United States
Department of
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Forest
Service

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Aquatic Species Viability Evaluation for

The Uwharrie National Forest

Land and Resource Management Plan

Environmental Impact Statement

Contents

1.0 Introduction

This document describes the purpose, methods, and results of a aquatic species viability evaluation for the Environmental Impact Statement (EIS) alternatives developed for the Uwharrie National Forest Land and Resource Management Plan, National Forests in North Carolina. Species viability is assessed within the context of National Forest Management Act regulations to "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives."

2.0 Purpose

The purpose for conducting this species viability evaluation is to determine the degree to which ecological conditions on national forest system lands contribute to the long-term viability (for a 50-year planning horizon) of species at risk. More specifically, this evaluation provides an estimate of the likelihood that these species will persist on the Uwharrie NF for a given period of time.

2.1 Requirements in the National Forest Management Act (NFMA)

The 1982 planning regulations implementing the National Forest Management Act (NFMA) (36 CFR 219.19) require national forests to provide habitat in order "to maintain viable populations of existing native and desired non-native vertebrate species in the planning area." Additional direction (USDA Regulation 9500-4) extends this mandate to include vascular plants. Native species are species indigenous to the planning area. Desired non-native species are those species that are not indigenous to the planning area but are valued for the social, cultural, ecological, or economic value.

NFMA regulations define a viable population: "For planning purposes, a viable population shall be regarded as one which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area." The regulations direct that "habitat must be provided to support, at least, a minimum number of reproductive individuals and that habitat must be well distributed so that those individuals can interact with others in the planning area." The planning area is defined as the national forest system lands included in the Uwharrie National Forest proclamation boundary.

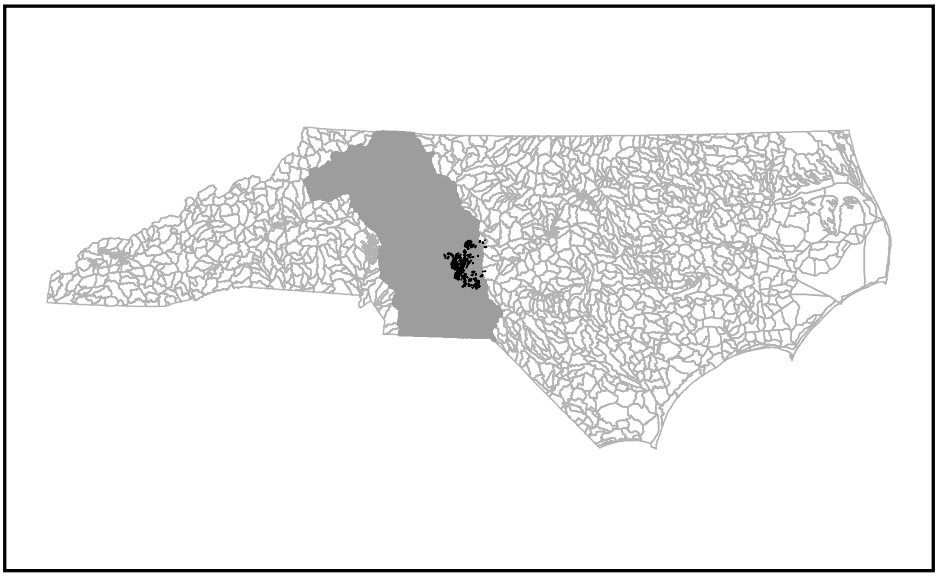
While the NFMA regulations focus on population viability, the Act itself does not contain an explicit requirement for "viability." Rather, it directs that management of national forests "provide for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives." The regulation also contains language on diversity (36 CFR 219.26), and directs that "Forest planning shall provide for diversity of plant and animal communities and tree species consistent with the overall multiple-use objectives of the planning area." Thus, viability of individual species must be considered within the context of overall diversity of plant and animal species and the multiple-use objectives for the planning area. While invertebrates are not specifically addressed in the 1982 planning regulations, the Uwharrie NF evaluated these as part of this process.

3.0 Aquatic Ecological Viability

Physical characteristics of the Yadkin-Pee Dee River Basin

The Yadkin-Pee Dee River basin is the second largest river basin in North Carolina, covering approximately 7,200 square miles within twenty-one counties of central North Carolina (Figure 1). Approximately 5,900 miles of freshwater streams and rivers within the basin drain several ecoregions, and many subecoregions. There are approximately 23,000 acres of lakes, ponds, and reservoirs within the Yadkin-Pee Dee River basin. The Yadkin River originates in Virginia, becomes the Pee Dee River in central North Carolina, and flows into South Carolina before entering the Atlantic Ocean.

Figure 1. Map of the Yadkin River basin within North Carolina. Gray area represents the Yadkin River Basin in North Carolina. Black area represents the Uwharrie National Forest.



There is a small portion of the Uwharrie National Forest within the Cape Fear River Basin. Few stream miles drain this area. Therefore, aquatic species viability will only be addressed for this area when it differs from the Yadkin-Pee Dee River Basin.

Land use and population trends within the Yadkin-Pee Dee River Basin

Approximately 50% of the land within the Yadkin-Pee Dee River basin is forested, while approximately 30% of the land is used for agriculture. Approximately 13% of the basin supports some level of urban development, and the remaining 7% of the basin is surface water. Approximately 95% of the Yadkin-Pee Dee River basin is privately owned.

Comparisons between land use in 1982 and 1997 show significant decreases in the amount of cultivated cropland and forested land within the basin, and notable increases in the amount of uncultivated cropland and pastureland. This coincides with a substantial increase in the urban/developed land use category over the same 15-year period. Approximately 45% of the increase in developed area occurred within the five-year period between 1992 and 1997.

The Yadkin-Pee Dee River basin is largely influenced by ninety-three small to large municipalities within the basin, most of which are located along the I-40 and I-85 corridors and in the areas surrounding Winston-Salem, Salisbury, and Charlotte. The basin population is projected to increase 36% to nearly two million people by 2020.

Physiographic description of the Yadkin-Pee Dee River basin

Within the Yadkin-Pee Dee River Basin, the Mountain Physiographic Region includes the Southern Crystalline Ridges and Mountains, and the Eastern Blue Ridge Foothills. The Piedmont Physiographic Region is a compilation of the Northern Inner Piedmont, Triassic Uplands, Sauratown Mountains, Southern Outer Piedmont, and Carolina Slate Belt. Streams within each area are affected by the soils, geology, vegetation, and topography characteristic of the physiographic region. There is moderate stream density in these areas, meaning that more streams drain a smaller amount of land.

There is a small portion of the basin in North Carolina (southeastern Montgomery County) that lies within the Inner Coastal Plain Physiographic Region. The geology of this area consists of alternating layers of sand, silt, clay and limestone. The topography is noticeably flatter in this area, and a smaller number of streams drain a larger area of land, resulting in lower stream density. In addition, streams in this area have the lowest potential for sustaining base flow in streams, particularly during the warmer months of the year. This characteristic limits a stream's ability to maintain high dissolved oxygen levels, which in turn limits primary and secondary productivity (aquatic life – plants and animals, respectively) in this area.

The physiographic regions described above are within the South Atlantic Ecoregion. A complete description of this (and other freshwater) ecoregion can be found in Abell et al. 2000. The Atlantic coastal ecoregion ranges from eastern Georgia to southern Virginia, covering all of South Carolina, and most of North Carolina. For a temperate ecoregion, the South Atlantic contains noteworthy levels of species richness and endemism, but its outstanding biodiversity is particularly evident when compared to other temperate coastal ecoregions. Like other ecoregions radiating from the Appalachian Mountains, age, favorable climate, and geologic stability have provided a variety of habitats, allowing diverse aquatic fauna to evolve and survive (Rohde et al. 1994).

4.0 Ecosystem Diversity

Ecosystem diversity can be considered at a range of spatial scales. The selection of an appropriate spatial scale for the analysis of aquatic ecosystem diversity is outlined below. This process started with consideration of the entire Yadkin-Pee Dee River basin, including all non-National Forest land, an area much larger than the planning area for the Uwharrie National Forest.

The Yadkin River originates in the Blue Ridge Mountains and Upper Piedmont physiographic regions within North Carolina. This area is referred to as the Upper Yadkin River, and includes Subbasins 01 through 07 (equivalent to United States Geological Survey (USGS) hydrologic units 03040101, 03040102, and 03040103 (source to Hamby Creek)). Many of the mountain streams in these subbasins are classified as trout streams. In terms of fish and aquatic invertebrate communities, these systems are considered coldwater and foothills coolwater types.

These types of communities are not representative of the landscape across the Uwharrie National Forest, and are therefore excluded from consideration in this sustainability analysis.

The Lower Yadkin River includes Subbasins 08 through 17 (equivalent to USGS hydrologic units 03040103 (downstream of Hamby Creek), 03040104, 03040105, 03040201, and 03040202), and flows entirely through the Piedmont physiographic region. In terms of fish and aquatic invertebrate communities, streams and rivers within the lower Yadkin River are considered warmwater types. These types of communities are entirely representative of the landscape across the Uwharrie National Forest, and are therefore included in this sustainability analysis.

Warmwater streams and rivers contain the largest number of native species, and support the highest overall diversity of all stream types. Warmwater streams flow through all forest types, and occur across all land types and geologies. They represent all stream orders and types. Water temperature is the primary stream classification parameter. Simply put, warmwater streams and rivers are aquatic systems that experience sustained maximum water temperatures above lethal limits of wild trout populations (typically greater than 25 degrees Celsius) for all or part of the year. This definition represents 100% of the aquatic resources on the Uwharrie National Forest.

The Uwharrie National Forest is within Subbasins 8, 9, 10, and 15 of the lower Yadkin-Pee Dee River Basin (NCDENR 2002). Table 1 summarizes National Forest System lands by subbasin for the Lower Yadkin River. Portions of the lower Yadkin River basin may also be referred to as the upper Pee Dee River (the Yadkin River becomes the Pee Dee River at the confluence of the Yadkin and Uwharrie Rivers). Important to note in Table 1 is that only two subbasins (Lower Uwharrie and Dutch John Creek) support enough public ownership to realistically assume that changes in aquatic community structure, function, or stability (positive or negative) could be attributed to Forest Service activities. These subbasins are both located in the Badin Lake area of the forest, where there is a high density of recreation use. Within most of the subbasins within the lower Yadkin-Pee Dee River basin, land use is dominated by private landownership and National Forest management has little influence (Lenat and Crawford 1994, Walsser and Bart 1999, and Allan 2004).

Table 1. National Forest System lands by NCDENR subbasins and USGS hydrologic unit within the Lower Yadkin River.

NCDENR Subbasin	USGS Hydrologic Unit	Watershed Name	% Forest Service Ownership
8	03040103050070	Upper Uwharrie	13.5
8	03040103050080	Middle Uwharrie	18.7
8	03040104030020	Barnes Creek	1.8
8	03040103050110	Badin Lake	15.2
8	**03040103050090**	**Lower Uwharrie**	**56.9**
8	**03040103050130**	**Dutch John Creek**	**56.8**
9	03030003020040	Richland Creek	1.0
9	03040104030010	Upper Little River	3.2
10	03040104030030	Denson's Creek	5.8
10	03040104040020	Rocky Creek	19.1
10	03040104020010	Pee Dee River	23.8

NCDENR Subbasin	USGS Hydrologic Unit	Watershed Name	% Forest Service Ownership
10	03040104040010	Middle Little River	9.0
10	03040104020020	Clark's Creek	5.3
10	03040104040030	Lower Little River	1.6
10	03040104050010	Cheek Creek	11.2
15	03030003020060	Fork Creek	0.8

Addressing aquatic ecosystem viability at this scale will allow for both local and broad-scale trends to be considered and to capture the range of variation associated with disturbances, as well as natural ecosystem dynamics.

4.1 Characteristics of Ecosystem Diversity

Warmwater streams and rivers contain the largest number of native aquatic species, and support the highest overall diversity of all stream types. Warmwater streams flow through all forest types on the Uwharrie NF, and occur across all land types and geologies, representing all stream orders and types. It is not uncommon to witness a warmwater fish community with over 30 native species, or an aquatic insect community numbering in the hundreds of native species. Aquatic community complexity is a result of the diverse characteristics (land form, forest type, etc.) of warmwater streams themselves.

Parameters selected to measure aquatic ecosystem diversity must be meaningful to describe and evaluate community composition, structure, and processes of aquatic ecosystems. These characteristics may include those required for rare species such as Federally-listed (PET), Regionally-sensitive (S), or locally rare (Forest concern, FC). They should also reflect ecosystem processes that contribute to variation in ecosystem diversity. Most importantly, the scale of selected characteristics must match the scale of planning efforts.

Basinwide water quality planning is a nonregulatory watershed-based approach to restoring and protecting the quality of North Carolina's surface waters. The North Carolina Division of Water Quality (NCDWQ) prepares basinwide water quality plans for each of the seventeen major river basins in the state, and revises them at five-year intervals. While these plans are prepared by the NCDWQ, their implementation and the protection of water quality involve the coordinated efforts of many agencies, local governments, and stakeholders.

The first basinwide plan for the Yadkin-Pee Dee River Basin was completed in 1998. The basin was reassessed in 2001 and 2006. The U.S. Forest Service is an active partner in the collection, analysis, and use of the information contained in these (and other basin) assessments. The Yadkin-Pee Dee River Basin will be reassessed in 2011, within the life of the revised Land and Resource Management Plan (LRMP) for the Uwharrie National Forest.

While these basinwide plans address many aspects of aquatic resource management, two are of specific relevance to maintaining aquatic ecosystem diversity: (1) fish community structure, and (2) benthic community structure. These two aspects will be used to evaluate aquatic ecosystem diversity and viability for the life of the Uwharrie National Forest LRMP.

4.1.1 Fish Community Structure

The North Carolina Index of Biotic Integrity (NCIBI) is a modification of the Index of Biotic Integrity (IBI) initially proposed by Karr (1981) and Karr et al. (1986). The IBI method was developed for assessing a stream's biological integrity by examining the structure and health of its fish community. The scores derived from this index are a measure of the ecological health of the waterbody, and may not always directly correlate with water quality. For example, a stream with excellent water quality, but with poor or fair fish habitat, would not be rated excellent with this index. However, in many instances, a stream which rated excellent on the NCIBI should be expected to have excellent water quality.

The IBI (and hence, the NCIBI) incorporates information about species richness and composition, trophic composition, fish abundance, and fish condition. The NCIBI summarizes effects of all classes of factors influencing aquatic faunal communities (water quality, energy source, habitat quality, flow regime, and biotic interactions). While change in a fish community can be caused by many factors, certain aspects of the community are more responsive to specific influences. For example: species composition measurements reflect habitat quality effects; information on trophic composition reflects effects of biotic interactions and energy supply; and fish abundance and condition information indicate additional water quality effects. It should be noted, however, that these responses may overlap—for example, a change in fish abundance may be due to decreased energy supply or a decline in habitat quality, and not necessarily a change in water quality. A complete description of the NCIBI method can be found at *http://portal.ncdenr.org/web/wq/ess/bau*.

4.1.2 Benthic Community Structure

Benthic macroinvertebrates (or benthos) are organisms that live in or on the bottom substrates of rivers and streams. These organisms are primarily insect larvae, but also include worms, crustaceans and mollusks. The use of benthos data has proven to be a reliable monitoring tool, as benthic macroinvertebrates are sensitive to subtle changes in habitat and water quality.

Sampling methods and criteria have been developed to assign bioclassifications to benthic samples taken from flowing fresh waters based on the number of taxa present within the generally intolerant species groups of ephemeroptera (mayflies), plecoptera (stoneflies), and trichoptera (caddisflies). This index is known as the EPT index. The North Carolina Biotic Index (NCBI) integrates EPT information with the remainder of the benthic community, and provides an overall assessment of the benthic community. Both indices are useful tools to describe benthic community structure and health. A complete description of the EPT and NCBI methods can be found at *http://portal.ncdenr.org/web/wq/ess/bau*.

It is important to note that these benthic community bioclassifications primarily reflect the influence of chemical pollutants, and that the major physical pollutant, sediment, is not assessed as well by a taxa richness analysis. The EPT and NCBI are extremely useful to assess species diversity and aquatic ecosystem viability (which is described later in this document). Therefore**,** it is important to use both fish community and benthic invertebrate community structure indices to assess overall aquatic ecosystem viability.

4.2 Range of Variation

The range of variation under both historic and present disturbance regimes is an important context to evaluate current and desired conditions. However, it is not necessarily wise to use

"historic condition" as the desired condition for aquatic ecosystems due to the fact that we have limited knowledge of aquatic systems within the Yadkin-Pee Dee River basin beyond the last 50 years and there has been a great deal of change even in recent history.

4.2.1 Fish Community Structure

The NCIBI is a cumulative assessment of twelve parameters (or metrics) . The values provided by each metric are converted into scores on a scale of 1, 3, or 5. A score of 5 represents conditions which would be expected for undisturbed reference streams in the specific river basin or region (the NCIBI takes into consideration physiographic region when defining the 1, 3, or 5 values). A score of 1 indicates that conditions deviate greatly from those expected in undisturbed streams of the region. Each metric is designed to contribute unique information to the overall assessment. The scores for all metrics are then summed to obtain the overall NCIBI score. The NCIBI score (an even number between 12 (extremely disturbed) and 60 (undisturbed)) is then used to determine the ecological integrity of the stream from which the sample was taken.

Table 2. NCIBI scores and classification for fish communities within the Piedmont Physiographic Region (including the Yadkin-Pee Dee River basin). In addition to scoring criteria, complete descriptions of NCIBI metrics and values can be found at *http://portal.ncdenr.org/web/wq/ess/bau*.

NCIBI Score	NCIBI Classification
> 54	Excellent
48 – 52	Good
42 – 46	Good-Fair
36 – 40	Fair
<= 34	Poor

Because it is highly unlikely that any aquatic ecosystem has ever been completely undisturbed, an NCIBI value of 54 will be used as the baseline (or historical reference) for the analysis of trends in fish community structure within the Yadkin-Pee Dee River basin and across the Uwharrie NF.

4.2.2 Benthic Community Structure

Benthic community parameters (or metrics) used in the EPT index focus primarily on taxa richness (particularly of intolerant species) and are based on the idea that unstressed streams and rivers have many invertebrate taxa and are dominated by intolerant species. Conversely, polluted streams have fewer numbers of invertebrate taxa and are dominated by more tolerant species. The diversity of the invertebrate fauna is evaluated using taxa richness counts (EPT index). Therefore, the higher the EPT value, the more diverse (or healthy) the stream (Table 3).

The NCBI integrates the relative abundance and tolerance of each species, and provides insight into the overall tolerance (or health) of the benthic community. Tolerance values for individual species, and the final NCBI, have a range of 0 to 10, with higher numbers indicating increasing influence of more tolerant species on overall benthic community structure (i.e. more polluted conditions) (Table 2).

Because it is highly unlikely that any aquatic ecosystem has ever been completely undisturbed, reference values of 27 (EPT index) and 5.19 (NCBI) will be used as the baseline (or historical reference) for the analysis of trends in benthic community structure within the Yadkin-Pee Dee River basin and across the Uwharrie NF.

Table 3. Benthos classification criteria for flowing water systems in the Piedmont physiographic region (including the Yadkin-Pee Dee River basin).

Index	Sample Type*	Bioclass	Score
EPT	10-sample qual	Excellent	>31
		Good	24-31
		Good-Fair	16-23
		Fair	8-15
		Poor	0-7
EPT	4-sample EPT	Excellent	>27
		Good	21-27
		Good-Fair	14-20
		Fair	7-13
		Poor	0-6
NCBI (range 0-10)	10-sample qual	Excellent	<5.19
		Good	5.19-5.78
		Good-Fair	5.49-6.48
		Fair	6.49-7.48
		Poor	>7.48

*** Note there are two sets of scores for the EPT index, which refers to acceptable sampling protocols. The NCBI uses only one sampling protocol. Each protocol can be referenced at** ***http://portal.ncdenr.org/web/wq/ess/bau*****.**

4.3 Current Condition and Trend of Ecosystem Characteristics and Status of Ecosystem Diversity

Comprehensive lists of fish and other aquatic species can be found in the Uwharrie Watershed Assessment (National Forests in North Carolina 2004). The lists are not reproduced here to conserve document and electronic storage space. This document also defines condition and vulnerability for each watershed on the Forest.

4.3.1 Fish Community Structure

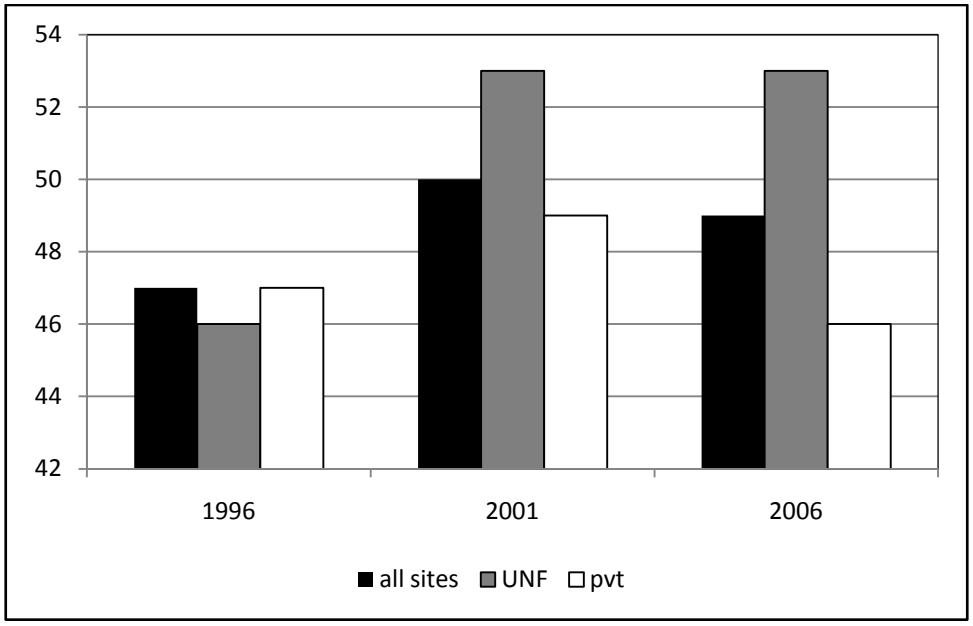
Mean NCIBI values are notably higher from sites within the Uwharrie NF than across the Yadkin-Pee Dee River basin, and have remained relatively stable since 1996 (Figure 3). Use of mean NCIBI values can result in odd values, which cannot be calculated for an individual site,

but can be the result of statistical analysis over one or more sites. This does not relieve site-specific changes in fish community composition as a result of land use changes or land management (i.e. there are individual streams rating fair or lower in several parts of the basin), but rather reflects the overall health of the landscape. Fish community structure and health across the Uwharrie NF does not differ significantly from established "historical" conditions, while values across the basin are slightly lower, but not trending towards loss of fish community structure or function.

A closer look at NCIBI values reveals that fish community health is stable or increasing in all subbasins containing parts of the Forest, except subbasin 08 (Badin Lake area) (NCDENR 2002, NCDENR 2006). This indicates that fish community structure is, for the most part, stable across the lower Yadkin River basin. Within the Badin Lake area, fewer fish species are present than the "typical" warmwater Piedmont fish community, and that community is dominated by more tolerant species such as bluehead chub and green sunfish, resulting in lower NCIBI ratings. It is important to note that no streams within the Uwharrie NF received an NCIBI rating lower than good. Maintaining an NCIBI rating of good or excellent for forest streams is the desired condition.

Maintenance of high quality, high integrity fish communities across the Uwharrie NF will ensure the continued existence of stable warmwater fish communities within the Yadkin-Pee Dee River basin. However, because of the zoogeography of native fish, maintenance of healthy, stable fish communities across the Forest will not ultimately guarantee the continued existence of all fish species occurring within the Yadkin-Pee Dee River basin.

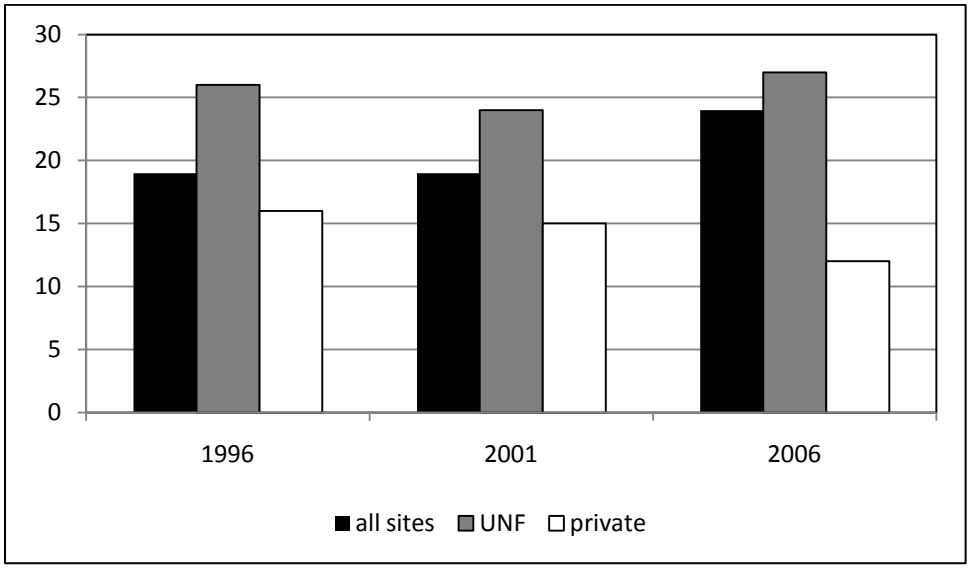
Figure 3. Mean NCIBI values from streams within subbasins of the Yadkin-Pee Dee River basin on or adjacent to the Uwharrie NF.



4.3.2 Benthic Community Structure

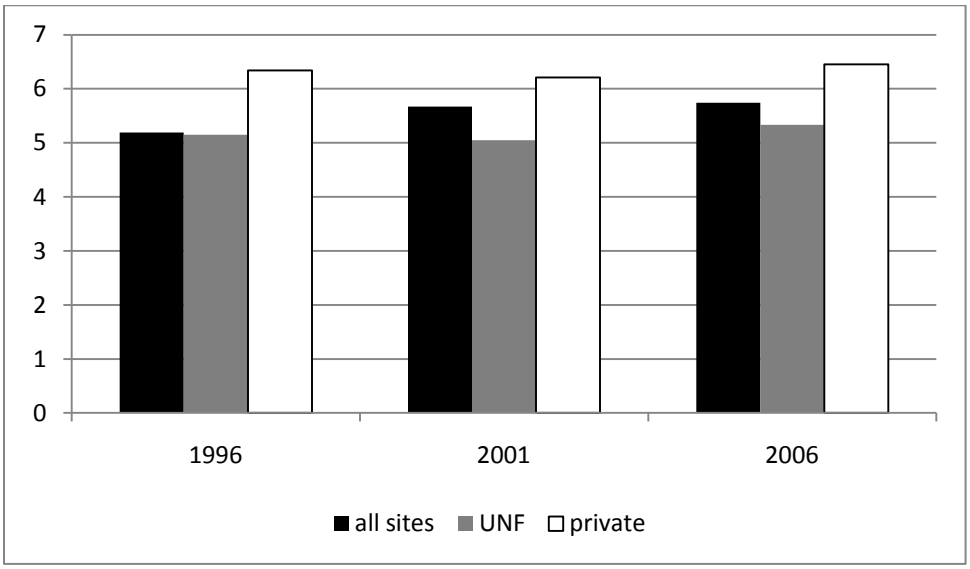
Mean EPT values are higher on sites within the Uwharrie NF (average rating of good) than across the entire Yadkin-Pee Dee River basin (average rating of good-fair), and have remained relatively stable across the basin since 1996 (Figure 4). It is important to note that no streams within the Uwharrie NF received an EPT rating lower than good, except within subbasin 08 (Badin Lake area). Streams in this area generally support fewer benthic organisms overall, but even more notable is the absence of many EPT species all together. This is directly related to habitat quality within the Badin Lake area. Maintaining an EPT rating of good or excellent for Uwharrie NF streams is the desired condition.

Figure 4. Mean EPT values from streams within subbasins of the Yadkin-Pee Dee River basin on or adjacent to the Uwharrie National Forest.



Mean NCBI values are slightly lower on sites within the Uwharrie NF (average rating of GOOD-EXCELLENT) compared to sites across the entire Yadkin-Pee Dee River basin, and have remained relatively stable across the basin since 1996 (Figure 5). It is important to note that no streams within the Uwharrie NF received an NCBI rating lower than good, except within subbasin 08 (Badin Lake area). This mirrors analysis of EPT ratings across the forest and basin. This is directly related to habitat quality within the Badin Lake area. Maintaining an NCBI rating of good or excellent for Uwharrie NF streams is the desired condition.

Figure 5. Mean NBCI values from streams within subbasins of the Yadkin-Pee Dee River basin on or adjacent to the Uwharrie NF.



Synopsis

Overall, stream community, health, and function have been, and remain, good across the Uwharrie NF. Indices representing both fish and aquatic invertebrate communities show slightly (but not statistically significant) higher health and function within streams on the Uwharrie NF when compared to streams across the basin. In general, aquatic resources within the lower Yadkin-Pee Dee River basin are in good condition. The viability of aquatic ecosystems is not in jeopardy across these areas.

The Yadkin-Pee Dee Basinwide Assessment Report outlines specific areas where declines in stream community health and function have occurred across the basin, and in many cases, identifies specific activities causing these declines. Habitat quality has been compromised by sediment or chemical pollutants in several parts of the basin, with one of these critical areas occurring in the Badin Lake area of the Uwharrie NF (subbasin 08). In this area biological indices reflect the loss of species, or groups of species, which are considered indicators of good stream health (e.g. darters, EPT species).

Lower biological index values in the Badin Lake area can be partly attributed to high levels of recreational use, particularly those uses relying on the dense trail network. Proximity of a trail to water is related to the potential for chemical impacts and stream sedimentation. However, because vegetated buffers are effective at mitigating stream impacts, proximity may not be a reliable indicator of potential impacts in the absence of hydrologic connectivity data. Points where there is no vegetated buffer and hydrologic connectivity is evident include trail/stream intersections (i.e. trail crossings) and locations where the trail and stream overlap. Hydrologic connectivity is water-mediated transfer of matter, energy, and/or organisms within or between elements of the hydrologic cycle (Pringle 2001). In general terms, it relates to the ease of movement, or rates of exchange, with which water, energy, nutrients, and organisms pass from one area to another. Human activities such as construction of roads and trails or degradation of stream banks and meadows can alter or disrupt hydrologic connectivity. This disruption can

negatively affect nutrient availability to organisms, limit the availability of suitable habitat, change the pattern of streamflow resulting in different hydrologic processes, and result in the decline of riparian or aquatic dependent species (SNFPA 2004).

A 2010 survey of the trail network within the Badin Lake area identified 187 points of potential hydrologic connectivity, including trail crossings. Approximately 70 of these points (37%) are associated with the designated trail system. Use of these trails includes foot, horse, bike, and/or off-road vehicle use. Hydrologic connectivity at these crossings is generally "improved" meaning that there is a design in place to minimize stream impacts when properly maintained.

The remaining approximately 117 points of hydrologic connectivity (63%) are located on non-system trails, and have no design or structure in place to minimize stream impacts. These areas are often point sources of chemical impact and stream sedimentation. Of these crossings, approximately 93 (79%) are associated with cross-country horse travel (Badin Area Trails Assessment 2011).

While Alternatives A and C of the proposed plan allow unrestricted travel for mountain bikers and horseback riders, Alternative B would reduce hydrologic connectivity through the designation of a trail system for bikers and horseback riders. Without mitigation of stream sedimentation coming from trail users, declines in stream health would continue in the Badin Lake area, jeopardizing the sustainability of healthy aquatic ecosystems.

4.4 Recommended Forest Plan Components

Based on the evaluation of spatial scales, existing conditions, range of variability, condition of ecological characteristics, and risks, the following plan components are recommended to be part of the framework that would provide for characteristics of aquatic ecosystem diversity on the Uwharrie NF:

Recommended Desired Conditions:

- Aquatic ecosystems are diverse, with properly functioning streams providing high quality habitat for all native aquatic species, including non-game species.
- Fish are plentiful in streams and lakes. Water is clean and clear of trash and pollutants, and there is in-stream habitat for fish to hide, spawn, and find food.
- Road crossings allow for passage of fish and other aquatic animals up and down stream corridors except when there is a need to prevent non-native invasive species from moving upstream.
- Non-native aquatic species do not threaten national forest lakes, rivers, or streams.
- Native fresh water mussel communities are diverse and represented by multiple age-classes, with signs of reproduction evident. Appropriate habitats support sustainable populations of native freshwater mussels, including those that are federally-listed, regionally-sensitive, or locally rare. Non-native mussel species are not negatively impacting native species.
- Streamsides are dominated by native riparian vegetation, including trees capable of adding large woody debris for hydrologic stability and instream habitat. Aquatic habitat

is diverse and relatively free of unnatural sediments. Pool habitats are frequent and provide cover for many species of fish. Vegetated streamside areas are effective in providing shading to the streams and filtering sediments.

- Stream channels are connected to their floodplains so that high streamflow events can be processed through the ecosystem without creating gullies or eroding stream banks. Man-made dikes and deposition are absent, allowing the stream to flood out of its banks and onto the floodplain in a natural way.
- Stream channels degraded by historic mining are exhibiting improved biological and hydrological conditions.
- Bogs and seeps are maintained or increasing their size through natural hydrologic processes and fire regimes.

Recommended objectives:

- Over the planning period, 1,500 linear feet of aquatic habitat are restored on sites with North Carolina Index of Biotic Integrity (NCIBI) and North Carolina Ephemeroptera, Plecoptera, Tricoptera (NCEPT) ratings below "good." This work entails establishing cover such as by adding large wood or boulders for in-stream habitat, establishing stream-shading riparian vegetation, eliminating sediment sources, etc.
- Over the planning period, 1,500 linear feet of unstable and/or poorly functioning stream channel are restored (in addition to the aquatic habitat restoration under Objective 1).
- Over the planning period, native freshwater mussel populations are augmented in one to three appropriate aquatic systems. These reintroductions will include Federally-listed, regionally-sensitive, or locally rare species.
- During the planning period approximately 10 road or trail crossings are reconstructed to improve water quality.

Recommended standards:

- Except for existing (as of 2010) loblolly and shortleaf plantations, the streamside forest is unsuitable for timber production (100 feet either side of perennial streams and alluvial forest).
- Best management practices shall be used to avoid impacts to water quality, soil productivity, and stream channel structure.
- When a ground disturbing project could potentially result in direct delivery of sediment to streams, erosion control measures shall be employed.
- All bare soil shall be seeded and/or mulched at the time of stream crossing construction.
- Aquatic species management activities shall not introduce or stock non-native aquatic organisms.

Recommended guidelines:

- When thinning in pine plantations in the Streamside Forest, entries should only be every 35 to 40 years, to reduce disturbance.
- Major soil disturbances that expose the soil surface or substantially alter soil properties such as temporary road, skid trails, landings, and rutting should not occupy more than 15 percent of forest vegetation management treatment areas except for watershed improvements, restoration of species, or to correct soil and water problems.
- Vegetation cutting and use of mechanized ground disturbing equipment should stay more than 33 feet away from perennial streams unless such activity is needed for riparian wildlife habitat, stream channel stability, to restore riparian vegetation, or to provide access for recreation or stream crossings. Vegetation cutting and ground disturbing equipment should stay more than 50 feet away from perennial streams (with the exceptions listed above) if the following conditions apply: steep slopes adjacent to the stream; highly erodible soils; soil areas with little or minimal groundcover near the waterbody. Refer to North Carolina Division of Forest Resources *Forestry Best Management Practices Manual* for additional guidance.
- Use of mechanized ground disturbing equipment should stay more than 33 feet away from intermittent streams. Refer to North Carolina Division of Forest Resources *Forestry Best Management Practices Manual* for additional guidance.
- When trees are felled, generally, tree portions that fall within 33 feet of a perennial stream should remain in place unless their placement is disrupting channel stability, is a public safety hazard, or if removal would benefit the riparian condition.
- New or re-routed roads or **motorized** trails should be located at least 100 feet from perennial streams and at least 50 feet from intermittent streams, except for designated stream crossings.
- New or re-routed **non-motorized** trails should be located at least 33 feet from perennial and intermittent streams, except for designated stream crossings and horse watering sites.
- Where roads or trails cross streams, crossings should be at right angles where possible.
- The design of stream crossings should first try to simulate the natural stream bottom through use of a bottomless culvert, bridge or other spanning structure. If this isn't feasible, crossings should incorporate the appropriate outlet drops and culvert slopes.
- Stream restoration designs should utilize the natural stream channel whenever possible.
- Stream restoration activities should include provisions to maintain or enhance existing ephemeral pools in the associated streamside forest.
- When selecting aquatic habitat for restoration the following criteria should be used:
- The condition and vulnerability of the watershed where the site is located - fair or poor sites within otherwise good condition, high vulnerability watersheds should be given first priority.
- Degree of improvement needed to achieve "good" condition - sites rated "fair" should be restored before sites rated "poor."

5.0 Species Diversity

The lower Yadkin-Pee Dee River Basin contains suitable habitat for sixty-nine rare aquatic species (Appendix A1). Of these 69 species, six are federally-listed: two freshwater fish, the Cape Fear shiner (*Notropis mekistocholas*) and the shortnose sturgeon (*Acipenser brevirostrum*), and four freshwater mussels, the dwarf wedgemussel (*Alasmidonta heterodon*), Tar River spinymussel (*Elliptio steinstansana*), Carolina heelsplitter (*Lasmigona decorata*), and the James spinymussel (*Pleurobema collina*). Of these species, only the Cape Fear shiner is known to occur adjacent to, but not on, the Uwharrie NF. There is suitable habitat for the dwarf wedgemussel, Tar River spinymussel, and James spinymussel across the Uwharrie NF; however, extensive surveys of freshwater mussel communities throughout the Yadkin river basin over the last 15-20 years have not documented the presence of these species on or adjacent to the forest. The upstream-most documentation of the ranges of the remaining two species, the shortnose sturgeon and Carolina heelsplitter, fall well downstream of the Uwharrie NF. The shortnose sturgeon requires large river habitats, which are not present on the Uwharrie NF. However, several sites on the forest are being studied as suitable species' restoration areas for the Carolina heelsplitter. It is possible that the species could occupy Uwharrie NF waters as experimental populations during the life of the revised forest plan.

Three federally-listed species, the Cape Fear shiner (*Notropis mekistocholas*), dwarf wedgemussel (*Alasmidonta heterodon*), and Carolina heelsplitter (*Lasmigona decorata*) will be evaluated further in the Uwharrie NF aquatic species diversity analysis since there is suitable habitat for these species on the forest. Implementation of Alternatives A, B, or C would not affect the viability of the Cape Fear shiner and dwarf wedgemussel because, while there is suitable habitat present, neither of these species is known to occur on the Uwharrie NF. It is possible, that with implementation of Alternatives B or C, the Carolina heelsplitter could be reintroduced to habitats on or adjacent to the Uwharrie NF, thereby increasing the viability of the species.

Of the remaining 63 rare aquatic species, 13 are listed as Sensitive by the regional forester. All 13 of these species are known to occur on or adjacent to the Uwharrie NF. Fifty aquatic species are listed as Locally Rare by the National Forests in North Carolina (Global status of G1, G2, or G3). Of these species, 35 are known to occur on or adjacent to the Uwharrie NF, or there is suitable habitat present on the Uwharrie NF.

Appendix A1 summarizes rare species addressed in the Uwharrie NF's aquatic species diversity analysis. This list includes three federally-listed (PET) aquatic species, thirteen regionally-sensitive (S), and 35 locally rare (LR) aquatic species. Smallmouth bass (*Micropterus dolomieu*) and largemouth bass (*Micropterus salmoides*) are in high demand by the angling public, therefore these species are also included in the analysis.

Table 5 summarizes the aquatic species listed in Appendix A1 by species group. It is reasonable to assume that these groups of species would respond similarly to subtle changes in the environment, such as landscape restoration activities proposed in Alternatives B and C. Individual species needs would be sufficiently addressed at the aquatic ecosystem level and do not require individual consideration.

Table 5. Summary of aquatic species addressed for species diversity.

Species Group	Number of Species
Crayfish	2
Fish	14
Freshwater Mollusks	15
Aquatic Insects	22

5.1 Maintaining Aquatic Species Sustainability and Diversity

Proposed forest plan Alternatives B and C include several measures to protect and conserve aquatic resources, including the recognition of streamside forests consisting of approximately 100 feet on either side of all perennial streams, plus any alluvial forest types known to occur on the Uwharrie NF. Timber production within these areas would not be allowed, and any timber harvest (or other vegetation management) would be for the benefit of the streamside forest, including the streams. Other forest management activities may occur within these areas, and potential site-specific effects on aquatic resources should be considered during project development.

Maintenance of forested habitats and intact riparian areas would maintain quality habitat for all aquatic species. Restoration of native forest communities, such as longleaf pine and oak woodlands would provide subtle habitat improvements for aquatic species, but the largest effect would be from the maintenance of intact, functioning stream and riparian systems. Restoration of degraded stream habitats (largely through sedimentation, but also loss of pool habitat and functioning riparian areas) would, over the life of the plan, improve habitats for crayfish species by returning stream conditions to a more stable, functioning condition. Implementation of Alternatives B or C would result in stable to increasing (as more survey and habitat information becomes available through monitoring and project-specific inventories) populations of all aquatic species. This would provide for sustainability at the local (i.e. forest) scale. Additionally, persistent and consistent implementation of North Carolina Best Management Practices and other buffer requirements (and enforcement of these requirements) across the basin would help ensure the sustainability of aquatic species across the landscape.

The lower Yadkin-Pee Dee River basin contains six Significant Aquatic Habitats (SAHs), as identified by the North Carolina Natural Heritage Program (NCNHP) (NCDENR 2002 and NCDENR 2006). Parts of two of these SAHs are located within the Uwharrie NF (Little River/Densons Creek and Uwharrie River/Barnes Creek/Caraway Creek). These areas support known populations of 17 (25%) of the 69 rare aquatic species with suitable habitat across the Uwharrie NF. Six additional rare aquatic species that do not receive some level of protection by the forest occur within one or more of these SAHs. Although current status and rank of these species do not warrant federal, state, or forest listing, it is likely that based on recent expansions in biological knowledge about these species, future revisions of these ranks will include one or more of these species as locally rare.

Table 6. Significant aquatic habitats within the lower Yadkin-Pee Dee River basin and rare species occurring in the area.

Group	Status	Common Name	Goose/ Duck	Lanes	Little/ Densons	Lower Pee Dee	South Fk Crooked	Uwh/Barnes/ Caraway
Fish	E	Shortnose sturgeon				x		
Mollusk	E	Carolina heelsplitter	x					(x)
Fish	S	Carolina darter		x			x	x
Mussel	S	Roanoke slabshell				x		x
Mussel	S	Atlantic pigtoe	x	x				x
Mussel	S	Savannah lilliput	x		x			x
Crayfish	LR	Greensboro burrowing crayfish						x
Fish	LR	highfin carpsucker				x		
Fish	LR	Carolina redhorse			x	x		
Mussel	LR	Carolina elktoe			x			x
Mussel	LR	triangle floater			x			
Mussel	LR	yellow lampmussel			x	x		
Mussel	LR	Carolina fatmucket			x	x		x
Mussel	LR	squawfoot	x	x	x	x		x
Mussel	LR	notched rainbow	x		x			x
Mussel	LR	Eastern creekshell	x		x			x
Mussel	LR	Carolina creekshell	x	x	x	x	x	x
Fish	other	*Cyprinella sp. 1*				x		
Fish	other	robust redhorse				x		
Mussel	other	*Alasmidonta sp. 2*			x			x
Mussel	other	alewife floater				x		
Mussel	other	Eastern pondmussel				x		
Snail	other	a valvatid snail						x

Substantial portions of the Little River/Densons Creek and Uwharrie River/Barnes Creek/Caraway Creek SAHs flow through the Uwharrie NF. These Significant Aquatic Habitats are critical to maintaining aquatic species diversity across the Forest, and within the lower Yadkin-Pee Dee River Basin. For example, of the 23 rare aquatic species occurring within SAHs, 16 (70%) are known to occur within the Little River/Densons Creek and/or Uwharrie River/Barnes Creek/Caraway Creek SAHs.The Carolina heelsplitter may be reintroduced into the Uwharrie River/Barnes Creek/Caraway Creek SAH.

Streams and rivers of the Uwharrie NF and vicinity (Montgomery and southwestern Randolph Counties) host large numbers of rare mollusks, as well as the Carolina darter, Carolina redhorse, and Greensboro burrowing crayfish. Whether these streams were originally more diverse than other streams in the basin is open to speculation, but it is likely that species have survived in these waters due to the relatively undeveloped nature of forest lands and resource protection offered by national forest management practices.

As population growth increases and urban development expands, the Significant Aquatic Habitats supporting these species may become the last strongholds for some aquatic species. Therefore, it is vitally important that any population of these species on or adjacent to the Uwharrie NF be protected from loss of sustainability and diversity.

All alternatives proposed for the revised Forest Plan (A, B, and C) would maintain aquatic species diversity and community stability as well as provide for individual species viability over the life of the plan. Alternatives B and C propose additional objectives for restoration of aquatic habitat which would effectively improve habitat conditions for aquatic wildlife. Alternatives B and C also propose reintroduction of the Carolina heelsplitter to the Uwharrie NF which would improve aquatic species diversity and freshwater mussel community stability.

Additionally, Alternative B, through limitations on cross-country horse travel, would reduce sedimentation of streams, which would improve aquatic community stability and function, particularly in the Badin Lake area.

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Appendix A1. Rare aquatic species with suitable habitat within the lower Yadkin-Pee Dee Basin (based on NCNHP 2008). This list is current at the time of Plan approval, and is updated on a two- or three-year cycle. The most current list should be referenced throughout Plan implementation.

Group	Scientific Name	Common Name	NC Status	US Status	NC Rank	Global Rank	Rationale for Exclusion
FEDERALLY-LISTED (PET)							
Freshwater fish	*Acipenser brevirostrum*	shortnose sturgeon	E	E	S1	G3	range does not include Forest
Freshwater fish	***Notropis mekistocholas***	**Cape Fear shiner**	**E**	**E**	**S1**	**G1**	
Mollusk: freshwater bivalve	***Alasmidonta heterodon***	**dwarf wedgemussel**	**E**	**E**	**S1**	**G1G2**	
Mollusk: freshwater bivalve	*Elliptio steinstansana*	Tar River spinymussel	E	E	S1	G1	range does not include Forest
Mollusk: freshwater bivalve	***Lasmigona decorata***	**Carolina heelsplitter**	**E**	**E**	**S1**	**G1**	
Mollusk: freshwater bivalve	*Pleurobema collina*	James spinymussel	E	E	S1	G1	endemic to area not on Forest
REGIONAL FORESTER-LISTED (S)							
Freshwater fish	***Etheostoma collis pop. 1***	**Carolina darter**	**SC**	**FSC**	**S3**	**G3T3Q**	
Freshwater fish	***Etheostoma mariae***	**pinewoods darter**	**SC**	**FSC**	**S3**	**G3**	
Freshwater fish	***Etheostoma vulneratum***	**Wounded darter**	**SC**	**FSC**	**S1**	**G3**	
Freshwater fish	***Semotilus lumbee***	**sandhills chub**	**SC**	**FSC**	**S3**	**G3**	
Insect: dragonfly	***Gomphus diminutus***	**diminutive clubtail**	**W2**		**S3S4**	**G3**	
Insect: dragonfly	***Gomphus septima***	**Septima's clubtail**	**SR**	**FSC**	**S1S2**	**G2**	
Insect: dragonfly	***Macromia margarita***	**mountain river cruiser**	**SR**	**FSC**	**S2S3**	**G3**	
Mollusk: freshwater	***Alasmidonta***	**brook floater**	**E**	**FSC**	**S1**	**G3**	

Group	Scientific Name	Common Name	NC Status	US Status	NC Rank	Global Rank	Rationale for Exclusion
bivalve	***varicosa***						
Mollusk: freshwater bivalve	***Elliptio roanokensis***	**Roanoke slabshell**	**T**		**S1**	**G2**	
Mollusk: freshwater bivalve	***Fusconaia masoni***	**Atlantic pigtoe**	**E**	**FSC**	**S1**	**G2**	
Mollusk: freshwater bivalve	***Lasmigona subviridis***	**green floater**	**E**	**FSC**	**S1**	**G3**	
Mollusk: freshwater bivalve	***Toxolasma pullus***	**Savannah Lilliput**	**E**	**FSC**	**S1**	**G1G2**	
Mollusk: freshwater bivalve	***Villosa vaughaniana***	**Carolina creekshell**	**E**	**FSC**	**S1**	**G2**	
		FOREST-LISTED (Locally Rare)					
Freshwater Fish	***Carpiodes sp. cf. cyprinus***	**a carpsucker**	**SR**		**S2**	**GNR**	
Freshwater Fish	***Carpiodes sp. cf. velifer***	**Atlantic Highfin Carpsucker**	**SC**		**S1**	**GNR**	
Freshwater Fish	*Cottus caeruleomentum*	Blue Ridge Sculpin	SC		S1	G4	range does not include Forest
Freshwater Fish	***Lampetra aepyptera***	**Least Brook Lamprey**	**T**		**S2**	**G5**	
Freshwater Fish	***Moxostoma ariommum***	**Bigeye Jumprock**	**T**		**S1**	**G4**	
Freshwater Fish	***Moxostoma robustum***	**Robust Redhorse**	**E**	**FSC**	**S1**	**G1**	
Freshwater Fish	***Moxostoma sp. 3***	**Carolina Redhorse**	**T**	**FSC**	**S1**	**G1G2Q**	
Freshwater Fish	***Notropis volucellus***	**Mimic Shiner**	**SR**		**S2**	**G5**	
Freshwater Fish	*Noturus gilberti*	Orangefin Madtom	E	FSC	S1	G2	range does not include Forest
Freshwater Fish	*Thoburnia hamiltoni*	Rustyside Sucker	E	FSC	S1	G3	range does not include Forest

Group	Scientific Name	Common Name	NC Status	US Status	NC Rank	Global Rank	Rationale for Exclusion
Mollusk: Freshwater Bivalve	***Alasmidonta sp. 2***	**a bivalve (Uwharries region)**	**SR**		**S1?**	**GNR**	
Mollusk: Freshwater Bivalve	***Alasmidonta undulata***	**Triangle Floater**	**T**		**S2**	**G4**	
Mollusk: Freshwater Bivalve	***Fusconaia subrotunda***	**Long-solid**	**SR**		**S1**	**G3**	
Mollusk: Freshwater Bivalve	***Lampsilis cariosa***	**Yellow Lampmussel**	**E**	**FSC**	**S1**	**G3G4**	
Mollusk: Freshwater Bivalve	***Lampsilis radiata***	**Eastern Lampmussel**	**T**		**S1S2**	**G5**	
Mollusk: Freshwater Bivalve	***Strophitus undulatus***	**Creeper**	**T**		**S2**	**G5**	
Mollusk: Freshwater Gastropod	***Somatogyrus virginicus***	**Panhandle Pebblesnail**	**SR**	**FSC**	**S1?**	**G2G3**	
Crustacean	***Cambarus catagius***	**Greensboro Burrowing Crayfish**	**SC**		**S2**	**G3**	
Crustacean	***Cambarus hystricosus***	**Sandhills Spiny Crayfish**	**SR**		**S2**	**G2**	
Insect: Mayfly	*Asioplax dolani*	a mayfly	SR		S2	G4	range does not include Forest
Insect: Mayfly	***Baetisca becki***	**a mayfly**	**SR**		**S1**	**G2G3**	
Insect: Mayfly	***Baetpous trishae***	**a mayfly**	**SR**		**S1**	**G1G2**	
Insect: Mayfly	*Cercobrachys etowah*	a caenid mayfly	SR		S2	G4	range does not include Forest
Insect: Mayfly	*Choroterpes basalis*	a mayfly	SR		S2	G5	range does not include Forest
Insect: Mayfly	***Homoeoneuria cahabensis***	**Cahaba Sand-filtering Mayfly**	**SR**		**S2**	**G2G3**	
Insect: Mayfly	***Macdunnoa brunnea***	**a mayfly**	**SR**		**S2**	**G3G4**	
Insect: Mayfly	***Plauditus cestus***	**a mayfly**	**SR**		**S1**	**G5**	

Group	Scientific Name	Common Name	NC Status	US Status	NC Rank	Global Rank	Rationale for Exclusion
Insect: Mayfly	***Pseudiron centralis***	**White Sand-river Mayfly**	**SR**		**S2**	**G5**	
Insect: Mayfly	*Tortopus puella*	a mayfly	SR		S1	G4	range does not include Forest
Insect: Stonefly	*Haploperla fleeki*	a stonefly	SR		S1	GNR	endemic to area not on Forest
Insect: Stonefly	*Hydroperla phormidia*	a stonefly	SR		S2	G3	range does not include Forest
Insect: Stonefly	***Isoperla sp. 1***	**a stonefly**	**SR**		**S1**	**GNR**	
Insect: Stonefly	*Perlesta bjostadi*	a stonefly	SR		S1	G1	endemic to area not on Forest
Insect: Stonefly	*Perlesta leathermani*	a stonefly	SR		S1	G1	endemic to area not on Forest
Insect: Stonefly	*Perlesta sp. 1*	a stonefly	SR		S2	GNR	endemic to area not on Forest
Insect: Stonefly	*Perlesta sp. 3*	a stonefly	SR		S1	GNR	endemic to area not on Forest
Insect: Stonefly	***Pteronarcy comstocki***	**Spiny Salmonfly**	**SR**		**S2**	**GNR**	
Insect: Caddisfly	***Beraea gorteba***	**a caddisfly**	**SR**		**S2**	**G1G2**	
Insect: Caddisfly	***Ceraclea cancellata***	**a caddisfly**	**SR**		**S2**	**G5**	
Insect: Caddisfly	***Ceraclea joannae***	**a caddisfly**	**SR**		**S1**	**G1**	
Insect: Caddisfly	*Ceraclea mentiea*	a caddisfly	SR		S2	G5	range does not include Forest
Insect: Caddisfly	***Dibusa angata***	**a caddisfly**	**SR**		**S2**	**G5**	
Insect: Caddisfly	***Hydropsyche bassi***	**a caddisfly**	**SR**		**S2**	**GNR**	
Insect: Caddisfly	*Hydroptila lloganae*	Llogan's Vari-colored Microcaddisfly	SR		S2	G3	range does not include Forest
Insect: Dragonfly	***Gomphus***	**Brimley's Clubtail**	**SR**		**S1S2**	**G4T3**	

Group	Scientific Name	Common Name	NC Status	US Status	NC Rank	Global Rank	Rationale for Exclusion
	cavillaris brimleyi						
Insect: Dragonfly	***Gomphus consanguis***	**Cherokee Clubtail**	**SR**	**FSC**	**S1S2**	**G2G3**	
Insect: Dragonfly	***Gomphus fraternus***	**Midland Clubtail**	**SR**		**S1?**	**G5**	
Insect: Dragonfly	***Gomphus quadricolor***	**Rapids Clubtail**	**SR**		**S1?**	**G3G4**	
Insect: Dragonfly	***Gomphus ventricosus***	**Skillet Clubtail**	**SR**		**S1S2**	**G3**	
Insect: Dragonfly	***Progomphus bellei***	**Belle's Sanddragon**	**SR**	**FSC**	**S1**	**G3**	

NFsNC list updated
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