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TRIPLOID GRASS CARP STOCKING FOR AQUATIC VEGETATION MANAGEMENT IN BEECH RESERVOIR

FINAL ENVIRONMENTAL ASSESSMENT

Henderson County, Tennessee

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List of Acronyms

AVM	Avian Vacuolar Myelinopathy
CFR	Code of Federal Regulation
CTGC	Certified Triploid Grass Carp
DDE	Dichlorodiphenyldichloroethylene
DO	Dissolved Oxygen
EA	Environmental Assessment
EIS	Environmental Impact Statement
ESA	Endangered Species Act
NEPA	National Environmental Policy Act
NLEB	Northern long-eared bat
NTGCICP	National Triploid Grass Carp Inspection and Certification Program
NWI	USFWS National Wetlands Inventory
PCB	polychlorinated biphenyls
RFAI	Reservoir Fish Assemblage Index
TDEC	Tennessee Department of Environment and Conservation
TVA	Tennessee Valley Authority
TWRA	Tennessee Wildlife Resources Agency
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

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CHAPTER 1 - PURPOSE AND NEED FOR ACTION

In recent years, invasive aquatic plants have continued to spread within the Tennessee Valley Authority's (TVA) reservoir system, causing environmental and economic impacts. The spread of the invasive species hydrilla *(Hydrilla verticillata)* throughout the TVA system poses the greatest threat. Hydrilla is capable of rapid growth and reproduction given ideal growing conditions. Hydrilla plant fragments can be easily transported from one waterbody to another via recreational and commercial boating. These transportation and reproduction methods have aided in hydrilla establishment throughout the valley causing conflicts with water resource uses.

Controlling the continued spread of hydrilla increases the overall health and function of newly affected reservoirs, which is an important environmental stewardship objective of TVA's Natural Resources program. Control and minimization of newly established hydrilla populations is the best strategy for reducing long term and costly impacts of the species. If allowed to establish over the course of several years, the cost of management and realized impacts increase exponentially and control options become limited.

Among the reservoirs affected by the spread of hydrilla is Beech Reservoir, located in Henderson County, Tennessee. Beech Reservoir serves the central western Tennessee region along the Beech River by providing flood damage reduction and various public recreational opportunities including boating, swimming, fishing, and hunting. The reservoir also serves as the primary drinking source for the City of Lexington, Tennessee, which has a population of nearly 8,000. Recent introductions of hydrilla into Beech Reservoir have severely impacted various uses and the continued spread of the plant within and beyond the reservoir may increase impacts to the area.

TVA proposes to introduce sterile Triploid Grass carp (*Ctenopharyngodon idella)* as a means of controlling the spread of hydrilla within Beech Reservoir. Grass carp eat submersed aquatic vegetation including hydrilla. Triploid fish are sterile and unable to naturally reproduce in a river system, which enables the fish populations to be easily monitored. Introduction of certified Triploid Grass Carp (CTGC) into a reservoir to control invasive aquatic plant growth is an effective measure to address new infestations of hydrilla that would otherwise continue to spread. Stocking CTGC is cost effective, provides long term aquatic vegetation management, and reduces the need for large scale herbicide and mechanical management techniques once a plant species becomes established.

1.1 Background

1.1.1 Beech Reservoir

TVA is a corporate agency and instrumentality of the United States, created by and existing pursuant to the TVA Act of 1933, to foster the social and economic wellbeing of the residents of the Tennessee Valley region. Beech Reservoir is a non-power, multipurpose reservoir located on the Beech River. Beech Dam was constructed by TVA in 1962 and 1963 to provide flood control, water supply, recreation opportunities, and land enhancement benefits. The drainage area for the reservoir is 15.74 square miles. The reservoir stretches for 3.65 miles from the dam and provides 4,430 acre-feet of storage. Beech Reservoir is part of the Beech River Projects which include eight reservoirs: Beech, Cedar, Dogwood, Lost Creek, Pin Oak, Pine, Red Bud, and Sycamore.

1.1.2 Aquatic Vegetation Management

Aquatic plants provide essential functions in aquatic ecosystems including food, shelter, and habitat for various species. They also produce dissolved oxygen (DO), stabilize sediments, and reduce turbidity in aquatic ecosystems. When present in excessive amounts however, these benefits are quickly negated as plant respiration (use of oxygen) can exceed oxygen production, and habitat complexity decreases. Furthermore, various economic impacts can occur as these plants begin to interfere with reservoir uses. Nuisance levels of aquatic plants can restrict recreation, clog water intake and control structures, and degrade water quality as well as increasing sedimentation rates resulting in a loss of flood storage capacity. This is especially true of non-native, invasive species that lack natural regulation through predation and disease.

The Tennessee Valley region's water resources have long been impacted by the establishment and spread of nuisance aquatic plant species. Since its creation in 1933, TVA has managed aquatic plants within its reservoirs on varying scales to ensure multiple uses of the water resources, to stifle reservoir-aging, and preserve flood storage capacity.

Prior to the 1950s, TVA's aquatic plant management focused on emergent aquatic species which initially root along the shoreline and develop self-supporting foliage that emerges at or above the water surface. These species were primarily managed through water level fluctuation, which reduces suitable habitat for these plant species as well as for mosquitoes. In the late 1950s, TVA began experiencing issues in its large main stem reservoirs with submersed non-native invasive aquatic plants, primarily Eurasian watermilfoil (*Myriophyllum spicatum*). Unlike emergent species, submersed species have the capacity to grow much deeper in the water column, thus potentially impacting a much larger portion of each reservoir. Much like the strategies used for emergent plant control, drawdown and subsequent dewatering of light accepting (littoral) habitat proved moderately successful, especially in reservoirs with a drawdown potential of 10 feet or more. However, drawdowns were not successful in main-stem reservoirs where drawdowns rarely exceeded 7.5 feet. Therefore, TVA began a program using aquatic herbicides, especially products with the active ingredient 2,4-D, to supplement drawdown efforts on reservoirs without substantial drawdown.

From the late 1980s through the present day, TVA has utilized an integrated approach to management of aquatic plants in its reservoirs. TVA realizes the various benefits of aquatic plants and its objective is neither to eradicate aquatic vegetation nor to allow unmanaged proliferation of aquatic vegetation. Scheduled drawdowns, targeted aquatic herbicide applications in high use public areas, and mechanical harvesting (removal of plants through mechanical means) have been the primary means of management utilized by TVA in the past few decades. However, aquatic plants continued to increase in the system, particularly during prolonged periods of drought in the late 1980s. From 1984 to 1988, aquatic plant distributions in the system increased two-fold from 23,000 acres in 1984 to 46,000 acres in 1988.

Hydrilla began appearing in the TVA system in the 1980s. This species is not impacted by winter drawdown nor susceptible to 2,4-D. By the 2000s, hydrilla replaced most native stands of submersed vegetation as well as other aggressive introduced species and quickly became the primary species of aquatic plant in the system and remains so today.

Hydrilla has continued to spread into reservoirs thought previously to be uninhabitable by most other submersed species. Currently, hydrilla establishment has been recorded as far

west as Kentucky Reservoir and as far east as Parksville Reservoir (Ocoee project #1) in the TVA system. Establishment in most of TVA's large main stem reservoirs and resistance to drawdown have aided in system-wide expansion of the species. Downstream transport of fragments and the transport of fragments from one waterbody to another via recreational and commercial boating have aided its spread into new reservoirs, including smaller reservoirs intended for recreation and economic development.

Currently, hydrilla occurs in roughly half of Beech Reservoir. Unabated, hydrilla has the potential to spread into the rest of Beech Reservoir, to other reservoirs within the Beech River System, and potentially to other reservoirs in the TVA system.

1.2 Decision to be Made

TVA has prepared an Environmental Assessment (EA) to consider whether to approve or disapprove the proposed introduction of CTGC to Beech Reservoir to manage the spread of hydrilla, a nuisance aquatic plant species.

1.3 Scope of the Environmental Assessment

Pursuant to the National Environmental Policy Act (NEPA) and its implementing regulations promulgated by the Council on Environmental Quality (40 Code of Federal Regulations [CFR] §§ 1500–1508), federal agencies are required to evaluate the potential environmental impacts of any proposals for major federal actions. TVA prepared this EA to assess the potential consequences of TVA's Proposed Action Alternative on the environment and human health in accordance with NEPA and TVA's procedures for implementing NEPA (TVA 1983).

This EA describes the existing environment at the project site, analyzes potential environmental impacts associated with the Proposed Action Alternative and the No Action Alternative, and characterizes cumulative impacts that could result from the proposed project in relation to other ongoing or reasonably foreseeable proposed activities within the surrounding area of the Beech Reservoir.

Although hydrilla occurs on less than half the reservoir (382 acres or 44 percent), the project Study Area includes the waters and shore lands around the entire Beech Reservoir.

This EA consists of six chapters discussing the project alternatives, environmental resources potentially affected, and analyses of impacts. The structure of the EA is outlined below:

- **Chapter 1.0:** Describes the purpose and need for the project, the decision to be made, related environmental reviews and consultation requirements, necessary permits or licenses, and the EA overview.
- **Chapter 2.0:** Describes the Proposed Action and No Action alternatives and provides a comparison of alternatives.
- **Chapter 3.0:** Discusses the affected environment within the Study Area and provides an analysis of the potential direct, indirect, and cumulative impacts on environmental resources of the alternatives. Mitigation measures also are proposed, as appropriate.

- **Chapters 4.0, 5.0, and 6.0:** Contain the list of preparers of this EA, the EA distribution list, and the literature cited in preparation of this EA, respectively.Based on the nature of the proposal, TVA's experience with conducting environmental reviews, and other available information, the potential effects to the following resources are considered in this environmental review:

- Surface Water
- Aquatic Ecology
- Wildlife
- Threatened and Endangered Species (terrestrial wildlife species)
- Wetlands
- Socioeconomics and environmental justice
- Recreation

TVA determined that there would be no or negligible impacts for the resources listed below for the reasons stated. Thus, TVA determined that detailed analysis was unnecessary for these resources because there is no potential for significant environmental impacts. They are not discussed further in the EA.

- Air Quality – Because no air impacts would result from introducing the CTGC in the reservoir, the issue is dismissed from further review.

- Cultural Resources – While the Beech Reservoir earthen dam is eligible for listing on the National Register of Historic Places, TVA does not anticipate any impacts to the dam. The Proposed Action Alternative would have "no potential to cause effects," 36 C.F.R. § 800.3; therefore, consultation with the Tennessee Historic Preservation Officer is unnecessary. TVA has met requirements under the National Historic Preservation Act.

- Floodplains – The introduction of the CTGC in the reservoir would not impact floodplains.

- Water Supply – Beech Reservoir serves as a water supply for the City of Lexington. The intake is located at the reservoir's dam. While impacts from rooted, growing hydrilla are unlikely in this area due to depth (20 or more feet), seasonal impacts are still likely. Hydrilla breaks apart in late fall and early winter leading to large, uprooted mats of the species which travel with current/water flow and wind current. Given the location of the intake; however, hydrilla has the potential to have only minor impacts to use during this time of year.

- Solid and Hazardous Waste – Because no solid or hazardous wastes would be generated by the proposal, the issue is dismissed from further review.

- Navigation – Other than personal recreational watercraft (addressed in Recreation), there is no commercial navigation on the reservoir. No watercourses would be blocked or otherwise affected by the proposed project.

- Noise – No noise impacts would result from introducing the CTGC in the reservoir.

- Terrestrial Vegetation – Beech Reservoir has a permanent pool elevation that is affected only by flood and drought conditions. Therefore, CTGC should have no impact to shoreline vegetation as inundation by the reservoir is unlikely under normal conditions.

- Threatened and endangered plant species – A review of the TVA Natural Heritage Database indicated that no state- and federally listed plant species occur on or adjacent to Beech Reservoir.

- Threatened and endangered aquatic species – A review of the TVA Natural Heritage Database indicated that no state-listed or federally listed aquatic species occur within Beech Reservoir or within the Beech River drainage downstream to its mouth at Kentucky Reservoir (Tennessee River). The only rare aquatic species record within ten miles of the project was a historical (greater than 25 years old) record for the firebelly darter (*Etheostoma pyrrhogaster*) that has an S2 rank in Tennessee, where it has a state heritage status indicating it is "in need of management". However, this record is outside the Beech River basin and therefore would not be affected by the proposed project.

- Transportation – No impacts to traffic or transportation infrastructure would result from the project.

- Visual Resources – In some locations, the elimination of hydrilla from the reservoir may have beneficial impacts by improving the appearance of the reservoir. However, such effects would be negligible.

- Land Use – No change to land uses would result from the proposed action.

- Prime Farmland – Prime farmlands would not be affected by the proposed action.

- Natural areas and parks – There are no natural areas directly associated with Beech Reservoir. Natchez Trace Wildlife Management Area and Natchez Trace State Park are located 3 to 5 miles away, a sufficient distance such that these areas would not be affected. No water bodies in these parks connect to the Beech River System.

- Groundwater - While reservoir waters may be affected by the project, groundwater resources would not be affected.

1.4 Necessary Permits

TVA would secure any permits necessary to undertake the Proposed Action Alternative. All permits would be held by TVA. TVA must obtain approval from the Tennessee Wildlife Resources Agency (TWRA) to stock fish within waters of the State. In addition, TVA may consult with the Tennessee Department of Environment and Conservation (TDEC) and the US Department of Agriculture – Animal and Plant Health Inspection Service. The US Fish and Wildlife Service (USFWS) oversees certification of triploid grass carp via the National Triploid Grass Carp Inspection and Certification Program (NTGCICP). TVA would obtain the necessary permits and follow all procedures required by the USFWS before and during stocking of CTGC.

1.5 Public Outreach

TVA released this document for public review and comment. TVA notified interested elected officials and other stakeholders that the Draft EA was available for review and comment for a 45-day period. TVA also notified government agencies, including TDEC, TWRA, the U.S. Army Corps of Engineers (USACE), and the USFWS. An electronic version of the document was posted on TVA's website. TVA did not receive any comments during the comment period.

CHAPTER 2 - ALTERNATIVES

2.1 Description of Alternatives

Preliminary scoping by TVA has determined that from the standpoint of NEPA, there is one alternative available to TVA that achieves TVA's purpose and need. In this section, the alternative, called the Proposed Action Alternative, and the alternative of taking no action, are analyzed in detail.

2.1.1 No Action Alternative

Under the No Action Alternative, TVA would not stock Beech Reservoir with CTGC to address the spread of hydrilla. TVA would continue to manage the aquatic vegetation in this reservoir as it currently does, using its reservoir specific, integrated management approach utilizing targeted herbicide applications in high use public areas such as boat ramps and courtesy docks and the use of mechanical harvesters to open up access to deeper water. These approaches are short term, usually lasting weeks at a time as hydrilla plants grow and re-grow quickly. Such action is not expected to reduce hydrilla abundance in the majority of the Reservoir.

The current practices of TVA's Aquatic Plant Management Program are outlined in TVA's 1993 Supplemental Environmental Impact Statement (EIS) addressing the control of nuisance aquatic vegetation in TVA reservoirs. The 1993 supplement addressed populations of watermilfoil, hydrilla, spiny naiad, and other species and is a supplement to the 1972 EIS for control of Eurasian watermilfoil within TVA reservoirs.

The potential environmental effects of adopting the No Action Alternative are considered in the EA to provide a baseline for comparison with respect to the potential effects of implementing the proposed action.

2.1.2 Proposed Action Alternative

Under the Proposed Action Alternative, TVA would stock CTGC for maximized control of hydrilla into Beech Reservoir. As part of TVA's integrated management approach, TVA would use biological control, consisting of sustained, incremental stocking of CTGC, supplemented by limited use of chemical control (application of herbicides) to control hydrilla. Mechanical removal of nuisance aquatic vegetation may also be used as needed when deemed necessary by program staff. Mechanical removal and chemical control would be implemented according to the methods described in the EIS (TVA 1993).

TVA would survey standing hydrilla biomass and coverage within Beech Reservoir annually to inform all management decisions. TVA would also continue to monitor other reservoirs within the Beech River system (i.e., Cedar, Dogwood, Lost Creek, Pin Oak, Pine, Redbud, and Sycamore reservoirs) for early hydrilla detection. Should hydrilla introductions occur in these reservoirs, TVA would consider if the survey and stocking protocol described in this document should be implemented as funding allows and subject to additional environmental review.

Description of Proposed Stocking Program

The introduction of triploid grass carp is generally considered an environmentally safe means of controlling nuisance aquatic vegetation in both open and closed waters (USFWS Biological Opinion 1987). The USFWS holds jurisdiction over certification of triploid grass

carp per the NTGCICP. The USFWS has issued a Biological Opinion stating that use of triploid grass carp for aquatic weed control is environmentally safe and that triploid grass carp may be stocked in closed or open waters[1] (USFWS 1987). TVA would obtain the necessary permits/approvals and follow all procedures required by the USFWS and TWRA before and during stocking of CTGC. The use of only CTGC is an important precaution to prevent stocked individuals from reproducing to unwanted levels in target areas, as well from spreading to unintended areas should they escape. Without continued restocking, CTGC populations will eventually die out over their life span.

Under the Proposed Action Alternative, TVA would stock Beech Reservoir with CTGC over approximately six years. Grass carp effectiveness after initial stocking is often delayed as much as four years before efficacy is noted (Stich et al. 2013). Therefore, TVA would stock Beech Reservoir over several years to establish age class structure and reduce the potential for a single stocking age class collapse before CTGC vegetation control is achieved.

The stocking rate would be determined on the amount of hydrilla standing biomass established, the projected coverage in the reservoir, and the desired level of vegetation management. Typical stocking rates across the country range from 5 to 50 individuals per vegetated acre. Stocking of CTGC would be based on a total number of fish per vegetated acre of submersed plants in a given year. Vegetated acres would be determined annually with the use of hydroacoustic and point sampling of the entire littoral zone of the reservoir.

Baseline stockings would occur in Years 1 and 2 to establish appropriate rate for control, and subsequent maintenance stocking would occur in year 3 and beyond to account for a projected mortality of 30 percent annually. Target stocking rate for CTGC would be to maintain 20 fish per vegetated acre for approximately 10 years, followed by maintaining 1 fish per 8 surface acres thereafter (Kirk and Manuel 2012). Stocking of CTGC would target 15 fish per vegetated acre in Year 1, and 7.25 fish per vegetated acre in Year 2 for a total rate of 22.25 fish per vegetated acres. A 30 percent mortality rate would be assumed of newly stocked individuals (year 0), followed by a 20 percent mortality for year 1+ individuals annually and accounted for during supplemental stocking each year.

Stocking would occur in April, May or June 2018 from pre-determined areas around Beech Reservoir. Only CTGC of 10-12 inches would be stocked to reduce the likelihood of predation by gamefish and other fish-eating (piscivorous) bird and mammal species. Based on a projected population of 20 fish per vegetated acre after Year 2, and a 20 percent mortality rate over Years 1 and 2, supplemental stocking in Year 3 would be at a rate of 4.5 fish per vegetated acre. Continued restocking rates would be informed by surveys of submersed plants in the year prior to each stocking.

As mentioned above, TVA expects that there would be a 4-year time lag from initial stockings until significant effects are observed. Therefore, Year 4 would be considered an observatory year and active management would be minimal. Active management and supplemental stocking in Years 5 and 6 would be informed by observations and surveys information gathered in Year 4. TVA would restock CTGC based on monitoring after Year 4 to maintain control of hydrilla. Because of the ability of hydrilla to re-grow from tubers and

[1] Closed water systems are those where no water flows out, and water which is not evaporated will remain in the system indefinitely. An open water system is where water constantly flows out under almost all climatic circumstances.

turions[2] that persist in the bottom sediments, it is likely that stocking of CTGC would be a permanent part of TVA's Aquatic Plant Management Plan on Beech Reservoir. However, if aquatic vegetation surveys show management to be successful, maintenance stocking of CTGC at a reduced rate may be appropriate.

2.2 Other Alternatives Evaluated, but Dismissed from Further Consideration

TVA evaluated a range of alternatives for addressing the spread of nuisance aquatic vegetation in its 1993 Supplemental EIS. These included various other biological controls, mechanical controls (harvesting), physical controls (barrier mats), and water level manipulation.

Other biological controls identified in the 1993 Supplemental EIS include insects, fungi or bacteria. The use of insects as an effective biological control is still being debated as there are no known native species that feed on hydrilla that can survive Tennessee winters. There have been some non-native insect species found that feed only on hydrilla and have been introduced to the United States. However, these insects are not predictable and do not reduce the need for other management options. No fungi or bacteria have been identified to help control hydrilla.

Beech Reservoir has a permanent pool elevation that is affected only by flood and drought conditions. Also, dormant hydrilla tubers are rarely impacted by winter drawdown in the southern United States as they remain deep in the hydrosoil. Therefore, water level manipulation would not be an effective aquatic vegetative management strategy for this reservoir.

Physical controls such as a barrier/benthic mat can interfere with fish spawning, are difficult to install, must be regularly inspected and maintained, and are expensive. Physical controls and water level manipulation were not addressed further in this EA because they do not fully meet TVA's objectives, purpose, or need for the project.

TVA also considered ceasing all current actions to control hydrilla on Beech reservoir. This would mean stopping the herbicide and mechanical control methods currently being used on Beech. This alternative would allow hydrilla to grow exponentially and negatively impact the Reservoir. This alternative would also not fully meet TVA's objectives, purpose, or need for the project and is not addressed further in this EA.

[2] A turion is a wintering bud of some aquatic plant species that becomes detached and remains dormant at the bottom of the water.

2.3 Comparison of Alternatives

A comparison of impacts associated with implementing the No Action Alternative and the Proposed Action Alternative is provided in Table 2-1.

Table 2-1 Comparison of Impacts of the No Action Alternative and the Proposed Action Alternative

Resource Area	No Action Alternative	Proposed Action Alternative
Aquatic Ecology	Long-term increases in hydrilla populations would reduce native aquatic plant diversity, decrease algal growth, decrease macroinvertebrates, and reduce fish diversity and populations.	Long-term decreases in hydrilla populations would increase native aquatic plant diversity, increase algal growth, increase macroinverterates, and increase fish diversity and populations.
Surface Water	Direct, indirect and cumulative negative water quality impacts would occur due to the continued increase in hydrilla, which would cause increased nutrients, decreased algal growth, and decreased water clarity.	Initially, potential increase in nutrients resulting in minor, short-term impacts to water quality. Long-term improvement as density of hydrilla is reduced, leading to more stable DO, pH, and other water quality measures.
Terrestrial Ecology (Wildlife)	Negative direct, indirect and cumulative impacts to terrestrial wildlife as a result of the increase in hydrilla.	Insignificant adverse impacts to common wildlife populations and beneficial impacts to some specific, common wildlife species.
Threatened and Endangered Species	No effect to Indiana Bat or Northern Long Eared Bat. Bald eagle may be negatively affected.	No effect to Indiana Bat or Northern Long Eared Bat. Bald eagle may be beneficially affected.
Wetlands	Minor direct, indirect or cumulative wetland impacts. The increase in hydrilla would result in reduced aquatic plant species diversity and reduced wetland quality. No direct, indirect or cumulative impacts to emergent and forested wetlands.	Short term impacts to non-native aquatic bed wetland communities. The gradual, localized loss of this non-native habitat would be insignificant. No direct, indirect or cumulative impacts to emergent and forested wetlands. Potential beneficial impacts on wetlands over time as native aquatics plant reestablish.
Recreation	Potential positive impact on certain activities such as boat fishing or waterfowl viewing, but adverse impacts on other recreational activities such as general boating, camping, swimming and water sports.	Beneficial recreational impacts.

Resource Area	No Action Alternative	Proposed Action Alternative
Socioeconomics or Environmental Justice	Minor impact on the local economy due to decrease in recreational opportunities. No disproportionate impacts on minority or poverty communities.	Beneficial direct, indirect and cumulative impacts to the local economy due to increase in recreational opportunities. No disproportionate impacts on minority or poverty communities.

2.4 Identification of Mitigation Measures

TVA did not identify any non-routine measures necessary to avoid, minimize, or mitigate adverse impacts on the environment.

2.5 The Preferred Alternative

The Proposed Action Alternative, stocking CTGC into Beech Reservoir for maximized control of invasive, non-native hydrilla, is TVA's preferred alternative.

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CHAPTER 3 - AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES

This chapter describes those resources or issues potentially affected by TVA's proposal. As stated in Chapter 1, the Study Area for the project encompasses the entire reservoir, including shore lands. According to TVA's most recent assessment of hydrilla on Beech Reservoir, as much as 44 percent of the reservoir is affected by the nuisance vegetation.

3.1 Aquatic Ecology

3.1.1 Affected Environment

TVA has monitored water quality and aquatic ecology conditions of the reservoirs in the Tennessee River system since 1990. The purpose of this monitoring program is to provide information on the "health" or integrity of Tennessee Valley reservoirs. The ecological health evaluation is based on five ecological indicators: DO, chlorophyll, sediment quality, fish assemblage, and benthic macroinvertebrates. Each indicator is evaluated separately based on expectations under reference conditions and assigned an ecological rating of "Good," "Fair," or "Poor" (TVA 2016a).

3.1.1.1 Physical and Chemical Characteristics

Monitoring takes place at one station on Beech Reservoir located in the dam's forebay (the deep, still water near the dam) on a two-year cycle. The overall ecological health condition of Beech Reservoir rated fair in 2012 (Table 3-1). Historically, ecological health ratings for this reservoir were poor. Consistent problems have been high chlorophyll concentrations and low DO levels near the bottom (TVA 2017). The lowest ecological health score (42) recorded for Beech Reservoir occurred in 2000. This was the result of several indicators concurrently scoring at the low end of their historical range rather than a substantial change in any one indicator. In 2012, a much better score (64) was recorded as the result of improved chlorophyll concentrations. These ratings are briefly explained in the paragraphs that follow.

Table 3-1 Beech Forebay Water Quality Results 2012

Monitoring Location	Dissolved Oxygen	Chlorophyll	Fish Assemblage	Benthic Macroinvertebrates (Bottom Life)	Sediment Quality
Forebay	Poor	Good	Fair	Good	Poor

Source: TVA 2017

Dissolved Oxygen

Dissolved oxygen is considered here (in addition to Surface Water above) as a qualitative component of ecological health for the reservoir (i.e., how well it supports aquatic life). As in previous years, dissolved oxygen rated Poor. Dissolved oxygen concentrations were low near the reservoir bottom from April through September, with extended periods of time when the bottom water was completely devoid of oxygen. (TVA 2017)

Chlorophyll

Chlorophyll, a surrogate measure for the amount of algae (phytoplankton) in the water, is important because it provides insights into the level of primary productivity within a water

body and can provide a measure of nutrient enrichment. High chlorophyll concentrations indicate excessive algal growth, which often signals nutrient enrichment. Nutrient enrichment can lead to algal blooms which lower or eliminate DO that fish and other aquatic life need to survive and can even lead to growth of human-harming bacteria.

Chlorophyll concentrations in Beech Reservoir were quite variable throughout the 2012 sampling period, but the average concentration was within the expected range, resulting in a Good rating for this indicator. High chlorophyll levels have been a problem in Beech Reservoir, typically resulting in Poor reservoir health ratings. (TVA 2017)

Sediment Quality

Sediments provide habitat for many aquatic organisms and are also a major repository for many of the more persistent chemicals that are introduced into the aquatic environment. A "Good" rating means sediment is free from polychlorinated biphenyls (PCBs), pesticides and large concentrations of metals. Sediment quality rated "Poor" because samples contained detectable levels of PCBs and Dichlorodiphenyldichloroethylene (DDE) (a breakdown product of the pesticide DDT), and slightly more arsenic than would be expected to occur naturally. Sediment quality has rated "Fair" most years due to chlordane, DDE or arsenic; however, it rated Good in 1994, 1996 and 2002, when no problems were detected. (TVA 2017)

3.1.1.2 Aquatic Animals

Grass Carp

The grass carp (or white amur, *Ctenopharyngodon idella,* Figure 3-1) is an herbivorous fish native to large river systems of Eastern Asia and has been used world-wide as food and as a biological control of aquatic weeds. Initial stocking of the grass carp for weed control in the United States took place in 1963 as part of cooperative effort between the USFWS and Auburn University (Mitchell and Kelly 2006). The species has since been utilized in 35 different states, primarily for weed control in closed public or private waterbodies. Introductions of diploid (reproductively fertile) grass carp in the early 1960s negatively impacted submersed plants (both native and non-native species) in the Mississippi and Missouri Rivers because the fertile grass carp have been successfully reproducing in these systems for over 50 years. Therefore, most states currently limit the use of grass carp to only artificially produced, triploid (sterile) fish in order to prevent any further natural reproduction in other river systems. The USFWS would test these fish for reproductive conditions to certify that only triploid fish are used. Triploid condition is induced by cold, heat, or pressure shocking of fertilized grass carp eggs that renders fish sterile and, thus, incapable of reproduction.

Triploid grass carp have been erroneously associated with bighead (*Hypophthalmichthys nobilis)*, black (*Mylopharyngodon piceus*) and silver (*Hypophthalmichthys molitrix*) carp, which have all become species of concern within the United States. Like the grass carp, all of these species originate from Asia and are subsequently lumped under the classification of "Asian Carp." Bighead and silver carp consume phytoplankton, upsetting native food webs and reducing food availability for many native species. Black carp consume snails and threaten various native mollusk populations. Therefore, these species are not used as biological control for aquatic vegetation.

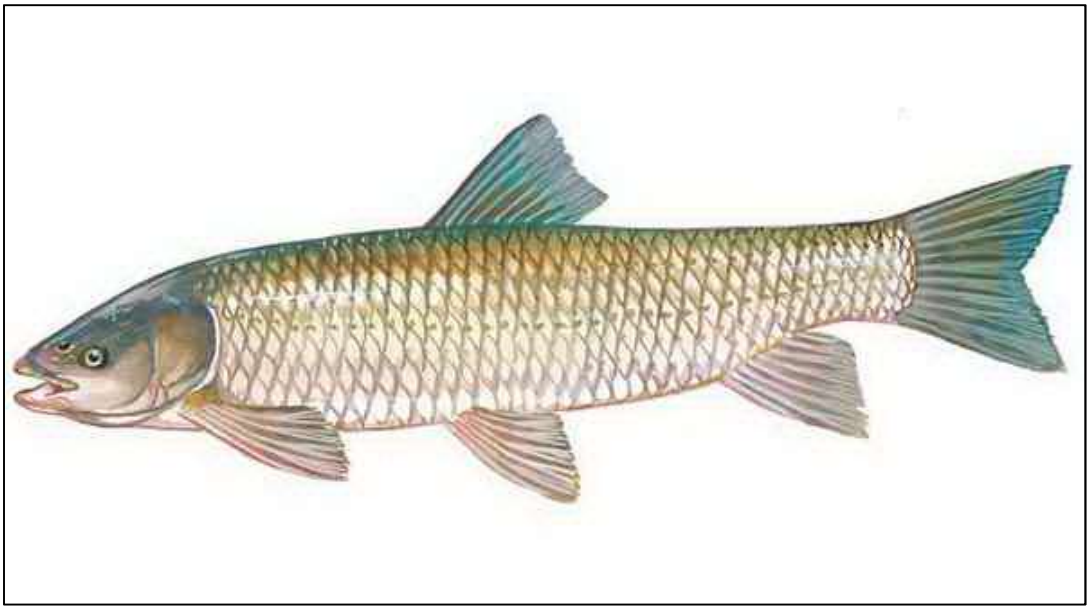

Figure 3-1 Grass carp or white amur (*Ctenopharyngodon idella*)

Grass carp can live to be more than 20 years in ideal conditions and can grow to weigh more than 80 pounds. Grass carp are almost solely herbivorous and rarely consume any animal material beyond invertebrates in the juvenile life stage. Consumption rates are affected by size of fish (consumption rates decrease as fish age and growth) and various environmental characteristics including water temperature, salinity, and oxygen content of water. (Sutton and Vandiver 2006)

Grass carp are considered to be generalist feeders, but tend to selectively feed on preferred species such as hydrilla, southern naiad, and duckweed if those species are available. If populations of their preferred plant species are diminished, however, grass carp will feed on nearly all other submersed aquatic vegetation except Eurasian watermilfoil. Grass carp are not recommended as a good option for invasive plant control in natural water bodies with diverse native populations of submersed plant species, as native species may be readily consumed once the target nuisance species have been depleted. In most reservoirs, diverse assemblages of submersed plants are absent or low in abundance when a naturally occurring seed bank is not present. (Garner et al. 2013).

Fish Assemblages and Macroinvertebrates

TVA typically monitors fisheries in Beech Reservoir during October and November. The fish assemblage in the forebay of Beech Reservoir generally rates Fair. As in previous years, a lack of species diversity, particularly the absence or low numbers of intolerant species, lowered the overall fish community score.

TVA also monitors contaminants in fish fillets from TVA reservoirs and their major tributary streams. TVA coordinates fish tissue studies in the Tennessee Valley region with state agencies that are responsible for advising the public of health risks from eating contaminated fish. TVA assists the states by collecting fish from TVA reservoirs and testing the tissue for metals, pesticides, PCBs, and other chemicals that could affect human health. The TWRA has issued a precautionary advisory for largemouth bass in Beech Reservoir due to high levels of mercury. (TVA 2017)

The overall condition of benthic (bottom-dwelling) macroinvertebrates in Beech Reservoir has usually been rated as Good, including the most recent evaluation, compared to other reservoirs in the Tennessee Valley's interior plateau ecoregion. (TVA 2017)

3.1.1.3 Aquatic Vegetation

Like most reservoirs, Beech Reservoir has very low diversity in terms of native, naturally occurring aquatic plants. During TVA's 2016 survey of Beech Reservoir, aside from the exotic hydrilla, common water nymph (*Najas guadalupensis*) and muckgrass (*Chara sp.)* were the only native submersed plants present.

Hydrilla is a submersed aquatic plant species native to Africa, Australia and parts of Asia that is highly invasive and can cause severe ecological alterations and economic impacts (Langeland 1996). Potential economic impacts could include decrease in commercial fishing; decrease in recreational activities that impact tourism; or clogging and/or damaging dams, power plants, and other water control structures. After introduction into Florida during the 1950s, the species has continued to spread, establishing itself as far north as Maine and as far west as Washington (Bailey and Calhoun 2008, Madeira et al. 2000). Hydrilla is uniquely adapted to grow in shaded areas with less than 1 percent sunlight, so that growth is limited only by extremely low water clarity and depth of light penetration. Therefore, hydrilla can survive at depths not previously inhabitable by many other species. Hydrilla has been reported at depths of greater than 20 feet in the Tennessee Valley.

Monoecious[3] hydrilla is the only biotype in Beech Reservoir (Figure 3-2). It has a shorter growing season (four to six weeks) at greater depths than other aquatic plant species (Madeira et al. 2000, Netherland 1997). The monoecious biotype has a higher tuber production, thus exacerbating the threat of potential spread in cooler, deeper waterbodies like those within the TVA system (Steward 1987). One square meter of monoecious hydrilla produces between 20 and 900 tubers annually. Once hydrilla is well established in a water body, it is virtually impossible to manage on a reservoir-wide scale and requires costly management and maintenance measures.

Hydrilla was discovered in Beech Reservoir in 2014 and TVA actively started managing it during the 2015 growing season. Baseline surveys of submersed aquatic vegetation in Beech Reservoir were last conducted on October 18-19, 2016 (Figure 3-3). An estimated total of 382 acres of submersed aquatic vegetation was surveyed within the approximately 426 acres littoral zone of the Reservoir. Hydrilla was the most dominant species in the reservoir, which also included water nymph (*Najas guadalupensis*), horned pondweed (*Zanichellia palustris*), and green algae (*Chara sp*.).

[3] A monoecious plant biotype has both the male and female reproductive organs in the same individual and does not need pollination for reproduction. A dioecious plant biotype has the male and female reproductive organs in separate individuals.

Figure 3-2 Dioecious hydrilla (left) and monoecious hydrilla (right).

Hydrilla is present in approximately 382 acres (44 percent) of the reservoir or approximately 90 percent of the littoral area (see Figure 3-4). The greatest concentrations of hydrilla were found in the upper third of the reservoir; however, the plant has established colonies throughout. As the plant continues to spread, expansion can be expected to exceed 50 percent of the entire area of the reservoir.

3.1.1 Environmental Consequences

3.1.1.1 No Action Alternative

3.1.1.1.1 Physical and Chemical Characteristics

If no CTGC were stocked in Beech Reservoir, it is likely that hydrilla would eventually spread distribution, establish a tuber bank, and increase in overall abundance over time since the current methods (herbicide and mechanical removal) are limited in scale and insufficient to stop reproduction and growth. Given close proximity to other water resources in the Beech River system, the potential for hydrilla to spread beyond Beech Reservoir should be considered high. Sediments from the reservoir bottom would be suspended during physical removal, which would temporarily increase local turbidity and hinder local algae production (chlorophyll) levels and generally disturb benthic habitat in the treated areas. Mats of hydrilla along the banks would have minor beneficial impacts as they absorb wave energy and reduce bank erosion and sediment runoff into the reservoir.

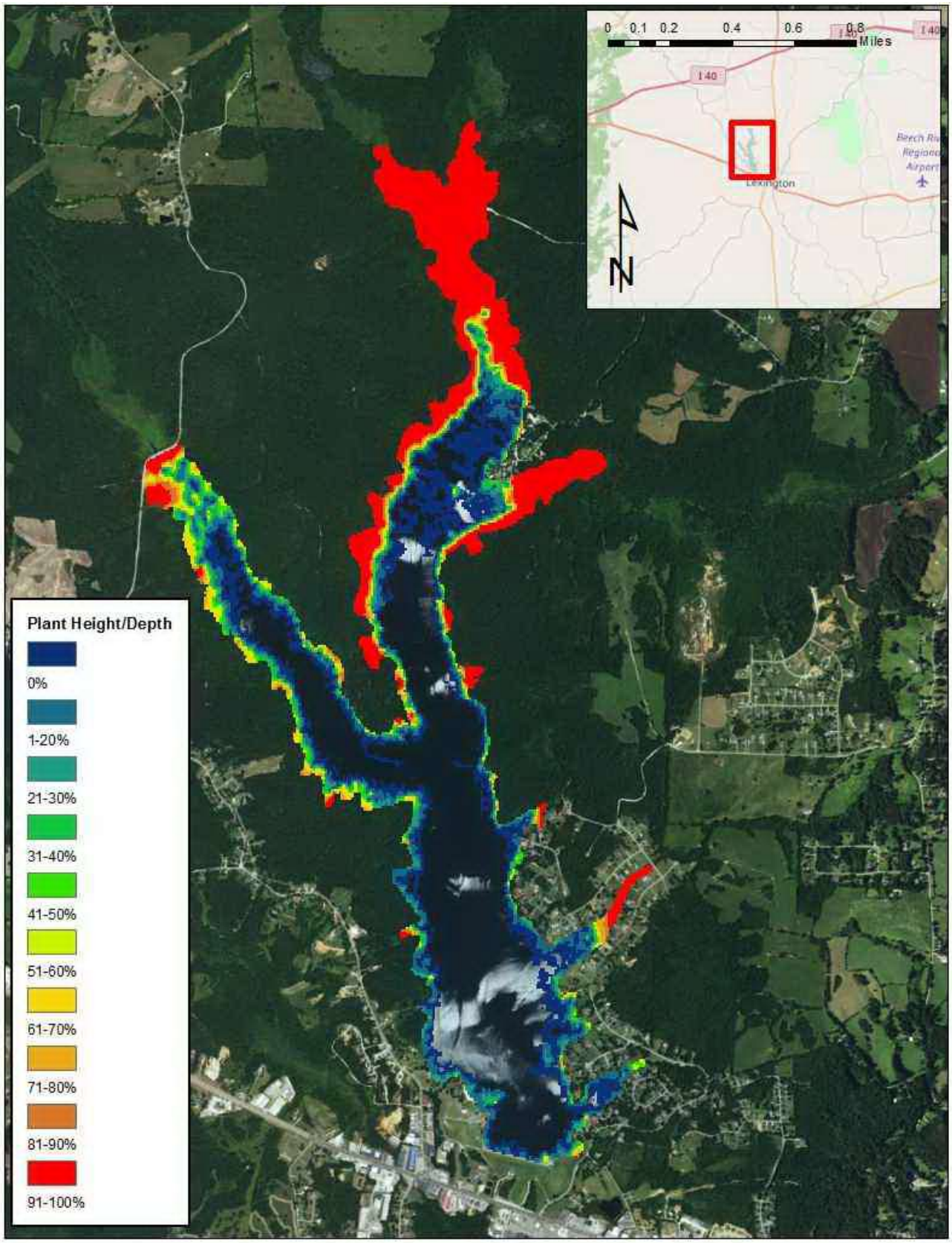

Figure 3-3 Submersed Aquatic Vegetation Distribution in Beech Reservoir

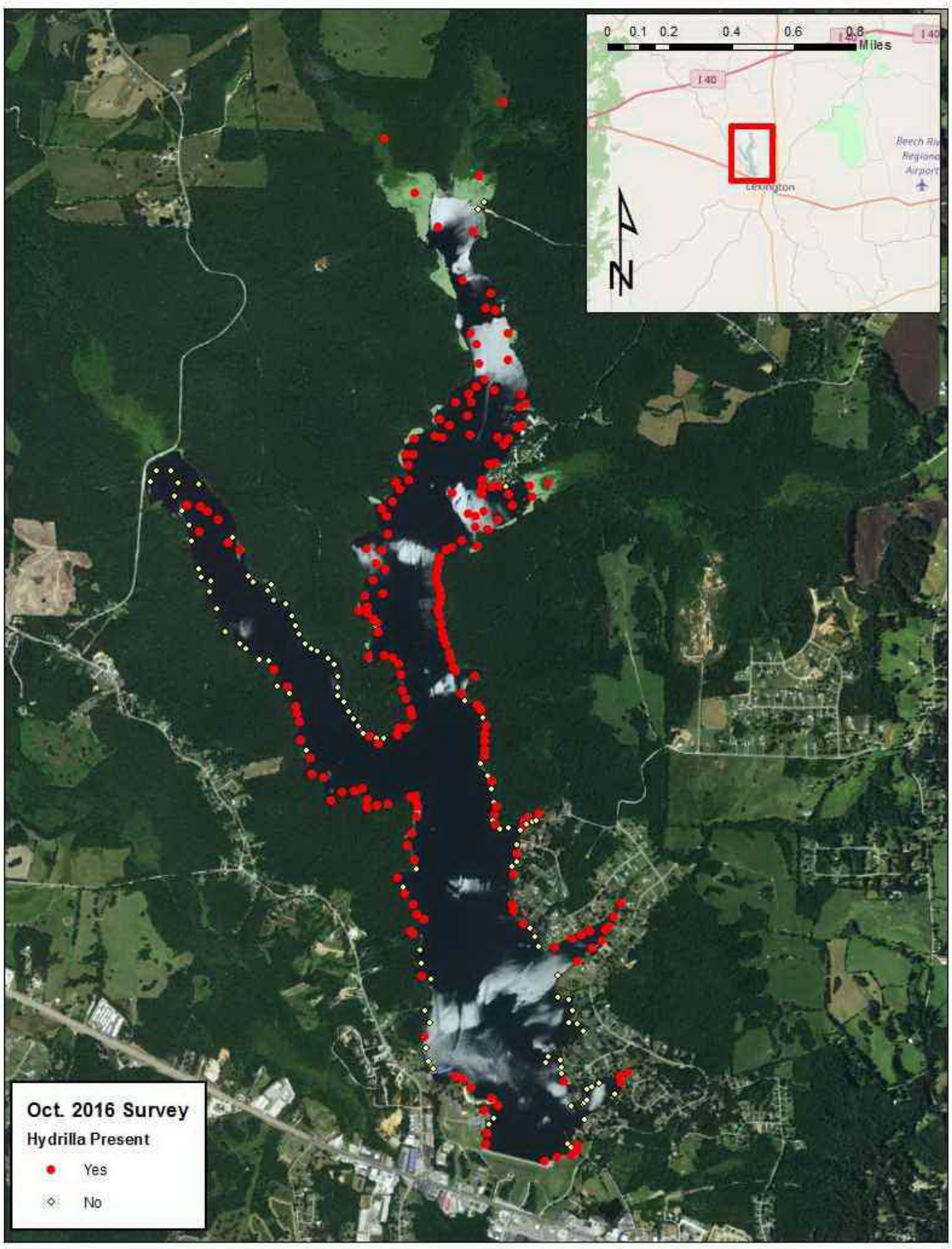

Figure 3-4 Hydrilla Distribution within Beech Reservoir

Long-term increases in hydrilla abundance and distribution within the littoral zone would eventually result in decreases in DO levels, fluctuations in pH (acidity), and a decline in temperature and light penetration relative to current levels. Therefore, there would be direct, indirect and cumulative impacts from the continued expansion of hydrilla populations associated with the No Action Alternative. However, the physical and chemical changes to open water areas of the reservoir, especially in locations where depths are greater than 20 feet, would not change significantly over time.

3.1.1.1.2 Aquatic Animals

With long-term increases of hydrilla in the reservoir, there would likely be some level of cascading effects through the food chain. Particularly in littoral areas of the reservoir, excessive abundance of hydrilla would cause shading that would decrease algae and phytoplankton, which reduces zooplankton abundance. Fish, macroinvertebrates, and trophic processes dependent on algal production would therefore be expected to decline in these areas. Overall fish and invertebrate community diversity, as well as reservoir ecological health scores, may decline over time, particularly within the littoral zone. Open water fish and invertebrate species that are adept at living in deeper waters would not change significantly.

3.1.1.1.3 Aquatic Vegetation

The implementation of the No Action Alternative would presumably result in increased invasive aquatic plant coverage, which could eventually result in reductions in native aquatic plant species diversity. Therefore, there may be increasingly adverse impacts to existing aquatic vegetation under the No Action Alternative.

3.1.1.2 Proposed Action Alternative

3.1.1.2.1 Physical and Chemical Characteristics

The introduction of CTGC to reduce hydrilla biomass in littoral areas of Beech Reservoir would shift the overall utilization of nutrients in the water column away from hydrilla and toward utilization by algae at the primary production level. It is unclear if and how much overall primary and secondary production would change throughout the reservoir. TVA expects that trophic levels and species composition would shift, but that overall reservoir production would not change significantly.

Hydrilla would be reduced gradually, allowing native aquatic vegetation to reestablish, which would help stabilize sediment. Based on observations in Guntersville Reservoir, where grass carp were stocked and native vegetation reestablished, TVA would expect little to no alteration in sediment stability and transport within Beech Reservoir.

The removal of the hydrilla mats could reduce wave buffering to the banks and result in greater bank erosion and sediment runoff into the reservoir. However, because native aquatic vegetation is expected to grow as more open water habitat is made available, the banks could be sufficiently vegetated or protected by man-made structures. Therefore, bank degradation and sediment runoff would not be expected to change significantly.

3.1.1.2.2 Aquatic Animals

The reduction of hydrilla would allow more sunlight to penetrate the water column, which would result in increased algal and phytoplankton production, as well as zooplankton and planktivorous invertebrates and fish. Therefore, we would expect to see a shift in the

proportions toward these trophic groups and predators (fish, birds, and mammals) that utilize or prefer planktivorous invertebrates and fish species. The amount of shift toward these trophic interactions is difficult to predict quantitatively. Overall changes in biomass within the reservoir would not be expected to change significantly, but a greater community diversity would be expected due to greater variation in primary production sources within the Beech Reservoir. The removal of hydrilla has the potential to increase water temperature. However, this increase in temperature would have minor and insignificant effects on species that occupy the littoral zone since Beech Reservoir does not have any cold water fish species.

3.1.1.2.3 Aquatic Vegetation

Although the CTGC may eat some native aquatic plant life, thereby reducing aquatic plant diversity, these decreases are not expected to be significant. Reservoirs like Beech are not diverse ecosystems for aquatic plants. The proposed action may also provide a benefit to native plant population as hydrilla population decreases, native plant populations would likely increase.

There is a rare possibility that the introduction of CTGC could result in a drastic reduction in aquatic plants in the reservoir and creation of an algae dominated system. This outcome would reduce water clarity and make nutrients readily available within the water column. However, the proposed sustained stocking of CTGC over several years would decrease the possibility of this happening on Beech Reservoir because those rare cases occur when a high stocking rate (100+ per acre) was used (Garner et al. 2013). The proposed action also includes annual surveys and monitoring to avoid such impacts. Surveys would directly inform and drive all management decisions and allow for adjustments to stocking rate each year. As noted in Section 2.1.2.2, TVA would maintain a low to moderate maintenance stocking based on the annual biomass surveys. This allows TVA to adjust the stocking rate in a way to greatly reduce the risk of complete aquatic plant removal (Stick et al. 2013). For example, if hydrilla biomass is decreasing too fast and algal blooms are created, TVA would stock less fish or no fish at all the following stocking year. Therefore, there would likely be only minor impacts to aquatic plants as hydrilla is reduced over time.

3.2 Surface Water

3.2.1 Affected Environment

The proposed project is located in Henderson County, Tennessee. The project area drains to several streams within the (8-digit Hydrologic Unit Code 06040001) Tennessee Western Valley - Beech River watershed and is located in the Southeastern Plains and Hills Ecoregion (TDEC 2005). This watershed is located in Tennessee and Mississippi and drains 2,097 square miles, with 14.5 percent of the watershed in Henderson County. Additionally, this watershed has 23 dams inventoried by TDEC in the Tennessee portion of the watershed (TDEC 2005). According to the TDEC 305(b)[4] monitoring data collected from 1996 to 2000, the Beech Reservoir waterbody can support aquatic algae or plant growth. The DO concentrations can be impacted by the occurrence of large colonies of aquatic plants. While aquatic plant production does produce large quantities of DO during the daylight hours when photosynthesis occurs, the respiratory requirements of these same plants during the hours of darkness or other periods of low light intensity exerts a large demand on the DO concentrations of a waterbody (TVA 1990).

[4] Section 305(b) of the Clean Water Act.

Approximately 32.6 percent of the streams in this watershed fully support TDEC's designated uses (Domestic Water Supply, Industrial Water Supply, Fish and Aquatic Life, Recreation, Livestock Watering and Wildlife, Irrigation, and Navigation), however 62.7 percent of streams have not be assessed. The surface water in the project area and its designated uses are listed below in Table 3-1.

The federal Clean Water Act requires states to identify all waters where required pollution controls are not sufficient to attain or maintain applicable water quality standards and to establish priorities for the development of limits based on the severity of the pollution and the sensitivity of the established uses of those waters. States are required to submit reports to the USEPA. The term "303(d) list" refers to the list of impaired and threatened streams and water bodies identified by each state. Beech Lake is currently listed on Tennessee's 303(d) list for mercury due to atmospheric deposition. Additionally, Brown's Creek is listed for iron, temperature alterations, and flow alternations due to an upstream impoundment and poor quality discharges from Browns Creek Lake (TDEC 2017). Table 3-2 provides a listing of local streams with their state (TDEC 2013) designated uses.

Table 3-2 Uses for Streams in the Vicinity of the Proposed Beech Reservoir Triploid Grass Carp Stocking for Aquatic Vegetation Management

Stream	Use Classification[1]						
	NAV	DOM	IWS	FAL	REC	LWW	IRR
Beech River	X	X	X	X	X	X	X
Beech Lake				X	X	X	X
Piney Creek				X	X	X	X
Pine Lake				X	X	X	X
Dry Creek				X	X	X	X
Sycamore Lake				X	X	X	X
Haley Creek				X	X	X	X
Cedar Lake				X	X	X	X
Brown Creek				X	X	X	X
Pin Oak Lake				X	X	X	X
Dry Creek				X	X	X	X
Red Bud Lake				X	X	X	X
Big Creek				X	X	X	X
Dogwood Lake				X	X	X	X

[1] Codes: DOM = Domestic Water Supply; IWS = Industrial Water Supply; FAL = Fish and Aquatic Life; REC = Recreation; LWW = Livestock Watering and Wildlife; IRR = Irrigation, NAV = Navigation

3.2.2 Environmental Consequences

3.2.2.1 The No Action Alternative

Under the No Action Alternative, it would be expected that aquatic vegetation would continue to grow and increase. Indirect water quality impacts (increased nutrients, decreased algal growth, and decreased water clarity) caused by use of herbicides generally have been found to be much greater than those caused by grass carp (Hestand and Carter 1978, Leslie et al. 1987). Also, the increase in aquatic plant vegetation would degrade water quality by causing extreme fluctuations in DO, pH (acidity), and other conditions (TVA 1990). Therefore, there would be negative direct, indirect and cumulative surface water impacts from the continued expansion of hydrilla populations associated with the No Action Alternative.

3.2.2.2 The Proposed Action Alternative

Aquatic plants can have positive effects on water bodies by reducing wave action erosion on shorelines, providing a food source for aquatic fish species, and providing cover and protection for fish species. However, invasive or nuisance species can decrease more desirable vegetation species and impact the water quality of the water body by causing extreme fluctuations in DO, pH, and other conditions (TVA 1990).

Grass carp potentially can impact water quality characteristics such as nutrients, DO, pH, calcium, water clarity, turbidity, and chlorophyll (an indicator of phytoplankton activity). Grass carp eat aquatic plants and then excrete nutrients into the water. The nutrient rich fecal material sinks to the bottom, and only a small portion of the nutrients become available to phytoplankton (Hestand and Carter 1978, Leslie et al. 1987).

A demonstration of the use of CTGC was conducted by TVA in the Guntersville Reservoir and found that nutrient release from grass carp wastes would not be measurable (TVA 1990). Without a significant increase in nutrients, any changes in associated water quality characteristics such as algal growth, pH, DO, and water clarity would likely be minor and of short duration. Minor, indirect effects of increased shoreline erosion and turbidity at some portions of the reservoir may occur with the initial reduction of aquatic vegetation levels. Experiences at other locations where grass carp have been used indicate that no odors or other objectionable aesthetic conditions are associated with use of grass carp for vegetation reduction (TVA 1990).

This proposed action would reduce the total quantity of hydrilla, but as the hydrilla population decreases, native plant populations would likely increase. As mentioned above, there is a potential for shoreline erosion due to wave action and increased turbidity. However, emergent shoreline vegetation, which would not be readily eaten by grass carp until other preferred foods had been eliminated, would stabilize large portions of the reservoir shoreline (TVA 1990). As part of the Proposed Action, TVA would survey Beech Reservoir annually to inform all management decisions, which would include adjusting stockings if erosion was increasing due to slow emergent vegetation growth. Also, the water quality characteristics would likely improve as the reservoir system and aquatic life adjust to the introduction of CTGC. The overall reduction in the density of hydrilla on Beech Reservoir would limit the existing fluctuations in DO, pH, and other conditions. Therefore, there would be minor long-term beneficial impacts under the proposed action.

Overall, there would be minor temporary indirect, direct and cumulative surface water impacts from the initial stocking of CTGC into Beech Reservoir and minor long-term beneficial impacts under the action alternative.

3.3 Terrestrial Ecology - Wildlife

3.3.1 Affected Environment

Beech Reservoir is a human constructed reservoir that provides habitat for common terrestrial and amphibious species. The open water provides habitat for common diving waterfowl species such as bufflehead, canvas back, common merganser, ring-necked duck, and greater and lesser scaup. Other species such as double crested cormorant and Canada goose are also likely to use this open water habitat. The northern two forks of Beech Reservoir contain emergent and aquatic vegetation. The western fork contains a small amount of wetland with emergent vegetation dominated by giant cut grass. The

eastern fork contains a large amount of hydrilla. These areas may provide suitable habitat for common dabbling ducks such as coots, gadwall, grebes, pintail, teals, and mallards. However, due to the overwhelming domination of giant cut grass and the hydrilla in each of these forks, the macroinvertebrate community diversity in these two areas is likely low. Therefore these areas would not provide suitable habitat for less common species that require more specialized food sources. Suitable habitat for shorebirds such as bitterns, rails, plovers, and sandpipers does not exist in the project action area due to the steep reservoir banks and forested shorelines. In addition, TVA does not draw down the lake levels in this reservoir to expose any potential mudflats used by these shorebirds.

Common amphibians may utilize the areas with emergent and submerged vegetation along shorelines. Species potentially found here include American bullfrog, Cope's gray treefrog, green frog, green treefrog, southern leopard frog, and upland chorus frog. Reptiles that also may use these areas or open water areas include diamond-backed watersnake, eastern spiny softshell, midland watersnake, red-eared slider, snapping turtle, and southern painted turtle. Mammals that may use this reservoir include beavers and muskrat.

Migratory birds of concern in this area as listed by the USFWS Information for Planning and Consultation website are American kestrel, bald eagle, chuck-will's widow, dickcissel, fox sparrow, Kentucky warbler, least bittern, loggerhead shrike, prairie warbler, prothonotary warbler, red-headed woodpecker, rusty blackbird, sedge wren, short-eared owl, Swainson's warbler, willow flycatcher, and wood thrush. Of these species the bald eagle is the only species with the potential to use the action area for foraging. No heronries of other aggregations of migratory birds are known within three miles of this reservoir. No caves are known within three miles of this reservoir.

3.3.2 Environmental Consequences

3.3.2.1 No Action Alternative

Diversity of food for terrestrial and amphibious wildlife species (aquatic macroinvertebrates and fish communities) would likely decrease as a result of the spread of hydrilla. Only common wildlife species with generalist diets would be able to utilize this hydrilla dominated habitat. Populations of some waterfowl that eat hydrilla (American coot, mallard) may increase due to the increase in food availability. Eventually the reservoir would be filled with hydrilla with only pockets or strips of open water habitat being temporarily available where mechanical and herbicide treatments occurred. Large mats of hydrilla formed throughout the reservoir would block access to more ideal waterfowl hunting grounds. Habitat for species requiring open water (diving ducks, goose, cormorants) would be severely limited. Species of water birds requiring open water habitat would leave Beech Reservoir to find more suitable habitat elsewhere. Common amphibian species, beavers, muskrats, and some turtle species would persist as long as some areas remained permeable to movement through the water column and food was available. Overall, there would be negative direct, indirect and cumulative impacts to terrestrial wildlife.

Presence of hydrilla in the southeastern United States also has been linked to a cyanobacteria that produces a neurotoxin that can cause neurological disease in birds (avian vacuolar myelinopathy or AVM). Birds that eat the hydrilla (such as American coot and mallards) can contract the disease that causes brain lesions and impairs motor skills. It is thought that this bacteria may be passed up through the food chain to bald eagles that prey on these impaired waterbirds, ultimately resulting in the death of bald eagles. This cyanobacteria has also been documented causing brain lesions in turtles and grass carp.

More research is needed to evaluate the potential spread of this disease-causing cyanobacteria and its implications on spread of disease through the food chain (Wilde et al 2014). The presence of this cyanobacteria on Beech Reservoir is unknown. However, it is reasonable to assume that the potential for presence and spread of this disease on Beech Reservoir would increase as hydrilla continues to spread. Until the presence/absence of this cyanobacteria is determined the impacts of this bacteria under this alternative to wildlife populations are not reasonable to assume at this time.

3.3.2.2 Proposed Action Alternative

Under the Proposed Action Alternative, TVA would stock CTGC for maximized control of hydrilla into Beech Reservoir. Immediate effects of the introduced CTGC would be to provide an additional food source to wildlife species able to capture and consume large fish (stocked carp would be 10-12 inches long). Populations of species such as osprey, double crested cormorants, and muskrat may benefit from the increased availability of food.

Controlling the spread of hydrilla across Beech Reservoir would maintain open water habitat available to wildlife. Natural wetlands would continue to support the common species that need emergent wetland vegetation as quantities of hydrilla decrease.

Although the CTGC may eat some native aquatic plant life, thereby reducing aquatic plant diversity and thus aquatic macro invertebrate diversity, these decreases are not expected to be significant. Reservoirs like Beech are not thought to be very diverse ecosystems for aquatic plants or macroinvertebrates. Thus the potential decrease in diversity of these food sources are not expected to impact wildlife populations.

The implementation of the Proposed Action Alternative is not expected to negatively affect common wildlife populations and may result in indirect, direct and cumulative benefits to some specific common wildlife species.

3.4 Threatened and Endangered Terrestrial Species

3.4.1 Affected Environment

The Endangered Species Act (ESA) provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered in the United States or elsewhere. The ESA (Section 7) outlines procedures for federal agencies to follow when taking actions that may affect federally listed species or their designated critical habitat. In addition, the state of Tennessee provides protection for species considered threatened, endangered or deemed in need of management within the state other than those already federally listed under the ESA. Plant species are protected in Tennessee through the Rare Plant Protection and Conservation Act of 1985. The listing of species is managed by TDEC. Additionally, the Tennessee Natural Heritage Program and TVA both maintain databases of aquatic and terrestrial plant and animal species that are considered threatened, endangered, of special concern, or are otherwise tracked in Tennessee because the species is rare and/or vulnerable within the state.

Reviews of the TVA Natural Heritage Database indicated that one state-listed species (northern pine snake) and no federally listed species exist within three miles of the project area. No federally listed species have been documented in Henderson County, Tennessee. The USFWS has determined that the federally endangered Indiana bat, federally threatened northern long-eared bat (NLEB), and federally protected bald eagle have the

potential to occur Henderson County. Thus, they have the potential to occur in the project area and impacts to these species will be evaluated for this project (Table 3-3).

Table 3-1 State and Federally Listed Terrestrial Animal Species Reported from Henderson County, Tennessee and other species of conservation concern within a 3-Mile Radius of the Project Area[1]

Scientific Name	Common Name	Federal Status	State Status	State Rank[3]
Haliaeetus leucocephalus	Bald eagle[4]	DM	D	S3
Myotis septentrionalis	Northern long-eared bat[4]	LT	-	S1S2
Myotis sodalis	Indiana bat[4]	LE	END	S1
Pituophis melanoleucus melanoleucus	Northern pine snake	-	THR	S3

[1] Source: TVA Regional Natural Heritage Database, extracted 04/21/2017 and USFWS Information for Planning and Consultation (http://ecos.fws.gov/ipac/), accessed 04/21/2017.
[2] Status Codes: D = Deemed in need of management; DM = Delisted, recovered, and still being monitored; END = Endangered; LE = Listed Endangered; LT = Listed Threatened; THR = Threatened.
[3] State Ranks: S1 = Critically Imperiled, Extremely rare and critically imperiled in the state, 5 or fewer occurrences, or very few remaining individuals, or because of some special condition where the species is particularly vulnerable to extinction. ; S2 = Imperiled, Very rare and imperiled within the state, 6 to 20 occurrences, some factor(s) making it vulnerable to extinction; S3 = Vulnerable, Rare or uncommon in the state, from 21 to 100 occurrences.
[4] Federally listed or protected species with the potential to occur in the project footprint, though it has not yet been reported from Henderson County, Tennessee.

Northern pine snakes are found in well-drained sandy soils in pine and pine-oak woodlands and on dry mountain ridges (NatureServe 2015). Habitat for this species may exist around the project area, but does not exist within the proposed action area. Therefore, this species is not discussed further in this EA.

Bald eagles are protected under the Bald and Golden Eagle Protection Act (USFWS 2013). This species is associated with large, mature trees capable of supporting its massive nests. These are usually found near larger waterways where eagles forage (Turcotte and Watts 1999). No records of this species are known from Henderson County, Tennessee. No bald eagle nests are known around Beech Reservoir. Suitable foraging habitat for this species in the action area occurs over Beech Reservoir.

Indiana bats hibernate in caves in winter and use areas around them in fall and spring (for swarming and staging), prior to migration back to summer habitat. During the summer, Indiana bats roost under the exfoliating bark of dead and living trees in mature forests with an open understory often near sources of water. Indiana bats are known to change roost trees frequently throughout the season, yet still maintain site fidelity, returning to the same summer roosting areas in subsequent years. This species forages over forest canopies, along forest edges, and tree lines, and occasionally over bodies of water (Pruitt and TeWinkel 2007, Kurta et al. 2002, USFWS 2016). No records of Indiana bat exist for Henderson County, Tennessee. The closest known occurrence of Indiana bat is approximately 20.4 miles from Beech Reservoir in Benton County, Tennessee. No caves are known to exist within three miles of the project footprint. Forested habitat around Beech Reservoir may provide suitable summer roosting habitat for Indiana bat, but this forested habitat is not within the action area of the proposed project. Beech Reservoir itself may provide foraging habitat and drinking water for the Indiana bat.

The NLEB predominantly overwinters in large hibernacula such as caves, abandoned mines, and cave-like structures. During the fall and spring they utilize entrances of caves and the surrounding forested areas for swarming and staging. In the summer, northern long-eared bats roost individually or in colonies beneath exfoliating bark or in crevices of both live and dead trees. Roost selection by northern long-eared bat is similar to Indiana bat; however it is thought that northern long-eared bats are more opportunistic in roost site selection. Northern long-eared bats emerge at dusk to forage below the canopy of mature forests on hillsides and roads, and occasionally over forest clearings and along riparian areas (USFWS 2014). No records of NLEB exist for Henderson County, Tennessee. The closest known occurrence of NLEB is approximately 28.1 miles away in Decatur County, Tennessee. No caves are known to exist within three miles of the project footprint. Forested habitat around Beech Reservoir may provide suitable summer roosting habitat for NLEB, but this forested habitat is not within the action area of the proposed project. Beech Reservoir itself may provide foraging habitat and drinking water for NLEB.

3.4.2 Environmental Consequences

3.4.2.1 The No Action Alternative

Indiana bat and NLEB that may forage over Beech Reservoir are not likely to be impacted by the No Action Alternative. Although these species are known to forage over open water like Beech Reservoir that would be impacted by the spread of hydrilla, their foraging habitat also occurs over and under forest canopies. These forested habitats would not be impacted by the proposed actions, therefore foraging availability for federally listed bats is not expected to be impacted by the proposed actions.

Bald eagle may be negatively impacted by this alternative. The spread of hydrilla throughout the reservoir would reduce foraging habitat and make foraging more challenging for this species. As open water is reduced to small patches temporarily opened by mechanical removal and herbicide, fish would be much less visible to bald eagles as the fish hide under the dense mats of hydrilla. Additionally, if the cyanobacteria causing Avian Vacuolar Myelopathy (AVM) is present in Beech Reservoir, the spread of hydrilla, on which the cyanobacteria is found, would have the potential to lead to bald eagle mortality. However, since the presence or absence of this cyanobacteria in Beech Reservoir has not been tested, potential impacts of this alternative to AVM in bald eagle populations are not reasonable to anticipate at this time.

3.4.2.2 The Proposed Action Alternative

Open water would continue to be available for foraging bats under this proposed alternative. Therefore, the Northern pine snake, Indiana bat, and NLEB would not be directly, indirectly or cumulatively impacted by the proposed actions. The introduced grass carp would provide an additional food source to bald eagles. The presence of grass carp would keep open water habitats exposed allowing for foraging eagles to easily find prey. Therefore, Bald eagles may benefit from the proposed action alternative from the increase in potential foraging habitat.

3.5 Wetlands

3.5.1 Affected Environment

Wetlands are areas that are inundated or saturated by water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of

vegetation typically adapted for life in saturated soil conditions (USEPA regulations at 40 C.F.R § 230.3(t)). Wetlands generally include swamps, marshes bogs and similar areas. Wetlands are highly productive and biologically diverse ecosystems that provide multiple public benefits such as flood control, reservoir shoreline stabilization, improved water quality and habitat for fish and wildlife resources.

Section 404 of the Clean Water Act prohibits the discharge of dredge and fill material to waters of the United States, which include most wetlands, unless authorized by a permit issued by the USACE. The scope of this regulation includes most construction activities in wetlands. Executive Order 11990, Protection of Wetlands, requires Federal agencies to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance their natural and beneficial values.

Beech Reservoir is located within the Southeastern Plains and Hills subdivision of the Southeastern Plains Ecoregion. Wetlands within this region comprise 10.3 percent of land cover (Sohl 2007). National Wetland Inventory (NWI) data indicates there are approximately 190 acres of forested wetlands surrounding Beech Reservoir; these areas occur on floodplain areas associated with tributaries such as Black Bottom Creek, Graves Branch, and Beech River as it enters the reservoir. There are also limited areas of emergent wetlands (approximately 6 acres) comprised primarily of giant cutgrass (*Zizaniopsis miliacea*). (Figure 3-4)

In 2016, aquatic bed wetlands composed primarily of hydrilla were found to be present in 44 percent of the Reservoir. The greatest concentrations of hydrilla are found in the Black Bottom Creek embayment northwest of Black Bottom Road, the northernmost portion of the reservoir, and in the Graves Creek embayment (Figure 3-5).

3.5.1 Environmental Consequences

3.5.1.1 No Action Alternative

The implementation of the No Action Alternative, continuation of the present integrated management approach, would likely result in increased coverage of aquatic bed wetlands because of the expansion of hydrilla. The No Action Alternative might initially result in increased aquatic plant coverage, but this could eventually result in reductions in aquatic plant species diversity and subsequent reduction in wetland habitat value. However, there would be no impacts to forested wetland communities in the area.

3.5.1.2 Proposed Action Alternative

Under the Proposed Action Alternative, there is a potential for the proposed project to impact aquatic bed wetland vegetation. The project does not propose dredge or fill within wetlands, so no state or federal permits are required. Over a period of 3-4 years, grass carp would reduce the surface coverage, biomass, and species composition of aquatic bed wetlands (Santos et a. 2011). There would be minor, secondary impacts to aquatic communities (invertebrates, zooplankton, fish) that utilize these aquatic bed wetlands as habitat.

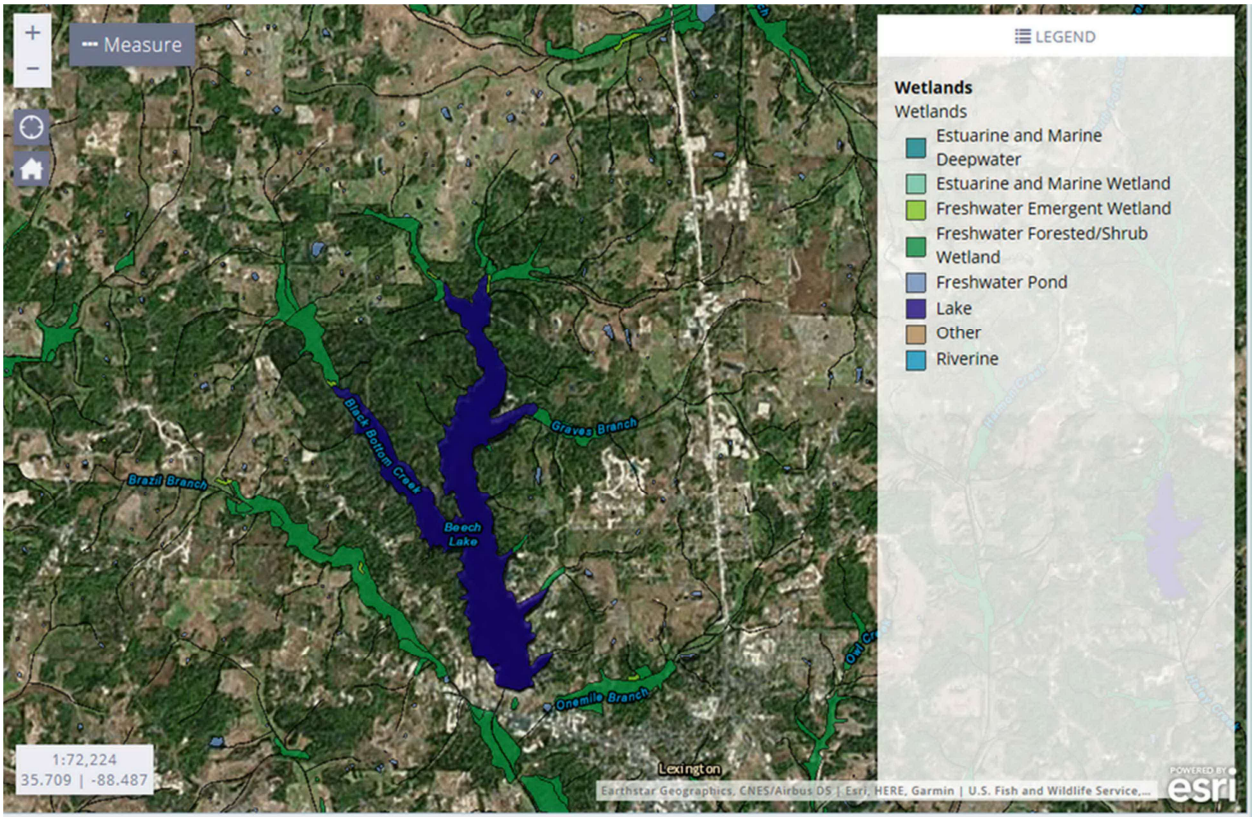

Figure 3-5 National Wetland Inventory – Beech Reservoir

If the proposed stocking is successful, unavoidable losses of aquatic bed wetlands and localized aquatic habitat would initially occur as CTGC decrease the volume of hydrilla within the aquatic bed wetlands. As discussed in Section 2.2, TVA has evaluated other alternatives for invasive aquatic vegetation management. No other method has shown to be as effective as introducing CTGC as a biological control to the reservoir and continuing the minimal herbicide treatment adjacent to public use spaces. TVA has determined that no practicable alternatives exist to remove hydrilla from the existing aquatic wetland beds and that the goals of the proposed action are therefore consistent with the provisions of Executive Order 11990. Additionally, there is the potential that native populations of submerged, aquatic bed wetlands would reestablish in conjunction with the decrease in hydrilla by having a greater area for growth and potential for re-establishment (USACE 2016). Therefore, there is a potential for minor long-term beneficial impacts on wetlands.

Grass carp do not consume emergent wetland vegetation even when the waterbody is heavily stocked or over stocked (Department of Ecology, State of Washington 2011). Therefore, the stocking of CTGC would have no direct, indirect or cumulative impacts on the 6 acres of emergent wetlands found on Beech Reservoir. There would also be no direct, indirect or cumulative impacts to forested wetlands anticipated under the Proposed Action Alternative.

In summary, there would be short term impacts to non-native aquatic bed wetland communities associated with the Proposed Action Alternative. The gradual, localized loss of this non-native habitat would be insignificant in context of regional aquatic bed wetland resources and would potentially allow for the reestablishment of native aquatic bed wetland vegetation. There will be no impacts to emergent and forested wetland communities in the area.

3.6 Recreation

3.6.1 Affected Environment

Beech Reservoir, the largest of the 8 Beech projects, receives a variety of recreation uses including boating, swimming, picnicking, camping, and fishing. Major developed recreation areas available to the public include a day use area (including boat launching ramp, picnic facilities, trails, and a swimming beach) situated just upstream from the dam and Beech Lake Family Resort (camping, watersports, boat launching and swimming) located on the upper end of the reservoir. Aquatic plants can have both positive and negative impacts on recreation users. The presence of some aquatic plants can enhance fishing and water based hunting or waterfowl viewing activities. However, plants can also have a negative impact on other activities such as general boating, swimming and wading, and water sports such as water skiing. Most recreation related concerns and complaints related to aquatic plants have been focused on the upper end of Beech Reservoir where the hydrilla is most prolific.

3.6.2 Environmental Consequences

3.6.2.1 No Action Alternative

Under the no action alternative, hydrilla in Beech Reservoir would likely continue to increase and expand beyond the present level. This could have some positive impact on certain activities such as boat fishing or waterfowl viewing. However, aquatic plants cause problems when they reach excessive levels. They can interfere with recreational opportunities such as swimming, water-skiing, and bank fishing. These plants can clog boat propellers and make it hard for boaters to reach ramps and docks. Therefore, adverse indirect, direct and cumulative impacts on recreational activities such as general boating, camping, swimming and water sports would occur under this alternative.

3.6.2.2 Proposed Action Alternative

The Proposed Action Alternative is expected to lead to an overall reduction in the density of hydrilla which allowing some hydrilla to remain. The reduction of hydrilla, especially in open water habitat and around existing recreational facilities, would provide optimum conditions for meeting the widest range of recreational activities on Beech Reservoir (TVA 1990). For example, aquatic plants would continue to provide some benefits to boat fishing and waterfowl watching/hunting activities while opportunities for other activities such as general boating, swimming, and shoreline camping would be enhanced. Therefore, beneficial indirect, direct and cumulative recreational impacts are anticipated under the Proposed Action Alternative.

3.7 Socioeconomic Conditions and Environmental Justice

3.7.1 Affected Environment

Census data available online through U.S. Census Bureau is summarized in Table 3-4. The most recent 10-year census data (2010) was utilized for population statistics. Intermittent estimates conducted after the formal 2010 census are available, but the base year of 2010 was used for analysis (U.S. Census Bureau 2017).

Table 3-2 Demographics Data for Henderson County, Tennessee

Statistic	Hardin County	State of Tennessee	National
2010 Population	27,769	6,346,105	308,745,538
Median household income*	$38,745	$44,621	$53,482
Percent Minorities, 2010 Census	9.2%	22.4%	27.6%
Percent below poverty level*	21.5%	17.8%	15.6%
Unemployment rate**	7.1%	5.1%	4.4%

*2015 American Community Survey 5-Year Estimates
**May 2017 United States Department of Labor – Bureau of Labor Statistics.

Henderson County's median household income is $38,745, or 13.2 percent lower than the state's median income of $44,621 and 27.6 percent lower that nation median income of $53,482. Henderson County also experiences a lower percentage of minorities and higher poverty and unemployment rates as compared to state and national rates.

3.7.2 Environmental Consequences

3.7.2.1 No Action Alternative

Under the No Action Alternative, the proposed project would not be implemented and no direct impacts to socioeconomic conditions or environmental justice would occur. However, hydrilla would continue to spread and impact local recreational opportunities. The loss of potential recreational activities would have a minor impact on the local economy as people would stop going to Beech Reservoir for recreational purposes (general boating, camping, swimming and water sports). Even though Henderson County experiences higher poverty, there would be no disproportionate impacts on these communities.

3.7.2.2 Proposed Action Alternative

The Proposed Action Alternative is expected to lead to an overall reduction in the density of hydrilla. Under this alternative, aquatic plants would continue to provide some benefits to boat fishing and waterfowl watching/hunting activities while opportunities for other activities such as general boating, swimming, and shoreline camping would be enhanced. Recreational opportunities would increase, which would lead to beneficial direct, indirect and cumulative impacts to the local economy. There would be no disproportionate impacts on minority or poverty communities.

3.8 Summary

The stocking of Beech Reservoir with CTGC would have a minor impact on the ecosystem of the Reservoir as the CTGC begin to feed on hydrilla. This would lead to a decrease in hydrilla biomass and a shift in aquatic species composition and nutrient levels. However, this shift would not impact the overall production (aquatic life, nutrients, etc.) in the reservoir.

There is a minor possibility that the introduction of CTGC could result in a drastic reduction in aquatic plants in the reservoir and creation of an algae dominated system. However, TVA's proposed annual monitoring and low to moderate maintenance stocking would greatly reduce the risk of complete aquatic plant removal. Therefore, there would likely be only minor impacts to aquatic plants as hydrilla is reduced over time.

Over time, the reduction of hydrilla would be beneficial to recreational activities and the local economy as more open water habitat would be available for boating, waterfowl watching/hunting, fishing and other water-based activities. The increase in open water habitat would also benefit some wildlife species (osprey, double crested cormorants, and muskrat) and allow for the possibility of native aquatic plant species growth throughout the reservoir. While the proposed action would lead to an unavoidable loss of aquatic bed wetlands and localized aquatic habitat, there is the potential for native populations of submerged aquatic plants to reestablish in these wetland habitats.

While there would be some minor impacts to resources on Beech Reservoir, the overall beneficial impacts of CTGC helping to reduce hydrilla biomass outweighs those negative impacts. Beech Reservoir is a small economic development and recreation reservoir with new hydrilla establishment. By reducing the biomass and preventing/limiting the spread of hydrilla on Beech, TVA is able to ensure that hydrilla does not spread into a string of other small TVA reservoirs located within the Beech River Reservoir System.

CHAPTER 4 - LIST OF PREPARERS

Table 4-1 summarizes the expertise and contribution made to the EA by the Project Team.

Table 4-1 Environmental Assessment Project Team

Name/Education	Experience	Project Role
Elizabeth B. Hamrick *M.S., Wildlife,* *B.S. Biology*	9 years in biological surveys and environmental reviews	Threatened and Endangered Species (terrestrial animals), ecological resources (wildlife)
Brett M. Hartis *Ph.D., Fisheries, Wildlife, and Conservation Biology; M.S., Natural Resources Management* *B.S., Biology*	13 years in fisheries and aquatic plant science	Project Manager and aquatic vegetation
Matthew Higdon *M.S., Environmental Planning; B.A., History*	14 years in natural resources planning and NEPA compliance	NEPA compliance and document preparation
Charles Howard *M.S., Zoology; B.S., Biology*	25 years in aquatic ecology research, impact assessment, and endangered species conservation.	Aquatic Ecology
Tim L. Keeling *B.S., Computer Science*	39 years in application and database design	Heritage data viewer, data quality
Robert Marker *B.S. Recreation Resources Management*	46 years in recreation planning and management	Recreation
Loretta A. McNamee *B.S. Environmental Biology*	10 years in NEPA compliance	NEPA Compliance and document preparation
Kim Pilarski-Hall *M.S., Geography, Minor Ecology*	21 years in wetlands assessment and delineation	Wetlands, Natural Areas
W. Doug White *B.S., Forestry*	3 years in NEPA compliance, 11 years in water resources management	NEPA compliance and document preparation
Chevales Williams *B.S., Environmental Engineering*	12 years of experience in water quality monitoring and compliance; 11 years in NEPA planning and environmental services	Surface Water

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CHAPTER 5 - ENVIRONMENTAL ASSESSMENT RECIPIENTS (AGENCIES AND ORGANIZATIONS)

5.1 Federal Agencies

- U.S. Army Corps of Engineers, Nashville District
- U.S. Fish and Wildlife Service, Cookeville, Tennessee

5.2 State Agencies

- Tennessee Department of Agriculture
- Tennessee Department of Environment and Conservation
  - Bureau of Parks and Conservation
  - Bureau of Environment
  - Division of Natural Areas
  - Division of Natural Heritage
  - State Parks
- Tennessee Historical Commission
- Tennessee Wildlife Resources Agency

5.3 Local Governments and Organizations

- City of Lexington, Tennessee

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CHAPTER 6 - LITERATURE CITED

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