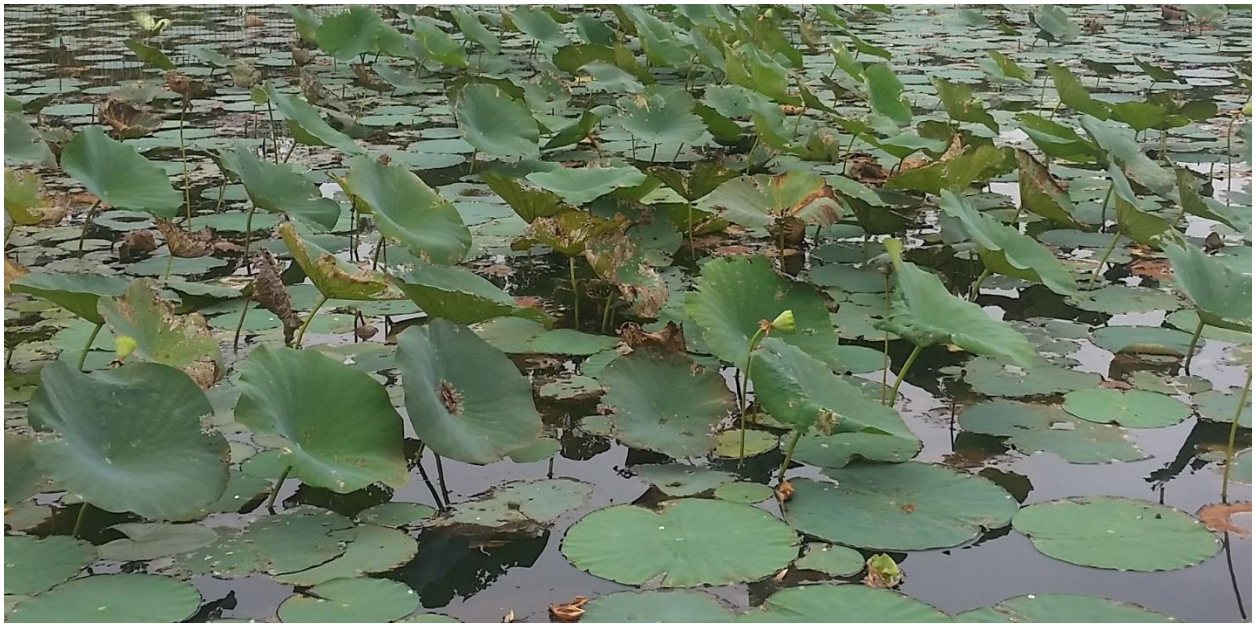
Harris Lake 5-Year Aquatic Habitat Enhancement Plan

2018-2022



NORTH CAROLINA Wildlife RESOURCES COMMISSION

Inland Fisheries Division

Updated: January, 2021

Objectives: The purpose of this 5-year plan is to address aquatic habitat needs in Harris Lake and maintain a balanced and popular fishery. To meet this objective the Commission proposes to enhance aquatic habitat by deploying approximately 30 acres of artificial and natural structure (400 to 700 fish attractors and at least 20 felled shoreline trees) and establish founder colonies totaling 1 acre of native vegetation.

Need: Harris Lake has an excellent Largemouth Bass *Micropterus salmoides* and Black Crappie *Pomoxis nigromaculatus* fishery in North Carolina. It was ranked 4th in the nation for best bass lakes in America and first in the southeast region by Bassmaster Magazine in 2017 (Bassmaster 2017). It has diverse aquatic habitat, including rock outcroppings, flats, roadbeds and aquatic vegetation. Hydrilla *Hydrilla verticillata*, a federally noxious and a Class A noxious weed in North Carolina, is present in the reservoir. Hydrilla is spreading from Harris Lake into other water bodies, including the Cape Fear River and Jordan Lake. In December 2018, the North Carolina Division of Water Resources – Aquatic Weed Program (NCDWR–AWP) implemented a management program to control Hydrilla using triploid Grass Carp in Harris Lake. A total of 4,000 triploid Grass Carp have been stocked in the lake so far, with 1,400 fish stocked in December 2018 and 2,600 fish stocked in May 2019. The potential loss of habitat may result in changes in fish behavior and could decrease angler catch rates. Offering other natural and artificial structures, including native aquatic vegetation for fish to utilize could help maintain angler catch rates and satisfaction.

Expected Results and Benefits: This 5-year plan identifies existing habitat, including native and exotic vegetation, bathymetry, natural features, and other existing natural and artificial structure and proposed enhancements. Habitat enhancements provide structure for fish utilization and provide areas for anglers to target. Native aquatic vegetation should help maintain water quality in the reservoir. The habitat plan will be evaluated periodically to adjust enhancement activities as needed and to develop the next 5-year habitat plan.

Background and Existing Conditions

Harris Lake is a 4,100-acre reservoir located in Chatham and Wake counties, North Carolina, near the town of New Hill (Figure 1). The reservoir serves as make-up cooling water for the Shearon Harris Nuclear Electrical Generation Station and general operational water supply for the nuclear station. The reservoir was created by impounding White Oak and Buckhorn creeks, which drain into the Cape Fear River, and reached full pool in 1981. The reservoir is utilized for recreational use including fishing, boating, and hunting. The reservoir is accessed using two Commission-maintained public boating access areas and the 600-acre Harris Lake County Park, operated by Wake County.

There is no direct shoreline homeownership. A wide shoreline buffer zone along the entire perimeter of the reservoir was created due to initial environmental requirements, agreements with state natural resource agencies and potential future lake expansion to support increased nuclear station operations.

With increasing watershed development, lake managers are concerned the reservoir will shift to a more alga dominated system with higher nutrients, turbidity and siltation. This could result in a loss of submerged aquatic vegetation (SAV) and higher Chlorophyll-a concentrations

and push the reservoir to a hyper-eutrophic level. Additional silt in the upper creek arms could reduce habitat and capacity in the reservoir.

Existing Conditions at the Beginning of the Project

Fisheries.—Harris Lake is a productive eutrophic reservoir that supports a multi-species fishery consisting of Largemouth Bass, Black Crappie, sunfish species *Lepomis* spp., Channel Catfish *Ictalurus punctatus*, White Catfish *Ameiurus catus*, bullhead catfishes *Ameiurus* spp., Chain Pickerel *Esox niger*, and White Perch *Morone americana*. Additionally, Gizzard Shad *Dorosoma cepedianum* and Threadfin Shad *Dorosoma petenense* play an important role in the food web at Harris Lake. During a 1997–1998 creel survey at Harris Lake, Largemouth Bass fishing was the most popular of all species and accounted for 67% of the directed effort, while crappie fishing accounted for 17% of directed effort (Jones et al. 2000).

The Commission monitors changes in size structure, condition, recruitment, and growth within the Largemouth Bass and Black Crappie fishery every two years. Duke Energy monitors the whole lake fish community annually. Any changes in these attributes from Hydrilla removal should be captured in the routine monitoring. Additional information on the game fish can be found at: https://www.ncwildlife.org/Fishing/Learn-Resources/Monitoring-Surveys/Fishing-Summary-Fact-Sheets.

Aquatic Habitat.—Harris Lake was cleared of all woody habitat prior to filling. There is no standing timber in the reservoir and only a few stumps remain in select coves. Despite the lack of standing timber, Harris Lake has diverse aquatic habitat, including rock outcroppings, flats, roadbeds, creek channels and aquatic vegetation. The existing habitat provides forage, refuge, spawning, nesting, and nursery areas for species that utilize structure, such as Black Crappie, Largemouth Bass, bluegill and other sunfish. In addition to the natural habitat, five fish attractor reef sites were in the reservoir at the beginning of the project. The reefs consist of a variety of artificial fish attractors, including Mossback trophy trees, stake beds, barrel structures, and polytrees.

Aquatic plants can play a major role as a food source for aquatic invertebrates and other wildlife and as juvenile and adult fish habitat (Dibble et al. 1996). This can be dependent on the species and abundance of both the fish and the vegetation. Aquatic plants can also improve water clarity and quality (James and Barko 1990) and can reduce rates of shoreline erosion and sediment resuspension (James and Barko 1995).

Visual aquatic vegetation surveys were conducted by Duke Energy from 1987 to 2016 (Duke Energy Progress 2013; DEP 2016) and by the Commission in October 2017 and October 2018 (this document). A detailed submerged aquatic vegetation survey (SAV) was conducted in the fall of 2015 by North Carolina State University (NCSU) (personal communication) and by NC DWR-AWP in 2018 (NCDWR 2020). Duke Energy's visual surveys focused on aquatic vegetation that could cause problems with the nuclear power plant's water intake cooling system. They identified Hydrilla with varying abundance throughout the entire main reservoir. Also present was bladderwort *Utricularia spp*., southern naiad *Najas spp*., slender spike rush *Eleochris baldwinii*, fanwort *Cabomba caroliniana* and creeping water primrose *Ludwigia spp*. Of these species, hydrilla, southern naiad and bladderwort were deemed of potential concern regarding

intake fouling. The detailed 2015 NCSU SAV survey found approximately 942 acres of hydrilla while the 2018 NC DWR-AWP survey identified only 230 acres. Officials do not know the exact cause for the decline in hydrilla.

The Commission's whole lake visual survey focused on emergent and rooted floating leaf plants along the shoreline. White Oak Creek, Little White Oak Creek and Tom Jacks Creek arms appeared to have greater than 60% of their shoreline with varying species of aquatic vegetation. The most common emergent plants included giant cutgrass *Zizaniopsis miliacea*, squarestem spikerush *Eleocharis quadrangulate*, cattail *Typha spp*. and creeping water primrose. These species, except for creeping water primrose were found at the water's edge to about 0.6 meter deep. The rooted floating leaf plants, American lotus *Nelumbo lutea*, white water lily *Nymphaea odorata* and spatterdock *Nuphar advena* [*N. lutea*] were primarily found in White Oak and Little White Oak Creek arms. Aquatic vegetation was less prevalent in the southern portion of the reservoir.

Approach

The presence of hydrilla has been positively correlated with angler catch rates for Largemouth Bass (Bonvechio and Bonvechio 2006); however, removal of this invasive macrophyte is shown to affect Largemouth Bass behavior and not abundances or size structure (Bettoli et al. 1993; Sammons et al. 2003). Changes in Largemouth Bass behavior in response to hydrilla removals could be perceived by anglers as decreased abundance until angler habits change as well. As fisheries managers, understanding this change in behavior and offering other structures for anglers to utilize could help maintain angler satisfaction. Largemouth Bass are known to have increased attraction to structure with high vertical profiles (Prince and Maughn 1979; Rodgers and Bergersen 1999), as well as structures that provide shade for ambushing prey (Helfman 1981). Sammons et al. (2003) found that Largemouth Bass switched primarily to large woody debris once large quantities of hydrilla were removed. Habitat enhancement, including artificial habitat, large woody debris, and native aquatic vegetation should be used to provide habitat for sportfish and give anglers specific areas to target fish.

Proposed Habitat Enhancements

All habitat work will be completed in areas in the reservoir where oxygen levels are adequate for fish to use year-round, characterized as the Habitat Enhancement Zone (Clark-Kolaks 2015). During summer months fish can utilize habitat down to 20ft in the deepest parts of the lake (pers. comm., Rob Nichols–Duke Energy). The Habitat Enhancement Zone is approximately 2400 acres (Figure 2). The proposed work will enhance over 31 acres or 1.3% of the Habitat Enhancement Zone.

Public Involvement.—Public input has been crucial to the development of this plan, including the design and site selection of artificial fish attractors and of habitat enhancement work. The Commission sought public input by providing an on-line habitat survey, holding a large public information meeting in October 2018, attending the January 2019 Bass and Saltwater Fishing Expo in Raleigh, presenting the habitat plan to several local fishing clubs, and facilitating a stakeholder group. The stakeholder group consists of representatives of state and local fishing clubs, a local fishing guide, Duke Energy, Harris Lake County Park, NC B.A.S.S., NC

Division of Environmental Quality, and the Commission. The stakeholder group will prioritize work over the 5-year period and meet periodically to update this plan and ensure the overall success of this project.

The amount of work being proposed is extensive. To implement this plan, volunteers are needed to help build and place artificial structures and help establish native aquatic vegetation. The Commission staff continue work with state and local fishing clubs and other user groups to develop and implement the habitat enhancement plan. Design, construction, and placement of all aquatic habitat will be approved by the Commission and Duke Energy. Commission staff will always be on site during enhancement activities to supervise and assist in construction and placement of artificial fish attractors and planting native aquatic vegetation.

Artificial Habitat.—Artificial habitats are designed to be effective, long-lasting structures that fish utilize for feeding, cover, and spawning, while providing increased opportunities for anglers to catch fish. Artificial habitats are designed to serve multiple purposes. They can provide areas for algae attachment, aquatic insect colonization, and other food organisms which may increase fishery production. Complex structures provide better refuge for small fish, while less complex cover in nesting areas is effective habitat for spawning activities.

The proposed goal is to place approximately 30 acres of natural and artificial habitat structure (approximately 400 to 700 fish attractors) throughout the reservoir. Fish attractors (Appendix A) will be placed throughout the reservoir at varying depths and habitat features (e.g., flats, creek channels, points, roadbeds) to ensure seasonal use by a variety of fish species. Additionally, artificial fish attractor sites will be identified by anglers to maximize use and satisfaction; proposed sites will be vetted by Commission biologists and selected for enhancement. Angler-selected enhancement sites from outreach efforts are identified in Figure 3. Commission biologist identified three shallow water habitat coves (Figure 4) that could be enhanced with a large quantity of natural and artificial structure. Scientific literature hasn't identified an optimal target acreage or percent surface area of artificial habitat that would measurably benefit Largemouth Bass or Black Crappie in large reservoirs. The exact number and type of structures placed will depend on the amount of current habitat available, habitat loss from hydrilla removal, and the amount of area that is available for fish to use throughout the year (i.e. Habitat Enhancement Zone; Clark-Kolaks 2015).

Habitat structures, especially when combined have a greater impact (acreage) than their respective footprint upon organisms that use them. The space between the structures and around the complex's periphery adds to the overall habitat. The impact acreages identified in Table 2 are adapted from Clark-Kolaks (2015) or based on best estimate of being slightly larger than the structure.

All fish attractor sites will be identified with GPS coordinates that are available to download and view from the Commission's website (www.ncpaws.org/ncwrcmaps/fishattractors). Artificial structure sites will only be marked with GPS coordinates if the top of the structure is 7ft below the full pool water surface or in approximately 12ft of water. These depth requirements facilitate safe boating recreation, even during periods of low water. Water elevation can fluctuate up to 4ft during severe drought conditions (pers. comm., Rob Nichols–Duke Energy). Three additional feet below this water level will provide a safe depth to reduce

boating accidents (Clark-Kolaks 2015). To reduce the number of buoys in the reservoir, only artificial structures placed in water less than 12ft deep will be marked with a fish attractor buoy. Larger shallow water reef sites or designated shallow habitat coves will be marked with multiple hazard buoys around the reef or at the mouth of the cove warning boaters about underwater structure (Figure 4).

Native Aquatic Vegetation.—The Commission proposes to complete the multi-year revegetation project in two phases. Phase 1 involves developing a list of resilient plant species for revegetation (Table 1, Appendix B), mapping existing vegetation, identifying areas for re-vegetation throughout the lake (plant protection areas, low development, low priority for chemical control) and planting and monitoring a variety of plant species within and outside of small protective fenced exclosures. Phase 1 will also focus on transplanting existing native aquatic vegetation. The Commission will follow draft protocols to minimize the risk of moving non-target plant and animal species (NCWRC 2017). To reduce competition from hydrilla, it may be necessary to treat the revegetation areas with herbicide. Monitoring during Phase 1 will help us ascertain the levels of protection needed from grazers and determine which species will likely result in the successful establishment of founder colonies. This information will dictate the best course of action to take during subsequent growing seasons (Phase 2). The size and number of protective exclosures will be expanded in Phase 2 and should result in the successful establishment of at least one-acre total of all founder colonies. Once established, these colonies should expand by either vegetative spreading from the colony or through colonization (formation of new colonies from fragments, seeds, etc.; Smart et al. 1996, 1998). Studies have suggested that about 20 to 30% vegetated cover of the entire reservoir was optimal for age-0 Largemouth Bass survival (Durocher et al. 1984; Dibble et al. 1996; Maceina 1996).

Native aquatic revegetation sites and plants will be selected based on location within the reservoir (coves, creek arms, and other protected areas), soils, water depth and potential for fish habitat use and water quality improvement. Revegetation work will focus on establishing emergent, submerged, and rooted floating leaf plants, with an emphasis on plants currently found in the reservoir (Table 1). The proposed revegetation sites and species list are based in part on the October 2017 survey and provide a starting point for enhancement work. They may be modified and expanded based on public input, detailed survey results, and monitoring results.

To reduce navigation issues, exclosures will only be placed in near-shore areas unlikely to be utilized by boat traffic and highly visual yellow fence guards will be placed on top of the exclosures. Corners may also be marked with PVC pipe with reflective tape at the top. Sites will be marked with signs letting anglers know the fencing and plants are to restore and improve aquatic habitat.

Felled Shoreline Trees.—Felled shoreline trees can provide excellent fish habitat. Largemouth Bass, crappie, and other gamefish use submerged trees in a variety of ways, including foraging, refuge, spawning and recruitment. Large branching hardwood trees are more suitable because the complex branching creates better fish habitat. Trees should be felled in areas with sufficient shoreline depth (>10ft) and cabled to their stump to ensure the trunk will not float off and cause a boating hazard (Houser 2007). During the October 2018 whole lake

survey, 23 trees were identified as possible candidates for felling and cabling to the shoreline (Figure 5). To ensure safety, qualified Commission staff will fell and cable all shoreline trees.

Project Timeline and Work Completed

The proposed aquatic habitat enhancement work is anticipated to occur over a period of five years. The timeline will be updated annually to reflect work completed each year.

Year 1 – 2018

- Surveyed existing habitat, including native and exotic vegetation, bathymetry, natural features, and other existing natural and artificial structure and identify potential sites for habitat enhancement.
- Obtained public input on locations and type of artificial structures that could be used to improve aquatic habitat.
- Developed a habitat enhancement plan.
- Established 6 artificial habitat sites (11 total) identified in the plan using 50 Polytrees.
- Established 3 native vegetation founder colonies using vegetation currently found in the reservoir.

Year 2 – 2019

- Initial stakeholder meeting
- Established 57 artificial habitat sites (68 total) identified in the plan using 273 artificial structures (Figure 6).
- Established 26 native vegetation founder colonies using vegetation currently found in the reservoir.
- Assessed vegetation founder colonies.

Year 3 – 2020

- Stakeholder meeting
- Constructed over 150 artificial structures.
- Planted 51 native vegetation founder colonies sites using over 1,400 plants (Figure 7).
- Assess vegetation founder colonies.

Year 4 – 2021

- Stakeholder meeting
- Cut and cable 21 shoreline trees - January.
- Establish 3 fishing coves and focus artificial habitat efforts on shallow water habitat.
- Continue planting native vegetation.
- Install kiosks and habitat project signs at boat ramps.
- Assess vegetation founder colonies.

Year 5 – 2022

- Stakeholder meeting
- Implement operational enhancements at sites identified in plan.
- Assess vegetation founder colonies.
- Survey public opinion on the success of habitat enhancement efforts
- Develop final report.
- Develop 2023 - 2027 habitat plan

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TABLE 1.—Proposed aquatic plant species list.

Species Name	Common Name	Plant Type	Substrate	Planting Depth (cm)	Max. Depth (m)	Individual Spacing (m)
Eleocharis quadrangulata	Squarestem spikerush	Emergent	Sand to muck	0 - 30	0.6	0.9
Justicia americana	Water Willow	Emergent	Rocky/gravel	0 - 91	1.2	0.9
Panicum hemitomon	Maidencane	Emergent	Clay to muck	0 - 15	2.1	0.3
Pontederia cordata	Pickerelweed	Emergent	Sand to muck	0 - 91	1.2	0.9
Schoenoplectus tabernaemontani [Scirpus validus]	Softstem Bulrush	Emergent	Sand to muck	0 - 91	1.5	0.9
Zizaniopsis miliacea	Giant Cutgrass	Emergent	Clay to silt	0 - 30	0.6	0.9
Nelumbo lutea	American lotus	Floating Rooted	Sand to muck	50 - 91	1.5	1.8-2.7
Nuphar advena [N. lutea]	Spadderdock	Floating Rooted	Sand to muck	50 - 91	1.8	1.8-2.7
Nymphaea odorata	White Water Lily	Floating Rooted	Sand to muck	50 - 91	1.8	1.8-2.7
Heteranthera dubia	Water stargras	Submergent	Sand to muck	30 - 122	2.4	0.9
Potamogeton nodosus	American Pondweed	Submergent	Sand to muck	30 - 122	1.5	0.9
Vallisneria americana	Ellgrass	Submergent	Sand to muck	30 - 122	3	0.9
Shrubs						
Cephalanthus occidentalis	Buttonbush	Shrub	Sand to muck	0 - 15	0.6	0.9

Table 2.—Habitat impact acreage for utilized artificial fish attractors in Harris Lake.

Type of Structure	Estimated habitat impact area (acre)
Felled shoreline tree	0.05 acre per tree
Mossback Trophy Tree Kit (20/acre)	1.5 acres per complex
Polytree (30/acre)	1.5 acres per complex
Spiderblock (40/acre)	1.5 acres per complex
Shelbyville Cube (20/acre)	1.5 acres per complex

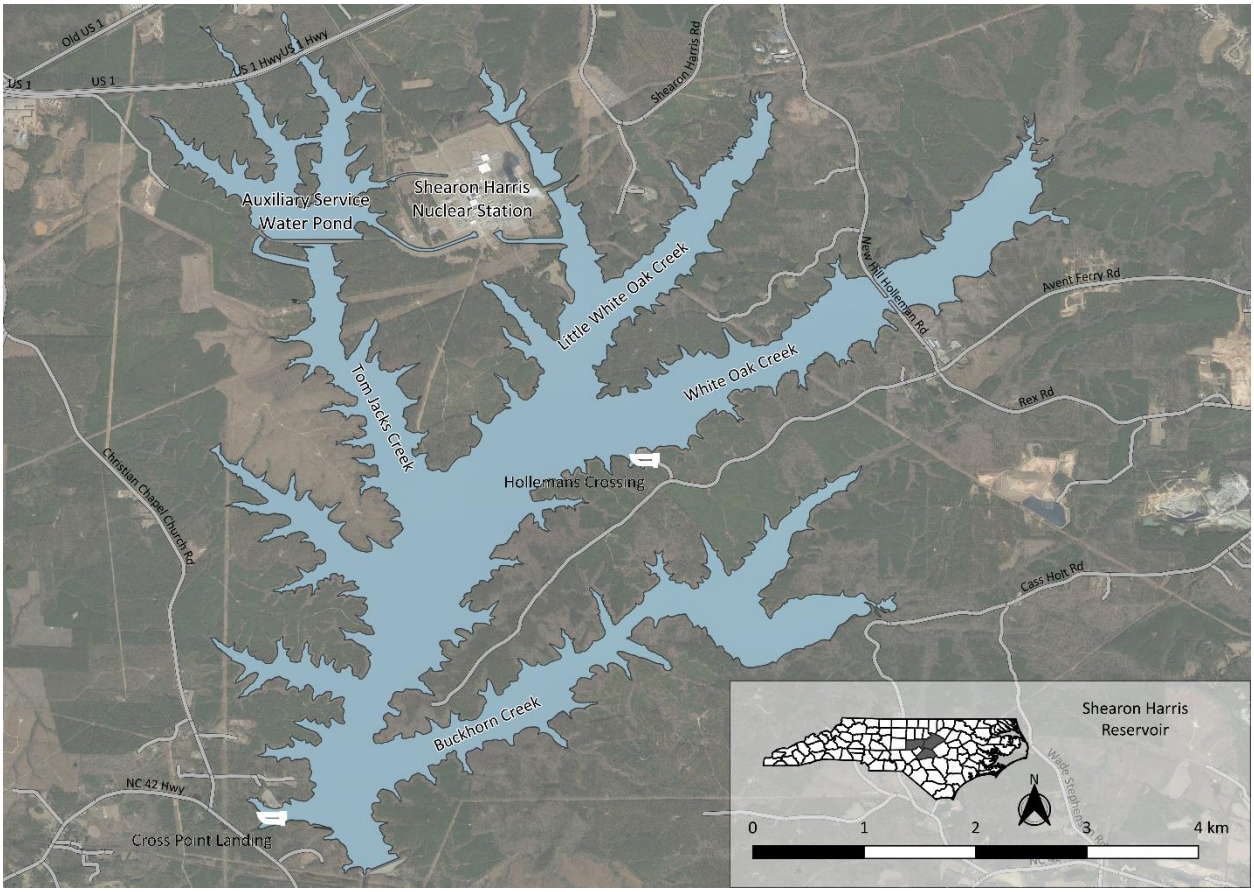


FIGURE 1.—Harris Lake, Chatham and Wake counties, North Carolina.

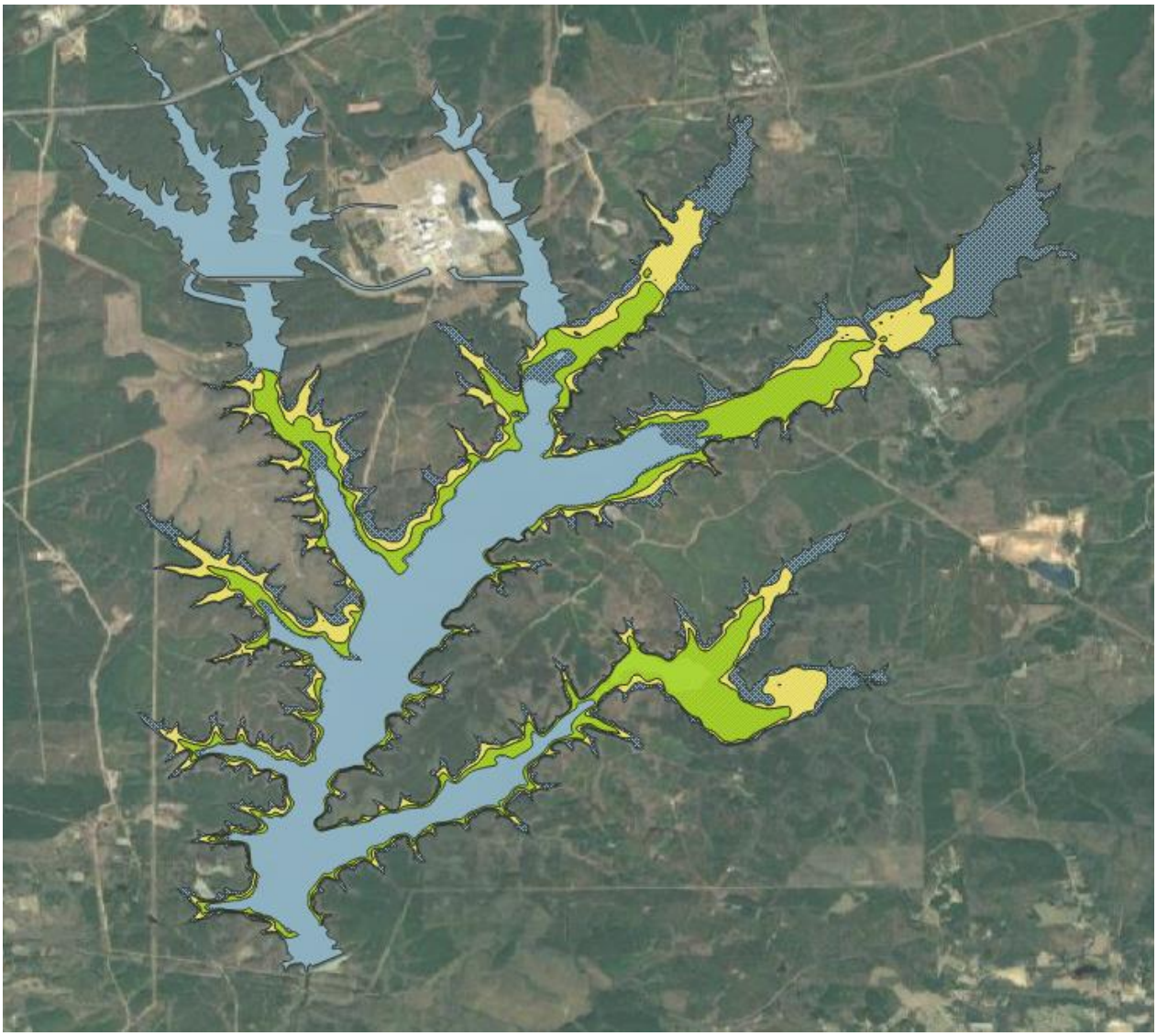


FIGURE 2.—Map of the Habitat Enhancement Zone. The hashed areas indicate the HEZ (0ft to 20ft), yellow areas are 6ft to 12ft water depth and green areas are 12ft to 20ft water depth

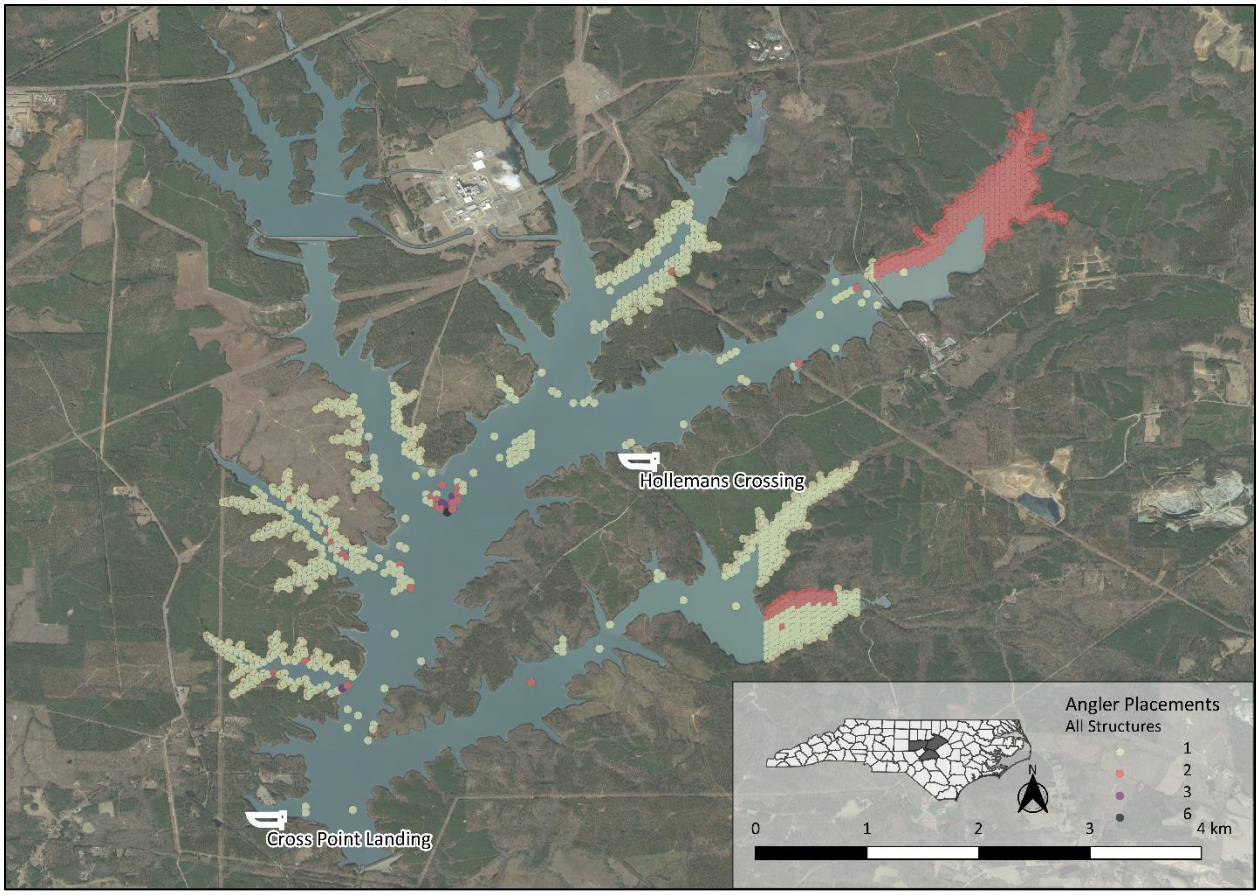


FIGURE 3.—Map of angler-selected proposed locations for habitat enhancement.

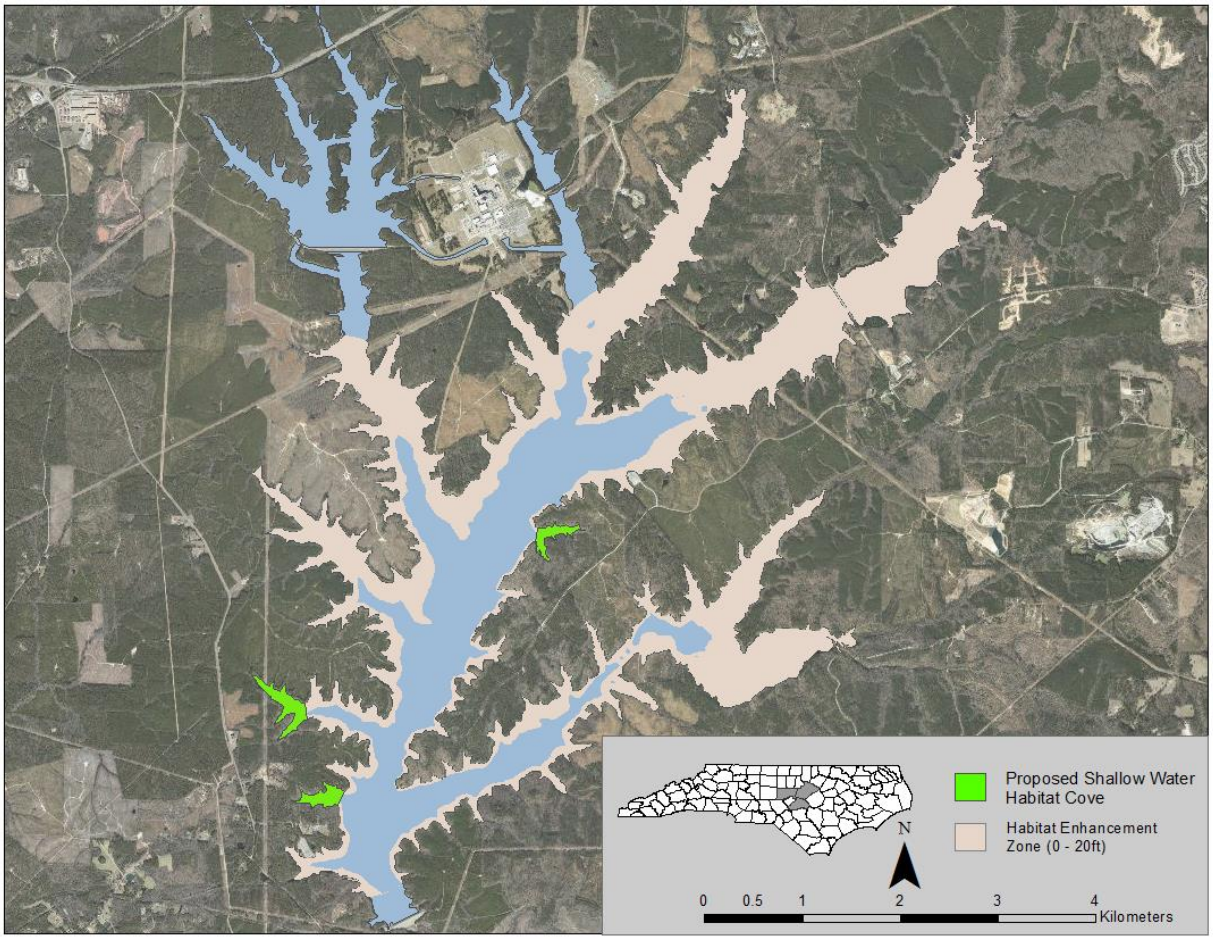


FIGURE 4.—Map of proposed shallow water habitat coves and the Habitat Enhancement Zone.

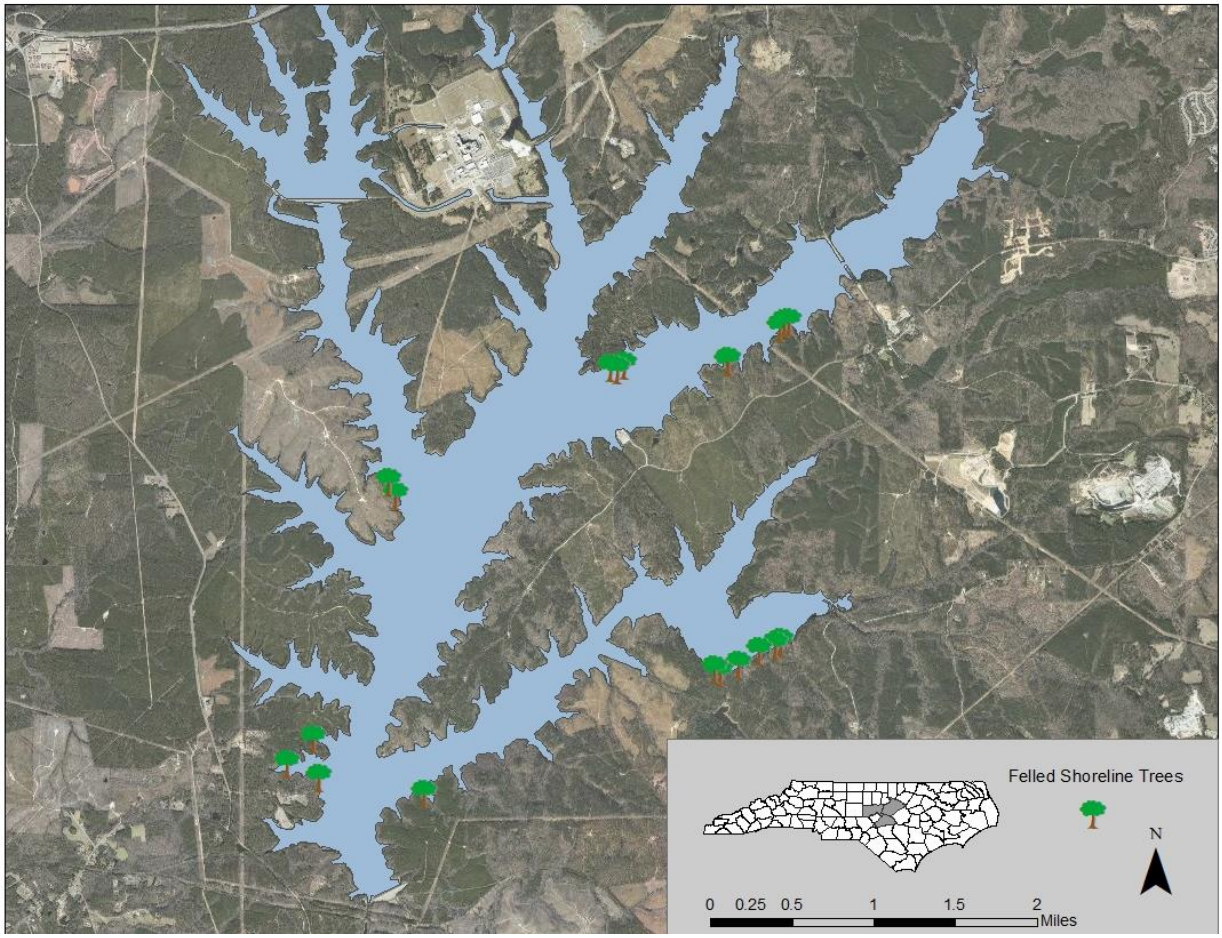


FIGURE 5.—Map of 21 felled shoreline trees.

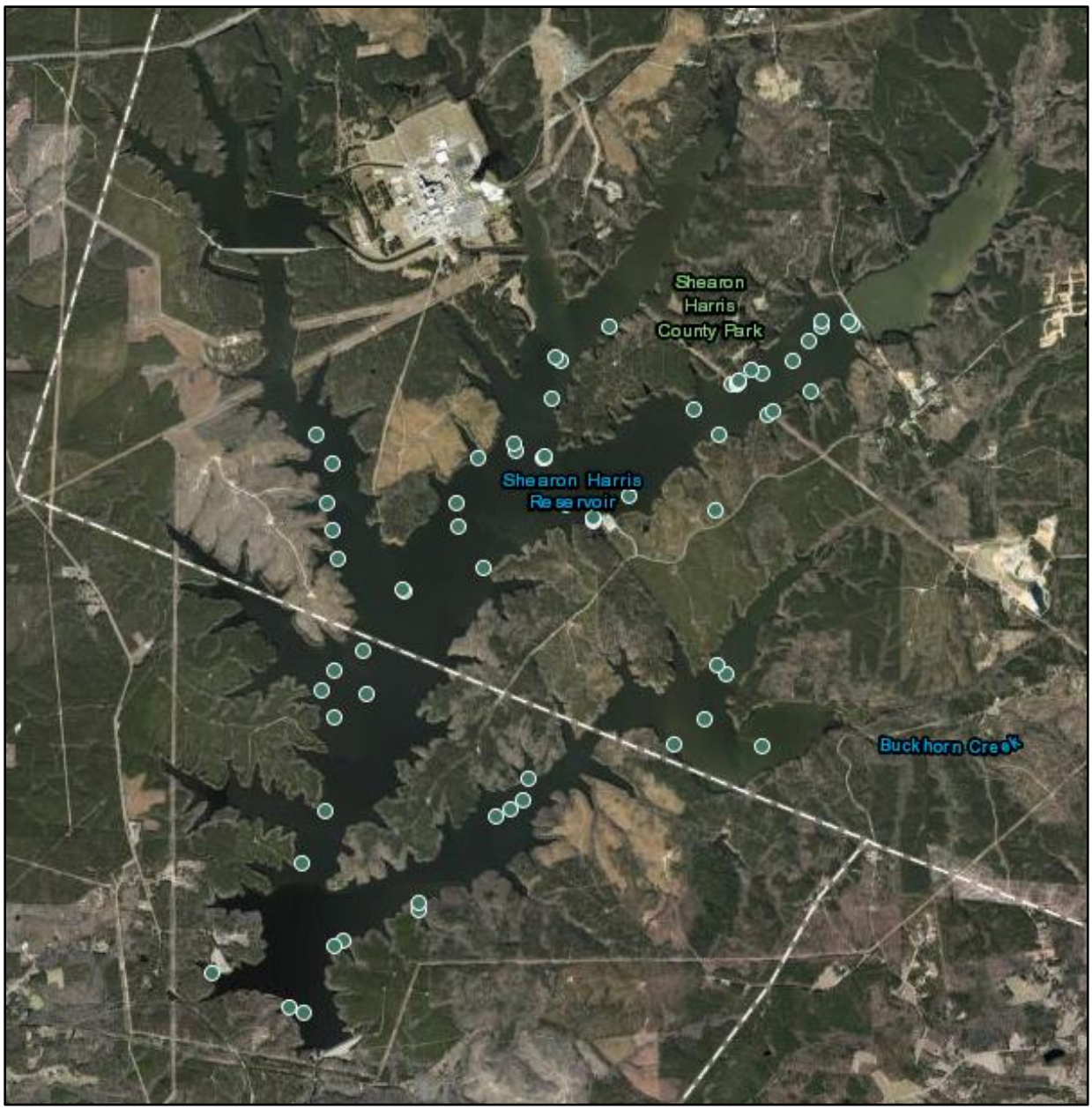


FIGURE 6.—Map of fish attractor reef sites in 2020.

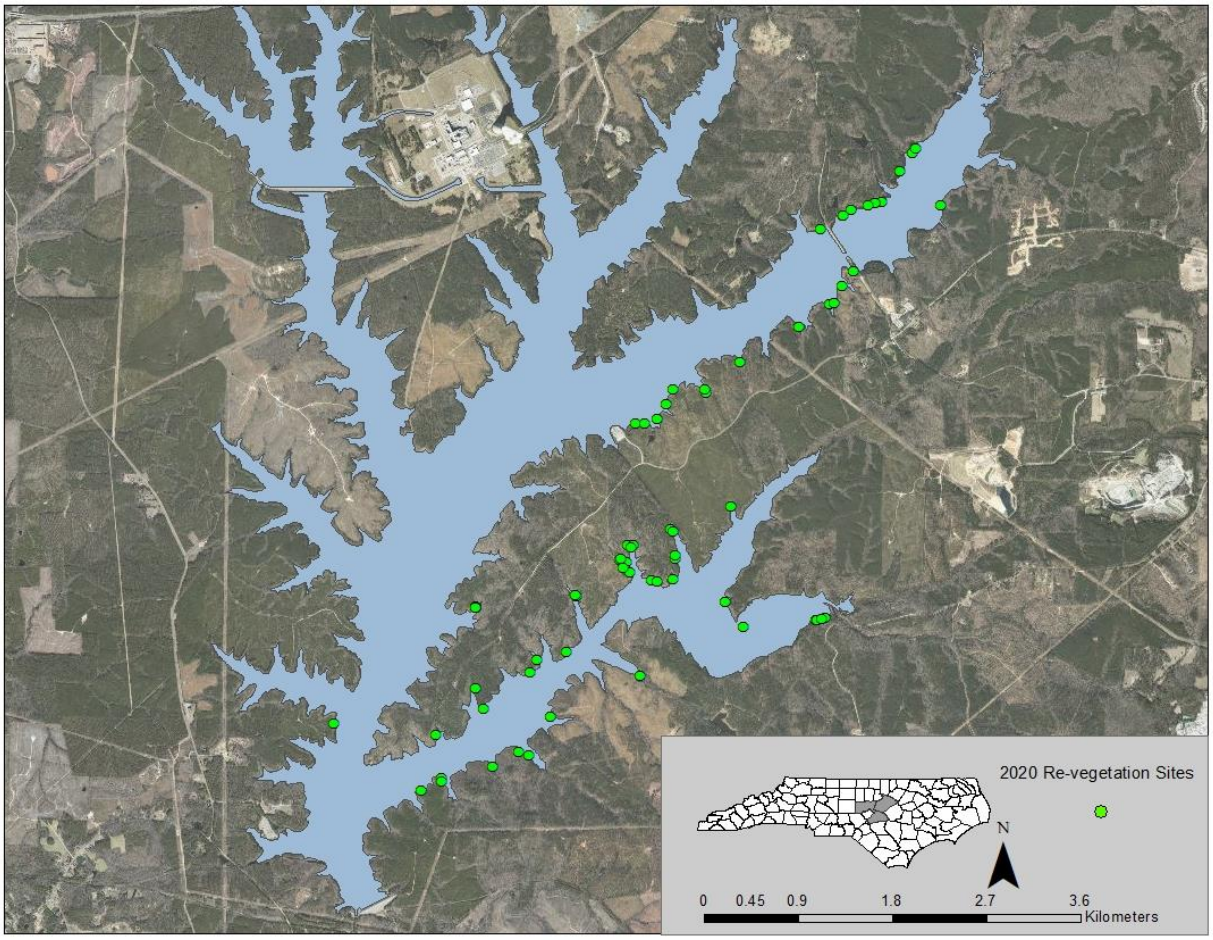


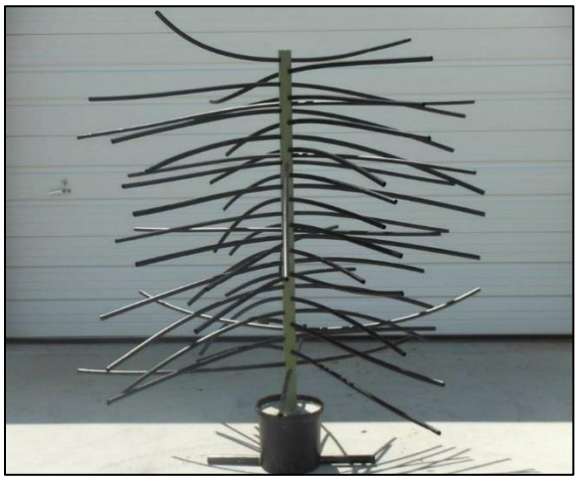
FIGURE 7.—Map of all aquatic vegetation establishment sites.

Appendix A – Potential Artificial Structures

Mossback Fish Attractor

Fishfinding

Stake Beds



PVC Tree

Spider Block

Honeyhole

Bass Jacks

Tarantula Block

Barrel Cube

Shelbyville Cube

Felled Shoreline Trees

Quad Tree

Appendix B – Proposed Native Aquatic Plants

Source: Webb, M. A., J. Richard A. Ott, C. C. Bonds, R. M. Smart, G. O. Dick and L. Dodd. 2012. Propagation and establishment of native aquatic plants in reservoirs. Texas Parks and Wildlife Department, Inland Fisheries Division, Management Data Series.

Squarestem Spikerush

Scientific name	*Eleocharis quadrangulata*
Common names	Squarestem spikerush
Growth form	Rhizomatous emergent sedge.
Reproduction	Producing new shoots along rhizome; also reproduces sexually by seed.
Perennation	Herbaceous perennial; overwinters as dormant rhizomes.
Range	Eastern U.S.
Use	Valuable for fish habitat, waterfowl food, and erosion control.

<u>Field Planting</u>

Propagule	Mature potted transplants.
Season	Spring to midsummer.
Substrate	Sand to muck.
Depth	Moist soil to 30cm.
Comments	Moderately tolerant of desiccation; not susceptible to herbivory; will tolerate depths of 0.6m once established.

Water Willow

Scientific name	*Justicia americana*
Common names	Water willow, American water-willow
Growth form	Rhizomatous emergent forb.
Reproduction	Produces new shoots along rhizomes. Also reproduces by fragmentation and seed.
Perennation	Herbaceous perennial; overwinters as dormant rhizomes.
Range	Eastern U.S.
Use	Valuable for fish habitat and erosion control.

<u>Field Planting</u>

Propagule	Mature potted transplants.
Season	Early spring to midsummer.
Substrate	Sand to muck.
Depth	Moist soil to 91cm.
Comments	Highly tolerant of drought and herbivory; will tolerate depths of 1.2m once established.

Maidencane

Scientific name	*Panicum hemitomon*
Common names	Maidencane**,** Paille fine, canouche
Growth form	Rhizomatous emergent grass.
Reproduction	Produces new shoots along rhizomes. Also reproduces by fragmentation and seed.
Perennation	Herbaceous perennial; overwinters as dormant rhizomes.
Range	Southeastern coastline from New Jersey to Texas and Tennessee.
Use	Valuable for fish habitat and erosion control.

Field Planting

Propagule	Mature potted transplants, seed.
Season	Early spring to midsummer.
Substrate	Firm clay to muck.
Depth	Moist soil to 15cm.
Comments	Tolerant of drought and herbivory.

Source: USDA Plant Guide https://plants.usda.gov/plantguide/pdf/pg_pahe2.pdf

Pickerelweed

Scientific name	*Pontederia cordata*
Common name	Pickerelweed, pickerel plant
Growth form	Rhizomatous emergent forb.
Reproduction	Produces new shoots along rhizomes; also reproduces sexually by seed.
Perennation	Herbaceous perennial; overwinters as dormant rhizomes.
Range	Eastern U.S.
Use	Valuable for fish habitat and waterfowl food.

<u>Field Planting</u>

Propagule	Mature potted transplants.
Season	Early spring to late summer.
Substrate	Sand to muck.
Depth	Moist soil to 91cm.
Comments	Moderately tolerant of desiccation; susceptible to herbivory by waterfowl and nutria; will tolerate depths of 1.2m once established.

Softstem Bulrush

Scientific name	*Schoenoplectus tabernaemontani* [*Scirpus validus*]
Common names	Softstem bulrush, great bulrush
Growth form	Rhizomatous emergent sedge.
Reproduction	Produces new shoots along rhizomes; also reproduces by seed.
Perennation	Herbaceous perennial; overwinters as dormant rhizomes/root crowns.
Range	Throughout the U.S.
Use	Valuable for fish and waterfowl habitat and erosion control.

<u>Field Planting</u>

Propagule	Mature potted transplants.
Season	Early spring to midsummer.
Substrate	Sand to muck.
Depth	Moist soil to 91cm.
Comments	Highly tolerant of desiccation; susceptible to herbivory by nutria and beavers; will tolerate depths of 1.5m once established.

Giant Cutgrass

Scientific name	*Zizaniopsis miliacea*
Common names	Giant cutgrass, water millet, and southern wildrice
Growth form	Rhizomatous emergent; leaves produced at apical tips of branching rhizomes.
Reproduction	Produces new shoots along rhizomes; also reproduces by seed.
Perennation	Herbaceous perennial; overwinters as dormant rhizomes.
Range	Southeastern U.S.
Use	Habitat for fish and waterfowl food. Provides nesting sites, cover, and food for animals.

<u>Field Planting</u>

Propagule	Mature potted transplants, seed.
Season	Early spring to midsummer.
Substrate	Firm clay to silt.
Depth	0 – 15cm.
Comments	Tolerant of desiccation; susceptible to herbivory by beavers and nutria.

American Lotus

Scientific name	*Nelumbo lutea*
Common names	American lotus
Growth form	Rooted floating-leaved; leaves produced at apical tips of branching rhizomes.
Reproduction	Produces new shoots along rhizomes; also reproduces by seed.
Perennation	Herbaceous perennial; overwinters as dormant rhizomes and/or tubers.
Range	Throughout the U.S.
Use	Valuable for fish habitat and waterfowl food. Floating leaves are adapted for shallow, turbid waters.

<u>Field Planting</u>

Propagule	Mature potted transplants, seeds.
Season	Late spring to midsummer.
Substrate	Sand to muck.
Depth	50 – 91cm.
Comments	Tolerant of desiccation; susceptible to herbivory by beavers and nutria; will tolerate depths of 1.8m once established.

White Water Lily

Scientific name	*Nymphaea odorata*
Common names	White water lily, fragrant water lily
Growth form	Rooted floating-leaved; leaves produced at apical tips of branching rhizomes.
Reproduction	Produces new shoots along rhizomes; also reproduces by seed.
Perennation	Herbaceous perennial; overwinters as dormant rhizomes and/or tubers.
Range	Throughout the U.S.
Use	Valuable for fish habitat and waterfowl food. Floating leaves are adapted for shallow, turbid waters.

<u>Field Planting</u>

Propagule	Mature potted transplants.
Season	Late spring to midsummer.
Substrate	Sand to muck.
Depth	50 – 91cm.
Comments	Tolerant of desiccation; susceptible to herbivory by beavers and nutria; will tolerate depths of 1.8m once established.

Spatterdock

Scientific name	*Nuphar advena* [*N. lutea*]
Common names	Spatterdock, yellow pond lily, cow lily
Growth form	Rooted floating-leaved; leaves produced at apical tips of branching rhizomes.
Reproduction	Produces new shoots along rhizomes; also reproduces by seed.
Perennation	Herbaceous perennial; overwinters as dormant rhizomes.
Range	Eastern U.S.
Use	Valuable for fish habitat. Floating leaves are adapted for shallow, turbid waters.

<u>Field Planting</u>

Propagule	Mature potted transplants.
Season	Late spring to midsummer.
Substrate	Sand to muck.
Depth	50 – 91cm.
Comments	Tolerant of desiccation once established; susceptible to herbivory by turtles and nutria; will tolerate depths of 1.8m once established.

Water Stargrass

Scientific name	*Heteranthera dubia*
Common name	Water stargrass
Growth form	Rooted submersed; produces alternate grass-like leaves along upright stems.
Reproduction	Produces new shoots from short stolons; also reproduces by fragmentation and seed.
Perennation	Herbaceous perennial; overwinters as dormant root crown.
Range	Throughout the U.S.
Use	Valuable for fish habitat and waterfowl food.

<u>Field Planting</u>

Propagule	Mature potted transplant.
Season	Early spring to late summer.
Substrate	Sand to muck.
Depth	30 – 122cm.
Comments	Tolerant of desiccation; moderately susceptible to herbivory by carp and turtles; will tolerate depths of 2.4m once established.

American Pondweed

Scientific name	*Potamogeton nodosus*
Common name	American pondweed
Growth form	Rooted submersed; produces submersed and floating leaves.
Reproduction	Produces new shoots along stolons; also reproduces by fragmentation and seed.
Perennation	Herbaceous perennial; overwinters as dormant winter buds.
Range	Throughout the U.S.
Use	Valuable for fish habitat and waterfowl food; floating leaves are adapted for shallow, turbid waters.
<u>Field Planting</u>	
Propagule	Mature potted transplants.
Season	Spring to late summer.
Substrate	Sand to muck.
Depth	30 – 122cm.
Comments	Tolerant of desiccation; susceptible to herbivory by carp, turtles and waterfowl; will tolerate depths of 3.0m once established.

Eelgrass

Scientific name	*Vallisneria americana*
Common names	Wild celery, eelgrass, tapegrass, ribbon grass, Vallisneria
Growth form	Rooted submersed; rosette form with a basal meristem and ribbon-like leaves.
Reproduction	Produces daughter plants along stolons; sexual reproduction by seed.
Perennation	Evergreen (southern ecotype) or winter bud forming (northern ecotype) perennial.
Range	Throughout the U.S. (absent from parts of the Midwest).
Use	Valuable for fish habitat and waterfowl food. In the south, evergreen habit allows planting over an extended period.
<u>Field Planting</u>	
Propagule	Mature potted transplants.
Season	Early spring to early fall (southern ecotype); early to late summer (northern ecotype).
Substrate	Sand to muck.
Depth	30 – 122cm.
Comments	Transplants must be planted deep enough to cover the root mass and anchor the plant, but care must be taken not to bury the basal rosettes. Not resistant to desiccation; highly susceptible to herbivory by Grass Carp, turtles, and waterfowl; will tolerate water up to 3.0m deep once established.