hydrology, is crucial for Robust Redhorse survival. Comments on permit reviews should stress minimizing inputs that include chemical pollutants such as herbicides, pesticides, pharmaceuticals and industrial compounds, as well as sediment and nutrients carried by storm water. Wildlife Commission Technical Guidance staff will recommend that all permits issued in the sub-basins of the Pee Dee River and its tributaries implement the recommendations of the 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.

Population Management

Utilize captive propagation and/or translocations to establish a population of Robust Redhorse in the Pee Dee River reach below Tillery Dam over a series of years. This would be followed by monitoring to document successful establishment and persistence over time.

Increase abundance and recruitment of Robust Redhorse below Blewett Falls Dam. Strategies to achieve progress will include augmenting the current population with propagated fish to boost numbers, protecting instream and riparian habitat around both the spawning shoals and the riverine travel corridor, and identification and reduction of current barriers to successful recruitment.

The Wildlife Commission will continue to participate in the Yadkin-Pee Dee TWG and the larger RRCC to implement effective conservation and management for the Pee Dee River population of Robust Redhorse, including pursuit of research objectives and opportunities for grant funds. If a statewide Safe Harbor Agreement is implemented with the USFWS, reintroduction of Robust Redhorse into the Tillery reach of the river will be pursued under the partner assurances of that framework, in cooperation with TWG members, pending approval from the Habitat, Nongame, and Endangered Species Committee. The Commission has planned to produce a minimum of 20 year-classes of captively reared Robust Redhorse to stock into this system in cooperation with SCDNR; three have been completed to date (2014, 2015, 2018 year-classes). Production is wholly dependent on successful collection of gametes from broodstock during spring sampling on spawning shoals. The timing and accessibility of ripe adults are driven by water temperatures and flow, including the availability of sufficient quantities of water delivered from successive hydroelectric projects upstream to release from Blewett Falls Dam. Therefore, a completion date for this phase of augmentation must remain adaptive to these constraints.

Incentives (Tax Break)

The Wildlife Commission will encourage private landowners adjacent to the Pee Dee River and its tributaries to participate in the Wildlife Conservation Lands program. This program allows qualifying landowners whose property is in proximity to streams with state listed species to get a break in property taxes for implementing conservation actions.

Monitoring and Research

The Wildlife Commission will continue to participate in population monitoring as part of the Yadkin-Pee Dee TWG's cooperative sampling efforts, collecting data for further modeling and metrics, as well as broodstock for propagation of juveniles.

Identify habitat use, movement patterns, and life history details of juvenile Robust Redhorse in the Pee Dee River between larval emergence and recruitment into the spawning population. This includes investigation of current barriers to recruitment, which may encompass predation by exotic species, mortality or sublethal effects from contaminants, or other environmental stressors reducing survival to sexual maturity.

The Commission will cooperate with SCDNR to monitor the genetic health of the Pee Dee Robust Redhorse population through analysis of fin clip material collected during sampling, as well as determine the proportion of fish recruiting into the breeding population that are products of wild, in-river spawning. In addition, the contributions of hatchery-reared fish will be tracked as stocked individuals mature, reproduce and contribute to the population.

Education and Outreach

The Wildlife Commission will continue to contribute to reports, educational materials, and other publications that comprise the RRCC website, as well as distribute public information about the species and associated projects through channels such as the NC Chapter of the American Fisheries Society and the Commission. Results of research and monitoring projects will be presented at scientific meetings of fisheries and conservation biologists and administrators.

Commission biologists will work with Wildlife Education staff to promote education and awareness of the Robust Redhorse 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

Take or possession of this species without a valid permit is currently prohibited under NC law and administrative code (15A NCAC 101 .0102) and is considered a Class 1 misdemeanor (§ 113 337b). Wildlife Commission regulations prohibit transport, purchase, possession or sale of live individuals of Japanese and Chinese Mystery Snail, Grass Carp, Black Carp, Bighead Carp or Silver Carp or stocking these species into public or private waters. Additionally, no fish can be stocked into public fishing waters without a permit and only certified triploid Grass Carp may be purchased, possessed or stocked with a permit. The Commission is currently considering implementing a rule that would prohibit bow fishing in the Pee Dee River for all fish except catfish. This would protect the Robust Redhorse from take associated with this activity.



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