Eastern North Carolina Listed Aquatic Species

(Tar, Neuse, Upper Cape Fear, Roanoke, and Yadkin-Pee Dee River Basin Species)

Atlantic Pigtoe (*Fusconaia masoni)*
Dwarf Wedgemussel (*Alasmidonta heterodon)*
Tar River Spinymussel (*Parvaspina steinstansana*)
Yellow Lance (*Elliptio lanceolata*)
James Spinymussel (*Parvaspina collina*)
Green Floater (*Lasmigona subviridis*)
Roanoke Logperch (*Percina rex*)
Cape Fear Shiner (*Notropis mekistocholas*)
Carolina Madtom (*Noturus furiosus*)
Neuse River Waterdog (*Necturus lewisi*)

I. Species Summary

All 10 aquatic species listed or proposed for listing within the Tar River, Neuse River, Upper Cape Fear River, Roanoke River, and Yadkin-Pee Dee River basins in the work area of the U.S. Fish and Wildlife Service's (USFWS) Raleigh, North Carolina Ecological Services Field Office (**Figure 1**) have been combined into one Standard Local Operating Procedures for Endangered Species (SLOPES). The USFWS species profiles and ecological summary for each species discussed in this document can be found by accessing the links provided in **Table 1**.

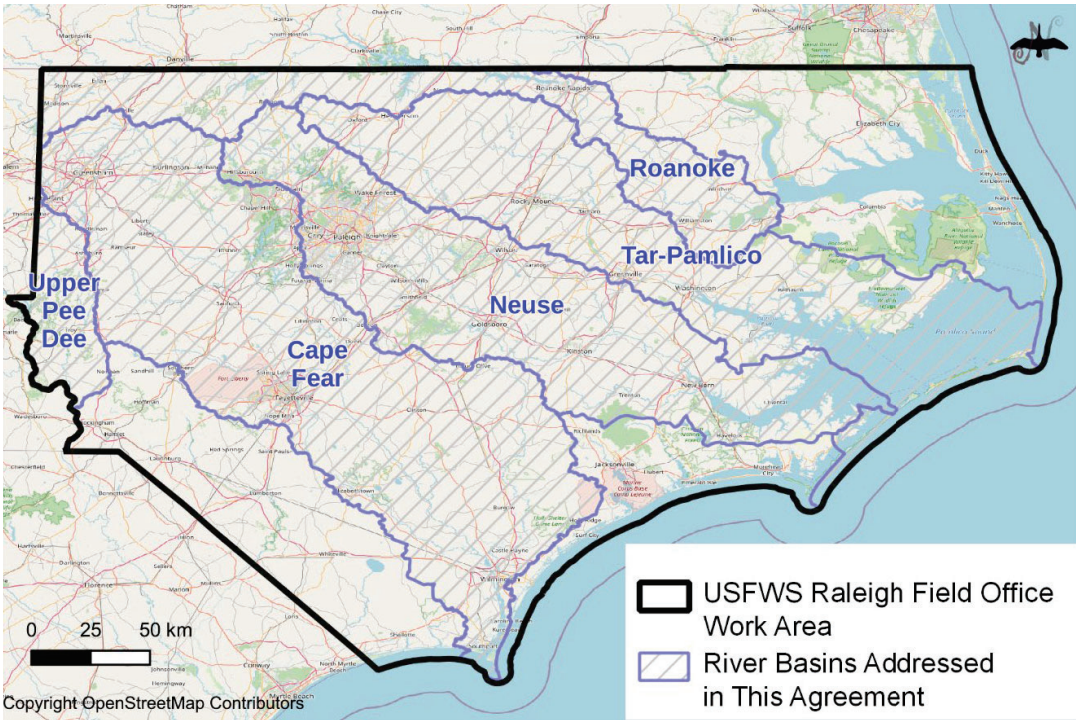


Figure 1. *Tar, Neuse, Upper Cape Fear, Roanoke, and Yadkin-Pee Dee River basins, within the work area of the USFWS' Raleigh Ecological Services Field Office (USFWS 2023)*

Table 1. *Federally listed and proposed aquatic species listed in Eastern North Carolina*

Common Name	Latin Name	Status	Year Listed	Year of Recovery Plan	Year of 5-Year Review	Species Status Assessment	Year of Critical Habitat Designation	Species Profile Location
1. Atlantic Pigtoe	*Fusconaia masoni*	T	2021	N/A	N/A	2021	2021	https://ecos.fws.gov/ecp/species/5164
2. Dwarf Wedgemussel	*Alasmidonta heterodon*	E	1990	1993	2019	N/A	N/A	https://ecos.fws.gov/ecp/species/784
3. Tar River Spinymussel	*Parvaspina steinstansana*	E	1985	1992	2020	N/A	N/A	https://ecos.fws.gov/ecp/species/1392
4. Yellow Lance	*Elliptio lanceolata*	T	2018	2023	N/A	2019	2021	https://ecos.fws.gov/ecp/species/4511
5. James Spinymussel	*Parvaspina collina*	E	1988	1990	2022	N/A	N/A	https://ecos.fws.gov/ecp/species/2212
6. Green Floater	*Lasmigona subviridis*	PT	Proposed 2023	N/A	N/A	2021	Proposed 2023	https://ecos.fws.gov/ecp/species/7541
7. Roanoke Logperch	*Percina rex*	E	1989	1992	2022	2022	N/A	https://ecos.fws.gov/ecp/species/1134
8. Cape Fear Shiner	*Notropis mekistocholas*	E	1987	1988	2017	2022	1987	https://ecos.fws.gov/ecp/species/6063
9. Carolina Madtom	*Noturus furiosus*	E	2021	2021	N/A	2021	2021	https://ecos.fws.gov/ecp/species/528
10. Neuse River Waterdog	*Necturus lewisi*	T	2021	2021	N/A	2021	2021	https://ecos.fws.gov/ecp/species/528

Note: T=Threatened, PT=Proposed Threatened, E = Endangered

Critical Habitat

Critical habitat is a term specific to the Endangered Species Act (ESA). Critical habitats are specific geographic areas that are designated by rulemaking under the ESA; they contain features essential to the conservation of an endangered or threatened species, and these areas may require special management and protection. This designation requires federal agencies to ensure that actions they plan to undertake, fund, or authorize do not destroy or adversely modify that habitat. Not all species have designated critical habitat. It is important to recognize that species may and do occur outside of designated critical habitat (e.g., those species for which critical habitat has not been designated, occurrences discovered after the critical habitat was designated, or in cases where only some areas occupied by a species have been designated as critical habitat). Suitable habitat for a species (described in **Section III** below) may occur in many locations outside of designated critical habitat areas. *Individuals* of a species may be present in suitable habitat, while designated critical habitat is essential to conserve the *species*.

II. Biological Information

Atlantic Pigtoe

The Atlantic Pigtoe is a freshwater mussel with a rhombus shape, like that of a pig's hoof/toe with a distinct posterior ridge. The outer surface of the shell is yellow to dark brown while the inner layer is iridescent blue to salmon, white, or orange (**Figure 2**). Although larger specimens exist, the Atlantic Pigtoe rarely exceeds 2 inches (5.1 centimeters [cm]) in length. Young individuals may have greenish rays across the entire shell surface. When collected fresh, the nacre tends to be salmon colored or iridescent (USFWS 2021a).

Critical habitat has been designated for Atlantic Pigtoe (86 FR 64000; November 16, 2021). The physical or biological features essential to the Atlantic Pigtoe are: (1) Suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (i.e., channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater mussel and native fish (such as stable riffle-run-pool habitats that provide flow refuges consisting of silt-free gravel and coarse sand substrates). (2) Adequate flows, or a hydrologic flow regime (which includes the severity, frequency, duration, and seasonality of discharge over time), necessary to maintain benthic habitats where the species is found and to maintain connectivity of streams with the floodplain, allowing the exchange of nutrients and sediment for maintenance of the mussel's and fish host's habitat, food availability, spawning habitat for native fishes, and the ability for newly transformed juveniles to settle and become established in their habitats. (3) Water and sediment quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages. (4) The presence and abundance of fish hosts necessary for recruitment of the Atlantic pigtoe.

***Figure 2**. Atlantic Pigtoe (NCWRC)*

Dwarf Wedgemussel

The Dwarf Wedgemussel is a freshwater mussel. It is a small bivalve, rarely exceeding 1.5 inches (3.8 cm) in length (USFWS 1993). Young shells are usually greenish brown with green rays (**Figure 3**). As the animal ages, the shell color becomes obscured by diatoms or mineral deposits and appears black or brown. The shell is thin but thickens somewhat with age, especially toward the anterior end. The anterior is rounded while the posterior end is angular, forming a point near the posterior-ventral margin. The nacre is bluish-white, appearing whiter in the thicker anterior end. The most distinctive shell character of the Dwarf Wedgemussel is the arrangement of the lateral teeth. There are two lateral teeth in the right valve and one in the left valve. The incurrent and excurrent apertures and their associated papillae are usually white. The foot and other organs are also white. Maximum age for the Dwarf Wedgemussel is around 12 years. The species is a long-term breeder; females become gravid in the early fall and glochidia are released by mid-spring. The Tessellated Darter (*Etheostoma olmstedi*), Johnny Darter (*E. nigrum*), and Mottled Sculpin (*Cottus bairdii*) have been identified as hosts for the Dwarf Wedgemussel (USFWS 2013, 2019a).

Critical Habitat

Critical habitat has not been designated for Dwarf Wedgemussel; therefore, the critical habitat couplet in the determination key (**Appendix B**) is not applicable to this species. Refer to the habitat descriptions for

this species (**Section III**) to assist in determining whether a project is located in, near, or upstream of suitable habitats for Dwarf Wedgemussel.

Figure 3. *Dwarf Wedgemussel (C. Eads, NCSU)*

Tar River Spinymussel

The Tar River Spinymussel is 1 of only 3 freshwater mussels with spines in the world. The brownish shell is rhomboid-shaped, up to 2.4 inches (6 cm) long, with 0 to 6 spines on each valve (**Figures 4a-4c**). The shell is smooth and shiny, with concentric rings, and ends in a blunt point. Younger individuals are orange-brown with greenish rays streaking outward from the hinge area. Adults are darker with less distinct rays. One to 3 small thin ridges run on the interior surface of the shell from the beak cavity to the lower ventral area of the shell. The anterior half of the shell's inner surface is salmon-colored, the posterior half is iridescent blue. Juveniles may have up to 12 spines, however, adults tend to lose their spines as they mature. Their method of reproduction is similar among freshwater mussel species. Males release sperm into the water column, and the sperm are taken in by the females through their siphons as they respire. The eggs are fertilized and develop within the females gills into larvae (glochidia). The females release the glochidia that must then attach to the gills or fins of unknown fish species. The glochidia transform into juvenile mussels and drop off the fish onto the stream bottom (USFWS 1992).

Based on the close relationship to the James Spinymussel (*Pleurobema collina*), fish hosts likely include Rosyside Dace (*Clinostomus funduloides*), Bluehead Chub (*Nocomis leptocephalus*), Rosefin Shiner (*Lythrurus ardens*), Satinfin Shiner (*Cyprinella analostana*), and Swallowtail Shiner (*Notropis procne*) (NCWRC 2018).

Critical Habitat

Critical habitat has not been designated for Tar River Spinymussel; therefore, the critical habitat couplet in the determination key (**Appendix B**) is not applicable to this species. Refer to the habitat descriptions for this species (**Section III**) to assist in determining whether a project is located in, near, or upstream of suitable habitats for Tar River Spinymussel.

Figure 4a. *Tar River Spinymussel (C. Eads)*

Figure 4b. *Tar River Spinymussel (C. Eads)*

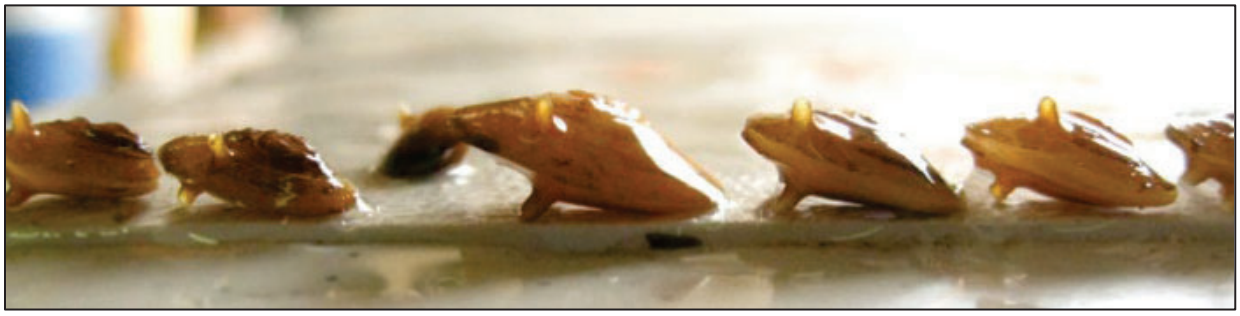


Figure 4c. *Tar River Spinymussel (C. Eads).*

Yellow Lance

The Yellow Lance is a bright yellow freshwater mussel with a shell more than twice as long as it is tall, reaching just over 3 inches (7.6 cm) in length (**Figures 5a and 5b**). The outermost layer of the shell has a waxy appearance with brownish ridges known as "growth rests" that formed during an intermediate stage of growth when the ridge area was the edge of the shell. The inner layer is usually an iridescent blue color, and sometimes has white or salmon color on the shorter end of the shell from the anterior. The posterior portion of the shell is rounded. Yellow Lance has interlocking hinge "teeth" on the inside of the shell to help keep the two valves in proper alignment (NCWRC 2018).

As with most freshwater mussels, the Yellow Lance has a unique life cycle that relies on fish hosts for successful reproduction. Recent lab studies evaluated 26 species of potential host fish and confirmed that White Shiners (*Luxilus albeolus*) and Pinewoods Shiners (*Lythrurus matuntinus*) are the most efficient host in a lab setting. Another study found that Yellow Lance could be successfully propagated using *in vitro* culture techniques (USFWS 2019b).

Critical Habitat

Critical habitat has been designated for the Yellow Lance (86 FR 18189; April 8, 2021). The physical or biological features essential to Yellow Lance are: (1) adequate flows, or a hydrologic flow regime (which includes the severity, frequency, duration, and seasonality of discharge over time), necessary to maintain benthic habitats where the Yellow Lance is found and to maintain connectivity of streams with the floodplain, allowing the exchange of nutrients and sediment for maintenance of the mussels and fish host's habitat, food availability, spawning habitat for native fishes, and the ability for newly transformed juveniles to settle and become established in their habitats; and (2) the presence and abundance of fish hosts necessary for Yellow Lance recruitment.

Figure 5a. *Yellow Lance (Chris Eads, NC State University)*

Figure 5b. *Yellow Lance (NCWRC)*

James Spinymussel

The James Spinymussel is a small freshwater mussel slightly less than 3 inches (7.6 centimeters [cm]) in length. Adults have a dark brown shell with prominent growth rings, and occasionally, short spines on each valve (**Figure 6**). Young mussels have a shiny yellow shell with or without 1 to 3 short spines. Like other freshwater mussels, this species is a filter feeder. It feeds on plankton collected from water that is passed over its gills. Reproduction occurs sexually. Females carry eggs in their gills. During spawning, the male releases sperm into the water column and the sperm is taken into the female through the gills. The resulting larvae (known as glochidia) are released from the female into the water column and must attach to a fish host to survive. While attached to the fish host, development of the glochidia continues. Once metamorphosis is complete, the juvenile mussel drops off the fish host and continues to develop on the stream bottom. Known fish hosts for this species include the Bluehead Chub, Rosyside Dace, Blacknose Dace, Mountain Redbelly Dace, Rosefin Shiner, Satinfin Shiner, Central Stoneroller, and Swallowtail Shiner, White Shiner, and Crescent Shiner (USFWS 1990, 2022a).

Critical Habitat

Critical habitat has not been designated for James Spinymussel; therefore, the critical habitat couplet in the determination key (**Appendix B**) is not applicable to this species. Refer to the habitat descriptions for this species (**Section III**) to assist in determining whether a project is located in, near, or upstream of suitable habitats for James Spinymussel.

Figure 6. *James Spinymussel (USFWS)*

Green Floater

Green Floaters are small freshwater mussels with ovate trapezoidal shaped shells. Their shells are yellowish brown to olive green with green rays (**Figure 7**). (Bogan and Ashton 2016, p. 43). Adults rarely exceed 5.5 centimeters (cm) (2.2 inches (in)) (Johnson 1970, p. 344) but can grow to 7.0 cm (2.8 in) in length (Watters et al. 2009, p. 347). Like all freshwater mussels, the Green Floater is an omnivore that feeds on a wide variety of microscopic particulate matter (*i.e.,* bacteria and algae).

The best available information suggests the Green Floater is a short-lived, fast-growing species compared to similar mussels. The Green Floater is considered a long-term brooder because individuals produce eggs that develop as larvae in the adult mussels and are then released after several months (Haag 2012, pp. 40–41, 203–204). While some mussels can live to 100 years old, Green Floaters typically live just 3 to 4 years (Watters et al. 2009, p. 349). In laboratory settings, Green Floaters can mature and release sperm at less than 1 year of age (Mair 2020, pers. comm.)

Green Floaters are hermaphroditic (Ortmann 1919, p. 122; van der Schalie 1970, p. 106) and have the ability to self-fertilize, which increases the probability of fertilization (Haag 2012, p. 191). Spawning and reproduction occur during the late summer or early fall. In the winter, Green Floaters can directly metamorphose larvae, called glochidia, meaning that adults keep the glochidia in their gills until they mature into juveniles and then release them into the water column in the spring (Barfield and Watters 1998, p. 22; Lellis and King 1998, p. 23; Haag 2012, p. 150). Green Floater adults have the ability to expel glochidia that use fish hosts, too (J. Jones 2020, unpublished data), but it is not known what proportion of Green Floaters use this method of reproduction. The added ability to directly metamorphose glochidia without requiring an intermediate fish host is unique to the Green Floater. This life strategy may allow the Green Floater to occur in small streams with small populations and few fish (Haag 2012, pp. 150, 191), although the use of fish hosts is necessary for periodic upstream dispersal.

Critical Habitat

Critical habitat has been proposed for the Green Floater in New York, Pennsylvania, Maryland, West Virginia, Virginia, North Carolina, and Tennessee. In North Carolina, critical habitat is proposed in the New River, Roanoke, Neuse, and Watauga River Basins.

The USFWS proposes that the following physical or biological features are essential to the conservation of green floater (88 FR 48294; July 26, 2023):

1) Flows adequate to maintain both benthic habitats and stream connectivity, allow glochidia and juveniles to become established in their habitats, allow the exchange of nutrients and oxygen to mussels, and maintain food availability and spawning habitat for host fishes. The characteristics of such flows include a stable, not flashy, flow regime, with slow to moderate currents to provide refugia during periods of higher flows.
2) Suitable sand and gravel substrates and connected instream habitats characterized by stable stream channels and banks and by minimal sedimentation and erosion.
3) Sufficient amount of food resources, including microscopic particulate matter (plankton, bacteria, detritus, or dissolved organic matter).
4) Water and sediment quality necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages, including, but not limited to, those general to other mussel species:
    a. Adequate dissolved oxygen;
    b. Low salinity;

c. Low temperature (generally below 86 °F (30 °C));
d. Low ammonia (generally below 0.5 parts per million total ammonia nitrogen), PAHs, PCBs, and heavy metal concentrations; and
e. No excessive total suspended solids and other pollutants, including contaminants of emerging concern.

5) The presence and abundance of fish hosts necessary for recruitment of the green floater (including, but not limited to, mottled sculpin (*Cottus bairdii*), rock bass (*Ambloplites rupestris*), central stoneroller
6) (*Campostoma anomalum*), blacknose dace (*Rhinichthys atratulus*), and margined madtom (*Noturus insignis*)).

Figure 7. *Green Floater (USFWS)*

Roanoke Logperch

The Roanoke Logperch is a large darter, growing to a maximum length of 4.5 inches (11.4 cm). Its back is dark green, and its sides are greenish to yellowish, both with dark markings; the belly is white to yellowish (USFWS, 2010). The lateral portions of the fish are covered with vertically elongate blotches (typically 8-11 blotches) and dark vermiculation's that are interspersed between dorsal saddles (**Figure 8**). It has a bulbous snout that is elongate and conical. Fins are strongly speckled, and the first dorsal fin contains an orange band that is particularly vivid in males (USFWS 2022b).

Roanoke Logperch actively feed during the warmer months by utilizing their snout to overturn gravel to forage on benthic aquatic macroinvertebrates. Spawning occurs in March to June in deep runs over gravel and small cobble, and Logperch typically bury their eggs with no subsequent parental care. Larval drift is likely an important dispersal and recolonization mechanism. Roanoke Logperch mature at 2 to 3 years of age and commonly live 5 to 6 years (USFWS 2022b).

Critical Habitat

Critical habitat has not been designated for Roanoke Logperch; therefore, the critical habitat couplet in the determination key (**Appendix B**) is not applicable to this species. Refer to the habitat descriptions for this species (**Section III**) to assist in determining whether a project is located in, near, or upstream of suitable habitats for the Roanoke Logperch.

Figure 8. *Roanoke Logperch (fishbase.org)*

Cape Fear Shiner

The Cape Fear Shiner is a North American species of freshwater fish in the minnow family. The Cape Fear Shiner is a small (approximately 2 inches [5.1 cm] long), yellowish minnow with black bands along the sides of its body (**Figure 9**). It has a black upper lip, and the lower lip bears a thin black bar along its margin. The Cape Fear Shiner is known to consume plant and animal material. However, unlike most other minnows in the genus *Notropis*, the Cape Fear Shiner's digestive tract is modified primarily for a plant diet by having an elongated, convoluted intestine (USFWS 2022c).

The species is most often found in rocky pools and runs adjacent to riffles in wide, shallow segments of rivers with gravel, cobble, and/or boulder substrates with a forest canopy and abundant Water Willow *(Justicia)*, Riverweed *(Podostemum)*, Stream Mosses *(Fontinalis)*, and filamentous green algae. Adults and large juveniles may also occupy the lower reaches of some major tributary creeks, at least temporarily. Juveniles are often found in slack water, among large rock outcrops of the midstream, and in flooded side channels and pools (USFWS 2022c). Cape Fear Shiners are sexually mature after their first year and are known to live up to 9 years in captivity, but in the wild, their life expectancy is 2 to 3 years (USFWS 2022c). The species has proved a great candidate for captive propagation efforts for augmentation in the future, with successful rearing results at two separate facilities in the last 10 years.

Like all aquatic species, the Cape Fear Shiner can be affected by impaired water quality, but sediment impacts resulting in buried habitat is the impact of most concern for the species. Connectivity and impounded reaches are another concern for the species, as they are unable to move upstream and join additional shiners. Conservation actions, such as dam removal and habitat restoration in impounded reaches have shown beneficial to connecting previously isolated populations.

Critical Habitat

Critical habitat has been designated for Cape Fear Shiner (52 FR 36034; September 25, 1987). A biological and physical feature description was not included in the Cape Fear Shiner Federal Register listing.

Figure 9. *Cape Fear Shiner (Carol Johnston, Auburn University)*

Carolina Madtom

The Carolina Madtom is a small freshwater catfish, reaching a maximum length of nearly 5 inches (12.7 cm). When compared to other madtoms, the Carolina Madtom has a short, robust body and a distinct color pattern (**Figure 10**). Three dark saddles along its back connect a wide, black stripe along its side extending from its snout to the base of its tail. The adipose fin has a dark blotch that does not reach the fin's edge, giving the impression of a fourth saddle. Yellowish to tan blotches space the saddles, while the rest of the fish is tan. The belly is un-speckled, and the tail has crescent-shaped brown bands near its edge and center. Its pectoral spines have well-defined serrated projections along both margins (USFWS 2021b).

Carolina Madtom nesting season extends from mid-May to late July. Nest sites are often found under or in relic freshwater mussel shells, under large pieces of water-logged tree bark, or in discarded beverage bottles and cans partially buried on the stream bottom. Most nest sites are in runs above riffles or in pools with current. All nests with embryos or larvae are guarded by solitary males, 2 to 4 years old. Embryos adhere to one another in a mass but not to other surfaces, and clutch sizes average 152 larvae (USFWS 2021b).

Critical Habitat

Critical habitat has been designated for the Carolina Madtom (86 FR 30688; June 9, 2021). Physical and biological features of Carolina Madtom include: (1) suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (i.e., channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of freshwater native fish (such as stable riffle-run-pool habitats that provide flow refuges consisting of silt-free gravel, small cobble, coarse sand, and leaf litter substrates) as well as abundant cover used for nesting; (2) adequate flows, or a hydrologic flow regime (which includes the severity, frequency, duration, and seasonality of discharge over time), necessary to maintain instream habitats where the species is found and to maintain connectivity of streams with the floodplain, allowing the exchange of nutrients and sediment for maintenance of the fish's habitat, food availability, and ample oxygenated flow for spawning and nesting habitat; (3) water quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages; and (4) aquatic macroinvertebrate prey items, which are typically dominated by larval midges, mayflies, caddisflies, dragonflies, and beetle larvae.

Figure 10. *Carolina Madtom (D. Biggins, former USFWS)*

Neuse River Waterdog

The Neuse River Waterdog is a permanently aquatic salamander. It can grow up to 11 inches (27.9 cm) long. It has a reddish-brown body with an irregular pattern of large blue or black spots (**Figure 11**). The waterdog has a laterally compressed tail the same coloration as the body; however, its ventral side is typically a dull brown or gray color with spots. Adult Neuse River Waterdogs have elongated heads with squared-off noses and cylindrical trunks. Three dark-red, bushy gills project from either side of the head and a dark line runs through the eye. The skin is smooth, slimy, and a light rusty brown color, with the underside a paler brown or grayish. The limbs are small, and the front and hind feet have 4 toes each (USFWS 2021c).

Critical Habitat

Critical habitat has been designated for Neuse River Waterdog (86 FR 30688; June 9, 2021). Physical and biological features of Neuse River Waterdog critical habitat include: (1) suitable substrates and connected instream habitats, characterized by geomorphically stable stream channels and banks (i.e., channels that maintain lateral dimensions, longitudinal profiles, and sinuosity patterns over time without an aggrading or degrading bed elevation) with habitats that support a diversity of native aquatic fauna (such as stable riffle-run-pool habitats that provide flow refuges consisting of silt-free gravel, small cobble, coarse sand, and leaf litter substrates) as well as abundant cover and burrows used for nesting; (2) adequate flows, or a hydrologic flow regime (which includes the severity, frequency, duration, and seasonality of discharge over time), necessary to maintain instream habitats where the species is found and to maintain connectivity of streams with the floodplain, allowing the exchange of nutrients and sediment for maintenance of the waterdog's habitat, food availability, and ample oxygenated flow for spawning and nesting habitat; (3) water quality (including, but not limited to, conductivity, hardness, turbidity, temperature, pH, ammonia, heavy metals, and chemical constituents) necessary to sustain natural physiological processes for normal behavior, growth, and viability of all life stages; and (4) invertebrate and fish prey items, which are typically hellgrammites, crayfish, mayflies, earthworms, snails, beetles, centipedes, slugs, and small fish.

***Figure 11**. Neuse River Waterdog (J. Beane, NCMNS)*

III. Suitable Habitat

Suitable benthic habitat for the 10 aquatic species includes high-quality waterways containing cool, well-oxygenated, and unpolluted water that has constant flow, a natural flow regime, unembedded substrate, and stable instream habitat. Stream habitats are naturally patchy, and suitable habitats for these aquatic species may occur within isolated pockets of unsuitable habitat. Many of the listed aquatic species are hanging on in streams that are somewhat impacted by pollutants, silt, and other stressors. Stream surveys should include the entire stream area to be impacted and should and include a predetermined distance upstream and downstream of a proposed impact area, since upstream disturbances may result in downstream effects. Common stressors that degrade these habitats include things that alter hydrology (e.g., perched/improperly installed culverts, impoundment) or those that alter the stream bed (e.g., excessive fine sediments).

Consideration of project-related impacts to benthic habitat that may occur between occupied reaches is also important. Most freshwater mussels are found in mussel beds that vary in size and are often separated by streams reaches in which mussels are absent or rare. Genetic exchange takes place between and among mussel beds via sperm drift, host fish movement, and movement of mussels during high flow events. Similarly, other aquatic species (e.g., fishes and salamander herein) migrate and disperse among suitable stream reaches across unsuitable habitat patches. Instream habitat fragmentation is a stressor that can be avoided with proper control of runoff, sediment, or other project factors that could degrade instream habitat quality or undermine population connectivity between reaches.

Atlantic Pigtoe

The Atlantic Pigtoe has been found in a variety of riverine habitats, from small headwater streams (< 1 meter [m] wide) in the Ridge and Valley and Piedmont physiographic regions downstream to large rivers in the Coastal Plain (e.g., the lower Tar River [more than 50 m wide] in Edgecombe and Pitt counties). This species needs clean, flowing water characterized by high dissolved oxygen concentrations and it prefers gravel beds and coarse sand habitats just downstream of riffles (i.e., rocky, or shallow stream areas with swift water currents). It also may be found less commonly in sand, cobble, and mixtures of sand, silt, and detritus (USFWS 2021a).

The Atlantic Pigtoe is native to several Atlantic Slope drainages from Virginia to Georgia, but it is presumed extirpated in the southern portion of its range. The current distribution Atlantic Pigtoe in North Carolina includes streams in the Roanoke, Tar, Neuse, Cape Fear, and the Yadkin-Pee Dee River basins. It has been documented recently in the Sandy and Swift Creeks, the Fishing Creek and Upper/Middle Tar subbasins, and the Lower Tar River of the Tar-Pamlico River basin; Contentnea, Middle, and Swift Creeks, and the Eno, Flat, and Little Rivers of the Neuse River basin; New Hope Creek and the Deep River subbasin of the Cape Fear River basin; and the Little and West Fork Little Rivers of the Yadkin-Pee Dee River basin (USFWS 2021a; 86 FR 64000).

In North Carolina, the Atlantic Pigtoe is known or believed to occur in 40 counties including: *Alamance, Anson, Beaufort, Bladen, Cabarrus, Caswell, Chatham, Cumberland, Davidson, Durham, Edgecombe, Franklin, Granville, Greene, Guilford, Halifax, Harnett, Johnston, Lenoir, Martin, Mecklenburg, Montgomery, Moore, Nash, Northampton, Orange, Pender, Person, Pitt, Randolph, Richmond, Rockingham, Sampson, Stanly, Union, Vance, Wake, Warren, Wayne,* and *Wilson.*

Dwarf Wedgemussel

The Dwarf Wedgemussel appears to be a generalist in terms of its preference for stream size, substrate and flow conditions – it inhabits small streams less than 16.4 ft (5.0 m) wide to large rivers more than 328.1 ft (100 m) wide; it is found in a variety of substrate types including clay, sand, gravel, and pebble, and sometimes in silt depositional areas near banks; and it usually inhabits hydrologically stable areas, including very shallow water along streambanks and under root mats, but it has also been found at depths of 25 ft (7.6 m) in the Connecticut River (**Figure 12**). Dwarf Wedgemussels are often patchily distributed in rivers (NCWRC 2018).

North Carolina supports several known sites in the Neuse River Basin and Tar River Basin, although most of these populations are very small and isolated. The Upper Tar River subpopulation includes the main stem of the Tar River, Shelton Creek, and Cub Creek. Evidence of recruitment in the Upper Tar River has been documented by repeat surveys; connected tributaries were also occupied (USFWS 2019a). However, the Upper Tar River population is considered to be unhealthy as few individuals have been recently identified (USFWS 2019a).

Upper Fishing Creek is considered a separate population from the Upper Tar River and is considered healthy because of persistent Dwarf Wedgemussel subpopulations in Little Shocco Creek, Maple Branch. Very small numbers of individuals were found in Isinglass Creek and Ben's Creek, while a previously documented population in Rocky Swamp Creek appears to be extirpated (USFWS 2019a).

The Neuse River population includes individuals located within the Little River, the Middle (potentially extirpated)/Swift Creeks (severe decline), and Turkey/Moccasin Creeks (likely extirpated). Since 2013, this population has not improved and is considered unhealthy (USFWS 2019a). Dwarf Wedgemussel has always been considered rare in the Little River, and despite many intensive surveys for co-occurring species, the Dwarf Wedgemussel has not been observed since 1998. The majority of recent surveys conducted (2014, 2016, 2017, and 2018) have been in the middle portion of the Neuse River system. Greater survey efforts are needed in the middle portion of the system to determine status/health in this system, as suitable habitat remains. Development (including dams, reservoirs, and wastewater discharge elimination systems) and natural causes, such as beaver activity, are known threats in this river (USFWS 2019a).

In North Carolina, Dwarf Wedgemussel is known or believed to occur in 17 counties including: *Beaufort, Durham, Edgecombe, Franklin, Granville, Halifax, Johnston, Martin, Nash, Orange, Person, Pitt, Vance, Wake, Warren, Wayne,* and *Wilson.*

Figure 12. *Typical Dwarf Wedgemussel underwater habitat (USFWS)*

Tar River Spinymussel

The Tar River Spinymussels preferred habitats include relatively fast-flowing, well-oxygenated, perennial waters, though water velocity may fluctuate widely in occupied stream reaches. This species also prefers relatively silt-free, stable, uncompacted coarse sand and gravel substrates (USFWS 1992). However, Pandolfo et al. (2016) reported that Tar River Spinymussels were anecdotally associated with partially compacted sand and slow water velocity, indicating the species has been relegated to, and may persist in, degraded habitat conditions compared to its preferred habitats. Experienced biologists have detected many individuals in small patches of transitional benthic habitat, where cobble/pebble meets sand/gravel substrates (NCWRC 2018).

The Tar River Spinymussel is endemic to the Tar River and Neuse River systems in North Carolina (**Figure 13**). In the Tar River system, the species has been documented from the mainstem of the Tar River, Shocco Creek, Fishing Creek, Little Fishing Creek, Sandy Creek, Swift Creek, and Chicod Creek, although it may have occurred historically throughout much of the Tar River basin (NCWRC 2018). In the Neuse River system, the species has been documented in the Little and Neuse rivers; however, it likely inhabited many other streams historically (NCWRC 2018). It is found in association with other mussels, but it is never very numerous. The Tar River Spinymussel has continued to experience severe declines, and wild individuals are sparsely distributed and difficult to detect. Species presence should not be ruled out in suitable reaches near occupied habitats without appropriate sampling methods for detecting rare mussels. The North Carolina Wildlife Resource Commission (NCWRC) and USFWS have partnered on significant efforts

to augment existing populations with hatchery-reared mussels. Since 2014, thousands of Tar River Spinymussels have been stocked into Fishing, Little Fishing, Swift, and Sandy creeks and the Tar River, and extra care is necessary in, near, and upstream of these high-quality habitat areas to ensure that augmented populations are not affected (USFWS 2020).

In North Carolina, the Tar River Spinymussel, is known or believed to occur in 14 counties including: *Beaufort, Edgecombe, Franklin, Halifax, Johnston, Martin, Nash, Pitt, Sampson, Vance, Wake, Warren, Wayne,* and *Wilson*.

Figure 13*. Tar River Spinymussel and Yellow Lance suitable habitat, Little River (Vann Stancil, NC Wildlife Resources Commission)*

Yellow Lance

The Yellow Lance is a sand associated mussel species often found buried up to 6 inches deep in clean and stable coarse to medium-grained sand; although it occasionally is found in gravel or mixed sand and gravel substrates (NCWRC 2018). Yellow Lance mussels often are moved with shifting sand and eventually settle in sand at the downstream end of stable sand and gravel bars. This species is found in medium-sized rivers to smaller streams and is dependent on clean, moderate flowing water with high dissolved oxygen content in riverine or larger creek environments (**Figure 13**). Historically, the most robust populations existed in creeks and rivers with excellent water quality, and no populations appear to be extant below pollution point sources or areas with increased nutrient loading (USFWS 2019b).

The Yellow Lance is native to the Atlantic Slope drainages of Maryland, Virginia, and North Carolina; it is found in the Tar-Pamlico and Neuse River basins in North Carolina (**Figure 14**). The Tar drainage holds the most resilient remaining populations, and it has been documented recently in several streams, including

the mainstem of the Tar River, Tabbs Creek, Crooked Creek, and Sandy and Swift Creeks, and the Fishing Creek subbasin (Fishing, Shocco, and Richneck Creeks). In the Neuse drainage, it has been documented recently in Swift Creek, Middle Creek, and the Little River (USFWS 2019b; 86 FR 18189).

In North Carolina, the Yellow Lance is known or believed to occur in 15 counties including: *Edgecombe, Franklin, Granville, Halifax, Johnston, Martin, Nash, Person, Pitt, Sampson, Vance, Wake, Warren, Wayne* and *Wilson.*

Figure 14*. Yellow Lance habitat underwater in the Tar River (USFWS)*

James Spinymussel

The James Spinymussel prefers free-flowing streams with a variety of flow regimes (**Figure 15**). The James Spinymussel is found in a variety of substrates with limited silt content. This freshwater mussel is found in the upper James River and Dan River basins. (USFWS 1990; 2022a).

In North Carolina, James Spinymussel is known or believed to occur in 4 counties: *Caswell, Rockingham, Stokes,* and *Surry*.

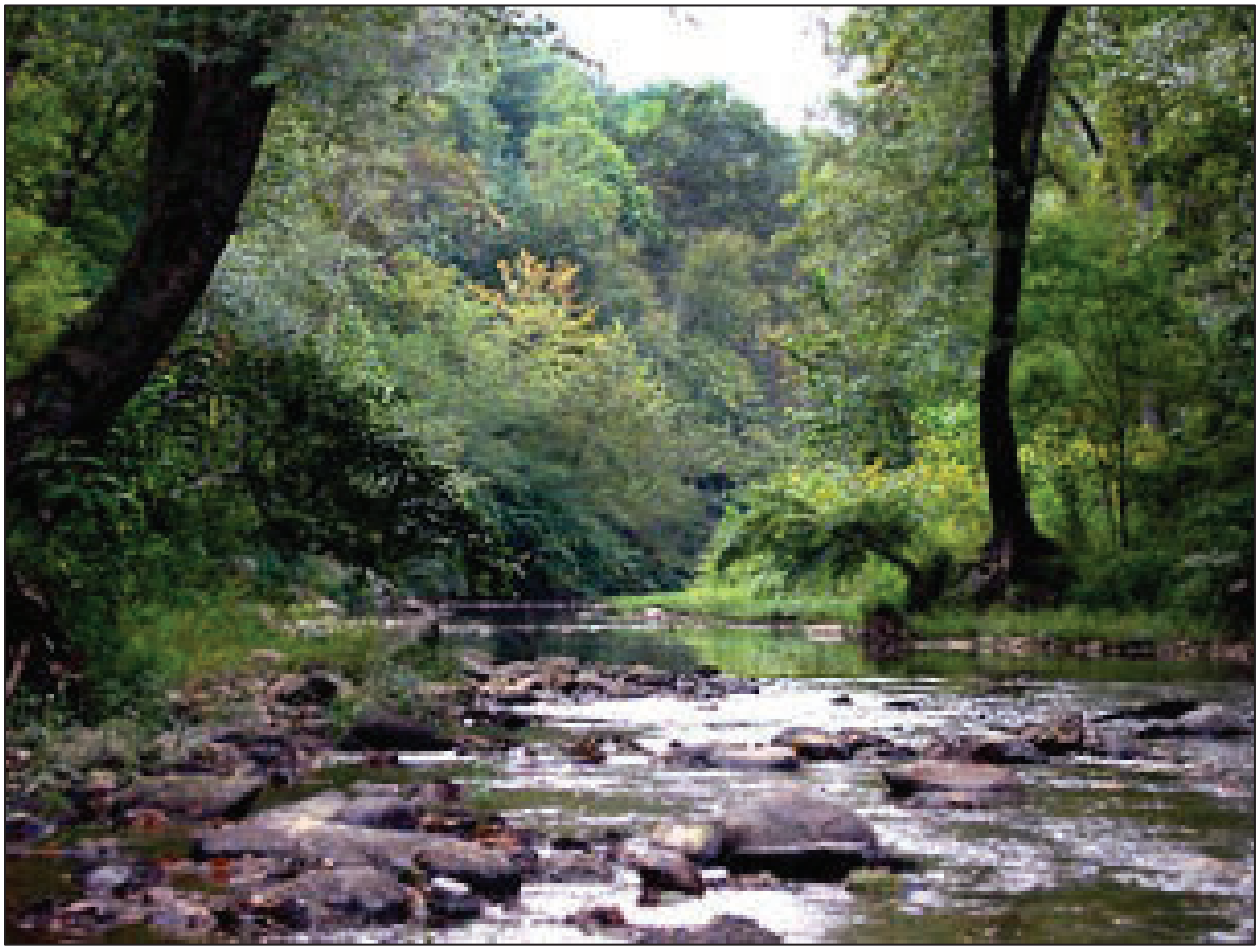


Figure 15*. James Spinymussel and Green Floater suitable habitat, Pedlar River, VA (USFWS)*

Green Floater

Green Floaters can occur singly or in small aggregations of a few individuals. Streams with slow to medium flows and good water quality provide the best habitat for Green Floaters (Ortmann 1919; Johnson 1970; Clarke 1985; Kerferl 1990) (**Figure 15**). They are often found in sand or small gravel substrates where they establish a foothold and bury themselves as deep as 38 cm (15 in) (Haag 2012; Lord 2020, pers. comm.). Their mobility is limited, and fast flowing currents or high-water events can cause them to be washed downstream (Strayer 1999). When they occur in larger streams and rivers, they are found in quieter pools and eddies, away from strong currents (WVDNR 2008). Green Floaters are often found in similar habitat types to Atlantic Pigtoe, James Spinymussel, and other listed mussels.

The current distribution of Green Floater in North Carolina includes streams in the Roanoke, Neuse, and Tar-Pamlico River basins. The distribution areas mostly overlap with other listed aquatic species. In North Carolina, the Green Floater is known or believed to occur in 18 counties including: *Ashe, Alleghany, Durham, Edgecombe, Franklin, Granville, Halifax, Johnston, Montgomery, Nash, Northampton, Orange, Person, Pitt, Randolph, Rockingham, Stokes, Wake, and Watauga.*

Roanoke Logperch

The Roanoke Logperch typically inhabits medium-to-large, warm, usually clear streams and small rivers of moderate to low gradient (**Figure 16**). Adults usually inhabit the main body of stream pools, runs, and riffles, and they select areas with exposed, silt-free gravel substrate. Young are usually found in slow runs and pools with clean sandy bottoms. The average width of a stream with suitable habitat is 10 feet, however, larger and smaller streams may also be suitable (USFWS 2022b).

This species is known from portions of the Chowan River and Roanoke River basins within the Ridge and Valley, Piedmont, and upper Coastal Plain physiographic regions, including recent collections in North Carolina in the Dan River, Mayo River, and Smith River watersheds. In North Carolina Roanoke Logperch is known or believed to occur in 3 counties: *Caswell, Rockingham,* and *Stokes*.

Figure 16. *Suitable habitat for Roanoke Logperch, Dan River (Dan River Basin Association)*

Cape Fear Shiner

The Cape Fear Shiner is generally associated with, and most often found in, clean river systems with rocky pools, riffles and runs within wide, shallow segments of moderate to fast flowing water with a forest canopy. The substrate is gravel, cobble and/or boulders often with abundant Water Willow *(Justicia)* **(Figure 17)**, Riverweed *(Podostemum)*, Stream Mosses *(Fontinalis)*, and filamentous green algae which may be used as cover or protection from predators (e.g., flathead catfish, bass and crappie) during juvenile and adult life stages. Adults and large juveniles may also occupy the lower reaches of some major tributary creeks, at least temporarily. Juveniles are often found in slack water, among large rock outcrops of the midstream, and in flooded side channels and pools.

Figure 17. *Cape Fear Shiner suitable habitat, Rocky River (Emily Wells, USFWS)*

Cape Fear Shiners are sexually mature after their first year and are known to live up to 9 years in captivity, but in the wild, their life expectancy is 2 to 3 years. During the spawning season, May through July, adult shiners move to slower flowing pools to lay eggs on the rocky substrate. The Cape Fear Shiner may also be found in low-gradient sand-dominated rivers with minimal rock riffle habitat, albeit in lower numbers and presumably moving between more rocky sections of water (USFWS 2022c). Cape Fear Shiners are usually found in mixed schools with other shiners but are rarely the dominant species (Pottern 2009).

The species is endemic to the upper Cape Fear River Basin in the Central Piedmont of north Carolina. It is historically known to occur in larger tributaries and mainstreams of the Deep, Haw, Rocky, and upper Cape Fear rivers in Chatham, Harnett, Lee, Moore and Randolph counties and has suitable habitat in additional specific river reaches in Alamance, Orange and Cumberland counties (USFWS 2022c). Cape Fear Shiners have been observed in larger tributaries near the confluence of the mainstem rivers during times of high-water events (**Figure 18 and Map A in Appendix B**), but primarily have been observed in the suitable habitat reaches listed in **Table 2**, which include the mainstem rivers and documented occurrences in tributary reaches.

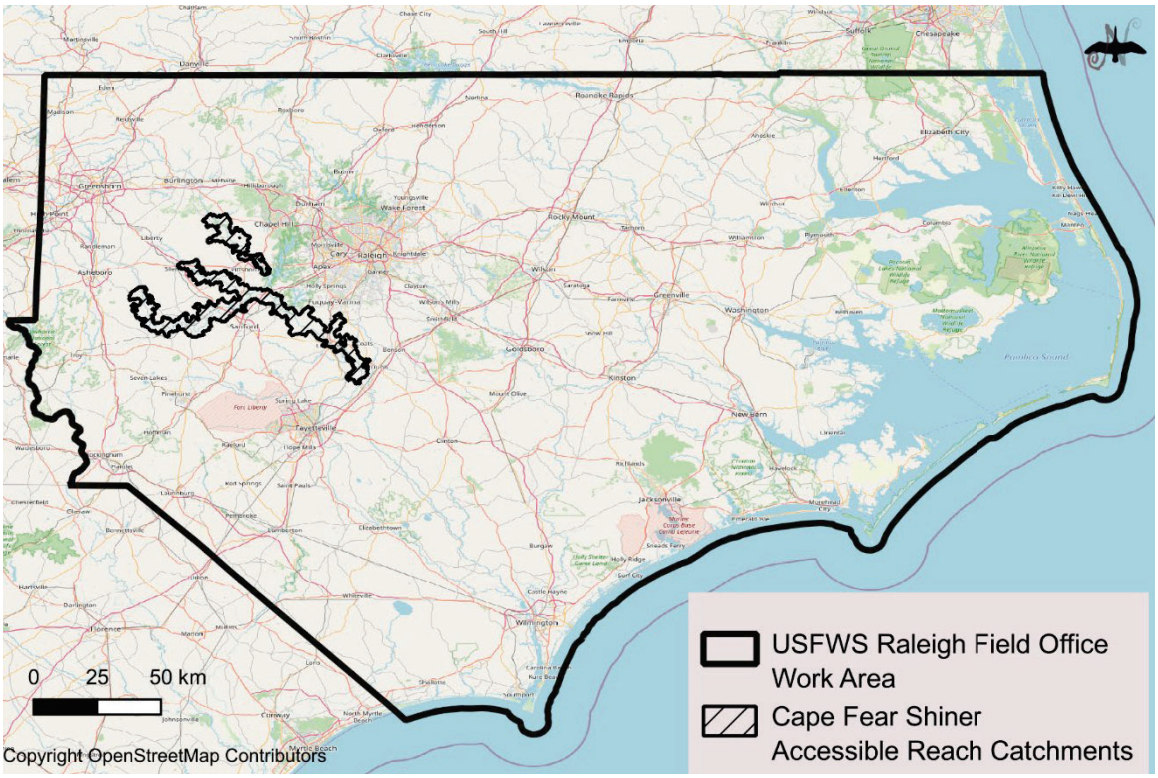


Figure 18. *Catchments with Accessible Reaches for Cape Fear Shiner (USFWS 2024)*

Table 2. *Known suitable habitat for Cape Fear Shiner in the Upper Cape Fear River Basin*

Cape Fear River and tributaries • Neill's Creek • Parker's Creek	**Haw River** and Roberson Creek	**Rocky River** and Bear Creek (tributary to Rocky River)	**Deep River and tributaries** • Bear Creek (tributary to Deep River) • McLendon's Creek

<u>Carolina Madtom</u>

The Carolina Madtom is endemic to the Tar-Pamlico and Neuse River Basins of North Carolina. It is typically found in medium to large rivers in the Piedmont and Coastal Plain physiographic regions and may be in the lower reaches of small streams (Burr et al. 1989) (**Figure 19**). Preferred habitats of this species include riffles, runs, and pools of shallow to moderate depth, with leaf packs and sand and gravel substrates, and adequate cover (e.g., boulders or woody debris) (Midway et al. 2010). They need continuous, perennial flows; Carolina Madtoms often are found in swift waters and will shift to areas of moderate or slow flow during the breeding season (USFWS 2021b). They nest from mid-May to late-July under natural or artificial cover (e.g., mussel shells, bark and other woody debris, glass jars, beverage cans, or other containers).

The Carolina Madtom has been documented most recently in the Upper Tar River, Sandy and Swift Creeks, and the Fishing Creek subbasin of the Tar-Pamlico River basin, and the Contentnea Creek and the Little River of the Neuse River basin.

The Carolina Madtom is known or believed to occur in 24 counties including: *Craven, Duplin, Durham, Edgecombe, Franklin, Granville, Greene, Halifax, Harnett, Johnston, Jones, Lenoir, Martin, Nash, Onslow, Orange, Person, Pitt, Sampson, Vance, Wake, Warren, Wayne* and *Wilson*.

Figure 19. *Carolina Madtom suitable habitat, Tar River (T. Dickinson and G. Pottern)*

Neuse River Waterdog

The Neuse River Waterdog is endemic to the Tar-Pamlico and Neuse River basins in North Carolina. It occurs in streams ranging from larger headwaters in the Piedmont downstream to coastal rivers, to the point of saltwater influence. Neuse River Waterdogs need clean, flowing water characterized by high dissolved oxygen concentrations. Their preferred habitats vary with season, temperature, dissolved oxygen content, flow rate, and precipitation; however, waterdogs maintain home retreat areas under rocks, in burrows, or under substantial cover (e.g., leaf litter) in backwater or eddy areas over hard clay, gravel, cobble, or coarse sand (Braswell and Ashton 1990) (**Figure 20**). They are not known to occur in reservoirs, ponds, or other impounded water habitats (e.g., established beaver impoundments), and they are unable to persist in Intermittently flowing streams that regularly run dry, or in perennial stream reaches dried by extended droughts.

Neuse River Waterdogs breed once per year in late autumn and winter, and females deposit fertilized eggs in spring, typically under large rocks over gravel or hard clay, where either parent can guard the rudimentary nest. In coastal rivers where rocky habitat is limited, they nest under available cover, such as logs or holes in banks (NCWRC 2018). The species thrives in cold water and is much more active in colder seasons and when water is near freezing (**Figure 21**). Researchers have documented activity decreasing after the water temperature rises above 64.4°F (18°C). Neuse River waterdogs spend much of their time under rocks or in burrows. In early spring they move into leaf beds over mud banks on the low-energy sides of riffles and where leaves are intact or only slightly decomposed and support prey species (USFWS 2021c).

The Neuse River Waterdog is endemic to the Tar-Pamlico and Neuse River basins in North Carolina. Its historical distribution included the Piedmont and Coastal Plain regions of North Carolina within all major tributary systems of the Tar-Pamlico and Neuse Rivers, including the Trent River, which is separated from the Neuse River by a saltwater barrier. The species is not known to migrate. The Neuse River Waterdog has been documented recently in Bens Creek, Sandy/Swift Creeks, Upper Fishing Creek, and the Upper, Middle, and Lower Tar River subbasins of the Tar-Pamlico River basin; and Crabtree, Contentnea, Middle, and Mill Creeks, Swift Creek (lower Neuse), Little, Flat, Eno, Middle and Lower Neuse, and Trent Rivers, and Tuckahoe Swamp of the Neuse River basin (USFWS 2021c; 86 FR 30688).

In North Carolina, Neuse River Waterdog is known or believed to occur in 23 counties including: *Beaufort, Craven, Duplin, Durham, Edgecombe, Franklin, Greene, Halifax, Johnston, Jones, Lenoir, Martin, Nash, Onslow, Orange, Person, Pitt, Sampson, Vance, Wake, Warren, Wayne* and *Wilson*.

Figure 20. *Neuse River (Photo by James Willamor, CC BY-SA 2.0) (USFWS, 2019c)*

***Figure 21**. Typical Neuse River Waterdog habitat (USFWS)*

Summary

Table 3 provides a summary of the suitable habitat descriptions, host species and other notable features of the Eastern North Carolina Aquatic species included herein.

Table 3. *Species' Summary Table*

Species	Suitable Habitat	Primary Known Host Species
Atlantic Pigtoe (CH)	Small headwater streams to large rivers; coarse sand and gravel at the downstream edge of riffles; clean, fast flowing, well oxygenated streams. Average minimum stream width where found: 1 meter(m).	Drift-feeding minnow species (Cyprinidae), Bluegill, Shield Darter, Rosefin Shiner, Creek Chub, and Longnose Dace, White Shiner, Satinfin Shiner, Bluehead Chub, Rosyside Dace, Pinewoods Shiner, Creek Chub, Swallowtail Shiner, Mountain Redbelly Dace (USFWS 2021a).
Dwarf Wedgemussel	Inhabits small streams less than 5 m wide to large rivers more than 100 m wide; found in a variety of substrate types including clay, sand, gravel and pebble, and sometimes in silt depositional areas near banks; usually inhabits hydrologically stable areas, including very shallow water along streambanks and under root mats.	Fantail darter, Tessellated Darter, Johnny Darter, and Mottled Sculpin, Slimy Sculpin, Atlantic Salmon (USFWS 2019a).
Tar River Spinymussel	Silt-free unconsolidated beds of coarse sand and gravel in relatively fast-flowing, well oxygenated stream reaches but may persist in partially compacted sand and slow water velocity; small patches of transitional benthic habitat, where cobble/pebble meets sand/gravel substrates. Average minimum stream width where found: 10 m.	White Shiner, Pinewoods Shiner, Bluehead Chub, Satinfin Shiner, Creek Chub (marginal), Swallowtail Chub (marginal) (USFWS 2020).
Yellow Lance (CH)	Sand-loving species often found buried deep in clean, coarse to medium sand, although it can sometimes be found in gravel substrates. Yellow lances often are moved with shifting sand and eventually settle in sand at the downstream end of stable sand and gravel bars. This species depends on clean, moderate flowing water with high dissolved oxygen. Average minimum stream width where found: 1 m.	White Shiner and Pinewoods Shiner (USFWS 2019b).
James Spinymussel	Inhabits free-flowing streams with a variety of flow regimes and a variety of substrates with limited silt content. Found in the upper James River and Dan River basins. Average minimum stream width where found: 3 m (10 feet).	Bluehead Chub, Rosyside Dace, Blacknose Dace, Mountain Redbelly Dace, Rosefin Shiner, Satinfin Shiner, Central Stoneroller, and Swallowtail Shiner (USFWS 2022a).
Green Floater (Proposed CH)	Small streams to large rivers, with stable flow regimes and substrates (most often sand and small gravel); sometimes found within pool and eddy areas. Typically found at depths of 0.3 to 1.3 m. May be present in	Mottled sculpin, rock bass, central stoneroller, blacknose dace and margined madtom. However, this species is also known to undergo direct development without involvement of a host fish (USFWS 2021d).

Species	Suitable Habitat	Primary Known Host Species
	small streams with slow flow and no fish populations. Average minimum stream width where found: 3 m.	
Roanoke Logperch	Inhabits medium-to-large, warm, usually clear streams and small rivers of moderate to low gradient, in the Dan, Mayo, and Smith River watersheds. The average width of a stream with suitable habitat is 10 feet, however, larger and smaller streams may also be suitable.	N/A
Cape Fear Shiner (CH)	Clean river systems with rocky pools, riffles and runs within wide, shallow segments of moderate to fast flowing rivers with gravel, cobble and/or boulder substrates with a forest canopy and often with abundant water willow; juveniles are often found in slack water, among large rock outcrops of the midstream, and in flooded side channels and pools. During the spawning season, May through July, adult shiners move to slower flowing pools to lay eggs on the rocky substrate. Juveniles are often found in slack water, among large rock outcrops of the midstream, and in flooded side channels and pools.	N/A
Carolina Madtom (CH)	Riffles, runs, and pools of shallow to moderate depth in medium to large streams and rivers and lower reaches of small streams. Optimal substrate is predominantly silt-free, stable, gravel and cobble bottom habitat, and it must have cover for nest sites, including under rocks, bark, relic mussel shells, and even cans and bottles; requires perennial flows.	N/A
Neuse River Waterdog (CH)	Clean, consistently flowing water with high dissolved oxygen content; low to moderate gradient streams and low current velocity; species dwells in streams wider than 15 m but has been found in smaller creeks; spend about 85% of the time under large granite rocks or in burrows. In early spring they move into leaf beds over mud banks on the low-energy sides of riffles and where leaves were intact or only slightly decomposed and many small critters are in the leaf litter. This species thrives in cold water and is much more active in colder seasons and when water is near freezing. Optimal survey window is December – April.	N/A

Note: CH = Critical habitat designated for species

IV. Agency Authority

This SLOPES details how the U.S. Army Corps of Engineers (USACE), Wilmington District will make determinations of effect to the Eastern North Carolina Aquatic Species Group when the USACE is the lead federal agency for a project, and it is applicable to activities regulated pursuant to Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbors Act in the state of North Carolina. Note that if another federal agency is the lead for a project, procedures for satisfying the requirements of Section 7(a)(2) of the ESA will be dictated by that agency and will not be applicable for consideration under this SLOPES.

Two USFWS offices are responsible for ESA Section 7(a)(2) compliance in North Carolina; the Raleigh Ecological Services Field Office is responsible for the eastern 59 counties (**Figure 22**). This SLOPES formalizes the coordination between the USACE and the Raleigh Ecological Services Field Office for effect determinations and the need for further consultation.

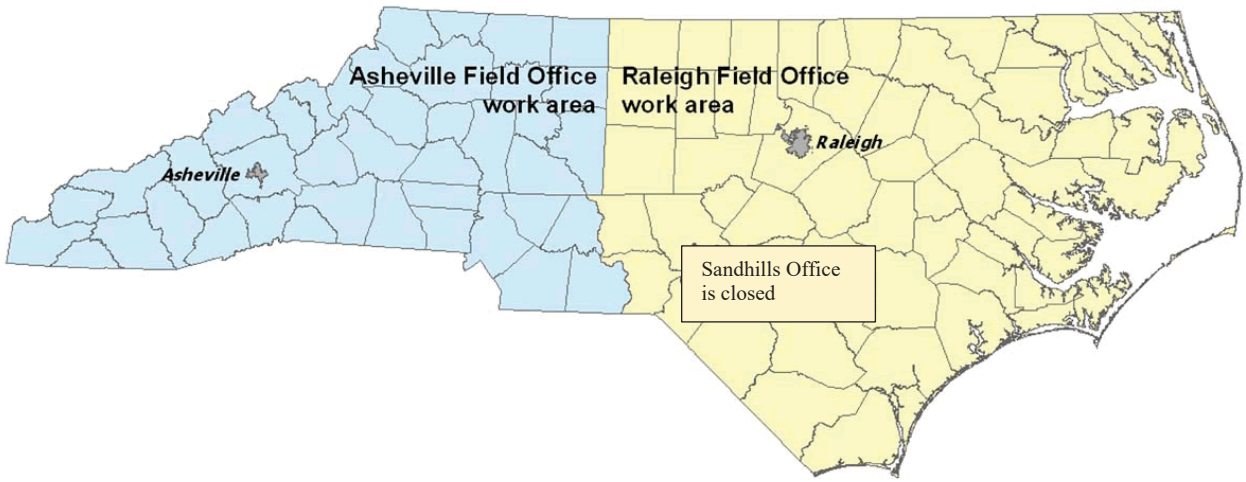


Figure 22. *USFWS Ecological Field Office work areas in North Carolina*

Endangered Species Act (ESA) (16 USC § 1531 *et seq*.), Section 7(a)(2), requires that federal agencies, in consultation with the USFWS and the National Marine Fisheries Service, take such actions as necessary to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of such endangered or threatened species or result in the destruction or adverse modification of habitat of such species, which is determined by the Secretary of the Interior or Secretary of Commerce, as appropriate, to be critical.

Section 404 Clean Water Act (CWA) (33 USC § 1344) requires authorization from the Secretary of the Army, acting through the USACE, for the discharge of dredged or fill material into all waters of the U.S., including wetlands. Discharges of fill material generally include, without limitation, placement of fill that is necessary for the construction of any structure or impoundment requiring rock, sand, dirt, or other material for its construction; site-development fills for recreational, industrial, commercial, residential, and other uses; causeways or road fills; dams and dikes; artificial islands; property protection or reclamation devices such as riprap, groins, seawalls, breakwaters, and revetments; beach nourishment; levees; fill for intake and outfall pipes and sub-aqueous utility lines; fill associated with the creation of ponds; and any other work involving the discharge of fill or dredged material. A USACE permit is required whether the work is permanent or temporary.

Section 10 of the Rivers and Harbors Act (RHA) of 1899 (33 USC § 403) requires authorization from the Secretary of the Army, acting through the USACE, for the construction of any structure in or over navigable waters of the U.S., and to conduct certain activities under navigable waters of the U.S. Work or structures outside the limits defined for navigable waters of the U.S. require a Section 10 permit if the work or structure affects the course, location, or condition of the water body. The law applies to any dredging or disposal of dredged materials, excavation, filling, re-channelization, or any other modification of a navigable waters of the U.S., and it applies to all structures, from the smallest floating dock to the largest commercial undertaking. It further includes, without limitation, any wharf, dolphin, weir, boom breakwater, jetty, groin, bank protection (e.g., riprap, revetment, bulkhead), mooring structure such as a piling, aerial or sub-aqueous power transmission line, intake or outfall pipe, permanently moored floating vessel, tunnel, artificial canal, boat ramp, aid to navigation, and any other permanent or semi-permanent obstacle or obstruction.

V. Determinations of Effect to the Eastern North Carolina Aquatic Species Group

See **Appendix A** for the Eastern North Carolina Aquatic species consultation areas in North Carolina.

The USACE will make determinations of effect for the Eastern North Carolina Aquatic species in accordance with the procedures in **Appendix B** – Eastern North Carolina Aquatic Species Effects Determination Key.

Species Guidance

The Action Area for this SLOPES is the USACE's defined Action Area (Action Area means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action) and those areas that may be affected by a disturbance (e.g., changes to hydrology [impeding water flow], water quality [physical and/or chemical], or streambed substrate [sedimentation], or impeding aquatic life passage [dams, weirs, or improper culvert installation]).

This SLOPES only addresses effects to aquatic species found in the Tar, Neuse, Roanoke, Upper Cape Fear, and Yadkin-Pee Dee River basins. Effects to other federally listed species and/or to federally designated critical habitat (critical habitat) will be processed via traditional consultation methods unless separate SLOPES or other agreements with the USFWS have been reached for those species and/or critical habitat.

VI. Conservation Recommendations

Conservation recommendations for aquatic species can be found in **Appendix C**. These recommendations are optional, and if implemented would support the agency's goals toward recovery. These recommendations are to be used at the discretion of the permittee.

VII. Geographic Information System Data

The USFWS Raleigh Ecological Services Field Office maintains geographic information system (GIS) data for the Eastern North Carolina Aquatic Species Group. The USACE will review all Pre-construction Notifications and permit applications via an internal GIS system (Regulatory Viewer), which uses this data.

VIII. Emergency Situations

Regional General Permit 199200297 (RGP 297) authorizes the discharge of dredged or fill material in non-tidal waters of the U.S. in North Carolina associated with forest management and wildfire control and suppression when performed by the U.S. Forest Service (USFS), the North Carolina Forest Service (NCFS), or when conducted on federal or state-owned property.

One of the activities authorized by this RGP is the discharge of dredged or fill material associated with the installation and maintenance of firebreaks for the purpose of wild-fire control during emergency wild-firefighting situations.

This USFWS through the SLOPES agrees that the USFS, NCFS, or others are authorized to conduct emergency wild firefighting. Associated activities may include the installation and maintenance of firebreaks and/or fire suppression lines. Every attempt should be made to contact NCWRC and USFWS as soon as possible to assist in minimizing habitat disturbance.

IX. Administration of this SLOPES

A. This SLOPES may be modified or amended only by written mutual agreement of the parties.

B. This SLOPES may be terminated, in its entirety, by written mutual agreement of the parties. An individual party to this agreement may withdraw from the agreement after providing 30 days written notice of such intent to withdraw to the other participating signatories.

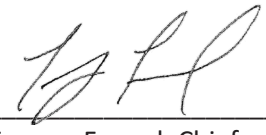
C. Acknowledgement that the authority and responsibilities of the parties under their respective jurisdictions are not altered by this SLOPES.

D. This SLOPES is intended only to improve the working relationships of the participating parties in connection with decisions regarding compliance with Section 7(a)(2) of the ESA for the federally listed Eastern North Carolina Aquatic Species Group, and pertains to permitting actions in North Carolina pursuant to Section 404 of the Clean Water Act and/or Section 10 of the Rivers and Harbor Act of 1899 when the USACE is the lead federal agency for a project.

E. The terms of this SLOPES are not intended to be enforceable by any party other than the signatories hereto.

F. The participating parties intend to fully carry out the terms of this SLOPES.

ACCORDINGLY, the parties have signed this SLOPES on the dates set forth below and it shall be effective as of the date last signed.



Date: 11 FEB 2025

Tommy Fennel, Chief
Regulatory Division
U.S. Army Corps of Engineers
Wilmington District

JENNIFER ARCHAMBAULT

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Date: February 11, 2025

Jennifer Archambault, Ph.D., Acting Field Supervisor
Raleigh Ecological Services Field Office
U.S. Fish and Wildlife Service

Literature Cited

Barfield ML, Watters ET. 1998. Non-parasitic life cycle in the green floater, *Lasmigona subviridis* (Conrad, 1835). Triannual Unionid Report 16: 22.

Bogan AE, Ashton MJ. 2016. Manual of the freshwater bivalves of Maryland. Maryland Department of Natural Resources, Resource Assessment Service, Monitoring and Non-Tidal Assessment Division, Aquatic Inventory and Monitoring Program, Annapolis, MD. 63 pp.

Braswell A, Ashton RJ. 1990. Distribution, ecology and feeding habitats of *Necturus lewisi* (Brimley). Brimleyana 10: 13-35

Burr BM, Kuhajda BR, Dimmick WW, Grady JM. 1989. Distribution, biology, and conservation status of the Carolina Madtom, Noturus furiosus, an endemic North Carolina catfish. Brimleyana 15: 57-86.

Clarke AH. 1985. The Tribe Alasmidontini (Unionidae: Anodontinae), Part II: *Lasmigona* and *Simpsonaias*. Smithsonian contributions to Zoology, Number 399. Smithsonian Institution Press, Washington D.C. pp. 51-60.

Haag WR. 2012. North American Freshwater Mussels: Natural History, Ecology, and Conservation. Cambridge University Press, Cambridge, NY. 379 pp.

Johnson RI. 1970. The systematics and zoogeography of the Unionidae (Mollusca: Bivalvia) of the southern Atlantic slope. Bulletin of the Museum of Comparative Zoology, Harvard University 140: 263-449.

Kerferl, E.A. 1990. *Lasmigona subviridis* (Conrad, 1835) Green Floater. A Report on the conservation status of North Carolina's freshwater and terrestrial molluscan fauna. Scientific Council on Freshwater and Terrestrial Mollusks. Raleigh, NC.

Lellis WA, King TL. 1998. Release of metamorphosed juveniles by the green floater, *Lasmigona subviridis*. Triannual Unionid Report 16. 23.

Lord, P. 2020. Instructor. Email on January 6, 2020. State University of New York. Oneota, NY.

Mair, R. 2020. Project leader. Unpublished data. Harrison Lake National Fish Hatchery, U.S. Fish and Wildlife Service. Charles City, VA.

Midway S, Kwak T, Aday D. 2010. Habitat suitability of the Carolina Madtom, an imperiled endemic stream fish. Transactions of the American Fisheries Society 139: 325-338.

NCWRC [North Carolina Wildlife Resources Commission]. 2018. North Carolina conservation plan for five rare aquatic species restricted to the Neuse and Tar-Pamlico River basins: Dwarf Wedgemussel *Alasmidonta heterodon*), Yellow Lance (*Elliptio lanceolata*), Tar River Spinymussel (*Parvaspina steinstansana*), Carolina Madtom (*Noturus furiosus*), and Neuse River Waterdog (*Necturus lewisi*). Raleigh, NC.

Ortmann AE. 1919. A monograph of the naiades of Pennsylvania. Part III. Systematic account of the genera and species. Memoirs of the Carnegie Museum, Volume VIII, (1919-1921). No 1. 1-384.

Pandolfo T, Kwak T, Cope W, Heise R, Nichols R, Pacifici K. 2016. Species traits and catchment-scale habitat factors influence the occurrence of freshwater mussel populations and assemblages. Freshwater Biology, 61: 1671-1684.

Pottern G. (2009). 2007 Status Update of the Cape Fear Shiner *(Notropis mekistocholas).* Report for the North Carolina Wildlife Resources Commission.

Strahler, AN. 1952. Hypsometric (Area-Altitude) Analysis of Erosional Topography. Geological Society of America Bulletin 63 (11): 1117-1142.

Strayer DL. 1999. Use of flow refuges by unionid mussels in rivers. Journal of the North American Benthological Society 18: 468-476.

USFWS [US Fish and Wildlife Service]. 1990. James Spinymussel (*Pleurobema collina*) recovery plan. Annapolis, MD. 35 pp.

USFWS. 1992. Tar Spinymussel recovery plan (*Elliptio (Canythria) steinstansana*). First revision. Atlanta, GA. 34 pp.

USFWS. 1993. Dwarf Wedgemussel (*Alasmidonta heterodon*) recovery plan. Hadley, MA. 52 pp.

USFWS. 2013. Dwarf Wedgemussel (*Alasmidonta heterodon*) 5-year review: summary and evaluation. New England Field Office, Concord, NH. 27 pp.

USFWS. 2019a. Dwarf Wedgemussel (*Alasmidonta heterodon*) 5-year review: summary and evaluation. New York Field Office, Cortland, NY. 35 pp.

USFWS. 2019b. Species status assessment report for the Yellow Lance (Elliptio lanceolata). Version 1.5. May 2019. Atlanta, GA.

USFWS. 2020. Tar River Spinymussel (*Parvaspina (=Elliptio) steinstansana*) 5-year review. Addendum 1. Summary of new information obtained since the 2014 5-year review. Atlanta, GA.

USFWS. 2021a. Species status assessment for the Atlantic Pigtoe (*Fusconaia masoni*). Version 1.4, June 2021. Atlanta, GA.

USFWS. 2021b. Species status assessment report for the Carolina Madtom (*Noturus furiosus*). Version 1.2. February 2021. Atlanta, GA.

USFWS. 2021c. Species status assessment report for the Neuse River Waterdog (*Necturus lewisi*). Version 1.2. February 2021. Atlanta, GA.

USFWS 2021d. Species status assessment report for the Green Floater (*Lasmigona subviridis*). Version 1.1. New York Field Office, Cortland, NY.

USFWS. 2022a. James Spinymussel (*Parvaspina collina*) 5-year review: summary and evaluation. Virginia Field Office, Gloucester, VA. 102 pp.

USFWS. 2022b. Species status assessment (SSA) report for the Roanoke Logperch (*Percina rex*). Version 1.1. April 2022. Gloucester, VA.

USFWS. 2022c. Species status assessment report of the Cape Fear Shiner (*Notropis mekistocholas*). Version 1.0. February 2022. Raleigh, NC.

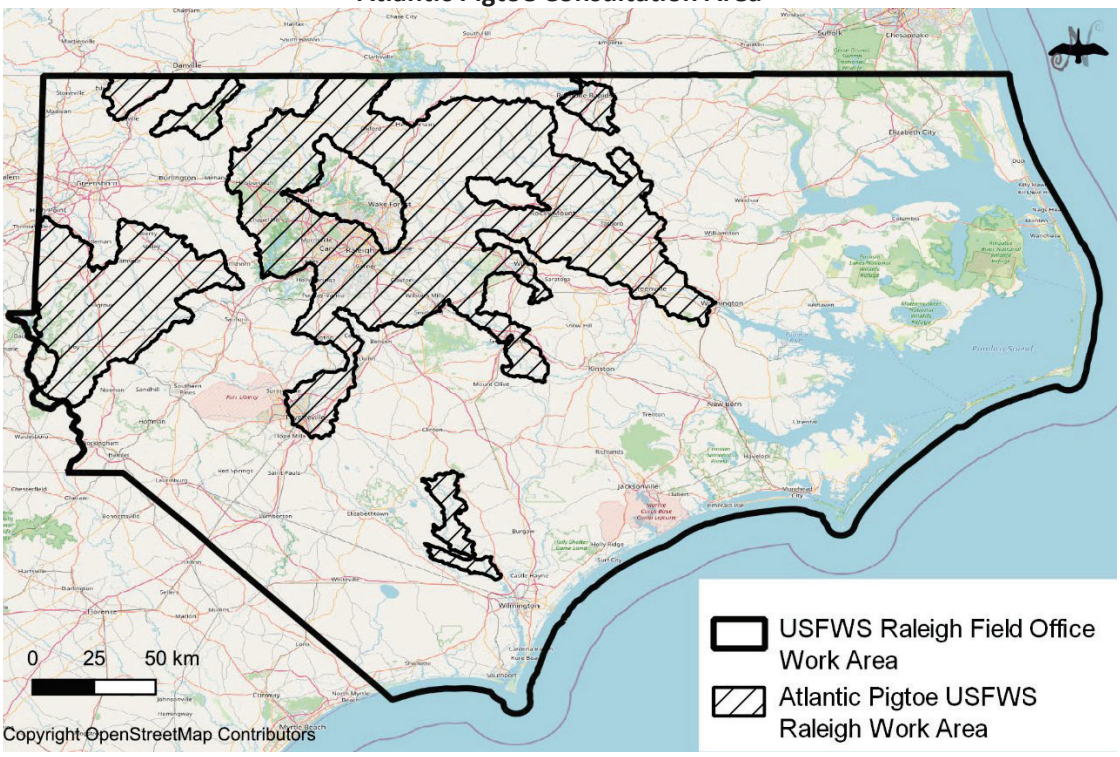
van der Schalie H. 1970. Hermaphroditism among North American freshwater mussels. Malacologia 10(1): 93-112.

Watters GT, Hoggarth MA, Stansbery DH. 2009. The freshwater mussels of Ohio. Ohio State University Press. 419 pp.

WVDNR [West Virginia Division of Natural Resources]. 2008. Conservation status assessment for *Lasmigona subviridis*, green floater (Unionidae). 16 pp.

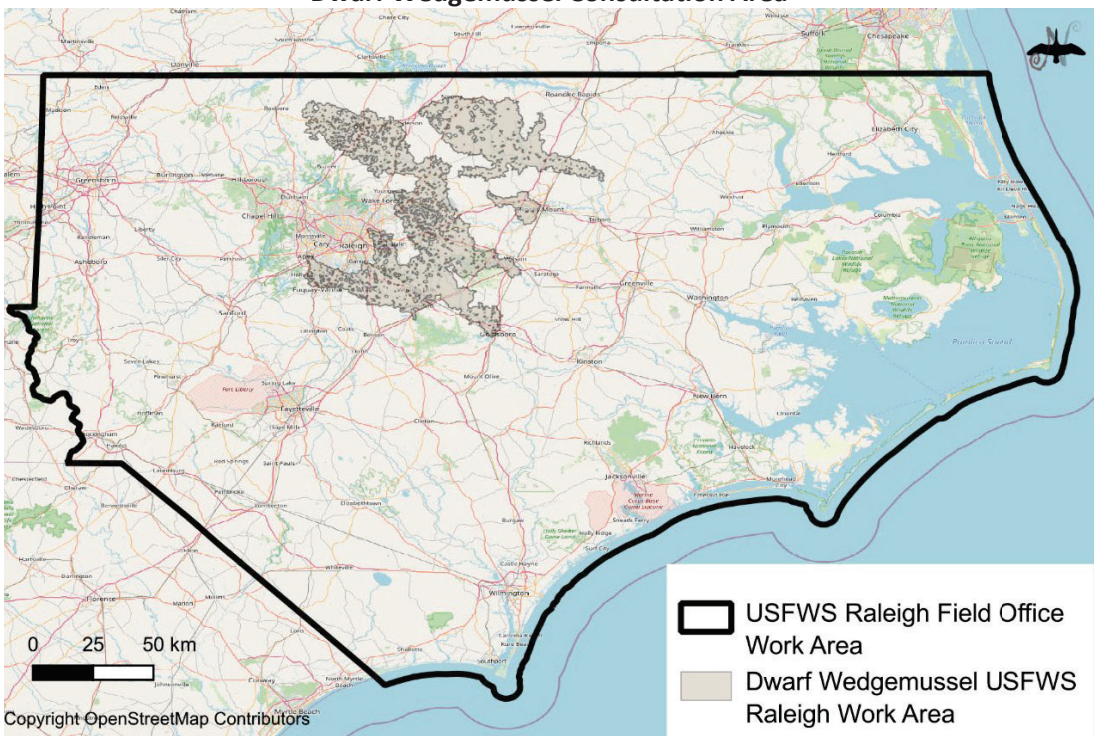
Appendix A – Eastern North Carolina Aquatic Species Group Consultation Areas

Atlantic Pigtoe Consultation Area



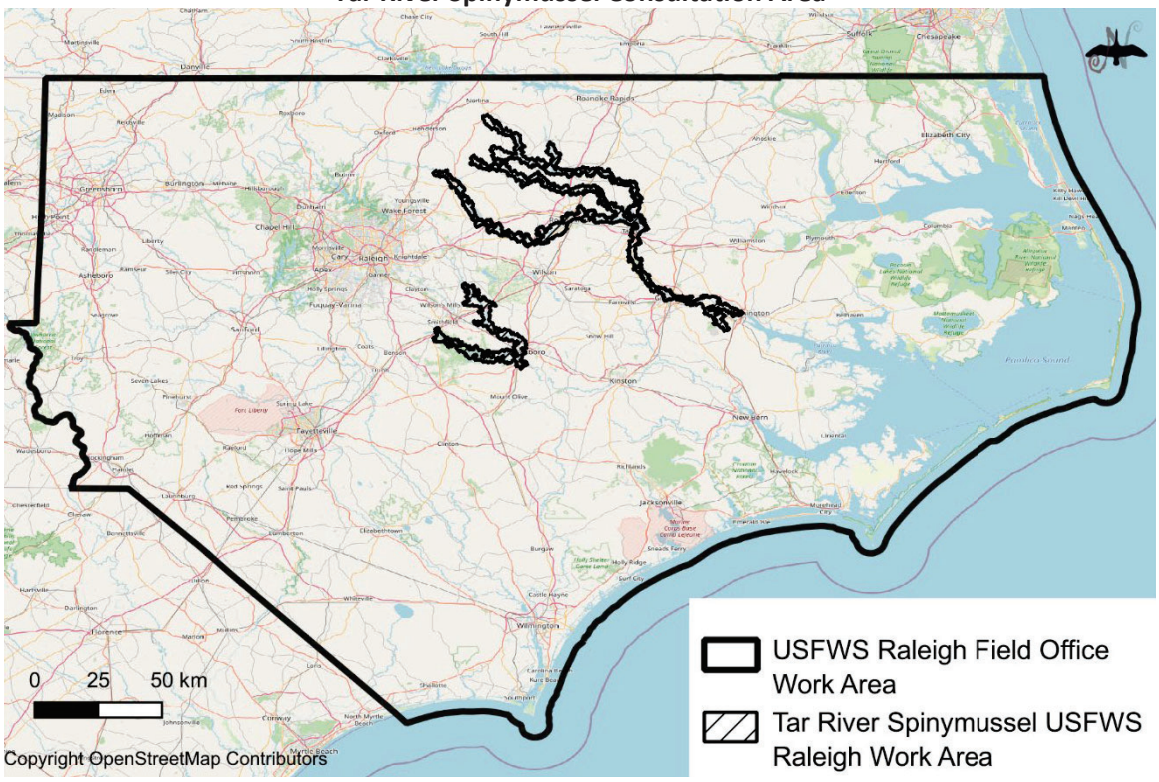
Source: USFWS, 2023

Dwarf Wedgemussel Consultation Area



Source: USFWS, 2024

Tar River Spinymussel Consultation Area



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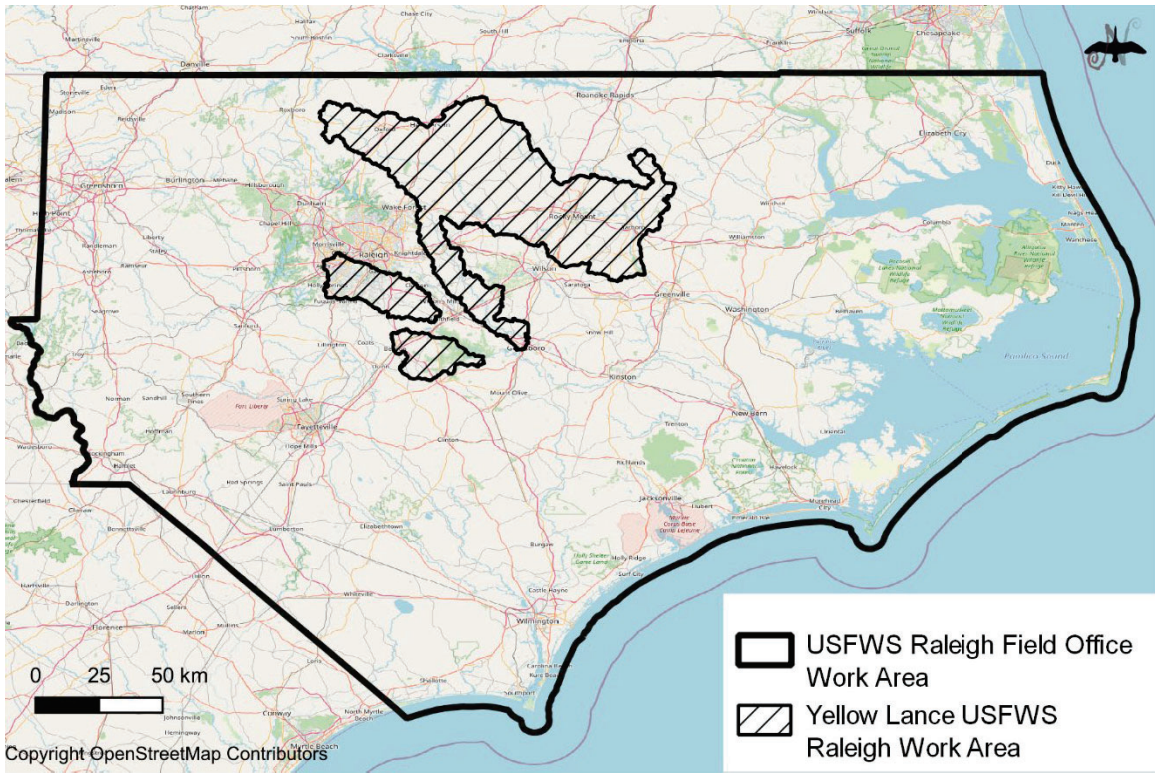
Yellow Lance Consultation Area



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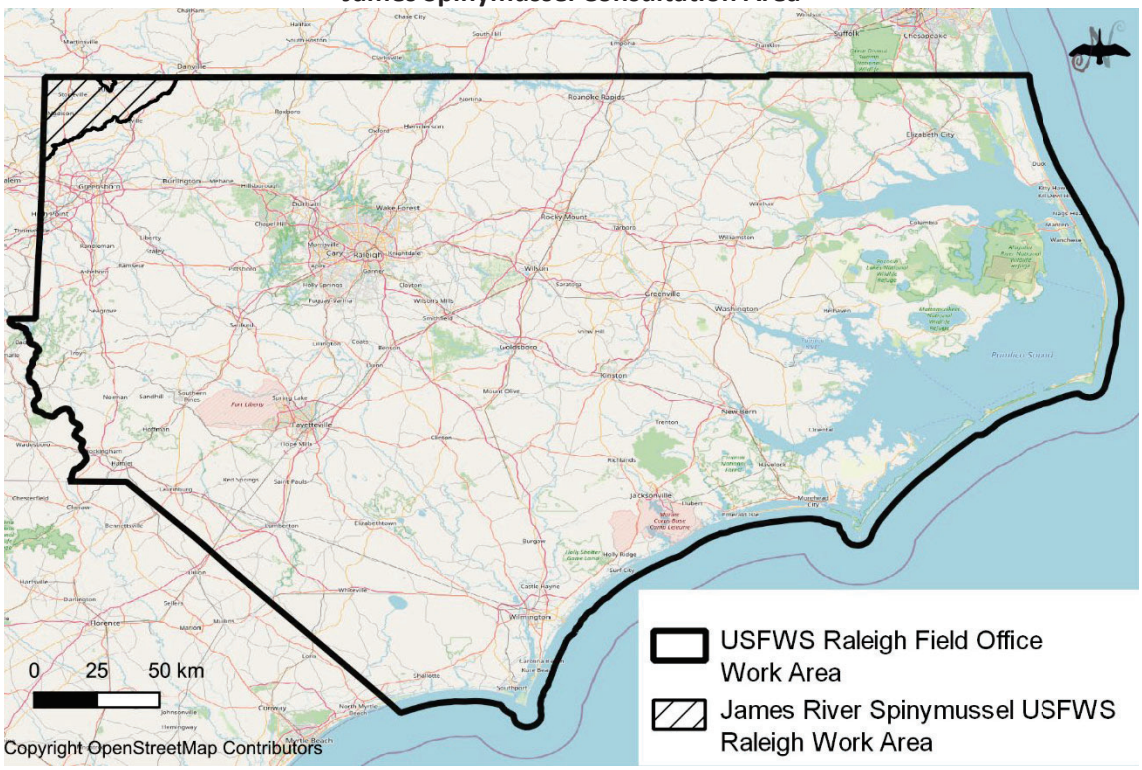
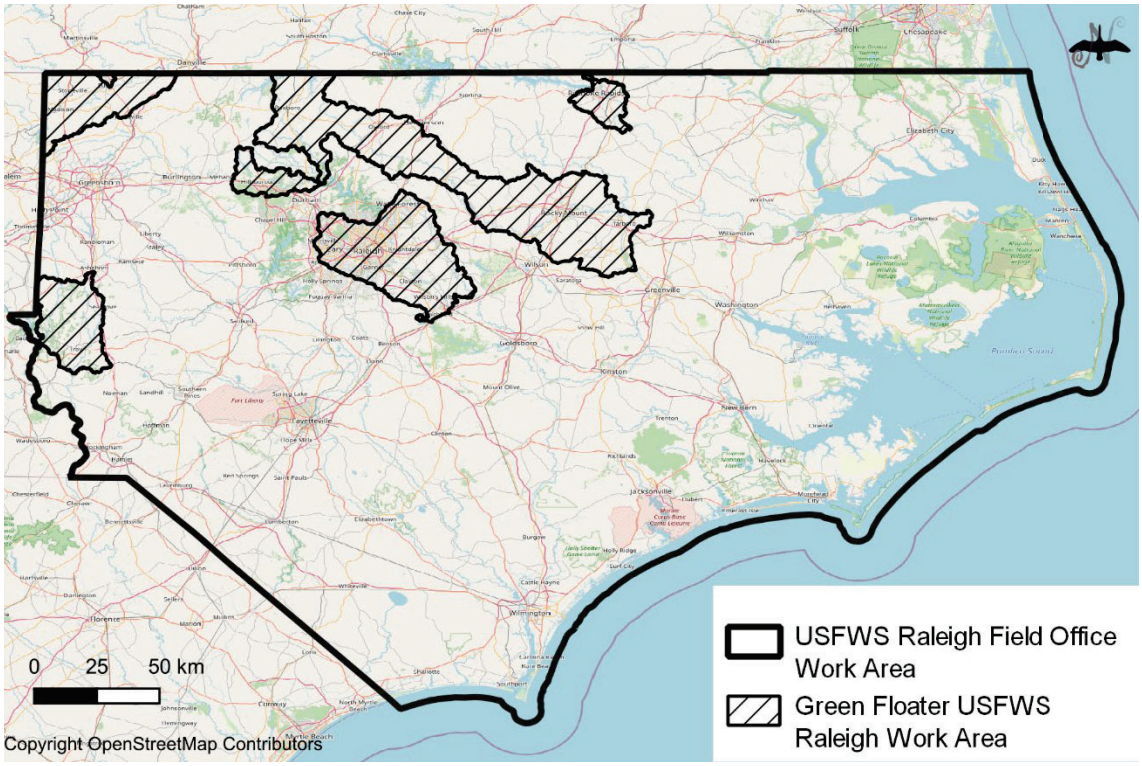
James Spinymussel Consultation Area



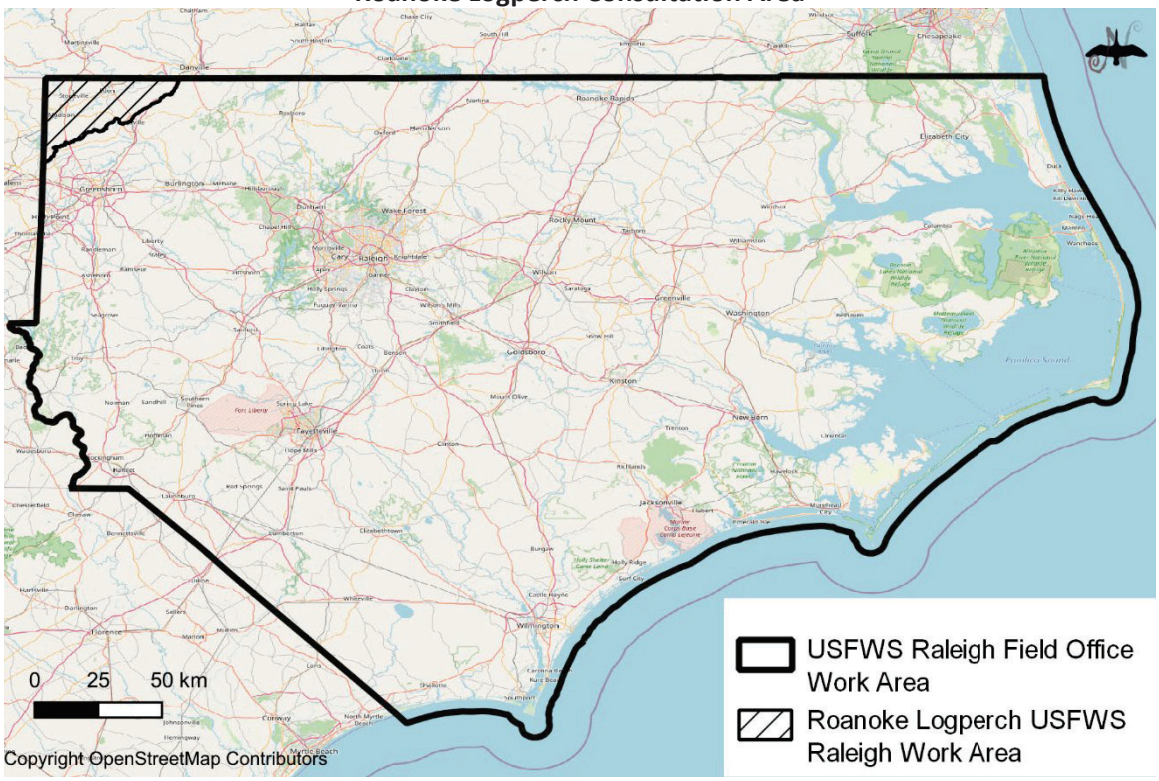
Source: USFWS, 2023

Green Floater Consultation Area



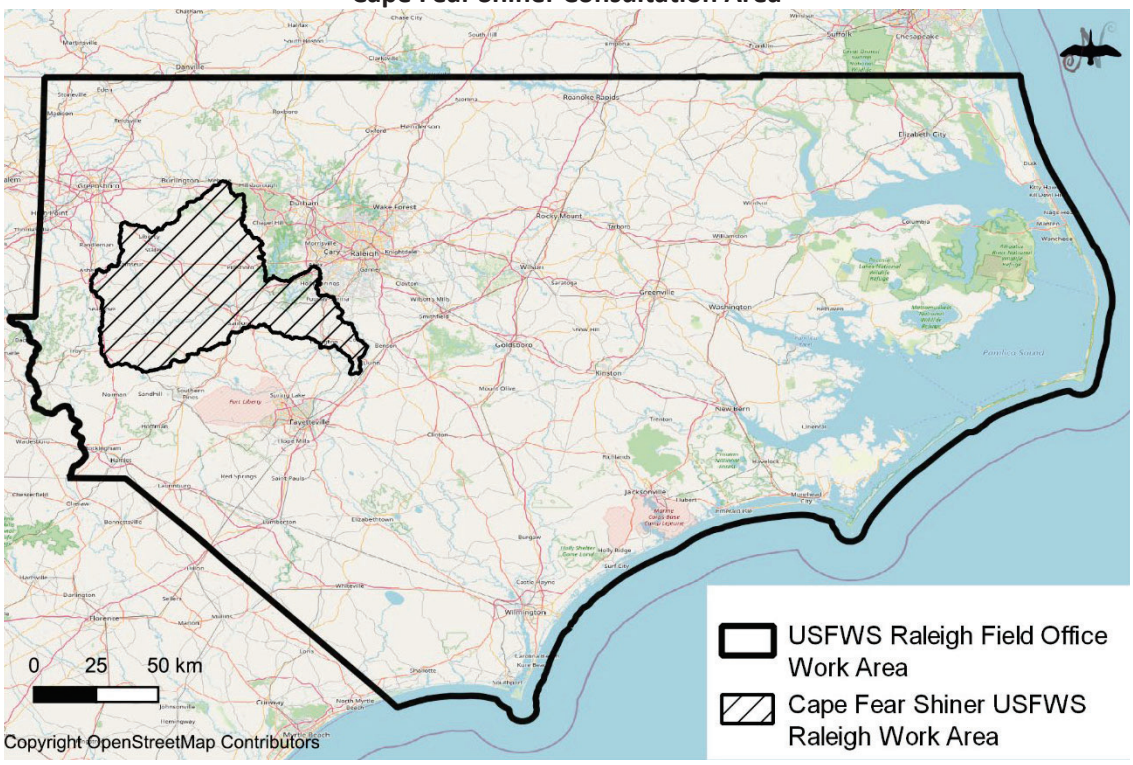
Source: USFWS, 2023

Roanoke Logperch Consultation Area



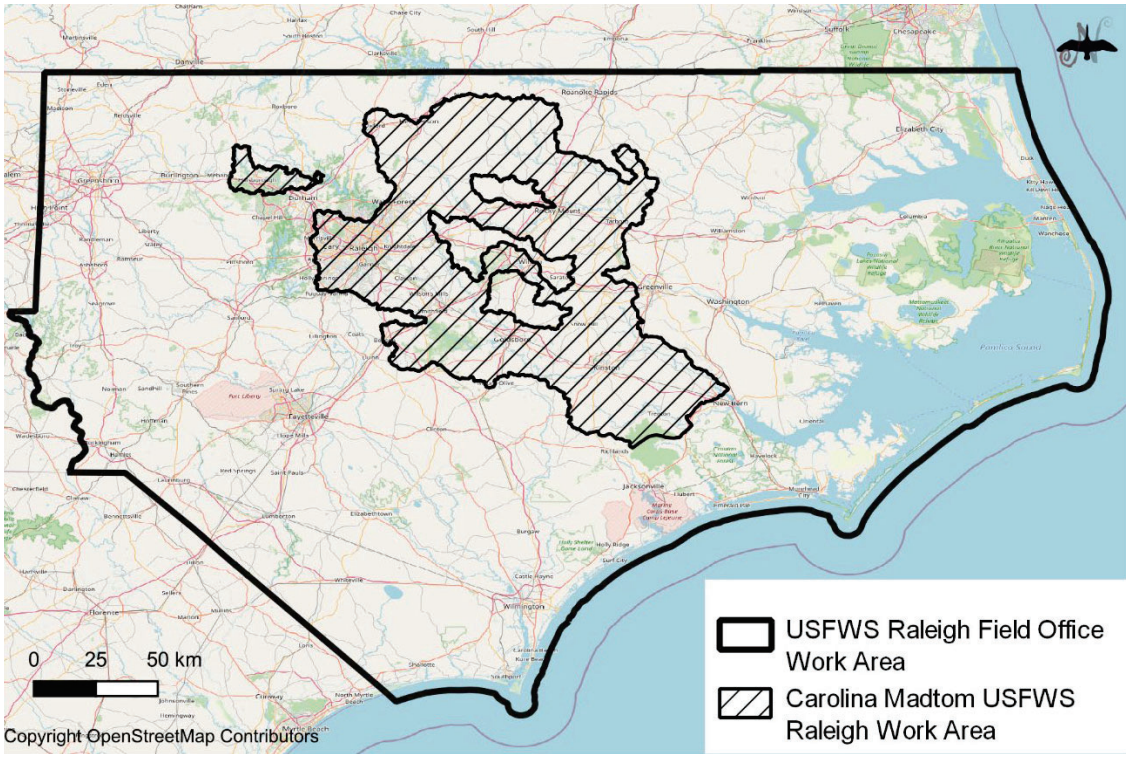
Source: USFWS, 2023

Cape Fear Shiner Consultation Area



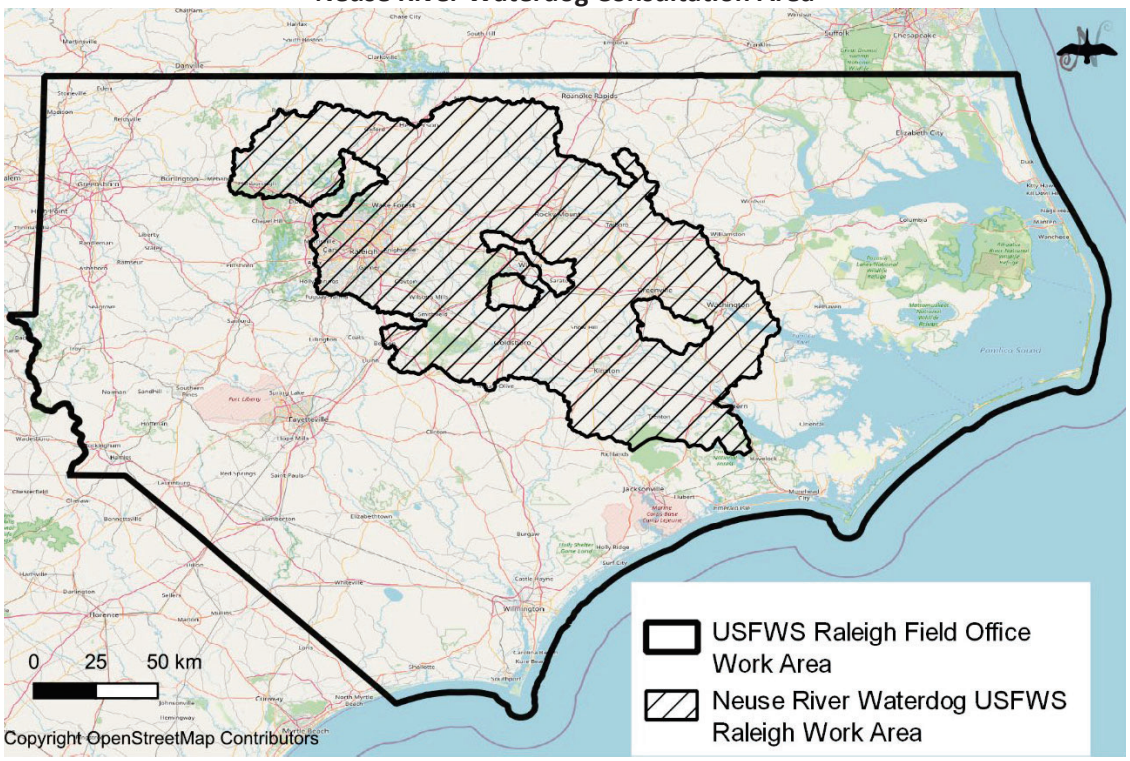
Source: USFWS, 2023

Carolina Madtom Consultation Area



Source: USFWS, 2023

Neuse River Waterdog Consultation Area



Source: USFWS, 2023

Appendix B – Eastern North Carolina Aquatic Species Group Determination Key

Project Name: _____

ORM2 No.: _____ Date _____

USFWS Project Code (from IPaC):_____

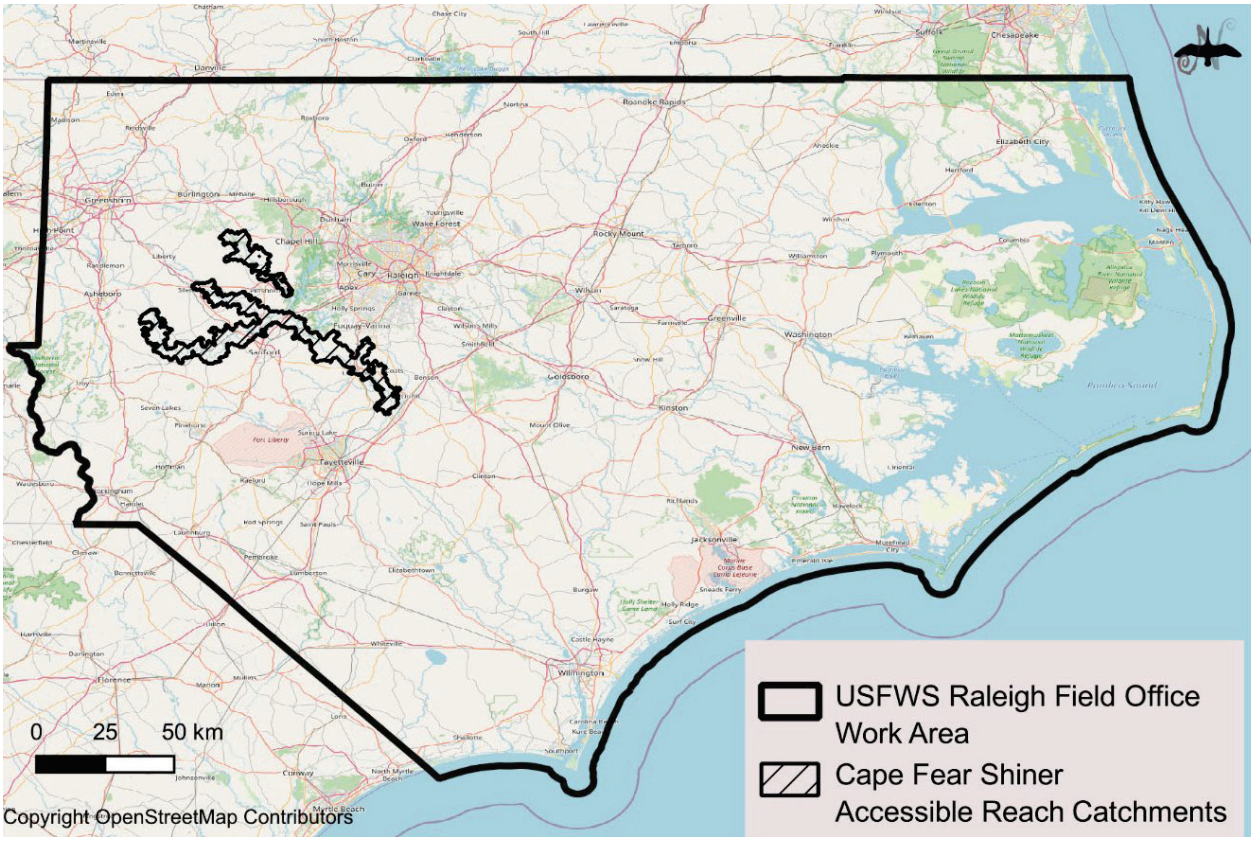
1) Is the project being implemented by or for North Carolina Department of Transportation (NCDOT), **AND** does it meet the description of activities covered by a Programmatic Biological Opinion (PBO) issued for NCDOT projects in NCDOT Divisions 1-8 (e.g., bridge and culvert replacements/repairs/ rehabilitations)?
   a) Yes, the project is covered by an existing PBO for NCDOT activities.....DNQ[1]
   b) No, the project is not covered by an existing PBO (includes NCDOT activities that are not covered by the NCDOT PBO).....go to 2

2) Does the project occur in designated or proposed critical habitat for any listed/proposed species **OR** intersect with an elemental occurrence (see project-specific results from Natural Heritage Program, a site-specific survey, or internal USACE GIS review)?
   a) Yes, the project occurs within critical habitat and/or intersects with an elemental occurrence.....Consultation required[2]
   b) No or Unknown .....go to 3

3) Is the action area[3] located in a target species consultation area (see **Appendix A**, or is a target species listed on your project-specific IPaC species list)? NOTE: If you have Cape Fear Shiner and other target species, please run each species separately through the Dkey.
   a) Yes, but only in the consultation area for Cape Fear Shiner .....go to 4
   b) Yes, but only in a consultation area(s) for target species other than Cape Fear Shiner.....go to 6
   c) No .....No effect[4]

4) Is the project located within one or more of the following?
   i. The floodplain or channel of a waterbody listed for Cape Fear Shiner in **Table 2** (see **Section III**), **OR**
   ii. The catchment of an accessible reach on **Map A** below (also available as **Figure 18 in Section III**).
   a) Yes.....Consultation required[2]
   b) No.....go to 5

Map A. Accessible Reaches for Cape Fear Shiner.
Shapefiles are Available from the USFWS Raleigh Ecological Services Field Office



5) Does the project require Nationwide Permit Nos. 3, 5, 13, 14, 18, 57 or 58[5]? **AND**
   i. The project does not require an impact to a second order or higher stream[6]; **AND**
   ii. The project will meet and comply with all General and Regional Conditions as described in the current Nationwide Permits listed above; **AND**
   iii. The project will not result in the need to submit a Pre-construction Notification as described in the Notification section and Regional Conditions of the Nationwide.
   a) Yes to all questions above [5) and sub-questions i., ii., iii] .....No effect[4]
   b) No to all questions above.....NLAA[7]

6) A Suitable Habitat Assessment[8] should be conducted in the proposed area of impact and the reach of stream within 100 m upstream and 400 m downstream. Provide qualifying descriptions with measurements and photographs to USACE (see **Section III**).
   a) Is suitable habitat for the species being considered located in the proposed area of impact?
      i) Yes.....go to 8
      ii) No.....go to 6b
   b) Is suitable habitat for the species being considered located within 100 m upstream or 400 m downstream of the proposed area of impact?
      i) Yes.....go to 7
      ii) No.....No Effect[4]

7) Does the project require Nationwide Permit Nos. 3, 5, 6, 13, 14, 18, 57 or 58[5]? **AND**
   i. The project does not require an impact to a second order or higher stream[6]; **AND**
   ii. The project will meet and comply with all General and Regional Conditions as described in the current Nationwide Permits listed above; **AND**
   iii. The project will not result in the need to submit a Pre-construction Notification as described in the Notification section and Regional Conditions of the Nationwide.
   a) Yes to all above [7) and sub-questions i., ii., and iii.] ……No effect[4]
   b) No to one or more questions above……Go to 8

8) Contact the appropriate USACE representative for a pre-application meeting to determine if a survey is necessary (for a list of USACE representatives please see the contact list at https://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program/Contact/). Note that project specific information, such as a delineation of waters of the U.S. and project plans, may be needed for the USACE to determine the action area(s) of the project. If a survey is required and agreed to by the applicant, all suitable habitat within 100 m upstream and 400 m downstream of the action area should be surveyed[9]. If the applicant is unwilling or unable to conduct the survey, standard consultation with the USFWS should begin. Was a survey performed?
   a) Yes, the survey was submitted to the USFWS for concurrence, and the USFWS concurred with the results (no listed species were observed and any recommended conservation measures from USFWS will be incorporated as permit conditions)……NLAA[7]
   b) Yes, a survey was performed and listed species were observed……Consultation required[2]
   c) No, the USACE determined that a survey was not required and USFWS concurred …….. NLAA[7]
   d) No, a survey was not performed OR assumed presence……..Consultation required[2]

[1]DNQ – Your project does not qualify for use of this SLOPES Dkey. Please refer to the most recent PBO that is applicable for your project.

[2]Consultation required - Contact the USACE to begin this consultation process. For a list of USACE representatives please see the contact list at: https://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program/Contact/. Further consultation with the USFWS Raleigh Field Office is necessary to discern if the activity would result in a "no effect", "not likely to adversely affect", or "likely to adversely affect" determination.

[3]Please contact the appropriate USACE representative for any questions as to the size of the action area. For a list of USACE representatives, please see the contact list at: https://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program/Contact/.

[4]No effect - The proposed project would result in no effect to this species and/or its federally designated critical habitat (if applicable). Further consultation with contact the USFWS Raleigh Field Office is not necessary for the project as described.

[5]Nationwide Permit Program (https://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program/Permits/2017-Nationwide-Permits/)

[6]Stream order should be determined in accordance with the Strahler Stream Order method (Strahler 1952).

[7]NLAA - The proposed project may affect but is not likely to adversely affect this species and/or its designated critical habitat (if applicable). NLAA determinations for projects made pursuant to this key require no further consultation with the USFWS Raleigh Field Office, therefore, consultation is considered complete for this species. For General Permits, a Pre-Construction Notification will be required for all NLAA determinations.

[8]Suitable Habitat Assessments – Habitat evaluations to determine if suitable habitat is present for this/these species should describe instream habitat conditions (e.g., substrate, flow regime, meso-habitats, presence of lithic and/or woody structure) as well as riparian habitat conditions (e.g., vegetative community structure, floodplain connectivity, evidence of erosion).

[9]Survey Guidance - A Section 10 ESA *Recovery Permit* is required. Surveys should be conducted by qualified biologists who are familiar with appropriate survey techniques for freshwater mussels and fish. The surveyors should be experienced in identification of target species. If surveys cannot be conducted by a qualified biologist, then consultation with the USFWS is required.

Additional Information _____

Appendix C – Conservation Recommendations

For project reviews that have resulted in a "No Effect" or May Affect, Not Likely to Adversely Affect" determination through the Dkey, these recommendations are optional and if implemented would support the agency's goals toward recovery. These recommendations are to be used at the discretion of the permittee, but any measures that avoid and minimize effects to the species are highly encouraged by the USFWS. For projects that have received a Dkey result of "Consultation Required," please note that USFWS may expect the applicant to incorporate many of these avoidance and minimization into the project plan in order to complete consultation.

These aquatic animals are sensitive to perturbations in water quality and alterations to physical habitats. Work activities in streams and in riparian areas that increase sedimentation, degrade water quality, alter geomorphic processes, and/or modify flow regimes could have direct and/or indirect impacts on the species' habitats. Work in areas upstream of sensitive species and habitats may cause adverse effects to them. Some of these recommendations may be required by state or local regulations or permits. However, where not required, we offer the following recommendations to protect aquatic species:

Equipment Use in Riparian Areas and in Streams

- Instream work should be avoided to the maximum extent practical. If instream work is necessary, stone causeways, work bridges, or mats (designed for the specific location and type of equipment) should be used.
- Minimize disturbance to woody vegetation. Areas where tree removal is not required and access is not otherwise needed should be fenced during construction to prohibit vehicle entry.
- Equipment operated in riparian areas and in or near aquatic resources should be inspected daily and maintained regularly to prevent contamination of surface waters from leaking fuels, lubricants, hydraulic fluids, or other toxic materials.
- Construction staging, toxic material storage, and equipment maintenance, including refueling, should occur outside of the riparian area. The project proponent should report any toxic material spills in riparian areas and/or aquatic resources to the USFWS within 24 hours.

Erosion and Sediment Control

- Measures to control sediment and erosion should be installed before any ground disturbing activities occur.
- Grading and backfilling should be minimized, and existing native vegetation should be retained (if possible). For example, leave individual lots wooded for as long as possible.
- Disturbed areas should be revegetated with native vegetation as soon as the project is completed. Revegetate with native species. *Sericea lespedeza* is invasive and should not be used for stabilization or revegetation. Cleared areas that are not intended for long-term maintenance should be revegetated with native trees and shrubs.
- Ground disturbance should be limited to what will be stabilized quickly, rather than clearing larger areas that may remain unstabilized for days or longer.
- Temporary and permanent stabilization measures should include only natural materials that are expected to degrade over time.

- Silt fence and other erosion control devices should not include outlets that discharge closer than 50 feet to the top of bank of any stream.
- If more than one row of silt fence is used, silt fence outlets for each row of silt fence should be offset to provide additional retention of water and sediment in the outer row.
- Conduct twice-weekly inspections of all erosion and sedimentation controls. In addition to twice-weekly inspections, inspect also within 24-hours of rain events (including a 1-inch total rain event or an event where rainfall rates are 0.3 inch/hour or greater). Inspect all of the erosion and sedimentation controls to ensure the integrity of the devices.

Riparian and Wetland Buffers

- Create and maintain forested riparian buffers (a minimum 50 feet wide along intermittent streams and 100 feet wide along perennial streams [or the full extent of the 100-year floodplain, whichever is greater]) along all aquatic areas.
- Impervious surfaces, ditches, pipes, roads, utility lines, and other infrastructures that require maintained, cleared rights-of-way and/or compromise the functions and values of the forested buffers should avoid riparian areas to the maximum extent practical.

Road Crossings

- Consider the use of bridges or spanning structures for all permanent roadway crossings of streams and wetlands. Structures should span the channel and the floodplain in order to minimize impacts to aquatic resources, allow for the movement of aquatic and terrestrial organisms, and eliminate the need to place fill in streams and floodplains. Culverts should be sufficiently sized to mimic natural stream functions and habitats located at the crossing site; allow for water depth, volume (flow), and velocity levels that will permit aquatic organism passage during all flow regimes; and accommodate the movement of debris and bed material during bankfull events.
- Culverts should be designed and installed at the same slope as the stream grade to maintain an acceptable water velocity for aquatic life passage and for stream substrate characteristics to be retained within the culvert.
- Multiple barrels, in addition to the low flow barrel(s), should be installed to accommodate flood flows. Floodplain barrels should be placed on or near stream bankfull or floodplain bench elevation and discharge onto floodplain benches. Where appropriate, install sills on the upstream end of floodplain barrels to restrict or divert the base stream flow to a single barrel.
- Where culverts are longer than 40 linear feet, alternating or notched baffles should be installed in a manner that mimics the existing stream pattern. This will enhance the passage of aquatic life by: (1) depositing and retaining sediment in the barrel, (2) maintaining channel depth and flow regimes, and (3) providing resting places for fish and other aquatic organisms.

Storm Water Controls and Low Impact Development

- Where detention ponds are used, storm-water outlets should drain through a vegetated area prior to reaching any natural stream or wetland area.
- Design and utilize stringent stormwater controls. Where possible, design stormwater systems to attenuate the 1- to 100-year storm.

- Design the discharge outlet from stormwater infrastructure to avoid stream buffers, including the dissipator pad or any other structures.
- Detention structures should be designed to allow for the slow discharge of storm water, attenuating the potential adverse effects of stormwater surges, and polluted discharges.
- No stormwater control measures or best management practices should be installed within any stream or wetland. Retention ponds should be located at least 750 feet from wetlands to minimize hydrologic disturbance and ecological function. Consider using pervious materials (i.e., pervious concrete, interlocking/open paving blocks) for the construction of roads, driveways, sidewalks, etc. Pervious surfaces minimize changes to watershed hydrology and may facilitate groundwater recharge. Pervious materials are also less likely to absorb and store heat. Pervious concrete requires less maintenance and is less susceptible to freeze/thaw cracking.