Eufaula Lake Shoreline Management Plan Revision and Master Plan Supplement Environmental Impact Statement

Terrestrial and Aquatic Habitats and Natural Resources Inventory Report

Eufaula Lake, Oklahoma

United States Army
Corps of Engineers
Tulsa District

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Acronyms

°C	Degrees Celsius
°F	Degrees Fahrenheit
a.m.	Ante Meridiem
CFR	Code of Federal Regulations
cm	Centimeter
CWA	Clean Water Act
DBH	Diameter at Breast Height
DDT	Dichloro-diphenyl-trichloroethane
DNA	Deoxyribonucleic acid
DO	Dissolved oxygen
DOKARRS	Distribution of Oklahoma Amphibian and Reptiles by Recorded Sightings
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FHWA	Federal Highway Administration
ft	Feet
FWP	Fish and Wildlife Propagation (beneficial use)
GIS	Geographic Information System
IUCN	International Union for the Conservation of Nature
km	Kilometer
lb	Pound
LMBV	Largemouth Bass Virus
m	Meter
mg/L	Milligrams per liter
MP	Master Plan
MSL	Above Mean Sea Level
N/A	Not Available
NAWMP	North American Waterfowl Management Plan
NEPA	National Environmental Policy Act
NRCS	Natural Resources Conservation Service
NTU	Nephelometric Turbidity Units
OBS	Oklahoma Biological Survey
OCC	Oklahoma Conservation Commission
ODEQ	Oklahoma Department of Environmental Quality
ODOT	Oklahoma Department of Transportation
ODWC	Oklahoma Department of Wildlife Conservation
ONHI	Oklahoma Natural Heritage Inventory
OWRB	Oklahoma Water Resources Board
PBCR	Primary Body Contact Recreation
p.m.	Post Meridiem
PPWS	Public and Private Water Supply
SAP	Southern Appalachian (U.S. EPA Lake Ecoregion)

SHA	Shoreline Habitat Assessment
SMP	Shoreline Management Plan
SPL	Southern Plains (U.S. EPA Lake Ecoregion)
µS/cm @ 25°C	Micro Siemens per Centimeter at 25 Degrees Celsius
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WDU	Wetland Development Unit
WMA	Wildlife Management Area
WQS	Water Quality Standards
WWAC	Warm Water Aquatic Community

Chapter 1

Executive Summary

In support of proposed revisions to the Eufaula Reservoir Shoreline Management Plan (SMP) and the supplement to the Master Plan (MP), the U.S. Army Corps of Engineers (USACE), Tulsa District is preparing an Environmental Impact Statement (EIS) in order to comply with the National Environmental Policy Act (NEPA) of 1969 (as amended) and other federal regulations. The environmental impact analysis in the EIS focuses on reservoir-wide potential impacts as well as specific potential impacts associated directly with the proposed development identified during the NEPA scoping process.

The primary purpose of this Terrestrial and Aquatic Habitats and Natural Resources Technical Report is to ensure compliance with NEPA through identification of the existing condition of habitats and natural resources within the Eufaula Lake study area and an analysis of potential impacts of the proposed actions. Terrestrial and aquatic habitats, and the natural resources located therein, are integral components of the aesthetic, cultural, and ecological identity of the Eufaula Lake study area. Therefore, habitats and natural resources are important to consider in a revision of the Eufaula Lake Shoreline Management Plan.

Any impacts that may change the existing composition of habitats and wildlife could threaten recreational opportunities, aesthetics, and the ecological balance of Eufaula Lake. This report provides information to decision-makers to make determinations on whether to proceed with the changes to the SMP and the supplement to the project MP.

The purpose of quantifying and characterizing the existing condition of terrestrial and aquatic habitats and natural resources is to form the basis to assess potential environmental impacts of the alternatives for shoreline management. The first step in evaluating habitats and natural resources is to identify the regulatory framework, which consists of laws and agreements that dictate human interaction with natural environments. For the Eufaula Lake EIS, applicable laws and agreements include, but are not limited to, the Migratory Bird Treaty Act, the Fish and Wildlife Coordination Act, the Clean Water Act, and Executive Order 11990.

After establishing the regulatory framework, a literature review was conducted to obtain all existing information applicable to the characterization of habitats and natural resources within the Eufaula Lake study area. This includes the application of visual data, including maps and GIS resources, which were used to identify landscape ecoregions, vegetation communities within each ecoregion, and the presence/absence of rare species. The literature review was supplemented with field data collected through the completion of habitat transects, threatened and endangered species surveys, and a shoreline habitat assessment. The combination of information from the literature and from the field enabled the identification of the existing condition of aquatic and terrestrial habitat types and rare and common wildlife present within the Eufaula Lake study area. The shoreline habitat assessment also allowed for comparison between Eufaula Lake's shoreline condition and the condition of lake shorelines throughout the region.

Based on similar geology, climate, and vegetation, the Eufaula Lake study area can be split into four Eco-regions: Northern Crosstimbers, Lower Canadian Hills, Osage Cuestas, and Scattered High Ridges and Mountains. Within the four larger Eco-regions, terrestrial habitats are made up of seven vegetation

communities. They include crosstimbers forest, oak-hickory forest, oak-pine forest, bottomland hardwood forest, savanna, and prairie. Similarly, aquatic habitats, which include wetlands and open water habitats, can be identified based on water depth, substrate, and vegetation. The six aquatic habitats within the study area include palustrine forested wetland, palustrine forested dead wetland, palustrine scrub-shrub wetland, palustrine emergent wetland, lacustrine littoral zone, and lacustrine limnetic zone habitats. Each of the seven terrestrial vegetation communities and six aquatic habitats are assessed and described using dominant plant species, hydrologic and geologic conditions, and other distinguishable characteristics. Invasive species and rare and imperiled plant species are also discussed.

The habitat assessment concluded that forest communities are the most common terrestrial habitat along the Eufaula Lake shoreline. Open habitats, including savanna and prairie, were most often embedded within larger forest tracts, and when found in large expanses, were often degraded. The most common aquatic habitats within the study area include the two lacustrine open-water habitats. Of the wetland habitat types, bottomland hardwood/forested wetlands occupy the greatest aerial extent.

The results of the shoreline habitat assessment indicate that the majority of areas with poor overall physical habitat conditions consist of shorelines with significant human disturbance designated Limited Development (*e.g.*, Site 15 – Eufaula Cove; Site 17 – N4250 Road; Site 28 – Blue Creek Road) or Public Recreation (*e.g.*, Site 25 – Arrowhead State Park; Site 30 – Hickory Point Recreation Area). These sites are more likely to have maintained shorelines, boat docks, and high levels of human activity. Shorelines designated Protected tend to have the highest Physical Habitat Complexity Index scores due to the presence of riparian vegetation, aquatic vegetation, and underwater structure (*i.e.*, boulders, woody snags).

In comparison to other lakes within Plains and Lowlands and Eastern Highlands Eco-regions, Eufaula Lake has moderate shoreline disturbance, average riparian quality, high littoral habitat conditions, and high physical habitat complexity. However, when compared to national quality standards, physical habitat complexity, riparian condition, and shoreline disturbance are in the low to moderate quality range.

The natural resources of the project area include threatened and endangered species, fish, mammals, reptiles and amphibians, birds, and invertebrates. While the common and invasive species of each are assessed as a group, the threatened and endangered species and species of special concern are discussed individually. The threatened and endangered species potentially found within the Eufaula Lake study area include the American burying beetle, Arkansas River shiner, and interior least tern. Field surveys confirm the presence of the American burying beetle on the proposed Carlton Landing development property and ONHI occurrence data indicate recent observances of the Arkansas River shiner and interior least tern. The bald eagle, a federally-protected species, as well as the state imperiled alligator snapping turtle and prothonotary warbler, a state species of concern, were observed during 2012 field surveys.

Once the existing condition of habitats and natural resources were determined, the potential impacts of the No Action Alternative and four action alternatives on the future condition of habitats and natural resources are analyzed. All alternatives were rigorously explored and objectively evaluated. An evaluation of the No Action Alternative, described in Section 2.4.1., is also included to serve as a basis for comparison for the evaluation of the action alternatives. Because USACE does not have a preferred alternative at this time, the analyzed No Action and action alternatives span a range of potential future scenarios from a strong emphasis on natural resource conservation to a strong emphasis on development of recreational

opportunities and private exclusive uses. In considering potential impacts to terrestrial and aquatic habitats, this discussion begins with the No Action Alternative and progresses from Alternative 1, which emphasizes natural resource conservation, sequentially through Alternative 4, which emphasizes recreational development opportunities and private exclusive uses.

Under each of the action alternatives, one of two potential shoreline vegetation management policies would be applied to shorelines designated as Limited Development. The policies vary in the width of the buffer that would be required to be left between the shoreline and the start of vegetation modification activities. The two policy options are referred to as baseline buffers and extended buffers. Under the extended buffer vegetation management policy, implemented under Alternatives 1 and 2, a buffer width of 55 to 95 feet wide would be established depending on slope, soil type, and vegetation cover type. The baseline buffer vegetation management policy, which would be implemented under Alternatives 3 and 4, would require smaller buffer zones of 30 to 70 feet in width. Larger buffer zones would be expected to protect a greater amount of existing shoreline habitat from mowing and cutting and would likely have a greater beneficial impact on water quality.

Likewise, the potential for disturbance to terrestrial and aquatic habitats would vary depending on the alternative selected due to differences in the amount of land development and dock construction each allows. The No Action Alternative would keep the status quo and would allow development within already designated Limited Development and Public Recreation areas. This has the potential to result in the construction of over 7,000 additional boat docks, which would likely alter shoreline habitats as compared to the existing condition. Alternatives 1 and 2, which emphasize natural resource conservation, would likely see an increase in the quality and quantity of both terrestrial and aquatic habitats resulting from an increase in shoreline allocated as Protected. The quality and quantity of habitats would decrease slightly under Alternative 3 and would decrease further under Alternative 4, as more shoreline allocated Protected would convert to Limited Development and/or Public Recreation. Potential impacts on each specific terrestrial vegetation community, wetland type, invasive species, and rare and imperiled species are explained in detail in their respective sections.

Potential impacts of each alternative on existing natural resources were also evaluated. Many potential impacts on natural resources are directly connected to potential alternative impacts on habitats, which are discussed in Section 5.1. Therefore, to avoid redundancy, for many common species likely found within the study area, potential impacts involving habitat loss or degradation are addressed generally with a reference to appropriate sub-sections in Section 5.1. However, for listed species, all potential impacts are covered completely.

The management of vegetation along the shoreline has a direct impact on natural resources in the study area. The potential for impacts on natural resources varies by alternative due to the amount of habitat disturbance that each allows and the width of the implemented buffer. The No Action Alternative would reflect the existing condition and, except for additional development adjacent to already designated Limited Development areas, would leave the shoreline relatively unchanged. Alternatives 1 and 2 with their emphasis on natural resource conservation would likely see an increase in the quality and quantity of habitats resulting from an increase in the shoreline acreage designated Protected. Protected shorelines would favor native species best adapted to occupy core habitat zones. The quality and quantity of habitats would decrease slightly under Alternative 3 and would decrease further under Alternative 4, as more

shoreline areas currently allocated Protected would convert to Limited Development and/or Public Recreation.

In general, under the No Action Alternative potential impacts would likely result in a future condition similar to the existing conditions described in Section 4.2.1 for most common species. However, for some species, the potential for increased dock construction, increased recreation levels, fire suppression, and the encroachment of forests into open habitats could adversely affect populations within the study area.

Potential impacts of the No Action Alternative would likely result in bald eagle populations and trends similar to those described under the existing condition in Section 4.2.4.1. This future condition would be characterized by the presence of a small number of resident breeding pairs with a larger migrant population present during winter months. In the future, as bald eagle populations recover both statewide and nationwide, the likelihood exists that populations of both resident and migratory birds would increase.

Potential impacts of the No Action Alternative would likely result in future tern population densities and trends similar to those described for the existing condition in Section 4.2.4.2. The future condition would be characterized by the presence of a small breeding population that utilizes river sand and gravel bars and lakeshore beaches to nest. However, high levels of recreational activity on sandbars and sandy beaches, including heavy use by off-road vehicles, could threaten local populations.

The future condition of the threatened piping plover and endangered whooping crane under the No Action Alternative and each of the four action alternatives would likely be similar to the existing condition described in Section 4.2.4.3. The combination of poor habitat quality and an absence of confirmed observations make it unlikely that piping plovers utilize the Eufaula Lake study area and future conditions expected under the proposed alternatives are unlikely to support plover populations. While, critical habitat for the whooping crane is designated in the western part of Oklahoma and suitable habitat exists within river systems upstream of Eufaula Lake, the study area and adjacent lands have had no recorded crane observations since reservoir construction. Therefore, impacts associated with the proposed alternatives should have no effect on the future condition of whooping cranes. Additionally, coordination with USFWS has confirmed that the proposed alternatives would not impact piping plovers and whooping cranes.

Under the No Action Alternative, the future condition of American burying beetle populations within the study area would be expected to be similar to the distributions and trends described under the existing condition in Section 4.2.5.1. Under the No Action Alternative, the future condition is characterized by potential adverse impacts to beetles and their habitats within areas already scheduled for development and within areas where future development is allowed.

Under Alternative 1, the future condition of most natural resources would improve relative to the No Action Alternative due to increased protection of shoreline habitats, implementation of extended buffers where development is allowed, and a reduction of indirect impacts, such as nutrient input and edge effects, associated with increased development.

Alternative 1, with the increase in designated Protected shoreline and establishment of extended shoreline buffers within remaining areas of Limited Development, would likely maintain Arkansas River shiner populations in portions of the study area where they currently exist and may expand its distribution due to a future reduction of impacts associated with human disturbance.

With an emphasis on natural resource conservation, Alternative 1 is likely to maintain or expand populations of rare bird species. Alternative 1 is likely to result in a small but stable population of bald eagles consistent with the No Action Alternative but with an increasing population trend due to benefits of buffer implementation and land protection. In addition, Alternative 1 is likely to maintain interior least tern populations where they currently exist, and could facilitate range expansion into other areas of the lake if sandbar and beach habitat is protected. Indirect impacts of Alternative 1 would likely include water quality improvements due to a decrease in impervious surfaces contributing to runoff. Increased water quality would benefit the small fish species that terns prey upon.

For all potential American burying beetle populations, the potential impacts of each individual action alternative would vary depending on habitat type and extent of development. Alternative 1 would likely preserve existing beetle populations and could facilitate range expansion. The implementation of extended vegetation management policy buffers and the emphasis on natural resource conservation would likely limit habitat alteration and fragmentation. This, combined with reduced edge effects, would benefit potential carrion species, preserve preferred American burying beetle habitats, and reduce predator and competitor densities.

The results of field surveys conducted in May 2012, as documented in Section 4.2.5.1 and Appendix D, indicate that the American burying beetle is present within the shoreline areas of the Carlton Landing proposed development. Therefore, revisions to the SMP and MP classifications that would accommodate development in this location would likely affect resident American burying beetle populations. Under Alternative 1, the proposed development at Carlton Landing would largely be the same as that described under the No Action Alternative; however, the Limited Development on the south side of Longtown Arm would be reallocated to Protected. While development of approximately 170 lots would still occur, direct and indirect potential impacts to beetle populations and habitats would increase exponentially with the magnitude and extent of land disturbance. Therefore, compared to the other proposed alternatives, Alternative 1 would result in the fewest impacts to local American burying beetle populations.

As compared to Alternative 1, Alternative 2 designates less land as Protected. However, as compared to the No Action Alternative, Alternative 2 implements extended vegetation management buffers, reduces the maximum number of potential boat docks, and designates more land as Protected. Therefore, the future condition of most natural resources would improve relative to the No Action Alternative, but expected improvement would be less than that observed under Alternative 1.

Under Alternative 3, the future condition of most natural resources would decline relative to the No Action Alternative due to a decrease in shorelines designated as Protected, increased dock construction, increased recreational activity, and an increase in potential indirect impacts, such as sedimentation and invasive species introduction, associated with increased development. However, unlike the No Action Alternative, Alternative 3 establishes baseline vegetation management buffers, which would protect some shoreline habitats. The increase in edge habitats would also likely favor species well adapted to human disturbance, including the Canada goose, raccoon, mallard, striped skunk, American crow, and blue jay.

Alternative 3 emphasizes shoreline development in that it would allow an increase in dock construction, dock access, and vegetation clearing due to a conversion of Protected shoreline to Limited Development. Dock construction would degrade littoral habitats and development of adjacent lands would remove vegetation; thereby, increasing sediment and nutrient inputs into aquatic habitats. The Arkansas River

shiner needs specific stream flow regimes in order to successfully spawn and feed, and increased development has the potential to alter flows through stream channelization, water withdrawal, erosion, and sedimentation (USFWS 2001). Therefore, in comparison to the No Action Alternative, the future condition under Alternative 3 would likely see a gradual decrease in the population of Arkansas River shiners.

Under Alternative 3, future population and distribution trends of bald eagles within the study area would be similar to those described under the No Action Alternative. The implementation of baseline management buffers would likely result in water quality improvements benefiting eagle prey species, but to a lesser extent than extended management buffers. Increased shoreline designated as Limited Development would likely increase home and dock construction, making some areas of potential eagle habitat unsuitable. Localized impacts may result in eagle relocation to more remote areas. However, 2012 surveys observed eagle activity in residential areas; therefore, limited development activity may not disrupt eagle behavior at Eufaula Lake to the extent reported elsewhere.

The future condition of interior least terns under Alternative 3 would likely to be similar to that described under the No Action Alternative due to the fact that the majority of observed tern populations currently exist on protected shorelines that would not be reallocated. Implementation of baseline buffers would likely result in reduced disturbance of shoreline habitats and a modest increase in water quality compared to the No Action Alternative. However, increased development, dock construction, and recreational activity associated with Alternative 3 would also be likely to inhibit range expansion of terns into other portions of the study area.

Under Alternative 3, the implementation of baseline buffers would likely conserve American burying beetle habitat not protected under the No Action Alternative. However, increased development and recreational opportunities within the study area would likely lead to decreases in beetle populations in areas where shoreline reallocation occurs. In addition to direct land disturbance, development increases artificial lighting, which has been linked to decreases in populations of nocturnal insects such as the American burying beetle. Additionally, the potential for increased development and recreation increases the potential for habitat fragmentation and degradation. Habitat alterations often result in increases in disturbed and edge habitats, which favor beetle predators and carrion competitors.

While artificial lighting and habitat fragmentation can affect American burying beetle populations, potential adverse impacts generally result from ground disturbance. Direct impacts to these beetles during inactive and active periods may occur as a result of vegetation clearing, heavy equipment operation, fuel and chemical contamination of the soil, grading, soil excavation, and filling and reseeding of disturbed areas (FHWA 2009). Under Alternative 3, the probability of ground disturbance increases; therefore, American burying beetle populations within the study area would be more likely to suffer potential impacts.

In comparison to the No Action Alternative, under Alternative 3, additional shoreline within the proposed Carlton Landing site would be designated Limited Development. While the increase in Limited Development would allow for more dock construction, the scale and extent of the proposed Carlton Landing development would be similar to that described under the No Action Alternative. Therefore, potential impacts to local American burying beetle populations would likely be similar to those described

under the No Action Alternative with direct adverse impacts associated with areas where current or potential future development is allowed.

As compared to Alternative 3, Alternative 4 designates more land as Limited Development and reallocates approximately eight miles of shoreline from Protected to Public Recreation. Alternative 4 also allows for full build out of proposed facilities at the Carlton Landing development property.

Therefore, the future condition of most natural resources would decline relative to the No Action Alternative and the other three proposed action alternatives due to a decrease in shorelines designated Protected, increased dock construction, increased recreational activity, and an increase in indirect impacts, such as infrastructure expansion and nutrient inputs associated with increased development. However, unlike the No Action Alternative, Alternative 4 establishes baseline vegetation management buffers, which will protect some shoreline habitats. The increase in edge habitats would also likely change relative abundances of most natural resource groups by increasing populations of generalists adapted to human disturbance and decreasing populations of species adapted to core habitats.

Alternative 4 would likely have similar potential impacts on the Arkansas River shiner as Alternative 3, but would increase the amount of recreational use substantially. Increased boat traffic and swimming in littoral zones could lead to substrate disturbance and the removal of aquatic vegetation. Therefore, Alternative 4 would likely decrease the quality of shiner habitat in areas of heavy development and high recreational activity, leading to a decrease in currently established populations.

The close proximity of a confirmed Arkansas River shiner observation to the proposed Carlton Landing development indicates that planned development at that site could impact the Arkansas River shiner. While impacts to adjacent shiner population s under Alternatives 1, 2, and 3 would likely reflect the No Action Alternative, under Alternative 4, the construction of boating facilities and other shoreline recreational facilities could significantly transform the shoreline and impact adjacent shallow water habitats. Additionally, proposed channel dredging would likely alter currents and substrate, which could displace resident shiners.

Compared to Alternative 3, potential habitat and water quality impacts under Alternative 4 could be more pronounced due to higher levels of development and recreation. Therefore, the future condition of bald eagles and interior least terns under Alternative 4 would likely be characterized by habitat loss and population declines. Full build-out of the Carlton Landing proposed development would likely displace any eagles and terns that may frequent the area. While no eagle activity was observed during 2012 surveys, suitable habitat conditions exist, particularly on Roundtree Landing, and USACE staff report frequently observing eagle activity there. However, the lack of observed nests in the area makes it likely that displaced eagles would be migrants that would relocate to more suitable lake habitats. Along the northern shoreline of Roundtree Landing, and in other suitable tern habitats, increased development and recreational opportunities provided by Alternative 4 would likely result in increased lake usage and human disturbance, thereby, confining tern populations to existing protected areas.

Compared to Alternative 3, potential impacts of Alternative 4 on American burying beetle populations would likely be magnified and more widespread due to increased land disturbance associated with an increased number of shoreline areas being reallocated from Protected to Limited Development and Public Recreation. Alternative 4 would allow for the reallocation of shoreline located at Carlton Landing, which would enable full build-out including the proposed development of approximately 2,570 home lots and

associated community facilities. Full-build out would likely result in the development of approximately 1,650 acres of confirmed American burying beetle habitat. This level of land disturbance, especially if conducted during the underground, inactive period in the lifecycle of the species, would likely result in direct beetle mortality and the destruction of suitable beetle habitat. Planned recreational facilities along the lake shoreline would also likely result in adverse impacts to beetle populations as protected buffers in these areas would not be required. Increased recreational activity would also likely drive potential carrion species from the area, depriving American burying beetles of necessary food and reproductive sources.

If an alternative would likely adversely affect shoreline habitats and natural resources within the Eufaula Lake study area, mitigation measures could be necessary. Mitigation includes the avoidance, minimization, rectification, reduction, and compensation for impacts associated with an action (40 CFR 1508.20). As a condition for shoreline reallocation, USACE could implement the following measures to mitigate the potential impacts of human disturbance on terrestrial and aquatic habitats and the natural resources that reside therein.

Under the No Action Alternative and the four action alternatives, the majority of shoreline construction on government properties would likely consist of paths, boardwalks, fencing, and other structures involved with lake and boat dock access. Best Management Practices (BMPs) should be used by construction contractors to avoid and minimize temporary construction impacts from the installation of shoreline structures. Potential BMPs include, but are not limited to, minimizing the amount of clearing and exposed soil, installing sedimentation controls, and protecting streams and waterways from unnecessary disturbance.

Shoreline construction consisting of lake access structures would likely be connected to boat dock and marina construction. Although no shoreline reallocation is proposed under the No Action Alternative, the maximum number of boat docks that could be potentially constructed within the Eufaula Lake study area could increase to 8,746 docks. This increase is due to the amount of shoreline that is allocated as Limited Development but which is currently undeveloped. The four action alternatives would likely result in varying degrees of boat dock and marina construction. Alternatives 1 and 2 would allow a maximum of 2,278 and 5,873 docks, respectively. Alternatives 3 and 4 would allow a maximum of 11,844 and 15,459 docks, respectively. In addition, Alternative 4 would allow for the construction of a marina at the Carlton Landing propsosed development.

The increase in boat dock construction would likely adversely impact shoreline wetlands and littoral zones and the species occupying these fragile habitats. In order to minimize potential impacts to the surrounding shoreline, boat dock and marina construction could include adherence to the National Oceanic and Atmospheric Administration's (NOAA) voluntary Clean Marina Initiative or mitigation for minor impacts to local fisheries and other aquatic wildlife as directed by USFWS and enforced by ODWC.

Within the Eufaula Lake study area, only floating docks are permitted. Therefore, environmental concerns specifically attributed to floating docks must be considered. The most common type of dock flotation is expanded polystyrene foam (EPS), which has been known to degrade and impact fish and wildlife (Marcy and Jackson 2009). Flotation product recommendations include floatable foams encapsulated in polyethylene or other surface covering, closed-cell polyethylene, and dedicated plastic float drums (Marcy and Jackson 2009). Several additional measures, including construction techniques and recycling of old

flotation, can minimize the potential impact of floating dock construction and long-term deployment on the surrounding shoreline environment.

Under the No Action Alternative, the future condition of wetlands and surface waters would likely be similar to that described for the existing condition. However, the potential for approximately 7,000 additional boat docks in areas designated as Limited Development would likely result in wetland and surface water degradation in these areas. In comparison to the No Action Alternative, Alternatives 1 and 2, which emphasize shoreline protection, would likely result in less disturbance and degradation of wetlands and surface waters. Conversely, Alternatives 3 and 4, which allow for additional boat dock construction in comparison to the No Action Alternative, would likely result in increased wetland and surface water degradation.

For the No Action Alternative and all four action alternatives, BMPs should be used to avoid and minimize disturbance to shoreline wetlands and surface waters. These BMPs include, but are not limited to, restriction of heavy equipment use in wetlands, quick re-establishment of vegetation and exposed soil, and implementation of erosion and sedimentation control measures.

The Oklahoma Comprehensive Wetland Conservation Plan also recommends measures to mitigate wetland losses. Successful mitigation of Oklahoma's wetland losses requires characterization of wetland functions, a thorough inventory of wetland resources, and a comprehensive monitoring system to track wetland gains and losses. The plan recommends that the state should look at establishing a wetland bank(s) to guide financial resources into constructive projects to restore, enhance, and create wetlands, in that order of priority (OCC 1996). The Oklahoma Department of Transportation is in the process of establishing a wetland bank for use in mitigating highway construction projects. This effort could serve as a model for the development of a statewide program and establishment of a wetland bank within the Eufaula Lake watershed that could be used to offset potential wetland impacts within the study area (OCC 1996).

The majority of pollution in the Eufaula Lake study area, including siltation, pesticides, suspended solids, and nutrients, come from non-point sources. Addressing Eufaula Lake's shoreline erosion is one step towards remediation of the in-lake turbidity problem. Suspended solids, whether washed in from the drainage basin or re-suspended in the reservoir, serve to prevent or eliminate the establishment of an aquatic plant community in the littoral zone. Littoral plants are essential to a healthy functioning reservoir ecosystem. In addition to the benefits provided the biological community, aquatic plants inhibit the physical process of shoreline erosion. Bioengineering, such as coir geotextile rolls (CGR), or live staking can halt the erosive process long enough to allow for establishment of a healthy aquatic plant community.

Due to the confirmed presence of the American burying beetle within the survey area containing the proposed Carlton Landing, Roundtree Landing, and adjacent lands, any proposed modification to the SMP that has the potential to affect this species would require an ESA Section 7 consultation with USFWS. No federal action is authorized that is likely to jeopardize the continued existence of the American burying beetle unless ESA Section 7 consultation addressing the effects of the proposed action has been completed.

According to the 2012 updated USFWS guidance, bait-away and trap-and-relocate procedures are no longer allowed as the primary means of avoiding potential impacts to the American burying beetle. Mitigation would likely be determined on a case-by-case basis through consultation with USFWS.

The bald eagle has also been documented in several areas of the Eufaula Lake study area, including areas near Brooken Cove, Mill Creek WMA, and Roberts Ridge. The seasonal and large geographic spread of these and other recent sightings suggest a low-density widespread resident population supplemented by a larger number of winter residents. While USFWS has documented recent nesting activities, no nests, nest-building activities, or eagle courtship were observed during several winter, spring, and summer surveys.

Due to the documented presence of eagles during breeding and non-breeding seasons, construction activities within the Eufaula Lake study area may come into contact with bald eagles. Avoidance of bald eagles nests would be the primary mitigation measure. Nesting bald eagles are most sensitive to disturbance during courtship, laying, and incubation. Thus, it is prudent to complete large-scale shoreline construction projects in potential bald eagle nesting areas during non-nesting periods from late-September until early-January.

If construction activities must be completed during nesting and rearing months, USFWS has guidelines and recommendations that should be followed (USFWS 2006). Under these management guidelines, no construction activity should take place within a one mile radius of a nest tree during the breeding season. However, the guidelines suggest that the buffer area only be “roughly circular”, with the intent being to limit disturbance along flight paths to and from foraging areas. Therefore, the shape of the buffer might be altered to accommodate construction within one mile of an active nest during the breeding season.

While encountering a resident breeding bald eagle is possible, most bald eagles in Oklahoma tend to be non-breeding, winter visitors. Bald eagles are less sensitive throughout this non-nesting period, but construction activities should attempt to avoid established roost and feeding sites. Permanent landscape changes may force eagles to seek out other, less desirable roosting and foraging areas. Therefore, it is recommended that large shoreline trees be preserved whenever possible to provide potential perching and nesting tress for bald eagles.

If any listed species are encountered during shoreline construction, all activities would need to cease and USFWS notification would be required. If listed species are encountered during recreational activity, any action that serves to harass or harm the individual(s) would be prohibited.

Chapter 2
Introduction

Eufaula Lake is a reservoir located in the upper Arkansas River basin, on river mile 27 of the Canadian River, in McIntosh County, Oklahoma. The reservoir incorporates several major tributaries of the Arkansas River including the North Canadian River, South Canadian River, Deep Fork River, and Gaines Creek, all of which come together in east-central Oklahoma immediately south of the Arkansas River. The U.S. Army Corps of Engineers (USACE) constructed Eufaula Lake between 1956 and 1964. The authorized purposes of the lake are flood control, water supply, hydroelectric power, and navigation. Eufaula Lake has approximately 808 miles of shoreline and contains approximately 105,500 surface acres of water, making it the largest lake located entirely within the state of Oklahoma. In addition to McIntosh County, associated counties include Haskell, Latimer, Okmulgee, and Pittsburg Counties. USACE is responsible for managing the lake's land and water resources.

The Tulsa District intends to revise the Eufaula Reservoir Shoreline Management Plan (SMP) and to supplement the project Master Plan (MP). The Tulsa District is preparing an Environmental Impact Statement (EIS) in order to comply with the National Environmental Policy Act (NEPA) of 1969 (as amended) and the Council on Environmental Quality's (CEQ) Regulations (40 CFR 1500-1508), as reflected in the USACE Engineering Regulation, ER 200-2-2. The EIS will address the potential impacts of the SMP revision and MP supplement from a lake-wide perspective, as well as evaluate potential environmental impacts of specific proposed developments at the reservoir identified during the NEPA scoping process.

It is expected that different aspects of the physical and cultural environment will be affected differently by proposed developments and by revising the SMP and supplementing the MP. Therefore, the study area may encompass varying areas as appropriate to each aspect of the environment, and the level of environmental analysis should be commensurate with the study area and the potential effects, including cumulative effects, of the SMP revision and associated proposed developments. For example, the analysis focuses specifically within the proposed development areas for an assessment of potential direct impacts on individual animals, especially concerning species listed as threatened or endangered. Alternately, the analysis focuses on the entire reservoir where appropriate, as with an assessment of dominant habitat types and important reservoir fisheries.

The primary purpose of this Terrestrial and Aquatic Habitats and Natural Resources Technical Report is to support the NEPA process through identification of the existing condition of habitats and natural resources within the Eufaula Lake study area and an analysis of potential impacts of the alternatives under consideration. Terrestrial and aquatic habitats, and the natural resources located therein, are integral components of the aesthetic, cultural, and ecological identity of the Eufaula Lake study area. Therefore, habitats and natural resources are important to consider in a revision of the Eufaula Lake SMP.

The dominant terrestrial and aquatic habitat types, including open water expanses and shallow littoral inlets shrouded by dense stands of crosstimbers and oak-pine forests occupying rocky shorelines give Eufaula Lake its identity and support a wide variety of fish and wildlife. The natural resources of Eufaula Lake, especially prized fish and game species, are woven into the cultural fabric of the area. The Eufaula Lake study area contains renowned bass and crappie fisheries and ample waterfowl and white-tailed deer

populations. Hunting and fishing are popular recreational activities and for many Oklahomans is a way of life. In addition, healthy wildlife populations make Eufaula Lake a prime destination for birdwatching, hiking, and canoeing.

While the habitats and natural resources of the Eufaula Lake study area are important aesthetically, culturally, and recreationally, their most significant contribution to the study area is ecologically. The presence of riparian forests and wetland areas along the shoreline help reduce erosion and contribute to water clarity. The absence of large areas of shoreline development reduces nutrient inputs that may foster algal blooms and contribute to poor water quality. Optimal water quality is of significant concern to boaters and swimmers and, combined with the presence of underwater structure, including buttonbush and stands of standing dead timber, provide the habitat conditions needed for healthy fish populations. Where development is present, plant roots help absorb excess nutrients from fertilizers, manure, leaking septic tanks, and municipal sewage.

Potential impacts that would change the existing composition of habitats and wildlife could threaten recreational opportunities, aesthetics, and the ecological balance of Eufaula Lake. This report provides information to decision-makers to make determinations on whether to proceed with proposed changes to the SMP and the MP.

Chapter 3

Methods for Impact Evaluation

3.1 Quantify and Characterize Terrestrial and Aquatic Habitats

The purpose of this report is to quantify and characterize terrestrial and aquatic habitats associated with Eufaula Lake for the existing environment section of the EIS on the Shoreline Management Plan revision and Master Plan supplement. This forms the basis to assess potential environmental impacts of the alternatives for shoreline management and to analyze potential cumulative impacts of the alternatives. Terrestrial and aquatic habitats include natural areas on land adjacent to the lake and in the lake. Characterization of these areas provide indicators of the habitats present for wildlife and waterfowl, including any federal or state listed species, that may be of concern.

3.1.1 Regulatory Framework

Section 1502.25 of the NEPA regulations require that draft EISs be prepared concurrently and integrated with environmental analyses and related surveys and studies required by other federal statutes (40CFR 1502.25). With respect to terrestrial and aquatic habitats those statutes would include the Migratory Bird Treaty Act, the Fish and Wildlife Coordination Act, the Clean Water Act, and Executive Order 11990.

3.1.1.1 Clean Water Act

The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. Section 404 of the Clean Water Act requires permits for the discharge of dredged or fill material into any water of the US, including wetlands (33 USC 1344). The U.S. Environmental Protection Agency (USEPA) guidelines (40 CFR 230 et seq.), United Sates Army Corps of Engineers (USACE) regulatory guidelines (33 CFR 320 et seq.), and NEPA guidelines (40 CFR 1500 et seq.) are the substantive environmental criteria used to evaluate permit applications submitted to USACE. Mitigation measures for potential impacts are considered only after the applicant shows that no practicable alternatives are available to achieve the basic project purpose with a lesser environmental impact. Section 404(b)(1) guidelines prohibit discharges of dredged or fill material into waters of the US, including wetlands, if a practicable alternative to the proposed discharge exists that would have less adverse impacts on the aquatic ecosystem (provided that the alternative does not cause other significant adverse environmental impacts) (40 CFR 230[a]).

The CWA made it unlawful to discharge any pollutant from a point source into navigable waters, unless a permit was obtained. The National Pollutant Discharge Elimination System (NPDES) permit program controls discharges. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters.

3.1.1.2 Executive Order 11990

Executive Order 11990 requires that federal agencies ensure that their actions minimize the destruction, loss, or degradation of wetlands. It also assures the protection, preservation, and enhancement of the

nation's wetlands to the fullest extent practicable during the planning, construction, funding, and operation of projects.

3.1.2 Data Collection Methods

The goal of this report is to produce a terrestrial and aquatic habitat map for Eufaula Lake that identifies the locations and quantities of these habitat types. Using existing available information including the ecoregions of Oklahoma (Woods *et al.* 2005) that are based on the Omernik (1987) classification system, a new comprehensive habitat map was developed. This new habitat map is based on the collection of existing available data, including the Oklahoma GAP land cover digital vegetation data from USACE, and field verification of the habitats for the Eufaula Lake EIS study area and for the area described in the Carlton Landing development proposal.

Existing available data was collected that assisted in the development of the new habitat map including existing habitat maps of the Eufaula Lake area, reports pertaining to these habitats, reports pertaining to the occurrence of federal and state listed species, aerial photographs, topographic maps, soils maps and reports, wetland maps, bathymetric maps and data from the following sources:

- Oklahoma Department of Wildlife Conservation (ODWC)
- Oklahoma Natural Heritage Inventory (ONHI) GIS database
- USFWS including the National Wetland Inventory (NWI)
- United Sates Geological Survey (USGS) including quadrangle maps
- USACE including the Oklahoma GAP land cover dataset
- USEPA
- National Resource Conservation Service (NRCS) including soil maps, and
- Other state and federal agencies as appropriate

A list of important habitat resources collected is as follows:

- Woods *et al.* (2005), *Ecoregions of Oklahoma*, http://www.epa.gov/wed/pages/ecoregions/ok_eco.htm
- Hoagland (2000), The Vegetation of Oklahoma: A Classification for Landscape Mapping and Conservation Planning
- USGS (1992), Oklahoma GAP land cover dataset, digital data obtained November 17, 2011 from U.S. Army Corps of Engineers, Tulsa District
- USFWS (1980), *Habitat Evaluation Procedures (HEP)*, http://www.fws.gov/policy/ESMindex.html
- Bailey (1995), *Description of the Ecoregions of the United States*, http://www.fs.fed.us/land/ecosysmgmt/
- Cowardin *et al*. (1979), Classification of Wetlands and Deepwater Habitats of the United States

- ODWC (1993), *Oklahoma's Biodiversity Plan: A Shared Vision for Conserving Our Natural Heritage*, http://www.wildlifedepartment.com/wildlifemgmt/biodiversity.htm
- ODWC (2005), *Oklahoma Comprehensive Wildlife Conservation Strategy*, http://www.wildlifedepartment.com/CWCS.htm
- ONHI (2005), *Oklahoma Vascular Plants Database*, http://www.oknaturalheritage.ou.edu/vegmap.htm

3.1.3 Analysis Methods

The terrestrial and aquatic habitat map for the lake that identifies the locations and quantities of existing habitat types was developed in GIS format (geo-referenced). A base habitat map of the Eufaula Lake EIS study area was developed based on maps, aerial photographs, reports and data as described above. An appropriate number of smaller maps representing the Eufaula Lake EIS study area (a subset of the base habitat map) were developed to present the results at a scale that provides a meaningful representation for understanding and interpretation. The base habitat map and the smaller habitat maps indicate the major terrestrial and aquatic habitat types in the Eufaula Lake EIS study area. Each habitat type location in the Eufaula Lake EIS study area is represented by a polygon. Digitization of polygons provided quantitative data for each habitat type.

The terrestrial habitat types are classified according Woods *et al.* (2005). This classification system was selected because it has been updated recently, provides a classification of habitat that is easy to understand and use, and is at a scale appropriate for use in the EIS. This classification system indicates that there are four eco-regions in the Eufaula Lake EIS study area, as follows.

- Northern Cross-timbers Eco-region
- Lower Canadian Hills Eco-region
- Osage Cuestas Plains Eco-region
- Scattered High Ridges and Mountains Eco-region

The classification system also indicates that there are seven major vegetation associations or habitat types in the Eufaula Lake EIS study area (some areas may be classified as a combination of these habitat types). All but "bottomland hardwood forest" are strictly terrestrial habitats.

- Oak-hickory forest
- Crosstimbers forest
- Oak- pine forest
- Savanna
- Bottomland hardwood forest
- Tall-grass prairie

The aquatic habitats types were classified according to Cowardin *et al.* (1979) *Classification of Wetlands and Deep Water Habitats*. A preliminary evaluation of National Wetlands Inventory (NWI) maps indicates that there are six major aquatic habitat types in the Eufaula Lake EIS study area (some areas may be classified as a combination of these habitat types). The Lacustrine Limnetic Unconsolidated Bottom habitat type is non-vegetated.

- Palustrine Forested Broad-leaved Deciduous (PFO1)
- Palustrine Forested Dead (PFO5)
- Palustrine Scrub-Shrub Broad-leaved Deciduous (PSS1)
- Palustrine Emergent Persistent (PEM1)
- Lacustrine Littoral Unconsolidated Shore (L2USC)
- Lacustrine Limnetic Unconsolidated Bottom (L1UBH)

After the habitat maps indicating the major terrestrial and aquatic habitat types in the Eufaula Lake EIS study area were developed, field verification of these habitat types occurred. Initially, the preliminary habitat maps were used to guide habitat field verification. The approach to verification was to visit at least two locations within the Eufaula Lake EIS study area for each major aquatic and terrestrial habitat type. Due to the size of the lake and the technical and logistical challenges associated with sampling along the bottom, open water habitat conditions were determined based on previous studies and a review of the literature. All other habitat types were field verified.

Modification to the habitat maps was conducted following field verification. Field verification also included an evaluation of habitats that could support federal and state listed species. Field verification of the presence of these habitats and listed species was provided. Specific sampling was warranted for some listed species in some locations and any such sampling was implemented pursuant to USFWS guidelines (*e.g.* American burying beetle surveys).

After the habitat types were verified, transects were established for each of six terrestrial and three aquatic vegetated habitat types. Due to similar soils, hydrology, and vegetation communities, palustrine forested wetlands and bottomland hardwood forests were assessed as one habitat community, leaving eight total habitats. The terrestrial vegetation transects were 100 to 200 feet (30.5 to 61 meters) in length and 20 feet (6.1 meters) in width and were established in an appropriate ordinal direction at each selected habitat location. To the extent possible, the vegetation transects were not located in ecotones. Species composition of the canopy, sub canopy and ground cover strata (if present) were determined. This provided a qualitative description of the habitat types in the Eufaula Lake EIS study area.

3.1.4 Shoreline Habitat Assessment

The lacustrine habitats (littoral and limnetic) were assessed based on the USEPA Lake and Reservoir Bioassessment and Biocriteria: Technical Guidance Document (EPA 2007) and the National Lake Assessment (NLA) Field Operations Manual (USEPA 2007). These protocols were established to assess the condition of lakes throughout the United States and to establish regional baseline conditions for comparison. They were designed to be reproduced at the local level and the Eufaula Lake shoreline habitat assessment closely followed these methods and analyses.

The lake habitat assessment consists of both watershed and in-lake observations. Several watershed parameters were obtained or estimated from existing sources of information such as maps and GIS. These included lake area, maximum and average depth, shoreline length, watershed area, watershed slope, soil types, geology, and land use of the surrounding watershed. This data was used to classify the lake into a category that allowed comparisons to regional water quality and habitat standards. The in-lake observations included physical and chemical measurement data and a shoreline habitat assessment based on the USEPA Environmental Monitoring and Assessment Program (EMAP) lake habitat assessment methodology (EPA 1994b). This shoreline habitat assessment methodology includes a littoral zone assessment component and a riparian zone assessment component.

The littoral zone assessment was used to characterize a littoral zone 33 feet (10 meters) wide beginning at the shoreline and 50 feet (15 meters) in length, and included dominant vegetation and percent cover, depth, surface film, substrate, macrophyte cover, and fish cover. A list of littoral zone assessment parameters is presented in **Table 3-1**.

Table 3-1. Littoral Zone Assessment Parameters for Eufaula Lake

Chemical	
Water Temperature	Specific Conductivity
pH	Turbidity
Dissolved Oxygen	Chlorophyll A (if possible)
Physical	
Water Odors	Trophic State
Surface Scum/Oils	Site Depth
Water Color	Secchi Disk (Water Clarity)
Aquatic Vegetation	Substrate Odors
Macrophtye Total Cover	Substrate Deposits/Contamination
Fish Habitat & Cover	Substrate Grain Size
Invasive Species	Woody Debris

The riparian zone assessment was used to characterize the riparian zone 50 feet (15 meters) wide beginning at the shoreline and 50 feet (15 meters) in length, and included bank features, riparian vegetation, substrate, and human influences. A list of riparian zone assessment parameters is presented in **Table 3-2**. The shoreline boundary is defined as the approximate interface between “lake-like” conditions and riparian or wetland conditions. In most cases, the shoreline was easily identified by the ordinary high water mark.

Table 3-2. Riparian Zone Assessment Parameters for Eufaula Lake

Physical	
Riparian Vegetation Strata	Bank Angle
Riparian Vegetation Community Composition	Bank Stability
Invasive Species	Substrate Odors
Ecological Integrity	Substrate Deposits/Contamination
Human Influences	Substrate Grain Size
Lake Management Activities	Woody Debris

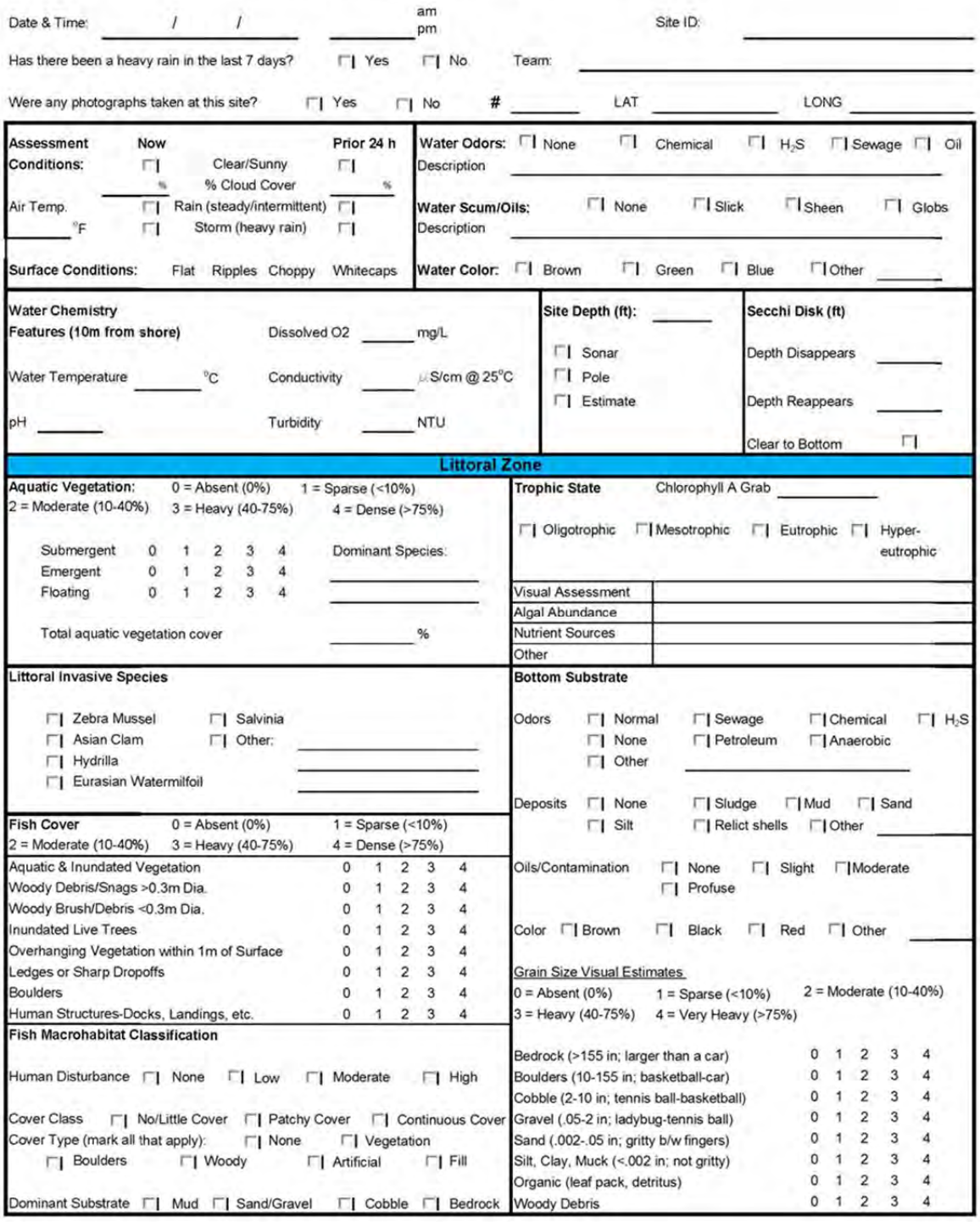
The shoreline habitat assessment was performed at several locations in the study area, including the area described in the Carlton Landing development proposal. The assessment focused on Protected and Limited Development shoreline allocation areas, particularly those areas where the shoreline allocation is proposed to be changed from Protected to Limited Development under various alternatives. This information along with available data and reconnaissance information was used to determine the location for the shoreline habitat assessments.

The field team consisted of two professionals familiar with the USEPA lake assessment protocols. The shoreline habitat locations were accessed primarily by foot, but some were accessed by boat. The shoreline site habitat assessment data sheet (**Figure 3-1** and **Figure 3-2**) was used to standardize the assessment process and enabled quick collection of all necessary data. The Eufaula Lake shoreline habitat assessment data sheet draws heavily on the NLA Field Operations Manual lake profile and assessment forms.

The field team first documented sampling conditions including date, time and weather. Water depth was measured using sonar or a calibrated depth pole. Water quality parameters including water temperature, pH, dissolved oxygen, and specific conductivity were measured with a YSI multiprobe datasonde. Calibration of the datasonde was completed at the beginning of each sampling day in accordance with the manufacturer's instructions. Turbidity was measured with a turbidity meter. Chlorophyll A was either measured with a chlorophyll probe or a sample was collected for laboratory analysis. Chlorophyll A values assisted in determining trophic state. If chlorophyll A measurements were not possible, trophic state was determined qualitatively through visual observations of algal abundance and the potential impact of nearby nutrient sources. Secchi disk transparency measurements were also collected to measure water clarity. Any observed water odors, surface scum, and water color was documented. All measurements were recorded on the shoreline habitat assessment data sheet.

The littoral zone physical assessment parameters include aquatic vegetation, fish cover and habitat, and characterization of the bottom substrate. Aquatic vegetation was assessed according to type (submergent, emergent, floating), frequency (absent, sparse, moderate, heavy, dense), and total cover with space to list dominant species. Any observed invasive species, including hydrilla, salvinia, and zebra mussels, were documented. Habitat features that provide fish cover were assessed using the same frequency scale used to assess aquatic vegetation. The level of abundance of aquatic vegetation, inundated vegetation, woody debris, overhanging vegetation, ledges, boulders, and human structures such as docks and landings resulted in an overall fish cover scores. Fish macrohabitat classification also took human disturbance and dominant substrate into consideration. Bottom substrate was assessed by making multiple probes using a long tube (*e.g.*, 3-m PVC pipe) if the bottom was not visible. Soft sediment was brought to the surface and hard sediments were identified using the sediment tube. Grain sizes and frequency was recorded. Sediment color, odor and any deposits was also recorded.

The riparian zone physical assessment parameters include vegetation type and aerial coverage, shoreline substrate, bank features, ecological integrity, and human influences. Shoreline vegetation was divided into three layers: canopy, understory, and ground cover. Vegetation type was recorded for the canopy and understory. Aerial coverage was assessed for all three layers using the same frequency scale used to assess aquatic vegetation in the littoral zone (absent, sparse, moderate, heavy, dense). Any observed riparian invasive species were documented.



Eufaula Lake - Shoreline Habitat Assessment

Date & Time: / / ____ am pm Site ID: ____

Has there been a heavy rain in the last 7 days? ☐ Yes ☐ No Team: ____

Were any photographs taken at this site? ☐ Yes ☐ No # ____ LAT ____ LONG ____

Assessment Conditions:	Now	Prior 24 h
	☐ Clear/Sunny	☐
____ %	% Cloud Cover	____ %
Air Temp. ____ °F	☐ Rain (steady/intermittent)	☐
	☐ Storm (heavy rain)	☐
Surface Conditions:	Flat Ripples Choppy Whitecaps	

Water Odors: ☐ None ☐ Chemical ☐ H_2S ☐ Sewage ☐ Oil
Description ____

Water Scum/Oils: ☐ None ☐ Slick ☐ Sheen ☐ Globs
Description ____

Water Color: ☐ Brown ☐ Green ☐ Blue ☐ Other ____

Water Chemistry
Features (10m from shore)

Dissolved O2 ____ mg/L
Water Temperature ____ °C
Conductivity ____ µS/cm @ 25°C
pH ____
Turbidity ____ NTU

Site Depth (ft): ____
☐ Sonar
☐ Pole
☐ Estimate

Secchi Disk (ft)
Depth Disappears ____
Depth Reappears ____
Clear to Bottom ☐

Littoral Zone

Aquatic Vegetation: 0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Dense (>75%)

						Dominant Species:
Submergent	0	1	2	3	4	
Emergent	0	1	2	3	4	
Floating	0	1	2	3	4	

Total aquatic vegetation cover ____ %

Trophic State Chlorophyll A Grab ____
☐ Oligotrophic ☐ Mesotrophic ☐ Eutrophic ☐ Hyper-eutrophic

Visual Assessment	
Algal Abundance	
Nutrient Sources	
Other	

Littoral Invasive Species
☐ Zebra Mussel ☐ Salvinia
☐ Asian Clam ☐ Other: ____
☐ Hydrilla ____
☐ Eurasian Watermilfoil ____

Fish Cover 0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Dense (>75%)

Aquatic & Inundated Vegetation	0	1	2	3	4
Woody Debris/Snags >0.3m Dia.	0	1	2	3	4
Woody Brush/Debris <0.3m Dia.	0	1	2	3	4
Inundated Live Trees	0	1	2	3	4
Overhanging Vegetation within 1m of Surface	0	1	2	3	4
Ledges or Sharp Dropoffs	0	1	2	3	4
Boulders	0	1	2	3	4
Human Structures-Docks, Landings, etc.	0	1	2	3	4

Fish Macrohabitat Classification
Human Disturbance ☐ None ☐ Low ☐ Moderate ☐ High
Cover Class ☐ No/Little Cover ☐ Patchy Cover ☐ Continuous Cover
Cover Type (mark all that apply): ☐ None ☐ Vegetation ☐ Boulders ☐ Woody ☐ Artificial ☐ Fill
Dominant Substrate ☐ Mud ☐ Sand/Gravel ☐ Cobble ☐ Bedrock

Bottom Substrate
Odors ☐ Normal ☐ Sewage ☐ Chemical ☐ H_2S ☐ None ☐ Petroleum ☐ Anaerobic ☐ Other ____
Deposits ☐ None ☐ Sludge ☐ Mud ☐ Sand ☐ Silt ☐ Relict shells ☐ Other ____
Oils/Contamination ☐ None ☐ Slight ☐ Moderate ☐ Profuse
Color ☐ Brown ☐ Black ☐ Red ☐ Other ____

Grain Size Visual Estimates
0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

Bedrock (>155 in; larger than a car)	0	1	2	3	4
Boulders (10-155 in; basketball-car)	0	1	2	3	4
Cobble (2-10 in; tennis ball-basketball)	0	1	2	3	4
Gravel (.05-2 in; ladybug-tennis ball)	0	1	2	3	4
Sand (.002-.05 in; gritty b/w fingers)	0	1	2	3	4
Silt, Clay, Muck (<.002 in; not gritty)	0	1	2	3	4
Organic (leaf pack, detritus)	0	1	2	3	4
Woody Debris	0	1	2	3	4

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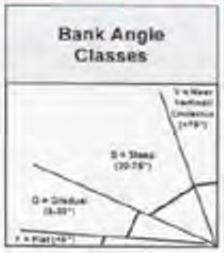
Figure 3-1. Eufaula Lake Shoreline Habitat Assessment Data Sheet *(front - containing sampling conditions and littoral zone assessment parameters)*

Eufaula Lake - Shoreline Habitat Assessment

Riparian Zone

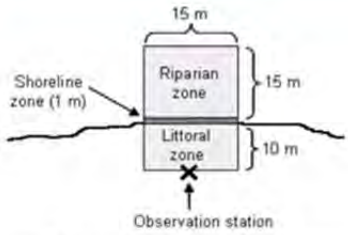
Bank Features

Angle
- ☐ Flat (<5°)
- ☐ Gradual (5-30°)
- ☐ Steep (30-75°)
- ☐ Near Vertical/Undercut (>75°)



Vertical height from waterline to high water mark: _____ ft

Horizontal distance from waterline to high water mark: _____ ft



Ecological Integrity

☐ Excellent ☐ Good ☐ Fair ☐ Poor

Wildlife Observed: _____

Bank Stability
- ☐ Optimal (Stable bank with minimal evidence of erosion. < 5% bank affected)
- ☐ Suboptimal (Moderately stable; infrequent, small erosion areas. 5-30% bank affected)
- ☐ Marginal (Moderately unstable; high erosion potential during floods. 30-60% bank affected)
- ☐ Poor (Unstable; obvious bank sloughing. 60-100% bank affected)

Vegetation 0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Dense (>75%)

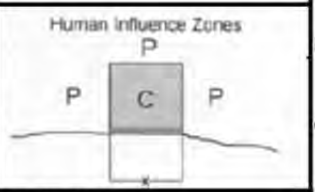
Canopy	☐ Deciduous	☐ Broadleaf Evergreen			☐ Coniferous	☐ Mixed	☐ None	(> 15 ft tall)		
Big Trees (Trunk > 1.0 ft dBH)	0	1	2	3	4					
Small Trees (Trunk < 1.0 ft dBH)	0	1	2	3	4					
Understory	☐ Deciduous	☐ Broadleaf Evergreen			☐ Coniferous	☐ Mixed	☐ None	(1.5 to 15 ft tall)		
Woody Shrubs & Saplings	0	1	2	3	4					
Tall Herbs, Grasses & Forbs	0	1	2	3	4					
Groundcover								(< 1.5 ft tall)		
Woody Shrubs & Saplings	0	1	2	3	4	Barren, Bare Dirt or Buildings		0	1	2	3	4
Herbs, Grasses & Forbs	0	1	2	3	4							
Standing Water/Inundated Vegetation	0	1	2	3	4							

Riparian Invasive Species
- ☐ Purple Loosestrife
- ☐ Knotweed
- ☐ Hairy Willow Herb
- ☐ Flowering Rush
- ☐ Other: _____

Human Influence

O = Absent
P = Present Outside Plot
C = Present Within Plot

Buildings	O	P	C
Commercial	O	P	C
Park Facilities/Beaches	O	P	C
Docks/Boats	O	P	C
Walls, Dikes, Revetments	O	P	C
Landfill/Trash	O	P	C
Roads/Railroads	O	P	C
Power Lines	O	P	C
Row Crops	O	P	C
Pasture/Range/Hayfield	O	P	C
Orchard	O	P	C
Maintained Lawns	O	P	C
Pipes/Drains	O	P	C
Logging/Brush Clearing	O	P	C
Construction	O	P	C



Lake Management

Intensity: L = Low, M = Med, H = High

Liming	L	M	H
Chemical Treatments	L	M	H
Angling Pressure	L	M	H
Macrophyte Control	L	M	H
Water Level Fluctuations	L	M	H

General Observations:

Shoreline Substrate

Odors ☐ Yes ☐ No
If yes, describe _____

Deposits ☐ Yes ☐ No
If yes, describe _____

Oils/Contamination ☐ Yes ☐ No
If yes, describe _____

Color ☐ Brown ☐ Black ☐ Red ☐ Other _____

Grain Size Visual Estimates 0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

Bedrock (>155 in)	0	1	2	3	4
Boulders (10-155 in)	0	1	2	3	4
Cobble (2-10 in)	0	1	2	3	4
Gravel (.05-2 in)	0	1	2	3	4
Sand (.002-.05 in)	0	1	2	3	4
Silt, Clay, Muck (<.002 in)	0	1	2	3	4
Organic	0	1	2	3	4
Woody Debris	0	1	2	3	4

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Figure 3-2. Eufaula Lake Shoreline Habitat Assessment Data Sheet *(back - containing riparian zone assessment parameters)*

Substrate odors, deposits, and color were recorded. Visual estimates of grain sizes and the frequency at which each sizewas observed was also documented. Bank feature measurements were made with a surveyor tape and a depth pole. It is important to characterize the bank features to estimate the level of erosion and potential sources of excess sedimentation.

Human disturbances may have profound impacts on shoreline habitats. The field team documented the presence or absence of a variety of human influences. These included buildings, park facilities, docks, walls, trash, roads, agriculture, maintained lawns, logging, pipes, and construction. The shoreline habitat assessment also documented the level of intensity of any lake management activities including liming, chemical treatments, angling pressure, macrophyte control, and significant water level fluctuations.

The field team assigned an overall ecological integrity score and documented any wildlife observed. Any possible cause of impairment was noted. The presence of higher-order consumers is an indication of a healthy food web and was recorded. Similarly, the absence of an expected organism is an important observation. The number of photographs taken at each location was recorded.

The field team reviewed the data sheets for accuracy, completeness, and legibility. The data from the datasheets was formatted for a direct comparison with accepted water quality standards and regional lake values from the NLA. Water quality data, such as dissolved oxygen was compared to the fish and wildlife propagation beneficial use designation outlined in the USEPA Water Quality Handbook and used by state agencies including the Oklahoma Water Resources Board (OWRB). If a particular location fails to meet the designated use standard for a water quality parameter it will help pinpoint potential areas with degraded habitat. This assisted in the determination of shoreline habitat quality.

The analysis of physical littoral and riparian shoreline habitat assessment data involved the following four integrative summary measures of lake condition:

- Lakeshore Disturbance Index (RDis_IX)—lakeshore and near-shore human land use and disturbances
- Lakeshore Habitat Index (RVegQ)—riparian vegetation structure and cover depth
- Shallow Water Index (LitCvrQ)—littoral fish cover and aquatic macrophytes
- Physical Habitat Complexity Index (LitRipCvQ)—riparian vegetation structure and cover; aquatic macrophyte structure; cover and structure of littoral fish concealment features

These four indices, taken from the NLA protocol, allow comparison of largely qualitative data in a quantitative manner. The collected data from Eufaula Lake was formatted into a version that is compatible with these measures and was entered into mathematical formulas to produce a habitat value for each of the four indices. These were cumulative scores from all sampled locations and provided a lake-wide quantitative shoreline habitat value. Each index is scaled 0 to 1, where 0 indicates poor habitat conditions and 1 indicates optimal habitat conditions. The NLA Technical Appendix (2007) provides uniform condition criteria to assess each index score individually. The criteria for the Lakeshore Disturbance Index (RDis_IX) are given below as an example:

Low Disturbance	RDis_IX ≤ 0.20
Medium Disturbance	RDis_IX > 0.20 but ≤ 0.75
High Disturbance	RDis_IX > 0.75

The values were then compared to NLA baseline values for lakes within the region (plains and lowlands-Cluster C). This provided a more accurate assessment than the uniform condition criteria because it takes regional characteristics such as landforms, geology, soils, vegetation and lake morphology into account. Higher than average values would reflect good shoreline habitat quality while values lower than average would indicate that the habitat quality in Eufaula Lake could be improved. Investigation into which sampling locations contributed to high or low scores assisted in pinpointing possible sources of impairment. It also allowed a habitat comparison between Protected and Limited Development shoreline allocation areas.

Riparian and littoral habitat structures serve as both an indicator of ecological condition and a context for interpreting biological information. The general expectation is that wetland and multi-layered riparian vegetation and abundant, complex fish concealment features foster native fish, macroinvertebrate, and avian assemblage diversity, whereas shoreline human activities that reduce natural riparian vegetation and reduce littoral cover complexity are probably detrimental to native biota. Therefore, the shoreline habitat assessment provides an important characterization of terrestrial and aquatic habitats and is an important component of the natural resources inventory and assessment sections of the environmental impact analysis. Additionally, the assessment of littoral lacustrine habitats for the shoreline allocation categories was used to evaluate changes in vegetation described in this report.

3.2 Conduct Natural Resources Inventories

The natural resource inventory started with a literature review of natural resources of the Eufaula Lake EIS study area. This included the area described in the Carlton Landing development proposal. Pedestrian surveys to evaluate natural resources were conducted within the area described in the Carlton Landing development proposal. The natural resource inventory augments the description of existing terrestrial and aquatic habitats.

The natural resource inventory identified and quantified, to the extent possible, mammals, birds, reptiles, amphibians, fish, and any federal threatened and endangered species, as well as other state listed species that may be of concern. The inventory included a survey for the American burying beetle in appropriate habitats within the Carlton Landing development proposal area. Field verification for other listed species and their habitats was conducted as described in this report.

3.2.1 Regulatory Framework

Section 1502.25 of the NEPA regulations require that draft EISs be prepared concurrently and integrated with environmental analyses and related surveys and studies required by other federal statutes (40CFR 1502.25). With respect to natural resources those statutes would include those mentioned under Section 2.2 as well as the Endangered Species Act of 1973 (16 U.S.C. 1531 et seq.).

3.2.1.1 Endangered Species Act

The Endangered Species Act and subsequent amendments provide for the conservation of endangered and threatened species and the ecosystems upon which they depend. Section 7 of the Endangered Species Act requires federal agencies to aid in the conservation of listed species, and to ensure that the activities of federal agencies will not jeopardize the continued existence of listed species or adversely modify designated critical habitat. At the federal level, USFWS and the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) are responsible for administration of the Endangered Species Act. Within the Eufaula Lake area, only species under the jurisdiction of USFWS occur.

3.2.1.2 Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 (MBTA), which implements various treaties and conventions between the United States, Canada, Japan, Mexico, and the former Soviet Union, decrees that all migratory birds and their parts (including eggs, nests and feathers) are fully protected (USFWS 2012a). Nearly all native North American bird species are protected by the act. Under the act, taking, killing, or possessing migratory birds is unlawful. Projects that are likely to result in taking of birds protected under the MBTA will require the issuance of take permits from the U.S. Fish and Wildlife Service. Activities that would require such a permit would include destruction of migratory bird nesting habitat during the nesting season when eggs or young are likely to be present. Under the act, surveys are required to determine if nests will be disturbed and, if so, a buffer area with a specified radius around the nest would be established so that no disturbance or intrusion would be allowed until the young had fledged and left the nest. If not otherwise specified in the permit, the size of the buffer area would vary with species and local conditions (*e.g.* presence of busy roads), and would be based on the professional judgment of a monitoring biologist.

In addition to the MBTA, migratory birds are protected under the Migratory Bird Conservation Act of 1929, which established the Migratory Bird Conservation Commission to consider and approve any areas recommended by the Secretary of the Interior for purchase or rental by USFWS (USFWS 2012b). This is especially important in the establishment of new waterfowl refuges. In 2000, the Neotropical Migratory Bird Conservation Act was passed to provide grants for the conservation of neotropical migratory birds that winter south of the United States' border and summer in North America (USFWS 2012c).

3.2.1.3 Fish and Wildlife Coordination Act

The amendments enacted in 1946 require consultation with the US Fish and Wildlife Service (USFWS) and the fish and wildlife agencies of States where the "waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted . . . or otherwise controlled or modified." Consultation is to be undertaken for the purpose of "preventing loss of and damage to wildlife resources." The 1958 amendments added provisions to recognize the vital contribution of wildlife resources to the Nation and to require equal consideration and coordination of wildlife conservation with other water resources development programs.

3.2.1.4 Lacey Act

The Lacey Act, enacted in 1900 and amended in 1981, makes it illegal to import, export, sell, acquire, or purchase fish, wildlife or plants taken, possessed, transported, or sold in violation of U.S. or Indian law. It also makes illegal any interstate or foreign commerce involving any fish, wildlife, or plants taken, possessed, or sold in violation of state or foreign law. The law covers all fish and wildlife and their parts or products, and plants protected by the Convention on International Trade in Endangered Species or state law.

3.2.1.5 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act of 1940 requires measures to prevent the harassment and take of bald eagles resulting from human activities (USFWS 2010a). The Act provides for the protection of the bald eagle and the golden eagle (as amended in 1962) by prohibiting the take, possession, sale, purchase, barter, transport, export or import, of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit (16 U.S.C. 668(a); 50 CFR 22). Take means to pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb. This includes inactive nests as well as active eagle nests (USFWS 2010a).

3.2.1.6 North American Waterfowl Management Plan

The North American Waterfowl Management Plan (NAWMP), composed and enacted by the wildlife agencies of Canada, Mexico, and the United States, outlines efforts to successfully protect and conserve waterfowl to ensure their continued enjoyment by hunters, birders, and the general public (NAWMP 2004). The strategy of NAWMP is to restore waterfowl populations through habitat protection, restoration, and enhancement via partners involving federal, state, provincial, tribal, and local governments, businesses, conservation organizations, and individual citizens. NAWMP partners:

1. implement the plan guided by biologically based planning, which is refined through ongoing evaluation;
2. define the landscape conditions needed to sustain waterfowl and benefit other wetland-associated species;
3. and collaborate with other bird initiatives and reach out to other sectors and communities to forge broader alliances.

3.2.2 Data Collection and Analysis Methods

The goal of this activity was to perform a literature review and provide an inventory of natural resources of the Eufaula Lake EIS study area including the area described in the Carlton Landing development proposal. Documents pertaining to the natural resources and ecology of the Eufaula Lake EIS study area were collected, evaluated, and summarized. An inventory of these natural resources was also provided in tabular form. The literature was collected, evaluated, and summarized and included reports, maps, figures, and tables regarding the ecology of Eufaula Lake and associated habitats, and mammals, birds, reptiles, amphibians, fish, and any federal threatened and endangered species, as well as other state listed species that may be of concern, from the following sources:

- ODWC
- OHNI GIS database
- USFWS including the NWI
- USACE
- USEPA
- USGS including quadrangle maps
- NRCS including soil maps, and
- Other state and federal agencies as appropriate

Pedestrian surveys to evaluate the natural resources were done in conjunction with field verification of habitats described above. In support of the inventory of natural resources, field verification included documented observations of listed species and their habitats. Specific sampling methods for listed species were implemented pursuant to USFWS guidelines.

A limited faunal survey was conducted on two days within the Eufaula Lake EIS study area and the area described in the Carlton Landing development proposal. Access to survey points was obtained by foot, vehicle, and boat, as necessary. Species were identified through both visual observation and identification of faunal indicators including tracks, nests, droppings, calls, and vocalizations. Observation sites were also selected in an attempt to capture the representative aquatic and terrestrial habitats in the Eufaula Lake EIS study area.

A survey for the American burying beetle was provided for the area described in the Carlton Landing development proposal. The beetle surveys were performed by a qualified biologist approved by USFWS and followed the protocols approved by USFWS (American Burying Beetle *Nicrophorus americanus* Range-wide Survey Guidance, updated 4-20-11). While the presence/absence survey protocols are not proposed for revision, the protocols for avoidance in the event of development are currently being revised. The EIS conclusions and proposed mitigation measures reflect these changes that include the preferred methods of avoidance. A major deviation from previous year's protocols for Oklahoma was the removal of bait-away conservation measures, which could only be used in exceptional circumstances.

A list of important natural resources references collected is as follows:

- NatureServe (2011), *NatureServe Explorer: An Online Encyclopedia of Life*. Version 7.1. NatureServe, Arlington, Virginia, http://www.natureserve.org/explorer/
- OHNI (2012), *Oklahoma Federal or State Regulatory Species Presence/Absence Data* (Site-specific GIS data obtained from S. Kirk of OHNI), http://www.oknaturalheritage.ou.edu/request_data.htm
- ODWC-Fisheries Division (2008), Eufaula Lake 5 Year Lake Management Plan
- ODWC (2011), *Oklahoma's Threatened, Endangered and Rare Species*, http://www.wildlifedepartment.com/wildlifemgmt/endangeredspecies.htm
- Oklahoma Ornithological Society (2011), *The Oklahoma Ornithological Society Checklist of Oklahoma Birds, 4th edition*, http://www.okbirds.org/2011_obrc_ok_checklist.pdf
- USFWS (2012), *Environmental Conservation Online System (ECOS) Federal Threatened and Endangered Species List by County*, http://ecos.fws.gov/ecos/indexPublic.do
- USFWS (2012), *ECOS Species Reports*, http://ecos.fws.gov/tess_public/
- USFWS (2012) *Critical Habitat Portal*, http://criticalhabitat.fws.gov/crithab/

The preliminary list of protected federal and state species in the Eufaula Lake EIS study area is as follows:

Federal

Common Name	Scientific Name	Status
American burying beetle	*Nicrophorus americanus*	Endangered
Least tern	*Sternula antillarum*	Endangered
Piping plover	*Charadrius melodus*	Threatened

Arkansas River shiner	*Notropis girardi*	Threatened
American peregrine falcon	*Falco peregrinus*	Recovery
Whooping crane	*Grus americana*	Endangered
Sprague's pipit	*Anthus spragueii*	Candidate
Gray bat	*Myotis grisescens*	Endangered
Prothonotary warbler	*Protonotaria citrea*	Conservation concern
Bell's vireo	*Vireo bellii*	Conservation concern

State

Bald eagle	*Haliaeetus leucocephalus*	Recovery
Alligator snapping turtle	*Macrochelys temminckii*	Species of Concern

Chapter 4

Affected Environment

4.1 Terrestrial and Aquatic Habitats

4.1.1 Terrestrial Habitats

The upland vegetation and terrestrial habitats present within the Eufaula Lake study area were classified according to the level IV Oklahoma ecoregion map (**Figure 4-1**) (Woods *et al*. 2005). The Oklahoma ecoregion map was compiled at a scale of 1:250,000 and revises and subdivides an earlier level III ecoregion map that was originally compiled at a smaller scale (Omernik 1987). These ecoregion maps are used by EPA to identify similar ecosystems that are critical for structuring and implementing ecosystem management strategies (USEPA 2005).

Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components. The approach used to compile the Oklahoma ecoregion map is based on the premise that ecoregions can be identified through the analysis of spatial patterns and the composition of biotic and abiotic characteristics that affect or reflect differences in ecosystem quality and integrity (Woods *et al*. 2005). These characteristics include physiography, geology, climate, soils, land use, wildlife, fish, hydrology, and vegetation. Current vegetation is described along with potential natural vegetation, which is defined as the vegetation that would exist today if human influence ended and the resulting plant succession was telescoped into a single moment (Woods *et al*. 2005). Therefore, the analysis of ecoregions within the Eufaula Lake study area allows for the classification of historical and current vegetation habitat types.

Oklahoma contains vast plains, elevated karst plains, hills, and folded, low mountains. Precipitation increases eastward, rainfall variability increases westward, and both the mean annual temperature and the length of the growing season increase southward (Woods *et al*. 2005). Soils influence the degree to which moisture is available for plant life. Forests cover most of the Ozark Plateau and Ouachita Mountains, becoming progressively more stunted and open westward. Prairies are native to central and western Oklahoma, giving way to mesquite and other xeric plants in the dry southwest. The strong east-west zonation of vegetation and climate in Oklahoma significantly influences the distribution of fauna. The western boundary of deciduous forest limits the westward expansion of many eastern species, while Rocky Mountain species integrate with Great Plains species in the western Panhandle. Great Plains species are found in intervening regions.

Much of Oklahoma's natural upland vegetation has been lost to overgrazing, burning, logging, erosion, and cultivation. Today, the state is a mosaic of grazing land, cropland, woodland, forests, and abandoned farmland. Wheat and alfalfa are the main crops with grain sorghum, soybeans, cotton, and corn grown in lesser quantities (Woods *et al*. 2005).

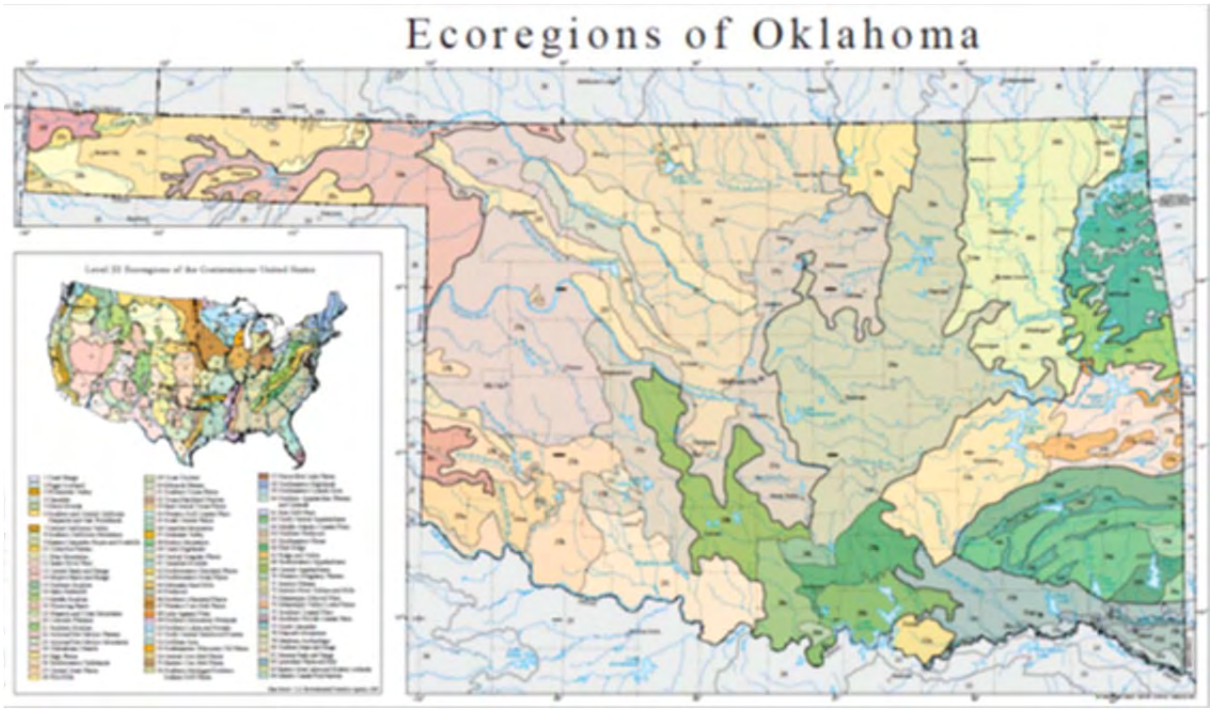

Figure 4-1. Level IV Oklahoma Ecoregion Map (*Woods et al. 2005*)

The four ecoregions located within the Eufaula Lake study area are the northern crosstimbers (29a), scattered high ridges and mountains (37a) and the lower Canadian hills (37e) of the Arkansas River valley, and the osage cuestas (40b) of the central irregular plains (**Figure 4-2**).

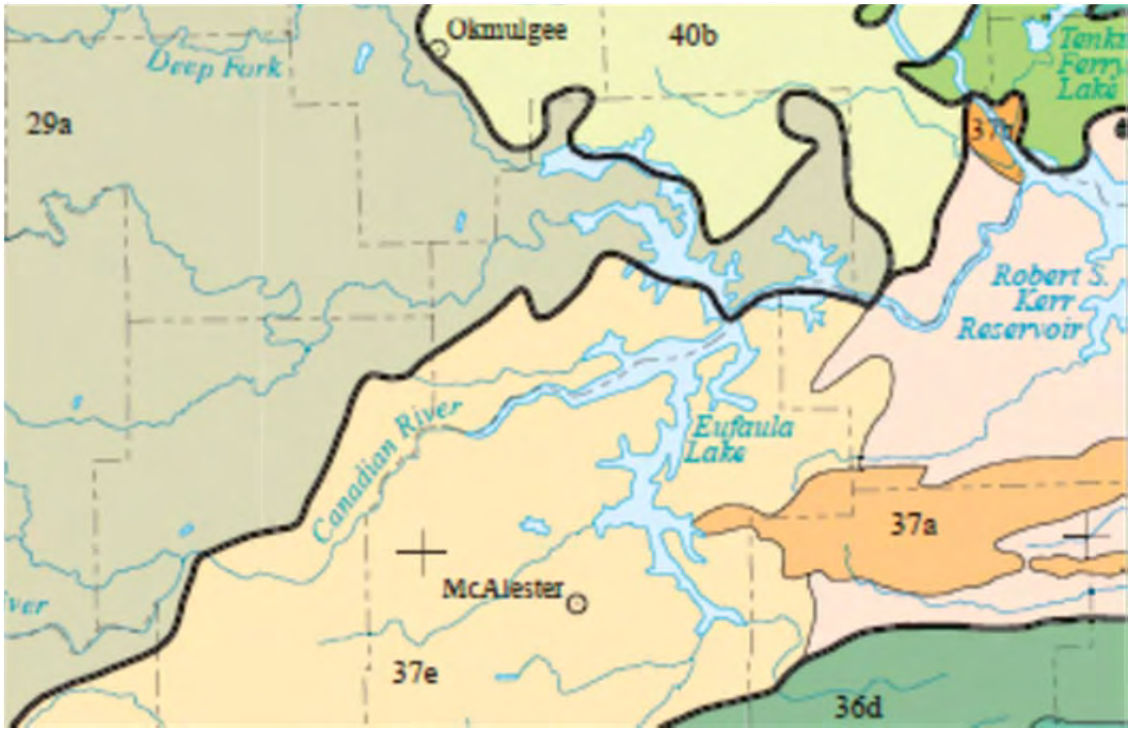

Figure 4-2. Level IV Ecoregions Located around Eufaula Lake (*Woods et al. 2005*)

Northern Crosstimbers Ecoregion

The northern crosstimbers are found in the northern and western portions of the Eufaula Lake study area, to the north of the main channel of the South Canadian River. Several main Eufaula Lake tributaries flow through this ecoregion, including the Deep Fork River, North Canadian River, and Duchess Creek. A mix of savanna, woodland, and prairie is native to the low hills, cuestas, ridges, and plains of the crosstimbers, and separates the forests of eastern ecoregions from the prairies of drier, western ecoregions. The boundary between the crosstimbers and the nearly treeless central Great Plains coincides with the western limit of many plant and animal species. Mean annual precipitation is 36-46 inches and the region typically experiences 195-235 frost-free days per year (Woods *et al*. 2005).

Historically, the northern crosstimbers consisted of a complex mosaic of upland deciduous forest, savanna, and prairie communities that highlighted the broad ecotone between the eastern forests and the grasslands of the Great Plains (Hoagland *et al*. 2000). The larger crosstimbers region was the largest single ecosystem in Oklahoma and occupied the central one-third of the state (Duck and Fletcher 1945). The pre-European settlement crosstimbers is estimated to have covered nearly 20 million acres (ODWC 2005).

Within the northern crosstimbers, oak woodland and savanna were present on porous, coarse-textured soils derived from sandstone (Woods *et al*. 2005). Within the oak woodland, dominant species included post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*). The percentage of blackjack oak increased westward. They also contained black hickory (*Carya texana*), black oak (*Quercus velutina*), persimmon (*Diospyros virginiana*), redbud (*Cercis canadensis*), and sumac (*Rhus spp*.). Within riparian areas, bottomland hardwood stands of hackberry (*Celtis laevigata*), American elm (*Ulmus americana*), post oak, black walnut (*Juglans nigra*), green ash (*Fraxinus pennsylvanica*), willow (*Salix spp*.), sycamore (*Platanus occidentalis*), and cottonwood (*Populus deltoides*) were common (Woods *et al*. 2005).

Savanna areas were typically dominated by little bluestem and other understory grasses. Overall, far more oak savanna occurred within the crosstimbers than in adjacent ecoregions (Woods *et al*. 2005). Tall-grass prairie was present on fine-texted, moisture deficient soils derived from limestone or shale. Dominant prairie species included big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), switchgrass (*Panicum spp*.), and Indian grass (*Sorghastrum nutans*). Drier, shallower soils supported small patches of short-grass prairie. The structure of these open habitats was maintained by frequent, naturally occurring fires that limit the growth of woody plant species and favor grasses and some forbs (ODWC 2005).

Today, woodland, grassland, rangeland, pastureland, limited cropland, and several extensive, but declining, oil fields occur within the crosstimbers ecoregion. Within the northern crosstimbers, livestock farming is the main land use (Woods *et al*. 2005). Despite extensive land conversion, the crosstimbers contain some of the most extensive tracts of woodland in the United States. In undisturbed regions within the Eufaula Lake study area scrubby oak forests, oak savanna, riparian forests, and prairie openings still occur unchanged from the historical condition. This is consistent with evaluations of the greater crosstimbers region, with oak forest habitats currently regarded as high in quality with a stable trend (ODWC 2005). Post oak and blackjack oak continue to remain dominant. Riparian bottomland hardwood forests are largely intact and contain stands of sycamore, American elm, hackberry, and willow. However, within the greater crosstimbers ecoregion, bottomland hardwood forest habitat is currently regarded as poor in quality with a declining trend (ODWC 2005). Many of these riparian forests were inundated with the construction of Eufaula Lake. Within the current study area, impacts are most evident where soils are

highly erodible when disturbed. In these areas, increased development has resulted in degraded riparian habitats.

Areas of savanna and prairie have been greatly reduced within the study area. Many of these former grassland areas have been cultivated or turned into parkland planted with non-native grasses. They are still present in protected areas and within regions that are drier and/or have a higher frequency of fire. However, most tracts of native prairie appear to be scattered and relatively small. Recent fire suppression and passive land use has increased forest density and allowed eastern red-cedar (*Juniperus virginiana*) to invade many savanna and prairie habitats (Woods *et al*. 2005). Moving away from the lakeshore, abandoned, depleted farmland is common. The remaining cropland is largely restricted to valleys near channelized streams. The main crops include small grains, grain sorghum, hay, and soybeans (Woods *et al*. 2005).

Osage Cuestas Ecoregion

The osage cuestas ecoregion consists of irregular and undulating plains that are broken by low hills and cuestas with east-facing scarps (ODWC 1996). The cuestas are mostly tall-grass prairie, grading eastward into a mosaic of prairie and oak-hickory forest. This transition zone separates the forested Ozark highlands to the east from the open central plains to the west. Mean annual precipitation is 44-45 inches and the region typically experiences 200-205 frost free days per year (Woods *et al*. 2005). Within the Eufaula Lake study area, osage cuestas can be found along the northern shoreline from Grave Creek to Oakwood Harbor.

Historically, the osage cuestas were dominated by tall-grass prairie communities that thrived on the native deep loams. Common species included big bluestem, little bluestem, switchgrass, and Indian grass. Wildflowers were also plentiful with sunflower (*Helianthus sp*.), Indian blanket (*Gaillardia pulchella*), blazing star (*Liatris spicata*), and others growing among the grasses (ODWC 1996). These grasslands were relatively free of shrubs except at borders with woodlands or clumps of persimmon trees in drainages. Forested areas were less common with bottomland forests containing cottonwood, oaks, and maples (*Acer* sp.) found within floodplains and low terraces. Stunted crosstimbers, dominated by blackjack and post oak, occupied rocky hilltops (Woods *et al*. 2005). Clear streams with gravel and cobble substrates were common, becoming more turbid nearing the stream mouth.

Today, the degree to which the osage cuestas reflects the historical condition varies depending on community type. Like many ecoregions dominated by tall-grass prairie, many areas have been converted into rangeland and cropland. USGS land use data for 2000 reflects this trend with agriculture being the predominant land use at 60 percent and prairie occupying only 16 percent (Karstensen 2011). Those areas in which tall-grass prairie continues to exist is often located on managed government-owned lands in Protected-zoned and recreation areas. Wheat, soybeans, grain sorghum and alfalfa are major crops. Excessive nutrient and sediment inputs from these agricultural operations, and natural resource mining and oil production within the region have degraded water quality in some streams.

Bottomlands and rocky hilltops have fared better than the tall-grass prairie. Land use data shows forested land expanding within the osage cuestas, overtaking prairie to become the second-greatest land-cover type with approximately 20 percent coverage (Karstensen 2011). Today, the habitats that occupy these areas within the Eufaula Lake study area are often comparable to the historic condition. Some residential development has fragmented forest areas but large tracts of dry upland oak-hickory forest and woodland are present. In riparian areas, bottomland forests containing boxelder (*Acer negundo*), silver maple (*Acer*

saccharinum), Shumard oak (*Quercus shumardii*), bur oak (*Quercus macrocarpa*), American elm, hackberry, pecan (*Carya illinoinensis*), walnut (*Carya sp*.), sycamore, and eastern cottonwood continue to shade stream banks.

Scattered High Ridges and Mountains—Arkansas River Valley Ecoregion

The scattered high ridges and mountains ecoregion occupies the smallest area within the Eufaula Lake study area and is found on the southeast side of the lake near the mouth of Jones Creek and the town of Blocker, Oklahoma. As the name implies, this ecoregion consists of disjunct mountains and ridges that are dissected by narrow, steep-sided stream valleys. Within the study area, these include foothills of the higher San Bois Mountains to the east (ODWC 1996). It is more rugged and wooded than the other ecoregions located within the Arkansas River valley and is covered by savannas, open woodlands, and forests. Mean annual precipitation is 48-51 inches and the region typically experiences 205-215 frost-free days per year (Woods *et al*. 2005).

Historically, the scattered high ridges and mountains ecoregion was covered by a mix of oak savanna, oak-hickory forest, and oak-hickory-pine forest on uplands. Dominant upland species include post oak, blackjack oak, black hickory, and shortleaf pine (*Pinus echinata*). On more mesic sites in ravines and on north-facing slopes, forests contained maples, white oak (*Quercus alba*), northern red oak (*Quercus rubra*), and chinquapin oak (*Quercus muehlenbergii*) (Woods *et al*. 2005). Bottomland forest was present in floodplains on low terraces and consisted of white oak, southern red oak (*Quercus falcata*), sycamore, hackberry, green ash, and blackgum (*Nyssa sylvatica*).

Today, this ecoregion still reflects the historical condition and remains mostly mixed and deciduous forest. Dry forests of post oak, blackjack oak, and scattered hickories dominate rugged areas and extend into the plains. These forests contain rather short, scattered trees similar to the crosstimbers, little to no understory, and a significant cover of tall-grass prairie plants on the floor (ODWC 1996). Shortleaf pine savannas and oak-pine forests occupy ridgetops and are similar in structure and function to those found in the Ouachita Mountains.

Along streams and the shallower slopes of the lake, bottomland hardwood riparian forests of oak, elm, and hackberry are dominant. These tall forests generally have two to three understory levels and often accumulate dense mats of leaf litter. In openings, a lush growth of herbaceous plants covers the ground. Grape (*Vitis sp*.), poison ivy (*Toxicodendron radicans*), and greenbrier (*Smilax sp*.) vines are common.

Although uncommon within this ecoregion, prairies can be found scattered between the upland forests and the riparian bottomland hardwood forests (ODWC 1996). Tall-grass communities containing bluestems, Indian grass, switchgrass, and other tall grasses are dominant. A wide variety of wildflowers including Indian paintbrush (*Castilleja sp*.) are also present. Fire is an important component in maintaining these communities, and where suppressed, tall-grass prairie communities in this ecoregion are often replaced by open woodland and eastern red-cedar forest.

Human disturbance within the study area is minimal and primarily agricultural. Steep slopes are wooded and used for timber, woodland grazing, or recreation. Gently sloping uplands are used as pastureland and hayland. Cropland and pastureland occur within bottomlands (ODWC 1996). Some residential communities are also present.

Lower Canadian Hills Ecoregion

The lower Canadian hills ecoregion is the largest within the Eufaula Lake study area and occupies the southern half of the lake from the town of Stidham in the west to Dam Site South in the east except for a small area south of Blocker occupied by the scattered high ridges and mountains ecoregion. The lower Canadian hills ecoregion consists of a mosaic of hills and valleys in the structural Arkoma Basin within the Arkansas River valley (Woods *et al*. 2005). Streams within this ecoregion consist of long sandy pools interspersed with short gravelly riffles. Hills along the Eufaula Lake shoreline are often cloaked in dry crosstimbers and oak-hickory forests. Mean annual precipitation is 41-46 inches and the region typically experiences 215-235 frost-free days per year (Woods *et al*. 2005).

The lower Canadian hills derive their name from the low hills that surround the Canadian River. Historically, this ecoregion was dominated by crosstimbers, tall grass prairie, and a mosaic of tall grass prairie, oak-hickory forest, and oak-pine forest (Woods *et al*. 2005). Dominant species included blackjack and post oaks in the crosstimbers, bluestem grasses and switchgrass in prairies, and white oak and shortleaf pine in the oak-pine forest. Up until the early 19th Century, tall grass prairie was relatively abundant. Along streams, dense deciduous bottomland hardwood forests were found in riparian areas.

Today, this ecoregion still possesses large tracts of forested areas. The crosstimbers, oak-hickory, and oak-pine forests reflect the historic condition. On high terraces, post oak, black oak, southern red oak, and black hickory are found. On wooded hills and ridges, blackjack oak, white oak, hickories, eastern red-cedar and shortleaf pine occur. Despite large areas of upland forest, riparian forests have been widely cleared for alternative land uses or inundated by the construction of reservoirs. The removal of riparian vegetation and mining and natural gas extraction have contributed to increased sedimentation and declining water quality in streams. Where bottomland forest habitats still exist, especially along Gaines Creek and the Deep Fork River within the study area, they contain stands of sycamore, oaks, black willow, green ash, pecan, and black walnut.

Within the lower Canadian hills ecoregion, tall grass prairie habitat has been greatly reduced due primarily to land conversion and fire suppression. Today, most tall grass prairie has been converted to pastureland, cropland, or for residential use (Woods *et al*. 2005). In areas where tall grass prairie has not been converted, fire suppression has allowed woody species, such as eastern red-cedar and persimmon, to invade open areas.

4.1.1.1 Vegetation Communities

Each of the four ecoregions is made up of a variety of natural vegetation communities (**Table 4-1**). As described by Hoagland (2000), these communities are dominated by characteristic plant associations that greatly influence the fauna found within. Vegetation transects were established in April 2012 and included at least two transects for each vegetation community. Transects were located to capture habitats in all four ecoregions and were positioned in an even geographic distribution around the periphery of the lake (**Figure 4-3**). All plant species present in the canopy, understory, and ground cover were noted and dominance was determined. This enabled a more detailed discussion of the specific habitat conditions located within each ecoregion. Efforts were made to capture characteristic communities for each ecoregion. For example, oak-hickory forest, crosstimbers, and bottomland hardwood forest/forested wetland vegetation communities were sampled within the northern crosstimbers ecoregion since these communities occupy the greatest extent within this ecoregion. Representative photographs from each transect can be found in Appendix A.

Table 4-1. Primary Natural Vegetation Communities and Vegetation Associations Found within the Eufaula Lake Study Area

Vegetation Community	Dominant Plant Associations*
Crosstimbers	Post Oak—Blackjack Oak—Black Hickory Forest
	Post Oak—Winged Elm Forest
	Post Oak—Eastern Red-cedar Forest
Oak-Hickory Forest	Post Oak—Black Hickory Forest
	Post Oak—Shumard Oak—Bitternut Hickory Forest
	Chinquapin Oak—Shumard Oak Forest
Oak-Pine Forest	Shortleaf Pine—Post Oak—Blackjack Oak Forest
	Shortleaf Pine—White Oak—Black Oak Forest
Bottomland Hardwood Forest (Forested Wetland)	American/Red Elm—Sugarberry—Green Ash Temporarily Flooded Forest
	Pin Oak—Pecan—Deciduous Holly Seasonally Flooded Forest
	River Birch—Sycamore Temporarily Flooded Forest
	Water Oak—Red Elm—Shumard Oak Temporarily Flooded Forest
Savanna	Broomsedge—Persimmon—Smooth Sumac Herbaceous Association
	Post Oak—Blackjack Oak—Little Bluestem Woodland Association
	Lespedeza Herbaceous Association
Prairie	Big Bluestem—Switchgrass Herbaceous Association
	Big Bluestem—Little Bluestem—Indian Grass Herbaceous Association
	Sunflower—Western Ragweed Herbaceous Alliance

**Hoagland (2000)*

The crosstimbers is one of the most widespread and abundant native habitat types located within the Eufaula Lake study area. Historically, the crosstimbers were a diverse mosaic of oak savannas, oak-hickory woodlands, and oak hickory forests that varied depending upon soil, rainfall, and fire history (ODWC 2005). It is found throughout the study area but is most common within the northern crosstimbers and lower Canadian hills ecoregions on the western side of the lake. Crosstimbers are also present on the rocky hilltops along the northern shoreline within the osage cuestas ecoregion. Within the study area, crosstimbers habitat was sampled at the proposed Carlton Landing development (lower Canadian hills ecoregion) and within the Deep Fork Arm of the Eufaula WMA (northern crosstimbers ecoregion) (**Table 4-2**).

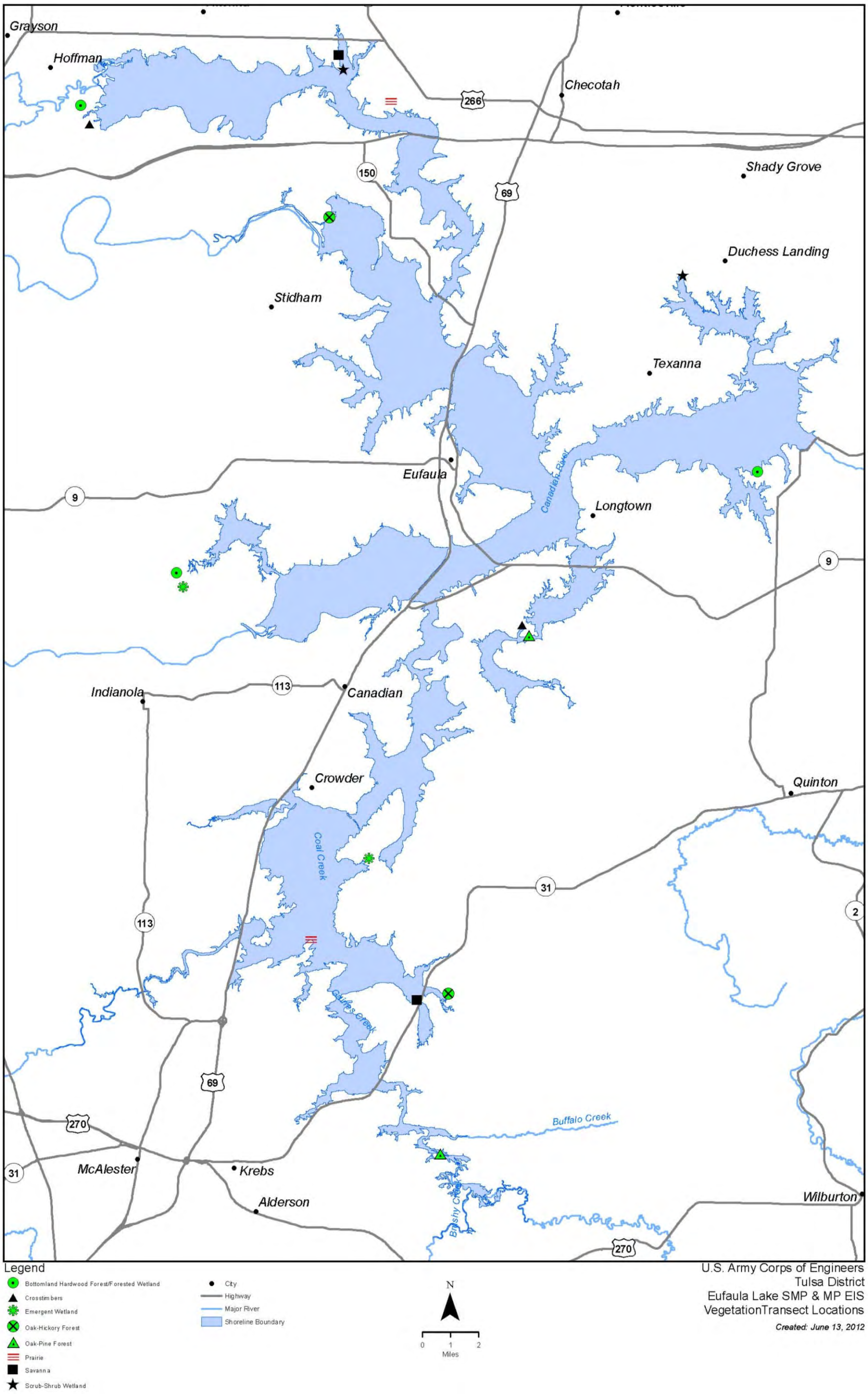

Figure 4-3. Eufaula Lake Study Area Vegetation Transect Locations-April 2012

Table 4-2. Plant Species Found within Crosstimbers Community Habitat Transects - April 2012

Common Name	Scientific Name
Canopy	
Black Hickory*	*Carya texana*
Blackjack Oak*	*Quercus marilandica*
Eastern Red-cedar	*Juniperus virginiana*
Green Ash	*Fraxinus pennsylvanica*
Mockernut Hickory	*Carya tomentosa*
Post Oak*	*Quercus stellata*
Winged Elm	*Ulmus alata*
Sub-Canopy	
Black Hickory	*Carya texana*
Blackjack Oak	*Quercus marilandica*
Eastern Redbud	*Cercis Canadensis*
Eastern Red-cedar*	*Juniperus virginiana*
Gooseberry	*Vaccinium arboretum*
Mexican Plum	*Prunus mexicana*
Post Oak*	*Quercus stellata*
Smooth Sumac*	*Rhus glabra*
Winged Elm*	*Ulmus alata*
Winged Sumac	*Rhus copallinum*
Ground Cover	
Black Hickory	*Carya texana*
Blackjack Oak	*Quercus marilandica*
Green Ash	*Fraxinus pennsylvanica*
Little Bluestem*	*Schizachyrium scoparium*
Lowbush Blueberry	*Vaccinium pallida*
Poison Ivy	*Toxicodendron radicans*
Post Oak*	*Quercus stellata*
Smooth Sumac	*Rhus glabra*
Sphagnum Moss	*Sphagnum* spp.
Switchgrass*	*Panicum* spp.
Virginia Creeper	*Parthenocissus quinquefolia*

**dominant species (determined by % composition)*

The Crosstimbers community is dominated by post oak and blackjack oak. In several areas, these two oaks may comprise as much as 90 percent of the canopy cover (Hoagland *et al*. 1999). Within the Eufaula Lake study area, blackjack oak is more common in western areas with post oak the dominant species throughout. Other common canopy species include black hickory, eastern red-cedar, and winged elm. Within the two habitat transects, canopy percent cover was 65-80 percent. Similar species are present throughout the sub-canopy; however, fewer blackjack oaks and more eastern red-cedar and winged elm make up the understory. Smooth sumac is also dominant. Sub-canopy percent cover fell between 5-40 percent.

Crosstimbers are generally considered open woodlands, thus have a more significant ground cover layer than other forest types found within the study area. Observations at the two transect sites documented post oak, little bluestem, and species of switchgrass dominated the ground cover community. Historically, these would have been accompanied by additional grasses included big bluestem and Indian grass. The presence of many tree seedlings from a variety of species demonstrates that tree recruitment is high and is a good indicator of forest health. Percent cover of the ground layer was 5-25 percent.

In sites that are drier and/or have a higher frequency of fire, the crosstimbers community has a more savanna-like structure (ODWC 2005). The Deep Fork transect site was located on a dry hilltop above the floodplain and exhibited this structure, with less complete canopy and sub-canopy coverage and a ground cover dominated by little bluestem. However, in a majority of the Eufaula Lake study area, relatively little crosstimbers habitat exists in this mosaic condition and has gradually changed to a more uniformly forest-like condition. Additionally, many acres of habitat exist as even-aged forests as a result of widespread timber harvest in the late 1800s and early 1900s (ODWC 2005). The combination of even-aged stand structure and long-term fire suppression appear to be responsible for greater tree densities than probably occurred historically and for an increase in abundance of some species such as eastern red-cedar.

Despite a history of widespread logging, areas supporting ancient crosstimbers stands occur throughout the region. These areas are often found in fragmented tracts along cliffs and rocky uplands (ODWC 2005). Within the study area, ancient crosstimbers were reportedly located on Roundtree Landing adjacent to the proposed Carlton Landing development. However, an extensive search of the peninsula during April 2012 surveys did not identify crosstimbers habitat that could be definitively defined as ancient (Roe 1998). Despite this, much of the crosstimbers habitat within the study area remains mature forest except for scattered areas impacted by residential development.

In addition to the crosstimbers vegetation community, several other forest communities can be found within the Eufaula Lake study area. The oak-hickory forest community closely resembles the crosstimbers community but is not dominated by post and blackjack oak to the same extent. In addition, oak-hickory forests tend to occupy sites with greater precipitation; whereas, crosstimbers are primarily located in drier areas. The oak-hickory vegetation community is found in all four ecoregions and throughout the study area but is most common within the lower Canadian hills and scattered high ridges and mountains ecoregions along the southern half of Eufaula Lake. For this vegetation community, the two habitat transects were located within the North Canadian Arm of the Eufaula WMA (northern crosstimbers ecoregion) and along Jones Creek Road adjacent to the James Collins WMA (scattered high ridges and mountains ecoregion) (**Table 4-3**).

Table 4-3. Plant Species Found within Oak-Hickory Forest Community Habitat Transects - April 2012

Common Name	Scientific Name
Canopy	
American Elm	*Ulmus americana*
Black Hickory*	*Carya texana*
Black Locust	*Robinia pseudoacacia*
Black Oak	*Quercus velutina*
Hackberry	*Celtis* sp.
Mockernut Hickory*	*Carya tomentosa*
Post Oak*	*Quercus stellate*

Common Name	Scientific Name
Shumard Oak*	*Quercus shumardii*
Slippery Elm	*Ulmus rubra*
Southern Red Oak	*Quercus falcata*
Winged Elm*	*Ulmus alata*
Sub-Canopy	
Black Hickory*	*Carya texana*
Boxelder	*Acer negundo*
Chickasaw Plum	*Prunus angustifolia*
Eastern Red-cedar	*Juniperus virginiana*
Green Ash*	*Fraxinus pennsylvanica*
Mexican Plum	*Prunus mexicana*
Post Oak*	*Quercus stellata*
Red Mulberry*	*Morus rubra*
Rough-leaf Dogwood	*Cornus drummondii*
Slippery Elm*	*Rhus glabra*
Winged Elm*	*Ulmus alata*
Ground Cover	
Black Hickory	*Carya texana*
Bedstraw*	*Galium* spp.
Eastern Red-cedar	*Juniperus virginiana*
Little Bluestem	*Schizachyrium scoparium*
Lowbush Blueberry	*Vaccinium pallida*
Mexican Plum*	*Prunus mexicana*
Mint*	*Mentha* spp.
Muscadine	*Vitis rotundifolia*
Oklahoma Grasspink Orchid	*Calopogon oklahomensis*
Poison Ivy*	*Toxicodendron radicans*
Post Oak	*Quercus stellata*
Red Mulberry*	*Morus rubra*
Roundleaf Greenbrier*	*Smilax rotundifolia*
Sedge	*Carex* spp.
Sphagnum Moss	*Sphagnum* spp.
Switchgrass	*Panicum* spp.
Trumpet Creeper	*Campsis radicans*
Virginia Creeper	*Parthenocissus quinquefolia*
Wild Oat	*Avena fatua*

**dominant species (determined by % composition)*

Within the study area, the dominant canopy species found in the oak-hickory forest community include post and Shumard oaks, black and mockernut hickories, and the winged elm. Oak-hickory forests are more diverse than crosstimbers and a total of 17 tree species were found within the canopy and sub-canopy on the two sampling sites. The dominant species within the sub-canopy include black hickory, post oak, and winged elm found in the canopy and also include green ash, slippery elm, and red mulberry. Percent cover

of the canopy was approximately 60 percent for both sites and ranged from 30-60 percent for the sub-canopy.

The amount of ground cover within the oak-hickory forest community depends on the openness of the canopy. Within the study area, the oak-hickory forests take on the characteristics of open woodland and support a variety of herbaceous plants. In the two sample sites, a total of 19 species were identified in the ground cover layer. Dominant species include Mexican plum, mint, poison ivy, red mulberry, roundleaf greenbrier, and bedstraw. Several additional vine species were also common including muscadine, trumpet creeper, and Virginia creeper. Total percent cover for the ground layer ranges from 20-65 percent.

Much like in the crosstimbers, historically, the oak-hickory forest community was regulated by a much higher frequency of fire. Long-term fire suppression has led to a proliferation of weedy herbaceous species including the bedstraw and poison ivy observed at both transects that have replaced native bluestem grasses. In addition, roads and infrastructure construction in areas where residential and agricultural development have occurred facilitate the dispersal of weedy herbaceous species.

In comparison to crosstimbers transects, very few tree species were observed in the ground cover of oak-hickory forests. The high density of herbaceous ground cover smothers tree seedlings and may inhibit tree recruitment. This could cause a decline in forest health as older trees die off and are not replaced. This is of great concern since many acres of oak-hickory forest habitat exist as even-aged forests as a result of widespread timber harvest in the late 1800s and early 1900s (ODWC 2005).

While not as common in the Eufaula Lake study area as crosstimbers and oak-hickory forest, several large tracts of oak-pine forest can be found within the lower Canadian hills and scattered high ridges and mountains ecoregions. Oak-pine forests are particularly common along the shorelines of Evergreen and Brooken Coves in the northeast, Hickory Point in the southeast, and Roundtree Landing in the east-central portion of the lake. The oak-pine forest community is comprised of a mosaic of woodlands and forests dominated by shortleaf pine and several species of oaks and hickories (Hoagland 2000). Historically, on mid to lower slopes, shortleaf pine, post oak, and blackjack oak were dominant in the canopy with little bluestem, lowbush blueberry, false indigo, St. John's wort, and stiff sunflower dominant in the herbaceous layer (ODWC 2005). On upper slopes, shortleaf pine would be joined by white oak, black oak, and northern red oak in the canopy with a predominantly shrubby understory of blueberry, winged sumac, blackberries, and American beautyberry. Within the study area, oak-pine forest habitat was sampled at Roundtree Landing adjacent to the proposed Carlton Landing development (lower Canadian hills ecoregion) and at Hickory Point Recreation Area (lower Canadian hills ecoregion) (**Table 4-4**).

Table 4-4. Plant Species Found within Oak-Pine Forest Community Habitat Transects - April 2012

Common Name	Scientific Name
Canopy	
American Elm	*Ulmus americana*
Black Hickory	*Carya texana*
Black Oak	*Quercus velutina*
Eastern Red-cedar*	*Juniperus virginiana*
Green Ash*	*Fraxinus pennsylvanica*
Mockernut Hickory	*Carya tomentosa*

Common Name	Scientific Name
Post Oak	*Quercus stellata*
Shortleaf Pine*	*Pinus echinata*
White Oak	*Quercus alba*
Winged Elm*	*Ulmus alata*
Sub-Canopy	
Black Hickory	*Carya texana*
Black Locust	*Robinia pseudoacacia*
Eastern Red-cedar*	*Juniperus virginiana*
Green Ash*	*Fraxinus pennsylvanica*
Green Hawthorn	*Crataegus viridis*
Hackberry	*Celtis* sp.
Mexican Plum	*Prunus mexicana*
Mockernut Hickory*	*Carya tomentosa*
Persimmon	*Diospyros virginiana*
Post Oak	*Quercus stellata*
Rough-leaf Dogwood	*Cornus drummondii*
Shortleaf Pine*	*Pinus echinata*
Water Oak	*Quercus nigra*
Winged Elm*	*Ulmus alata*
Winged Sumac	*Rhus copallinum*
Ground Cover	
Blackberry	*Rubus* spp.
Blackjack Oak	*Quercus marilandica*
Christmas Fern	*Polystichum acrostichoides*
Eastern Red-cedar	*Juniperus virginiana*
False Indigo	*Amorpha fruticosa*
Gooseberry	*Vaccinium arboretum*
Green Ash	*Fraxinus pennsylvanica*
Japanese Climbing Fern*	*Lygodium japonicum*
Japanese Honeysuckle	*Lonicera japonica*
Little Bluestem	*Schizachyrium scoparium*
Lowbush Blueberry*	*Vaccinium pallida*
Mockernut Hickory*	*Carya tomentosa*
Poison Ivy	*Toxicodendron radicans*
Post Oak	*Quercus stellata*
Roundleaf Greenbrier	*Smilax rotundifolia*
Switchgrass*	*Panicum* spp.
Virginia Creeper	*Parthenocissus quinquefolia*
Winged Sumac	*Rhus copallinum*

**dominant species (determined by % composition)*

Within the study area, the dominant canopy species found in the oak-pine forest community include shortleaf pine and winged elm on the higher slopes of Roundtree Landing and shortleaf pine, eastern red-cedar, and green ash within the lowlands of Hickory Point Recreation Area. These species are joined by additional canopy species including several oaks (white, post, black) and hickories (mockernut, black) on slopes and elms at lower elevations. The transect at Roundtree Landing reflected the historic open woodland condition with a canopy cover of 60 percent while Hickory Point reflected the growing transition in the region from open woodland to forest with a percent canopy cover of 85 percent. The dominant species within the sub-canopy included canopy dominants like shortleaf pine and winged elm, and also included green ash at Hickory Point and mockernut hickory on Roundtree Landing. The sub-canopy was more diverse than the canopy with 15 total species observed including hawthorns, plums, dogwoods, and hackberry. Percent cover of the sub-canopy is approximately 50 percent for both sites.

The amount of ground cover within the oak-pine forest community at the two sampling sites varied widely. The rocky hilltop oak-pine forest on Roundtree Landing contained a herbaceous percent cover of eight percent, whereas the wetter, gradual slopes of Hickory Point approached 90 percent cover. Ground cover at Roundtree Landing was dominated by an upland grass and contained many oak, hickory, winged sumac seedlings. Due to nearby campgrounds, the Hickory Point site exhibited species associated with human disturbance including Japanese climbing fern, honeysuckle, greenbrier, and poison ivy. Christmas ferns, Virginia creeper, lowbush blueberry, little bluestem, and false indigo were also present.

Though data are sparse, historic accounts from the early 1800s suggest that much of the oak-pine forest in Oklahoma existed in an open woodland condition much like that found on Roundtree Landing (ODWC 2005). Widespread tree harvest through the early 1900s was followed by six or more decades of reduced fire frequency. As a result, most of the current habitat is a more densely stocked, relatively even-aged, second-growth forest like that observed at Hickory Point. Additional areas of oak-pine forest have been lost in the study area due to limited residential/commercial development and succession to a climax oak-hickory forest.

While upland forests may cover the greatest aerial extent within the study area, bottomland hardwood forests represent the most widespread habitat. Occurring along streams and on shallow lakeshore slopes, these riparian forests are found in all four ecoregions and are most common along the many tributaries that feed into Eufaula Lake. Bottomland hardwood forests serve important roles in erosion control, maintaining water quality, and supporting wildlife (Hoagland 1998). Within the study area, bottomland hardwood forests were assessed within the Mill Creek (lower Canadian hills ecoregion) and Deep Fork (northern crosstimbers ecoregion) Arms of the Eufaula WMA and at Brooken Cove Recreation Area (lower Canadian hills ecoregion) (**Table 4-5**). Mill Creek and Deep Fork are examples of riverine wet forests whereas Brooken Cove is an example of a lakeshore wet forest protected in a sheltered cove. For the purposes of this assessment, forested wetlands will be considered part of the bottomland hardwood forest community as the two are often synonymous due to similarities in species composition and hydrology. Emergent and scrub-shrub wetlands will be included in the discussions on aquatic habitats.

Table 4-5. Plant Species Found within Bottomland Hardwood Forest Community Habitat Transects - April 2012

Common Name	Scientific Name
Canopy	
American Elm*	*Ulmus americana*
Black Gum	*Nyssa sylvatica*
Black Walnut	*Juglans nigra*
Black Willow*	*Salix nigra*
Boxelder*	*Acer negundo*
Green Ash	*Fraxinus pennsylvanica*
Hackberry	*Celtis* sp.
Persimmon	*Diospyros virginiana*
Pin Oak*	*Quercus palustris*
Pond Cypress**	*Taxodium distichum imbricarium*
River Birch**	*Betula nigra*
Shumard Oak	*Quercus shumardii*
Silver Maple	*Acer saccharinum*
Slippery Elm*	*Ulmus rubra*
Sycamore**	*Platanus occidentalis*
Water Locust	*Gleditsia aquatica*
Water Oak*	*Quercus nigra*
Sub-Canopy	
American Elm*	*Ulmus americana*
Bur Oak	*Quercus macrocarpa*
Buttonbush	*Cephalanthus occidentalis*
Chickasaw Plum	*Prunus angustifolia*
Deciduous Holly	*Ilex decidua*
Green Ash*	*Fraxinus pennsylvanica*
Green Hawthorn	*Crataegus viridis*
Hackberry	*Celtis* sp.
Persimmon	*Diospyros virginiana*
Pin Oak	*Quercus palustris*
Red Maple	*Acer rubrum*
Red Mulberry	*Morus rubra*
River Birch**	*Betula nigra*
Shumard Oak	*Quercus shumardii*
Slippery Elm	*Ulmus rubra*
Smooth Sumac	*Rhus glabra*
Water Locust	*Gleditsia aquatica*
Water Oak	*Quercus nigra*
Ground Cover	
American Germander	*Teucrium canadense*
Blackberry	*Rubus* spp.
Broomsedge	*Andropogon virginicus*
Common Rush*	*Juncus effusus*
Indian Pennywort	*Centella asiatica*
Late-flowering Thoroughwort	*Eupatorium serotinum*

Common Name	Scientific Name
Poison Ivy	*Toxicodendron radicans*
River Oats**	*Chasmanthium latifolium*
Roundleaf Greenbrier*	*Smilax rotundifolia*
Sedge*	*Carex* spp.
Spider Lily	*Hymenocallis lirisome*
Swamp Smartweed	*Polygonum hydropiperoides*
Sweetscent	*Pluchea odorata*
Sweet Woodreed	*Cinna arundinacea*
Switchgrass**	*Panicum virgatum*
Trumpet Creeper	*Campsis radicans*
Virginia Creeper*	*Parthenocissus quinquefolia*

**Riverine bottomland hardwood dominant species (determined by % composition)*

***Lakeshore bottomland hardwood dominant species (determined by % composition)*

The canopy of the bottomland hardwood forests is the most diverse of all forest canopies located within the study area with a total of 17 species observed. Within more riverine habitats dominants include American elm, black willow, boxelder, slippery elm, pin oak, and water oak. Within the forested wetlands along the lakeshore, dominant canopy trees include river birch, pond cypress, and sycamore. Canopy percent cover is high in bottomland hardwood communities and ranges from 70-90 percent. Sub-canopy dominants include river birch in lake margins at Brooken Cove and American elm, green ash, and hackberry along the shores of Mill Creek and the Deep Fork River. Due to the dense canopy, sub-canopy percent cover is slightly less, ranging from 40-50 percent.

The herbaceous ground layer within bottomland hardwood forests is often characterized by sparse clumps of wetland vegetation sporadically distributed within barren, muddy areas of decaying organic matter. Therefore, percent cover is low, ranging from 5-35 percent. Dominant species include river oats and switchgrass within protected lake coves and rushes and sedges in riverine riparian forests. Several vines are also common including Virginia creeper, trumpet creeper, greenbrier, and poison ivy.

Several stream types feed water into Eufaula Lake and each support different habitats. Historically, the seasonal fluctuation in water volume, characterized by high flow during spring months followed by a period of much lower flow during the summer months, of the large rivers such as the Canadian and North Canadian Rivers maintained a dynamic mosaic of habitats including sandbars, mudflats, willow thickets, and marshy sloughs along channels dependent upon periodic scouring flows (ODWC 2005). Smaller river systems, such as the Deep Fork River, had more moderate seasonal flow fluctuations and supported broad, forested floodplains. Finally, narrow forests of fast-growing tree species were typical of the small, sandy-bottom tributaries including Gaines, Mill, and Duchess Creeks. In addition to well-developed floodplains, these streams were less entrenched, had high degrees of sinuosity, and relatively low width to depth ratios (ODWC 2005).

The stream systems and associated riparian forests within the Eufaula Lake region have been modified by the construction of reservoirs and other human disturbances. This has altered the normal seasonal fluctuation in flow rates and the magnitude of annual flood events in large rivers. Smaller rivers, while also impacted by changes to flow seasonality, have been largely affected by the clearing of riparian forests for agricultural and residential uses and possess narrower forested floodplains than historically present. Giant

cane (*Arundinaria gigantea*), once an extensive and important understory component in eastern Oklahoma bottomland forests, has been greatly reduced by grazing and land clearing activities (Hoagland 2000). In addition to riparian vegetation removal, many small tributaries have been altered by human activity including the straightening of stream channels (Barclay 1978). All of these impacts have resulted in separation of stream systems from former riparian zones, thus decreasing the health of bottomland hardwood systems.

While a good portion of historical bottomland hardwood forests within study area stream systems, especially along the large rivers, have been inundated by the construction of the Eufaula Lake reservoir, the riverine areas surrounding the lake maintain some of the largest tracts of bottomland forest in the region primarily due to protection provided by the Eufaula WMA. Some activities that reduce the size and quality of bottomland forest habitats are evident in the study area, including the channelization of small tributaries and the removal of riparian forests for residential, commercial, and recreational land use. Many homeowners have removed vegetation for landscaping reasons or to improve lake access. In several areas, steep banks and flood control measures sever the connection between streams and floodplains. The vegetation on these steep banks is often replaced by riprap and invasive weedy grasses and shrubs that provide little habitat value to wildlife and contribute to declines in water quality.

In drier areas, trees thin out and are replaced by large areas dominated by grasses and shrubs. These open woodlands and savannas are fire-maintained plant communities that rely on frequent fires to reduce the densities of oaks, pines, and other tree species (ODWC 2005). Historically, the savanna understory was dominated by grasses and forbs including little bluestem, big bluestem, Indian grass, narrowleaf woodoats, and panic grasses (Hoagland 2000). Tree and shrub density was related to fire frequency and may have been sparse historically. Dominant species included post oak, blackjack oak, shortleaf pine, coralberry, sumacs, and persimmon.

Within the Eufaula Lake study area, savanna habitats are predominantly found within the osage cuestas ecoregion along the northern lake shoreline but can be found intermittently throughout the study area in the remaining three ecoregions. Savannas are generally embedded within other, larger habitats or serve as a transition habitat from the open prairies to densely wooded oak-hickory and oak-pine forested habitat (Boren *et al*. 1997). In more open areas with a lower tree density, portions of the crosstimbers are better classified as oak savannas (Johnson and Risser 1975).

In April 2012, savanna habitats were sampled at Elm Point Recreation Area in the southeast corner of the lake (lower Canadian hills ecoregion) and at Gentry Creek Recreation Area along the lake's northern shoreline (osage cuestas ecoregion) (**Table 4-6**). As expected, the canopy cover of the two savanna sites was low with a percent cover ranging from 15-30 percent. At Gentry Creek, a wet savanna community is present with persimmon as the dominant canopy species with hackberry also present. At Elm Point, a drier oak savanna community is present and dominants include honey locust and Shumard oak with slippery elm, black locust, and green ash also present. The sub-canopy in savanna habitats prove to be just as sparse as the canopy layer with percent cover values ranging from one to ten percent. Sub-canopy dominants at Gentry Creek include persimmon while Shumard oak and red mulberry are dominant at Elm Point.

Table 4-6. Plant Species Found within Savanna Community Habitat Transects - April 2012

Common Name	Scientific Name
Canopy	
Black Locust	*Robinia pseudoacacia*
Green Ash	*Fraxinus pennsylvanica*
Hackberry	*Celtis* sp.
Honey Locust*	*Gleditsia triacanthos*
Persimmon*	*Diospyros virginiana*
Shumard Oak*	*Quercus shumardii*
Slippery Elm	*Ulmus rubra*
Sub-Canopy	
Honey Locust	*Gleditsia triacanthos*
Northern Catalpa	*Catalpa speciosa*
Persimmon*	*Diospyros virginiana*
Red Mulberry*	*Morus rubra*
Shumard Oak*	*Quercus shumardii*
Ground Cover	
Big Bluestem*	*Andropogon gerardii*
Blackberry*	*Rubus* spp.
Broomsedge	*Andropogon virginicus*
Buckbrush	*Symphoricarpos orbiculatus*
Canadian Woodnettle	*Laportea canadensis*
Chinese Lespedeza*	*Lespedeza cuneata*
Fox Sedge	*Carex vulpinoidea*
Hairy White Oldfield Aster	*Symphyotrichum pilosum*
Little Bluestem	*Schizachyrium scoparium*
Mint	*Mentha* spp.
Muscadine	*Vitis rotundifolia*
Narrowleaf Knotweed	*Polygonum bellardii*
Panic Grass*	*Dichanthelium* spp.
Roundleaf Greenbrier*	*Smilax rotundifolia*
Sedge*	*Carex* spp.
Spider Lily	*Hymenocallis lirisome*
Smooth Sumac	*Rhus glabra*
Sweetscent	*Pluchea odorata*
Switchgrass*	*Panicum virgatum*
Tall Dropseed	*Sporobolus asper*
Western Ragweed	*Ambrosia psilostachya*

**Dominant species (determined by % composition)*

**Dominant species (determined by % composition)*

Species diversity in savanna habitats is greatest within the herbaceous layer. Dry conditions and thin tree and shrub layers enable the growth of many grasses and forbs (Penfound 1962). Within both sampled savanna habitats, Chinese lespedeza, an invasive from eastern Asia dominated the transects. The presence of this invasive is likely due to significant human use of both recreation areas. Other dominants at Gentry

Creek include blackberry, switchgrass, and panic grasses. The savanna at Elm Point is closer to the historical condition, dominated by big bluestem and upland sedges. Other species present include little bluestem, western ragweed, winged sumac, broomsedge, spider lily, asters, and mint.

The quality of savanna habitats within the study area depend on isolation from human disturbance. The introduction of invasive weedy species and the suppression of periodic fires have displaced many of the native prairie grasses and forbs in the herbaceous layer. The loss of historic fire regimes has also resulted in forest encroachment and many former savanna habitats are now dense forests with thick understories. This includes the well-documented spread of eastern red-cedar into woodland and open habitats (Engle *et al*. 1997). Fragmentation and loss of savanna habitat due to increasing numbers of residential developments, including secondary homes, cabins, and ranchettes, is also conservation issue within the region (ODWC 2005). Overall, within the study area, savanna habitat exists in poor condition with a declining trend. While some open habitat is increasing with the abandonment of historical farm fields and homesteads, this habitat is often of lesser quality due to the quick establishment of invasive species that provide sub-optimal forage and shelter for local wildlife.

The final primary vegetation community located within the Eufaula Lake study area is the open grasslands that make up the prairie. While several prairie communities, including short-grass and mixed-grass prairie, exist in Oklahoma, it is the tall-grass prairies that grace the dry shallow slopes and flat regions within the study area. Historically, tall-grass prairies occurred on sites that possessed deep, fine textured silt and clay soils and were subject to frequent fires (ODWC 2005). Natural communities were dominated by four species: big bluestem, Indian grass, switchgrass, and little bluestem. Although the quantity and quality of tall-grass prairies has declined, it still remains a widespread habitat within the study area, especially in protected areas with little human disturbance. While most often encountered within the osage cuestas and lower Canadian hills ecoregions, prairie habitats are also relatively common interspersed between the oak forests in the northern crosstimbers ecoregion. Two transects, one at Juniper Point Recreation Area in the southwest (lower Canadian hills ecoregion) and another just north of I-40 along E1060 Road (osage cuestas ecoregion), were sampled to document plant species representative of Eufaula Lake prairie communities (**Table 4-7**).

Table 4-7. Plant Species Found within Prairie Community Habitat Transects - April 2012

Common Name	Scientific Name
Sub-Canopy	
Eastern Red-cedar	*Juniperus virginiana*
Persimmon	*Diospyros virginiana*
Winged Elm	*Ulmus alata*
Ground Cover*	
Big Bluestem**	*Andropogon gerardii*
Blackberry**	*Rubus* spp.
Broomsedge	*Andropogon virginicus*
Common Chickweed	*Stellaria media*
Common Goldstar**	*Hypoxis hirsuta*
Compass Plant	*Silphium laciniatum*
Eastern Gamagrass	*Tripsacum dactyloids*
Indian Grass**	*Sorghastrum nutans*
Indian Paintbrush**	*Castillega coccinea*

Common Name	Scientific Name
Little Bluestem**	*Schizachyrium scoparium*
Prairie Dropseed	*Sporobolus hetrolepis*
Purple Prairie Clover	*Petalostemum purpurea*
Roundhead Lespedeza	*Lespedeza capitata*
Sphagnum Moss	*Sphagnum* spp.
Switchgrass**	*Panicum virgatum*
Thin Paspalum	*Paspalum setaceum*
Tiny Bluet	*Houstonia pusilla*
Western Ragweed**	*Ambrosia psilostachya*
Wild Alfalfa**	*Psoralea tenuifolia*

** Only those species displaying identifiable characteristics in early-Spring were identified*
***Dominant species (determined by % composition)*

As expected, large woody species were absent and no canopy layer was observed. At the E1060 Road site, some stunted trees located on the periphery of the transect were observed; however, total sub-canopy percent cover was approximately two percent. No woody species of any height were observed within the tall-grass prairie located at Juniper Point.

The herbaceous layer of the tall-grass prairie contains similar species found in the same layer within savanna habitats. However, prairie habitats often possess slightly different soils and hydrology to prevent the establishment of woody tree species. Within the study area, 19 herbaceous species were identified. Dominant species at Juniper Point include little bluestem, Indian grass, Indian paintbrush, wild alfalfa, and common goldstar. Indian grass was also a dominant species within the prairie located off of E1060 Road in the northern portion of the study area, with other dominants such as blackberry, western ragweed, and big bluestem also present. Due to varied growth and flowering seasons, many prairie grasses and wildflowers are difficult to identify. Since prairie habitats were assessed in the beginning of April, the list provided in **Table 4-7** contains only those species displaying identifiable characteristics during the early spring.

Prairies were probably never common within the Eufaula Lake study area as the hills and floodplains adjacent to the large rivers and streams were predominantly forested (Stevens and Shannon 1917). However, the construction of the Eufaula Lake reservoir would have inundated tall-grass prairie communities not previously converted to agriculture that existed in the valleys between stream systems. Additional conversion to other land uses including agriculture, infrastructure, and private residential and commercial development have further reduced prairie coverage. Human disturbance also introduces the over-application of herbicides and introduction of invasive plant species. Therefore, the remaining tracts of tall-grass prairie are small, isolated, and often found in government-managed conservation areas.

In general, the tall-grass prairies located within the study area reflect region-wide poor condition with a declining trend (ODWC 2005). Tall-grass prairies are extremely sensitive habitats that are easily overrun by competitive weedy species or encroached upon by forested habitats when human disturbance and fire suppression policies are present (Netherland 1979). In the plains adjacent to the Eufaula Lake study area, much of the habitat has been tilled and converted to introduced pastures planted to Bermuda and other non-native grasses, or converted to cropland for the production of wheat, alfalfa, cotton, or peanuts (ODWC 2005). Within the study area, the magnitude of land conversion varies widely and development consists mainly of residential and commercial properties and the establishment of maintained parklands.

4.1.2 Aquatic Habitats

Aquatic habitats, including open water and wetlands, are integral to physical, chemical, and biological processes within lake and stream ecosystems and support rich biodiversity by providing unique habitat to many plants and animals. Over half of federally threatened or endangered animals in the U.S. depend exclusively on wetland habitats (OCC 2000a). Vegetated wetlands, in particular, provide a vast array of ecosystem services including water quality improvement, flood protection, erosion control, and groundwater recharge (OCC 2000b). In addition, wetlands provide recreation opportunities, appealing aesthetics, and support natural product industries including timber and fisheries. Studies have documented that nearly all commercially harvested fish and shellfish, and most recreational fish, depend on wetlands for food and habitat during some part of their life cycle (Feierabend and Zelanzy 1987). While the benefits of wetlands for fisheries and waterfowl are substantial, especially on a lake system with a recreational management focus such as Eufaula Lake, they pale in comparison to the economic benefits from ecosystem functions such as groundwater recharge, flood control, water quality improvement, and erosion control (Costanza *et al*. 1997).

The state of Oklahoma supports a wide variety of aquatic habitats and wetland types from large open water lakes to small, vernal prairie potholes. Open water systems can be found throughout the state and are associated with large river systems. This includes man-made impoundments, of which Oklahoma has approximately 4,500—more than any other state (OCC 2000a). Wetland type tends to vary depending on climatic conditions. Temperature and precipitation tends to increase as one moves across the state from northwest to southeast, and as a result, the predominant wetland type changes from playas in the panhandle, to riparian areas and depressions throughout the interior, to bald cypress swamps in the extreme southeast (OCC 2000b).

Aquatic habitats with the Eufaula Lake study area vary from deepwater lentic systems found within the Conservation Pool to shallow water littoral habitats consisting of emergent and scrub-shrub wetlands. All aquatic habitats were evaluated using the classification system proposed by Cowardin *et al*. (1979) Classification of Wetlands and Deep Water Habitats. An evaluation of National Wetlands Inventory (NWI) maps indicates that there are six major aquatic habitat types in the Eufaula Lake study area (some areas may be classified as a combination of these habitat types).

- Palustrine Forested Broad-leaved Deciduous (PFO1)
- Palustrine Forested Dead (PFO5)
- Palustrine Scrub-Shrub Broad-leaved Deciduous (PSS1)
- Palustrine Emergent Persistent (PEM1)
- Lacustrine Littoral Unconsolidated Shore (L2USC)
- Lacustrine Limnetic Unconsolidated Bottom (L1UBH)

Aquatic habitats differ from one another due to hydrology and the types of hydric soils and aquatic vegetation present. Open water habitats, such as the lacustrine limnetic unconsolidated bottom habitat type, are characterized by deep water and are often non-vegetated due to water depth resulting in inadequate sunlight penetration. In contrast, palustrine wetlands located along the shoreline of Eufaula

Lake and its tributaries often consist of shallow water habitats that support a variety of plant species adapted to aquatic environments.

Historical and existing conditions of palustrine forested, forested dead, scrub-shrub, and emergent wetlands will be assessed in detail and field verified. Determination of the existing wetland condition provides a reference for comparison of future potential impacts that may result from a change in the SMP. Field verification consisted of vegetation transects that were established in April 2012 and included at least two transects for each wetland type. All plant species present in the canopy, understory, and ground cover were noted and dominance was determined. However, due to similar species composition and habitat structure, the discussion of the historical and existing conditions of forested wetlands is located in the review of the synonymous bottomland hardwood forest habitat in Section 4.1. Shoreline habitat assessments (SHA) were performed to characterize the shoreline habitats, including several wetland types.

Because proposed changes to the SMP are likely to have little direct impact on the status of lacustrine aquatic habitats, the existing conditions of these areas of open water and unconsolidated bottoms will be discussed generally. While open water habitats are affected by shoreline land uses, the majority of these potential impacts involve changes in water quality and they are discussed in Section 5.1.2.

Lacustrine habitats include shallow and deep open water areas with the following characteristics: (1) situated in a topographic depression or dammed river channel; (2) lacking trees, shrubs, persistent emergent, emergent mosses or lichens with greater than 30 percent aerial coverage; and (3) total area exceeds 20 acres (Cowardin *et al*. 1979). For Eufaula Lake, the lacustrine areas are bounded by the contour approximating the normal spillway or pool elevation (585 feet MSL). Therefore, many of the waters within Eufaula Lake proper are considered lacustrine open water habitats.

The lacustrine open water habitats are broken down further into limnetic and littoral zones (**Figure 4-4**). Lacustrine limnetic habitats include all deepwater habitats. Within the Eufaula Lake study area this includes all open water and lake bottom habitats that occur at a water depth of greater than 2 m. Lacustrine littoral habitats extend from the shoreward boundary of Eufaula Lake to a water depth of 2 m or to the maximum extent of emergent vegetation (Cowardin *et al*. 1979). In Eufaula Lake, most of the lacustrine littoral zone is devoid of vegetation due to steep banks and significant wave action.

The lacustrine limnetic habitats within the Eufaula Lake study area include much of the storage capacity of the reservoir. Eufaula Lake is considered a relatively shallow reservoir with a mean depth of 21.94 feet (Bowen 2008). However, deeper habitats exist, especially directly upstream of the dam, where the maximum lake depth reaches 87 feet (Bowen 2008). Substrates within limnetic habitats vary depending on lake location; however, much of the lake bottom in deepwater habitats is composed of unconsolidated sand or silt. These unconsolidated bottoms are dynamic environments with conditions shifting due to strong water currents. In deeper areas, limnetic habitats are stratified with different temperatures at different depths in the lake. According to OWRB sampling, anoxic conditions can be found below the thermocline in summer months (Bowen 2008). Due to these anoxic conditions, the lacustrine limnetic zone supports little resident wildlife with most fish species occupying the shallow portions of lakes.

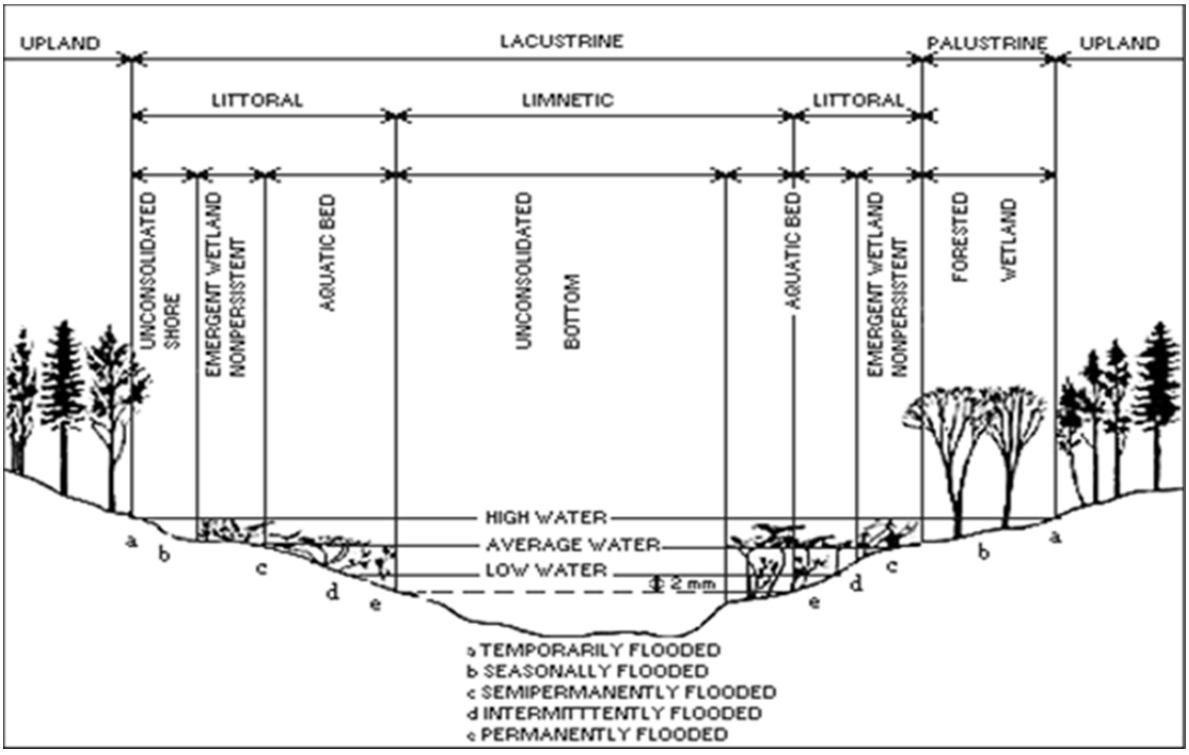

Figure 4-4. Wetland Classification and Location in a Typical Lake System (*Cowardin et al. 1979*)

In contrast to the deepwater lacustrine limnetic habitats, the lacustrine littoral zone contains shallower waters that support most of the aquatic wildlife in Eufaula Lake. Substrates in littoral habitats vary widely and are influenced by shoreline substrates. Therefore on rocky shorelines, substrates can range from large boulders to fine gravels becoming finer with water depth. Littoral habitats adjacent to unstable sandy slopes or beaches often have sandy or silt substrates as a result of shoreline erosion. In many developed parts of the study area, including roads, bridges, and residential developments, adjacent lacustrine littoral habitats contain riprap and other unnatural bank stabilization substrates. Unlike in many lakes where the lacustrine littoral zone supports a wide variety of submergent and emergent vegetation, the steep slopes of most shorelines along Eufaula Lake result in unsuitable water depths and attachment points for aquatic plants. This not only eliminates cover and forage for many fish species but contributes to high erosion and turbidity rates due to unencumbered wave action, especially along unforested shorelines.

Unlike open water habitats, palustrine wetlands are dominated by trees, shrubs, persistent emergents, mosses, and lichens. Palustrine wetlands may also lack such vegetation but include the following characteristics: (1) area less than 20 acres; (2) active wave-formed or bedrock shoreline features are lacking; and (3) water depth in the deepest part of the basin is less than 2 m at low water (Cowardin *et al*. 1979). Situated shoreward of the lake and stream channels, palustrine wetlands within the Eufaula Lake study area consist of emergent freshwater marshes, scrub-shrub wetlands, and forested wetlands (**Figure 4-5)**.

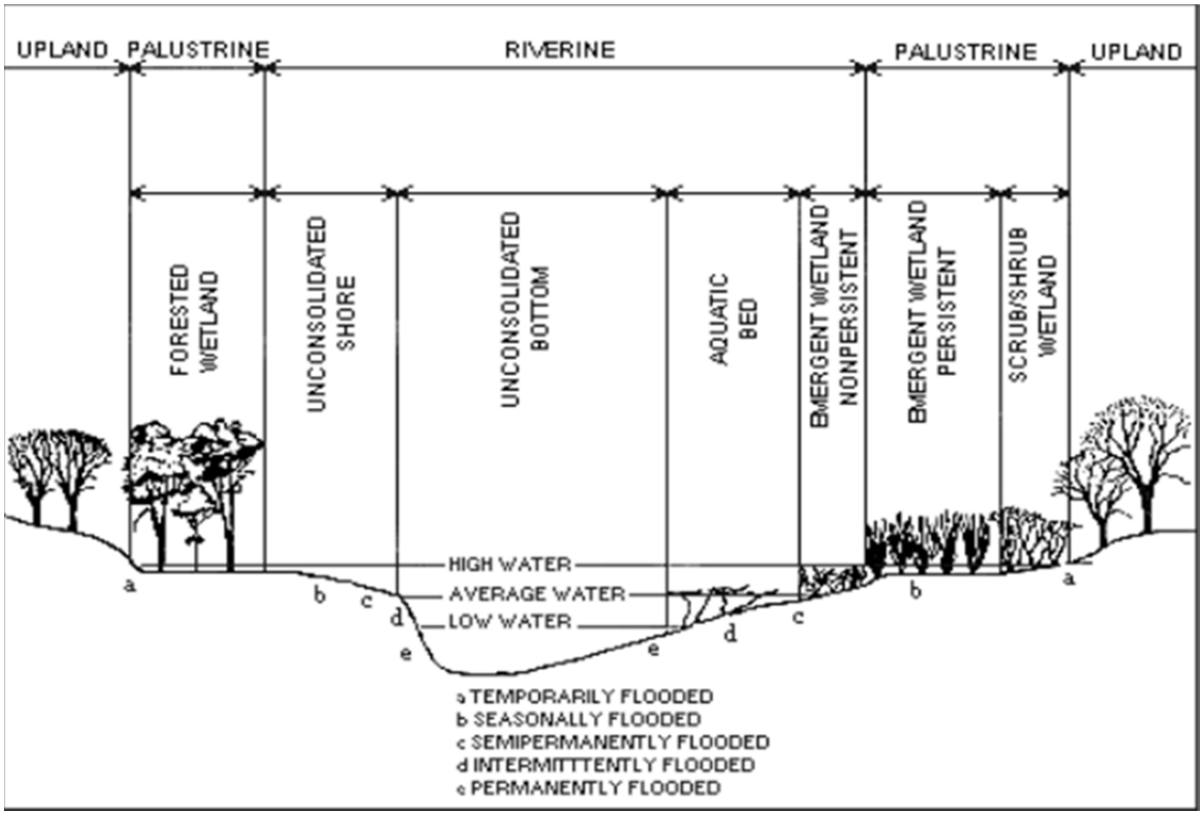

Figure 4-5. Wetland Classification and Location in a Typical Riverine System (*Cowardin et al. 1979*)

In order to avoid confusion with lacustrine littoral habitats, emergent vegetation immediately adjacent to streams and the lakeshore is often referred to as the shore zone or the zone of emergent vegetation and is generally considered separately from the river or lake (Cowardin *et al*. 1979). Emergent wetlands are characterized by erect, rooted, herbaceous hydrophytes and hydrologic regimes that enable the establishment of such vegetation. Plants are present for most of the growing season in most years. Emergent wetlands in Oklahoma are known by many names including marsh, wet meadow, fen, prairie pothole, and slough. Common species included several species of sedges, rushes, reeds, cattail, smartweed, duckweed, and arrowhead.

In areas where hydrology and substrate prohibit the establishment of herbaceous emergents, scrub-shrub wetlands, dominated by woody shrubs and small trees, may occur. Scrub-shrub wetlands are characterized by woody vegetation less than 20 feet tall (Cowardin *et al*. 1979). They may represent a successional stage leading to forested wetland or may be relatively stable communities. In Oklahoma, scrub-shrub wetlands are also known as shrub swamps and bogs.

Scrub-shrub and emergent wetlands, in addition to the forested wetlands discussed in Section 4.1.1, make up the vegetated wetland community within the study area. Each wetland type has characteristic vegetation associations named for the dominant species present. The vegetation associations observed with the greatest frequently within the Eufaula Lake study area are listed in **Table 4-8**.

Table 4-8. Wetland Communities and Respective Associations Found within the Eufaula Lake Study Area

Wetland Community	Dominant Plant Associations*
Palustrine Emergent Wetland	Broadleaf Cattail Herbaceous Association
	Softstem Bulrush—Spike Rush Herbaceous Association
	Common Rush Wetland Association
	Creeping Water Primrose—Swamp Smartweed Herbaceous Association
Palustrine Scrub-Shrub Wetland	Buttonbush Shrubland Association
	Black Willow Woodland Association
	Swamp Privet—Buttonbush Shrubland Association

**Hoagland (2000)*

The steep slopes of many shorelines with the Eufaula Lake study area result in unsuitable water depths and attachment points for wetland plants; therefore, most of the emergent wetlands in the study area are within protected coves or exist landward of the shoreline in terrestrial depressions. Several of these wetlands, including a marsh in Brooken Cove Recreation Area, are found in association with beaver activity. The beavers impound small areas of shoreline and create permanently flooded, protected habitats.

Emergent wetlands, while uncommon, exist within all four ecoregions and in all geographic areas of the Eufaula Lake study area. Vegetation transects were established in emergent wetlands in April 2012 in the Mill Creek Arm of the Eufaula WMA and within a public hunting area near the intersection of Blocker Road and Massey Point Road. A complete list of observed species can be found in **Table 4-9**.

Table 4-9. Plant Species Found in Emergent Wetland Community Habitat Transects - April 2012

Common Name	Scientific Name
Emergent Woody	
Black Willow*	*Salix nigra*
Buttonbush*	*Cephalanthus occidentalis*
Eastern Swampprivet	*Forestiera acuminata*
Green Ash	*Fraxinus pennsylvanica*
Water Locust*	*Gleditsia aquatica*
Emergent Herbaceous	
American Water Willow	*Justicia americana*
Barnyard Grass	*Echinochloa* spp.
Broadleaf Cattail*	*Typha latifolia*
Common Rush*	*Juncus effusus*
Common Spike Rush*	*Eleocharis palustris*
Duckweed*	*Lemna minor*
Marsh Seedbox	*Ludwigia palustris*
Poverty Rush*	*Juncus tenuis*
Ravenfoot Sedge	*Carex crus-corvi*
Salvinia*	*Salvinia molesta*
Softstem Bulrush	*Scirpus tabernaemontani*

Common Name	Scientific Name
Spotted Water Hemlock	*Cicuta maculata*
Swamp Smartweed	*Polygonum hydropiperoides*
Valley Redstem	*Ammania coccinea*
Submergent	
Coontail	*Ceratophyllum demersum*
Watermilfoil*	*Myriophyllum pinnatum*

**Dominant species (determined by % composition)*

Emergent wetlands are dominated by herbaceous hydrophytic vegetation and generally lack an overstory of woody trees and shrubs. However, the assessment of emergent wetlands within the study area documented a few woody species including buttonbush, green ash, and black willow. The percent cover of these overstory layers was approximately 5-15 percent and consisted of only a few individuals around the periphery of the emergent wetlands.

Between the two transects, a total of 14 emergent species and two submergent species were observed within the groundcover. Dominant species included broadleaf cattail, common rush, and salvinia at the Mill Creek transect, and common spike rush, poverty rush, duckweed, and watermilfoil at the Blocker Road transect. Species distribution along soil saturation and water depth gradients accounted for the high number of observed dominant species. As soil saturation and water depth increased, one dominant species would be replaced by another that was better adapted to those growing conditions.

The species composition of scrub-shrub wetlands within the study area was also evaluated. Around Eufaula Lake, scrub-shrub wetlands are found along river floodplains, lake margins, and within seasonally flooded depressions. Much like emergent wetlands, scrub-shrub wetlands are found in all four ecoregions and throughout the geographic extent of the study area. Observations suggest that scrub-shrub communities are better equipped than emergent communities to handle the environmental conditions present along the lakeshore, as many more scrub-shrub wetlands were documented in April 2012. Vegetation transects were established in scrub-shrub wetlands in April 2012, one in the Duchess Creek Arm of the Eufaula WMA and another located in Gentry Creek Recreation Area. Therefore, scrub-shrub communities were assessed in the northern and eastern regions of the study area. A complete list of observed species can be found in **Table 4-10**.

Table 4-10. Plant Species Found in Scrub-shrub Wetland Community Habitat Transects - April 2012

Common Name	Scientific Name
Emergent Woody	
Black Willow*	*Salix nigra*
Buttonbush*	*Cephalanthus occidentalis*
Cockspur Hawthorn	*Crataegus crux-galli*
Green Ash*	*Fraxinus pennsylvanica*
Shumard Oak	*Quercus shumardii*
Sugarberry	*Celtis laevigata*
Sycamore	*Platanus occidentalis*
Water Locust*	*Gleditsia aquatica*

Common Name	Scientific Name
Emergent Herbaceous	
American Germander*	*Teucrium canadense*
Barnyard Grass	*Echinochloa* spp.
Carolina Elephantsfoot	*Elephantopus caroliniana*
Common Rush*	*Juncus effuses*
Fox Sedge*	*Carex vulpinoidea*
Hop Sedge*	*Carex lupulina*
Pale Dock	*Rumex altissimus*
Ravenfoot Sedge	*Carex crus-corvi*
Roundleaf Greenbrier*	*Smilax rotundifolia*
Sweet Woodreed	*Cinna arundinacea*
Virginia Wildrye	*Elymus virginicus*

**Dominant species (determined by % composition)*

Scrub-shrub wetlands predominantly consist of woody species up to 20 feet in height. The species composition at the two transect sites reflect this structure, as eight species of small trees and shrubs were recorded. Dominant species include black willow and buttonbush in the Gentry Creek transect and include black willow, buttonbush, green ash, and water locust in the Duchess Creek transect. Other observed species include sycamore, sugarberry, cockspur hawthorn, and Shumard oak. Individual trees and shrubs were young and/or stunted. Woody plant distribution was varied. At Gentry Creek, they formed a dense, thicket-like overstory, whereas at Duchess Creek the individual trees and shrubs were more spread out. Overall percent cover was 95 and 25 percent, respectively.

Due to the thicket-like distribution of woody species at Gentry Creek, fewer species were observed in the ground cover when compared to that of Duchess Creek. Overall, 11 different herbaceous species were documented. Dominants include American germander, fox sedge, and hop sedge at Duchess Creek, while Gentry Creek was dominated by common rush and roundleaf greenbrier. Overall herbaceous species richness was lower in scrub-shrub wetland transects than in emergent wetland transects due to higher competition for limited resources.

Although often overlooked in habitat analyses, palustrine forested dead wetlands exist in small, localized areas within the Eufaula Lake study area. In addition to the standing dead timber located in the shallows, the Eufaula Lake study area has significant dead timber in open water lacustrine habitats including standing timber in Longtown Arm. Most palustrine forested dead wetlands and lacustrine dead timber habitats resulted from the creation of the Eufaula Lake reservoir when large, incompletely cleared areas of forest were inundated. All that remains are the emergent, gnarled trunks and treetops periodically disrupting areas of open water. Recent causes of palustrine forested dead wetland creation include lake water level fluctuations that submerge forested wetlands.

While these wetlands are not as productive as their vegetated counterparts, they do provide optimal structural underwater habitat for fish species, especially crappie, and provide perches for several piscivorous bird species including the bald eagle and double-crested cormorant. Despite being populated by stands of deceased trees, palustrine forested dead wetlands are dynamic environments that are continuously changing due to physical and biological processes. Biologically, the wood of these trees gradually decays over time. Physically, fluctuating water levels resulting in continuous wet and dry cycles

can cause the wood to become weak and brittle. In addition, many forested dead wetlands decrease in area over time due to emergent dead trees being knocked over by wind and wave action. Water currents can also undermine snag stability. Since open water areas are more impacted by these physical lake processes, stands of dead timber are often more frequent in sheltered bays and lake inlets closer to the shoreline.

In Oklahoma, the conservation and management of state waters and wetlands are shared responsibilities among federal, state, and local agencies as well as conservation organizations, private corporations, landowners, and other interest groups. At the federal level, USACE, USFWS, EPA, and NRCS have principal authority over wetlands and waters. USACE and EPA jointly enforce Section 404 of the Clean Water Act (CWA), while USFWS is primarily involved in wetland mitigation and NRCS is responsible for wetlands on agricultural lands outlined in the 1985 and 1990 Farm Bills (OCC 1996). At the state level, agencies with wetland responsibilities include the Oklahoma Conservation Commission (OCC), Oklahoma Water Resources Board (OWRB), Oklahoma Department of Environmental Quality (ODEQ), and the Oklahoma Department of Wildlife Conservation (ODWC) (OCC 1996).

Wetland habitats continue to be degraded and converted to alternative land uses. In Oklahoma, approximately 67 percent (1.9 million acres) of wetlands have been removed from the landscape over the past 200 years (Mitsch and Gosselink 1993). Bottomland hardwood forested wetlands have been especially hard hit; surveys in southeastern Oklahoma estimate that approximately 84 percent of such habitats were destroyed between 1960 and 1985 (Brabander *et al*. 1985). Emergent and scrub-shrub wetlands are particularly impacted by influxes of sediment, pesticides, and nutrients through stormwater runoff from agricultural and residential areas (ODWC 2005).

While many natural wetlands in the study area exist in their historic condition, steep slopes from reservoir construction, lakeshore development, fire suppression, and reservoir water level fluctuations have contributed to their decline. Historically, scrub-shrub and emergent wetland areas within the Eufaula Lake study area would have existed in greater quantity along the now inundated stream and river channels. They would also have occurred in seasonally-flooded depressions between hills and on relatively level prairies.

Today, many shorelines consist of steep rocky slopes or wide sandy beaches that inhibit wetland establishment. To a smaller extent, residential development of the shoreline has led to removal of wetland vegetation in favor of turf grass yards and construction of flood control and shoreline stabilization structures that sever the hydrologic connection between wetlands and the lake. This, in turn, has increased the percentage of open water habitat. Finally, emergent and scrub-shrub wetlands were once maintained by seasonal environmental cycles including fire and fluctuating water levels that prevented the establishment of larger, woody tree species (ODWC 2005). Suppression or alteration of these cycles has enabled forest encroachment and has contributed to a decline in open canopy wetland habitats.

While wetland plants are adapted to seasonal water fluctuations, those driven by reservoir water control needs are often detrimental. Lake levels fluctuate on average almost ten feet per year, with levels typically above the Conservation Pool each spring, dropping to several feet below the Conservation Pool in the summer (RFHP 2009). This fluctuation limits establishment of aquatic vegetation and produces scoured, bare shorelines in many areas of the lake. Soils have been transported downslope leaving underlying rock and gravel exposed. Fish species dependent on shoreline vegetation for nursery habitat such as largemouth bass and sunfish have been limited in areas impacted by these changes (RFHP 2009).

4.1.3 Shoreline Habitat Assessment

A shoreline habitat assessment (SHA) was conducted in May 2012 to determine the relative condition of the Eufaula Lake study area shoreline in comparison to that observed at lakes in the region. Assessments were conducted throughout the study area, and locations were selected based on proposed re-zoning, historical and current land use, and site access. In total 28 locations were assessed by foot and 10 were assessed by boat **(Figure 4-6)**. Two sites, 3 and 23, are not included in **Figure 4-6** and were not assessed due to the presence of river, not lake, conditions at these locations. Due to its importance to the development of the EIS, the proposed Carlton Landing development, Roundtree Landing, and adjacent shorelines were sampled extensively (**Figure 4-7**).

Oklahoma's Water Quality Standards (WQS) are set forth under statutory authority of the OWRB authorized under 82 O.S. § 1085.30 (ODEQ 2010). These standards are designed to maintain and protect the quality of waters in Oklahoma and specify numerical and narrative criteria to protect beneficial uses designated for certain waters of the state. The WQS have established the following specific beneficial uses for Eufaula Lake and its major tributaries (*i.e.*, Canadian River, Gaines Creek) (OWRB 2011):

- Public and Private Water Supply (PPWS) beneficial use
- Fish and Wildlife Propagation beneficial use – Warm Water Aquatic Community (WWAC) subcategory
- Agriculture beneficial use
- Primary Body Contact Recreation (PBCR) beneficial use
- Aesthetics beneficial use

The PPWS beneficial use is designed to protect surface waters that serve to supply water to surrounding communities. While this beneficial use outlines criteria for radioactive materials, bacteria, chlorophyll-a, and fish flesh and water consumption, only the criterion on oil and grease is addressed in the SHA. This criterion states that all PPWS surface waters are to be free from oil and grease and associated tastes and odors (OWRB 2011). At all 38 SHA locations, no slicks, sheens, globs, or odors attributed to oil and grease were observed. Therefore, within the Eufaula Lake study area, this criterion is met and the oil and grease component of the PPWS beneficial use is supported.

The Fish and Wildlife Propogation beneficial use encompasses several subcategories, which are capable of sustaining different climax communities of fish and shellfish. Eufaula Lake and its tributaries located within the study area are placed in the WWAC category because biotic and abiotic habitat conditions in these waterbodies favor a climax community composed of warm water aquatic species.

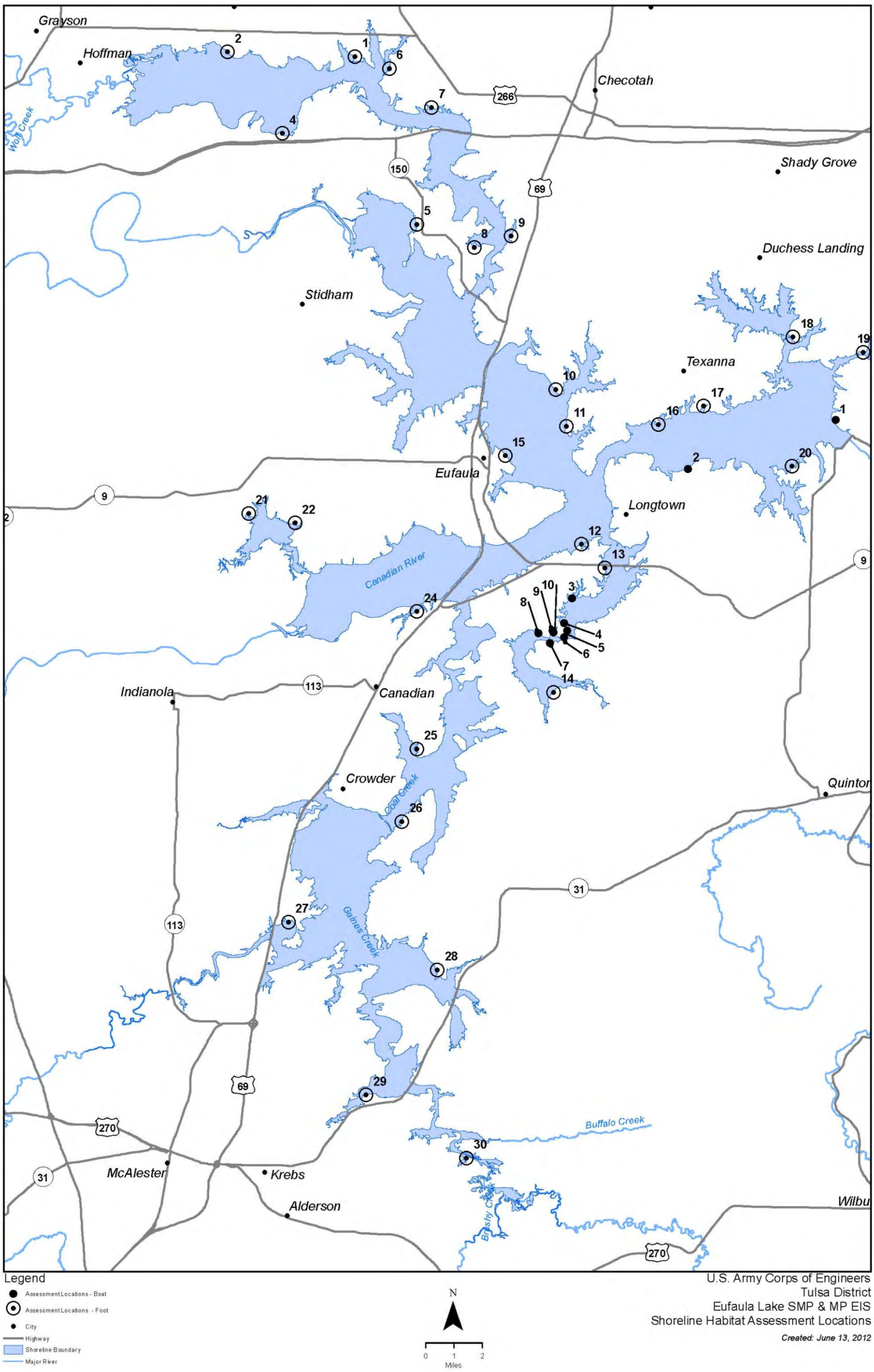

Figure 4-6. Shoreline Habitat Assessment Locations—Eufaula Lake Study Area Overview

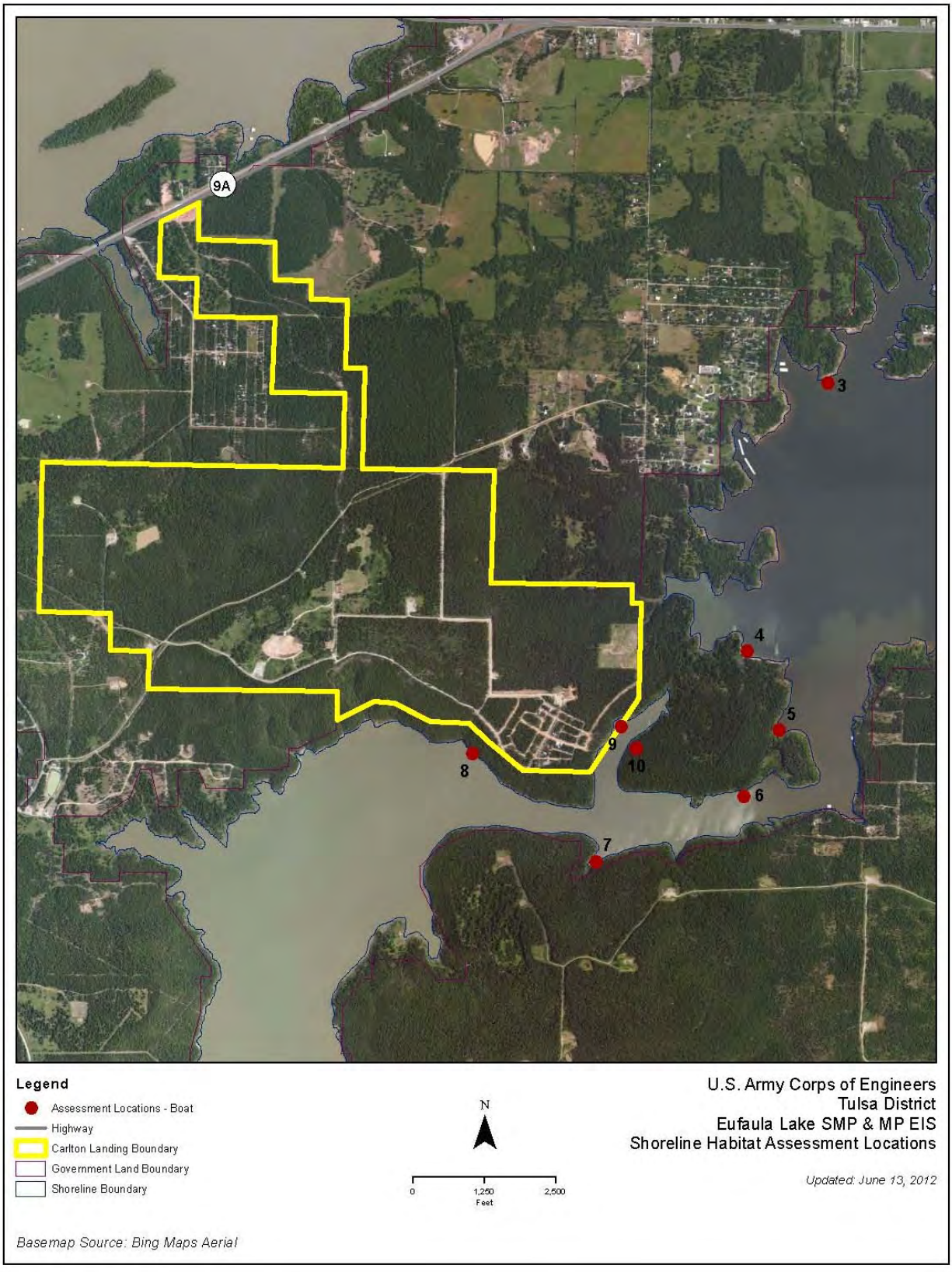

Figure 4-7. Shoreline Habitat Assessment Locations—Carlton Landing Proposed Development

The numerical limits to protect the beneficial use and subcategories of Fish and Wildlife Propagation for the single parameter of dissolved oxygen is set forth in OAC 785:45-5-12(f)(1) and depends on several factors including the pertinent subcategory or fishery class, the time of year, and the season temperature (OWRB 2011). For dissolved oxygen, the WWAC subcategory of the Fish and Wildlife Propagation beneficial use designated for a stream or the surface water of a lake is deemed to be attained if ten percent or fewer of collected samples are less than 5.0 mg/L from April 1 through June 15 and less than 4.0 mg/L from June 16 through October 15 (ODEQ 2010). Since the SHA was conducted in May, the numerical limit of 5.0 mg/L will be used. **Table 4-11** contains dissolved oxygen values for all 38 SHA locations. None of the 38 sites contained dissolved oxygen levels below the 5.0 mg/L threshold. Only one site, boat assessment location seven, comes close to non-attainment. This site is located alongside the existing Carlton Landing boat dock. The low dissolved oxygen level could be attributed to shading from the dock, which inhibits phytoplankton photosynthesis or to the site's location in a relative stagnant cove with little mixing. Despite one location exhibiting relatively low dissolved oxygen levels, the littoral surface waters of the Eufaula Lake study area fully support the Fish and Wildlife Propogation beneficial use in terms of dissolved oxygen and indicate that unlike many lakes in the region, Eufaula Lake does not appear to suffer from low dissolved oxygen levels attributed to high nutrient and sediment inputs.

In addition to establishing numerical limits on dissolved oxygen, the Fish and Wildlife Propogation beneficial use establishes numerical limits on pH (hydrogen ion activity). The pH of water is a measure of its acidity or alkalinity. Vegetation removal, building and road construction, and other land use changes can influence the acidity of surface waters by altering the chemistry within the watershed.

In waters such as those within the Eufaula Lake study area, the beneficial use is considered attained if pH values in ten percent of samples or fewer fall outside the screening range of 6.5 and 9.0; unless pH values outside that range are due to natural conditions (ODEQ 2010). **Table 4-11** contains pH values for all 38 SHA locations. Of the 38 sites, seven recorded pH values outside of the acceptable range. Therefore, 18.4 percent of locations failed to support the beneficial use, which is greater than the ten percent threshold. These observations suggest that waters within the Eufaula Lake study area do not attain the Fish and Wildlife Propagation beneficial use in terms of pH.

Three sites, including land-based assessment location six and boat-based assessment locations five and seven, recorded values below the minimum value of 6.5. A rise in acidity is often attributed to acid rain or acid mine drainage, but some wetland waters contain high levels of naturally occurring organic acids. While acid rain has not been documented as an issue, acid mine drainage from extensive natural resource extraction in adjacent hills and tributary headwaters has been cited as a concern. This could explain the acidic conditions located at boat-based locations five and seven. However, location six is located on the northshore of the lake with little history of mining activity. Location six, as with boat-based locations five and seven, do not have shoreline wetland areas associated with natural acidity. Therefore, acidic conditions at this site could be a result of a nearby dirt track and residential development altering water chemistry.

Table 4-11. Water Chemistry and Physical Properties for Shoreline Habitat Assessment Locations and Potential Impacts on Resident Aquatic Wildlife Communities

Water Chemistry and Water Physical Properties											
Parameters Subjected to Fish & Wildlife Propagation Beneficial Use*							Water Temperature (°C) and Whether or Not it Falls Within Spawning Temperature Thresholds for Selected Fish Species**				
Site	Dissolved O_2 (mg/L)	F&W Propagation (>5.0 mg/L)	pH	F&W Propagation (6.5 – 9.0)	Turbidity (NTU)	F&W Propagation (<25 NTU)	Water Temp. (°C)	Gizzard Shad (17-29°C; Mar-Aug)	Bluegill (19-32°C; Feb-Aug)	Smallmouth Bass (13-23°C; Apr-Jul)	Flathead Catfish (22-28°C; May-Jul)
Land-based Assessment Locations											
1	9.63	Yes	8.09	Yes	201	**No**	26.14	Yes	Yes	**No**	Yes
2	8.05	Yes	8.24	Yes	394	**No**	28.24	Yes	Yes	**No**	**No**
4	9.38	Yes	7.12	Yes	145	**No**	26.37	Yes	Yes	**No**	Yes
5	8.74	Yes	7.94	Yes	81.6	**No**	27.30	Yes	Yes	**No**	Yes
6	6.94	Yes	6.06	**No**	135	**No**	25.48	Yes	Yes	**No**	Yes
7	8.38	Yes	7.12	Yes	228	**No**	26.48	Yes	Yes	**No**	Yes
8	6.92	Yes	6.96	Yes	93.5	**No**	27.02	Yes	Yes	**No**	Yes
9	9.59	Yes	6.93	Yes	88.3	**No**	27.45	Yes	Yes	**No**	Yes
10	9.46	Yes	7.78	Yes	26.9	**No**	25.75	Yes	Yes	**No**	Yes
11	8.82	Yes	8.14	Yes	36.5	**No**	26.96	Yes	Yes	**No**	Yes
12	11.00	Yes	8.52	Yes	32.6	**No**	25.40	Yes	Yes	**No**	Yes
13	11.39	Yes	8.62	Yes	17.4	Yes	25.45	Yes	Yes	**No**	Yes
14	8.44	Yes	7.67	Yes	46.1	**No**	24.64	Yes	Yes	**No**	Yes
15	10.71	Yes	8.46	Yes	34.6	**No**	26.35	Yes	Yes	**No**	Yes
16	8.92	Yes	7.93	Yes	16.5	Yes	26.64	Yes	Yes	**No**	Yes
17	8.39	Yes	9.03	**No**	12.1	Yes	25.71	Yes	Yes	**No**	Yes
18	10.20	Yes	9.01	**No**	66.3	**No**	27.81	Yes	Yes	**No**	Yes
19	7.90	Yes	8.18	Yes	16.1	Yes	27.20	Yes	Yes	**No**	Yes
20	10.26	Yes	8.54	Yes	12.2	Yes	24.14	Yes	Yes	**No**	Yes
21	10.60	Yes	8.87	Yes	142	**No**	31.90	**No**	Yes	**No**	**No**
22	11.11	Yes	8.88	Yes	65.0	**No**	29.96	**No**	Yes	**No**	**No**
24	9.17	Yes	7.09	Yes	43.8	**No**	25.08	Yes	Yes	**No**	Yes

Water Chemistry and Water Physical Properties											
Parameters Subjected to Fish & Wildlife Propagation Beneficial Use*							Water Temperature (°C) and Whether or Not it Falls Within Spawning Temperature Thresholds for Selected Fish Species**				
Site	Dissolved O_2 (mg/L)	F&W Propagation (>5.0 mg/L)	pH	F&W Propagation (6.5 – 9.0)	Turbidity (NTU)	F&W Propagation (<25 NTU)	Water Temp. (°C)	Gizzard Shad (17-29°C; Mar-Aug)	Bluegill (19-32°C; Feb-Aug)	Smallmouth Bass (13-23°C; Apr-Jul)	Flathead Catfish (22-28°C; May-Jul)
25	9.89	Yes	8.98	Yes	39.5	**No**	25.30	Yes	Yes	**No**	Yes
26	8.48	Yes	8.27	Yes	49.0	**No**	25.75	Yes	Yes	**No**	Yes
27	12.19	Yes	9.64	**No**	85.8	**No**	29.00	Yes	Yes	**No**	**No**
28	10.90	Yes	9.70	**No**	84.0	**No**	30.51	**No**	Yes	**No**	**No**
29	9.02	Yes	8.61	Yes	121	**No**	29.30	**No**	Yes	**No**	**No**
30	8.81	Yes	8.32	Yes	104	**No**	29.15	**No**	Yes	**No**	**No**
Boat-based Assessment Locations											
1	9.12	Yes	8.63	Yes	10.3	Yes	25.20	Yes	Yes	**No**	Yes
2	8.40	Yes	8.34	Yes	9.31	Yes	24.71	Yes	Yes	**No**	Yes
3	7.97	Yes	7.76	Yes	13.1	Yes	27.26	Yes	Yes	**No**	Yes
4	8.43	Yes	8.17	Yes	10.5	Yes	26.84	Yes	Yes	**No**	Yes
5	8.26	Yes	5.60	**No**	19.7	Yes	26.14	Yes	Yes	**No**	Yes
6	8.60	Yes	7.68	Yes	16.3	Yes	27.27	Yes	Yes	**No**	Yes
7	5.95	Yes	6.42	**No**	16.7	Yes	25.38	Yes	Yes	**No**	Yes
8	9.76	Yes	7.91	Yes	18.5	Yes	27.81	Yes	Yes	**No**	Yes
9	8.89	Yes	7.85.	Yes	19.6	Yes	27.73	Yes	Yes	**No**	Yes
10	8.58	Yes	7.19	Yes	12.6	Yes	27.99	Yes	Yes	**No**	Yes

**F&W Propagation threshold values obtained from "Water in Oklahoma: 2010 Integrated Report" (ODEQ 2010)*

**Spawning threshold values obtained from "USEPA Technical Support Manual: Waterbody Surveys and Assessments for Conducting Use Attainability Analyses" (USEPA 1983)*

Four sites, including land-based assessment locations 17, 18, 27, and 28, recorded values above the maximum of 9.0. The pH in lakes can rise due to an increase in photosynthesis. Photosynthesis uses up hydrogen molecules, which causes the concentration of hydrogen ions to decrease and therefore the pH to increase. For this reason, pH may be higher during daylight hours and during the growing season, when photosynthesis is at a maximum. Increased photosynthesis at three of the four locations is probably due to observed algal growth. In addition, all four sites have some degree of human influence including the presence of boat docks and trash accumulation.

For turbidity, a minimum of ten samples must be collected under seasonal base flow conditions to make an attainment determination. The Fish and Wildlife Propagation beneficial use is considered attained with respect to turbidity if ten percent or fewer of the samples collected exceed the screening level of 25 NTUs (ODEQ 2010). Of the 38 assessment sites, 23 contained turbidity values greater than the 25 NTU threshold value (60.5 percent). Therefore, the waters of the Eufaula Lake study area do not attain the Fish and Wildlife Propagation beneficial use in terms of turbidity.

High turbidity levels are well-known throughout the study area and are typical of reservoirs created by the damming of low-gradient, sediment-choked streams such as the Canadian and Deep Fork Rivers. While turbidity values in such systems are naturally high, they are inflated by upstream land uses and erosion. Within the study area, water level fluctuations, agricultural use, and shoreline development all contribute to excessive sedimentation. Even though the highest turbidity values are located in the shallow waters of the Deep Fork and Gaines Creek arms of the lake, the majority of shoreline development occurs within the central portion of the study area known as the triangle of development. These developed areas are known to have the best water clarity. The SHA confirms this observation, as turbidity values for land-based sites 10 to 20 and all boat-based sites were below or slightly above the 25 NTU threshold. This could be due to several factors including the fact that boat assessment locations contained little human influence and were relatively inaccessible from the upland.

However, within the triangle of development, shoreline development is relatively high in comparison to the rest of the study area. The increased water clarity in this area is due mostly to lake dynamics, which offsets the increased sedimentation due to land disturbance. The triangle of development surrounds the deepest and slowest-moving portions of the lake, allowing sediments to drop out of the water column. Of the land-based assessment locations with the lowest turbidity levels (sites 13, 16, 17, 18, and 20), four of them are located within the deepest arm of the lake directly upstream of Eufaula Dam. Despite the role of lake dynamics, USACE personnel have reported a recent decline in water quality in the area, most likely due to an increase in shoreline modification in the form of riparian vegetation removal.

In addition to the five specific beneficial uses, the Eufaula Lake study area is subject to the standards outlined in the general narrative criteria applicable to all waterbodies in Oklahoma. Under the general narrative criteria for beneficial uses, solids (suspended and/or settleable), water taste and odor, and nutrients are addressed. For solids, the surface waters of Oklahoma are to be essentially free of floating debris, bottom deposits, scum, foam, and other persistent suspended substances from other than natural sources (OWRB 2011). As shown in **Table 4-11**, several assessment sites identified the presence of floating white foam, which compromises the Eufaula Lake study area's ability to meet the solids beneficial use criteria.

The criteria for beneficial use regarding water taste and odor states that any unnatural substances that interfere with the production of a potable water supply, produce abnormalities in the flesh of fish and

other edible wildlife, or result in offensive odors in the vicinity of the water are prohibited (OWRB 2011). While several assessment locations contained a natural fishy smell, no unnatural water odors were encountered.

Finally, nutrients from all sources are not to cause excessive growth of periphyton, phytoplankton, or aquatic macrophyte communities, which impairs any existing or designated beneficial use (OWRB 2011). While excessive nutrient inputs were absent in many assessment locations, the presence of green algae in the littoral zone of 18 locations and a blue-green algal bloom at Porum Landing on May 25-28, 2012, demonstrate that localized nutrient inputs are an issue. An examination of sites containing algae determined that these locations tend to experience high levels of human influence, including heavy recreational use and adjacent residential development. In fact, of the 14 land-based habitat locations with algae present, ten are currently designated Limited Development or Public Recreation.

In addition to shoreline water chemistry and physical water properties, the physical habitat, including substrate, riparian zone condition, and littoral zone condition, is critically important to benthic communities, fish, and other aquatic organisms. Using protocols and indices developed for the U.S. EPA National Lakes Assessment, the SHA determined values for four integrative measures of lake condition in order to ascertain shoreline quality within the study area (USEPA 2010). The measures include the Lakeshore Disturbance Index (RDis_IX), Lakeshore Habitat Index (RVegQ), Shallow Water Habitat Index (LitCvrQ), and Physical Habitat Complexity Index (LitRipCvQ). The calculation of each of these index values enables comparison between each of the 38 assessed study area sites and between Eufaula Lake and lakes region-wide. The lake assessment index values for all shoreline habitat locations can be found in **Table 4-12**.

Table 4-12. Eufaula Lake Assessment Index Values for All Shoreline Habitat Locations

Lake Assessment Index Values						
Site	Lakeshore Disturbance Index (RDis_IX)	Lakeshore Habitat Index (RVegQ)		Shallow Water Habitat Index (LitCvrQ)	Physical Habitat Complexity Index (LitRipCvrQ)	
		RVegQ_2	RVegQ_7		LRCVQ_2D	LRCVQ_7D
Land-based Assessment Locations						
1	.6075	.4530	.3593	.4063	.4297	.3828
2	.5913	.6130	.6107	.6086	.6108	.6097
4	.5096	.4170	.3507	.1356	.2763	.2432
5	.5451	.2490	.2593	.7381	.4936	.4987
6	.5096	.1850	.1679	.3290	.2570	.2485
7	.5442	.5730	.6107	.3063	.4397	.4585
8	.6406	.3130	.3507	.0221	.1676	.1864
9	.5096	.2890	.1679	.2623	.2757	.2151
10	.6071	.0200	.0143	.2056	.1128	.1100
11	.6075	.0800	.0286	.0913	.0857	.0600
12	.5998	.2140	.0714	.1351	.1746	.1033
13	.6486	.1100	.0857	.0801	.0951	.0829
14	.5822	.2490	.2593	.1467	.1979	.2030
15	.6265	0	0	0	0	0
16	.5714	.1840	.0857	.0801	.1321	.0829
17	.5708	.0700	.0714	0	.0350	.0357
18	.6067	.1200	.0286	.0802	.1001	.0544

Lake Assessment Index Values						
Site	Lakeshore Disturbance Index (RDis_IX)	Lakeshore Habitat Index (RVegQ)		Shallow Water Habitat Index (LitCvrQ)	Physical Habitat Complexity Index (LitRipCvrQ)	
		RVegQ_2	RVegQ_7		LRCVQ_2D	LRCVQ_7D
19	.3824	.1850	.1107	.1801	.1826	.1454
20	.6315	.1200	.0286	.1357	.1279	.0822
21	.5822	.1600	.0857	.0443	.1022	.0650
22	.3824	.1050	.0536	.0221	.0636	.0379
24	.5708	.1850	.1679	.2579	.2215	.2129
25	.6071	.0600	.0143	.0222	.0411	.0183
26	.5451	.1840	.0857	.0661	.1251	.0759
27	.6198	.1200	.0857	.0222	.0711	.0540
28	.5442	.1200	.0286	.0222	.0711	.0254
29	.5908	.1050	.0536	.0691	.0871	.0614
30	.6201	.0800	.0286	.0222	.0511	.0254
Boat-based Assessment Locations						
1	.2500	.2880	.1771	.3113	.2997	.2442
2	.3824	.2090	.1107	.7942	.5016	.4525
3	.2500	.2490	.1679	.2167	.2329	.1923
4	.2500	.3730	.3021	.1352	.2541	.2187
5	.2500	.3130	.2593	.0912	.2021	.1753
6	.2500	.4130	.3021	.3278	.3704	.3150
7	.3824	.2730	.2021	.2845	.2788	.2433
8	.2500	.2090	.1107	.6320	.4205	.3714
9	.5708	.0650	.0536	.1579	.1115	.1058
10	.2500	.1850	.1107	.2134	.1992	.1621

The Lakeshore Disturbance Index is based on the presence and proximity of 12 types of human activities or disturbances at each SHA location (USEPA 2010). The index is scaled from 0 to 1, where 0 indicates absence of any human disturbance and 1 indicates extremely high disturbance. The Eufaula Lake study area values range from .2500 to .6486; therefore, indicating medium levels of disturbance. Several boat-based assessment sites, including sites 1, 3, 4, 5, 6, 8, and 10, contained no human disturbance within or adjacent to the plot, but received a value of .2500 instead of 0 due to a factor in the index that accounts for the proportion of shoreline stations lake-wide that have at least one type of human activity. The majority of areas with low lake disturbance values consist of shorelines designated Protected (*e.g.*, Site 19 – Bixby Creek) and low-use public recreation areas (*e.g.*, Site 22 – Mill Creek Recreation Area). The highest lake disturbance values, indicating areas of moderate human activity, were recorded at high-use public recreation areas (*e.g.*, Site 8 – Lake Eufaula State Park) and highly-modified shorelines designated Limited Development (*e.g.*, Site 13 – Longtown Estates).

The Lakeshore Habitat Index quantifies riparian cover and complexity based on visual estimates of vegetation cover and structure (USEPA 2010). The formulation of this index is assigned by aggregate ecoregion. Since the Eufaula Lake study area is located on the boundary of the Southern Plains (SPL) and Southern Appalachian (SAP) U.S. EPA Lake Ecoregions and contains features of both, values were calculated using index formulations for both ecoregions (EPA 2009). This includes the RVegQ_2 formulation for the

SAP Ecoregion, which is most appropriate where tree vegetation can be expected in relatively undisturbed locations, and the RVegQ_7 formulation for the SPL Ecoregion, which accommodates sites where tree canopies may not be expected in the absence of human activities, or where the presence of enhanced tree canopy cover around lakes may be associated with human activities (USEPA 2010). Both indices include inundated vegetation as a positive characteristic.

Like the Lakeshore Disturbance Index, the Lakeshore Habitat Index varies from 0 to 1, where 0 indicates the absence of riparian cover and complexity and 1 indicates riparian vegetation conditions of the highest quality (USEPA 2010). For RVegQ_2, the Eufaula Lake study area values range from 0 to .6130; therefore, indicating low to medium levels of riparian cover and complexity. Similarly, values for RVegQ_7 range from 0 to .6107. For both formulations, the majority of areas with poor riparian conditions consist of shorelines with little or no riparian canopy cover dominated by grasses or by large expanses of barren ground (*e.g.*, Site 10 – Belle Starr Park). These sites are often designated Limited Development (*e.g.*, Site 15 – Eufaula Cove) or Public Recreation (*e.g.*, Site 25 – Arrowhead State Park). Shorelines designated Protected tend to have the highest Lakeshore Habitat Index scores due to the presence of dense forests dominated by woody species (*e.g.*, Site 2 – N4080 Road) with little or no human activity or land disturbance. However, some of the highest riparian scores were recorded on sites designated Limited Development containing little adjacent development or human usage (*e.g.*, Site 7 – N4150 Road).

The Shallow Water Habitat Index quantifies littoral cover and complexity and is based on visual estimates of the aerial cover of ten types of littoral cover features including woody snags, inundated brush, inundated live trees, inundated herbaceous vegetation, overhanging vegetation, rock ledges, boulders, and human structures, plus a separate estimation of floating, emergent, and submergent aquatic macrophytes (USEPA 2010). Like the Lakeshore Habitat Index, several Shallow Water Habitat Index formulations are used and are assigned by lake type class. Eufaula Lake falls under U.S. EPA Lake Type C; therefore, the LitCvr_D formulation is used to assess littoral cover and complexity (USEPA 2009). This formulation is appropriate where increases in submerged aquatic macrophytes (*e.g.*, green algae) are typically associated with nutrient inputs from human disturbances. It excludes submerged aquatic macrophytes, but increases the weighting of woody snags and floating and emergent macrophytes.

The Shallow Water Habitat Index varies from 0 to 1, where 0 indicates the absence of littoral cover and complexity and 1 indicates the presence of a diverse array of littoral cover types that has the potential to support high aquatic organism diversity (USEPA 2010). The Eufaula Lake study area values range from 0 to .7942; therefore, indicating littoral cover quality ranging from absent to high. Several boat-based assessment sites, including sites 2 and 8, recorded high values due to the presence of woody snags and boulders, respectively. Land-based assessment locations with high littoral habitat values often included shorelines designated Protected (*e.g.*, Site 2 – N4080 Road) and low-use public recreation areas (*e.g.*, Site 5 – Lake Eufaula State Park). The majority of areas with low Shallow Water Habitat Index values consist of shorelines with high levels of human activity (*e.g.*, Site 15 – Eufaula Cove), are maintained for public use (*e.g.*, Site 30 – Hickory Point Recreation Area), or contain high boat dock density (*e.g.*, Site 17 – N4250 Road).

The fourth and final lake assessment index is the Physical Habitat Complexity Index, which is simply the arithmetic mean of the respective values for the Lakeshore and Shallow Water Habitat Indices (USEPA 2010). Therefore, this Index evaluates the overall quality of shoreline habitats. As with the Lakeshore Habitat Index, the Physical Habitat Complexity Index consists of several formulations that are assigned by lake class type and Ecoregion. Formulation LRCVQ_2D is applicable to Eufaula Lake since it is categorized in

U.S. EPA Lake Type C and is located on the edge of the SAP Ecoregion. Formulation LRCVQ_7D is also applicable for lakes in Lake Type C, but is used for lakes located within the SLP Ecoregion (USEPA 2010). Using both formulations increases assessment accuracy as shorelines within the Eufaula Lake study area are consistent with the forested shorelines of the SAP Lake Ecoregion and the more open shorelines of the SPL Lake Ecoregion.

The Physical Habitat Complexity Index varies from 0 to 1, where 0 indicates the absence of riparian and littoral cover and complexity and 1 indicates the presence of optimal overall shoreline habitat (USEPA 2010). For LRCVQ_2D, the Eufaula Lake study area values range from 0 to .6108; therefore, indicating low to medium levels of riparian and littoral cover and complexity. Similarly, values for LRCVQ_7D range from 0 to .6097. While habitat quality values are almost identical for both formulations, discrepancies exist because LRCVQ_2D takes canopy tree cover into account, whereas LRCVQ_7D does not.

For both formulations, the majority of areas with poor overall physical habitat conditions consist of shorelines with significant human disturbance designated Limited Development (*e.g.*, Site 15 – Eufaula Cove; Site 17 – N4250 Road; Site 28 – Blue Creek Road) or Public Recreation (*e.g.*, Site 25 – Arrowhead State Park; Site 30 – Hickory Point Recreation Area). These sites are more likely to have maintained shorelines, boat docks, and high levels of human activity. Shorelines designated Protected tend to have the highest Physical Habitat Complexity Index scores due to the presence of riparian vegetation, aquatic vegetation, and underwater structure (*i.e.*, boulders, woody snags). Sites like boat-based assessment location 2 contain no access to the shoreline from the upland; thereby, preserving the natural condition. However, some of the highest physical habitat scores were recorded on sites designated Limited Development (*e.g.*, Site 7 – N4150 Road) or Public Recreation (*e.g.*, Site 5 – Lake Eufaula State Park). These sites are characterized by wide, vegetated riparian buffers containing little adjacent development or human usage.

In addition to comparing lake assessment index values between each of the 38 assessed study area sites, the overall mean values for Eufaula Lake can be compared to mean values for lakes region-wide (**Table 4-13**).

Table 4-13. Mean Lake Assessment Index Values for Eufaula Lake and Applicable Lake Ecoregions

Mean Lake Assessment Index Values						
Site	Lakeshore Disturbance (RDis_IX)	Lakeshore Habitat Index (RVegQ)		Shallow Water Habitat Index (LitCvrQ)	Physical Habitat Complexity Index (LitRipCvrQ)	
		RVegQ_2	RVegQ_7		LRCVQ_2D	LRCVQ_7D
Eufaula Lake (n = 38 SHA sites)	.5011	.2142	.1594	.2015	.2078	.1805
Plains and Lowlands Region (Range)	.5200 (0 - .9360)	N/A	.1600 (0 - .5580)	.1300 (0 – 1.0)	N/A	.1400 (0 – .5880)
Eastern Highlands Region (Range)	.4200 (0 - .9320)	.2100 (0 - .4890)	N/A	.1400 (.002 - .6300)	.1800 (.0110 - .4570)	N/A

The Plains and Lowlands Lake Ecoregion is a combined region that incorporates several similar ecoregions including the SPL Ecoregion in which Eufaula Lake is located. Similarly, the Eastern Highlands Lake

Ecoregion is a combination of similar ecoregions including the SAP Ecoregion. Therefore, lake assessment values are compared to each. Eufaula Lake has a mean Lakeshore Disturbance Index value of .5011, which falls under the medium disturbance condition criterion. This value is slightly lower than lakes located in the Plains and Lowlands Ecoregion and slightly higher than lakes located in the Eastern Highlands Ecoregion. This is consistent with observations that the Eufaula Lake study area is less developed and impacted by development and agricultural operations than many plains lakes, but more impacted by human disturbance than eastern highland lakes of which many are heavily forested and located in remote areas.

The Eufaula Lake study area has mean Lakeshore Habitat Index values of .2142 (RVegQ_2) and .1594 (RVegQ_7), which are almost identical to the mean values for lakes in each respective ecoregion. While both of these values indicate that overall riparian quality is low, it suggests that shorelines within the study area contain riparian cover and complexity similar to the majority of lakes located within shared ecoregions. In addition, the maximum riparian values of lakes assessed region-wide are approximately .5000; therefore, values recorded for Eufaula Lake likely suggest riparian conditions of moderate, not low, quality. The riparian vegetation of lakes and reservoirs region-wide suffer from extensive shoreline development for residential, agricultural, and recreational reasons. While the shorelines within the Eufaula Lake study area are subjected to these human disturbances, the Lakeshore Habitat Index values suggest that riparian conditions are better there than in approximately half of lakes assessed regionally.

While the riparian habitat index value is similar to those of lakes assessed region-wide, the Shallow Water Habitat Index value for the Eufaula Lake study area is greater than the mean values for lakes in the Plains and Lowlands and Eastern Highlands Ecoregions. Therefore, the littoral habitat conditions are of higher quality than lakes region-wide and enable Eufaula Lake and its tributaries to support diverse aquatic communities and world class fisheries. The relatively high value is most likely due to the presence of large quantities of woody debris, boulders, and other aquatic habitat structures. While the region-wide comparison suggests the study area contains high-quality littoral zone habitats, the mean Shallow Water Habitat Index value of .2015 still falls below what is considered medium quality. Reasons for this likely include a prevalence of modified shorelines (*e.g.*, riprap, maintained beaches), boat docks, and a lack of aquatic vegetation.

Since the Physical Habitat Complexity Index incorporates both the Lakeshore Habitat Index and Shallow Water Habitat Index, the mean values for this index are similar to those recorded for those two indices. The Eufaula Lake study area has mean Physical Habitat Complexity Index values of .2078 (LRCVQ_2D) and .1805 (LRCVQ_7D). The LRCVQ_2D value is slightly higher than the LERCVQ_2D value because the former accounts for tree canopy cover, with high values recorded for the widespread forested shorelines in the study area. While both of these values indicate that overall physical habitat quality is low, the maximum Physical Habitat Complexity Index values of lakes assessed region-wide are .4570 and .5880; therefore, values recorded for Eufaula Lake likely suggest habitat conditions of moderate, not low, quality. Regionally, the mean physical habitat values for the study area are slightly higher than those recorded for lakes within the Plains and Lowlands and Eastern Highlands Ecoregions. Therefore, Eufaula Lake exhibits shoreline littoral and riparian cover and complexity of a quality that is slightly higher than those of lakes region-wide.

4.1.4 Terrestrial and Aquatic Habitat Map

A base habitat map of the Eufaula Lake study area was developed based on maps, aerial photographs, reports, and digital resource data. Original digital data was obtained from the 1992 Oklahoma GAP land

cover dataset. Development of the base habitat map indicates the general location of the major terrestrial and aquatic habitat types discussed above. Once the base habitat map was completed, the habitats were field verified in April 2012 to ensure map accuracy. However, due to the size of the study area, the base habitat map provides habitat data at a scale in which individual habitats are indistinguishable to the viewer. Therefore, six separate terrestrial and aquatic habitat maps were created from the base habitat map in order to identify the locations and quantities of existing habitat types at an appropriate scale. These maps can be found in Appendix C.

Each habitat type location is represented by a polygon and provides quantitative data for each habitat type. Total acreage amounts for each major terrestrial and aquatic habitat type, calculated from a database embedded in the digital data, enables an overall characterization of the Eufaula Lake study area and allows for comparison between habitat communities (**Table 4-14**).

Table 4-14. Terrestrial and Aquatic Habitat Communities within the Eufaula Lake Study Area (acres)

Habitat Community	Acreage within Study Area
Terrestrial Habitats	
Crosstimbers	13,209.86
Oak-Hickory Forest	10,734.75
Oak-Pine Forest	5,704.34
Bottomland Hardwood Forest*	12,282.98
Savanna	10,786.48
Prairie	4,238.24
Aquatic Habitats	
Open Water	94,853.42
Emergent Wetland	3,208.90
Scrub-Shrub Wetland	15,371.02
Modified Habitats	
Crop – Warm Season	506.90
Pasture	6,150.78
Residential/Industrial	1,176.50

**Palustrine forested wetland is included within the bottomland hardwood forest habitat community*

According to acreage totals derived from the final habitat map, forests and woodlands dominate the terrestrial component of the Eufaula Lake shoreline. The most prevalent terrestrial habitat is the crosstimbers followed by bottomland hardwood forest. Combined, these two habitats comprise approximately 25,500 acres of shoreline habitat, or approximately 45 percent of the total natural terrestrial habitat present. While savanna habitats, including oak savanna and cedar savanna, occupy the third-largest area among terrestrial habitats, open habitats tend to make up a relatively small percentage of the total shoreline. Combined, savanna and prairie habitats occupy approximately 15,000 acres of shoreline habitat, or approximately 26 percent of the total natural terrestrial habitat present. Prairies occupy the smallest total acreage of all natural terrestrial habitat types, which is consistent with the historical, region-wide trend of prairie loss and degradation.

Aquatic habitats within the Eufaula Lake study area are dominated by the open waters of Eufaula Lake and its large tributaries. Open water habitats occupy more area, approximately 95,000 acres, than all other habitats combined. This is to be expected considering the vast majority of government-owned property

consists of the lake proper. Among wetland habitats, scrub-shrub wetlands are the most prevalent, occupying over 15,000 acres. To put this in perspective, scrub-shrub wetlands occupy an area equal to that of savanna and prairie habitats combined and are the second-most common habitat type after open water. The prevalence of scrub-shrub wetlands is typical of steep-sloped shorelines with wide water level fluctuations. These conditions often inundate emergent herbaceous species and prevent the establishment of large trees. As such, emergent wetlands are relatively rare within the Eufaula Lake study area and occupy the smallest area of all natural habitats with approximately 3,200 acres of coverage.

While not depicted on the habitat maps, which characterize natural habitats, the Eufaula Lake study area shoreline contains habitats extensively modified and maintained by human activity. While these modified habitats, including cropland, pasture, and residential/industrial, occupy only 12 percent of total terrestrial habitat, the characterization of the Eufaula Lake shoreline is incomplete without their inclusion. Of the modified habitats, croplands make up a very small percentage with pastures occupying roughly 79 percent. In comparison, residential/industrial land uses occupy only 15 percent of developed lands. These totals support the conclusion that the Eufaula Lake study area shoreline is relatively undeveloped and the majority remains in its natural condition. Overall, these acreage numbers describe a shoreline that is mostly forested with significant areas of scrub-shrub wetland and limited quantities of human-modified habitats.

4.1.5 Invasive Species - Vegetation

Invasive species are widely recognized as one of the greatest threats to global biodiversity. In the United States alone, the cost of invasive species management exceeds $120 billion annually (Dorcas *et al*. 2011). The negative impacts inflicted by invasive species on native species and ecosystems may only be exceeded by human-caused habitat destruction and has played a role in the listing of 42% of the species protected by the U.S. Endangered Species Act (ESA) (Engeman *et al*. 2011). As such, Oklahoma's State Wildlife Action Plan identifies invasive species as one of five priority issues that threaten the conservation of the state's wildlife resources (Foster *et al*. 2009).

Invasive plant species often increase and spread rapidly because the habitat into which they are introduced is free of insects and diseases that are natural controls in their native habitats. Habitats intrinsically vary in their vulnerability to invasion, with disturbance events increasing susceptibility. A study by Picket and White (1985) define disturbance as the process by which an ecosystem is modified by an exogenous event (human or natural) to a condition that is not otherwise common for that ecosystem. By reducing competition, disturbance events facilitate the colonization and establishment of invasive species. Within the Eufaula Lake study area, the removal of native vegetation for transportation, infrastructure, and residential and commercial development constitute disturbance events. In addition, the introduction of invasive species for landscaping or agricultural reasons can also pose problems when these species escape cultivation and spread into natural areas. Within aquatic habitats, disturbance can include impacts to water quality including an influx of sediment, nutrients, or pollutants and impacts to water quantity and periodicity including channelization and unnatural water level fluctuations associated with flood control.

Once established, invasive species negatively impact extant ecosystem function and structure. Through mechanisms such as competitive exclusion, these species alter the ability of native species to grow and reproduce, thus impacting the continuance of ecosystem services formerly provided. For example, invasive plant species may interfere with drainage and flood control, impede navigation and recreational activities, and degrade water and habitat quality. Invasive plants also frequently displace native species, reducing the

amount and quality of wildlife forage. Therefore, not only are invasive plants a threat to native plant species, but they can easily contribute to the decline of native animal species as well.

The Arkansas River basin has been identified as a major pathway for the introduction of invasive aquatic nuisance species (Foster et al. 2009). The following species are considered of special concern in Oklahoma: alligatorweed (*Alternanthera philoxeroides*), Eurasian watermilfoil (*Myriophyllum spicatum*), hydrilla (*Hydrilla verticillata*), purple loosestrife (*Lythrum salicaria*), salvinia (*Salvinia* sp.), and water hyacinth (*Eichornia crassipes*) (Foster et al. 2009), with hydrilla considered a high priority species throughout the state. Two invasive aquatic plant species have been documented within the study area. Habitat transects in wetland areas determined that salvinia is present within the Eufaula Lake study area. In addition, while not observed during 2012 field activities, previous studies indicate that water hyacinth has been documented in Eufaula Lake (Foster et al. 2009).

Hydrilla is currently not documented within the study area, but is considered the most damaging aquatic weed in the United States (Foster *et al*. 2009). Imported as an aquarium plant from Asia in the 1950s, it has established populations in the wild and is present in all but a few states. Hydrilla plants thrive in low light conditions and can be found in streams, ponds, lakes, and reservoirs. It is likely spread to new habitats when fragments are carried on boat trailers (Foster *et al*. 2009). This species causes significant damage by clogging water control structures and interfering with recreational vessel navigation. In addition, it hampers swimming, displaces native vegetation, and can damage sport fish populations (Foster *et al*. 2009). In Oklahoma, infestations are known to occur in Arbuckle, Murray, and Sooner reservoirs.

Salvinia refers to a genus of perennial, aquatic ferns from South America that is common in water garden and aquarium industries. In Oklahoma and within the study area, giant salvinia has established in ponds, lakes, and slow moving streams. It prefers nutrient-rich waters and forms extensive mats that can completely cover water surfaces resulting in the degradation of natural habitats by shading native plants, reducing available dissolved oxygen, and creating large amounts of decaying plant material (Foster *et al*. 2009). Giant salvinia can clog water intakes, which interferes with irrigation, drainage, and electrical generation. Human transport aids in the spread of this species, with plants adhering to anything entering infested waters including boats, trailers, vehicular wheels, intakes and gear, and other plants.

Water hyacinth is common in Gulf Coast states and its presence has caused massive problems with navigation, water-based recreation, canal systems, pumping stations, and water intakes (Foster *et al*. 2009). In addition, it can completely cover areas under dense, floating mats. While the risk of establishment in Oklahoma is low due to cold winter air temperatures, its continued popularity in water gardens poses a threat it could adapt to colder temperatures or become established in thermal refugia. In addition to Eufaula Lake, this species has been documented in Soldier Creek in Midwest City and Landsbrook Lake in Oklahoma City, all probable releases from water gardens (Foster *et al*. 2009).

In addition to aquatic invasive plants, several species of terrestrial invasive species threaten the prairies, savannas, and forests of Oklahoma. Oklahoma has a total 22 terrestrial invasive plant species on the Oklahoma Invasive Plant Council (OIPC) problem list and another 150 species that are on watch lists or are problems in bordering states (OIPC 2012). The field work conducted in spring of 2012 identified several invasive species including Japanese honeysuckle (*Lonicera japonica*), Chinese lespedeza (*Lespedeza cuneata*), and Japanese climbing fern (*Lygodium japonicum*). Chinese lespedeza was dominant in both sampled savanna habitats and Japanese climbing fern was a dominant in the herbaceous layer in oak-pine forest. All three of these transects took place in protected recreation areas; therefore, the total number of

terrestrial invasive species within the study area is likely underrepresented. Additional species such as tall fescue (*Festuca arundinacea*), Chinese privet (*Ligustrum sinense*), and autumn olive (*Elaeagnus umbellata*) have been observed nearby and are known invaders of the vegetative communities present within the study area (ODWC 2005).

Long-term fire suppression and significant habitat fragmentation have changed the structure of many prairie and savanna habitats and have fostered the spread of non-native grasses and forbs. Many invaders of grassland and open woodland habitats include winter annuals and exotic pasture weeds that have been planted for pasture or landscaping. In addition to Chinese lespedeza and tall fescue, Japanese brome has become widespread throughout the region.

In forested habitats throughout the Arkansas River basin, several invasive exotics appear to be displacing native understory plants and may alter plant communities and habitat conditions for wildlife. In bottomland hardwood forests, autumn olive and Chinese privet have been observed replacing native species and can form dense understories, which block out sunlight to the ground cover and inhibits tree recruitment. In oak-hickory and oak-pine forests, weedy vines like Japanese honeysuckle and climbing fern have become established outside of cultivation and smother native vegetation through formation of dense, herbaceous mats.

While not an exotic, the rapid westward spread of eastern red-cedar into previously uninhabited ecosystems has raised concerns with habitat managers in the state. Prior to European and American settlement of Oklahoma, eastern red-cedar infestation was not a problem as the trees were limited to protected alcoves and canyons that were rarely burned by fire (ODAFF 2002). However, settlement brought with it a policy of fire suppression and eastern red-cedar has encroached on prairie and upland forest ecosystems throughout the state. It is estimated that eight million acres in Oklahoma are currently infested with at least 50 red-cedars per acre. The encroachment is increasing at an estimated rate of 762 acres a day or nearly 300,000 acres per year (ODAFF 2002). This encroachment is evident within the Eufaula Lake study area as red-cedar was observed within crosstimbers, oak-hickory forest, oak-pine forest, and prairie habitat transects, with it being dominant in oak-pine and crosstimbers habitats.

The expansion of eastern red-cedar has an impact on native ecosystems with observed effects on wildlife, water quality, and native vegetation. While small plots of red-cedar provide thermal and loafing cover for wildlife, displacement of native plants by red-cedar reduces biological diversity. Studies have shown that it is a dominant factor in the displacement of grassland birds and songbirds from native prairie habitats (ODAFF 2002). Results indicate that grassland bird abundance is practically nonexistent with only 25 percent juniper cover present (Coppedge *et al*. 2002). In addition, popular game birds including turkey and bobwhite quail show population declines in invaded areas (Smith 2001). Water quality is impacted because red-cedar stands increase the amount of bare soil; therefore, increasing erosion rates (Thurow and Carlson 1994). Degradation in habitat quality is due to the high densities that red-cedar can attain.

In addition to adverse ecological effects, dense stands of eastern red-cedar have negative impacts on air quality and threaten human developments due to increased fuel for wildfires. Large red-cedar populations can affect human health and air quality negatively by creating more pollen, which causes allergic reactions and respiratory issues (ODAFF 2002). The need for controlled burns to stem red-cedar encroachment can also result in smoke-derived respiratory problems in nearby communities. Red-cedar forests are extremely dry and are prone to intense fires whether natural or deliberately set. Therefore, red-cedar forest fires are harder to control and are more likely to threaten nearby residential communities. Dense, highly-

flammable forests are in contrast to many native habitats, such as prairie and crosstimbers, which are historically regulated by fire.

4.1.6 Rare, Unique, and Imperiled Vegetation

There are no threatened or endangered plant species known to occur or likely to occur within the Eufaula Lake study area; however, the Oklahoma Natural Heritage Inventory (ONHI) has identified several plant species and plant associations of state conservation concern (**Figure 4-8**) (ONHI 2012). Several of these plant communities identified in **Figure 4-8** are relatively common within the Eufaula Lake study area but may be uncommon regionally. These communities, including pin oak-pecan-deciduous holly and shortleaf pine-white oak-black oak forest associations were documented by the habitat transects and are discussed within the bottomland hardwood forest and oak-pine forest sections, respectively. This also applies to the listed wetland (*e.g.*, cattail herbaceous association) and prairie shrubland (*e.g.*, big bluestem-little bluestem-Indian grass herbaceous association) communities. Therefore, this section will only address those plant species confirmed as located within or adjacent to the Eufaula Lake study area that are ranked as imperiled or critically imperiled in Oklahoma by ONHI (**Table 4-15**).

Table 4-15. Plant Species of State Conservation Concern Documented to Occur within or adjacent to the Eufaula Lake Study Area

Common Name	Scientific Name	ONHI Rarity Ranking*
Blackfoot Quillwort	*Isoetes melanopoda*	State Critically Imperiled
Bradley's Spleenwort	*Asplenium bradleyi*	State Critically Imperiled
Indian-Pipe	*Monotropa uniflora*	State Critically Imperiled
Kentucky Wisteria	*Wisteria macrostachya*	State Critically Imperiled
Lobed Spleenwort	*Asplenium pinnatifidum*	State Critically Imperiled
Small-Headed Pipewort	*Eriocaulon koernickianum*	State Critically Imperiled

**Obtained from ONHI occurrence database (2012)*

All of the six rare and imperiled plant species have been given an OHNI rarity ranking of state critically imperiled. This designation means that these species are critically imperiled in Oklahoma because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because some factor of their biology makes them especially vulnerable to extinction (ONHI 2012). While none of the six species were observed during any of the spring 2012 field activities, and presence is unlikely, all have the potential to be within the Eufaula Lake study area. Therefore, a brief discussion on current status and natural history of each is warranted.

Blackfoot quillwort is a perennial obligate wetland plant often found in wet prairies and in depressions in sandstone and is listed as state endangered in the northern and eastern portions of its range (USDA 2012). It derives its name from the dark bases of its leaves. Morphologically, quillworts look similar to spikerushes (Eleocharis) but are technically fern allies with sporangia located at the inflated bases of the leaves (USDA 2012). Blackfoot quillwort populations have declined due to conversion of their wet prairie pothole habitat into pasture and cropland. In 1999, ONHI documented one species occurrence just north of the mouth of the North Canadian River and just south of I-40 (ONHI 2012).

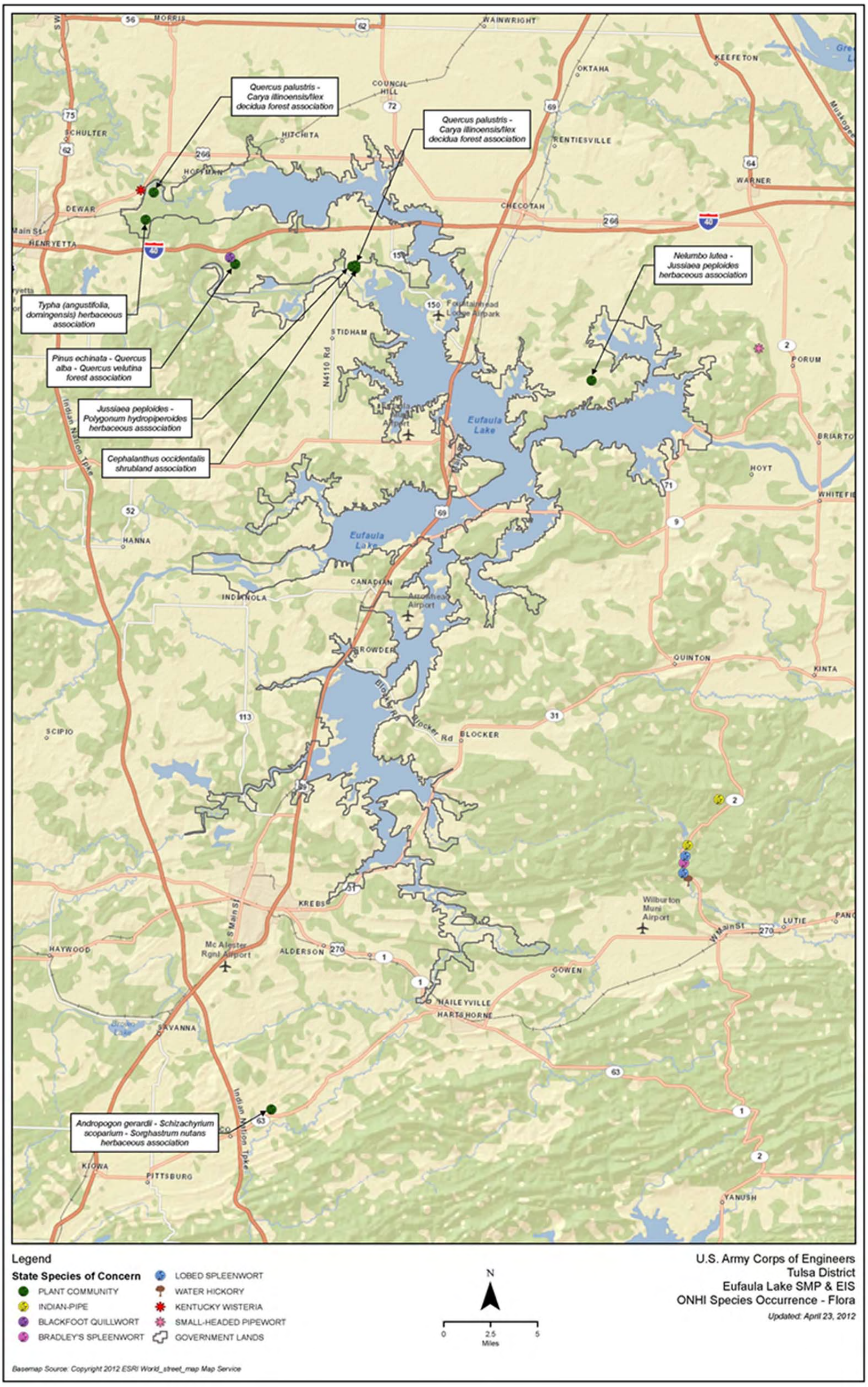

Figure 4-8. Occurrences of Rare, Unique, and Imperiled Vegetation (*ONHI 2012*)

Bradley's spleenwort is a small tufted evergreen perennial fern found in a very distinctive and limited habitat. Typically, the plants grow tightly rooted in vertical or horizontal crevices on hard, well-weathered vertical sandstone cliffs and other highly exposed bedrock (Hill 2003). Due to its specific requirements for an uncommon and discrete habitat and intolerance of competition, Bradley's spleenwort was probably never common. The Eufaula Lake study area would represent the extreme western edge of its distribution and its lone ONHI species occurrence record is a 1981 observation south of Lake Carlton in Robbers Cave State Park (ONHI 2012). Robbers Cave State Park is located approximately 12 miles east of the southeast corner of the Eufaula Lake study area.

Indian-pipe is an herbaceous, perennial plant native to temperate regions of North America where it is generally scarce or rare in occurrence. Unlike most plants, it is white and does not contain chlorophyll. Instead it is a parasite of certain fungi that are mycorrhizal with trees (Yang and Pfister 2006). This enables the plant to grow in dark environments such as the understory of dense forest, but specific habitat requirements makes widespread propagation difficult (Yang and Pfister 2006). Only a few locations within the scattered high ridges and mountains ecoregion exhibit the forest densities necessary for Indian-pipe growth. This would suggest that Indian-pipe could only be found in the densest of oak-hickory and oak-pine forests within the southeastern corner of the Eufaula Lake study area. Two ONHI species occurrence records, both located within Robbers Cave State Park, were recorded in 1974 and 1981 (ONHI 2012).

Kentucky wisteria is a woody deciduous vine found in the southeastern United States. It is generally found in wet forests and stream banks and grows best in moist, partly-shaded soils (USDA 2012b). After only two to three years, it bears bluish-purple flowers in racemes, making it the quickest wisteria to bloom. Other than early blooming, it is generally identical to American wisteria, with some references treating it as part of that species (USDA 2012b). Oklahoma represents the western extent of the range of Kentucky wisteria. Within the study area, this species is most likely to occur within bottomland hardwood forest habitats. The lone ONHI species occurrence, recorded in 1968, was located along the Deep Fork River south of US-266 within the boundaries of the Eufaula WMA (ONHI 2012).

Lobed spleenwort is an Appalachian rock fern, growing in rock crevices in moderately acid to subacid strata. It is often confused with Bradley's spleenwort due to similarity of appearance and habitat preference. It is theorized that both species of spleenwort grow only in sandstone with low pH (Story 2002). Within Oklahoma, the species is found only in Robbers Cave State Park. In 2002, several attempts were made to locate lobed spleenwort in areas of suitable habitat within Latimer, Haskell, and Pittsburg Counties but no specimens were observed (Story 2002). While several individuals were located in Robbers Cave State Park in 2002, the two ONHI species occurrence records, both located within Robbers Cave State Park, were recorded in 1931 and 1973 (ONHI 2012).

Small-headed, or dwarf, pipewort is an annual or biennial plant that grows in acid seeps and glades in the sand hillsides of southeastern Oklahoma (ONHI 2009). Populations are widely scattered, but single populations usually have numerous individuals. This species is one of only two pipeworts in the state and has been documented in three Oklahoma counties including Atoka, Muskogee, and Pushmataha (ONHI 2009). Because of its small size, small-headed pipewort can be difficult to find and is most easily located when its clusters of white to gray-green flowers are in bloom in mid-May (ONHI 2009). Habitat loss, as a result of wetland draining, and fire suppression are serious threats to pipewort populations in Oklahoma. The single ONHI species occurrence was recorded in 1929, two miles to the west of Porum near Henlsey Mountain (ONHI 2012).

4.2 Natural Resources

As part of the EIS, the natural resources in the affected environment are described. Once the existing condition is established, potential impacts of the proposed action to these natural resources are assessed.

Within the State of Oklahoma, there are sixteen animal and two plant species (some with critical habitats) under the jurisdiction of USFWS that are presently classified as federally endangered or threatened. Oklahoma also classifies four additional animal species as state-listed endangered or threatened. Of the animals and plants under USFWS or state jurisdiction, six animal species and no plant species are potentially found within the Eufaula Lake study area. Although some of these species may be occasionally found in the study area, only those species that may be potentially impacted by the proposed action are described. After coordination with state and federal agencies, it has been determined that the American burying beetle (*Nicrophorus americanus*), interior least tern (*Sterna antillarum*), bald eagle (*Haliaeetus leucocephalus*) and Arkansas River shiner (*Notropis girardi*) have the potential to occur in habitats within the Eufaula Lake study area where there is the potential for changes under one or more alternatives. Therefore, more detailed descriptions of these listed species are given and potential impacts due to the proposed action are assessed.

In addition to the six species that fall under federal or state jurisdiction, correspondence with ODWC identified one candidate species proposed for federal listing and nine species of either federal or state conservation concern that are likely to be found within the Eufaula Lake study area (**Table 4-16**) (Howery 2011a; Howery 2011b). While not afforded the same protection as listed species, populations of these species are in decline and could be listed in the near future. Following coordination with state and federal wildlife agencies, it was determined that the EIS will address potential impacts to the candidate species and species of concern generally, and not in the same depth as required for listed species likely to be found within the Eufaula Lake study area (Stubbs 2012).

The Oklahoma Natural Heritage Inventory (ONHI) maintains a statewide database of all federally and state listed species and species of concern. This database was consulted to provide occurrence locations of animal species within the Eufaula Lake study area. A total of 41 occurrences of 11 listed species or species of concern were located within or immediately adjacent to the study area (**Figure 4-9**). A discussion of each of these species occurs within their respective sub-section.

Table 4-16. Federally-listed Species and Oklahoma State Species of Concern Potentially Found within the Eufaula Lake Study Area

Common Name	Scientific Name	Regulatory Status*
Alligator snapping turtle**	*Macrochelys temminckii*	State Imperiled
American burying beetle	*Nicrophorus americanus*	Federal Endangered
Arkansas River shiner	*Notropis girardi*	Federal Threatened
Bachman's sparrow	*Aimophila aestivalis*	State Imperiled
Bald eagle**	*Haliaeetus leucocephalus*	Federally Protected; State Critically Imperiled
Bell's vireo	*Vireo bellii*	State Conservation Concern
Interior least tern	*Sterna antillarum*	Federal Endangered
Long-tailed weasel	*Mustela frenata*	State Critically Imperiled
Mississippi map turtle	*Graptemys kohnii*	State Imperiled
Paddlefish	*Polyodon spathula*	State Critically Imperiled
Peregrine Falcon	*Falco peregrinus*	Federal Conservation Concern
Piping plover	*Charadrius melodus*	Federal Threatened
Prairie mole cricket	*Gryllotalpa major*	State Imperiled
Prothonotary warbler	*Protonotaria critea*	State Conservation Concern
River otter	*Lontra Canadensis*	State Imperiled
Sprague's pipit	*Anthus spragueii*	Federal Candidate Species (ESA)
Whooping crane	*Grus americana*	Federal Endangered

**Obtained from ODWC website (2012), USFWS and ODWC email correspondence (2012), and ONHI occurrence database (2012)*

***observed during Spring 2012 Eufaula Lake surveys (includes visual ID, sign, or tracks)*

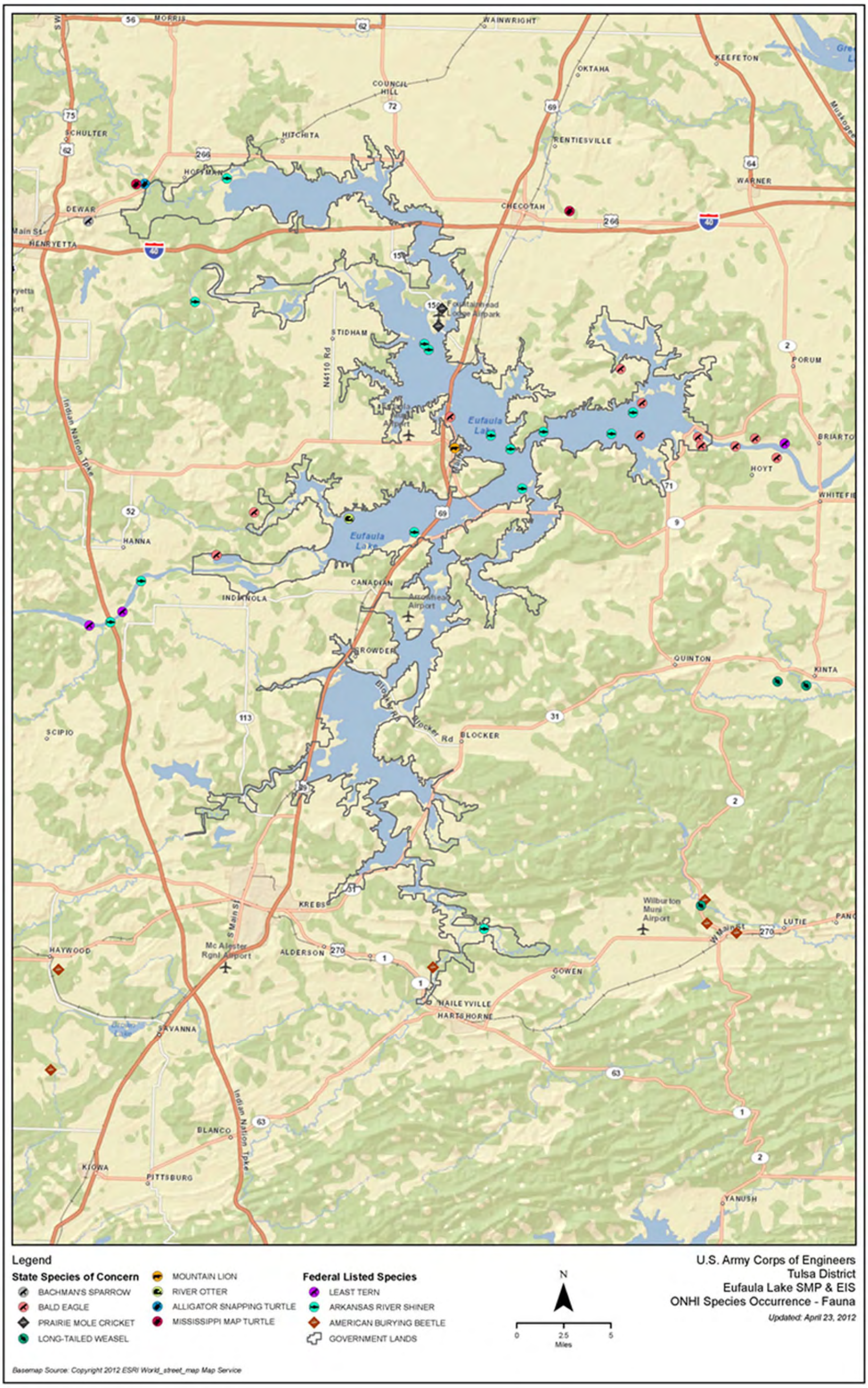

Figure 4-9. Occurrences of Federally-listed Species and State Species of Concern (*ONHI 2012*)

4.2.1 Fish

4.2.1.1 Arkansas River Shiner (*Notropis girardi)*

Status

On November 23, 1998, the Arkansas River shiner was listed as a threatened species under the Endangered Species Act (ESA), and USFWS designated critical habitat for this species throughout its range on April 4, 2001 (USFWS 1998). In Oklahoma, Arkansas River shiner critical habitat includes portions of the Canadian River (often referred to as the South Canadian River), the North Canadian (Beaver) River, and the Cimarron River and includes 300-foot riparian corridors on either side of these designated waters (USFWS 2001). According to the final critical habitat designation, elements essential for Arkansas River shiner conservation are habitat components supporting individual and population growth, feeding, resting, sheltering, reproduction, and development. Important physical features include abundant habitat for food organisms; adequate spawning flows and spawning sites; rearing and juvenile habitat for growth and development; appropriate flow regime and water quality characteristics; and safe and unobstructed dispersal pathways (*e.g.*, a river unobstructed by a permanent structure, or a dammed river that still allows for passage) (USFWS 2001). Although critical habitat has not been designated within the Eufaula Lake study area, the critical habitat unit on the South Canadian River extends downstream to the Indian Nation Turnpike Bridge northwest of McAlester in Pittsburg County, Oklahoma. This is within 15 river miles of the confluence of the South Canadian River and Eufaula Lake. In addition to recorded populations in Pittsburg County, extant populations are believed to exist in McIntosh County. Therefore, any revisions to the Eufaula Lake SMP or the supplement to the MP could potentially impact the Arkansas River shiner.

Species and Habitat Description

The Arkansas River shiner is a freshwater minnow that inhabits the main channels of wide, shallow, sand-bottomed rivers and larger streams of the Arkansas River basin. Adults are uncommon in quiet pools or backwaters, and almost never occur in tributaries having deep water and bottoms of mud or stone (Cross 1967). Juvenile Arkansas River shiners are associated with strong currents, high turbidity, and backwater and island habitat types (Polivka and Matthews 1997). Adult Arkansas River shiners are small minnows with a flat head, round snout, and small mouth. Adults attain a maximum length of 8 cm. Dorsal, anal, and pelvic fins all have eight rays, and there is usually a small, black chevron present at the base of the caudal fin (NatureServe, 2011a). Dorsal coloration tends to be light tan, with silvery sides gradually grading to white on the belly.

The peak spawning season of Arkansas River shiners is between June and July, with some spawning occurring in August. Spawning is trigged by an increase in water flow and takes place in the main stream channel. Eggs may travel many miles downstream before hatching. Eggs hatch within 24-48 hours, and larvae stay in the main channel for up to 4 days before seeking backwater pools and side channels where food is more abundant (Moore 1944). Adult Arkansas River shiners are non-migratory and seldom live more than 3 years. They are invertivores and feed primarily on plankton (Sublette *et al*. 1990). Adults will congregate on the downstream side of large transverse sand ridges, feeding on organisms exposed by moving sand or drifting downstream (Cross and Collins 1995).

Range and Population Dynamics

Historically, the Arkansas River shiner could be found throughout the western portion of the Arkansas River basin in Kansas, New Mexico, Oklahoma, and Texas. Records from the Oklahoma Museum of Natural History indicate that they were present in large numbers, with greater than 200 individuals collected in each of six sampling events on the South Canadian River between 1928 and 1963 (Pigg *et al*. 1999).

However, within the last 35 years, the Arkansas River shiner has lost over 80 percent of its historical habitat, due largely to human-caused alteration of natural stream-flow patterns, drought, and introduced fishes. Within the Eufaula Lake study area, it is believed to be extirpated in Haskell, Muskogee, and Okmulgee Counties, with extant populations located in McIntosh and Pittsburg Counties (NatureServe 2011a). No historical or current evidence exists of populations within Latimer County. It has recently been collected at 23 sites in the wild and is currently found along an 820 km stretch of the Canadian River in Oklahoma, Texas, and New Mexico, with a small population still found in the Cimarron River in Oklahoma and Kansas (NatureServe 2011a). In addition, a potential population is thought to exist in the North Canadian River. An introduced population exists in the Pecos River in New Mexico, but is considered experimental and is thus not protected under the ESA (Bestgen *et al*. 1989).

Eufaula Lake represents the downstream extent of the current range of the Arkansas River shiner in the Canadian River (**Figure 4-10**). Within the study area, ONHI occurrence records indicate this species is most often found along the old channels of the North and South Canadian Rivers (ONHI 2012). Since 1977, there has been a general annual decrease in both the total number and the relative abundance of Arkansas River shiners collected in the Canadian River (**Figure 4-11**) (Pigg *et al*. 1999). Overall population size for the species is currently estimated at 1000 to 2500 individuals, with populations expected to decline 50 to 70 percent in the short-term (NatureServe 2011a). Current threats include habitat destruction, water quality degradation, reduced stream flow due to the diversion of surface water, groundwater pumping, and construction of impoundments. Competition, accidental capture, drought, and other natural causes may also be contributing to the decline in populations (Bestgen *et al*. 1989).

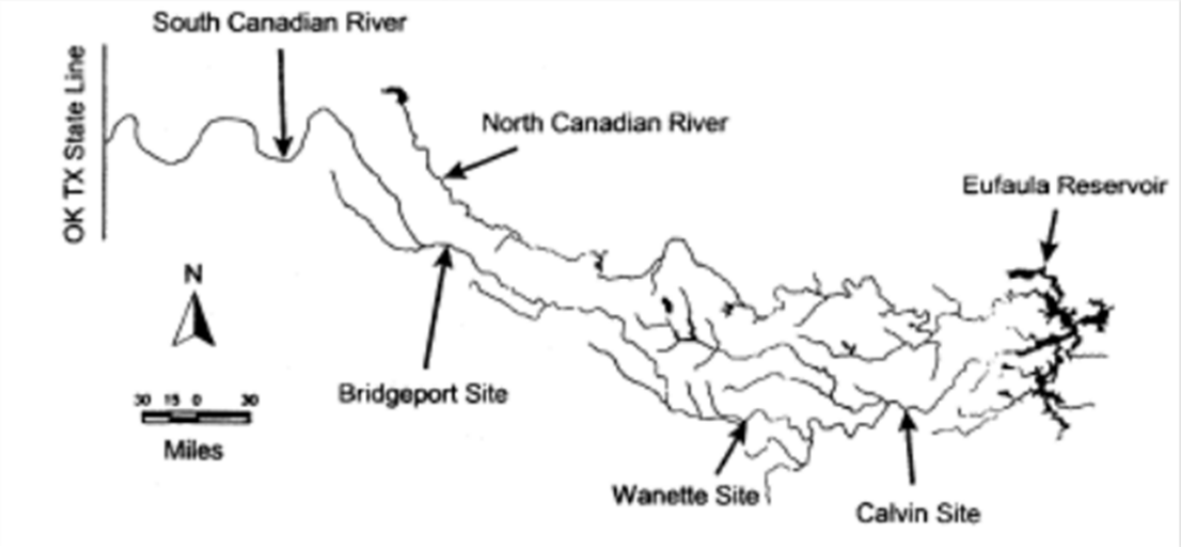

Figure 4-10. Long-term Arkansas River Shiner Sampling Sites on the South Canadian River
(*Pigg et al. 1999*)

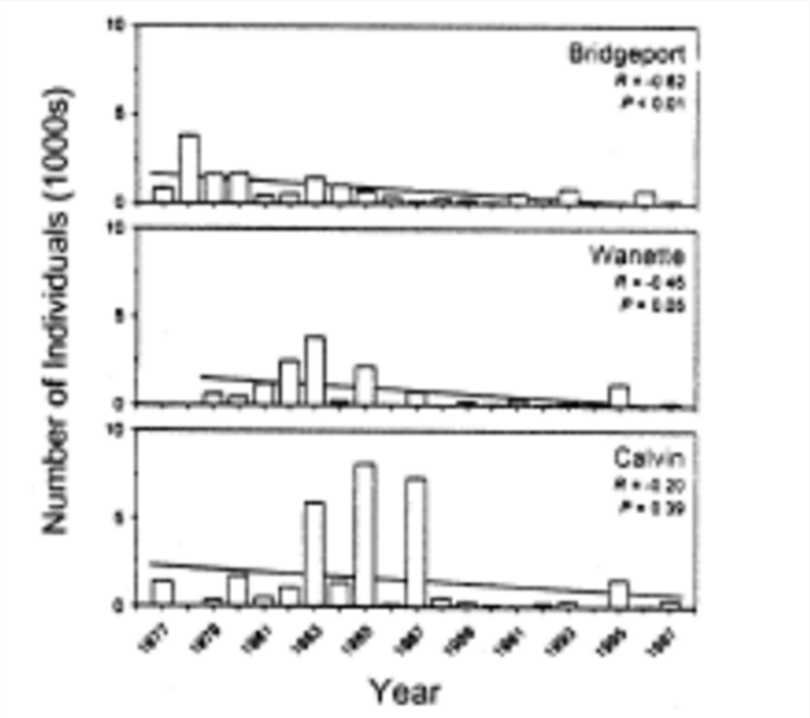

Figure 4-11. Number of Arkansas River Shiners Collected, 1977-1997 (*Pigg et al. 1999*)

Management and Protection

Life history characteristics and the limited natural range of the Arkansas River shiner may complicate and protract recovery efforts. Arkansas River shiners require specific stream flow regimes to successfully spawn and feed, and prefer a fairly restricted habitat consisting of wide, shallow rivers with sand substrates. The presence of nonnative species, including the red shiner (*Notropis lutrensis*) and mosquitofish (*Gambusia affinis*), also compromises the recovery of the Arkansas River shiner through direct competition and predation (Bestgen *et al*. 1989). Although Arkansas River shiners are highly mobile, low numbers, separation distance, and existing dispersal impediments make it unlikely that natural recruitment will occur from other wild populations.

In order to supplement existing populations, a hatchery program is currently being carried out at the Tishomingo National Fish Hatchery in Oklahoma (Springer 2000). Hatchery fish stocks come from the introduced population in the Pecos River, New Mexico. Propagated fishes are released into protected habitats throughout the historical range.

The take of Arkansas River shiners is prohibited in the state waters of Oklahoma and other states where wild populations occur. Section 6(a) of the ESA provides for extended cooperation with states for the purpose of conserving threatened and endangered species (USFWS 1998). Under that provision, the Departments of the Interior and Commerce may enter into cooperative agreements with a state, provided that state has an established program for the conservation of a listed species. The agreements authorize the states to implement the authorities and actions of the ESA relative to the listed species recovery. Specifically, the states are authorized: 1) to conduct investigations to determine the status and requirements for survival of resident species of fish and wildlife (this may include candidate species for listing), and 2) to establish programs, including acquisition of land or aquatic habitat or interests for the

conservation of fish and wildlife (USFWS 1998). Federal funding is also provided to states under those agreements to implement the approved programs.

4.2.1.2 Paddlefish (*Polyodon spathula*)

Growing to over six feet long and weighing over 100 pounds, paddlefish are a prehistoric species that gather algae and zooplankton from the water by swimming slowly with their mouths open. Habitat includes slow or quiet waters of large rivers or impoundments. Paddlefish tolerate, or even seek out, turbid aquatic systems.

In Oklahoma, paddlefish begin staging at the upper end of reservoirs in early spring in anticipation of the spawning run. As water temperatures rise and river flows increase, paddlefish move upstream to spawn. Preferred spawning habitat consists of gravel bars in large rivers that are inundated during spring high water. Males mature at about age nine and females mature at about age 16. Tagging studies indicate that a given female only spawns every three years, and a given male about every two years. This low reproductive potential contributes to paddlefish population decline.

Paddlefish are considered critically imperiled to imperiled in Oklahoma and are found mainly in the Grand, Neosho, and Arkansas River systems. However, dams on several of these rivers and their tributaries have blocked annual paddlefish movements associated with spawning. In addition to dam construction, reasons for paddlefish decline include habitat alteration, specifically the destruction of spawning areas, pollution, and harvesting for caviar. Since 2007, USFWS and ODWC have stocked Eufaula Lake with juvenile paddlefish in an effort to restore the species throughout its historical range. The 2011 ODWC public stocking report documents the release of 9,206 juvenile paddlefish measuring 12-24 inches in length (ODWC 2011a). Management of this species also includes a small rod and reel snagging fishery that requires a free paddlefish permit. All banded paddlefish must be reported as part of on-going research at the Paddlefish Research and Processing Center.

4.2.1.3 Common Fish Species

As the largest lake in Oklahoma with approximately 808 miles of shoreline and over 105,500 acres of surface water, Eufaula Lake and its tributaries provide habitat for over 70 species of fish. Natural fish habitat consists of large expanses of open water, areas of submerged standing timber, sandstone rock and coarse gravel, and mud or sand flats (Bowen 2008). Tributary creeks often are lined with laydown timber and brush carried from the watershed during flood events. Water willow (*Justicia* sp.) is established in some parts of the lake, including dense stands found in areas within or adjacent to Longtown and Duchess Creeks. It grows partially submerged to depths of one foot, upslope to one to two feet above Conservation Pool elevation, and provides optimal fish habitat (Bowen 2008). Buttonbush (*Cephalanthus occidentalis*) is also common along the shorelines in many areas of the lake, growing at or above the Conservation Pool elevation. However, extended periods of high water during the past 20 years have hindered shoreline plant establishment and some areas that once had large plant beds are now bare.

High average winds and areas of long fetch also impact fish habitat by contributing to shoreline erosion and increased turbidity in shallow areas where wave action disturbs mud bottoms. Lake level fluctuations have also contributed to water quality degradation by producing scoured, bare shorelines in many areas of the lake (Bowen 2008). Soils have been transported down slope leaving underlying rock and gravel exposed. Fish species that prefer rocky habitats have benefited from this fluctuation, while species dependent on shoreline vegetation for spawning and rearing of young have been limited in those areas.

The primary forage species in Eufaula Lake are gizzard shad (*Dorosoma cepedianum*) and threadfin shad (*D. petenense*). Recent gillnetting surveys indicate that both species are present at levels that exceed the minimum acceptable catch rate for a quality forage base. Additionally, the high relative weights of sport fish recorded in the 2008 ODWC Eufaula Lake 5-Year Management Plan indicate adequate forage abundance and availability (Bowen 2008). During very cold winters the lake cools enough to cause winterkill of threadfin shad and re-stocking of this species has occurred when deemed necessary. A list of all common fish species likely found within the Eufaula Lake study area is included in **Table 4-17**.

Table 4-17. Common Fish Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name
American eel	*Anguilla rostrata*
Bigeye shiner	*Notropis boops*
Bigmouth buffalo	*Ictiobus cyprinellus*
Blackband topminnow	*Fundulus notatus*
Black buffalo	*Ictiobus niger*
Black bullhead	*Ictalurus melas*
Black crappie*	*Pomoxis nigromaculatus*
Blackside darter	*Percina maculate*
Blackspotted topminnow	*Fundulus olivaceus*
Blue catfish*	*Ictalurus furcatus*
Bluegill*	*Lepomis macrochirus*
Bluntface shiner	*Notropis camurus*
Bluntnose darter	*Etheostoma chlorosomum*
Bluntnose minnow	*Pimephales tenellus*
Brook silverside	*Labidesthes sicculus*
Channel catfish*	*Ictalurus punctatus*
Channel darter	*Percina copelandi*
Common carp	*Cyprinus carpio*
Creek chubsucker	*Erimyzon oblongus*
Cypress darter	*Etheostoma proeliare*
Dusky darter	*Percina sciera*
Emerald shiner	*Notropis atherinoides*
Fathead minnow	*Pimephales promelas*
Flathead catfish*	*Pylodictis olivaris*
Freckled madtom	*Noturus nocturnus*
Freshwater drum	*Aplodinotus grunniens*

Common Name	Scientific Name
Ghost shiner	*Notropis buchanani*
Golden redhorse	*Moxostoma erythrurum*
Green sunfish*	*Lepomis cyanellus*
Gizzard shad	*Dorosoma cepedianum*
Golden shiner	*Notemigonus crysoleucas*
Goldeye	*Hiodon alosoides*
Inland silverside	*Menidia beryllina*
Johnny darter	*Etheostoma nigrum*
Kiamichi shiner	*Notropis stramineus*
Largemouth bass*	*Micropterus salmoides*
Log perch	*Percina caprodes*
Longear sunfish*	*Lepomis megalotis*
Longnose gar	*Lepisosteus osseus*
Mimic shiner	*Notropis volucellus*
Mosquitofish	*Gambusia affinis*
Orangespotted sunfish	*Lepomis humilis*
Orangethroat darter	*Etheostoma spectabile*
Plains minnow	*Hybognathus placitus*
Pubnose minnow	*Notropis emiliae*
Redear sunfish*	*Lepomis microlophus*
Redfin darter	*Etheostoma whipplei*
Redfin shiner	*Notropis umbratilis*
Red shiner	*Notropis lutrensis*
River carpsucker	*Carpiodes carpio*
River shiner	*Notropis blennius*
Shortnose gar	*Lepisosteus platostomus*
Silver chub	*Hybopsis storeriana*
Slenderhead darter	*Percina phoxocephala*
Slough darter	*Etheostoma gracile*
Smallmouth bass*	*Micropterus dolomieu*
Smallmouth buffalo	*Ictiobus bubalus*
Speckled dace	*Hybopsis aestivalis*
Spotted bass*	*Micropterus punctulatus*

Common Name	Scientific Name
Spotted gar	*Lepisosteus oculatus*
Stoneroller	*Campostoma anomalum*
Striped bass*	*Morone saxatilis*
Suckermouth minnow	*Phenacobius mirabilis*
Threadfin shad	*Dorosoma petenense*
Walleye*	*Stizostedion vitreum*
Warmouth	*Chaenobryttus gulosus*
White bass*	*Morone chrysops*
White crappie*	*Pomoxis annularis*
Yellow bullhead	*Ictalurus natalis*

**managed game or sport fish in Oklahoma*

Fisheries

Eufaula Lake has established populations of several game fishes that are actively managed to provide anglers with quality fisheries. Major sport fish species present in Eufaula Lake include largemouth bass (*Micropterus salmoides*), smallmouth bass (*M. dolomieu*), crappie (*Pomoxis* sp.), blue catfish (*Ictalurus furcatus*), white bass (*Morone chrysops*), channel catfish (*I. punctatus*), and sunfish (*Lepomis* sp.). Walleye (*Stizostedion vitreum*), spotted bass (*Micropterus punctulatus*), and flathead catfish (*Pylodictis olivaris*) can also be caught, and striped bass (*Morone saxatilis*) are present in significant numbers below the dam. Bow fishermen are able to target gar and other rough fish like carp (*Cyprinus carpio*) and buffalo (*Ictiobus* sp.).

The black bass fishery, which includes largemouth and smallmouth bass, is among the most popular in Eufaula Lake. The largemouth bass fishery has been characterized by variable recruitment over the last 20 years. A correlation exists between high summer pool elevation and strong year class recruitment (Bowen 2008). Florida strain largemouth bass have been stocked since the late 1980s and stockings have continued on a bi-annual basis in the Longtown, Porum, and Belle Star areas of the lake. While these stockings have had limited success, largemouth bass abundance in the most recent spring survey (2008) was the second highest recorded for the lake. Reservoir-strain smallmouth bass were first stocked into the lake in 1992. Stockings continued through 1998 and were discontinued when natural reproduction was confirmed. Both the largemouth and smallmouth bass fisheries exceed the minimum electrofishing catch rate for a quality fishery.

White bass and spotted bass can also be found in healthy numbers in Eufaula Lake. White bass is Oklahoma's state fish and the current state record was caught on Eufaula Lake in 1984. The catch rate for white bass in the most recent sampling surveys was well over the minimum accepted level for a quality fishery. The abundance of spotted bass in the lake has also been increasing in recent surveys. However, there is concern that their numbers will increase further because changes in the reservoir environment as it ages may favor the reproduction and recruitment of this species (Bowen 2008). With the removal of length and bag limits on spotted bass statewide in 2009, it is hoped that anglers will increase harvests thereby reducing competition with largemouth and smallmouth bass for available food.

The Arkansas River system supports one of the few inland populations of naturally reproducing striped bass in the southeastern United States. Studies of striped bass indicate that water temperature, flow regime, and spawning habitat influence movement and migration patterns (ODWC 2010). For striped bass to successfully reproduce, a long reach of free-flowing river is needed for proper development of eggs and fry. The tailwaters of Eufaula Lake provide these conditions and support a popular fishery. Sampling in 2009 documented that striped bass from Eufaula Lake tailwaters had the highest mean length per age class of all Arkansas River system locations (ODWC 2010).

Eufaula Lake has a national reputation for great crappie fishing. Crappie thrive in areas of dense cover and prefer to spawn on sand and clay beds such as those found throughout the lake. Some of the more popular crappie areas are near bridges, riprap shorelines, brush piles, and standing timber. Recent gillnetting surveys have consistently shown catch rates well above the minimum acceptable level for a quality fishery (Bowen 2008).

Three catfish species are present in Eufaula Lake: blue, channel, and flathead. Catfish tend to prefer the deeper creek channels and rocky areas. They often use boat ramps, submerged roadways, and abandoned underwater culverts as nesting areas. Blue catfish are the most abundant in the lake with recent surveys indicating the presence of a quality fishery. While 2004 sampling surveys resulted in the highest recorded catch of channel catfish, this species tends to be less prevalent than blue catfish. The same surveys indicated that the population of flathead catfish in the lake decreased—a trend that has continued since 1988. However, ODWC still maintains that Eufaula Lake supports an abundant, fairly stable population of flathead catfish (ODWC 2004). Flathead catfish are the only species for which noodling is allowed.

Threats to both the fisheries of Eufaula Lake and the overall fish community include siltation, stratification, turbidity, aquatic nuisance species, competing water uses, declining water quality, and disease. A 2004 USACE sedimentation survey concluded that 12 percent of the water storage capacity of the lake below the normal pool elevation has been lost to sediment inflows (Bowen 2008). Erosion and sedimentation directly affect water quality and can eliminate optimal fish habitat and spawning conditions. Turbidity and true color values can also indicate a decline in water quality. As of 2008, the Fish and Wildlife Propagation (FWP) beneficial use based on these values were not supported (Bowen 2008). The FWP beneficial use is a set of minimum water quality thresholds described in the Oklahoma Water Quality Standards for parameters that impact the reproduction and survival of fish and wildlife. Therefore, by not meeting this standard, Eufaula Lake's elevated turbidity and true color values adversely impact aquatic wildlife. Colloidal clay soils in the watershed, extensive shallow areas, and strong prevailing winds all contribute to turbidity issues. Additional water quality threats include inadequate stratification due to anoxic conditions below the thermocline during summer months and acid mine drainage from abandoned coal mines into lake tributaries.

In addition to water quality threats, the fish of Eufaula Lake also face water quantity issues. Approximately 98 percent of the total water storage in the Conservation Pool of the lake is allocated to uses other than recreation (Bowen 2008). The main competing water use is hydropower generation. Approximately 96 percent of the Conservation Pool is allocated to this use, while the other 2 percent is allocated to power plant cooling water for the Kiowa Power Plant and municipal water supplies for cities and towns surrounding the lake (Bowen 2008). While there is currently no agreement with USACE for a water level management plan to benefit fisheries, under the direction of USFWS, the water level management plan in effect for the least tern (*Sterna antillarum*) inundates terrestrial shoreline weeds, grasses, and brush in the

summer months, increasing nursery habitat for juvenile fish. However, USFWS has not requested water level adjustments for the least tern since 2010.

Aquatic invasive and nuisance species also threaten the fish community of Eufaula Lake. Zebra mussels (*Dreissena polymorpha*) are present in the McClellan-Kerr Arkansas River Navigation System, 27 miles from Eufaula Lake (Bowen 2008). Quagga mussels (*Dreissena rostiformis bugensis*) also pose a threat as they, and zebra mussels, can be transported on boats and trailers moving from infested waters. Signs at public boat ramps warn recreationists of the ecological damage possible due to the introduction of these invasive freshwater mussels. Asian carp species, including silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Aristichthys nobilis*), and grass carp (*Ctenopharyngodon idella*) also present potential problems. These species are voracious feeders and prolific breeders that often displace and outcompete native species where introduced. Grass carp have been collected during ODWC sampling in Eufaula Lake. Although reproduction has not been documented, they are known to have reproduced in Lake Texoma (Bowen 2008). No widespread aquatic nuisance plant species have been widely documented in the lake; however, localized populations of both salvinia and water hyacinth have been observed. In addition, alligatorweed (*Alternanthera philoxeroides*) and curlyleaf pondweed (*Potamogeton crispus*) are both established in the Arkansas River Navigation System and have expanded their range in recent years (Bowen 2008).

Invasive species can also include bacteria and viruses that cause fish disease. Largemouth Bass Virus (LMBV) was found in the bass population in 2001. Sampling conducted by ODWC in 2002 indicated 38.9 percent of the population was infected with the virus with the level declining to 19.4 percent in 2003 (Bowen 2008). Unknown numbers of bass were lost to the disease. Dying bass were not found, but tournament results show significant increases in the average amount of time required to catch a 5 lb. bass during this time period. Further LMBV sampling has not been conducted since 2003. The presence of fish diseases is often attributed to declines in water quality and efforts to improve water quality conditions often reduce the occurrence of fish disease.

4.2.2 Reptiles & Amphibians

Oklahoma is rich in reptiles and amphibians, with 132 native species from 26 families, which is only exceeded by a few states like Texas, Florida, and Georgia in terms of species richness (ODWC 1996). Much of this variety is due to the number and contrasting characteristics of Oklahoma's ecoregions and its location in the center of the continent. Oklahoma contains a number of species found as disjunct populations—populations left behind as species' ranges shrank and shifted following climatic changes. None of Oklahoma's species are endemic to the state. Most of the reptiles and amphibians found in the state appear to have healthy, stable populations, although the status of several species is unknown or declining (ODWC 1996). Declines in reptile and amphibian populations are mainly due to loss of breeding habitat and forest fragmentation, although widespread use of pesticides and increased contamination of aquatic habitats also play a role. Species from the eastern, wetter ecoregions appear to be more at risk than species from the western, drier areas.

4.2.2.1 Reptiles

Oklahoma has 81 species of reptiles native to the state. This includes 17 species of turtle, representing four families and eleven genera, and 17 species of lizard representing seven families and ten genera. The state also contains 46 species of snake representing three families and 26 genera, and the American alligator (*Alligator mississippiensis*), which is found in the southern portions of the state outside of the Eufaula Lake study area (ODWC 1996).

According to the Distribution of Oklahoma Amphibian and Reptiles by Recorded Sightings (DOKARRS) maintained by the Oklahoma Biological Survey (OBS), over 55 species of reptiles have been observed in the five counties that are included within the Eufaula Lake study area (**Table 4-18**). This includes 12 species of turtle, 8 species of lizard, and 35 species of snake. None of these species are federally or state listed as endangered or threatened.

Table 4-18. Common Reptile Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name
Black rat snake	*Elaphe obsoleta*
Blotched water snake*	*Nerodia erythrogaster transversa*
Brown snake	*Storeria dekayi*
Bullsnake	*Pituophis melanoleucus sayi*
Coachwhip	*Masticophis flagellum*
Coal skink	*Eumeces anthracinus*
Collared lizard	*Crotaphytus collaris*
Common garter snake*	*Thamnophis sirtalis parietalis*
Common musk turtle	*Sternotherus odoratus*
Common slider	*Trachemys scripta*
Copperhead	*Agkistrodon contortrix*
Corn snake	*Elaphe guttata*
Cottonmouth	*Agkistrodon piscivorous*
Diamondback water snake	*Nerodia rhombifera*
Eastern box turtle*	*Terrapene carolina triunguis*
Eastern hog-nosed snake	*Heterodon platyrhinos*
Fence lizard*	*Sceloporus undulatus*
Five-lined skink	*Eumeces fasciatus*
Flat-headed snake	*Tantilla gracilis*
Florida cooter	*Pseudemys floridana*
Glossy crayfish snake*	*Regina rigida sinicola*
Graham's crayfish snake	*Regina grahami*
Green turtle	*Pseudemys elegans*
Ground skink	*Scincella lateralis*
Ground snake	*Sonora episcopa*
Lined snake	*Tropidoclonion lineatum*
Milk snake	*Lampropeltis triangulum*
Mississippi mud turtle	*Kinosternon subrubrum*

Common Name	Scientific Name
Missouri River cooter	*Pseudemys concinna*
Northern banded water snake*	*Nerodia sipedon pleuralis*
Night snake	*Hypsiglena torquata*
Ornate box turtle	*Terrapene ornate*
Ouachita map turtle	*Graptemys pseudogeographica ouachitensis*
Prairie kingsnake	*Lampropeltis calligaster*
Prairie skink	*Eumeces septentrionalis*
Racer*	*Coluber constrictor flaviventris*
Red-bellied snake	*Storeria occipitomaculata*
Red-eared slider*	*Chrysemys scripta elegans*
Ring-necked snake	*Diadophis punctatus arnyi*
Rough earth snake	*Virginia striatula*
Rough green snake	*Opheodrys aestivus*
Scarlet snake	*Cemophora coccinea*
Six-lined racerunner	*Cnemidophorus sexlineatus viridis*
Slender glass lizard	*Ophisaurus attenuatus*
Smooth earth snake	*Virginia valeriae elegans*
Snapping turtle*	*Chelydra serpentine*
Speckled kingsnake	*Lampropeltis getulus holbrooki*
Texas horned lizard	*Phrynosoma cornutum*
Timber rattlesnake	*Crotalus horridus horridus*
Western diamondback rattlesnake	*Croatlus atrox*
Western hog-nosed snake	*Heterodon nasicus*
Western pygmy rattlesnake	*Sistrurus miliarius streckeri*
Western ribbon snake	*Thamnophis proximus*
Worm snake	*Carphophis amoenus vermis*
Yellow mud turtle	*Kinosternon flavescens*

**observed during Spring 2012 Eufaula Lake surveys (includes visual ID or tracks)*

Among reptiles known to occur within or adjacent to the Eufaula Lake study area, alligator snapping turtle (*Macrochelys temminckii*) and Mississippi map turtle (*Graptemys kohnii*) populations are declining. These two species are listed as state species of concern with both species considered imperiled. Collection or possession of individuals is banned.

Mississippi Map Turtle

The Mississippi map turtle, while secure throughout much of its range, is declining in Oklahoma due primarily to habitat loss and collecting from the wild for the pet trade. This diurnal, freshwater turtle prefers rivers, lakes, and sloughs with soft bottom substrates and abundant aquatic vegetation. Eggs are laid in a shallow nest on land near water. ONHI occurrence data records two observations within or adjacent to the Eufaula Lake study area. The first is located near the mouth of the Deep Fork River, and the second is located in Grove Creek just east of Checotah (ONHI 2012).

Alligator Snapping Turtle

Alligator snapping turtles are large, highly aquatic turtles emerging from the water only for nesting or rarely, for basking. Preferred habitat consists of the slow-moving, deep water of rivers, sloughs, oxbows, and canals or lakes associated with rivers (*e.g.*, large impoundments). Usually these turtles occur in water with a mud or sand bottom with aquatic vegetation and underwater structures such as submerged woody debris. Nesting habitat includes sand banks and sandbars approximately 30-70 meters from water's edge (Heck 1998). Ongoing threats include habitat alteration and fragmentation, water pollution, deliberate harvest for human consumption, and incidental catch by commercial fishers. Protection requires the preservation of adequate nesting habitat and water quality (Riedel *et al*. 2005). ONHI occurrence data records an observation at the mouth of the Deep Fork River, and February 2012 field surveys recorded tracks moving from the lake to an adjacent pond near Sycamore Bay. In addition, Oklahoma State University used the area around Eufaula Lake as a capture site for a study on the genetic variation of alligator snapping turtles in Oklahoma (ODWC 2009). USFWS currently reintroduces approximately 150 alligator snapping turtles a year into state waters in an attempt to establish stable populations throughout its historic range.

4.2.2.2 Amphibians

Oklahoma has 51 species of amphibians native to the state. This includes 24 species of salamanders, representing six families and ten genera, and 27 species of frogs and toads representing five families and seven genera (ODWC 1996). Of these, DOKARRS identifies 20 that have been documented to exist within counties surrounding the Eufaula Lake study area (**Table 4-19**). None of the amphibians likely to be found within the study area are listed as threatened, endangered, or as a species of conservation concern at the federal or state level.

Table 4-19. Common Amphibian Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name
American toad*	*Bufo americanus*
Bullfrog*	*Rana catesbeiana*
Crawfish frog	*Rana areolata*
Cricket frog*	*Acris crepitans*
Eastern narrow-mouthed toad	*Gastrophryne carolinensis*
Green frog	*Rana clamitans*
Grey treefrog	*Hyla versicolor*
Many-ribbed salamander	*Eurycea multiplicata*

Common Name	Scientific Name
Mudpuppy	*Necturus maculosus*
Narrow mouth salamander	*Ambystoma texanum*
Northern leopard frog*	*Rana pipiens*
Plains leopard frog	*Rana blairi*
Red back salamander	*Plethodon cinereus*
Southern leopard frog	*Rana utricularia*
Southern toad	*Bufo terrestris*
Spring peeper*	*Hyla crucifer*
Strecker's chorus frog	*Pseudacris streckeri*
Striped chorus frog*	*Pseudacris triseriata feriarum*
Western narrow-mouthed toad	*Gastrophryne olivacea*
Woodhouse's toad	*Bufo woodhousei*

**observed during Spring 2012 Eufaula Lake surveys (includes visual or vocalization ID)*

While most amphibians often do not use the open water habitats at Eufaula Lake, they do find optimal habitat in the backwaters and emergent and forested wetlands along the shoreline. Open freshwater wetland habitats are favored by larger anuran species like the bullfrog (*Rana catesbeiana*) and southern leopard frog (*Rana utricularia*), whereas large numbers of small, vocal frogs, like the spring peeper (*Hyla crucifer*) and striped chorus frog (*Pseudacris triseriata feriarum*), prefer dense forested wetlands. Both habitats contain specific hydrologic parameters that facilitate amphibian reproduction. In addition, wetlands and adjacent uplands provide shelter and food resources. These two cover types need to be in optimal proximity to one another and not separated by impassible barriers such as busy roads. Amphibians are often exceptional indicators of ecosystem health and water quality; therefore, they often are the most sensitive to anthropogenic impacts. Any alteration or development of backwater or wetland systems or activities that sever the connection between these systems and upland habitats could potentially impact amphibian communities.

4.2.3 Mammals

Oklahoma has 101 native species of mammals from 24 families, of which four species are now extirpated (ODWC 1996). Two mammalian species, the Indiana bat (*Myotis sodalis*) and the gray bat (*Myotis grisescens*), are federally listed as endangered, and the Ozark big-eared bat (*Corynorhinus townsendii ingens*) is a federally listed endangered subspecies. These bats have declined as a result of disturbances to cave habitats, loss of bottomland forests, pesticide use, and disease. The three listed species of bats and are rare in the Eufaula Lake study area and USFWS has determined that a detailed discussion of these species and of potential project impacts is unwarranted (Stubbs 2012).

4.2.3.1 State Species of Concern

OHNI species occurrence data has identified the long-tailed weasel (*Mustela frenata*), river otter (*Lontra canadensis*), and mountain lion (*Puma concolor*) as state species of concern with recorded observations within the Eufaula Lake study area (**Figure 4-9**). While the river otter and long-tailed weasel have been documented recently, the mountain lion occurrence was from a single observation in 1968 outside of

Eufaula (OHNI 2012). This was most likely a transient individual as eastern Oklahoma does not have current evidence of a resident breeding population. Therefore, a brief discussion is given for the long-tailed weasel and river otter—the two species with documented recent occurrences within, or adjacent to, the Eufaula Lake study area.

Long-tailed Weasel

The long-tailed weasel, while fairly common in northeast Oklahoma, is a rare inhabitant in the Eufaula Lake study area and is considered critically imperiled within the state (ONHI 2012). This is primarily due to the secretive nature of the weasel, as population estimates are hard to obtain, and the fact that local populations can fluctuate wildly in conjunction with prey availability. ODWC states that populations have likely stabilized throughout the state (ODWC 2011b). Unlike many mammals, long-tailed weasels often adapt well to human habitat conversion and can be found in woodlands, agricultural fields, bottomland waterways, and brushy areas (ODWC 2011b). Weasels occupy a home range of 30 acres or more depending on prey abundance. While no long-tailed weasels have been documented within the Eufaula Lake study area, observations have been recorded in areas to the south and east of Eufaula Lake near the towns of Kinta and Lutie (ONHI 2012).

River Otter

Prior to European settlement and westward expansion, the river otter inhabited much of the United States and all major rivers of North America. River otters were documented throughout Oklahoma except in the Panhandle (ODWC 2008). However, habitat destruction, human settlement, unregulated harvest, and water pollution severely depleted or extirpated rivers otters in much of their historic range by the early 1900s. As a result, river otters have been protected by Oklahoma state law since 1917. Despite protection, between 1917 and 1971, there were only four documented accounts of otters in the state (Hatcher 1984). Otter populations are dependent on water quality, prey availability, availability of wetland habitat, and den site availability, and habitats within Oklahoma have failed to provide these necessary conditions. However, in 1984 and 1985, ODWC reintroduced river otters in eastern Oklahoma and they have since reclaimed much of their former range (ODWC 2008). During 2007-2008 studies, one otter carcass and otter sign was documented above Eufaula Lake along the North Canadian River in McIntosh County. River otter sign was also collected along the Canadian River above and below Eufaula Lake (ODWC 2008). This data is supplemented by an ONHI documented occurrence within Eufaula Lake near Mill Creek (ONHI 2012). Therefore, it is likely that river otters exist in low densities within the study area.

Even though both the river otter and long-tailed weasel are considered state imperiled and state critically imperiled, respectively, both are not exempt from legal trapping within the study area.

4.2.3.2 Common Species

According to the OBS database and observations during field surveys, over 40 native species are known to exist within or adjacent to the Eufaula Lake study area (**Table 4-20**). Four species of rodents (house mouse, Norway rat, black rat, nutria) have been introduced and populations or individuals of several domestic mammals (especially dogs, cats, and pigs) also now occur in the wild.

Table 4-20. Common Mammal Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name
Beaver*	*Castor canadensis*
Big brown bat	*Eptesicus fuscus*
Bobcat*	*Felis rufus*
Brazilian free-tailed bat	*Tadarida brasiliensis*
Coyote	*Canis latrans*
Deer mouse	*Peromyscus maniculatus*
Eastern chipmunk*	*Tamias striatus*
Eastern cottontail*	*Sylvilagus floridanus*
Eastern harvest mouse	*Reithrodontomys humulis*
Eastern mole	*Scalopus aquaticus*
Eastern pipistrel	*Pipistrellus subflavus*
Eastern spotted skunk	*Spilogale putorius*
Eastern woodrat	*Neotoma floridana*
Elliot's short-tailed shrew	*Blarina hylophaga*
Evening bat	*Nycticeius humeralis*
Fox squirrel*	*Sciurus niger*
Fulvous harvest mouse	*Reithrodontomys fulvescens*
Gray fox	*Urocyon cinereoargenteus*
Gray squirrel*	*Sciurus carolinensis*
Hispid cotton rat	*Sigmodon hispidus*
House mouse	*Mus musculus*
Long-tailed weasel	*Mustela frenata*
Marsh rice rat	*Oryzomys palustris*
Mink*	*Mustela vison*
Muskrat	*Ondatra zibethicus*
Nine-banded armadillo*	*Dasypus novemcinctus*
Nutria	*Myocastor coypus*
Old World rats (Norway, Black)	*Rattus sp.*
Plains harvest mouse	*Reithrodontomys montanus*
Plains pocket gopher	*Geomys bursarius*
Porcupine	*Erethizon dorsatum*
Prairie vole	*Microtus ochrogaster*

Common Name	Scientific Name
Raccoon*	*Procyon lotor*
Red bat	*Vespertilionidae lasiurus*
Red fox*	*Vulpes vulpes*
River otter	*Lutra canadensis*
Southern flying squirrel	*Glaucomys volans*
Striped skunk*	*Mephitis mephitis*
Swamp rabbit*	*Sylvilagus aquaticus*
Texas mouse	*Peromyscus attwateri*
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*
Virginia opossum*	*Didelphis virginiana*
White-footed mouse*	*Peromyscus leucopus*
White-tailed deer*	*Odocoileus virginianus*
Woodland vole	*Microtus pinetorum*

**observed during Spring 2012 Eufaula Lake surveys (includes visual ID, sign, or tracks)*

Game Species

Both economically and culturally, hunting and trapping have been frequent recreational and subsistence activities. Hunting and trapping is allowed in publically managed areas, such as Wildlife Management Areas (WMAs), and on private lands within the Eufaula Lake study area. Common game mammals include white-tailed deer, feral hog, eastern cottontail, swamp rabbit, gray squirrel, and fox squirrel (ODWC 2011f). While rare in areas around the lake, black bear and elk are present in portions of adjacent Latimer and Muskogee Counties, respectively. Furbearers include muskrat, nutria, raccoon, mink, Virginia opossum, striped skunk, river otter, bobcat, beaver, gray fox, red fox, and coyote (ODWC 2011f). The management of white-tailed deer, recognized as the most significant local game species, will be discussed in depth.

Currently, white-tailed deer occur in all 77 counties in Oklahoma, with an estimated statewide population of 325,000 (ODWC 2011f). They occur in all major habitat types including bottomland forests, commercial pine forests, upland hardwoods (including the cross timbers), and all of the major prairie and shrubland habitat types. Seasonal and annual movements vary greatly and are influenced by land use practices, amount of protective cover, temperature, and seasonal changes in food supplies. Carrying capacity for white-tailed deer in Oklahoma ranges from one deer per 15 acres to one deer per 125 acres depending on habitat productivity, with an average of one deer per 35 acres (Masters *et al.* 1996). Optimal deer habitat provides protective cover for shelter and bedding and loafing areas. Early to mid-successional stage forests and prairies with riparian zones or a shrub component are usually preferred (Masters *et al.* 1996).

Studies indicate that deer may eat over 100 different plant species, but the bulk of their diet in any one area may be made up of relatively few foods (Masters *et al.* 1996). Deer are primarily browsers, feeding on woody twig ends and leaves during most of the year but will also feed on forbs. When hard mast is available in the fall and winter, it is the most preferred food and may compose 50 percent of more of the diet. Hard mast includes the nuts of oaks, hickories, beech, and walnuts—trees often found in the forested

uplands within the Eufaula Lake study area. In general, the greatest hard mast yields are from older trees greater than 10 inches in diameter at breast height (DBH) with a well-developed crown (Masters *et al.* 1996). Introduced forages such as tall fescue, Bermuda grass, and Old World bluestem are undesirable food sources and single species plantings are detrimental to native wildlife.

Timber harvest, thinning, selective herbicide use, and prescribed fire are all deer habitat management techniques used in Oklahoma. However, game managers generally recommend that mature oak-pine stands are retained for acorn production and protective cover. Protection of riparian areas from grazing and development is also a good deer management strategy. Food plots are often used to provide easily accessible forage. When used as an attractant, they may increase hunter success but are not viewed as a substitute for proper habitat and population management (Masters *et al.* 1996). Due to the absence of historically-present predators, population management, through regulated hunting, is essential because deer have the capability to degrade habitat if numbers are not kept at or below carrying capacity.

Invasive Species

Several mammal species have been introduced into Oklahoma and have established populations. These invasive species include the house mouse, Norway rat, black rat, nutria, and feral hog. The house mouse and the two Old World rat species prefer areas of extensive human development, which provide ample food sources and nesting sites. The nutria and feral hog are more suited to the habitats surrounding Eufaula Lake and have the ability to do significant ecological damage within the study area.

The nutria is an aquatic rodent from South America that was introduced in the hopes of establishing a commercial fur industry. In high densities, nutria, through direct vegetation consumption, den-building activity, underground runs, and surface trails, often degrade and destroy existing marsh ecosystems (Gosselink 1984). Nutria are voracious herbivores that consume the roots of wetland plants, including the seedlings of woody species and herbaceous and aquatic plants at all life stages, which can consequently alter the composition of wetland communities. Especially vulnerable are bald cypress, which are present in only a few protected areas of Eufaula Lake such as Brooken Cove and Juniper Point Recreation Areas. Conner and Toliver (1990) reported that nearly all naturally germinating or planted bald cypress seedlings, even if protected with plastic sleeves, were destroyed by nutria if present in high densities. Nutria also displace native species such as the muskrat and beaver through direct competition. Although nutria activity has been documented to the south of the Eufaula Lake study area, little evidence of nutria activity was found during 2012 surveys.

Feral hogs are a genetic crossing between purebred wild boars, purebred domestic livestock, and hybrids of these species. Wild feral hogs cause extensive damage to natural wildlife habitat, managed food plots for deer and waterfowl, agricultural areas, farm ponds, and watering holes for livestock (Stevens 1996). The wild omnivores also compete with native wildlife for food resources, prey on young domestic animals and wildlife, damage shorelines through trampling, and carry diseases that can affect pets, livestock, wildlife, and people. Research suggests that the increasing hog population is not only damaging to terrestrial flora and fauna, but is negatively impacting native freshwater mussels and insects by contributing E. coli to water systems (Stevens 1996). According to the Samuel Roberts Noble Foundation, feral hogs are present in 74 of Oklahoma's 77 counties, including all counties within the study area (Noble Foundation 2012). Feral hogs were first observed in the east and southeast portions of the study area prior to the 1970s. Observations of hogs in the west and southwest portions of the study area began in the 1980s, with feral hogs only recently being sighted in the northern portions of the study area. In 2007, the

estimated feral hog density within the study area was 13-58 hogs per square mile (Noble Foundation 2012).

4.2.4 Birds

Due to its geographic position and diverse habitats, Oklahoma contains a diverse array of bird species. The state has 182 species of breeding resident birds, 182 species of winter residents, and 289 migrant species (ODWC 1996). Combined, they represent 17 of the 28 extant orders of birds. High species richness is due to the study area's position within the Central Flyway, a major migratory route for vast numbers of songbirds, waterfowl, waterfowl, and birds of prey. Six species have become extinct in Oklahoma, including the passenger pigeon (*Ectopistes migratorius*) and Carolina parakeet (*Conuropsis carolinensis*), and six species are federally-listed as endangered. The bald eagle (*Haliaeetus leucocephalus*) is protected by the Bald and Golden Eagle Protection Act. The bald eagle is found frequently throughout the state and is often seen along Eufaula Lake's shorelines.

Within Oklahoma, declines in bird populations are often attributed to habitat degradation and loss, hunting, predation, and pesticide use. As compared to the historical condition, Oklahoma has experienced a significant loss of prairie and wetland habitats. Extensive dam construction has also resulted in the loss of stream and bottomland forest habitats and has increased the quantity of open water lake systems. As expected, the loss and conversion of certain habitats has led to the decline of species that are dependent on them. In particular, the decline of open woodland, bottomland hardwood, and wetland habitats has negatively impacted species of ground birds and songbirds. On the other hand, several habitats currently located within the Eufaula Lake study area, while not present in large tracts historically, have provided resting, nesting, and forage areas for a variety of bird species. For example, the open water habitats of Eufaula Lake have benefited certain waterfowl and waterbird species and the encroachment of dense forests into savanna and prairie habitats have benefited certain forest-dwelling songbirds.

Coordination with USFWS and ODWC identified the federal and state protected species as well as species of conservation concern that could be affected by changes in the Shoreline Management Plan. Per discussions with regulatory authorities, the EIS should specifically address the existing condition of the bald eagle and interior least tern within the Eufaula Lake study area (Stubbs 2012). All other listed bird species and species of concern are migrants that are rarely encountered within the study area and only need to be addressed briefly within the larger migratory bird section (Stubbs 2012). Therefore, current status and life history requirements of these species are briefly discussed within **Section 4.2.4.3** and reasons why potential significant impacts are unlikely are discussed within **Section 5.2.5.3.**

4.2.4.1 Bald Eagle

Status

The bald eagle (*Haliaeetus leucocephalus*) was first listed as a federally endangered species in 1967 and was declared endangered by the state of Oklahoma in 1978 (Tulsa Audubon Society 2008). However, conservation successes have led to a rebound in eagle populations both nationally and statewide. Except for the distinct Sonoran Desert population segment in Arizona, the bald eagle was removed throughout its range from the federal list of U.S. threatened and endangered species on August 9, 2007 (USFWS 2010a). To ensure the eagles continue to thrive, USFWS is working with the ODWC and the Sutton Avian Research Center to monitor and protect eagles. If it appears that bald eagles again need the protection of the ESA, USFWS would propose to relist the species. Even though they are currently delisted, the bald eagle is still protected by the Migratory Bird Treaty Act, Lacey Act, and the Bald and Golden Eagle Protection Act

(USFWS 2010a). These laws require measures to prevent human activities from resulting in the harassment and take of bald eagles.

Species and Habitat Description

Adult bald eagles have a dark brown body and distinctive white head and tail. Unlike their parents, juveniles have mottled brown and white plumage. As they mature, juvenile eagles gradually acquire their adult plumage over the course of four to five years. Most bald eagles reach breeding age at 4 or5 years old, but many delay breeding until much older (USFWS 2010b). Adult bald eagles are 3 to 3.5 feet tall with a wingspan of 6.5 to 7 feet and can weigh 8 to15 pounds (USFWS 2010b). Like many birds of prey, the female is larger than the male. In the wild, bald eagles may live 15 to 25 years.

In Oklahoma, bald eagles tend to be migratory, with birds that nest in the northern Great Plains, Great Lakes and Canada flying south to find food and open water for the winter. Eagles begin arriving in the state in mid-October and their numbers peak in January and February (USGS 2006a). All of Oklahoma's major rivers and reservoirs, including Eufaula Lake, support wintering eagles. Major reservoirs provide areas of flooded timber that make ideal perches and open water for fishing usually can be found below dams even when other areas freeze. In contrast to their territorial behavior during the breeding season, bald eagles become sociable in winter and roost communally at night in trees near reliable food sources. In Oklahoma, the same trees are traditionally used as roost sites each year with up to 200 birds known to use a single roost (USGS 2006a). Wintering birds often use different sites for feeding and night roosts, but the sites are often in close proximity to one another.

Bald eagles are opportunistic feeders with fish comprising the majority of their diet. They will also prey on waterfowl, shorebirds, colonial waterbirds, small mammals, turtles, and carrion. Since eagles have difficulty carrying prey greater than their own weight, prey items are generally within the 3 to 5 pound range (Tulsa Audubon Society 2008). Because they rely on vision to hunt, eagles typically locate their prey while soaring or from a perch and then swoop down and strike.

Although most migrating bald eagles leave for their northern breeding grounds by the end of March, Oklahoma does have a small population of resident breeding eagles (Tulsa Audubon Society 2008). The bald eagle nesting period consists of 5 phases: courtship and nest building, egg laying, incubation and hatching, early nestling, and late nestling (USFWS 2010b). Resident eagles generally begin nest building activities in December and occupy nesting sites until eaglets fledge in late summer. During the nesting season, eagles occupy and defend a territory. A territory may include an active nest and alternate nests that are built and maintained but not used every year. Nests are usually located near large bodies of water in mature or old-growth trees, snags, and rock outcrops. In the study area, nests would be located along the shorelines of Eufaula Lake and near large tributaries in tall trees with limbs that can support a nest that can weigh more than 1000 pounds. Clutch size generally ranges from 1-3 eggs and incubation lasts 5 weeks (Tulsa Audubon Society 2008). In Oklahoma, fledging generally takes place in July (USFWS 2010b). Therefore, the entire breeding season, from the laying of eggs to first flight normally takes 16 to 18 weeks.

Range and Population Dynamics

Bald eagles are a North American species that historically occurred throughout the contiguous United States and Canada. The largest North American breeding populations are in Alaska and Canada, with significant populations residing in the Great Lakes states, Florida, the Pacific Northwest, Greater Yellowstone area, and the Chesapeake Bay region (USFWS 2010b). Most eagles that breed in Canada and

the northern United States move south for the winter. Migrations begin with eagles moving south in the late summer and early fall with eagles returning north in the spring.

Historically, many of the bald eagles that wintered in Oklahoma lived on the prairies and fed on carrion found there. An 1820 report by E. James observed that the bald eagle was seen "swarming like flies" about any spot where a bison, an elk, or a deer had fallen prey (Lish and Sherrod 1986). As the state was settled and land use changed, buffalo and elk largely disappeared from the prairies and wintering bald eagles no longer congregated in the state in such large numbers (USGS 2006a). During the 1900s, habitat degradation, pesticide use, and illegal hunting decreased the population of Oklahoma bald eagles, coinciding with a general decline nationwide. Once considered a common resident, bald eagles were reported as rare by the mid-1920s (Lish and Sherrod 1986).

However, protection under the law and restorative efforts enabled the population to begin to rebound. In addition, reservoir construction in Oklahoma over the last 60 years increased the amount of suitable habitat for bald eagles. Between 1976 and 1992, bald eagles made 25 known nesting attempts in the state (USGS 2006a). From 1984 until 1992, the Bald Eagle Restoration Program released 275 southern bald eagles into eastern Oklahoma to augment the small native population (Tulsa Audubon Society 2008). Today, over 100 breeding pairs of bald eagles nest in the state (**Figure 4-12**). In the winter, numbers surge up to approximately 800-1500 individuals. According to USFWS, the bald eagle population in the state continues to expand. In an email on December 23, 2011, ODWC reported that dozens of bald eagles migrate to the Eufaula Lake study area during the winter months (November-March) and approximately six pairs of resident, non-migratory eagles remain year-round (Howery2011b). According to the ONHI occurrence database, 11 bald eagle observances were recorded along the old South Canadian River channel (ONHI 2012). Records of 2010 eagle nest locations are currently unavailable (Barstow 2011a). The field surveys conducted for this EIS did not confirm any new nests or roosts, but did record observations of individual bald eagles flying along the shoreline in Brooken Cove on February 6, 2012, over the Mill Creek portion of the lake on May 28, 2012, and across a cove near Roberts Ridge on May 29, 2012.

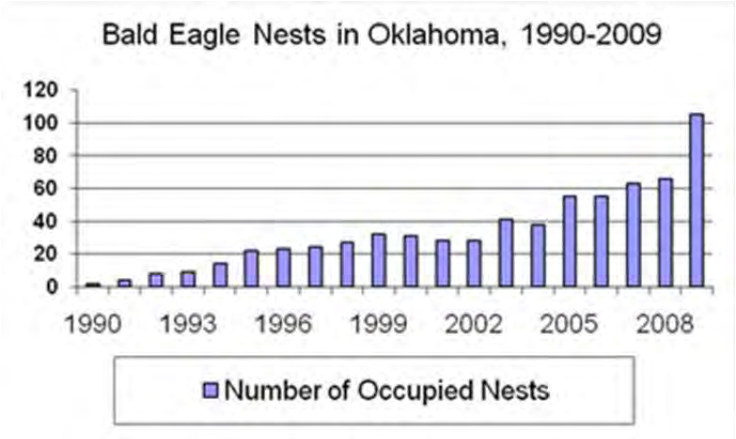

Figure 4-12. Occupied Bald Eagle Nests in Oklahoma: 1990-2009 (*Tulsa Audubon Society*)

Management and Protection

Even though they are delisted, bald eagles are still protected by the Migratory Bird Treaty Act, Lacey Act, and the Bald and Golden Eagle Protection Act (Section 3.2). USFWS continues to work with state agencies and conservation organizations to ensure the long-term viability of a sustainable bald eagle population in Oklahoma. In addition the ESA requires that a delisted species be monitored for at least five years. The

bald eagle post-delisting monitoring plan monitors the status of the bald eagle by collecting data on occupied nests over a 20-year period with sampling events held every five years starting in 2009 (USFWS 2010a). In addition, the Sutton Avian Research Center in Bartlesville, Oklahoma, has established a successful captive breeding center and continues to conduct annual nest surveys and research on the state's bald eagle population (Tulsa Audubon Society 2008).

USFWS also provides management guidelines and conservation measures to protect the bald eagle when they are most sensitive to human disturbance—during the nesting and wintering periods. Eagles are most sensitive to human disturbance during the courtship and nest building phase. It is during this period that eagles are most likely to abandon nest sites. In Oklahoma, this phase generally occurs between December and February (USFWS 2010b). Even if human disturbance is avoided during the critical first phase, eagles continue to be extremely sensitive until the young have fledged in July.

4.2.4.2 Interior Least Tern

Status

On May 28, 1985, the interior population of the least tern (*Sterna antillarum*) was listed as an endangered species under the ESA. No critical habitat rules have been published for the interior least tern. The USFWS Recovery Plan outlines strategies to conserve functional riverine sandbar habitat with the goal of increasing the interior least tern population to approximately 7,000 birds throughout its range (USFWS 1990). In Oklahoma, least terns may be found on portions of the Arkansas, Cimarron, Canadian, and Red Rivers. Although critical habitat has not been designated within the Eufaula Lake study area, interior least terns have been documented using tributaries of Eufaula Lake in Pittsburg, Muskogee, Haskell, and McIntosh Counties (ODWC 2011c). Terns may also use shallow areas along the Eufaula Lake shoreline to feed.

Species and Habitat Description

The interior least tern is the smallest North American member of the gull and tern family, measuring about 8 to 10 inches (21-24 cm) long with a 20 inch (51 cm) wingspan. Sexes are alike, characterized by a black-capped crown, white forehead, gray back and dorsal wing surfaces, snow white breast and belly, and legs of various orange and yellow colors (Szell and Woodrey 2003). It has a forked tail and a straight, pointed beak that is usually a black-tipped, deep yellow color. Immature birds have darker plumage than adults, a dark bill, and dark eye stripes on their white foreheads (USFWS 1990).

Terns live along large rivers and may sometimes be found hunting fish in shallow wetlands and the margins of ponds and lakes. The riverine nesting areas of interior least terns are sparsely vegetated sand and gravel bars within a wide, unobstructed river channel. Colonies also occur on salt flats, such as those located at the Salt Plains National Wildlife Refuge, and on beaches along lake shorelines (ODWC 2011c). Terns generally feed close to their nesting sites. Fish prey is small sized and important genera include Fundulus, Notropis, and Gambusia (USFWS 1990). Fishing behavior involves hovering and diving over standing or flowing water.

In Oklahoma, the interior least tern can be found during the late spring and summer breeding season (mid-May through late August). The peak of the nesting season occurs from mid-June to mid-July (Downing 1980). They require bare sand and gravel for nesting and typically nest in small colonies consisting of two to 20 pairs along large rivers on sand bars and scoured bends (Burger 1984). Nesting starts when river flows are high and the size of nesting areas depends on water levels (USFWS 1990). Nests are bowl-shaped depressions about 4" across containing a typical clutch of 2-3 pale to olive-buff eggs (Szell and Woodrey 2003). Both parents incubate the eggs, which hatch after approximately 24 days. Both parents feed the

young, which are able to fly after about 21 days. Least terns typically live for 1-5 years in the wild (USFWS 2011a).

Range and Population Dynamics

The interior least tern is migratory and historically bred along the Mississippi, Missouri, Red, and Rio Grande River systems. The breeding range extended from Texas to Montana and from eastern Colorado and New Mexico to southern Indiana. At the time of listing in 1985, fewer than 3,000 least terns had been recorded in the interior United States (Hill 1993). During migration, terns usually stay in close proximity to large rivers. Birds from the interior population winter along the Gulf of Mexico and on Caribbean islands. Migration begins with least terns moving south in early September and returning north to breeding grounds in May.

Widespread loss and alteration of its riverine nesting habitat has eliminated the interior least tern from many locations within its former breeding range in the interior United States. The construction of dams, large reservoirs, and river channelization has permanently submerged some nesting areas and has altered the seasonal flooding dynamics that are required to build and sustain the sandbars that terns need for nesting (Leslie *et al*. 2000). In comparison to warmer, shallower riverine habitats, reservoirs often increase the amount of deep, cold water, which decreases the availability of preferred small forage fish (USFWS 2011a). Additionally, recreational vehicle use and other disturbances around nesting colonies have reduced nesting success and reproduction (ODWC 2011c).

However, with protection under the law and restorative efforts the population has begun to rebound. Current data indicates over 8,000 least terns occur in the interior population, exceeding the 7,000-bird goal outlined in the Recovery Plan (USFWS 2011a). From 1981 to 1992, least terns were found breeding at 88 locations on major rivers, at two sites on reservoir beaches or sand spits, and at three major salt flats within Oklahoma (Hill 1993). The least tern is known to nest on sandbars along the Arkansas, Cimarron, and Canadian Rivers. They have also been documented in the Salt Plains and Sequoyah National Wildlife Refuges and along the Optima Reservoir. At Sam's Point on Eufaula Lake a 1992 survey found 25-30 adult least terns. Annual surveys on the Canadian River from 1987 to 1992 from the Burlington Northern Railroad to the river mouth found an average of 55 adult birds (Hill 1993). More recently, in an email on January 23, 2012, USFWS has indicated terns forage at Eufaula Lake and nest on the Canadian River upstream and downstream of the lake (Stubbs 2012). The OHNI occurrence database also records three least tern observations from along the Canadian River (OHNI 2012). Habitat and faunal surveys conducted in the spring of 2012 by CDM Smith biologists failed to document the presence of least terns, but did record several, undisturbed sand beaches that could serve as potential nest sites including the north shore of Roundtree Landing.

Management and Protection

Despite recent evidence of population increases, the interior least tern is still listed as an endangered species and is afforded maximum protection under the ESA. The ESA requires measures to prevent the harassment and take of interior least terns resulting from human activities. USFWS continues to work with state agencies and conservation organizations to ensure the long-term viability of a sustainable least tern population in Oklahoma. This has resulted in the development of a memorandum of understanding between the Nature Conservancy, USACE, ODWC, USFWS, Tulsa Audubon Society, City of Tulsa River Parks Authority and riverbed landowners for protection and management of essential habitat within the Arkansas River basin (USFWS 1990).

The 1990 Recovery Plan set Oklahoma recovery objectives at 1,650 breeding adults maintained in the following distribution: Arkansas River 250, Salt Plains Refuge 300, Cimarron River basin 400, Canadian River 300, North Canadian River 100, and Red River system 300 (Hill 1993). In 1988, USFWS and USACE began using airboats to census least terns along major rivers of Oklahoma. Improved survey techniques have allowed for more accurate bird counts. In 2005, this resulted in a USFWS Biological Opinion, which set a five-year goal of averaging 500 adult terns and 125 fledglings in the Arkansas River basin (Overall 2010). The 2010 annual survey counted 619 adult terns and 211 fledglings, exceeding the stated goal. In addition to "area closed" signs, colony monitoring, and public education, USACE is credited for adjusting the release of water from hydropower stations to protect nesting areas downstream (Overall 2010). Due to heavy off-road vehicle use of sandy shorelines within the study area, additional protection of local tern communities may be achieved by establishing protective shoreline buffers or by restricting development and recreation activities when terns are present during the spring and summer months.

4.2.4.3 Migratory Birds

Migratory birds are afforded protection under several regulations including the Migratory Bird Treaty Act, Migratory Bird Conservation Act, and Neotropical Migratory Bird Conservation Act (Section 3.2). While these regulations protect migratory birds at the federal level, the responsibility for managing waterfowl and other migratory species in Oklahoma falls on the Central Flyway Council. The flyway system of management was initiated in 1948 and is funded by federal tax programs on waterfowl hunters (USGS 2006b). A flyway is a term given to a heavily used bird migration route and four major flyways exist in North America. The Central Flyway generally follows the Great Plains from central Canada in the north to the Texas Gulf Coast in the south. Eufaula Lake sits on the easternmost edge of the Central Flyway and provides ample food, water, and cover for migrating birds.

Listed Species

Correspondence with USFWS in January 2012 instructed that addressing several migratory listed species individually was unnecessary and should be included within the general discussion on all migratory birds (Stubbs 2012). This is justified because these species are rare to the Eufaula Lake study area and would only be present during brief stopovers in spring and fall. Therefore, brief discussions on the status and habitat requirements of the piping plover (*Charadrius melodus*) and whooping crane (*Grus americana*) are included.

The piping plover is a small, stocky shorebird with a sand-colored upper body, white underside, and orange legs (USFWS 2011b). The piping plover is listed as federally threatened in Oklahoma. Major threats are related primarily to human activity; nesting disturbance, predation, development pressure, and inappropriate water management. It has been known to nest sporadically in Oklahoma, but no known nesting has occurred within the Eufaula Lake study area. Most birds observed in the state are passage migrants moving quickly through Oklahoma between wintering areas on the Gulf Coast and breeding grounds in the northern plains (NatureServe 2011b). Therefore, birds are most likely to be encountered at low densities within the study area during spring (April-May) and fall (August-September) migrations (Howery 2011b). Preferred nonbreeding habitats include sand and algal flats in protected bays where they feed on invertebrates. Piping plover populations are increasingly dependent on local conservation efforts and management that restrict access to beaches, enforce leash laws, and control water levels to increase exposed shoreline habitat (NatureServe 2011b).

The whooping crane stands five feet tall and has a long, sinuous neck and long legs. Its snowy white body feathers are accented by jet-black wingtips and a red and black head with a long, pointed beak (USFWS 2011c). The whooping crane has a wingspan of seven feet, and is named for its shrill, bugle-like call. It was listed as endangered throughout its range in 1967. Whooping cranes are extremely sensitive to human disturbance and declined due to conversion of pothole and prairie habitats to hay and grain production. Oklahoma, especially the Cimarron River, is a migration and staging area for whooping cranes as they migrate from breeding grounds in Canada and wintering areas along the Gulf Coast of Texas (USFWS 2011c). Critical habitat has been designated in the western portion of Oklahoma. Whooping cranes use a variety of habitats during migration, including croplands for feeding and palustrine wetlands and submerged sandbars in wide channels for roosting. While the study area contains these habitats, OHNI has no reports of whooping cranes in the vicinity of Eufaula Lake (OHNI 2012). If cranes use the study area, it would most likely be during spring (April-May) or fall (September-October) migration.

Species of Conservation Concern

Species of conservation concern are species that, while not listed, are monitored by state or federal wildlife officials. Federal and state species of conservation concern are not afforded the same protections as listed species under the ESA; therefore, in-depth analysis on potential impacts of Eufaula Lake shoreline rezoning on their populations is unwarranted. However, these species are protected under laws designed to protect all migratory birds, including the Migratory Bird Treaty Act. Thus, brief discussions on the status and habitat requirements of the peregrine falcon (*Falco peregrinus*), Sprague's pipit (*Anthus spragueii*), Bell's vireo (*Vireo bellii*), Bachman's sparrow (*Aimophila aestivalis*), and prothonotary warbler (*Protonotaria citrea*) are warranted and are included. Potential impacts to these species, some of which are seasonal residents within the Eufaula Lake study area, and to all migratory birds, are included in **Section 5.2.4.3.**

The peregrine falcon is a crow-sized raptor with slate blue-gray wings, backs barred with black, pale undersides, and white faces with a black stripe on each cheek (USFWS 2011d). They primarily inhabit mountain ranges, river valleys, and coastlines that have cliffs on which to nest. The peregrine falcon was initially listed as federally-endangered in 1970, due primarily to population declines associated with the use of the pesticide DDT. Recovery efforts and the ban of DDT increased falcon numbers to the point where both the Arctic and American subspecies were delisted (USFWS 2011d). Both subspecies are only spring (April-May) and fall (August-November) migrants in Oklahoma and both are considered federal species of concern. Due to rising population numbers in the state, in 2009, ODWC opened its first peregrine season in 30 years, which enables the trapping of one bird for falconry purposes. They are most frequently seen hunting birds near rivers and lakes, and the potential exists that they could be found within the study area at low densities during migration periods (Howery 2011b). However, OHNI does not have any documented occurrences within the Eufaula Lake study area (OHNI 2012).

Sprague's pipit is a pale, slender, sparrow-sized bird with white outer tail feathers, a thin bill, pale legs, and a heavily streaked back. A small passerine endemic to the North American grassland, the population of the Sprague's pipit is experiencing long-term, ongoing decline as a result of habitat loss, degradation, and fragmentation due to cultivation, wetland drainage, overgrazing, and invasion of non-native vegetation (NatureServe 2011c). USFWS found listing of this species to be warranted, but precluded by higher priority actions. It is currently on the candidate species list. Sprague's pipit is both a non-breeding winter resident and a passage migrant of Oklahoma. Birds leave their breeding grounds in the northern Great Plains in early September and return in late April. Therefore, Sprague's pipit would most likely be in the study area in September-October and again in March-April with an outside possibility of some birds residing there

through the winter months. Habitat during migration and in winter consists of pastures and weedy fields, including grasslands with dense herbaceous vegetation or grassy agricultural fields (NatureServe 2011c). Sprague's pipit is intolerant of grazing and low densities are reported in mowed areas.

Bell's vireo is an olive-gray songbird slightly smaller than a sparrow with a faint white eye-ring and fainter wingbars (Bull and Farrand Jr 1993). A winter resident of Central America, the Bell's vireo breeds in dense, bottomland forest thickets and in scrub-prairie. It is currently listed in Oklahoma as a species of conservation concern due to habitat loss and degradation and nest parasitism by brown-headed cowbirds (*Molothrus ater*). Preferred Bell's vireo habitat is often compromised by urban development, flood control projects, invasive plants, and agriculture (Audubon 2012). Urban encroachment increases brown-headed cowbird populations and isolates populations, which are then susceptible to localized extirpations (Audubon 2012). Bell's vireo is a summer resident that has the potential to occur in the Eufaula Lake study area from early April through late September. ODWC has documented populations in all six study area counties, particularly within sandbar willow thickets along the North and South Canadian Rivers (Howery 2011b).

Bachman's sparrow is a large sparrow that is gray above with heavy chestnut or dark brown streaks down its back. The subspecies most likely to be found within the Eufaula Lake study area, *A .a. illinoensis*, is redder in color than the other subspecies (National Geographic 2002). A summer resident of southeastern Oklahoma, Bachman's sparrow inhabits dry, open pine woodland. Spring migration occurs from mid-March to May and fall migration occurs from late-August to late-October (Dunning Jr. and Watts 1990). Populations have declined due to the effects of urban encroachment and fire regulation. As ground nesters, Bachman's sparrows are particularly sensitive to increased predation and habitat disturbance associated with edge habitats (Dunning Jr. and Watts 1990). As such, it is currently listed as imperiled in Oklahoma by ODWC. The OHNI occurrence database lists one documented sighting of Bachman's sparrow occurring in Okmulgee County near Dewar, just to the northwest of the Eufaula Lake study area (OHNI 2012).

The prothonotary warbler is a large, short-tailed, and long-billed warbler with golden yellow head and underparts and blue-gray wings and tail (National Geographic 2002). As with the Bachman's sparrow, the prothonotary warbler is a summer-resident songbird in Oklahoma where it is listed as a species of conservation concern by ODWC. This species is most likely to be observed in the study area from mid-April to mid-September (Howery 2011b). These warblers have a very specialized habitat, occurring in forested wetlands, bottomland forests, and other forested riparian habitats. These habitats occur in pockets throughout the study area and are often located where tributaries drain into Eufaula Lake. Prothonotary warblers utilize holes and cavities within riparian trees to make their nests. An active nest was located on May 28, 2012 in a cavity along the Carlton Landing shoreline to the east of the proposed Town Center. Prothonotary warbler decline is attributed to habitat loss and degradation as riparian forests are cleared for residential uses and agriculture.

Birds of Prey

One of the most visible groups of migratory birds found within the study area is the birds of prey, or raptors. Many species of hawk, falcon, owl, and vulture can be seen soaring and hunting along the lakeshore in habitats ranging from open prairie to dense oak-hickory forest (**Table 4-21**). While the conversion from a lotic to a lentic system that occurred with the creation of Eufaula Lake has had little effect on the populations of birds of prey in comparison to waterbirds and waterfowl, the development of shoreline areas and terrestrial habitat destruction and alteration greatly impact these species. Human-

associated disturbance is seen as the primary threat to raptor populations. Raptors are especially sensitive during courtship and nesting, and disturbance has been shown to lead to decreased hunting success (Richardson and Miller 1997). This is of note because the majority of raptor species are likely to be found within the study area during the breeding season. Thus, as compared to the historical condition, the current Eufaula Lake study area conditions favor species that are habitat generalists that can tolerate limited human disturbance. Field surveys in 2012 documented several observations of species well suited to the variable habitats located in the study area such as the red-tailed hawk (*Buteo jamaicensis*), red-shouldered hawk (*Buteo lineatus*), Cooper's hawk (*Accipiter cooperii*), American kestrel (*Falco sparverius*), barred owl (*Strix varia*), and black vulture (*Coragyps atratus*).

Table 4-21. Common Birds of Prey Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name	Migrant or Resident*
American kestrel**	*Falco sparverius*	Year-round Resident
Barred owl**	*Strix varia*	Year-round Resident
Black vulture**	*Coragyps atratus*	Year-round Resident
Broad-winged hawk	*Buteo platypterus*	Summer Resident
Cooper's hawk**	*Accipiter cooperii*	Year-round Resident
Great horned owl	*Bubo virginianus*	Year-round Resident
Northern harrier**	*Circus cyaneus*	Winter Resident
Red-shouldered hawk**	*Buteo lineatus*	Year-round Resident
Red-tailed hawk**	*Buteo jamaicensis*	Year-round Resident
Rough-legged hawk	*Buteo lagopus*	Winter Resident
Sharp-shinned hawk**	*Accipiter striatus*	Winter Resident
Turkey vulture**	*Cathartes aura*	Year-round Resident

**obtained from the Cornell Lab of Ornithology (2012)*

***observed during Spring 2012 Eufaula Lake surveys (includes visual or vocalization ID)*

Songbirds

In addition to birds of prey, the study area supports many species of resident and migratory passerine birds. Over 60 of Oklahoma's 180 breeding songbird species are neo-tropical migrants, which utilize the Central Flyway to reach summer breeding grounds from wintering grounds in the tropics (ODWC 2011d). Migrant songbirds occur in every habitat from short-grass prairies to moist forests and most feed on insects. Breeding bird surveys have shown that some neo-tropical migrants are currently experiencing population declines due to degradation of specific habitat requirements (ODWC 2011d). For example, species such as the white-breasted nuthatch (*Sitta carolinensis*) and northern parula (*Parula americana*) are dependent on large forested acreages to successfully reproduce (Sallabanks *et al.* 2000). Other species, such as the Kentucky warbler (*Oporornis formosus*), indigo bunting (*Passerina cyanea*), and savannah sparrow (*Passerculus sandwichensis*) utilize prairies and open woodlands, while species such as the painted bunting (*Passerina ciris*), blue-gray gnatcatcher (*Polioptila caerulea*), and tufted titmouse (*Baeolophus bicolor*) prefer scrubby crosstimbers. As these open habitats are converted to agriculture or are taken over by forest encroachment due to fire suppression, the songbird species composition shifts.

The Eufaula Lake study area, with its diverse habitats likely supports over 70 species of migrant and resident songbirds (**Table 4-22**). During CDM Smith spring 2012 habitat and faunal surveys, 30 species were observed using visual and auditory identification techniques. Many of these species are year-round residents as several of the surveys were conducted in February before the spring migration. Observed songbird species composition also depended on habitat type, with habitat generalists seen more often than habitat specialists. The most commonly observed species included the tufted titmouse, blue jay (*Cyanocitta cristata*), brown thrasher (*Toxostoma rufum*), Carolina wren (*Thryothorus ludovicianus*), Carolina chickadee (*Poecile carolinensis*), hermit thrush (*Catharus guttatus*), northern cardinal (*Cardinalis cardinalis*), northern mockingbird (*Mimus polyglottos*), swamp sparrow (*Melospiza georgiana*), and white-breasted nuthatch (*Sitta carolinensis*). Also, present were other species of wrens, cuckoos, sparrows, swifts, hummingbirds, vireos, and warblers.

Table 4-22. Common Songbird Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name	Migrant or Resident*
Acadian flycatcher	*Empidonax virescens*	Summer Resident
American goldfinch**	*Carduelis tristis*	Year-round Resident
American pipit	*Anthus rubescens*	Migrant
American redstart	*Setophaga ruticilla*	Migrant/Summer Resident
American robin**	*Turdus migratorius*	Year-round Resident
American tree sparrow	*Spizella arborea*	Winter Resident
Baltimore oriole	*Icterus galbula*	Summer Resident
Bewick's wren**	*Thryomanes bewickii*	Winter/Year-round Resident
Black-and-white warbler	*Mniotilta varia*	Migrant/Summer Resident
Blackburnian warbler	*Dendroica fusca*	Migrant
Black-throated green warbler	*Dendroica virens*	Migrant
Blue-gray gnatcatcher**	*Polioptila caerulea*	Summer Resident
Blue grosbeak	*Passerina caerulea*	Summer Resident
Blue jay**	*Cyanocitta cristata*	Year-round Resident
Brewer's blackbird	*Euphagus cyanocephalus*	Winter Resident
Brown creeper**	*Certhia americana*	Winter Resident
Brown-headed cowbird	*Molothrus ater*	Year-round Resident
Brown thrasher**	*Toxostoma rufum*	Summer/Year-round Resident
Canada warbler	*Wilsonia canadensis*	Migrant
Carolina chickadee**	*Poecile carolinensis*	Year-round Resident
Carolina wren**	*Thryothorus ludovicianus*	Year-round Resident
Cedar waxwing**	*Bombycilla cedrorum*	Migrant/Winter Resident
Chipping sparrow	*Spizella passerina*	Summer Resident

Common Name	Scientific Name	Migrant or Resident*
Common grackle**	*Quiscalus quiscula*	Year-round Resident
Common yellowthroat	*Geothlypis trichas*	Summer Resident
Dark-eyed junco**	*Junco hyemalis*	Winter Resident
Dickcissel	*Spiza americana*	Summer Resident
Eastern bluebird**	*Sialia sialis*	Year-round Resident
Eastern kingbird	*Tyrannus tyrannus*	Summer Resident
Eastern meadowlark	*Sturnella magna*	Year-round Resident
Eastern phoebe**	*Sayornis phoebe*	Summer Resident
Eastern towhee**	*Pipilo erythrophthalmus*	Winter Resident
Field sparrow**	*Spizella pusilla*	Year-round Resident
Golden-crowned kinglet	*Regulus satrapa*	Winter Resident
Grasshopper sparrow	*Ammodramus savannarum*	Summer Resident
Gray catbird	*Dumetella carolinensis*	Summer Resident
Gray-cheeked thrush	*Catharus minimus*	Migrant
Great crested flycatcher	*Myiarchus crinitus*	Summer Resident
Harris's sparrow	*Zonotrichia querula*	Winter Resident
Hermit thrush**	*Catharus guttatus*	Winter Resident
Horned lark**	*Eremophila alpestris*	Year-round Resident
House finch	*Carpodacus mexicanus*	Year-round Resident
Indigo bunting**	*Passerina cyanea*	Summer Resident
Kentucky warbler	*Oporornis formosus*	Summer Resident
Lark sparrow	*Chondestes grammacus*	Summer Resident
Loggerhead shrike	*Lanius ludovicianus*	Year-round Resident
Marsh wren**	*Cistothorus palustris*	Winter Resident
Mourning warbler	*Geothlypis philadelphia*	Migrant
Northern cardinal**	*Cardinalis cardinalis*	Year-round Resident
Northern mockingbird**	*Mimus polyglottos*	Year-round Resident
Northern parula	*Parula americana*	Summer Resident
Orchard oriole	*Icterus spurius*	Summer Resident
Painted bunting	*Passerina ciris*	Summer Resident
Red-eyed vireo**	*Vireo olivaceus*	Summer Resident
Red-winged blackbird**	*Agelaius phoeniceus*	Year-round Resident
Ruby-crowned kinglet**	*Regulus calendula*	Winter Resident

Common Name	Scientific Name	Migrant or Resident*
Savannah sparrow**	*Passerculus sandwichensis*	Winter Resident
Scissor-tailed flycatcher**	*Tyrannus forficatus*	Summer Resident
Summer tanager	*Piranga rubra*	Summer Resident
Swamp sparrow**	*Melospiza georgiana*	Winter Resident
Tennessee warbler	*Oreothlypis peregrina*	Migrant
Tufted titmouse**	*Baeolophus bicolor*	Year-round Resident
Warbling vireo	*Vireo gilvus*	Summer Resident
White-breasted nuthatch**	*Sitta carolinensis*	Year-round Resident
White-crowned sparrow**	*Zonotrichia leucophrys*	Winter Resident
White-eyed vireo**	*Vireo griseus*	Summer Resident
White-throated sparrow	*Zonotrichia albicollis*	Winter Resident
Winter wren	*Troglodytes troglodytes*	Winter Resident
Yellow warbler	*Dendroica petechial*	Summer Resident
Yellow-billed cuckoo**	*Coccyzus americanus*	Summer Resident
Yellow-breasted chat	*Icteria virens*	Summer Resident
Yellow-rumped warbler	*Dendroica coronate*	Winter Resident
Yellow-throated vireo	*Vireo flavifrons*	Summer Resident
Yellow-throated warbler	*Dendroica dominica*	Summer Resident

**obtained from the Cornell Lab of Ornithology (2012)*

***observed during Spring 2012 Eufaula Lake surveys (includes visual or vocalization ID)*

Common non-native songbird species include the European starling (*Sturnus vulgaris*) and house sparrow (*Passer domesticus*). Starlings are aggressive, superb competitors and often out-compete native species such as the red-headed woodpecker for nest holes (National Geographic, 2002). The house sparrow also interferes with the reproductive success of native species through active nest destruction. House sparrows have been documented to remove nest linings, remove or peck eggs, and remove or peck nestlings (Weisheit and Creighton 1989). While at home in a variety of habitats, both species thrive in human disturbed and edge habitats and are less common in core, interior forested areas.

Ground Birds

Historically, the prairies, savanna, and crosstimbers were regulated by frequent fires, which kept the understory free of weeds and shrubs. These open habitats supported several species of ground birds such as the greater roadrunner (*Geococcyx californianus*) and northern bobwhite (*Colinus virginianus*). However, policies restricting natural fires and a lack of controlled burns have resulted in a loss of much of this habitat. Additionally, conversion of native prairie to introduced grasses has deprived ground birds of food and cover. While many of these species can still be found in the Eufaula Lake study area, as evidenced by the observation of a greater roadrunner at Carlton Landing during 2012 surveys, populations of several species are in decline (**Table 4-23**).

Ground birds are of particular concern because several, including the mourning dove (*Zenaida macroura*), wild turkey (*Meleagris gallopavo*), and northern bobwhite are recreationally-important game species. Doves are the most hunted species of wildlife in Oklahoma and can be found in agricultural fields, savanna, and other open habitats within the study area. While dove numbers remain stable, the population of northern bobwhite, known locally as quail, is in decline. The 2011 roadside quail survey saw a decline of 81 percent below the 21-year average in bobwhite numbers statewide (Schoeling 2011). The resulting 2011 Oklahoma Quail Outlook projects low quail numbers for much of the eastern part of the state due to habitat destruction and drought (Schoeling 2011). Bobwhite can be found in protected areas of the study area, such as in the Eufaula WMA, but occurs in very low numbers (Ridge 2011).

Both Rio Grande (*M. g. intermedia*) and Eastern (*M. g. silvestris*) wild turkey inhabit the Eufaula Lake study area but they are not considered abundant and are present in only a few localized areas (Ridge 2011). While only the Rio Grande subspecies is native, the eastern subspecies was introduced for recreational hunting purposes. Birds of the open woodland, turkeys thrive in savanna and crosstimbers habitats. CDM Smith field surveys in 2011 observed wild turkeys in Arrowhead State Park and additional 2012 surveys observed wild turkeys in the Mill Creek arm of the Eufaula WMA.

Table 4-23. Common Ground Bird Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name	Migrant or Resident*
American woodcock	*Scolopax minor*	Year-round Resident
Greater roadrunner**	*Geococcyx californianus*	Year-round Resident
Killdeer	*Charadrius vociferus*	Year-round Resident
Mourning dove**	*Zenaida macroura*	Year-round Resident
Northern bobwhite	*Colinus virginianus*	Year-round Resident
Rock dove	*Columbia livia*	Year-round Resident
Upland sandpiper	*Bartramia longicauda*	Migrant
Wild turkey**	*Meleagris gallopavo*	Year-round Resident

**obtained from the Cornell Lab of Ornithology (2012)*

***observed during Spring 2012 Eufaula Lake surveys (includes visual or vocalization ID)*

Woodpeckers and Other Common Species

Woodpeckers are mentioned separately due to their need for specific habitat requirements and impact on forest health. Woodpeckers use strong claws and short legs to climb trees in order to chisel out insect prey and nest holes. Their preference for standing dead timber and territoriality make them especially vulnerable to human development and disturbance. Six species of woodpecker, including five confirmed during 2012 field surveys, are likely to inhabit the study area (**Table 4-24**). This includes the downy woodpecker (*Picoides pubescens*), hairy woodpecker (*Picoides villosus*), northern flicker (*Colaptes auratus*), pileated woodpecker (*Dryocopus pileatus*), red-bellied woodpecker (*Melanerpes carolinus*), and red-headed woodpecker (*Melanerpes erythrocephalus*). All are year-round residents and improve forest health by consuming pests such as wood-boring beetles, ants, and grasshoppers. They differ in their ability to adjust to human disturbance with downy, red-bellied, and northern flicker adapting well to areas of modest development and pileated, hairy, and red-headed woodpeckers preferring undisturbed forests and open woodland (Bull and Farrand Jr, 1993).

Both bank and barn swallows can be seen nesting under the many bridges within the study area, while tree swallows utilize standing dead timber. The American crow is a common visitor to the many parks and recreation areas and its smaller, rarer relative, the fish crow, and the belted kingfisher can be seen frequenting the marshes and riverine habitats within the study area (National Geographic, 2002). These birds tend to adapt well to some degree of human disturbance and can occupy a variety of altered habitats.

Table 4-24. Woodpeckers and Other Common Bird Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name	Migrant or Resident*
American crow**	*Corvus brachyrhynchos*	Year-round Resident
Bank swallow**	*Riparia riparia*	Summer Resident
Barn swallow**	*Hirundo rustica*	Summer Resident
Belted kingfisher**	*Ceryle alcyon*	Year-round Resident
Chimney swift	*Chaetura pelagica*	Summer Resident
Chuck-will's-widow	*Caprimulgus carolinensis*	Summer Resident
Common nighthawk	*Chordeiles minor*	Summer Resident
Downy woodpecker**	*Picoides pubescens*	Year-round Resident
Fish crow	*Corvus ossifragus*	Summer Resident
Hairy woodpecker	*Picoides villosus*	Year-round Resident
Northern flicker**	*Colaptes auratus*	Year-round Resident
Pileated woodpecker**	*Dryocopus pileatus*	Year-round Resident
Purple martin	*Progne subis*	Summer Resident
Red-bellied woodpecker**	*Melanerpes carolinus*	Year-round Resident
Red-headed woodpecker**	*Melanerpes erythrocephalus*	Year-round Resident
Ruby-throated hummingbird	*Archilochus colubris*	Summer Resident
Tree swallow	*Tachycineta bicolor*	Summer Resident
Whip-poor-will	*Caprimulgus vociferous*	Summer Resident

**obtained from the Cornell Lab of Ornithology (2012)*

***observed during Spring 2012 Eufaula Lake surveys (includes visual or vocalization ID)*

Waterfowl

Waterfowl are among the most highly valued natural resources in North America. These birds embark twice each year on long-distance journeys between their breeding areas and wintering grounds. Millions of hunters and birders flock to waterways during peak migrations; therefore, maintaining waterfowl populations and habitat is a priority for both the federal government and the state of Oklahoma. The North American Waterfowl Management Plan (NAWMP), composed and enacted by the wildlife agencies of Canada, Mexico, and the United States and described thoroughly in **Section 3.2.6**, outlines efforts to successfully protect and conserve waterfowl to ensure their continued enjoyment by hunters, birders, and the general public (NAWMP 2004).

Wetland wintering and stopover habitats provide sanctuaries, energy for maintenance, and breeding, and social requirements that perpetuate continental populations (Heitmeyer and Vohs 1984). The availability, dispersion, and quality of these habitats influence waterfowl concentrations, movements, energy budgets, and pairing processes and affect reproductive potential through physiological condition.

The Eufaula Lake study area is located along the eastern edge of the Central Flyway and is just to the west of the Mississippi Flyway (Krause 2005). Therefore, a great variety of waterfowl utilize aquatic habitats in the area. Historically, the study area consisted of large expanses of riverine habitat supplied by the North Canadian, South Canadian, and Deep Fork Rivers and their tributaries and adjacent wetlands. In nearby upland areas, prairie potholes would have dotted the landscape. These waters would have provided significant habitat for migrating and seasonally-resident waterfowl species with natural wetlands supplying the food resources needed to support large waterfowl populations. Large numbers of dabbling ducks, including mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), gadwall (*Anas strepera*), American wigeon (*Anas americana*), and green-winged teal (*Anas crecca*), were common in emergent wetland areas. Diving ducks, including canvasback (*Aythya valisineria*) and redhead (*Aythya americana*), were present in significant numbers in open water habitats. In riverine forest areas, wood duck (*Aix sponsa*) and common merganser (*Mergus merganser*) could be readily found. Three species of goose, the Canada goose (*Branta canadensis*), Snow goose (*Chen caerulescens*), and greater white-fronted goose (*Anser albifrons*) were common winter visitors (Heitmeyer and Vohs 1984).

Development of prairie pothole habitat, intense hunting pressure, and the modification of watercourses in the early 20th Century contributed to the decline of quality waterfowl habitat and led to steep population declines. Several species were granted protected status, including the Canada goose, and management programs were implemented. The loss was significant enough that the original 1986 version of the NAWMP identified prairie pothole habitat as the top priority for protection (NAWMP 2004).

The creation of Eufaula Lake from 1956 to 1964 turned the riverine and wetland system into a lake system dominated by steep banks and little aquatic vegetation. Reservoirs are constructed to maximize water storage, and most lack natural water fluctuations and shallow littoral zones that maintain the biological productivity of natural wetlands. The development of shoreline areas also reduced habitat available to waterfowl. While the species composition found within study area boundaries remains the same as the historical condition, populations of several species have declined due to shoreline degradation and the elimination of large wetland areas. Studies on waterfowl habitat in Oklahoma have concluded that protection of natural wetlands and unaltered rivers appears more ecologically beneficial to waterfowl in the state than enhancing areas associated with large reservoirs and construction of farm ponds (Heitmeyer and Vohs 1984). Species such as wood duck and mergansers that occupy riverine habitats have declined. The same is true of species like the canvasback, redhead, and northern pintail, which are sensitive to development and prefer marsh habitats (Krause 2005).

However, some species such as mallard and Canada goose have adapted well to open water habitats and human disturbance and can still be found in significant numbers. In addition, the 2005 Central Flyway Harvest and Population Survey indicates that populations of gadwall, American wigeon, green-winged teal, ring-necked duck (*Aythya collaris*), and common goldeneye (*Bucephala clangula*) in the area are rebounding from historic lows (Krause 2005). Field surveys conducted in spring 2012 documented frequent sightings of mallard, Canada goose, wood duck, and gadwall. **Table 4-25** provides a complete list of waterfowl species likely to inhabit the Eufaula Lake study area.

Waterfowl management in the study area is most evident on public protected lands. The Eufaula WMA covers over 48,000 acres and contains the largest tracts of protected wildlife habitat within the study area (Ridge 2011). The Eufaula WMA consists of six protected areas spread throughout the geographic extent of the lake. The majority of the area is located on the upper reaches of river and creek arms of Eufaula Lake, including the Deep Fork River, North Canadian River, South Canadian River, Mill Creek, and Gaines Creek. Available habitat is comprised of mainly floodplain and river bottoms and adjacent natural wetlands and uplands. In addition to maintaining the Eufaula WMA, ODWC actively manages two wetland development units (WDUs) totaling approximately 780 acres at Deep Fork and Mill Creek to provide important habitat and refuge resources to waterfowl and other migratory birds (Ridge 2011). This often includes the establishment of emergent wetland areas and the planting of quality food species.

Table 4-25. Common Waterfowl Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name	Migrant or Resident*
American wigeon**	*Anas americana*	Winter Resident
Blue-winged teal	*Anas discors*	Summer Resident
Bufflehead	*Bucephala albeola*	Winter Resident
Canada goose**	*Branta canadensis*	Year-round/Winter Resident
Canvasback	*Aythya valisineria*	Winter Resident
Common goldeneye	*Bucephala clangula*	Winter Resident
Common merganser	*Mergus merganser*	Winter Resident
Gadwall**	*Anas strepera*	Winter Resident
Greater white-fronted goose	*Anser albifrons*	Migrant
Green-winged teal	*Anas crecca*	Winter Resident
Hooded merganser**	*Lophodytes cucullatus*	Winter Resident
Lesser scaup	*Aythya affinis*	Migrant/Winter Resident
Mallard**	*Anas platyrhynchos*	Year-round/Winter Resident
Northern pintail	*Anas acuta*	Winter Resident
Northern shoveler	*Anas clypeata*	Migrant
Redhead	*Aythya americana*	Winter Resident
Ring-necked duck	*Aythya collaris*	Migrant/Winter Resident
Snow goose	*Chen caerulescens*	Migrant
Wood duck**	*Aix sponsa*	Year-round Resident

**obtained from the Cornell Lab of Ornithology (2012)*

***observed during Spring 2012 Eufaula Lake surveys (includes visual or vocalization ID)*

Waterbirds

In addition to the variety of waterfowl species, several waterbird and gull species make up a significant proportion of the avian community likely to be found within the Eufaula Lake study area (**Table 4-26**). Waterbirds, in this case, refer to birds that live in or around water and are differentiated from waterfowl in that they are not actively managed game species. This group ranges from duck-like birds such as the American coot (*Fulica americana*) to gulls and large wading birds such as the great egret (*Ardea alba*). All waterbirds have adaptations that enable an aquatic lifestyle and depend on aquatic systems for food and nesting sites. While some, such as the great blue heron (*Ardea herodias*) and double-crested cormorant (*Phalacrocorax auritus*) are year-round residents, most are seasonal visitors to Eufaula Lake.

Table 4-26. Common Waterbird and Gull Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name	Migrant or Resident*
American coot**	*Fulica americana*	Year-round Resident
American golden plover	*Pluvialis dominica*	Migrant
Black-crowned night-heron	*Nycticorax nycticorax*	Summer Resident
Cattle egret	*Bubulcus ibis*	Summer Resident
Common tern**	*Sterna hirundo*	Migrant
Double-crested cormorant**	*Phalacrocorax auritus*	Year-round Resident
Forster's tern	*Sterna forsteri*	Migrant
Franklin's gull	*Larus pipixcan*	Migrant
Great blue heron**	*Ardea herodias*	Year-round Resident
Great egret	*Ardea alba*	Summer Resident
Greater yellowlegs	*Tringa melanoleuca*	Migrant
Green heron	*Butorides virescens*	Summer Resident
Herring gull**	*Larus argentatus*	Winter Resident
Horned grebe**	*Podiceps auritus*	Winter Resident
Least bittern	*Ixobrychus exilis*	Summer Resident
Least sandpiper	*Calidris minutilla*	Migrant
Lesser yellowlegs	*Tringa flavipes*	Migrant
Little blue heron	*Egretta caerulea*	Migrant
Pied-billed grebe**	*Podilymbus podiceps*	Year-round Resident
Ring-billed gull**	*Larus delawarensis*	Winter Resident
Snowy egret	*Egretta thula*	Migrant/Summer Resident
Spotted sandpiper	*Actitis macularia*	Migrant/Summer Resident
White pelican	*Pelecanus erythrorhynchos*	Migrant
White-rumped sandpiper	*Calidris fuscicollis*	Migrant
Wilson's snipe**	*Gallinago delicate*	Winter Resident
Yellow-crowned night-heron	*Nyctanassa violacea*	Summer Resident

**obtained from the Cornell Lab of Ornithology (2012)*

***observed during Spring 2012 Eufaula Lake surveys (includes visual or vocalization ID)*

Historically, the riverine systems in the study area would have favored waterbirds adapted to floodplain wetlands and bottomland forests such as the least bittern (*Ixobrychus exilis*), green heron (*Butorides virescens*), and both species of night-heron. The creation of Eufaula Lake increased open water habitats and relegated shoreline specialists to remnant riverine areas. It is very likely that lake creation increased the individual abundance of some species, but decreased the overall number of species present. While some wetland habitats exist in backwater coves and river mouths, much of the lake shoreline has lost the aquatic vegetation and shallow littoral zones that waterbird species utilize to find food. This is due both to inundation and limited shoreline development. These same processes have favored species adapted to open water habitats such as gulls (*Larus sp.*), white pelicans (*Pelecanus erythrorhynchos*), and double-crested cormorants, which can now be frequently seen within the Eufaula Lake study area. Habitat

generalists that can tolerate human disturbance in foraging areas such as the great blue heron and American coot have also adapted to the conversion of habitat and are often seen feeding along Eufaula Lake's shorelines.

4.2.5 Invertebrates

Invertebrates constitute the largest and most diverse group of organisms found within the Eufaula Lake study area. Arthropods, insects, crustaceans, annelids, mollusks, and aquatic macroinvertebrates all fall under this umbrella. Unfortunately, detailed study on the historical and current condition of populations of invertebrates located within the Eufaula Lake study area, and within Oklahoma as a whole, is lacking. One can expect that the historical condition would have favored invertebrate species suited to the riverine and prairie systems that were prevalent before impoundment. Today, species that inhabit lentic aquatic systems and oak-pine and crosstimbers forests make up the majority of the invertebrate community. Areas adjacent to and within the Eufaula Lake study area may provide habitat for the federally-endangered American burying beetle (*Nicrophorus americanus*) and the prairie mole cricket (*Gryllotalpa major*), a state species of conservation concern. The results of a presence/absence study for the American burying beetle on government lands adjacent to the proposed Carlton Landing development are presented below.

4.2.5.1 American Burying Beetle

Status

The American burying beetle (*Nicrophorus americanus*), formerly distributed throughout temperate eastern North America, now persists in only low-density, widespread, and disjunct populations. Based on the drastic decline and extirpation of the species over nearly its entire range, in 1983, the American burying beetle was included as an endangered species in the Invertebrate Red Book published by the International Union for the Conservation of Nature (IUCN) (Ratcliffe 1997). The species was granted federal and state endangered species status in July 1989 (Federal Register Vol. 54 (133): 29652-5) (USFWS 1991).

The recovery objective is to reduce the immediacy of the threat of extinction to the American burying beetle, and over time, improve its status so that it can be reclassified from endangered to threatened (USFWS 1991). USFWS has indicated that three stable populations of at least 500 adults must be found in at least four USFWS regions of historic occurrence before a downlisting could be considered (ODWC 1995). Each population should also be self-sustaining for five consecutive years, and, ideally, contain several satellite populations. In order to facilitate recovery, at least three laboratory colonies are being maintained and reintroduction efforts are underway (USFWS 1991).

Species and Habitat Description

The American burying beetle is the largest member of the carrion beetle family Silphidae and feeds on the carcasses of dead mammals, birds, and reptiles (ODWC 2011e). Carrion beetles are an important component of a vast host of scavengers that are responsible for recycling nutrients from decaying organic matter. It reaches approximately 1.5 inches in length. Like many other beetles in the genus *Nicrophorus*, the American burying beetle is predominantly black in color, and has red or reddish-orange markings on its wing covers and red antennae. Unlike other species, the ponotum (thorax) is also red or reddish-orange and there is a small orange patch on the face between the eyes (Ratcliffe 1997).

American burying beetles reproduce only once or twice a year in the spring and summer (early May through August) (ODWC 1995). Adult beetles are nocturnal and search widely for carrion. Beetles are mobile insects and are capable of moving at least 6 km in three days or less and that movements of 1.5-2

km per night appear common (ODWC 1995). Using organs on their antennae, they are remarkably adept at detecting the odor of recently deceased organisms from as far away as two miles (Ratcliffe 1997). After flying to the vicinity of a carcass, they drop to the ground, go under the body, turn over onto their backs, and experimentally lift the remains (Ratcliffe 1997). A pair of beetles may move remains several feet until a substrate soft enough for burial is found. Gradually, soil from beneath the carcass is displaced to the side, and the carcass settles into the ground and is buried under several inches of soil.

After burial, the beetles strip away fur or feathers and work the mass into a compact ball. They then use secretions to preserve the carrion and modify the course of decomposition (Ratcliffe 1997). The female constructs a short chamber above the carcass in which she lays 10-30 eggs. Returning to the carcass, she prepares a conical depression on top of it, in which both parents regurgitate partially digested food (Ratcliffe 1997). The fluid accumulates and serves as food for the larvae that hatch within a few days.

The larvae receive parental care for the entirety of development. This is an extremely rare and highly developed behavior in insects, normally only seen in social bees and ants. The adults continue to tend the carcass, removing fungi and preventing bacterial accumulation (Ratcliffe 1997). After approximately one week, the larvae have consumed all but the bones of the carcass and the adults fly away and soon die. The young pupate in the nearby soil and emerge as adults after 48-60 days (USFWS 1991). They will overwinter as adults before resuming their active period in late spring.

Of principal importance to the American burying beetle is the burial of the food source, which removes it from competition by maggots, other carrion-feeding insects, and mammal scavengers. A significant positive relationship exists between carcass weight and brood size with beetles most likely to reproduce successfully on carcasses with a mass between 60-140 grams (ODWC 1995). Habitat and soil type also tend to influence reproductive success with success more likely in loose soil and leaf litter than in clay or gravelly soils (ODWC 1995).

Specific habitat requirements for the American burying beetle are unknown (Ratcliffe 1997). Considering the broad geographic range once inhabited by the species, it is unlikely that a specific soil or vegetation type was a limiting factor. Currently, the American burying beetle is largely restricted to areas undisturbed by human influence. This includes a wide range of habitat types including tall-grass prairie, open woodlands, and forests (ODWC 2011e).

Range and Population Dynamics

Historically, the American burying beetle was distributed in 35 states across the eastern and central United States from the eastern edge of the Great Plains to the Atlantic Coast (ODWC 2011e). However, collection records indicate that east of the Appalachian Mountains, the decline of the American burying beetle occurred in a general north to south direction, and was well underway, if not complete, by 1923 (Ratcliffe 1997). West of the Appalachians, the decline occurred later and proceeded generally from the center of the range outward, with all collections since 1960 coming from the periphery of the historical range.

The reasons for the widespread decline of the American burying beetle are uncertain. One prevailing theory involves habitat fragmentation. Fragmented habitats may have changed species compositions and lowered the reproductive success of species providing beetles with preferred carrion sources (Ratcliffe 1997). Fragmentation also increases the quantity of edge habitats, which support increased populations of vertebrate predators and scavengers such as crows, raccoons, foxes, opossums, and skunks, all of which compete with the burying beetle for available carrion.

Despite the potential role of fragmentation, American burying beetle populations appear to be more limited by the availability of suitable carcasses for reproduction (ODWC 2011e). Local and widespread extirpations of potential carrion species result in reduced abundances of carcasses that are of suitable size for successful beetle reproduction. The extinction of one of the most widespread birds in North America, the passenger pigeon, which was of optimal carrion size, could be a factor. Finally, pesticide use has been speculated as another leading cause of American burying beetle decline (ODWC 2011e).

Most agree that the population decline of the American burying beetle is most likely the result of interplay of several complex factors that include (1) artificial lighting that decreases populations of nocturnal insects, (2) changing sources of carrion because of habitat alteration and extinctions, (3) isolation of preferred habitat due to land use changes, (4) increased edge effect harboring more predators and competitors for carrion, and (5) the possibility of reduced reproductive ability due to genetic impairments caused by small population sizes (Ratcliffe 1997).

Populations of the American burying beetle have rebounded from historical lows in the 1970s to the current distribution that includes several populations located within at least seven states. In addition to Oklahoma, populations exist in Arkansas, Missouri, Kansas, Nebraska, South Dakota, Rhode Island, and Massachusetts (ODWC 2011e). The population rise is likely due to increased awareness and protection, but may also be due to an increase in surveys for remnant populations. As of 2011, the American burying beetle occurred across the eastern third of Oklahoma and has been documented in over 30 counties since 1995 (**Figure 4-13**) (ODWC 2011e). Despite its apparently wide range, it occurs in very low densities in areas where it has been observed.

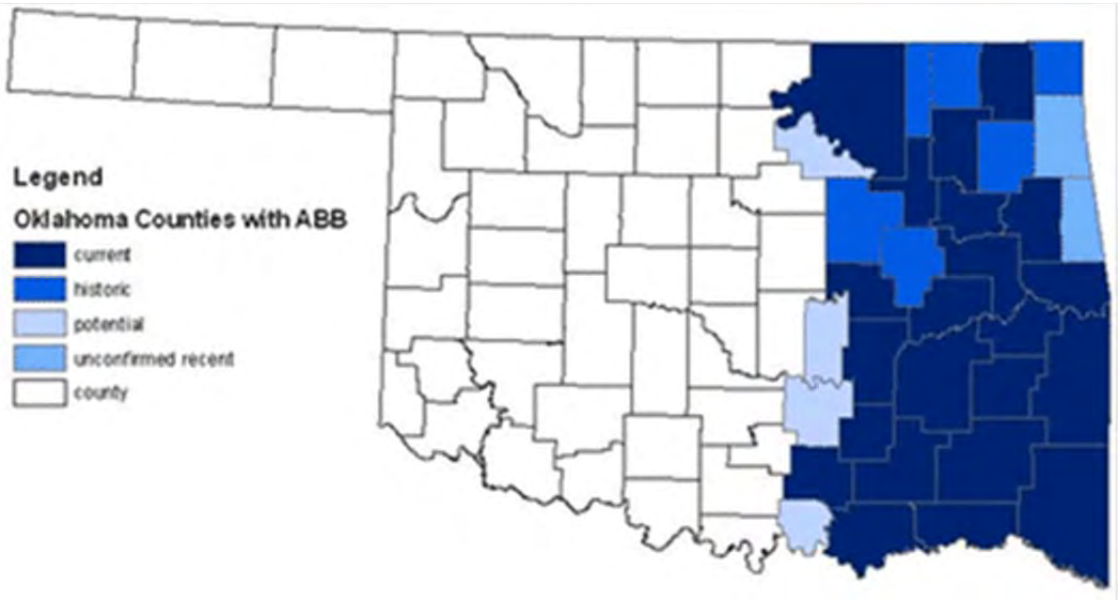

Figure 4-13. American Burying Beetle Distribution within Oklahoma (FHWA 2009)

In order to determine the presence of populations within the Eufaula Lake study area, American burying beetle surveys were conducted in May 2012. Selected survey sites include Carlton Landing and the shoreline immediately west along the Longtown Creek Arm **(Figure 4-14)**. All surveys follow procedures outlined in the USFWS Rangewide Survey Guidance and survey personnel hold a USFWS Section 10 Recovery Permit for the handling of the American burying beetle (USFWS 2011e; USFWS 2009). Survey-specific methodologies and the results are discussed below.

Figure 4-14. May 2012 American Burying Beetle Survey Transect Station Locations
(*Source: Blackbird Environmental*)

The survey was conducted over four nights from May 24 to May 28, 2012. Each of the five transect locations consisted of one, five-gallon bucket baited pitfall trap. As directed by the updated 2012 USFWS survey guidance, each pitfall trap was baited by 5:00 p.m. each evening and checked by 10:00 a.m. the following morning. All *Nicrophorus* species must be identified and recorded during the survey and should be released along the transect where they were captured.

Over the course of the four night survey five American burying beetle individuals were collected. One individual each was collected on transects one, two, and three, and two individuals were collected on transect four (**Table 4-27**). No American burying beetle individuals were collected on transect five. Transects one through four cover the entire geographic extent of the beetle survey area, and the presence of American burying beetles at all four transects indicate a widespread population present in the area, albeit at low densities. Of the five American burying beetles captured, two were female and three were male with at least two individuals of breeding age.

In addition, four other *Nicrophorus* species were collected between all survey transects. This includes three *N. orbicollis*, 46 *N. tomentosus*, one *N. marginatus*, and two *N. pustulatus*. These results indicate that the shoreline habitat within and adjacent to Carlton Landing contains suitable carrion beetle habitat supporting high species diversity. The final American burying beetle survey report composed by Blackbird Environmental that documents the survey methodology and results in detail can be found in **Appendix D**.

Table 4-27. Data Associated with *N. americanus* Captures during Presence/Absence Surveys

Date	Transect Location	Gender	Age
May 25, 2012	2	Male	Unknown*
May 26, 2012	1	Female	Unknown*
May 26, 2012	4	Female	Unknown*
May 27, 2012	4	Male	Breeding Adult
May 28, 2012	3	Male	Breeding Adult

**Individual exhibited characteristics of a newly emerged adult; however, newly emerged adult not expected during survey date.*

Management and Protection

As an endangered species, the American burying beetle continues to have full protection under the ESA. Due to the vulnerable status of this species in the wild, the overriding management priority is to protect and maintain known natural populations (USFWS 1991). The identification of unknown extant populations is integral to the species recovery. American burying beetle surveys in several areas, especially in the eastern United States, continue to be conducted in order to locate additional remnant populations and protect them from land development. Existing populations, including those in Oklahoma, continue to be monitored and managed to prevent potential harm. Several academic and zoological institutions actively breed captive populations of burying beetles in order to increase genetic stock and provide individuals for reintroduction. These institutions also conduct life history studies to determine potential causes of population decline. Similarly, DNA studies are ongoing to ascertain if any genetic differences exist between the widespread eastern and western known populations (Ratcliffe 1997).

In addition to the general protections afforded by the ESA, the American burying beetle is protected by species-specific guidance concerning its capture and handling. In order to handle the American burying

beetle, USFWS requires the acquisition of a Section 10 Recovery permit, which ensures personnel are appropriately trained in beetle identification and husbandry (USFWS 2009). Presence/absence surveys, such as the one conducted for this study, must adhere to strict USFWS protocols (USFWS 2011e). According to USFWS, the American burying beetle relocation protocol is currently being revised (Barstow 2011a).

4.2.5.2 Terrestrial Arthropods

The terrestrial invertebrate community is dominated by arthropods, specifically insects and arachnids. Arthropods serve important roles in decomposition, pollination, and as food sources for other organisms. Because this group is not well studied, accurate counts of arthropod species are unavailable; however, it is estimated that Oklahoma is home to at least 10,000 species of insects from 30 of 32 known orders (ODWC 1996). Observations during 2012 Eufaula Lake study area surveys document that butterflies and grasshoppers are most common in open habitats with beetles, wasps, and flies common in forest habitats. Common species encountered on 2012 field surveys are included in **Table 4-28**. Insect diversity in Oklahoma has likely suffered from habitat destruction and pesticide use.

Currently listed as state imperiled in Oklahoma, the prairie mole cricket has been documented within Lake Eufaula State Park in the northern portion of the study area (ONHI 2012). Historically, this large cricket was found throughout tall-grass ecosystems. However, due to habitat conversion for agricultural use, the prairie mole cricket was thought to be extinct by 1984 (Layher *et al*. 2005). Several populations have since been found in Kansas, Arkansas, Missouri, and Oklahoma. It is theorized that soil type plays a large role in determining habitat suitability (Layher *et al*. 2005). Large-scale grazing operations and urbanization, both of which compact soils, are thought to contribute to the prairie mole cricket's decline. While prairies supporting a high diversity of native grasses produce greater mole cricket populations, the species has also been found in hayfields, mowed lawns, and secondary growth fields (Layher *et al*. 2005).

Table 4-28. Terrestrial Invertebrate Species Frequently Encountered During 2012 Surveys of the Eufaula Lake Study Area

Common Name	Scientific Name
American Hover Fly	*Metasyrphus americanus*
Argiope Spider	*Argiope aurantia*
Assassin Bug	*Zelus* spp.
Backswimmer	*Notonecta* spp.
Band-winged Grasshopper	*Pardalophora phoenicoptera*
Black Swallowtail	*Papilio polyxenes*
Black-winged Damselfly	*Calopteryx maculata*
Broad-winged Katydid	*Microcentrum rhombifolium*
Cabbage White Butterfly	*Pieris rapae*
Deer Fly	*Chrysops* spp.
Deer Tick	*Ixodes scapularis*
Differential Grasshopper	*Melanoplus differentialis*

Common Name	Scientific Name
Digger Wasp	Podium rufipes
Eastern Tailed Blue Butterfly	*Everes comyntas*
Giant Wolf Spider	*Hogna carolinensis*
Great Spangled Fritillary Butterfly	*Speyeria cybele*
Hackberry Emperor Butterfly	*Asterocampa celtis*
Honey Bee	*Apis melifera*
Horse Fly	*Tabanus* spp.
Orb-weaver Spider	*Araneus* spp.
Planthopper	*Acanaloniidae* spp.
Silvery Checkerspot Butterfly	*Chlosyne nycteis*
Stinkbug	*Menecles insertus*
Water Strider	*Gerris remigis*
Widow Skimmer	*Libellula luctuosa*
Zebra Swallowtail	*Eurytides Marcellus*

4.2.5.3 Aquatic Invertebrates

Aquatic invertebrates are important indicators of water quality and comprise the base of the aquatic food web. Aquatic macroinvertebrate communities often vary widely depending on substrate and hydrologic gradient. Before impoundment, the Canadian River within the Eufaula study area would likely have had a community consisting largely of species of mayflies and caddisflies common to low-gradient rivers of the region.

The creation of Eufaula Lake would have eliminated the habitat of more lotic species and selected for aquatic macroinvertebrates that thrive in lake systems with fine sediments. In the summer months, reservoirs typically stratify and go anoxic at lower depths. The duration and geographic extent of low-oxygen conditions in part determines the composition of the benthic community. In addition to seasonal anoxic conditions derived by temperature stratification in deeper portions of the lake, Eufaula, like many regional reservoirs is characterized by periods of low dissolved oxygen due to significant organic input (Wagner 1996). However, shallow areas with a long fetch tend to remain well mixed with sufficient oxygen levels (Wagner 1996). When considering all of these factors, current macroinvertebrate communities within the study area are likely dominated by tolerant species including true flies (Diptera), mollusks (Gastropoda), worms (Oligochaeta), and several groups of crustaceans including cladocerans (Brachiopoda) and copepods (Wagner 1996). Crayfish are also abundant along lake margins and in wetland areas. During 2012 surveys, several burrows were observed in wet meadows near the mouth of the North Canadian River.

Like their benthic counterparts, invertebrates that make up the floating plankton communities are often overlooked and understudied. Plankton is made up of both plants (phytoplankton) and animals (zooplankton). However, they comprise a large portion of the living matter in lake systems and are acutely

affected by pollutants, transferring pollutants to sediments and other organisms and functioning in their biological transformation (Walsh 1978). In 1973, an Oklahoma State University study characterized the pelagic zooplankton of Eufaula Lake (Bowles 1973). Since the lake was completely filled at the time, it is expected that the current open water zooplankton community shares similarities with the community observed in 1973. A total of 23 species were found. Nine species and immature copepods composed approximately 99 percent of individuals collected. They included three cladocerans (*Diaphanasoma leuchtenbergianum, Ceriodaphnia lacustris, Bosmina longirostris*), two copepods (*Diaptomus clavipes, Mesocyclops edax*), and four rotifers (*Keratella valga, Hexarthra spp., Asplanchna spp., Polyartha vulgaris*) (Bowles 1973). The abundance of rotifers was unexpected as they are often more prevalent in the stream-like conditions that would have existed pre-impoundment. While not characterized in the 1973 study, the phytoplankton community in the study area likely reflects that of other reservoir systems and would include mainly green and blue-green algae (Walsh 1978).

Riverine systems and their associated wetlands would also have contained a different freshwater mussel community in comparison to the lentic system present today. Oklahoma has approximately 57 species of native Unionid mussels, with species richness declining from east to west across the state (Mather 2005). A relatively large proportion of these species have been identified as Species of Greatest Conservation Need, a list that was developed as part of the Oklahoma Comprehensive Wildlife Conservation Plan, due primarily to habitat conversion and destruction and invasive species (Mather 2005). After impoundment of the lake, mollusks that require faster-moving water over rocky substrates would have given way to species that can handle the low flows and fine substrates of Eufaula Lake. Historical mussel communities would have likely included rock-pocketbooks (*Arcidens spp*.), washboard (*Megalonaias nervosa*), plain pocketbook (*Lampsilis cardium*), deertoe (*Truncilla truncata*), pyramid pigtoe (*Pleurobema sintoxia*), and fatmucket (*Lampsilis siliquoidea*) (Mather 2005). Despite the loss of these species, Eufaula Lake and its surrounding riverine and wetland habitats are estimated to still possess at least 15 species of freshwater mussels (**Table 4-29**).

Three species have been confirmed within the waters of Eufaula Lake. The pink papershell was documented in Eufaula Cove (Mather 2005). The giant floater, which has been introduced in many reservoirs and is becoming widespread throughout Oklahoma, was observed at Brooken Cove Recreation Area during 2012 field surveys. Records also indicate that this species has been observed at Elm Point south of Blocker (Mather 2005). Additionally, a fragile papershell mussel was observed at Arrowhead State Park. The fragile papershell is particularly suited for Eufaula Lake in that it is one of the few mussel species that often inhabits unconsolidated and unstable substrates. Extremely weathered shells of several species were found in upland areas at several locations in the study area, indicating the presence of at least historical populations. At Carlton Landing, weathered yellow sandshell, pondmussel, and pimpleback mussel shells were observed.

Table 4-29. Freshwater Mussel Species Likely Found within the Eufaula Lake Study Area

Common Name	Scientific Name
Bluefer	*Potamilus purpuratus*
Fragile Papershell*	*Leptodea fragilis*
Giant Floater*	*Pyganodon grandis*
Lilliput	*Toxolasma parvus*
Mapleleaf	*Quadrula quadrula*

Common Name	Scientific Name
Paper Pondshell	*Utterbackia imbecillis*
Pimpleback**	*Quadrula pustulosa*
Pink Papershell*	*Potamilus ohiensis*
Pistolgrip	*Tritogonia verrucosa*
Pondhorn	*Uniomerus tetralasmus*
Pondmussel**	*Ligumia subrostrata*
Southern Mapleleaf	*Quadrula apiculata*
Threeridge	*Amblema plicata*
White Heelsplitter	*Lasmigona complanata*
Yellow Sandshell**	*Lampsilis teres*

Distribution data obtained from Mather (2005)
observed during Spring 2012 Eufaula Lake surveys (weathered specimens)*

Oklahoma's State Wildlife Action Plan identifies exotic and invasive species as one of five priority issues that threaten the conservation of state wildlife resources and two of the most prolific invaders are the freshwater zebra mussel (*Dreissena polymorpha*) and Asian clam (*Corbicula fluminea*). Zebra mussels have already been observed throughout the McClellan-Kerr Arkansas River Navigation system and are progressing down the Arkansas River (Benson *et al*. 2012). In January 2010, they were found in Eufaula Lake and monitoring is ongoing to determine the extent of infestation (Laney 2010). The zebra mussel is a prolific fouling organism, causing billions of dollars in damage to water control structures. It consumes large quantities of plankton from the water column, thus competing with native mollusks and fish. Zebra mussels also impact water quality, food availability, and fish spawning areas (Benson *et al*. 2012). Signs at public boat ramps within the project area warn visitors of the potential impacts of the zebra mussel and provide preventative measures meant to stop dispersal.

The Asian clam, while not recorded within the Eufaula Lake study area, has invaded freshwater ecosystems throughout Oklahoma including the Arkansas River from Cherokee to Wagoner Counties, Little River, Lake Texoma, Lake Overholser, and Lake Thunderbird (Foster *et al*. 2012). Several of these locations share similar habitat conditions with Eufaula Lake and are located nearby; therefore, increasing the likelihood of invasion. Much like the zebra mussel, the Asian clam is a prolific fouling organism, alters benthic substrates, and competes with native species for limited resources. Unlike the zebra mussel, several native species, including catfish, crayfish, and raccoons, have been known to feed on the Asian clam (Foster *et al*. 2012). Any changes within the study area that alter littoral zone and benthic conditions have the potential to influence the risk of establishment and spread of both invasive freshwater mussel species.

Chapter 5

Environmental Consequences

5.1 Terrestrial and Aquatic Habitats

As described in Chapter 2, NEPA requires USACE to consider a reasonable range of alternatives in the environmental impact statement. All alternatives must be rigorously explored and objectively evaluated. An evaluation of the No Action Alternative, described in Section 2.4.1., is also included to serve as a basis for comparison for the evaluation of the action alternatives. Because USACE does not have a preferred alternative at this time, the analyzed No Action and action alternatives span a range of potential future scenarios from a strong emphasis on natural resource protection to a strong emphasis on limited development and private exclusive uses. In considering potential impacts to terrestrial and aquatic habitats, this discussion begins with the No Action Alternative and progresses from Alternative 1, which emphasizes natural resource conservation, sequentially through Alternative 4, which emphasizes recreational development opportunities and private exclusive uses. Potential impacts of each alternative on existing terrestrial and aquatic habitats are evaluated.

While the No Action Alternative and four action alternatives are thoroughly explained in Section 2.4, several of the components of each of these alternatives may have a particular impact on the vegetation communities within the study area. This would include changes in shoreline allocations, vegetation management, and rezones that determine the amount of potential land disturbance and habitat alteration that might occur under each alternative.

Under existing conditions, the management of vegetation along the shoreline is permitted on a case by case basis after review of a permit application. When issued, a vegetation modification permit may allow mowing up to the shoreline unless significant wildlife or aesthetics could be impacted. The current SMP restricts the removal of flowering trees, shrubs, or redbud regardless of size as well as individuals of any species greater than 4 inches in diameter. These existing vegetation management policies, as described under the existing condition, would be the same in the future condition under the No Action Alternative.

Under each of the action alternatives, one of two potential shoreline vegetation management policies would be applied to areas designated as Limited Development. The policies vary in the width of the buffer that would be required to be left between the shoreline and the start of vegetation modification activities. The two policy options are referred to as baseline buffers and extended buffers. Under the extended buffer vegetation management policy, implemented under Alternatives 1 and 2, a buffer width of 55 to 95 feet wide would be established depending on slope, soil type, and vegetation cover type. The baseline buffer vegetation management policy, which would be implemented under Alternatives 3 and 4, would require smaller buffer zones of 30 to 70 feet in width. Larger buffer zones would be expected to protect a greater amount of existing shoreline habitat from mowing and cutting and would likely have a greater beneficial impact on water quality.

Likewise, the potential for disturbance to terrestrial and aquatic habitats would vary depending on the alternative selected due to differences in the amount of land development and dock construction each allows. The No Action Alternative would keep the status quo and would allow development within already designated Limited Development and Public Recreation areas. This has the potential to result in the

construction of over 7,000 additional boat docks, which would likely alter shoreline habitats as compared to the existing condition. Alternatives 1 and 2, which emphasize natural resource conservation, would likely see an increase in the quality and quantity of both terrestrial and aquatic habitats resulting from an increase in shoreline allocated as Protected. The quality and quantity of habitats would decrease slightly under Alternative 3 and would decrease further under Alternative 4, as more shoreline allocated as Protected would convert to Limited Development and/or Public Recreation. Potential impacts on each specific terrestrial vegetation community, wetland type, invasive species, and rare and imperiled species are explained in detail.

5.1.1 Terrestrial Habitats

The Eufaula Lake study area lies within four Level IV ecoregions that are made up of six terrestrial natural vegetation communities. These communities include crosstimbers, oak-hickory forest, oak-pine forest, bottomland hardwood forest, savanna, and prairie. Each terrestrial vegetation community consists of several dominant plant associations that support a variety of wildlife. Therefore, the potential impact of each alternative on the terrestrial habitats would not only affect plant species diversity but would influence the wildlife species diversity therein. Fire suppression practices would not change under any of the alternatives because these practices are largely outside of USACE control; therefore, effects related to fire suppression would likely to continue under all future scenarios.

USACE generally honors past written commitments, such as permits related to vegetation modification practices. Any changes to vegetation management policies included within any proposed alternative would only aply to the issuance of new permits.

No Action Alternative

The crosstimbers, dominated by stands of stunted post and blackjack oaks, is one of the most common habitat types in the Eufaula Lake study area. Under the No Action Alternative, the future condition of the crosstimbers would likely be the same as that described for the existing condition outlined in Section 4.3.1.1. Therefore, this habitat would likely remain stable with losses concentrated in undeveloped areas currently zoned Limited Development or Public Recreation. Much of the crosstimbers habitat in the study area would exhibit a more forest-like structure than historically as a result of continued fire suppression. Fire suppression would also enable an increase in abundance of eastern red-cedar (ODWC 2005).

The oak-hickory forest community resembles the crosstimbers in species composition and structure; therefore, the No Action Alternative and action alternatives would likely have similar potential impacts on both forested habitats. The future condition under the No Action Alternative would likely consist of an oak-hickory community similar to the existing condition outlined in Section 4.3.1.1. Therefore, this habitat would likely remain stable or may decline slightly, with losses concentrated in undeveloped areas zoned as Limited Development or Public Recreation and scheduled for development. Unlike the crosstimbers, Spring 2012 habitat transects observed very little variation in age structure in oak-hickory forests and little tree recruitment was evident. Therefore, the future condition under the No Action Alternative could become an unstable forest community if older trees die and are not replaced.

Much like the crosstimbers habitat, oak-hickory forests in the study area would continue to exhibit a more forest-like structure than historically as a result of long-term fire suppression. This practice, which is largely outside of USACE control, has also enabled an increase in abundance of eastern red-cedar (ODWC 2005).

The oak-pine forest community is dominated by shortleaf pine and a variety of oak species. Often occupying ridgetops and upper slopes within the project area, the future condition of oak-pine forests under the No Action Alternative would likely reflect the existing condition described in Section 4.3.1.1. Much like the crosstimbers and oak-history forests, oak-pine forests represent second-growth, even-aged forests with a tree density exceeding the historical condition. The amount of ground cover, presence of invasive species, and evidence of tree recruitment vary throughout the study area and is influenced by decades of fire suppression.

While the potential impacts of the five alternatives on the three upland forest communities are remarkably similar, differences exist when analyzing the expected impact of each alternative on the bottomland hardwood forest community. While historical wetland conversions were dominated by agriculture, development now accounts for the majority of forested wetland loss (Faulkner 2004). Bottomland hardwood forests, often represented by floodplain forested wetlands dominated by tall deciduous trees, are particularly sensitive to changes in hydrology; especially flood cycles (Faulkner 2004). Under the No Action Alternative, the decreasing trend in the quantity and quality of riparian forests documented region-wide and in Section 4.3.1.1 would likely continue. This trend would be continued due primarily to land use conversion, fluctuating hydroperiod, and the severed connection of many streams in the study area from their floodplains. The largest tracts exist within the floodplains of the Deep Fork River in the northwest and Gaines Creek in the south. While these bottomland forests are protected and are not subject to shoreline reallocation, the greatest habitat losses would likely occur in areas previously zoned Limited Development or Public Recreation, particularly along smaller tributaries.

Revisions to the SMP and MP land classifications may have the greatest potential impact on open habitats, such as savannas and prairies, because these habitats are often preferred locations for development. The flat topography, well-drained dry soils, and lack of dense understory and canopy vegetation are conducive to easy land conversion. Unprotected open habitats occur throughout the Eufaula Lake study area, but are most prevalent along the northern shoreline. Specific areas include prairies found adjacent to Paradise Point and Midcreek Arm Cove and savanna areas adjacent to the Mill Creek Bay Estates development.

While open habitats represent a relatively small portion of the study area, they support a large diversity of plants and animals maladapted for forest life. As explained in Section 4.3.1.1, savanna and prairie communities are dependent on fire and post-settlement fire suppression policies have slowly aided in the conversion of these habitats into forestlands. Where prairie habitat remains, encroachment of non-native plants has resulted in changes to the plant community composition and structure. Under the No Action Alternative, the future condition of natural open habitats would likely be the same as the trend described under the existing condition. Prairie and savanna habitats would likely continue to exist in a poor and degraded condition. In addition to direct habitat conversion for human uses, natural open habitats are decreasing because woody species, especially eastern red-cedar, are expanding. This results in prairie habitats transitioning to savanna and savanna habitats to forest as a result of fire suppression.

Alternative 1

Under Alternative 1, the quantity and quality of crosstimbers habitat would likely increase compared to the condition described under the No Action Alternative. The establishment of extended vegetation management policy buffers would protect more crosstimbers habitat along the lakeshore than would be protected under the No Action Alternative. In addition, the increase in shorelines allocated as Protected would conserve current crosstimbers habitat from future development for dock access and from increased edge effects due to development of adjacent properties. Edge effects refer to the increase in adverse

environmental conditions experienced by individuals located on the periphery, rather than within the interior core, of a habitat unit. Effects include increased exposure to wind, predators, disease, and invasive species.

The potential increase in shoreline allocated as Protected would likely reduce the effects of fragmentation caused by urbanization, road construction, and utility right of ways. Fragmentation reduces ecosystem health by decreasing plant reproductive potential, increasing the percentage of plants exposed to edge effects, and providing an avenue for pest and disease introduction. Alternative 1 would also help stem the widespread loss of native understory vegetation due to the introduction of exotic forbs associated with human disturbance, which is widely documented in Oklahoma (ODWC 2005).

Alternative 1 would also likely result in an increase in the quantity and quality of oak-hickory habitat compared to the condition described under the No Action Alternative. Extended vegetation management policy buffers implemented under this alternative would conserve more oak-hickory habitat along the lakeshore. In addition, the increase in shoreline designated Protected would protect current oak-hickory habitat from future development and increased edge effects due to development of adjacent properties. The increase in areas allocated as Protected, especially under Alternative 1 and to a lesser extent under Alternative 2, would reduce the effects of fragmentation caused by urbanization, road construction, and utility right of ways.

Under Alternative 1, the future condition of oak-pine forest habitat would likely be similar to that described under the No Action Alternative with a slight increase in the quantity of conserved areas. The inclusion of extended buffers in areas of Limited Development would protect oak-pine forests along the shoreline, such as those found in unprotected areas along Brushy and Gaines Creeks. However, shoreline buffers may have a lesser impact on oak-pine forests in comparison to oak-hickory forests, since oak-pine forests are often found on higher slopes and ridges. Under Alternative 1, the increase in land allocated as Protected would conserve current oak-pine habitat from future development and decrease edge effects due to less development of adjacent properties. This would have the additional effect of reducing fragmentation caused by urbanization, road construction, and utility right of ways. However, as in the other upland forest communities, continued fire suppression could continue to promote dense understory growth and favor species able to thrive under such conditions.

Potential impacts of Alternative 1, with its significant emphasis on habitat conservation, would likely result in a future bottomland hardwood forest community similar to that described under the No Action Alternative. However, Alternative 1 differs from the No Action Alternative in that it would prevent future human disturbance and development in many areas now allocated as Limited Development. Less development would likely result in fewer sediment and nutrient inputs into these forested wetlands and could improve overall forest health (Faulkner 2004).

Maybe more importantly, and in contrast to the No Action Alternative, the extended buffers implemented under Alternative 1 would likely protect a large proportion of these stream bank and lakeshore forests. The proposed establishment of extended riparian buffers would not only conserve bottomland hardwood forests but would improve water quality by filtering out sediment and nutrients from overland flow. Despite increased protections, Alternative 1 would not address degradation of many areas of bottomland forest cut off from periodic floodwaters due to channelized streams, armored banks, and water management policies. Flooding delivers necessary sediments and nutrients into the forested wetland systems, but a delicate balance is required. Excess water would likely result in tree die off and conversion

to emergent wetland or open water, and inadequate water would likely contribute to takeover by more competitive upland species.

Alternative 1 would likely protect existing areas of savanna and prairie in their existing condition and prevent direct land conversion in areas not allocated Limited Development or Public Recreation. The establishment of extended management buffers would conserve any open habitats immediately adjacent to the shoreline; however, most open habitats exist in flat upland areas far from the lakeshore and buffers may have little impact on overall habitat protection. Alternative 1, unless accompanied by a future change in land management policy, likely would not curb the expansion of eastern red-cedar and other woody plants or the increased abundance of exotic grasses and forbs into savanna and prairie habitats.

Alternative 2

In comparison to the No Action Alternative, an increase in areas allocated Protected under Alternative 2 would discourage shoreline development, thereby conserving terrestrial habitats on properties unsuitable for docks or without adjacent subdivisions. The establishment of extended buffers would also conserve more habitat than the No Action Alternative. However, Alternative 2 allocates far less shoreline as Protected in comparison to Alternative 1 and could result in as many as 5,873 total boat docks. This maximum build out is greater than the 2,278 docks that could potentially be constructed under Alternative 1. Therefore, Alternative 2 would likely have similar types of potential impacts, but would offer less protection, than Alternative 1 on terrestrial habitats due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline allocated as Limited Development.

Alternative 3

Under Alternative 3, the potential for development of crosstimbers habitat would likely increase with the reallocation of lands from Protected to Limited Development. Limited Development would likely facilitate the conversion of crosstimbers habitat due to an increasing number of residential developments and associated infrastructure expansion. Fragmentation of large areas of crosstimbers habitat would likely increase edge effects and increase the susceptibility of disturbed areas to invasive exotics. An increase in development would also likely result in an increase of herbicide use. Herbicides influence forest structure and result in fewer closed-canopy forests and more open woodland and park-like settings (Schulz *et al*. 1992). This, in turn, would favor a wildlife community that is more adapted to open woodland habitats. Despite the impacts of increased development, Alternative 3 establishes baseline vegetation management policy buffers, which, while smaller than the extended policy buffers, would conserve more shoreline crosstimbers habitat than under conditions described for the No Action Alternative.

Under Alternative 3, the reallocation of lands from Protected to Limited Development would increase the potential for development of oak-hickory habitat. As described for crosstimbers habitats, Limited Development would facilitate the conversion of oak-hickory forest habitat to maintained open habitats due to an increasing number of residential developments and associated infrastructure expansion. Fragmentation of large forested areas would likely increase edge effects and increase the susceptibility of disturbed areas to invasive exotics. Development also would likely result in an increase in selective forest management, resulting in removal of sub-canopy and ground layers. This conversion to parkland would likely favor a wildlife community better adapted to disturbed, suburban habitats. Despite the potential impacts involved with increased development, Alternative 3 establishes baseline buffers, which would

likely protect more shoreline oak-hickory habitat than the No Action Alternative but less than extended buffers proposed in Alternatives 1 and 2.

The potential for increased development and associated human disturbance of oak-pine forests would likely increase under Alternative 3 with the reallocation of lands from Protected to Limited Development. Increased areas of Limited Development would likely facilitate the conversion of oak-pine habitat due to an increasing number of residential developments and associated infrastructure expansion. Habitat conversion may be disproportionately high because oak-pine habitats often occupy lakeshore ridges ideal for residential communities. Fragmentation of large areas of oak-pine habitat would likely increase edge effects and increase the susceptibility of disturbed areas to invasive exotics. Even in government-managed areas such as Hickory Point Recreation Area, high human traffic has resulted in the establishment of invasive plant species like Japanese honeysuckle. Human influence also contributes to eastern red-cedar expansion, of which oak-pine communities are particularly susceptible due to the similar environmental requirements of red-cedar and shortleaf pine. Despite the potential impacts of increased development, Alternative 3 establishes the baseline vegetation management policy buffers, which, while smaller than extended policy buffers, would conserve more shoreline oak-pine habitat than future conditions described under the No Action Alternative.

As previously described for the three upland forest habitats, Alternative 3 establishes baseline vegetation management buffers in Limited Development areas that would likely preserve large areas of bottomland hardwood forest. However, in comparison to upland forest habitat types, bottomland hardwood forests are more likely to be located adjacent to the shoreline and would likely derive greater benefit from buffer implementation. While baseline buffers would protect more bottomland hardwood habitat than under the No Action Alternative, it would conserve less acreage than the extended buffers proposed in both Alternatives 1 and 2.

Despite buffer protection for forested wetlands immediately adjacent to the shoreline, Alternative 3 would likely subject large tracts of bottomland forest located in broad floodplains to development. The emphasis on Limited Development would likely promote direct riparian vegetation removal as residential subdivisions seek greater stream and lake access.

Although Alternative 3 would subject those bottomland hardwood forests located outside of the baseline buffers and within areas reallocated to Limited Development to greater levels of development, within the study area, most remaining contiguous bottomland hardwood habitats are present along lake tributaries in areas designated as Protected under Alternative 3. Therefore, the greatest potential impacts of shoreline reallocation on bottomland hardwood forests would likely be indirect as a result of upstream development. The survival of these forested wetlands is dependent on levels of water, nutrient, and sediment inputs from surrounding upland areas. Potential increased development under Alternative 3 would likely disrupt natural hydrology and increase sediment and nutrient inputs through land disturbance activities including construction, increased impervious surfaces, and active vegetation management.

Under Alternative 3, shoreline reallocation would likely facilitate development of existing savanna and prairie habitats located outside baseline vegetation management policy buffers. Within the study area, these open habitats are often small and embedded within larger tracts of forest. Therefore, these open habitats are often some of the first areas identified for residential developments and infrastructure projects including roadways and utility easements due to ease of construction and less intensive vegetation removal. Savanna areas would likely experience selective vegetation removal where all but the largest

trees are removed to establish parkland, residential lawns, and easy lake access. Prairies would likely be seeded with turf grass for landscaping purposes in residential and recreational areas. Potential indirect impacts to savanna and prairie habitats would likely include herbicide use in adjacent road and utility right of ways that reduce the abundance and diversity of native forbs and shrubs.

Alternative 4

Compared to Alternative 3, the future condition under Alternative 4 would likely result in potential terrestrial habitat impacts that are magnified and more widespread due to an increase in the number of shoreline miles being reallocated from Protected to Limited Development. Under Alternative 3, 96 shoreline miles would be reallocated, but that number increases to 208 shoreline miles under Alternative 4. In addition, eight miles of shoreline, most of which are concentrated adjacent to the proposed Carlton Landing development property, would be reallocated from Protected to Public Recreation. Shorelines designated Public Recreation do not need to comply with proposed vegetation management policy buffers and could result in greater potential impacts to terrestrial habitats in those areas.

Due to the fact that the majority of the proposed Carlton Landing development property consists of crosstimbers habitat, the level of development on this property would determine the quantity and quality of crosstimbers in that region. Under Alternatives 1, 2, and 3, the shoreline allocation would not allow for the development of recreation facilities on the government shoreline, and the scale and extent of development would be similar to that described for the No Action Alternative. However, under Alternative 4, the full build-out would be allowed leading to conversion of crosstimbers habitat to parkland and recreational facilities. Adjacent areas left in their native state would be highly disturbed by landscaping activities and high levels of foot and vehicle recreational traffic.

In addition to crosstimbers forests, the Carlton Landing proposed development and adjacent Roundtree Landing consist of oak-pine forest habitat. Some of the largest tracts of oak-pine forest within the study area exist on or near Carlton Landing; therefore, the level of development would likely determine the quantity and quality of remaining habitat in this area. Under Alternatives 1, 2, and 3, the shoreline designation would not allow for the development of recreation facilities on the government shoreline and the scale and extent of development would be similar to that described for the No Action Alternative. However, under Alternative 4, the full build-out would be allowed leading to extensive conversion of oak-pine habitat to parkland and recreational facilities. Adjacent areas left in their native state would be highly disturbed by landscaping activities and high recreational traffic. However, removal of nearby crosstimbers forests could eventually result in a greater percentage of oak-pine forest as shortleaf pine often regenerates faster than post or blackjack oak.

Because bottomland hardwood forests, oak-hickory, and prairie habitats are not located within the proposed Carlton Landing development property, the development proposal would not directly impact these communities. Savanna habitats are present only in small openings within surrounding crosstimbers and oak-pine forests; therefore, the potential impacts associated with Alternative 4 on savanna habitats would be similar to those described for the two forested habitats.

5.1.2 Aquatic Habitats

Open water and wetland habitats within the study area have the potential to be impacted by any of the alternatives. Aquatic habitats are landscape sinks that accumulate materials resulting from both terrestrial and wetland disturbances including excess storm flows, nutrients, sediments, salts, heavy metals, trash, debris, and other contaminants (Zedler and Kercher 2004). Nearly every disturbance to an upland

watershed causes some change downstream. For example, sediments flow into wetlands from increased erosion stemming from increased development and transform water quality in lacustrine limnetic habitats and cover rock and gravel substrates under a layer of silt. Therefore, the greatest potential impacts of all alternatives on open water lacustrine habitats would most likely be changes in water quality, which are discussed in the Water Quality Technical Memorandum. Additionally, low-lying wet depressions that make up most of the emergent and scrub-shrub wetlands within the study area can be topographically altered by sediment influx and can be smothered by accumulated trash and debris (Zedler and Kercher 2004).

All potential future actions, including the No Action Alternative, do not change current fire management policies and thus do not address the role of fire in maintaining emergent and scrub-shrub wetlands. If fire is absent and hydrological conditions are favorable, woody species may encroach upon herbaceous wetland systems, slowly converting them into scrub-shrub wetlands. Likewise, the stunted or young trees that dominate scrub-shrub wetlands may mature in the absence of fire or hydrological controls and transform into forested bottomland hardwood wetlands. The conversion of open wetland habitats into forested wetland habitats alters community structure and could reduce the overall habitat and wildlife diversity found within the study area.

No Action Alternative

The substrates present in lacustrine littoral zones could change dramatically with changes in the type of development adjacent to the government shorelands, thereby potentially impacting the native plant and animal species that utilize such habitats. The future condition under the No Action Alternative would continue to allow moderate development in areas designated Limited Development or Public Recreation. Therefore, sedimentation rates and nutrient inputs would likely be similar to those described for the existing condition in the short-term with gradually increasing levels expected as the percentage of developed land increases. In areas of highly erodible soils and steep banks, fine sediments disturbed by an increase in dock construction and recreational activity would likely transform rock and gravel dominated substrates. In addition, the current vegetation management policy, which allows mowing and fertilizer use up to the shoreline, would continue to contribute to littoral zone degradation through sediment and nutrient runoff.

In addition to the potential impacts to littoral zone wetland and open water habitats along the shoreline, each alternative could potentially affect palustrine emergent and scrub-shrub wetlands located along stream floodplains and in wet depressions within the Eufaula Lake study area. The future condition under the No Action Alternative would likely reflect the continued downward trend in wetland quantity and quality described under the existing condition.

The final wetland habitat present within the Eufaula Lake study area, palustrine forested dead wetlands, may also be potentially impacted by revisions to the SMP and MP land use classifications. However, because they often exist in open water habitats within the lake proper, shoreline use may have minimal impact. Therefore, only those stands close to shore or within a planned boating channel would likely be impacted. Under the No Action Alternative, the future condition of areas of standing dead timber would be the same as those described under the existing condition and would slowly be reduced due to wind and wave action and decay. Standing dead timber may also be removed to reduce navigation hazards, but most areas would likely remain untouched to provide ideal fish habitat.

Alternative 1

In the lacustrine littoral zone, the future condition under Alternative 1, which would implement extended management policy buffers, would likely improve substrate heterogeneity throughout the lake by decreasing sedimentation and would reduce algal blooms due to a reduction in nutrient inputs. Alternative 1, with its emphasis on natural resource conservation, would also allow less development associated with lake access and recreation along the shoreline. Fewer developments on adjacent properties would result in less riparian vegetation removal and fewer flood control structures, which would improve shoreline aquatic habitats. Additionally, Alternative 1 would limit dock construction considerably, with a maximum of only 2,278 potential docks compared with 8,746 under the No Action Alternative. While docks can provide habitat for fish and resting places for waterfowl, the benefits of private floating docks are generally offset by the fact they shade shoreline waters, reducing plant productivity. They also provide optimal attachment points for invasive mussels and facilitate their dispersal.

Similarly, in comparison to the No Action Alternative, protections derived from land allocation changes and extended buffer implementation under Alternative 1 would likely improve vegetated wetland quality and quantity. In addition to the benefits listed for littoral zone wetland habitats, many undeveloped areas currently designated Limited Development would be changed to Protected. This rezoning would likely discourage adjacent residential development, which could avoid future wetland filling and dredging. Lower levels of development in uplands, which provide wetlands with sources of water, nutrients, and sediment, would also protect adjacent wetlands from potential impacts.

Under Alternative 1, areas containing stands of dead timber would be rezoned as Protected or would not see a change in shoreline designation. Therefore, under this alternative, the future condition of areas of palustrine forested dead wetlands would largely be similar to that described under the No Action Alternative.

Alternative 2

In comparison to the No Action Alternative, an increase in areas allocated as Protected under Alternative 2 would discourage shoreline development, thereby conserving wetland areas on properties unsuitable for docks or without adjacent subdivisions. However, Alternative 2 allocates far less shoreline as Protected in comparison to Alternative 1. Alternative 2 allocates 87 additional miles to the Protected shoreline designation in comparison to the No Action Alternative. This is 140 miles less than the 227 miles Alternative 1 allocates to the Protected shoreline designation. In addition, Alternative 2 allows for approximately 2,800 fewer docks to be constructed than the No Action Alternative, but allows for the potential construction of almost 4,000 more docks than Alternative 1. Therefore, while Alternative 2 would likely have similar potential impacts as Alternative 1 on aquatic habitats due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer miles of shoreline allocated as Limited Development, the potential impacts would be smaller in magnitude due to fewer conserved shoreline miles and an increase in dock construction.

Alternative 3

Within the Eufaula Lake study area lacustrine littoral zone, Alternative 3 would likely have both beneficial and adverse potential impacts. In comparison to the No Action Alternative, the implementation of the smaller buffers associated with the baseline vegetation management policy would benefit littoral zone aquatic habitats. However, compared to No Action, the positives derived from the implementation of baseline buffers would likely be offset by potential impacts related to the increased development allowed

under Alternative 3. Increased development would increase impervious surfaces; thereby, increasing runoff of sediment and nutrients into Eufaula Lake's shallow water habitats. Increased construction of boat docks would likely lower the productivity of littoral habitats and could promote invasive species establishment. A greater number of boat docks would also increase recreation activity on the lake. The presence of more recrational activity in the shallows could lead to the removal of shoreline aquatic vegetation and additional littoral zone disruptions, especially in sandy beach areas.

Under Alternative 3, potential impacts to vegetated wetlands due to increased development would likely be similar to those described for littoral zone habitats. Vegetated wetland habitats would benefit from the baseline buffers implemented under Alternative 3, but existing wetlands would likely be degraded due to indirect impacts associated with increased development and recreation. Vegetated wetlands are extremely sensitive ecosystems and any changes to sediment and nutrient inputs, community structure, or hydrology can quickly transform areas into upland or open water habitats. These changes would likely be brought on by land clearing activities, increased impervious surfaces, and debris and trash accumulation. In addition, invasive species introduction and establishment would be more likely in wetland areas located close to human disturbance. Finally, nutrient inputs would likely rise due to landscaping activities associated with development resulting in potential impacts to water quality and species composition.

Wetland vegetation that is located between the shoreline and open water areas suitable for dock construction would likely be cleared to enable dock access. This is especially true in areas where wetland vegetation exists in low densities and goes relatively un-noticed. April 2012 field studies document several areas where floating dock walkways are located among small stands of buttonbush and emergent sedges and grasses, including docks along the north shore of Longtown Arm and in Sandpiper Cove.

Potential direct wetland impacts would also likely occur due to increased recreational lake usage resulting from increased development allowed under Alternative 3. Increased boating and swimming would likely result in increased pollution from spills and litter. In addition, these recreational activities would likely result in some trampling of shoreline wetland vegetation. For those wetlands located landward of the shoreline, increased levels of waterfowl hunting could result in increased levels of discarded trash items often observed in heavily-trafficked areas.

While Alternative 3 reallocates many miles of shoreline from Protected to Limited Development, there is no specific proposal that would remove standing dead timber under this alternative. However, it is possible that areas of standing dead timber may be removed to clear channels of navigation hazards. Therefore, the future condition under Alternative 3 would likely be similar to conditions described under the No Action Alternative.

Alternative 4

The future condition under Alternative 4 would likely result in types of potential aquatic habitat impacts that are similar to those described for Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an increased number of shoreline areas being reallocated from Protected to Limited Development and from Protected to Public Recreation. Additionally, the maximum potential number of boat docks allowed under Alternative 4 is 15,459, which is an increase over the 11,844 docks potentially allowed under Alternative 3. This increase in potential dock construction would also likely magnify potential impacts to shallow-water and wetland habitats.

The potential littoral zone impacts of Alternative 4 would be most evident in and around the Carlton Landing proposed development. The type of littoral zone activities planned for this area, including Roundtree Landing, if full build-out is realized, includes water withdrawal, activated water features, dredging, swimming area, inflatable floating kids play zone, and retaining walls. Additional structures would include a marina with boat fueling and storage facilities. In addition to issues related with dock construction, these proposed littoral zone features would likely result in the clearing of native aquatic vegetation, removal of riparian vegetation, altering depth profiles, and removing native substrates. These activities would likely result in increased sedimentation, decreased water quality, and degraded habitat for aquatic invertebrates and fish.

Due to proposed dead timber removal at Carlton Landing, Alternative 4, which emphasizes private exclusive uses and recreational development opportunities, would have the greatest potential to impact palustrine forested dead wetlands and other standing dead timber habitats. Under Alternative 4, a channel through the standing timber in Longtown Arm would be cleared to allow boat access around Roundtree Landing to the southwest side of Carlton Landing. Removal of standing dead timber greatly impacts the underwater environment and deprives fish, especially crappie and bass, of optimal habitat. Removal may also disrupt water flow and substrate immediately surrounding the dead trees. Allowing tree removal in Longtown Arm could clear the way for additional requests to remove standing dead timber from other lake areas to improve recreational opportunities.

5.1.3 Invasive Species - Vegetation

Wetlands and other aquatic habitats are especially vulnerable to invasions by exotic species. The introduction and establishment of invasive species is directly attributable to the magnitude and extent of human disturbance within wetland ecosystems. As described in Section 4.3.4.1, human disturbance including excess nutrient and sediment input transforms the fragile ecological balance in wetlands and make them more susceptible to invasive species. Therefore, any considered alternative that proposes to increase areas of human disturbance would likely result in an environment more conducive to invasive species establishment.

Invasive species are a concern within terrestrial communities as well. Invasive species such as Japanese honeysuckle, Chinese lespedeza, and Japanese climbing fern have been documented within the study area. Additional species such as tall fescue, Old World bluestems, Japanese brome, autumn olive, and Chinese privet are known invaders of southeastern Oklahoma open and forested habitats. Similar to aquatic systems, the ease and probability of invasion by terrestrial exotics is directly attributable by the extent of human disturbance. Human disturbance has even been shown to spur the development of invasive characteristics in certain species (Buczhkowski 2010). Invasive species thrive in disturbed agricultural and oil fields as well as within homesteads and along roadways and utility easements. Therefore, alternatives that would increase areas of development and associated roads and infrastructure, have the potential to increase the distribution of already established invasive species and facilitate the introduction of new ones. In addition, increased development furthers fire suppression policies, which enable the spread of both invasive species and the native eastern red-cedar into prairie, woodland, and forest habitats.

No Action Alternative

Under the No Action Alternative, no changes in land use allocations or vegetation management would occur and the threat of introduction and establishment by aquatic invasive species such as hydrilla or Eurasian watermilfoil would likely be similar to that described under the existing condition. In addition,

already established invasive species that are primarily restricted by their own dispersal ability, like Salvinia, would likely expand, and nearby populations of invasive species could be introduced due to heavy recreational use in the Eufaula Lake study area. All of the likely aquatic invasive species can reproduce by fragmentation, with fragments easily becoming attached to boats, trailers, and any other objected placed in infested waters.

The No Action Alternative would likely result in a future condition with moderate levels of terrestrial introduction and establishment of invasive species similar to that described under the existing condition (Section 4.1.3). Even if eradication efforts are implemented, disturbed open habitats would likely continue to support Chinese lespedeza, tall fescue, and other invasive grasses and forbs, whereas forested habitats within close vicinity of human disturbance would likely contain Japanese honeysuckle or Chinese privet. The continued success of these invasive species would be due primarily to superior competitive, reproductive, and dispersal abilities. The threat of new invasions would be moderate and the spread of existing invasive species would most likely continue along disturbance corridors (*e.g.*, roads and utility easements), especially in areas designated Limited Development that have not yet been developed.

Alternative 1

Alternative 1, which would substantially increase the amount of shoreline designated Protected and would establish wide buffers under the extended vegetation management policy, would likely lessen the chances of aquatic invasive introduction and establishment. This is due primarily to reduced human influence on Eufaula Lake study area habitats. The combined conservation of native wetland and open water habitats and the establishment of extended buffers would decrease sediments, nutrients, and other human impacts associated with landscaping, stormwater runoff, and other system inputs associated with development. Additionally, the increase in shoreline allocated to the Protected designation would reduce lands available for dock construction, thus limiting recreational activities and likely resulting in fewer people utilizing lake areas. Fewer recreationists lessen the likelihood that aquatic invasive species would be transported and introduced into the Eufaula Lake study area.

Alternative 1, with its emphasis on habitat conservation, would do the most of all of the proposed action alternatives to curtail the introduction and spread of terrestrial invasive species. It is widely accepted that healthy, protected terrestrial ecosystems are more resilient and are better able to withstand invasion than those threatened by human disturbance and associated edge effects and system inputs. Therefore, under Alternative 1, an increase in shoreline miles allocated as Protected and the implementation of extended buffers along shorelines where Limited Development is allowed would conserve greater amounts of core habitat areas that are better equipped to resist invasion. In addition, the decrease in development and associated decrease in human traffic would deprive invasive species of introduction and dispersal pathways.

Alternative 2

In comparison to the No Action Alternative, Alternative 2, which increases the miles of shoreline allocated to Protected but not to the same extent as under Alternative 1, would still likely see a decrease in the spread of established invasive species and would lessen the chances of new species introductions. This would be due primarily to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Alternative 3

Alternative 3, which would convert unencumbered Protected shorelines to Limited Development, would result in the potential for increased human disturbance over approximately an additional 6,600 acres within the study area. Therefore, Alternative 3 would likely have the opposite effect on aquatic invasive species as Alternative 1. Land disturbance and its associated impacts would increase, potentially resulting in changes to open water and wetland communities making them more susceptible to invasion. Additional dock construction, including within the proposed Carlton Landing development on the north side of Longtown Arm, would facilitate more boat usage and recreational opportunities.

In comparison to the No Action Alternative, Alternative 3 would increase the likelihood of invasion into terrestrial habitats and would potentially enhance the ability of established invasive species to expand into new areas. In addition to creating additional disturbance through development and associated road and infrastructure construction, the reallocation of Protected shorelines to Limited Development would increase landscaping activities, which often introduce invasives when they escape cultivation.

Despite land allocations that would likely result increased development and recreation, Alternative 3, would implement baseline vegetation management zone buffers. Although smaller than the extended buffers implemented under Alternatives 1 and 2, these corridors of protected vegetation would help decrease the likelihood of invasive species expansion compared to the No Action Alternative. However, in comparison to the wider buffers of Alternatives 1 and 2, the baseline buffers would increase the quantity of edge habitat favored by terrestrial invasive plant species. This would likely lead to degradation of core habitat areas, making them more susceptible to invasion.

Finally, as with all of the analyzed alternatives, Alternative 3 would not change existing fire suppression policies that have enabled the infestation of Oklahoma habitats by eastern red-cedar and that favor invasive herbaceous plants over fire-tolerant natives. As a result of increased development and recreation expected under this alternative, areas on which prescribed burns could potentially be conducted would be limited.

Alternative 4

The future condition under Alternative 4 would likely result in an invasive species community of a size and structure similar to that described for Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an increased number of shoreline areas being reallocated from Protected to Limited Development and Public Recreation. Alternative 4 would increase the quantity of shoreline designated Limited Development by approximately 110 miles more than Alternative 3, and would also increase Public Recreation shorelines by approximately eight miles. This emphasis on development, private exclusive uses, and recreational opportunities would further the likelihood of new invasive introduction. Existing invasive expansion into aquatic and terrestrial habitats would also be likely because both development and recreation provide primary pathways for the immigration of invasive species.

5.1.4 Rare, Unique, and Imperiled Vegetation

All of the six rare and imperiled plant species listed in **Table 4-15** are state critically imperiled in Oklahoma and, where they do exist, they do so in very low numbers. Therefore, any decision that alters the potential habitat of these species could impact local populations. Of the six species, Bradley's spleenwort, Indian-pipewort, and lobed spleenwort are only known from populations in Robbers Cave State Park,

approximately 12 miles east of the Eufaula Lake study area. Despite the close proximity, Robbers Cave State Park is located in the wooded highlands of the San Bois Mountains, which only share habitat similarities with a small portion of the scattered high ridges and mountains ecoregion. This ecoregion, the smallest in the study area, consists of less than ten miles of shoreline south of Blocker, OK. In addition, past survey attempts were made to locate lobed spleenwort in suitable habitats within the counties that make up the Eufaula Lake study area, yet none were found (Story 2002). Due to the extremely specific habitat requirements and the low probability of these species being found within the study area, they are not included in the analysis of potential impacts. While the remaining three rare and imperiled species are also unlikely to be found within the Eufaula Lake study area, historical occurrence records and the presence of necessary habitats within the study area justify analysis of potential impacts.

Despite the differing levels of protection given by the proposed alternatives, none of them address all of the factors that have made these plants rare. In addition to the conversion of emergent wetland habitat to other land uses, the Blackfoot quillwort and dwarf pipewort have declined due to the loss of emergent wetlands from fire suppression and the introduction of invasive grasses and forbs into open habitats. Kentucky wisteria, is rare due partially to the impacts of water control on bottomland hardwood forest habitats and the introduction of the more aggressive Chinese wisteria. Therefore, if any of these plants exist within the Eufaula Lake study area, it is possible that even the most natural resource conscious of the alternatives would have little impact on the survival of rare and imperiled plant populations.

No Action Alternative

Under the No Action Alternative, any current populations of Blackfoot quillwort, Kentucky wisteria, and dwarf pipewort would likely remain in existing suitable habitats designated Protected. However, populations in areas designated Limited Development or Public Recreation would be at risk of potential future development and impacts associated with human disturbance.

Alternative 1

Under Alternative 1, additional habitat within the study area would be protected; thereby, increasing the likelihood that rare plant populations would be conserved. The implementation of extended management buffers would also conserve more acres of potential habitat, thus increasing the probability of survival for rare species. For Blackfoot quillwort and dwarf pipewort, this would include areas that consist of emergent wetlands underlain by sandstone, particularly in the North Canadian and Duchess Creek portions of the study area. For Kentucky wisteria, potential habitat that would be protected under Alternative 1 would include bottomland hardwood forests, particularly in the northeast Deep Fork arm of the lake.

Alternative 2

Although Alternative 2 designates less shoreline as Protected as compared to Alternative 1, it would likely have similar potential impacts on populations of Blackfoot quillwort, dwarf pipewort, and Kentucky wisteria due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Alternative 3

While the establishment of baseline buffers under Alternative 3 would better conserve rare plants than vegetation management policies under the No Action Alternative, the emphasis Alternative 3 places on development would likely promote the disturbance and conversion of many natural habitats. Increased development and an associated increase in recreational activity would increase the likelihood that any

existing populations of these species would be extirpated. Potential species-specific impacts are consistent with impacts of development and recreation on their habitats. Therefore, Blackfoot quillwort and dwarf pipewort would be sensitive to potential emergent wetland impacts including sedimentation and invasive species introduction (Section 5.1.2), whereas, Kentucky wisteria is impacted by the effects of development on bottomland hardwood forests including direct removal of riparian vegetation (Section 5.1.1).

Alternative 4

Compared to Alternative 3, the future condition under Alternative 4 would likely result in potential impacts to Blackfoot quillwort, dwarf pipewort, and Kentucky wisteria populations that would likely be magnified and more widespread due to an increased number of shoreline areas being rezoned from Protected to Limited Development and Public Recreation. The increased scope of potential impacts under Alternative 4 would increase the probability that rare and imperiled plant communities would be affected by activities associated with development and recreation.

No impacts associated with full build-out of the proposed Carlton Landing development on the three rare and imperiled species would be likely because the property proposed for development lacks the specific habitat conditions necessary for the growth of these species.

5.2 Natural Resources

The No Action and four action alternatives are thoroughly explained in Section 2.4. Several of the components of each of the alternatives have specific potential impacts on the natural resources found within the study area. When considering potential impacts to natural resources, discussion begins with No Action, followed by Alternative 1, which favors natural resource conservation, through Alternative 4, which emphasizes private exclusive uses and recreational development opportunities. Potential impacts of each alternative on existing natural resources will be evaluated. Many potential impacts on natural resources are directly connected to potential alternative impacts on habitats, which are discussed in Section 5.1. Therefore, to avoid redundancy, for many common species likely found within the study area, potential impacts involving habitat loss or degradation will be addressed generally with a reference to appropriate sub-sections in Section 5.1. However, for listed species, all potential impacts will be covered completely.

The management of vegetation along the shoreline has a direct impact on natural resources in the study area. Current vegetation modification permit processes and the potential vegetation buffer policies proposed under the action alternatives are described in detail in Section 2.4. The existing vegetation management policies would be the same as the future condition under the No Action Alternative. Under each of the action alternatives, one of two shoreline vegetation management policies would be implemented—baseline or extended. Under the extended vegetation management policy, implemented in Alternatives 1 and 2, wider buffers would be established in comparison to the baseline buffers implemented under Alternatives 3 and 4. Larger buffers are expected to protect a greater amount of existing shoreline habitat, which has the potential to support larger populations of resident species.

The potential for impacts on natural resources varies by alternative due to the amount of habitat disturbance that each allows. The No Action Alternative would reflect the existing condition and, except for additional development adjacent to already designated Limited Development areas, would leave the shoreline relatively unchanged. Alternatives 1 and 2 with their emphasis on natural resource conservation would likely see an increase in the quality and quantity of habitats resulting from an increase in the shoreline acreage designated Protected. Protected shorelines would favor native species best adapted to

occupy core habitat zones. The quality and quantity of habitats would decrease slightly under Alternative 3 and would decrease further under Alternative 4, as more shoreline areas currently allocated as Protected would convert to Limited Development and/or Public Recreation. In the discussion of potential impacts of these alternatives, shoreline development would not include residential development, as this occurs on private lands adjacent to the government-owned shoreline. Therefore, shoreline development refers to dock construction, dock access, and vegetation management. Under these alternatives, habitat conditions would likely favor edge species and those best able to adapt to human disturbance.

The level of habitat fragmentation and conservation of travel corridors are essential to populations of terrestrial organisms and each would likely vary with each alternative. Continued development expected under the No Action Alternative on shorelines allocated as Limited Development would likely result in an increase in habitat fragmentation as compared to the existing condition. For terrestrial wildlife, increased habitat fragmentation would likely sever travel corridors. Travel corridors are essential to maintaining connectivity between disparate populations; thereby, enabling gene flow and providing access to additional suitable habitat and food resources.

In comparison to the No Action Alternative, Alternative 1 and Alternative 2 would likely result in a decrease in levels of future shoreline development due to more areas allocated as Protected and fewer areas allocated as Limited Development. Therefore, these alternatives would likely result in a decrease in habitat fragmentation as compared to the No Action Alternative. For terrestrial wildlife, a decrease in habitat fragmentation would likely preserve travel corridors.

Alternately, an increase in the rate of shoreline development would be expected under Alternative 3 and Alternative 4, as more areas would be allocated as Limited Development and fewer areas would be allocated as Protected. Therefore, these alternatives would likely result in an increase in shoreline habitat fragmentation as compared to the No Action Alternative. For terrestrial wildlife, an increase in habitat fragmentation would likely sever travel corridors.

Potential impacts of each alternative on each specific group of organisms, with particular focus on listed species and species of conservation concern, are described below.

5.2.1 Fish

5.2.1.1 Arkansas River Shiner

For all action alternatives, potential impacts on the Arkansas River shiner would likely include those listed for shallow littoral zone stream and lakeshore waters described in Section 5.1.2.

No Action Alternative

Potential impacts of the No Action Alternative on the Arkansas River shiner would likely result in a future condition similar to the existing condition described in Section 4.2.1.1. The existing condition within the study area provides few areas of suitable shiner habitat, consisting mostly of river reaches upstream of Eufaula Lake. Overall population numbers in these upstream habitats has decreased over the last 30 years (Pigg *et al*. 1999). Therefore, under the No Action Alternative, Arkansas River shiner populations are expected to continue their slowly declining trend and inhabit suitable habitat at the currently observed low densities.

Alternative 1

Alternative 1, with the increase in designated Protected shoreline and establishment of wide shoreline buffers within remaining areas of Limited Development, would likely maintain shiner populations in portions of the study area where they currently exist and may expand their distribution due to future reduction of impacts associated with human disturbance. Arkansas River shiners are highly sensitive to water quality degradation, altered stream flows, and the introduction of competitive invasive species (Bestgen *et al*. 1989). Invasive competitors such as the red shiner and mosquitofish are superior competitors in altered habitats. However, in Alternative 1, the likelihood of these habitat alterations and associated potential impacts are reduced.

Alternative 2

Alternative 2 would likely impact the Arkansas River shiner in ways similar to Alternative 1, albeit to a lesser extent due to fewer shoreline areas being reallocated from Limited Development to Protected.

Alternative 3

Alternative 3 emphasizes shoreline development in that it would allow an increase in dock construction, dock access, and vegetation clearing due to a conversion of Protected shoreline to Limited Development. Dock construction would degrade littoral habitats and shoreline development would remove vegetation; thereby, likely increasing sediment and nutrient inputs into aquatic habitats. Arkansas River shiners need specific stream flow regimes in order to successfully spawn and feed and shoreline development has the potential to alter flows through stream channelization, water withdrawal, erosion, and sedimentation (USFWS 2001).

Alternative 4

Alternative 4, which would increase shorelines designated both Limited Development and Public Recreation, would likely have similar potential impacts on the Arkansas River shiner as Alternative 3 but would increase the amount of recreational use substantially. Increased boat traffic and swimming in littoral zones could lead to substrate disturbance and the removal of aquatic vegetation. Therefore, Alternatives 3 and 4 would likely decrease the quality of shiner habitat in areas of heavy development and high recreational activity, leading to a decrease in currently established populations. This would include populations in or around the old South Canadian River channel including the north shore of the Longtown peninsula and Canadian Landing, which are both documented Arkansas River shiner strongholds.

ONHI occurrence data documents an Arkansas River shiner observation on the north side of Longtown Arm opposite the Highway 9 Marina (ONHI 2012). The close proximity of this sighting to the Carlton Landing development proposal indicates that planned development at that site could potentially impact the Arkansas River shiner. While potential impacts to the shiner in habitats adjacent the development property under Alternatives 1, 2, and 3 would likely reflect the No Action Alternative, under Alternative 4, which would allow full build-out, the construction of boating facilities and other recreational uses could significantly transform the shoreline and potentially impact adjacent shallow-water habitats. The most significant potential impacts would come from construction of the marina and boat fueling facility, due to littoral zone shading, direct alteration during construction, and the potential for fuel spills. Full build-out would also involve increases in impervious surfaces due to residential, road, and infrastructure development resulting in increased sedimentation. Additional potential impacts would include the establishment of a swimming beach, water withdrawal, and dredging. A swimming beach could provide

sandy substrates favored by Arkansas River shiners but this potential habitat benefit would be offset by high recreational usage.

5.2.1.2 Paddlefish

Paddlefish, considered critically imperiled in Oklahoma, are managed by ODWC through a Eufaula Lake stocking program. Paddlefish are particularly susceptible to habitat alteration, including the destruction of spawning habitat, and water pollution.

No Action Alternative

Potential impacts of the No Action Alternative on paddlefish would likely result in a future condition similar to the existing condition described in Section 4.2.1.2. Populations would likely continue to remain at low densities and would slowly increase primarily due to annual stocking efforts.

Alternative 1

Under Alternative 1, paddlefish populations are likely to increase as stocked populations mature and find protected spawning habitat and improved water quality resulting from the increase of protected lands and a decrease in development. Water quality, especially in regards to dissolved oxygen, is of particular importance to paddlefish and a reduction in development would likely decrease erosion and sedimentation rates (Mims *et al*. 1999). In addition, nutrient inputs from lawn fertilizers and stormwater runoff would also decrease with an increase in Protected shoreline. The combination of reduced sediment and nutrient inputs would likely result in increased water quality; therefore, benefiting paddlefish.

Alternative 2

Alternative 2 would likely impact paddlefish in ways similar to Alternative 1, albeit at a lesser extent due to fewer shorelines being reallocated from Limited Development to Protected.

Alternative 3

Under Alternative 3, potential impacts to paddlefish would likely result in a future condition similar to that described under the No Action Alternative. Depending on the percentage of Limited Development lands actually developed, the influx of sediment and nutrients associated with erosion, landscaping, and stormwater runoff could degrade water quality (Mims *et al*. 1999). The smaller buffers would likely filter out fewer water pollutants than the larger buffers implemented in Alternatives 1 and 2. Finally, increased recreational opportunities could increase the number of paddlefish snagged by anglers. While the goal is to eventually establish a fishery for paddlefish, increased mortality due to recreational activities in the early stages of population recovery could derail or slow conservation efforts.

Alternative 4

Alternative 4 would likely impact paddlefish in ways similar to Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an increased number of shorelines being reallocated from Protected to Limited Development and Public Recreation.

5.2.1.3 Common Fish Species

Eufaula Lake and its tributaries provide habitat for over 70 species of fish. Each of these species has different habitat preferences and requirements when it comes to structure, substrate, water quality, and spawning habitat. Additionally, the food requirements of each species vary widely as do the habitat requirements of prey species. Therefore, discussion of potential alternative impacts will be limited to

overarching effects that would apply to the majority of fish species. Specific potential impacts on species that constitute popular fisheries will be discussed in detail.

No Action Alternative

Potential impacts of the No Action Alternative on common fish species would likely result in similar aquatic habitats, species compositions, and population numbers present in the existing condition described in Section 4.2.1.3.

Alternative 1

Under Alternative 1, which emphasizes natural resource conservation, large areas of the shoreline would be designated as Protected and wide, extended shoreline buffers would be implemented. The reduction in areas of Limited Development and the protection of forested shorelines would likely reduce sediment and nutrient input levels resulting in improved water quality and the reduction in anoxic conditions. While some species such as catfish and bullhead can thrive under poor water quality conditions, most fish are acutely sensitive to even a small decline in water quality. In addition, boat dock construction would be limited, which would reduce littoral zone shading and direct habitat alteration during construction resulting in improved conditions for fry and small forage species. Finally, the protection of shoreline areas and reduced development would reduce the likelihood of potential competing water uses including water withdrawals needed to support large developments and would reduce the likelihood of invasive species establishment and disease often associated with high levels of recreational activity.

Alternative 2

Alternative 2 would likely impact common fish species in ways similar to Alternative 1, albeit to a lesser extent due to fewer shorelines being reallocated from Limited Development to Protected.

Alternative 3

Alternative 3, which would increase the quantity of shoreline with a Limited Development designation, would establish a baseline buffer that would protect more shoreline than under the No Action Alternative, but less than the extended buffers under Alternatives 1 and 2. The presence of the baseline buffers would provide essentially the same benefits as those in Alternatives 1 and 2 but on a smaller scale. Despite increased shoreline conservation as compared to the No Action Alternative, changing land use designations under Alternative 3 would likely facilitate increased shoreline usage and human disturbance. Additional dock construction could also provide overhead cover and habitat structure for some species. However, the benefits of buffers and dock construction would likely be offset by the degradation in water quality and littoral habitats that would be associated with increased levels of development and recreation. In addition, the probability of invasive species establishment, whether they are plants introduced as hitchhikers on boats and trailers or minnows from bait buckets, increases with high levels of recreational activity.

Alternative 4

Alternative 4 would likely impact common fish species in ways similar to Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an increased number of shorelines being reallocated from Protected to Limited Development.

Fisheries

Eufaula Lake supports several popular fisheries, and similar to non-game species, sport fish vary widely in their preferred habitat requirements. While potential impacts to game species are consistent with those

described for common species, natural history characteristics of some game species make them particularly vulnerable to certain habitat alterations.

While over 25 species of fish typically considered game species reside within the study area, potential impacts of the proposed alternatives are assessed only on actively managed and popular species. Additionally, while actively managed, potential impacts to striped bass are not assessed because they exist primarily in the dam tailwaters located outside of the Eufaula Lake study area. Potential impacts to game species that are not covered in detail can be assumed to mirror those discussed for common fish species (Section 5.2.1.3) and game species that share similar natural history or habitat requirements. Additionally, as with all fish species, potential impacts on lacustrine habitats (Section 5.1.2) would likely have similar impacts on game fish species.

No Action Alternative

Potential impacts of the No Action Alternative on all game species would likely result in future conditions similar to the existing conditions outlined in Section 4.2.1.3. Overall threats to Eufaula Lake's fisheries introduced within that section would be unlikely to change under the No Action Alternative.

Alternative 1

The black bass fishery, which includes both largemouth and smallmouth bass, is likely to reflect the No Action Alternative under Alternative 1. While the increase in protected shorelines and implemented buffers would result in increased quality of lacustrine habitats, both bass species, and in particular largemouth, have achieved high population numbers in degraded habitats such as stormwater ponds with high sediment and nutrient inputs. In addition to population numbers, population health is an important measure of fishery status. Largemouth Bass Virus (LMBV), which has been documented within the Eufaula Lake study area, is often attributed to poor water quality (Bowen 2008). Water quality improvements likely to be realized under Alternative 1 could reduce the occurrence of LMBV and other fish diseases. Therefore, while population numbers may not increase substantially, the health of the overall population is likely to improve.

A reduction in erosion and sedimentation rates under Alternative 1 would likely have little impact as both species prefer to spawn in gravel substrates but have been known to utilize sand and silt substrates when preferred sediment is unavailable. Fewer boat docks may actually negatively impact both species as bass often utilize docks as habitat structures. However, the conservation of shorelines would likely improve littoral habitats on which bass prey species depend, thus improving food availability for bass populations. Overall, these habitat generalists likely already occupy the majority of available habitat and would see a negligible increase in population numbers under natural resource protection alternatives.

For all action alternatives, potential impacts to white bass and spotted bass would be similar to those described for black bass and common fish species.

Under Alternative 1, crappie populations are likely to be similar in size and structure to those described for the No Action Alternative for many of the same reasons listed for black bass. However, several factors related to riparian conservation may improve crappie size structure and expand crappie distribution throughout the study area. The increased protection of shoreline habitats and limited dock construction could prevent the removal of underwater structure that crappie prefer, leading to colonization of additional littoral areas. Conservation of natural shorelines would also likely result in larger populations of

prey species such as threadfin shad. Larger prey bases support both larger populations and larger individuals.

Under Alternative 1, the catfish fishery would likely be similar, in size and structure, to the No Action Alternative. The emphasis on shoreline protection under these alternatives would likely have little impact on these habitat and forage generalists that can survive in water bodies with marginal water quality. However, the conversion of shoreline from Limited Development to Protected would likely conserve optimal catfish nesting habitat and could increase the rate of natural recruitment.

Alternative 2

For all fisheries, Alternative 2 would likely impact game species in ways similar to Alternative 1, albeit to a lesser extent due to fewer shorelines being reallocated from Limited Development to Protected.

Alternative 3

Under Alternative 3, the primary potential impact to the black bass fishery would be increased angling pressure. Increased development and recreational opportunities would likely result in more anglers. Increased angling pressure often disrupts normal age structure and could result in a population dominated by small, young individuals (Webb and Ott, Jr. 1991). The result could be a decrease in natural recruitment leaving the black bass fishery dependent on continued stockings. Overfishing is also possible, but not likely, on a lake the size of Eufaula. While increased sedimentation and nutrient inputs associated with human development could smother preferred spawning substrates and decrease water quality, black bass are remarkably adaptable to moderate habitat disturbance. Increased boat dock construction, while disturbing natural littoral habitats, would likely provide black bass with increased habitat structure and result in little impact to bass populations.

Increased development and recreational opportunities would likely have little impact on crappie populations overall, but effects of heavy angling pressure described for black bass could be realized (Webb and Ott, Jr. 1991). Increased development and recreation could also lead to road and infrastructure expansion resulting in additional bridge abutments and riprap shorelines that often attract crappie. An increase in sedimentation associated with development could benefit crappie by covering rock and gravel substrates with the finer sediments on which crappie prefer to spawn. However, excessive shoreline development could potentially impact habitats preferred by prey species and result in a decreased forage base.

The catfish fishery is the fishery least likely to be adversely impacted by increased shoreline development and recreation. Catfish often utilize turbid waters and disturbed aquatic habitats to feed, rest, and nest. Within the Eufaula Lake study area, catfish take shelter near boat ramps, submerged roadways, and abandoned underwater culverts. Under Alternative 3, increased dock and infrastructure construction (*e.g.* power lines and bridges) associated with increased residential development could provide underwater structure and increase available catfish habitat. In addition, catfish are indiscriminate consumers of aquatic organisms from detritus to insects to fish and are unlikely to suffer from a depleted forage base due to effects of increased shoreline disturbance. However, catfish in the study area prefer deeper creek channels and rocky substrates. Any increase in sedimentation could quickly fill deeper channels and submerge rocky substrates. Another potential adverse impact of Alternative 3 could be overharvesting. Noodling, allowed for flathead catfish, is growing in popularity throughout the study area, and specifically targets large and nesting catfish. Specifically targeting reproducing individuals can cause population

decline and may be a reason for the observed decline in flathead catfish—a trend that has continued since 1988 (Bowen 2008).

Alternative 4

In comparison to Alternative 3, potential impacts would likely be magnified and more widespread under Alternative 4 due to an increased number of shorelines being reallocated from Protected to Limited Development and Public Recreation. Also, the removal of standing dead timber to improve navigation for recreational activities would eliminate the underwater structure that makes Eufaula Lake a trophy crappie fishery. Under Alternative 4, the proposed Carlton Landing development would be allowed to remove dead timber which could result in additional removal requests. In areas in which underwater structure is removed, these actions would likely result in large reductions in populations of crappie and other game species.

5.2.1.4 Invasive Species

Aquatic invasive and nuisance species can also threaten the diversity and stability of fish community structure within the Eufaula Lake study area. Asian carp species, including silver carp, bighead carp, and grass carp are the invasive fish species most likely to cause significant impacts on native fish. Asian carp are indiscriminate consumers possessing high fecundity and they often displace and outcompete native species where introduced. Of the three species, only grass carp have been collected in Eufaula Lake; however, reproduction has not been confirmed (Bowen 2008). Stopping Asian carp introduction is paramount, because once established they tend to occupy all aquatic habitats, regardless of quality. The changes to the SMP and MP on the potential for Asian carp introduction and establishment can be used as a proxy to estimate the effects of each alternative on the introduction potential of any invasive or exotic fish species.

The No Action Alternative would most likely follow existing trends with moderate to high potential of Asian carp introduction. If carp, especially grass carp already documented within the Eufaula Lake study area, were to become established in significant numbers, they would pose a significant threat to existing fisheries. In comparison, Alternatives 1 and 2 would likely lower introduction potential due to expected lower recreation rates associated with a decrease in areas designated Limited Development. Fewer recreationists lessen the probability of introduction from nearby infested rivers and reservoirs. If Asian carp were introduced, the habitat protection and increased quality likely to be realized under these two alternatives would be of little significance.

Alternatives 3 and 4, with the conversion of shoreline from Protected to Limited Development and/or Public Recreation, would not make aquatic habitat conditions any more susceptible to Asian carp establishment because carp have invaded many quality aquatic habitats throughout the Mississippi River basin. However, the expected rise in people utilizing the study area would likely increase the potential for accidental Asian carp introduction. Once introduced, eradication efforts are difficult, if not impossible, on a lake the size of Eufaula and could lead to a severe decline to managed fisheries and other native species.

5.2.2 Reptiles & Amphibians

5.2.2.1 Reptiles

Many reptile species are heavily dependent on aquatic resources and wetland habitats, including water snakes and several turtle species, while others prefer dry uplands including the eastern box turtle and fence lizard. Therefore, the potential impacts of alternatives on reptile species often reflect the impacts on

the respective habitats in which they are found, which are outlined in Section 5.1. However, certain aspects of the biology and behavior of reptiles introduce novel impacts that go beyond habitat degradation. All reptiles, as ectotherms, need appropriate thermal refuges in winter and basking sites during the active months. In addition, most reptiles are oviparous, or egg-laying, and often have specialized nesting behaviors that require specific nest habitats or materials (Baldwin *et al*. 2004). Therefore, both behavioral and habitat requirements must be considered when analyzing the potential impact of each alternative.

No Action Alternative

In general, potential impacts of the No Action Alternative would likely result in a future reptile community similar to that described under the existing condition in Section 4.2.2.1. The likely future condition includes trends that favor reptile species adapted to low levels of development and seasonally-high levels of human recreation, especially during the summer breeding season.

Alternative 1

Alternative 1, with its large increase in protected shoreline and implementation of expanded buffers, would likely increase populations of semi-aquatic and terrestrial reptiles. Terrestrial reptiles would benefit from the conservation of forests, woodlands, and prairies and would thrive in conditions associated with less development including road construction and road traffic. Road traffic is a primary cause of mortality for many reptiles, especially turtles and snakes (Gibbs and Shriver 2002). Reptiles are drawn to the heat of roadways and the removal of vegetation in right of ways provides optimal basking sites. In addition, all reptiles are susceptible to herbicide use. Herbicides contaminate aquatic habitats through runoff and often eliminate many herbaceous plants reptiles feed on. The implementation of wide shoreline buffers on lands designated as Limited Development would help filter out sediments, nutrients, and additional pollutants that could impair water quality. Finally, an increase in shoreline designated Protected would protect more hibernation habitat, including hollow logs and burrows, from disturbance and would protect fragile nesting areas, especially emergent wetlands and sandy shorelines. For the imperiled alligator snapping turtle, observed along the sandy shoreline of Sycamore Bay, Alternative 1 would reject individual zoning request #10. While this rejection would allow existing boat docks and development to remain, new shoreline vegetation management policies in this area would protect some snapping turtle habitat from disturbance.

Alternative 2

Alternative 2 would likely impact reptiles and reptile habitats in ways similar to Alternative 1, albeit to a lesser extent due to fewer shorelines being reallocated from Limited Development to Protected.

Alternative 3

Generally speaking, Alternative 3, with its emphasis on conversion of Protected shoreline to Limited Development, would likely result in localized adverse impacts to most reptile populations within the study area. The smaller proposed management buffers would improve water quality and conserve some riparian habitat as compared to the No Action Alternative, and the creation of open edge habitats as a result of development may favor species like the racer and common garter snake that are well adapted to human disturbance. However, for most reptile species, the potential for an increase in development has the opposite potential impacts as those listed for Alternatives 1 and 2. Aquatic habitat and wetland degradation is likely to increase along with clearing and conversion of upland habitats to make room for home sites and associated infrastructure. Roads and construction activities could contribute directly to

increased mortality and indirectly by fragmenting habitat and eliminating sources of thermal refuge. Habitat fragmentation serves to isolate populations of many reptiles with limited mobility (Baldwin *et al*. 2004). Finally, development also makes habitats more susceptible to invasive species, which could replace native reptile food sources and provides avenues for predators like raccoons and opossums that readily prey on reptiles and their eggs (Riedel *et al*. 2005).

Alternative 4

In comparison to Alternative 3, Alternative 4 converts even more land to Limited Development and increases the acreage of Public Recreation lands. The majority of this land conversion would take place at Carlton Landing, where fence lizards, eastern box turtles, and racers were observed. These reptiles, while adapted to edge habitats, would likely find little available suitable space if full build-out of proposed recreational facilities and parklands occurs. Increased recreational opportunities would lead to degraded shallow water habitats as this is where most recreational activity takes place and most semi-aquatic reptiles reside. Increased recreational activity would particularly impact the state imperiled alligator snapping turtle, as it requires sandy beaches and sandbars to nest (Heck 1998). Within the study area, these habitats are heavily used recreationally with beachgoers often discouraging nesting activities or unknowingly destroying nests. Fishermen using live bait also occasionally hook alligator snapping turtles causing injury or death. Finally, an increase in human population and lake access could result in increased reptile collection. Collection concerns contribute to the state imperiled designation of the Mississippi map turtle and collection is also a threat to eastern box turtles.

5.2.2.2 Amphibians

All amphibians depend on specific hydrologic regimes stable water sources to complete their reproductive cycle, with many preferring the forested and herbaceous wetlands found most frequently in depressions landward of the lakeshore. When the magnitude, duration, and timing of hydrologic events are disrupted, amphibians are often adversely impacted. Because of their sensitivity to water pollutants and habitat degradation, amphibians are also often used as indicator species of wetland health (Beasley *et al*. 2002). Therefore any potential impacts to bottomland hardwood, wetland, or shallow aquatic habitats listed in Section 5.1 would most likely impact resident amphibian communities.

No Action Alternative

Under the No Action Alternative, potential impacts would likely result in levels of amphibian diversity and population trends similar to those described for the existing condition in Section 4.2.2.2. Some amphibian decline would likely continue due to potential conversion of wetland habitats and from altered water level fluctuation cycles. In addition, existing fire suppression practices could increase the percentage of forested wetlands, thus favoring species adapted to wet woodlands over herbaceous emergent wetlands. Therefore, populations of small, vocal woodland frogs like the spring peeper and cricket frog would likely increase and populations of green frogs, bullfrogs, and other species of open wetlands would likely decrease.

Alternative 1

In comparison to the No Action Alternative, under Alternative 1 amphibian diversity would be maintained and populations would be expected to increase and expand due to the protection of shoreline habitats and establishment of expanded shoreline buffers. More than any other group of animals, amphibians are significantly impacted by the effects of water pollution. This is because amphibians spend the earliest stages of development in aquatic systems, and once they become adults, they can readily absorb harmful

pollutants through their skin (Beasley *et al*. 2002). Any alternative that reduces adjacent development and associated pollutant-laden runoff would benefit amphibian populations. In addition to improving water quality, Alternative 1 would likely protect areas of secure thermal refuge from shoreline disturbance. The protection of shoreline habitats would especially benefit salamanders that seek out woody debris within forested riparian wetlands, which tend to be significantly impacted by clearing of bottomland hardwoods or selective removal of downed trees to establish parkland.

Alternative 2

Although Alternative 2 designates less shoreline as Protected as compared to Alternative 1, it would likely have similar impacts on amphibian communities due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Alternative 3

While the proposed baseline vegetation management policy buffers established under Alternative 3 would improve amphibian condition over the No Action Alternative, the conversion of Protected shoreline to Limited Development would likely adversely impact amphibian diversity and amphibian populations overall. Studies have shown that increased habitat fragmentation due to development is directly correlated with a decrease in amphibian diversity (Beasley *et al*. 2002). Increased development would not likely result in the direct mortality of many wetland-dwelling amphibians because the majority of development is located in dry uplands. However, adults of some species, especially salamanders and toads spend significant time in upland areas and could be adversely impacted by land disturbance activities.

Indirect effects of development are likely to adversely impact amphibian populations regardless of habitat preference. Development would lead to increased water pollutants in stormwater runoff coming from impervious surfaces and landscaped areas. Additionally, development often leads to stream channelization, which severs the hydrologic connection between bottomland hardwood forests and replenishing floodwaters. Finally, increased development often leaves aquatic habitats more susceptible to aquatic invaders and amphibian diseases and parasites (Beasley *et al*. 2002). Invasive species like Hydrilla and Salvinia provide little habitat value to amphibians in comparison to native wetland vegetation.

Alternative 4

Alternative 4 would likely impact amphibian populations in ways similar to Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an increased number of shorelines being reallocated from Protected to Limited Development. The increase in areas designated Public Recreation would only likely impact those amphibian populations located along the six miles of converted shoreline at Carlton Landing. In these areas, especially within the proposed Carlton Landing development, shoreline conversion would likely eliminate most shallow water habitat in favor of deepwater channels, revetments, and swimming beaches. Throughout the rest of the Eufaula Lake study area, increased recreational activities can degrade shallow water habitats due to high volumes of human traffic. This is often visually evident from the piles of trash and debris that congregate in backwaters or in driftwood piles.

5.2.3 Mammals

While invasive species are a concern, the major threat to Oklahoma mammals comes from habitat alterations for urban and agricultural development. Pesticide use and various pollutants may also impact a

variety of species. Predator removal has impacted populations of large carnivores in the past and many, including gray wolves, have been systematically extirpated through human actions. While mammals often require larger areas of optimal habitat, many are highly mobile and can often withstand temporary human impacts. Permanent changes that reduce the size and quality of contiguous habitat often lead to changes in the composition of the local mammal community.

While mammals are more mobile than many other groups of organisms and can readily move between areas of human disturbance, increased development and fragmentation facilitated by rezoning can impact species composition and population levels. As with other groups of animals, the potential indirect impacts of rezoning, including greater development, often lead to habitat degradation resulting in decreased individual fitness and population decline. However, several groups of mammals benefit from low levels of disturbance. This is likely due to the inclusion and maintenance of non-matrix habitat patches (Rosalino *et al*. 2009). One example would be white-tailed deer preference for edge habitats between forest and open habitats, often maintained by residential and agricultural development. Other mammals, such as raccoons, opossums, and rodents often find low and moderately disturbed habitats advantageous due to increased food availability, decreased predation, or a preference for open habitats.

5.2.3.1 State Species of Concern – River Otter and Long-tailed Weasel

Even though the Eufaula Lake study area is unlikely to contain any listed mammal species, the four action alternatives and the No Action Alternative could potentially impact two state species of concern—the river otter and long-tailed weasel. The river otter, as a semi-aquatic mammal, is dependent on high water quality, wetland availability, adequate prey base, and den site availability (ODWC 2008). Long-tailed weasel populations are more difficult to evaluate as local populations fluctuate significantly in response to prey availability. However, unlike otters, weasels often adapt well to human disturbance and can be found in woodlands, fields, bottomland forests, and shrublands (ODWC 2011b). This is likely due to the abundance of rodent prey species in slightly disturbed environments. Therefore, potential impacts of each alternative may have opposite effects on otter and weasel populations within the study area.

No Action Alternative

For both species, potential impacts associated with the No Action Alternative would result in population structures and numbers similar to the existing condition described in Section 4.2.3. The most recent status reports on both species indicate that populations within Oklahoma are on the rise and are expanding into areas of suitable habitat that have not been occupied for decades (ODWC 2008; ODWC 2011b). Therefore, the No Action Alternative may result in higher otter and weasel populations than currently observed due to the existing trend toward range expansion and the presence of suitable habitat within the study area.

Alternative 1

Alternative 1 would likely facilitate increasing numbers of both species, especially the river otter. Alternative 1, with its extended shoreline buffers, would likely improve water quality conditions in lake, stream, and wetland habitats; therefore, improving populations of amphibian and fish prey species and reducing turbidity resulting in improved hunting success. Wide buffers and an increase in Protected shoreline would conserve habitat utilized by both species. In particular, due to exclusive use of shoreline areas for denning, potential impacts of Alternative 1 would likely include increased otter den site availability. In comparison to the river otter, the potential impact of Alternative 1 could be less beneficial to the long-tailed weasel as the amount of slightly disturbed and edge habitat preferred by the weasel would likely be reduced.

Alternative 2

Compared to Alternative 1, Alternative 2 would likely have slight increases in preferred weasel habitat and slight decreases in preferred otter habitat.

Alternative 3

Alternative 3 would likely have a slight positive impact on long-tailed weasel populations; whereas, it would likely reduce the amount of suitable habitat for the river otter. The proposed vegetation management buffers on shoreline designated Limited Development would improve water and habitat quality as compared to the No Action Alternative, but would have a lesser potential impact than the larger buffers in Alternatives 1 and 2. Additionally, the conversion of Protected shoreline into Limited Development would reduce the quantity of preferred natural habitats for both species. Development impacts would have additional negative impacts on the river otter, a species intricately tied to the health of aquatic and wetland systems. An influx of water pollutants near developments could make hunting unsuitable, decrease prey populations, and impact individual health.

Alternative 4

Potential impacts described for Alternative 3 would be more significant under Alternative 4, which proposes to rezone additional shoreline areas as Limited Development and Public Recreation thereby increasing potential development and recreational opportunities. Increased recreation would likely increase human-otter interaction resulting in stress, decreased hunting success, and potentially more trappers during the winter season (ODWC 2011f). In contrast to the negative impacts of on river otters, increased development could have a positive impact on long-tailed weasel populations as any loss of natural habitats would be replaced by equally-preferred edge and slightly disturbed habitats. Low levels of human disturbance would also likely increase populations of small mammals, the favored prey of long-tailed weasels. While an increase in shoreline designated Limited Development could potentially assist weasel populations, the increase in shoreline designated as Public Recreation would likely lead to an increase in human-weasel interaction. As prolific raiders of chicken coops, weasels could be increasingly targeted during the trapping season (ODWC 2011f). The absence of a trapping limit on weasels could potentially have significant localized population impacts.

5.2.3.2 Common Species

As explained earlier in Section 5.2.3, many mammals extremely mobile and can readily move between areas of human disturbance. However, if land use changes indirectly resulting from shoreline rezoning converts habitat to something less suitable, then the overall carrying capacity declines and mammal populations would likely decline. Under the action alternatives, mammal species richness and evenness is likely to vary. Depending on the species and their level of tolerance for human activity, increased development and fragmentation can positively or negatively impact species diversity and population levels. One mammal species in particular, white-tailed deer, is recognized as the most significant local game species. Culturally and economically important in the study area, deer hunting is a popular recreational activity. Therefore, it is important to assess likely impacts to deer populations.

No Action Alternative

Under the No Action Alternative, most mammal populations would result in a future condition similar to that described for the existing condition and observed rates of increase or decline would most likely continue. Likewise, the No Action Alternative would likely result in deer populations similar in size and characterized by the existing stable or slightly increasing trend described under the existing condition.

Alternative 1

Under Alternative 1, the size and structure of populations of most small- to medium-sized mammal species would likely be similar to that described under the No Action Alternative. For small rodents and medium-sized opportunists, likely benefits associated with a decrease in human disturbance and habitat conservation would be offset by a decrease in the edge habitats in which many of these species thrive. However, larger-bodied mammal species, especially carnivores like coyotes, and species requiring specialized or undisturbed habitats would likely see population increases due to the establishment of wide extended buffers and a decrease in development on lands adjacent to the shoreline. A greater proportion of bat roost sites would be likely preserved and larger predators would have larger areas of contiguous habitat in which to hunt. The establishment of wide riparian buffers would particularly improve the quality of aquatic habitats, likely increasing local beaver and muskrat populations.

Under Alternative 1, white-tailed deer populations would likely be similar to that described under the No Action Alternative. While increased natural resource protection would undoubtedly preserve optimal deer habitat, white-tailed deer occur in all major habitat types in the Eufaula Lake study area, including those with moderate levels of human disturbance. In addition, deer are generalist browsers and have been documented feeding on over 100 different plant species (Masters *et al*. 1996). Therefore, while the conservation of diverse plant assemblages would be realized under Alternative 1, deer are likely to occur at peak population densities even without these measures. The major benefit to deer from alternatives emphasizing natural resources would be to lessen the likelihood of establishment of introduced forages such as tall fescue and Old World bluestem.

Alternative 2

Although Alternative 2 designates less shoreline as Protected as compared to Alternative 1, it would likely have similar potential impacts on mammal communities due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Alternative 3

Under Alternative 3, populations of bats, larger predators like bobcats and coyotes, and habitat specialists like beaver and muskrat, would likely decrease due to removal or disturbance of roosting sites, direct human conflict, and degraded habitats. For several of these species direct human conflict refers to heightened animal control policies and an increase in recreational trapping that often result from increases in human populations in rural areas.

Despite the potential for adverse impacts on predators and habitat specialists, under Alternative 3, small rodents and medium-sized opportunists such as mice, squirrels, raccoons, and skunks would find increased levels of low-level human disturbance, advantageous due to increased food availability, decreased predation, or a preference for edge habitats.

Due to existing high population densities and the ability for deer to thrive in areas of human disturbance, Alternative 3 would likely have little potential impact on deer populations. Increasing the number of edge and open habitats may benefit deer populations, which thrive in open woodlands historically managed by fire. However, any observed increase is likely to be offset by a reduction in mature oak and pine stands, which provide deer with winter food and cover. Shoreline buffers, identified as a key tenet of good deer management strategy, would be established under Alternative 3 but would provide less benefit in comparison to the extended buffers in Alternatives 1 and 2 (Masters *et al*. 1996).

Alternative 4

In comparison to Alternative 3, potential impacts of Alternative 4 would likely be magnified and more widespread due to an increased number of shoreline areas being rezoned from Protected to Limited Development. Alternative 4 would likely see an increase in residential and community development, which would decrease the number of areas where deer hunting is allowed. In particular, the approval of the proposed Carlton Landing lease under Alternative 4 would permit community development activities on Roundtree Landing—an area known as one of the most popular deer hunting areas within the study area. Also, increased levels of development would likely increase road-building and vehicular traffic, resulting in additional vehicle collisions. Finally, the increased development and increased recreational opportunities of Alternative 4 are likely to increase the total number of deer hunters. While increased hunting pressure is unlikely to significantly reduce deer populations, it could impact age structure and reduce trophy potential, especially in heavily used public hunting and recreation areas.

5.2.3.3 Invasive Species

As discussed in prior sections, land use changes and human disturbance within the Eufaula Lake study area can significantly impact the likelihood of invasive species introduction and establishment. As with other groups of organisms, this holds true with invasive mammals. Small, invasive rodents such as the house mouse and Old World rats are specifically adapted to human disturbance and often rely on urban sprawl to spread into new areas. Under the No Action Alternative these species would likely experience little change, with significant populations present only in the most urban areas.

Alternatives 1 and 2 would also reflect this condition and would likely prevent the spread of small, invasive rodents into other portions of the study area by preserving natural habitats and limiting development. Similarly, Alternatives 3 and 4 would result in invasive rodent populations like those described for the No Action Alternative, but could facilitate the introduction of invasive mice and rats as residents from urban areas relocate into the study area. The potential impact of this relocation would be greater in large residential communities where these species are likely to reproduce quickly and spread.

The absence of nutria from the study area should not change under the No Action Alternative or any of the action alternatives. Unlike some of their other rodent relatives, nutria are unlikely to spread due to increased development. Introduction would be more likely to occur through the spread of individuals via interconnected waterways from more established populations to the south of the study area. If they were to become established, nutria could significantly reduce resident beaver and muskrat populations through direct competition and would contribute to forested wetland decline (Conner and Tolliver 1990).

The feral hog is a habitat generalist and can adapt to increases in human disturbance. However, feral hogs have been present within the study area for over four decades and continue to exist at moderate densities. Therefore, under the No Action Alternative, feral hog populations would likely remain stable with the continuing trend of slow northward range expansion. This condition is unlikely to change under any of the action alternatives.

5.2.4 Birds

5.2.4.1 Bald Eagle

No Action Alternative

Potential impacts of the No Action Alternative would likely result in bald eagle populations and trends similar to those described under the existing condition in Section 4.2.4.1. This future condition would be

characterized by the presence of a small number of resident breeding pairs with a larger migrant population present during winter months. In the future, as bald eagle populations recover both statewide and nationwide, the likelihood exists that populations of both resident and migratory birds would increase.

Alternative 1

Alternative 1 is likely to result in a small but stable population of bald eagles consistent with the No Action Alternative but with an increasing population trend due to benefits of buffer implementation and land protection. The designation of more Protected shoreline and the establishment of the extended vegetation management buffers would likely conserve important nesting and roosting trees in addition to favored perches. Eagles are particularly sensitive to human disturbance within a 750-foot radius of nest trees (USFWS 2010b). Therefore, establishment of Protected shoreline and buffers would likely increase reproductive success and secure secluded nesting habitats for additional breeding pairs. An increase in Protected shoreline and buffer implementation would also likely increase water quality due to fewer developed areas that often lead to influxes of sediment and nutrients and additional forms of water pollution. Increased water quality would be likely to benefit prey species and limit the amount of chemical bioaccumulation in eagles.

Alternative 2

Compared to Alternative 1, Alternative 2 would likely have fewer positive impacts on water quality and nesting habitat due to fewer shoreline areas being designated Protected.

Alternative 3

Alternative 3 would likely reflect the trends associated with the No Action Alternative and would likely maintain observed bald eagle populations. The implementation of proposed management buffers would likely result in water quality improvements benefiting eagle prey species, but to a lesser extent than the larger extended vegetation management buffers. Increased shoreline designated as Limited Development would likely increase home and dock construction, making some areas of potential eagle habitat unsuitable. However, currently, eagles do not occupy all suitable habitats within the Eufaula Lake study area and eagles may relocate to other areas of the lake to avoid developed parcels, especially when breeding. Likewise, any potential impacts to water quality are likely to be concentrated in areas of increased development or intense recreational activity. Localized impacts may result in eagle relocation to more remote areas. However, 2012 surveys observed that most eagle activity was centered within Lake Area 4 near the Sequoyah Acres development. Therefore, limited development activity may not disrupt eagle behavior at Eufaula Lake to the extent reported elsewhere.

Alternative 4

Compared to Alternative 3, potential habitat and water quality impacts under Alternative 4 could be more pronounced due to higher levels of development and recreation. Full build-out of the Carlton Landing proposed development would likely displace eagles that may frequent the area. While no eagle activity was observed during 2012 surveys, suitable habitat conditions exist, particularly on Roundtree Landing, and USACE staff report frequently observing eagle activity there. However, the lack of observed nests in the area makes it likely that displaced eagles are migrants that would relocate to more suitable lake habitats.

5.2.4.2 Interior Least Tern

No Action Alternative

Potential impacts of the No Action Alternative would likely result in future tern population densities and trends similar to those described for the existing condition in Section 4.2.4.2. The future condition would be characterized by the presence of a small breeding population that utilizes river sand and gravel bars and lakeshore beaches to nest. The majority of least tern activity is centered on the South Canadian River both upstream of Eufaula Lake and downstream of the dam. The No Action Alternative would likely maintain small populations within existing suitable habitats, but high levels of recreational activity on sandbars and sandy beaches, including heavy use by off-road vehicles, could threaten local populations.

Alternative 1

Alternative 1 is likely to maintain interior least tern populations where they currently exist, and could facilitate range expansion into other areas of the lake if sandbar and beach habitat is protected. The increase in shoreline designated Protected would likely limit human disturbance on these shorelines; thereby, reducing potential impacts that result in low tern breeding success. The implementation of wider vegetation management buffers is also likely to lessen the impact of prolific nest raiders such as raccoons that thrive in disturbed edge habitats. Potentail indirect impacts of Alternative 1 would likely include water quality improvements due to a decrease in impervious surfaces contributing to runoff. Increased water quality would benefit the small fish species that terns prey upon.

Alternative 2

Compared to Alternative 1, the quantity of protected tern habitat and the extent of water quality improvements would be expected to be less under Alternative 2 because less shoreline would be designated as Protected.

Alternative 3

Alternative 3 is likely to reflect the No Action Alternative due to the fact that the majority of observed tern populations currently exist on protected shorelines that would not be rezoned. Implementation of proposed vegetation management buffers would likely result in reduced disturbance of shoreline habitats and a modest increase in water quality compared to the No Action Alternative, benefiting least terns and their preferred small prey fish species. However, increased development and dock construction associated with Alternative 3 would also be likely to inhibit range expansion of terns into other portions of the study area. Interior least terns are extremely sensitive to disturbance during the breeding season and even minor anthropogenic influences can result in nest abandonment and decreased reproductive success. Additionally, increased dock construction would alter littoral zone habitats in which terns breed and forage and an increase in the local human population would likely lead to high utilization of sandy beach habitats.

Alternative 4

Compared to Alternative 3, the extent of least tern habitat would be reduced and potential water quality impacts could be more pronounced under Alternative 4 due to high levels of development and recreation. Full build-out at the Carlton Landing site would likely displace any terns frequenting the area. While no least tern activity has been observed in this portion of the study area, the small adjacent inlet known locally as Ski Cove contains the shallow, protected lake margins in which terns preferably feed. During 2012 surveys, a large sandy beach was identified on the north shore of Roundtree Landing. USACE staff indicated that this beach received very little human traffic; therefore, could serve as potential nest habitat. At Roundtree Landing and in other suitable tern habitats, increased development and recreational

opportunities provided by Alternative 4 would likely result in increased lake usage and human disturbance, thereby, confining tern populations to existing protected areas.

5.2.4.3 Migratory Birds

Due to its location on the Central Flyway, the majority of species likely to be found within the Eufaula Lake study area are seasonal residents or migrants. While only present for part of the year, any changes in environmental conditions in the study area could have a potential impact on these species. Therefore, any potential impacts of the proposed alternatives on preferred habitats, as discussed in Section 5.1, are likely to significantly disturb associated bird populations. Potential impacts to listed species and species of conservation concern are discussed first, followed by an impacts analysis on groups of common bird species.

Listed Species

While unlikely to be found within the Eufaula Lake study area, two listed bird species, the piping plover and whooping crane, were identified by ODWC and USFWS as infrequent passage migrants. Due to its geographical location, size, and the presence of a variety of suitable habitat types, Eufaula Lake is a potential stopover site for wayward individuals of these two species.

No Action Alternative

The potential impacts associated with the No Action Alternative on the threatened piping plover would likely result in a future condition similar to that described under the existing condition found in Section 4.2.4.3. As it is only known to nest sporadically in Oklahoma and no nesting has been observed within the study area, the piping plover is most likely a passage migrant only briefly stopping in the study area to rest and feed as it moves between wintering areas on the Gulf Coast and breeding grounds in the northern plains. However, habitats used for resting and foraging such as sand and algal flats are rare within the study area. Where they do occur, they are small and of poor quality due to high levels of human disturbance. The combination of poor habitat quality and an absence of confirmed observations make it unlikely that piping plovers utilize the Eufaula Lake study area.

The endangered whooping crane is also sensitive to human disturbance and frequently utilizes pothole and prairie habitats on its migration from wintering areas in coastal Texas to breeding grounds in Canada. Cranes prefer to roost in palustrine wetlands and submerged sandbars in wide channels with nearby croplands for feeding. Critical habitat is designated in the western part of Oklahoma and, while suitable habitat conditions exist within river systems upstream of Eufaula Lake, the study area and adjacent lands have had no recorded crane observations since reservoir construction. Therefore, potential impacts associated with the No Action Alternative should have no effect on whooping crane populations and future conditions should be similar to those described under the existing condition in Section 4.2.4.3.

Alternative 1

Under Alternative 1, piping plovers are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the unlikelihood of the piping plover being present within the study area and the scarcity and low quality of preferred plover habitat, it is unlikely that activities associated with Alternative 1 would have an adverse impact on this species.

Under Alternative 1, whooping cranes are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the absence of recorded

whooping crane observations in recent history and the absence of preferred habitat within the study area, it is unlikely that activities associated with Alternative 1 would have an adverse impact on this species.

Alternative 2

Under Alternative 2, piping plovers are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the unlikelihood of the piping plover being present within the study area and the scarcity and low quality of preferred plover habitat, it is unlikely that activities associated with Alternative 2 would have an adverse impact on this species.

Under Alternative 2, whooping cranes are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the absence of recorded whooping crane observations in recent history and the absence of preferred habitat within the study area, it is unlikely that activities associated with Alternative 2 would have an adverse impact on this species.

Alternative 3

Under Alternative 3, piping plovers are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the unlikelihood of the piping plover being present within the study area and the scarcity and low quality of preferred plover habitat, it is unlikely that activities associated with Alternative 3 would have an adverse impact on this species.

Under Alternative 3, whooping cranes are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the absence of recorded whooping crane observations in recent history and the absence of preferred habitat within the study area, it is unlikely that activities associated with Alternative 3 would have an adverse impact on this species.

Alternative 4

Under Alternative 4, piping plovers are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the unlikelihood of the piping plover being present within the study area and the scarcity and low quality of preferred plover habitat, it is unlikely that activities associated with Alternative 4 would have an adverse impact on this species.

Under Alternative 4, whooping cranes are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the absence of recorded whooping crane observations in recent history and the absence of preferred habitat within the study area, it is unlikely that activities associated with Alternative 4 would have an adverse impact on this species.

Species of Conservation Concern

No Action Alternative

The peregrine falcon, a federal species of special concern, is a spring and fall migrant in Oklahoma and can be found hunting birds in mountainous terrain, river valleys, and shorelines. Therefore, the potential exists for populations to be found within the Eufaula Lake study area at low densities during migration periods. However, no falcon observations have been recorded in the area. In addition, the reallocation of shoreline and associated levels of resource protection or development would be unlikely to impact peregrines as populations have been known to inhabit both pristine habitats and densely populated urban cities. Any

migrants to the study area would likely avoid unsuitable conditions and relocate to preferred lakeshore areas. Therefore, potential impacts associated with the No Action Alternative are likely to result in future peregrine falcon conditions similar to those described under the existing condition in Section 4.2.4.3.

Sprague's pipit is a non-breeding winter resident and passage migrant in Oklahoma and would most likely be observed in the study area during spring and fall migrations. While suitable prairie habitats, croplands, and pastures exist within the study area, they occupy a relatively small percentage of shoreline habitats and are much more likely to be found in level topographies found in plains and fields to the north and west of the study area. In addition, many of these habitats exist in a degraded condition within the study area and are dominated by invasive species. These existing conditions are expected to persist under the No Action Alternative, and future populations and conditions would likely be similar to those described under the existing condition in Section 4.2.4.3.

Found in all six study area counties between April and September, Bell's vireo is a summer resident that breeds in dense bottomland forest and scrub-prairie thickets. Population declines are related to habitat loss and degradation due to urban development, flood control projects, and invasive plants. In addition, habitat fragmentation has led to significant parasitism of vireo nests by brown-headed cowbirds. The potential impacts associated with the No Action Alternative on the Bell's vireo would likely be similar to those described under the existing condition in Section 4.2.4.3 and would result in similar population distributions and trends.

Bachman's sparrow, a summer resident of southeastern Oklahoma and a species of conservation concern, has declined due to urban encroachment and fire suppression practices that have transformed oak-pine woodland habitat. Oak-pine woodland within the study area has lost much of its savanna-like character as fire suppression has contributed to dense understories and eastern red-cedar infestation. One observation of this species was recorded to the northwest of the study area, but this observation occurred in 1969, and no recent observations have been documented. Therefore, under the No Action Alternative, the future condition would likely see the decreasing trend continue, as described under the existing condition in Section 4.2.4.3. Several areas of pine forest and savanna exist within the study area yet are apparently devoid of Bachman's sparrow populations. Therefore, it is likely that only a change in fire suppression practices, which are not under the control of USACE, would significantly benefit the species.

Similar to the Bachman's sparrow, the prothonotary warbler is a summer resident of southeastern Oklahoma and is a species of conservation concern. However, this species has been routinely documented and observed within the mature bottomland hardwood forests throughout the study area, especially in riparian areas just upstream of Eufaula Lake. The status of this warbler is intimately connected to the availability of mature forested nesting habitat, as it requires cavities in mature hardwood species in which to nest. Since much of the shoreline would remain forested, the No Action Alternative would likely result in warbler populations similar to those described for the existing condition in Section 4.2.4.3.

Alternative 1

Under Alternative 1, peregrine falcon populations in the Eufaula Lake study area would be the same as those described under the No Action Alternative. Due to the absence of peregrine falcon observations and the ability of this species to occupy both altered and un-altered habitats, it would be unlikely that activities associated with Alternative 1 would have an adverse impact on this species.

Under Alternative 1, Sprague's pipit populations in the Eufaula Lake study area would be the same as that described under the No Action Alternative. Due to a lack of presence data and limited and degraded habitats within the study area, it is unlikely that activities associated with Alternative 1 would have an adverse impact on the Sprague's pipit.

Under Alternative 1, Bell's vireo populations in the Eufaula Lake study area would likely increase in comparison to the No Action Alternative. The establishment of extended vegetation management buffers under Alternative 1 would likely preserve forested wetland habitats and would contribute to the health and stability of vireo populations. Under this alternative, the increase in Protected shoreline and decrease in human disturbance would likely limit habitat degradation and reduce edge habitats favored by nest parasites.

Under Alternative 1, Bachmann's sparrow populations in the Eufaula Lake study area would be the same as those described under the No Action Alternative. Due to a lack of confirmed recent sightings and the existing absence and conversion of much of its preferred habitat, it is unlikely that activities associated with Alternative 1 would adversely impact the Bachman's sparrow.

Under Alternative 1, prothonotary warbler populations in the Eufaula Lake study area would likely increase in comparison to the No Action Alternative. The warbler's habitat specificity dictates that significant impacts of any of the alternatives on the bottomland hardwood community, as discussed in Section 5.1.1, would likely impact local populations of prothonotary warblers. Therefore, Alternative 1, with a focus on habitat protection and extended riparian and shoreline buffers, is likely to facilitate an increase in the health of mature riparian areas, thereby, benefiting populations of the prothonotary warbler.

Alternative 2

Although Alternative 2 designates less shoreline as Protected than Alternative 1, it would likely have similar potential impacts on all five bird species of conservation concern. Populations of the peregrine falcon, Sprague's pipit, and Bachmann's sparrow, would likely be similar to those described for the No Action Alternative. Although the increase would be smaller than under Alternative 1, populations of Bell's vireo and prothonotary warbler would increase slightly due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Alternative 3

Under Alternative 3, peregrine falcon populations in the Eufaula Lake study area would be the same as those described under the No Action Alternative. Due to the absence of peregrine falcon observations and the ability of this species to occupy both altered and un-altered habitats, it is unlikely that activities associated with Alternative 3 would have an adverse impact on this species.

Under Alternative 3, Sprague's pipit populations in the Eufaula Lake study area would be the same as those described under the No Action Alternative. Due to a lack of presence data and limited and degraded habitats within the study area, it is unlikely that activities associated with Alternative 3 would have an adverse impact on the Sprague's pipit.

Under Alternative 3, Bell's vireo populations would likely experience a slight decrease in comparison to the No Action Alternative. The increased development and recreation expected under Alternative 3 would likely increase urban encroachment, thereby, increasing fragmentation and the quantity of edge habitats.

While the proposed management buffers established under these alternatives would preserve some bottomland hardwood forest, an increase in limited development would likely increase the susceptibility of buffered areas to invasive species.

Under Alternative 3, Bachmann's sparrow populations in the Eufaula Lake study area would be the same as those described under the No Action Alternative. Due to a lack of confirmed recent sightings and the existing absence and conversion of much of its preferred habitat, it is unlikely that activities associated with Alternative 3 would adversely impact the Bachman's sparrow.

Under Alternative 3, prothonotary warbler populations in the Eufaula Lake study area would likely decrease compared to the No Action Alternative. The warbler's habitat specificity dictates that significant impacts of any of the alternatives on the bottomland hardwood community, as discussed in Section 5.1.1, would likely impact local populations of prothonotary warblers. Alternative 3, with a focus on development and recreation, would likely cause a decline in bottomland forest habitats. This habitat conversion and fragmentation would likely impact prothonotary warbler populations due to a reduction in preferred nesting sites.

Alternative 4

Although Alternative 4 designates more shoreline as Limited Development and increases shoreline designated Public Recreation as compared to Alternative 3, it would likely have similar potential impacts on all five bird species of conservation concern. Populations of the peregrine falcon, Sprague's pipit, and Bachmann's sparrow, would likely be similar to those described for the No Action Alternative. However, decreases in Bell's vireo and prothonotary warbler populations would likely be greater than those under Alternative 3 due to habitat degradation and other potential impacts associated with a likely increase in development on adjacent lands.

Birds of Prey

No Action Alternative

Under the No Action Alternative, potential future impacts on the birds of prey community would be similar to those described under the existing condition, resulting in similar species diversity and population numbers. This includes a community dominated primarily by habitat generalists that can tolerate limited human disturbance. Most species present within the Eufaula Lake study area would be present during the breeding season; a time in which birds of prey are particularly susceptible to human activity.

Alternative 1

The action alternatives are unlikely to impact species richness but may potentially impact species evenness. Under Alternative 1, an increase in protected shoreline and the establishment of extended vegetation management buffers would likely increase the quantity of relatively undisturbed natural habitats. This would favor species such as the red-shouldered hawk and the barred owl, which prefer relatively dense forests. Alternative 1 would also likely limit development and the creation of edge habitats, which are exploited by species such as the red-tailed hawk. As habitats mature, especially forested habitats, it is likely that birds of prey would simply shift their distribution in order to occupy the most suitable areas for each species. Therefore, potetnial impacts to the birds of prey community would be unlikely under Alternative 1, but relative abundances could shift as a result of observed habitat conditions.

Alternative 2

Although Alternative 2 designates less shoreline as Protected than Alternative 1, it would likely have similar potential impacts on birds of prey due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Alternative 3

Alternative 3, which emphasizes development and would likely result in greater recreational activity, would not impact birds or prey species diversity but would potentially select for species best suited to human disturbance. With increased development, edge habitats would increase resulting in higher populations of vultures and well-suited hawk species. This would also result in decreasing populations of species suited to dense forested habitats.

Alternative 4

Alternative 4 would likely impact birds of prey populations in ways similar to Alternative 3. However, compared to Alternative 3, potential impacts would likely be magnified and more widespread due to an increased number of shoreline areas being rezoned from Protected to Limited Development. The increase in areas designated Public Recreation would likely impact only those populations located along the six miles of converted shoreline at Carlton Landing, resulting in displacement of individuals to suitable environments.

Songbirds

The vast majority of birds likely to be found within the study area are migratory songbirds. Although they occur in every habitat within the study area, many species are in decline due to degradation of the specialized habitats they inhabit. Therefore, in addition to the potential specific impacts addressed here, songbirds would likely be affected by any potential impacts that lead to habitat changes as discussed in Section 5.1. The vast diversity represented by the over 70 species of migrant and resident songbirds potentially found within the study area makes it infeasible to cover all potential impacts to all species. Therefore, those potential impacts most likely to affect the greatest number of songbird species are discussed.

No Action Alternative

Under the No Action Alternative, potential impacts would likely result in a future songbird condition similar to the existing condition outlined in Section 4.2.4.3 and would result in songbird distributions that mirror current extents, trends, and population numbers.

Alternative 1

Similar to birds of prey, the action alternatives are unlikely to impact species richness by causing the disappearance of certain species, but would potentially impact species evenness by selecting for species best adapted to resulting environmental conditions. Therefore, under Alternative 1, an increase in shoreline designated as Protected would likely result in habitats reflecting the existing condition with some notable exceptions. Protected forest habitats would likely mature, and without the presence of fire, acquire high canopy and understory densities. Therefore, birds of the open woodland and savanna such as the savannah sparrow would be displaced and replaced by birds adapted to closed canopies such as the white-breasted nuthatch. Additionally, under existing fire suppression practices, prairie habitats would likely be encroached upon by woody species, forming open woodlands. The savanna species that were displaced due to increasing forest density would likely immigrate into these transformed prairies. As these

examples illustrate, the protection of habitat does not necessarily mean habitats would not change dynamically. Under Alternative 1, it is likely that species' distributions within the study area would change but a loss of species is unlikely.

The reduced potential for future development in comparison to the No Action Alternative and the establishment of extended vegetation management buffers under Alternative 1 would also likely impact songbird species. The preservation of riparian and shoreline areas would likely benefit species dependent on habitats found in these locations including wetlands and bottomland hardwood and crosstimbers forests. Decreasing the amount of land available for future development is likely to reduce future fragmentation and edge effects, thereby, benefiting species adapted to core habitats. Reduction of edge effects is also likely to reduce nest parasites like brown-headed cowbirds and nest predators like raccoons that significantly alter songbird reproductive success. However, many songbirds thrive in edge habitats due to a large insect forage base often found in ecotones.

Alternative 2

Although Alternative 2 designates less shoreline as Protected than Alternative 1, it would likely have similar potential impacts on songbird species due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Alternative 3

Compared to the No Action Alternative, the establishment of baseline vegetation management buffers under Alternative 3 would likely benefit songbird species of all habitat types, but to a lesser extent than the wider buffers implemented under Alternatives 1 and 2. Direct benefits of baseline buffer implementation would include vegetation management stressing conservation. Indirect benefits would include improved water quality due to fewer sediment and nutrient inputs into the lake.

Similar to potential impacts expected under Alternatives 1 and 2, some songbird groups would benefit and some would decline due to land use changes associated with shoreline reallocations under Alternative 3. The increase in future potential development would likely increase birds tolerant of increased human disturbance. Species like the American robin, blue jay, and northern cardinal are staples at backyard feeders and human structures often provide nesting opportunities. Therefore, Alternative 3 should have a beneficial impact on songbird communities tolerant of disturbed, edge habitats and an adverse impact on songbird communities that prefer core habitats.

Another widespread potential impact of increased development on songbirds, and all native birds in general, is the increase in invasive competitors and nest predators. Invasive songbirds such as the European starling and house sparrow are aggressive, superb competitors that displace native cavity-nesting songbirds like the northern parula and brown creeper as well as most woodpeckers. Both species also lower native songbird reproductive success by actively destroying nests, eggs, and nestlings. While at home in most open habitats, starlings and house sparrows often use human development and disturbance to access new areas of core, interior habitat. Therefore, implementation of Alternative 3 would likely result in an expansion of invasive species distributions and an increase in starling and house sparrow populations in areas of development.

Alternative 4

Compared to Alternative 3, potential impacts of Alternative 4 would likely be magnified and more widespread due to an increased number of shoreline areas being rezoned from Protected to Limited Development and Public Recreation.

Under Alternatives 3 and 4, especially under full build-out on the Carlton Landing site in Alternative 4, increased development and its associated increased use of herbicide application is likely to alter songbird composition. One of the greatest potential impacts of development on songbirds, and their food base, is the widespread use of herbicides. Herbicide application, which increases with landscaping activity associated with development, impacts songbird populations by selecting for species adapted to open parkland settings created by residential communities. Crosstimbers habitat studies in Payne County, Oklahoma show that although total bird density, diversity, and richness of breeding songbirds did not change with herbicide application, the species composition differed significantly (Schulz *et al*. 1992). On treated sites, species including the eastern bluebird, Bewick's wren, and indigo bunting replaced species that require dense forests such as the black-and-white warbler. Therefore, areas of intense residential development, such as that proposed at Carlton Landing, would likely result in the replacement of species adapted to dense forests or closed canopy systems with species at home in open park-like settings and maintained landscapes.

Ground Birds

While not considered migratory, many ground birds are afforded protections due to their cultural and recreational importance as popular game species. Three species in particular, northern bobwhite, turkey, and mourning dove are among the most popular statewide and occur within the study area. Due to habitat and behavioral similarities, discussion concerning potential impacts of alternatives on these three game species will describe likely impacts on other ground bird species including the greater roadrunner, killdeer, and American woodcock.

Ground birds are so named because unlike many birds, they spend most of the time on the ground. This unique behavioral adaptation makes them particularly vulnerable to land use changes. The majority of ground birds prefer open habitats including prairie, savanna, and open woodland. Therefore, potential impacts to these habitat types as described in Section 5.1 are likely to impact ground bird species.

No Action Alternative

Under the No Action Alternative, potential impacts would likely result in a future ground bird community condition similar to that described under the existing condition in Section 4.2.4.3. However, ground birds are reliant on fires to maintain relatively open habitats, and existing fire suppression practices would likely favor future forest encroachment and a loss of open habitat. While some ground birds, such as the wild turkey, can adapt to forest environments, other ground birds including the greater roadrunner cannot. Therefore, under the No Action Alternative, some ground bird species adapted to open habitats would likely experience population decline.

Alternative 1

Alternative 1, which emphasizes natural resource conservation, would likely benefit populations of ground birds such as the wild turkey and American woodcock that prefer forests and bottomland hardwoods. These habitats are most prevalent along the Eufaula Lake shoreline and would be conserved under extended management buffers. In addition, turkeys prefer to roost in mature pine and hardwood forests,

and an increase in land designated Protected would likely increase available roost sites. While vegetation buffers and protection of land from the impacts of potential future development would likely benefit all ground birds in the short-term, without fire, large areas of open ground bird habitat would likely convert to woodland. Therefore, in comparison to the No Action Alternative, species diversity would likely be similar under Alternative 1, but populations of all ground bird species would likely increase in the short-term. Long-term, species able to adapt to forest systems would likely benefit to the detriment of species adapted to open habitats.

Alternative 2

Although Alternative 2 designates less shoreline as Protected than Alternative 1, it would likely have similar potential impacts on ground bird species due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Alternative 3

Alternative 3, which emphasizes development, would likely result in a future condition similar to that described for the No Action Alternative. In addition to fire suppression and forest encroachment, ground birds in open habitats would likely be impacted by invasive forage species introduction. Much of eastern Oklahoma already does not provide high quality bobwhite habitat due to extensive land use changes such as the conversion of native prairie to introduced grasses (Schoeling 2011). An increase in development and recreational opportunities would likely increase the potential for the introduction of new invasive plants and the spread of established invasive species.

Alternative 4

Compared to Alternative 3, potential impacts of Alternative 4 would likely be magnified and more widespread due to an increased number of shoreline areas being rezoned from Protected to Limited Development. Most ground birds do not tolerate high levels of human disturbance. While limited human disturbance could increase open habitats within greater forested areas, intense development often converts suitable habitat and decreases nesting success due direct ground nest destruction and predation by raccoons and domestic cats. Therefore, under Alternative 4, full build-out of the proposed Carlton Landing development would likely displace many ground birds from the area.

Woodpeckers and Other Common Species

Many of the species in this category could have been discussed with the songbirds; however, their specific habitat requirements require additional discussion. As such, the potential impacts of Alternatives 1-4 evaluated for songbirds would also apply to woodpeckers.

While several species in the songbird category are cavity-nesters, additional potential impacts that are unique to cavity-nesting birds such as woodpeckers, purple martin, and northern flicker are addressed here. These species excavate nest holes in dead or deteriorating trees that have often been considered undesirable by foresters and landowners because they are not aesthetically pleasing, conflict with forest management practices, may harbor insect pests, or may be fire or safety hazards (Scott *et al*. 1977). Many species of cavity-nesting birds have declined because of habitat destruction, primarily due to logging of mature forests or the selective removal of snags.

No Action Alternative

The No Action Alternative and associated potential impacts would likely result in a future condition in which woodpecker, crow, and swallow distributions, populations, and community composition are similar to those described for the existing condition in Section 4.2.4.3.

Alternative 1

Under Alternative 1, natural resource protection through land reallocation and rezoning and the establishment of extended buffers would likely preserve areas of mature forest and the snags contained within. Therefore, species composition would likely reflect the No Action Alternative but the distribution of cavity-nesters would likely expand and populations would likely increase.

Alternative 2

Although Alternative 2 designates less shoreline as Protected than Alternative 1, it would likely have similar potential impacts on woodpeckers and other common species due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Alternative 3

Alternative 3, with an emphasis on development, would likely result in a species composition of cavity-nesting birds similar to that described for the No Action Alternative but distributions and populations would likely shrink and decrease with the removal of mature forests. Even where mature forests are only thinned, as is often the case with rural residential development, selective management often prioritizes snag removal for safety and aesthetic reasons. Eliminating snags would deprive woodpeckers and other cavity-nesters of vital food sources and nesting habitats. In addition, because they play a role in the control of forest pests, a decline in insectivorous cavity-nesters could spark an overall decline in forest health.

Alternative 3 would also likely have beneficial impacts on some species in this group. Populations of crows and swallows generally increase with human disturbance, as swallows often nest on structures like bridges and barns and crows, as generalists, take advantage of foraging opportunities associated with edge habitats.

Alternative 4

Compared to Alternative 3, Alternative 4 would likely result in magnified and more widespread potential impacts to woodpecker, crow, and swallow populations due to an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation. This includes expected adverse impacts to cavity-nesting species and beneficial impacts to edge species adapted to human disturbance.

Waterfowl

The availability, dispersion, and quality of habitats influence waterfowl concentrations, movements, energy budgets, and pairing processes; thereby, affecting waterfowl reproductive potential (Heitmeyer and Vohs, Jr. 1984). Therefore, the potential impacts of each of the alternatives on waterfowl habitat have potentially profound effects on waterfowl populations.

Several waterfowl species have preferred habitat types, and study area populations would likely be impacted by the potential effects of alternatives on these habitats. For example, wood ducks would be

affected by beneficial and adverse impacts to bottomland hardwood forests outlined in Section 5.1.1, including the benefits of buffer establishment and the direct removal of riparian vegetation in broad floodplains. Likewise, species such as canvasback, redhead, green-winged teal, and northern pintail would be impacted by potential impacts to emergent and scrub-shrub wetlands discussed in Section 5.1.2, including potential water quality benefits under Alternatives 1 and 2 and impacts of increased dock construction under Alternatives 3 and 4. Therefore, potential impacts of the action alternatives discussed in this section should be combined with those for each waterfowl species' preferred habitat type to adequately address the full suite of potential impacts on individual waterfowl species.

As with previous groups exhibiting a wide diversity of behavior and habitat preferences, discussion of potential impacts for each alternative will focus on those impacts most likely to impact the greatest number of waterfowl species.

No Action Alternative

The No Action Alternative and associated potential impacts would likely result in a future condition that maintains waterfowl populations, trends, and distributions described for the existing condition in Section 4.2.4.3.

Alternative 1

Alternative 1, which establishes extended management buffers to conserve shoreline habitat, would likely improve water quality resulting in an increase in the quantity of optimal habitat suitable for waterfowl. Increases in water quality would likely bolster populations of aquatic vegetation and aquatic invertebrates on which most waterfowl feed. Conservation management implemented under Alternative 1 would likely increase the amount of protected littoral zone and wetland habitat, which would likely improve waterfowl fitness and reproductive success.

Under Alternative 1, the amount of shoreline designated Protected increases while limiting the potential for development on adjacent lands. Studies in east-central Oklahoma have shown that protection of natural wetlands and unaltered rivers is more beneficial to wintering ducks than attempting to enhance areas associated with large reservoirs (Heitmeyer and Vohs, Jr. 1984). Therefore, capital spent on wetland development units and shoreline enhancement may be better spent on protecting existing habitats within the Eufaula Lake study area.

In addition to limiting wetland losses, Protected shorelines would likely limit disturbance associated with development including increased potential for human-waterfowl interaction. Human-waterfowl interactions often cause escape behavior, which is particularly detrimental to waterfowl fitness during the breeding season. For migrant and winter resident species, frequent escape behavior could potentially impact waterfowl fitness required for successful migration.

Alternative 2

Alternative 2 also would increase the amount of land designated as Protected, but at levels lower than those proposed under Alternative 1. In addition, Alternative 2 would establish the same extended vegetation management buffers implemented under Alternative 1. Therefore, types of potential waterfowl impacts under Alternative 2 would likely be similar to, but less extensive than, those described for Alternative 1.

Alternative 3

Alternative 3 establishes smaller vegetation buffers than Alternatives 1 and 2 and reallocates approximately 6,600 acres of shoreline habitat from Protected to Limited Development. The establishment of baseline vegetation management buffers would likely improve water quality and waterfowl habitat when compared to the No Action Alternative, but at levels lower than those established by the wider extended management buffers. An increase in development as a result of Alternative 3 would likely impact certain waterfowl species differently depending on preferred habitat type and the level of human disturbance and interaction each is willing to tolerate. Development could actually help expand populations of generalist waterfowl species that adapt well to human disturbance such as mallards and Canada geese.

However, for the majority of waterfowl species likely to be found within the study area, increased areas of development and associated human disturbances would likely lower forage quality, reproductive success, and available optimal habitat. Lowered reproductive success would include failed nest attempts due to nest site disturbance and increased nestling mortality due to increases in nest predators adapted to human settlement like raccoons, red fox, and domestic cats. While the response by sensitive waterfowl species would likely be a shift in distribution to lesser developed portions of the study area, the concentration of waterfowl populations into smaller areas of optimal habitat is likely to place additional stress on these areas. It would also increase the probability that significant natural impacts, such as disease, could reduce large percentages of the population.

Under Alternative 3, an increase in additional boat dock construction would be likely. While several species of waterfowl use floating docks for refuge, construction of these structures impacts littoral zone areas where waterfowl not only take refuge, but feed and nest as well. Therefore, while creating some waterfowl habitat, boat dock construction does so by eliminating productive natural habitats resulting in no net benefit. Additionally, an increase in development and boat dock construction would likely result in increased lake usage for recreational activity, which would increase human-waterfowl interaction.

Alternative 4

Compared to Alternative 3, potential impacts of Alternative 4 on waterfowl populations would likely be magnified and more widespread due to an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation.

In addition, the increase in shoreline designated Limited Development would likely result in increased recreational lake usage from an increase in residential and boat dock construction. It is this increase in recreational activity that sets likely impacts resulting from Alternative 4 apart from the other action alternatives. Alternative 4, in comparison to Alternative 3, designates even more land as Limited Development and increases areas of Public Recreation. The increase in recreational activity on the lake would likely result in energy costs to individuals associated with fleeing response and disturbance of aquatic habitats, including nest sites. Areas of significant development and shoreline conversion, such as that allowed under the full build-out at Carlton Landing, would likely eliminate habitat for sensitive species such as teal. However, it could possibly benefit adaptable species by increasing forage opportunities through direct feeding.

Another potential impact on waterfowl due to increased lake usage under Alternative 3, and more so under Alternative 4, is increased hunting pressure. Waterfowl hunting is extremely popular within the Eufaula Lake study area and an increase in the local human population expected as a result of increased

development and recreational opportunities would likely increase the number of hunters. While hunting is closely regulated and is not expected to reach high enough levels to cause a significant decline in waterfowl populations, it could potentially compound the impact to localized populations of species already stressed by habitat reduction. For example, increased residential development would likely reduce areas where hunting is allowed; thereby, concentrating hunting in fewer areas far from significant development. Waterfowl would also be concentrated in these same areas because they are refuges from degraded habitat and human disturbance. While this would likely increase hunter success in the short-term, it has the potential to significantly reduce widely-distributed waterfowl populations compared to the existing condition.

Waterbirds

Waterbirds, like waterfowl, are extremely sensitive to land use changes that impact surrounding aquatic habitats. Therefore, potential impacts to waterfowl species outlined for the No Action Alternative and Alternatives 1-4 also apply to waterbirds. However, one major difference between waterbirds and most waterfowl species is that many waterbirds including herons, egrets, pelicans, gulls, and terns are piscivorous. Therefore, potential impacts to fish species as described in Section 5.2.1 would also impact the health and stability of waterbird populations.

Another significant concern is that waterbirds tend to adjust poorly to increased levels of recreation. Outdoor recreation, resulting in increased interactions between humans and waterbirds often leads to deleterious effects on nesting success, foraging efficiency, and foraging-site quality (Schummer and Eddleman 2003). Disturbances can be just as costly, energetically, due to lost feeding time and increased escape activities. While some species, such as the great blue heron and herring gull, have adapted well to human disturbance, the majority of waterbird species examined at Tishomingo National Wildlife Refuge, including American coot, American white pelican, and Franklin's gull, exhibited increased energy expenditure and stress fleeing from boat activities than from natural disturbances or shore fishing (Schummer and Eddleman 2003). Disturbance is particularly acute for migrating waterbirds, often resulting in decreased nutrient reserves and late arrival to breeding grounds leading to reduced reproductive success.

The increased development of properties adjacent to the shoreline and the construction of additional boat docks under Alternatives 3 and 4 would likely increase human-waterbird interactions, resulting in costly fleeing behavior. This would likely impact waterbird health within the Eufaula Lake study area and could result in observed population declines. The increased recreational opportunities of Alternative 4 would likely lead to even greater levels of interaction resulting in negative health consequences for waterbirds.

5.2.5 Invertebrates

As the largest and most diverse group of organisms found within the Eufaula Lake study area, the potential exists for any of the four action alternatives to impact resident populations. However, the status of most invertebrates within the study area cannot be determined; therefore, accurate analysis of potential impacts could not be directly attributed to the proposed alternatives. In addition, relatively few studies exist that evaluate the impacts of increased development or recreation activities on specific invertebrate groups. Therefore, the potential impacts of the four action alternatives will be assessed for invertebrates on which information is known. This includes species of conservation concern, including the endangered American burying beetle, and freshwater mussels.

Under the No Action Alternative, the future condition for all invertebrates would be expected to be similar to the distributions and trends described under the existing condition found in Section 4.2.5. Additionally, for invertebrates that are habitat specialists, potential impacts to the habitat type in which they reside would likely reflect impacts to the invertebrates themselves. Potential habitat impacts can be found in Section 5.1.

5.2.5.1 American Burying Beetle

The American burying beetle is an endangered species with confirmed populations located to the south of the Eufaula Lake study area. American burying beetle surveys were conducted within the Eufaula Lake study area on the Carlton Landing site in May 2012. The results of the survey, as documented in Section 4.2.5.1 and Appendix D, indicate that the American burying beetle is present within the shoreline areas of the Carlton Landing site. Therefore, the proposed revisions to the SMP and MP supplement would likely affect resident American burying beetle populations.

Specific habitat requirements are unknown, but given the once broad geographic distribution of the American burying beetle, it is unlikely that specific soil or vegetation types limit its distribution. While the reasons for widespread decline are uncertain, most agree that the population decline of the American burying beetle is most likely the result of interplay of several complex factors that include (1) artificial lighting that decreases populations of nocturnal insects, (2) changing sources of carrion because of habitat alteration and extinction, (3) isolation of preferred habitat due to land use changes, (4) increased edge effect harboring more predators and competitors for carrion, and (5) the possibility of reduced reproductive ability due to genetic impairments caused by small population size (Ratcliffe 1997). All but the fifth potential factor would be impacted to varying degrees by the action alternatives.

In addition to the potential impacts likely to affect all American burying beetle populations, the population occurring within the vicinity of the survey locations at the Carlton Landing site would likely face additional potential impacts from the proposed action alternatives due to on-going and proposed land disturbance activities.

No Action Alternative

The potential impact of the No Action Alternative on all American burying beetle populations would likely result in future conditions similar to those described under the existing condition in Section 4.2.5.1. The future condition is characterized by potential adverse impacts to beetles and their habitats within areas already scheduled for development and within areas where future development is allowed.

Alternative 1

For all potential American burying beetle populations, impacts of each individual action alternative would vary depending on habitat type and extent of development. Alternative 1 would likely preserve existing beetle populations and could facilitate range expansion. The implementation of extended management zone buffers and the emphasis on natural resource protection would likely limit habitat alteration and fragmentation. This, combined with reduced edge effects, would benefit potential carrion species, preserve preferred American burying beetle habitats, and reduce overall predator and competitor densities.

Under Alternative 1, the proposed development at Carlton Landing would largely be the same as that described under the No Action Alternative; however, the Limited Development on the south side of Longtown Arm would be rezoned to Protected. This, in combination with the proposed extended buffers

for remaining Limited Development areas, would protect more American burying beetle habitat than the No Action Alternative and would limit the extent of direct land disturbance. In addition, the limit on dock construction would likely limit potential future residential development in areas where American burying beetle presence has been confirmed. While development of approximately 170 lots would still occur, potential direct and indirect impacts to beetle populations and habitats increase exponentially with the magnitude and extent of land disturbance. Therefore, Alternative 1 would result in the fewest potential impacts to local American burying beetle populations in comparison to the No Action and three remaining action alternatives.

Alternative 2

Although Alternative 2 designates less shoreline as Protected than Alternative 1, it would likely have similar potential impacts on all American burying beetle populations due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Under Alternative 2, the potential scope of future development at Carlton Landing would be the same as that described for the No Action Alternative. Therefore, the potential impacts associated with this alternative would likely be similar to those described for the No Action Alternative, with the caveat that the installation of extended buffers would protect American burying beetle habitat close to the shoreline.

Alternatives 3 and 4 convert Protected shoreline into those designated as Limited Development and/or Public Recreation. The implementation of baseline management zone buffers would preserve American burying beetle habitat not protected under the No Action Alternative. However, increased development and recreational opportunities within the study area would likely lead to decreases in beetle populations in areas where land reallocation occurs. Development increases artificial lighting, which has been linked to decreases in populations of nocturnal insects such as the American burying beetle. Additionally, the potential for increased development and recreation increases the potential for habitat fragmentation and degradation. Habitat alterations often result in increases in disturbed and edge habitats, which favor beetle predators and carrion competitors such as flies, raccoons, and opossums.

While artificial lighting and habitat fragmentation can affect American burying beetle populations, potential adverse impacts generally result from ground disturbance. Development and construction activities, especially related to roadway projects, frequently disturb soils and potentially harm individuals (FHWA 2009). Direct adverse impacts to these beetles during inactive and active periods may occur as a result of vegetation clearing, heavy equipment operation, fuel and chemical contamination of the soil, rough terrain grading, soil excavation, and filling and reseeding of disturbed areas (FHWA 2009). Under Alternatives 3 and 4, the probability of ground disturbance increases; therefore, American burying beetle populations within the study area would be more likely to suffer potential impacts.

Alternative 3

Under Alternative 3, large areas of designated Protected shoreline are rezoned as Limited Development. The implementation of baseline management zone buffers would preserve American burying beetle habitat not protected under the No Action Alternative. However, increased development and recreational opportunities within the study area would likely lead to decreases in beetle populations in areas where land reallocation occurs. Development increases artificial lighting, which has been linked to decreases in populations of nocturnal insects such as the American burying beetle. Additionally, the potential for increased development and recreation increases the potential for habitat fragmentation and degradation.

Habitat alteration often results in increases in disturbed and edge habitats, which favor beetle predators and carrion competitors such as flies, raccoons, and opossums.

While artificial lighting and habitat fragmentation can affect American burying beetle populations, potential adverse impacts generally result from ground disturbance. Development and construction activities, especially related to roadway projects, frequently disturb soils and potentially harm individuals (FHWA 2009). Direct adverse impacts to these beetles during inactive and active periods may occur as a result of vegetation clearing, heavy equipment operation, fuel and chemical contamination of the soil, rough terrain grading, soil excavation, and filling and reseeding of disturbed areas (FHWA 2009). Under Alternative 3, the probability of ground disturbance increases; therefore, American burying beetle populations within the study area would be more likely to suffer potential impacts.

In comparison to Alternatives 1 and 2, under Alternative 3, additional shoreline within the Carlton Landing site would be designated Limited Development. While the increase in Limited Development would allow for more dock construction, overall the scale and extent of the proposed Carlton Landing development would be similar to that described under the No Action Alternative. Therefore, potential impacts to local American burying beetle populations would likely be similar to those described under the No Action Alternative with direct adverse impacts in areas where current or potential future development is allowed.

Alternative 4

Compared to Alternative 3, potential impacts of Alternative 4 on American burying beetle populations would likely be magnified and more widespread due to an increased number of shoreline areas being rezoned from Protected to Limited Development.

Alternative 4 would allow for the re-designation of shoreline located at Carlton Landing from Protected to Public Recreation. This would enable full build-out including the development of approximately 2,570 home lots and associated community facilities. Full-build out would likely result in the development of 1,650 acres of confirmed American burying beetle habitat. This level of land disturbance, especially if conducted during the underground, inactive period in the lifecycle of the species, would likely result in direct beetle mortality and the conversion of suitable beetle habitat. Planned recreation activities along the lake shoreline would also likely result in potential adverse impacts to beetle populations as protected buffers in these areas would not be required. Increased recreational activity would also likely drive potential carrion species from the area, depriving American burying beetles of necessary food and reproductive sources.

5.2.5.2 Terrestrial Arthropods

Terrestrial arthropods are dominated by various groups of insects and arachnids. Unfortunately, little information is known concerning the potential impacts of shoreline buffers, increased development, or increased recreation on terrestrial arthropods. In addition, many are extremely mobile and possess high fecundity; therefore, they are able to easily move to more suitable habitat conditions or replenish populations after numbers have been reduced due to a disturbance event. Any potential impacts from the action alternatives would likely be temporary and localized population loss offset by immigration from adjacent communities. Therefore, the overall impacts of the No Action Alternative and four action alternatives on the terrestrial arthropod community would be similar to those described for the existing condition in Section 4.2.5.2.

During 2012 habitat surveys, greater diversity of butterfly and grasshopper species was observed in open habitats, whereas beetles, wasps, and flies were more often observed in forest habitats. Therefore, potential impacts to these groups would be similar to impacts described for their respective habitats in Section 5.1.

The prairie mole cricket, which has been documented within Lake Eufaula State Park, would not be impacted by any of the action alternatives in that location. Additional populations located within the study area would likely be found in prairie habitats, mowed lawns, hayfields, and secondary growth fields (Layher *et al*. 2005). Prairies and agricultural fields are rarely located within 95 feet of the shoreline, so the implementation of baseline or extended management buffers would likely have little impact on mole cricket populations. In addition to these habitats, prairie mole crickets have been found within maintained lawns and distribution appears more influenced by soil type than by level of human influence. However, any development activity likely to disturb the soil layer could impact the prairie mole cricket. Therefore, while future conditions under all four action alternatives would be unlikely to impact overall prairie cricket populations, localized impacts would be possible, especially in Alternatives 3 and 4 where the potential for increased ground disturbance exists.

5.2.5.3 Aquatic Invertebrates

Aquatic invertebrates are important indicators of water quality and lacustrine ecosystem health. Aquatic macroinvertebrate communities, both in the water column and in the benthos, vary widely depending on substrate and nutrient availability. Therefore, the species composition of benthic macroinvertebrates and pelagic zooplankton would likely be influenced by factors that impact these habitat parameters.

The plankton community generally exhibits cyclic stability and varies in composition in relation to changes in light, temperature, and nutrient availability (Walsh 1978). Pollutants can affect the relation between growth rate and each of these variables, with increased suspended solids filtering out light needed for algae growth. In contrast, increased nutrient inputs facilitate growth, often resulting in large blooms. Therefore, potential impacts on the phytoplankton community are not likely to change species composition but instead influence population size. Likewise, pelagic zooplankton are sensitive to water pollutants and often accumulate rather large amounts, with larvae much more sensitive than adults. Varying sensitivities to pollutants could cause changes in community structure by affecting variables such as rate of increase, rate of predation, mortality, and population density (Walsh 1978). As the base of the aquatic food web, any change in the plankton community is likely to significantly impact local fish species.

The littoral zone and wetland habitats within the study area also contain a freshwater mussel community in the benthos. Similar to benthic macroinvertebrates and plankton, freshwater mussels are highly susceptible to changes in water quality because they are filter feeders and depend on relatively clean waters for respiration and reproduction. Individual observations of pink papershell, giant floater, and fragile papershell mussels were made in several locations. In contrast to many freshwater mussel species, all three species are known to reach high densities in reservoirs and can tolerate silt substrates that many other mussel species cannot (Mather 2005). Therefore, it is likely that the potential impacts of all four action alternatives would be similar to those future conditions described under the No Action Alternative.

No Action Alternative

Under the No Action Alternative, potential impacts would likely result in a future condition for all aquatic invertebrates similar to that described under the existing condition in Section 4.2.5.3. However, over time,

continued development would likely increase sediment and nutrient inputs, which would slowly shift species composition to favor species that can tolerate poorer water quality in eutrophic systems.

Alternative 1

The current benthic macroinvertebrate community is likely made up of tolerant true flies, mollusks, worms, and several groups of crustaceans that are adapted to fine-sediment, eutrophic reservoir systems with significant organic inputs. While Alternative 1 would unlikely change the existing condition in many parts of the lake, the implementation of extended buffers and an increase in Protected shoreline could reduce sediment and nutrient inputs resulting in localized improvements to water quality. An increase in water quality could shift the composition of the benthic macroinvertebrate community away from tolerant species to more sensitive species including beetles (Coleoptera), mayflies (Ephemeroptera), caddisflies (Trichoptera), and dragonflies and damselflies (Odonata). The macroinvertebrate mollusk community would also likely shift from fairly tolerant gastropods to more sensitive pelecypods.

While the species composition of the plankton community would be unlikely to change under Alternative 1, the expected water quality improvements would likely impact plankton populations. A reduction in suspended solids from lower rates of erosion would facilitate plankton growth, and reduced nutrient inputs from a decrease in development would likely reduce potential algal blooms. The reduced nutrient input would also decrease zooplankton impairment and mortality, leading to higher populations and a larger fish forage base.

Increased water quality and protection of shoreline habitats under Alternative 1 would likely result in the expansion of localized freshwater mussel populations. Several species, which have been documented to exist within the study area, including the giant floater, are adapted to reservoir conditions. Therefore, if sedimentation rates and nutrient inputs associated with development are kept low, as they would be in Alternative 1, there would be little to prevent the resident freshwater mussel community from expanding.

Alternative 2

Although Alternative 2 designates less shoreline as Protected as compared to Alternative 1, it would likely have similar potential impacts on aquatic invertebrate populations due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development. The decrease in development would likely improve water quality, which is essential for the survival of many aquatic invertebrate species.

Alternative 3

The future condition under Alternative 3 would also likely see a localized increase in water quality due to the implementation of baseline management buffers; however, this increase would likely be offset by increased sediment and nutrient inputs associated with increased levels of development. Therefore, the benthic macroinvertebrate community would likely be similar to that of the No Action Alternative.

Under Alternative 3, potential increases in water quality due to the establishment of baseline management buffers would likely impact plankton communities in ways similar to those described for Alternatives 1 and 2, but to a lesser extent. Increased impervious surfaces and other factors leading to higher sediment and nutrient inputs associated with increased development would likely have varied impacts on plankton. While an Increase in suspended solids would likely inhibit plankton growth, an increase in nutrients often results in algal blooms and significant zooplankton impairment.

In addition, the future condition under Alternative 3 would likely result in increased lake usage. Shoreline activities, including dock construction and recreational boating and swimming, would likely result in direct take of mussels and could potentially impact water quality to the extent that even the most tolerant species would be adversely impacted. However, the levels of development proposed in these alternatives would be unlikely to degrade water quality of the entire Eufaula Lake study area to that point; although, localized extirpation would be possible in heavily developed areas.

Alternative 4

Compared to Alternative 3, potential impacts of Alternative 4 on aquatic invertebrate populations and communities would likely be magnified and more widespread due to an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation. These potential impacts would be magnified at the Carlton Landing location, as planned shoreline disturbances and landscaping activities within the enclosed inlet known locally as Ski Cove would likely provide the nutrient and environmental conditions conducive to algal population explosions.

5.2.5.4 Invasive Species

Two invasive mussel species, the zebra mussel and Asian clam, are recognized as threats to the stability of the Eufaula Lake ecosystem. While changes to the littoral zone and benthic environments have the potential to influence the risk of establishment of both species, the predominant factor involved in introduction is the level of human lake usage. Adult mussels attach to boats and trailers and their microscopic larvae can be transported in bait buckets, live wells, and moisture on carpets and ropes (Laney 2010). In January 2010, sampling documented zebra mussels within the study area. Once established, spread of zebra mussels may be inevitable. However, the construction of more boat docks could provide additional attachment points for zebra mussels and facilitate spread throughout the lake.

No Action Alternative

Under the No Action Alternative, potential impacts would likely result in a future condition for invasive aquatic invertebrates similar to that described under the existing condition in Section 4.2.5.3. However, the recent discovery of zebra mussels within the Eufaula Lake study area indicates that establishment has occurred and future range expansion throughout the study area would be likely.

Alternative 1

Under Alternative 1, the probability of introduction, ease of establishment, and extent of expansion of the invasive zebra mussel and Asian clam would likely be similar to those future conditions described under the No Action Alternative. The designation of more shoreline as Protected with limits on dock construction could lower lake usage and lower the probability of additional zebra mussel or Asian clam introduction, but would do little to reduce the susceptibility of the Eufaula Lake study area to invasion.

Alternative 2

Under Alternative 2, the probability of introduction, ease of establishment, and extent of expansion of the invasive zebra mussel and Asian clam would likely be similar to those future conditions described under Alternative 1.

Alternative 3

Due to an emphasis on development, Alternative 3 would likely see an increase in lake usage, leading to an increased probability of initial Asian clam introduction and subsequent zebra mussel introductions from

nearby infested waters. Once introduced, an increase in the number of boat docks under Alternative 3 would likely provide attachment points for adult zebra mussels and could contribute to range expansion throughout the study area.

Alternative 4

Concerning the invasive zebra mussel and Asian clam, the future condition under Alternative 4 would likely result in a probability of introduction, ease of establishment, and extent of expansion similar to that described for Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an increased number of shoreline areas being rezoned from Protected to Limited Development. The allowance of additional boat dock construction would likely result in a faster and more complete expansion of the zebra mussel's range within the Eufaula Lake study area.

Chapter 6

Potential Mitigation Measures

Mitigation includes avoidance, minimization, rectification, reduction, and compensation for potential impacts associated with an action (40 CFR 1508.20). To mitigate for potential impacts of human disturbance on terrestrial and aquatic habitats and the natural resources that reside therein, USACE would implement the mitigation measures described in the following sections as appropriate.

6.1 Shoreline Construction

Under the No Action Alternative and the four action alternatives, the majority of potential shoreline construction on government properties would likely consist of paths, boardwalks, fencing, and other structures involved with lake and boat dock access. Construction contractors could implement Best Management Practices (BMPs) to avoid and minimize potential temporary construction impacts for the installation of shoreline structures. These BMPs would be included as conditions of shoreline permit approvals and would include:

- Minimize the amount of clearing and exposed soil to control potential sedimentation and erosion.
- Bring in suitable fill as needed.
- Protect existing drain inlets from debris, soil, and sedimentation.
- Install sedimentation and erosion controls prior to beginning construction activities.
- Schedule land stabilization activities, such as landscaping, immediately after land has had final contouring.
- Protect streams, wetlands, forests, and other natural areas from any unnecessary construction activities or disturbance.

6.2 Boat Dock/Marina Construction

Most of the potential shoreline construction activity under the alternatives would likely be connected to boat dock and marina construction. Although no shoreline reallocation is proposed under the No Action Alternative, the maximum number of boat docks that could be potentially constructed would be significantly more than the number of existing docks because there is a large amount of shoreline designated as Limited Development but which is currently undeveloped. The four action alternatives would likely result in varying degrees of boat dock and marina construction. Alternatives 1 and 2 would allow a maximum of 2,278 and 5,873 docks, respectively, which is less than the potential total allowed under the No Action Alternative. Alternatives 3 and 4 allow a maximum of 11,844 and 15,459 docks, respectively, which is more than the potential total allowed under the No Action Alternative. In addition, Alternative 4 would allow for the construction of a marina at the proposed Carlton Landing development site.

Boat dock construction would likely adversely impact shoreline wetlands and littoral zones and the species occupying these fragile habitats. In order to minimize potential impacts to the surrounding shoreline, approvals for boat dock and marina construction would include:

- Adherence to the National Oceanic and Atmospheric Administration's (NOAA) voluntary Clean Marina Initiative. Lakes under this program typically require foam floats encapsulated with concrete, wood, galvanized steel, plastic, or fiberglass.
- Mitigation for minor potential impacts to local fisheries and other aquatic wildlife as directed by USFWS and enforced by ODWC.

Within the Eufaula Lake study area, only floating docks are permitted. Therefore, mitigation for environmental concerns specifically attributed to floating docks should be considered and already established BMPs should be continued. According to the *Flotation Analysis for Boat Docks on U.S. Army Corps of Engineers Projects* published by the Little Rock District, the most common type of dock flotation is expanded polystyrene foam (EPS) (Marcy and Jackson 2009). Potential environmental impacts associated with EPS and other plastics used for boat dock flotation include: the rate of degradation (water and sunlight), ingestion of particles by fish and wildlife, exposure to chemical elements such as benzene, styrene, and ethylene, and aesthetics/littering associated with particles of flotation (Marcy and Jackson 2009).

BMPs for floating facilities and flotation product recommendations include:

- using floatable foams encapsulated in polyethylene or other surface covering,
- closed-cell polyethylene, and
- dedicated plastic float drums.

Several additional measures may minimize the potential impact of floating dock construction and long-term deployment on the surrounding shoreline environment. Additional BMPs are related to construction techniques and the recycling of old flotation where feasible and available (Marcy and Jackson 2009). These measures may be added to shoreline permit approvals as appropriate.

Additional best practices include:

- Dock structure protection – to keep floats from contacting the lake bottom, add legs to the float when installed to keep it a few inches off the lake bottom to prevent punctures. The legs should be cut to the lake bottom contour and allow the dock to rest fairly level for extended periods of time when the lake level is low.
- Management of existing materials during construction and remodeling - All foam and debris would be contained with a floating boom; old foam would be recycled through the foam installer, contractor, or garbage hauler; and the area would be cleaned of dislodged foam particles prior to the close of construction.
- Ultra-violet protection - Protection against ultra-violet deterioration would be addressed with ultra-violet inhibitors and/or carbon black pigment

- Impermeability - Flotation material should be fire resistant and impervious to water and damage from gasoline and other marine fuels
- Protected species requirements - Additional flotation design requirements would be used as applicable for protected species

6.3 Wetlands and Surface Waters

Alternatives 1 and 2, which emphasize shoreline conservation, would likely result in less disturbance and degradation of wetlands and surface waters over time than the No Action Alternative or Alternatives 3 and 4. Under the No Action Alternative and Alternatives 3 and 4, the potential construction of significant numbers of additional boat docks in areas designated as Limited Development would likely result in wetland and surface water degradation.

BMPs that could avoid and minimize disturbance to shoreline wetlands and surface waters would include the following measures that would be included in shoreline permit approvals as appropriate:

- Do not remove or damage vegetation growing in wetlands.
- Do not operate heavy equipment in wetlands.
- Do not disturb the ground surface in wetlands, except in the fill area specified in a permit issued by USACE.
- Reestablish vegetation on exposed soil as soon as possible.
- Implement and maintain erosion and sedimentation control measures sufficient to prevent deposition of sediment and eroded soil in onsite and offsite wetlands and to prevent erosion in onsite and offsite surface water areas.
- Provide compensatory mitigation for unavoidable wetland impacts (this mitigation measure would be implemented through a Section 404 permit issued by USACE).

The Oklahoma Comprehensive Wetland Conservation Plan also recommends measures to mitigate wetland losses. The plan recommends that the state evaluate establishing a wetland bank(s) to guide financial resources into constructive projects to restore, enhance, and create wetlands (OCC 1996). The Oklahoma Department of Transportation is in the process of establishing a wetland bank for use in mitigating highway construction projects. This effort could serve as a model for the development of a statewide program and establishment of a wetland bank within the Eufaula Lake watershed that could be used to offset potential wetland impacts within the study area (OCC 1996).

6.4 Shoreline Erosion

The majority of the water pollution in the Eufaula Lake study area, including siltation, pesticides, suspended solids, and nutrients, comes from non-point sources. In particular, this poptential impact is exacerbated by highly erodible soils and bank instability throughout the watershed. Addressing Eufaula Lake's shoreline erosion is one step towards remediation of the in-lake turbidity problem. Suspended solids, whether washed in from the drainage basin or re-suspended in the reservoir, serve to prevent or eliminate the establishment of an aquatic plant community in the littoral zone. Aquatic plants inhibit the physical process of shoreline erosion and help to mitigate potential impacts of shoreline erosion. Once

physical processes such as shoreline erosion have begun in Oklahoma reservoirs, it often takes human intervention to stabilize the shoreline long enough to establish the littoral zone as a functioning community. Bioengineering techniques may halt the erosive processes long enough to allow for the establishment of a healthy aquatic plant community and may be a low-cost long-term erosion control solution (OWRB 2006).

Coir Geotextile Rolls (CGR) with live staking is a simple treatment that was proven more effective at reducing bank erosion and facilitating plant growth than cedar tree breakwaters and unprotected herbaceous plantings during shoreline stabilization activities at Lake Carl Blackwell in Payne County, Oklahoma (OWRB 2006). This treatment results in a very dense stand of willow trees heavily armoring an eroding bank and may be complemented with herbaceous aquatics planted within the bottom tier. Since willow trees formed by live staking create dense thickets, this method would be inappropriate where broad lake access or viewing is desired.

Fluctuating lake levels are a prominent issue in regard to plant survival in shoreline stabilization projects. If water levels remain high, plant establishment is restricted and when water levels are too low then the moist conditions needed by wetland plants may be eliminated. Wave action and aquatic herbivory are also issues. Newly planted herbaceous species may be protected from herbivory by caging them in wire pens. Field reconnaissance and the development of a shoreline erosion control plan would identify suitable sites and methods available for shoreline stabilization. Site selection would consider shoreline type, shoreline sediment and its capability to support plantings, and adequate access to bring in materials (OWRB 2006).

At several sites within the Eufaula Lake study area, including Longtown, Duchess Creek, and the Brooken Cove area, water willow has been planted for habitat enhancement and erosion control (Bowen 2008). However, in many cases, water willow communities were unable to become established. This is most likely due to extended periods of high water, wave action, and herbivory. The use of CGR with live staking helps protect plant communities from wave action and herbivory while supplementing herbaceous species with resilient woody willows (OWRB 2006).

6.5 Protected Species

Due to the confirmed presence of the American burying beetle within the survey area containing the proposed Carlton Landing development, Roundtree Landing, and adjacent lands, any proposed modification to the SMP that would have the potential to affect this species would require consultation with USFWS under Section 7 of the ESA. No federal action would be authorized that is likely to jeopardize the continued existence of the American burying beetle unless ESA Section 7 consultation addressing the effects of the proposed action has been completed. According to the 2012 updated USFWS guidance, bait-away and trap-and-relocate procedures are no longer allowed as the primary means of avoiding impacts to the American burying beetle. The consultation would generate appropriate conservation measures that would be implemented in association with any approvals for shoreline development on government lands.

The bald eagle has also been documented in several areas of the Eufaula Lake study area, including areas near Brooken Cove, Mill Creek WMA, and Roberts Ridge. The seasonal and large geographic spread of these and other recent sightings suggest that the eagles comprise a low-density, widespread resident population supplemented by a larger number of winter residents. While USFWS has documented recent nesting activities, no nests, nest-building activities, or eagle courtship were observed during several winter, spring, and summer surveys.

Due to the documented presence of eagles during breeding and non-breeding seasons, construction activities within the Eufaula Lake study area may come into contact with bald eagles. Bald eagles nests would be avoided. Nesting bald eagles are most sensitive to disturbance during courtship, laying, and incubation. Thus, it would be prudent to complete large-scale shoreline construction projects in potential bald eagle nesting areas during the non-nesting periods from late-September until early-January.

Shoreline construction activities that take place during the non-breeding season would have little effect on bald eagles. It is recognized that this may severely restrict construction activities and cause logistical problems because the breeding season in Oklahoma may last nine months. However, this is the most effective way to avoid potential impacts on bald eagles. USFWS guidelines and recommendations would be followed for construction activities that must be completed during nesting and rearing months (USFWS 2006).

Under the USFWS management guidelines, no construction activity would take place within a one mile radius of a nest tree during the breeding season. The guidelines suggest that the buffer area only needs to be "roughly circular", with the intent being to limit disturbance along flight paths to and from foraging areas. Therefore, the shape of the buffer might be altered to accommodate construction within one mile of an active nest during the breeding season depending on local topography and eagle use patterns.

To avoid disturbing nesting eagles it is recommended that workers also maintain natural forest (vegetation) buffers around nest trees and minimize potential visual and auditory impacts associated with human activities. The potential impact of a new human activity on a pair of nesting eagles depends on how far the activity is from the nest and on the birds' tolerance. Visibility is a factor as eagles react more profoundly to a disturbance that is within full view of their nest. Therefore, larger buffers may be needed for nests surrounded by open areas.

While encountering a resident breeding bald eagle is possible, most bald eagles in Oklahoma tend to be non-breeding, winter visitors. Bald eagles are less sensitive throughout this non-nesting period, but construction activities would attempt to avoid established roost and feeding sites. Large shoreline trees would be preserved whenever possible to provide potential perching and nesting tress for bald eagles.

If any protected species are encountered during shoreline construction, all activities must cease and USFWS notification required. If listed species are encountered during recreational activity, any action that serves to harass or harm the individual(s) is prohibited.

6.6 Invasive Species

Through active management of government lands, lease agreement terms, and education of lakeshore residents and recreationists, USACE would control the spread of invasive plants listed by the Oklahoma Invasive Plant Council or organisms listed in the Oklahoma Aquatic Nuisance Species Management Plan.

Chapter 7
Conclusions

7.1 Terrestrial and Aquatic Habitats

While the No Action Alternative and four action alternatives are thoroughly explained in Section 2.4, several of the components of each of these alternatives may have a particular impact on the vegetation communities within the study area. This would include changes in shoreline allocations, vegetation management, and rezones, which determine the amount of potential land disturbance and habitat alteration that might occur under each alternative.

Under existing conditions, the management of vegetation along the shoreline is permitted on a case by case basis after review of a permit application. When issued, a vegetation modification permit may allow mowing up to the shoreline unless significant wildlife or aesthetics could be impacted. The current SMP restricts the removal of flowering trees, shrubs, or redbud regardless of size as well as individuals of any species greater than 4 inches in diameter. These existing vegetation management policies, as described under the existing condition, would be the same in the future condition under the No Action Alternative. In addition, USACE generally honors past written commitments, such as permits related to vegetation modification practices. Any changes to vegetation management policies included within any proposed alternative would apply only to the issuance of new permits.

Under each of the action alternatives, one of two potential shoreline vegetation management policies would be applied to areas designated as Limited Development that vary in the width of the buffer that would be required to be left between the shoreline and the start of vegetation modification activities. The two options are referred to as baseline buffers and extended buffers. Under the extended buffer vegetation management policy, implemented under Alternatives 1 and 2, a buffer width of 55 to 95 feet wide would be established depending on slope, soil type, and vegetation cover type. The baseline buffer vegetation management policy, which would be implemented under Alternatives 3 and 4, would require smaller buffer zones of 30 to 70 feet in width. Larger buffer zones would be expected to protect a greater amount of existing shoreline habitat from mowing and cutting and would likely have a greater potential impact on the improvement of water quality.

Likewise, the potential for disturbance to terrestrial and aquatic habitats would vary depending on the alternative selected due to differences in the amount of land development and dock construction each allows. The No Action Alternative would keep the status quo and would allow development within already designated Limited Development and Public Recreation areas. This has the potential to result in the construction of over 7,000 additional boat docks, which would likely alter shoreline habitats as compared to the existing condition. Alternatives 1 and 2, which emphasize natural resource conservation, would likely see an increase in the quality and quantity of both terrestrial and aquatic habitats resulting from an increase in shoreline allocated as Protected. The quality and quantity of habitats would decrease slightly under Alternative 3 and would decrease further under Alternative 4, as more shoreline miles allocated as Protected would convert to Limited Development and/or Public Recreation. Potential impacts on each specific terrestrial vegetation community, wetland type, invasive species, and rare and imperiled species are explained in detail.

The Eufaula Lake study area lies within four Level IV ecoregions that are made up of six terrestrial natural vegetation communities. These communities include crosstimbers, oak-hickory forest, oak-pine forest, bottomland hardwood forest, savanna, and prairie. Each terrestrial vegetation community consists of several dominant plant associations that support a variety of wildlife. Therefore, the potential impact of each alternative on the terrestrial habitats would not only affect plant species diversity but would influence the wildlife species diversity therein.

Much like terrestrial habitats, open water and wetland habitats within the study area have the potential to be impacted by any of the five alternatives. Nearly every disturbance to an upland watershed causes some change downstream. For example, sediments flow into wetlands from increased erosion stemming from increased development and transform water quality in lacustrine limnetic habitats and cover rock and gravel substrates under a layer of silt. Therefore, the greatest potential impacts of all alternatives on open water lacustrine habitats would most likely be changes in water quality, which are discussed in the Water Quality Technical Memorandum. Additionally, low-lying wet depressions that make up most of the emergent and scrub-shrub wetlands within the study area can be topographically altered by sediment influx and can be smothered by accumulated trash and debris (Zedler and Kercher 2004).

None of the Alternatives, including the No Action Alternative, address the role of fire in maintaining emergent and scrub-shrub wetlands. If fire is absent and hydrological conditions are favorable, woody species may encroach upon herbaceous wetland systems, slowly converting them into scrub-shrub wetlands. Likewise, the stunted or young trees that dominate scrub-shrub wetlands may mature in the absence of fire or hydrological controls and transform into forested bottomland hardwood wetlands. The conversion of open wetland habitats into forested wetland habitats alters community structure and could reduce the overall habitat and wildlife diversity found within the study area.

Invasive species are a concern with both terrestrial and aquatic habitats, with wetlands particularly vulnerable to invasions by exotic species. The introduction and establishment of invasive species is directly attributable to the magnitude and extent of human disturbance within ecosystems. Therefore, any considered alternative that proposes to increase areas of human disturbance would likely result in an environment more conducive to invasive species establishment and the spread of eastern red-cedar.

All of the six rare and imperiled plant species described in **Section 4.1.6** are state critically imperiled in Oklahoma and, where they do exist, they do so in very low numbers. Therefore, any decision that alters the potential habitat of these species could impact local populations. Due to the extremely specific habitat requirements and the low probability of Bradley's spleenwort, Indian-pipewort, and lobed spleenwort being found within the study area, they are not included in the analysis of impacts. While the remaining three rare and imperiled species, Blackfoot quillwort, Kentucky wisteria, and dwarf pipewort, are also unlikely to be found within the Eufaula Lake study area, historical occurrence records and the presence of necessary habitats within the study area justify analysis of potential impacts. Despite the differing levels of protection given by the five alternatives, none of them address all of the factors that have made these plants rare. Therefore, if any of these plants exist within the Eufaula Lake study area, it is possible that even the most natural resource conscious of the alternatives would have little impact on the survival of rare and imperiled plant populations.

7.1.1 No Action Alternative

Under the No Action Alternative, the future condition of the crosstimbers would likely be the same as that described for the existing condition outlined in Section 4.3.1.1. Therefore, this habitat would likely remain

stable with losses concentrated in undeveloped areas currently zoned Limited Development or Public Recreation.

The oak-hickory forest community resembles the crosstimbers in species composition and structure; therefore, the No Action Alternative would likely have similar potential impacts on both forested habitats. However, unlike the crosstimbers, Spring 2012 habitat transects observed very little variation in age structure in oak-hickory forests and little tree recruitment was evident. Therefore, the future condition under the No Action Alternative could become an unstable forest community if older trees die and are not replaced.

The future condition of oak-pine forests under the No Action Alternative would likely reflect the existing condition described in Section 4.3.1.1.

Under the No Action Alternative, the decreasing trend in the quantity and quality of riparian forests documented region-wide and in Section 4.3.1.1 would likely continue. While the largest tracts exist within the floodplains of the Deep Fork River and Gaines Creek, these bottomland forests are protected and are not subject to shoreline reallocation. Therefore, the greatest habitat losses would likely occur in areas previously zoned Limited Development or Public Recreation, particularly along smaller tributaries.

Revisions to the SMP and MP land classifications may have the greatest potential impact on open habitats, such as savannas and prairies, because these habitats are often preferred locations for development. Under the No Action Alternative, the future condition would likely be the same as the trend described under the existing condition. Prairie and savanna habitats would likely continue to exist in a poor and degraded condition. Habitat conversion would also be likely, with prairie habitats transitioning to savanna and savanna habitats to forest as a result of existing fire suppression practices, which are largely outside of USACE control.

For shallow-water and wetland habitats, the future condition under the No Action Alternative would continue to allow moderate development in areas designated Limited Development or Public Recreation. Therefore, sedimentation rates and nutrient inputs would likely be similar to those described for the existing condition in the short-term with gradually increasing levels expected as the percentage of developed shoreline increases and recreation levels rise.

In addition to the potential impacts to littoral zone wetland and open water habitats along the shoreline, each alternative could potentially affect palustrine emergent and scrub-shrub wetlands located along stream floodplains and in wet upland depressions within the Eufaula Lake study area. The future condition under the No Action Alternative would likely reflect the continued downward trend in wetland quantity and quality as described under the existing condition.

The final wetland habitat present within the Eufaula Lake study area, palustrine forested dead wetlands, may also be potentially impacted by revisions to the SMP and MP land use classifications. Under the No Action Alternative, the future condition of areas of standing dead timber would be the same as that described under the existing condition. Areas of standing dead timber would slowly be reduced due to wind and wave action and decay. Standing dead timber may also be reduced to remove navigation hazards, but most areas would likely remain untouched to provide ideal fish habitat.

Under the No Action Alternative, no changes in land use allocations or vegetation management would occur and the threat of introduction and establishment by aquatic invasive species such as hydrilla or

Eurasian watermilfoil would likely be similar to that described under the existing condition. However, already established invasive species that are primarily restricted by their own dispersal ability, like Salvinia, would likely expand. Nearby populations of invasive species could be introduced due to increased recreational use in the Eufaula Lake study area. All of the likely aquatic invasive species can reproduce by fragmentation, with fragments easily becoming attached to boats, trailers, and any other objected placed in infested waters.

The No Action Alternative would likely result in a future condition with moderate levels of introduction and establishment of terrestrial invasive species similar to that described under the existing condition. Even if eradication efforts are implemented, disturbed open habitats would likely continue to support Chinese lespedeza, tall fescue, and other invasive grasses and forbs, whereas forested habitats within close vicinity of human disturbance would likely contain Japanese honeysuckle or Chinese privet. The continued success of these invasive species would be due primarily to superior competitive, reproductive, and dispersal abilities. The threat of new invasions would be moderate and the spread of existing invasive species would most likely continue along disturbance corridors (*e.g.*, roads and utility easements), especially in areas designated Limited Development that have not yet been developed.

Under the No Action Alternative, any current populations of Blackfoot quillwort, Kentucky wisteria, and dwarf pipewort would likely remain in existing suitable habitats designated Protected. However, populations in areas designated Limited Development or Public Recreation would be at risk of potential future development and potential impacts associated with human disturbance.

7.1.2 Alternative 1

Under Alternative 1, the quantity and quality of crosstimbers, oak-hickory, and oak-pine habitat would likely increase as compared to the condition described under the No Action Alternative. The establishment of extended vegetation management policy buffers would conserve more upland forest habitat along the lakeshore than would be protected under the No Action Alternative. The potential increase in shoreline miles allocated as Protected would also reduce the effects of fragmentation caused by urbanization, road construction, and utility right of ways and would help stem the widespread loss of native understory vegetation due to the introduction of exotic forbs associated with human disturbance.

Potential impacts of Alternative 1, with its significant emphasis on habitat conservation, would likely result in a future bottomland hardwood forest community similar to that described under the No Action Alternative. However, Alternative 1 differs from the No Action Alternative in that it would prevent future human disturbance and development in many areas now allocated as Limited Development. Less development would likely result in fewer sediment and nutrient inputs into these forested wetlands and could improve overall forest health.

Maybe more importantly, and in contrast to the No Action Alternative, the extended buffers implemented under Alternative 1 would likely conserve a large proportion of these stream bank and lakeshore forests. Despite increased protections, Alternative 1 would not address degradation of many areas of bottomland forest cut off from periodic floodwaters due to channelized streams, water control structures, and water management policies.

Alternative 1 would likely protect existing areas of savanna and prairie in their existing condition and prevent direct land conversion in areas not allocated as Limited Development or Public Recreation. The establishment of extended management buffers would conserve any open habitats immediately adjacent

to the shoreline; however, most open habitats exist in flat upland areas far from the lakeshore and buffers may have little impact on overall habitat protection. Alternative 1, unless accompanied by a future change in land management policy, likely would not curb the expansion of eastern red-cedar and other woody plants or the increased abundance of exotic grasses and forbs into savanna and prairie habitats.

In the lacustrine littoral zone, the future condition under Alternative 1 would likely see improved substrate heterogeneity, fewer algal blooms, and a reduction in boat dock construction and flood control structures as compared to the No Action Alternative. These factors would likely result in an increase in ecological function and value of shallow-water habitats throughout the study area.

Similarly, in comparison to the No Action Alternative, protections derived from land allocation changes and extended buffer implementation under Alternative 1 would likely improve vegetated wetland quality and quantity.

Under Alternative 1, areas containing stands of dead timber would be rezoned as Protected or would not see a change in shoreline designation. Therefore, under this alternative, the future condition of areas of palustrine forested dead wetlands would largely be similar to that described under the No Action Alternative with removal restricted to areas that pose a hazard to navigation.

Alternative 1, with its emphasis on habitat conservation, would do the most of all of the proposed action alternatives to curtail the introduction and spread of invasive species. It is widely accepted that healthy, protected ecosystems are more resilient and are better able to withstand invasion than those threatened by human disturbance and associated edge effects and system inputs. Therefore, under Alternative 1, an increase in shoreline miles allocated to the Protected designation and the implementation of extended buffers on shorelines where Limited Development is allowed would conserve greater amounts of core habitat areas that are better equipped to resist invasion.

Under Alternative 1, the decrease in development and associated decrease in human traffic would deprive invasive species of introduction and dispersal pathways. Additionally, the increase in shorelines allocated to the Protected designation would reduce lands available for dock construction, thus limiting recreational activities. Fewer recreationists lessen the likelihood that aquatic invasive species would be transported and introduced into the Eufaula Lake study area.

Under Alternative 1, additional habitat within the study area would be protected; thereby, increasing the likelihood that rare and imperiled plant populations would be conserved. The implementation of extended management buffers would also conserve more acres of potential habitat, thus increasing the probability of survival for rare species.

7.1.3 Alternative 2

In comparison to the No Action Alternative, an increase in shoreline miles allocated as Protected under Alternative 2 would discourage shoreline development, thereby conserving terrestrial habitats on properties unsuitable for docks or without adjacent subdivisions. However, Alternative 2 allocates far less shoreline as Protected in comparison to Alternative 1. Therefore, Alternative 2 would likely have similar types of potential impacts, but would offer less protection, than Alternative 1 on terrestrial habitats due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline allocated as Limited Development.

In comparison to the No Action Alternative, an increase in shoreline miles allocated as Protected under Alternative 2 would discourage shoreline development, thereby conserving wetland areas on properties unsuitable for docks or without adjacent subdivisions. However, Alternative 2 allocates far less shoreline as Protected and allows far more boat dock construction in comparison to Alternative 1. Therefore, while Alternative 2 would likely have similar potential impacts as Alternative 1 on open water and wetland habitats due to the establishment of extended buffers and the likely decrease in development on adjacent lands, the potential impacts would be less pronounced due to fewer conserved shoreline miles and an increase in dock construction.

In comparison to the No Action Alternative, Alternative 2, which increases areas designated Protected but not to the same extent as Alternative 1, would still likely see a decrease in the spread of established invasive species and would lessen the chances of new species introductions.

Although Alternative 2 designates less shoreline as Protected as compared to Alternative 1, it would likely have similar potential impacts on populations of the rare and imperiled Blackfoot quillwort, dwarf pipewort, and Kentucky wisteria due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

7.1.4 Alternative 3

Under Alternative 3, the potential for development of upland forest habitat would likely increase with the reallocation of lands from Protected to Limited Development. Limited Development would likely facilitate the conversion of crosstimbers, oak-hickory, and oak-pine habitat due to an increasing number of residential developments and associated infrastructure expansion. Development of oak-pine forests may be disproportionately high because they often occupy lakeshore ridges ideal for residential communities. Fragmentation of large areas of forest habitat would likely increase edge effects and increase the susceptibility of disturbed areas to invasive exotics. An increase in development would also likely result in an increase of herbicide use, which results in fewer closed-canopy forests and more open woodland and park-like settings (Schulz *et al*. 1992). This, in combination with mechanical vegetation removal of sub-canopy and ground layers, would favor a wildlife community that is more adapted to open woodland habitats. Despite the potential impacts of increased development, Alternative 3 establishes baseline vegetation management policy buffers, which, while smaller than the extended policy buffers, would conserve more shoreline crosstimbers habitat than under conditions described for the No Action Alternative.

A likely indirect result of Alternative 3 implementation is the potential impact of higher human traffic in upland forest areas associated with allowing greater levels of development. Higher human traffic often results in a disturbed ground cover layer due to direct trampling and the introduction of invasive species. Human influence also contributes to the expansion of eastern red-cedar, a species that adapts well to disturbance.

As previously described for the three upland forest habitats, Alternative 3 establishes baseline vegetation management buffers in Limited Development areas that would likely preserve large areas of bottomland hardwood forest. However, in comparison to upland forest habitat types, bottomland hardwood forests are more likely to be located at the shoreline and would likely derive greater benefit from buffer implementation. While baseline buffers would protect more bottomland hardwood habitat than under the No Action Alternative, it would conserve less acreage than the extended buffers proposed in both Alternatives 1 and 2.

Despite buffer protection for forested wetlands immediately adjacent to the shoreline, Alternative 3 would likely subject large tracts of bottomland forest located in broad floodplains to development. The emphasis on Limited Development would likely promote direct riparian vegetation removal as residential subdivisions seek greater stream and lake access. However, within the study area the quantity of remaining bottomland forest subject to development remains small, with most remaining contiguous habitat present along lake tributaries in areas designated as Protected under Alternative 3. Therefore, the greatest potential impact of shoreline reallocation on bottomland hardwood forests would likely be indirect as a result of upstream development. Potential increased development under Alternative 3 would likely disrupt natural hydrology and increase sediment and nutrient inputs through land disturbance activities including construction, increased impervious surfaces, and active vegetation management.

Under Alternative 3, shoreline reallocation would likely facilitate development of existing savanna and prairie habitats located outside baseline vegetation management policy buffers. Within the study area, these open habitats are often small and embedded within larger tracts of forest. As such, they are some of the first areas identified for residential developments and infrastructure projects including roadways and utility easements. Savanna areas would likely experience selective vegetation removal where all but the largest trees are removed to establish parkland, residential lawns, and easy lake access. Prairies would likely be seeded with turf grass for landscaping purposes in residential and recreational areas. Potential indirect impacts to savanna and prairie habitats would likely include herbicide use in adjacent road and utility right of ways that reduce the abundance and diversity of native forbs and shrubs.

Within the Eufaula Lake study area lacustrine littoral zone and wetland habitats, Alternative 3 would likely have both beneficial and adverse impacts. In comparison to the No Action Alternative, the implementation of the smaller buffers associated with the baseline vegetation management policy would directly conserve large areas of aquatic habitat. However, the positives derived from the implementation of baseline buffers would likely be offset by potential impacts related to the increased development allowed under Alternative 3. Increased development would increase impervious surfaces and fertilizer use; thereby, increasing runoff of sediment and nutrients into Eufaula Lake's shallow-water habitats. Increased construction of boat docks would likely lower the productivity of littoral habitats, lead to direct vegetation removal, and could promote invasive species establishment. A greater number of boat docks would also increase recreation activity on the lake. The presence of more recreational activity in the shallows could lead to the removal of shoreline aquatic vegetation, increased spills and discarded trash, and additional littoral zone disruptions, especially in sandy beach areas. Shallow-water and wetland habitats are extremely sensitive ecosystems and any changes to sediment and nutrient inputs, community structure, or hydrology can quickly transform areas into upland or open water habitats.

While Alternative 3 reallocates many miles of shoreline from Protected to Limited Development, there is no specific proposal that would remove standing dead timber under this alternative. Therefore, the future condition under Alternative 3 would likely be similar to conditions described under the No Action Alternative with removal restricted to areas that pose a hazard to navigation.

Alternative 3 would result in the potential for increased human disturbance over approximately additional 6,600 acres within the study area compared to the No Action Alternative due to the conversion of unencumbered Protected shorelines to Limited Development. Therefore, Alternative 3 would likely have the opposite effects on invasive species as those described for Alternatives 1 and 2. Land disturbance and its associated impacts would increase, resulting in changes that make habitats more susceptible to invasion. In addition to creating additional disturbance through development and associated road and

infrastructure construction, the reallocation of shorelines would increase landscaping activities, which often introduce invasives when they escape cultivation. Under Alternative 3, additional dock construction would facilitate more boat usage and recreational opportunities, which are proven pathways for invasive introduction and establishment.

Although smaller than the extended buffers implemented under Alternatives 1 and 2, the baseline buffers implemented under Alternative 3 provide protection from human disturbance and would help decrease the likelihood of invasive species expansion compared to the No Action Alternative. However, in comparison to the wider extended buffers, the baseline buffers would increase the quantity of edge habitat favored by invasive plant species. This would likely lead to degradation of core habitat areas, making them more susceptible to invasion.

Finally, as with all of the analyzed alternatives, Alternative 3 would not change existing fire suppression practices that are outside of USACE control. Fire suppression has enabled the infestation of Oklahoma habitats by eastern red-cedar and favors invasive herbaceous plants over fire-tolerant natives.

While the establishment of baseline buffers under Alternative 3 would better conserve rare and imperiled plants than vegetation management policies under the No Action Alternative, the emphasis Alternative 3 places on development would likely promote the disturbance and conversion of many natural habitats. Increased development and an associated uptick in recreational activity would increase the likelihood that any existing populations of these species would be extirpated.

7.1.5 Alternative 4

Compared to Alternative 3, the future condition under Alternative 4 would likely result in potential terrestrial habitat impacts that are magnified and more widespread due to an increase in the number of shoreline miles being reallocated from Protected to Limited Development. In addition, eight miles of shoreline, most of which are concentrated adjacent to the proposed Carlton Landing development property, would be reallocated from Protected to Public Recreation. Shorelines designated Public Recreation do not need to comply with proposed vegetation management policy buffers and could result in greater potential impacts to terrestrial habitats in those areas.

Due to the fact that the majority of the proposed Carlton Landing development property consists of crosstimbers and oak-pine habitat, the level of development on this property would determine the quantity and quality of these habitats in that region. Under Alternative 4, full build-out would be allowed leading to conversion of crosstimbers and oak-pine habitat to parkland and recreational facilities. Adjacent areas left in their native state would be highly disturbed by landscaping activities and high levels of foot and vehicle recreational traffic. Habitat conversion in the area could also impact future forest composition. Removal of nearby crosstimbers forests could eventually result in a greater percentage of oak-pine forest as shortleaf pine often regenerates faster than post or blackjack oak.

Savanna habitats are also present at the proposed Carlton Landing development property and occur in small openings within surrounding crosstimbers and oak-pine forests. Therefore, the potential impacts associated with Alternative 4 on savanna habitats would be similar to those described for the two forested habitats.

Because bottomland hardwood forests, oak-hickory, and prairie habitats are not located on the property, the Carlton Landing development proposal would not directly impact these communities.

The future condition under Alternative 4 would likely result in types of potential aquatic habitat impacts similar to those described for Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an increased number of shoreline miles being reallocated from Protected to Limited Development and from Protected to Public Recreation. Additionally, the maximum potential number of boat docks allowed under Alternative 4 is 15,459, which is an increase over the 11,844 docks potentially allowed under Alternative 3. This increase in potential dock construction would also likely magnify potential impacts to shallow-water and wetland habitats.

Due to the extent of planned littoral zone development, potential impacts to shallow-water habitats under Alternative 4 would be most evident in and around the Carlton Landing proposed development property. The type of littoral zone activities planned for this area, including Roundtree Landing, if full build-out is realized, includes water withdrawal, activated water features, dredging, swimming area, inflatable floating kids play zone, and retaining walls. Additional structures would include a marina with boat fueling and storage facilities. In addition to issues related with dock construction, these proposed littoral zone features would likely result in the clearing of native aquatic vegetation, removal of riparian vegetation, altering depth profiles, and removing native substrates. These activities would likely result in increased sedimentation, decreased water quality, and degraded habitat for aquatic invertebrates and fish.

Due to proposed standing dead timber removal to create a channel in Longtown Arm at Carlton Landing, Alternative 4, would have the greatest potential to impact palustrine forested dead wetlands and other standing dead timber habitats. Removal of standing dead timber greatly impacts the underwater environment. It deprives fish of optimal habitat and may disrupt water flow and substrate immediately surrounding the dead trees. Allowing snag removal in Longtown Arm could clear the way for additional requests to remove standing dead timber from other lake areas to improve recreational opportunities.

The future condition under Alternative 4 would likely result in an invasive species community of a size and structure similar to that described for Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation. Invasive introduction and expansion into aquatic and terrestrial habitats would be likely because both development and recreation provide primary pathways for the immigration of invasive species.

Compared to Alternative 3, the future condition under Alternative 4 would likely result in potential impacts to Blackfoot quillwort, dwarf pipewort, and Kentucky wisteria populations that would likely be magnified and more widespread due to an increased number of shoreline areas being rezoned from Protected to Limited Development and Public Recreation. The increased scope of potential impacts under Alternative 4 would increase the probability that rare and imperiled plant communities would be affected by activities associated with development and recreation.

No impacts associated with full build-out of the proposed Carlton Landing development on the three rare and imperiled species would be likely because the property proposed for development lacks the specific habitat conditions necessary for the growth of these species.

7.2 Natural Resources

The No Action and four action alternatives are thoroughly explained in Section 2.4. Several of the components of each of these alternatives have specific potential impacts on the natural resources found within the study area. When considering potential impacts to natural resources, discussion will begin with

the No Action and will progress from Alternative 1, which favors natural resource conservation up through Alternative 4, which emphasizes private exclusive uses and recreational development opportunities. Potential impacts of each alternative on existing natural resources will be evaluated. Many potential impacts on natural resources are directly connected to potential alternative impacts on habitats, which are discussed in Section 5.1. Therefore, to avoid redundancy, for many common species likely found within the study area, potential impacts involving habitat loss or degradation will be addressed generally with a reference to appropriate sub-sections in Section 5.1. However, for listed species, all potential impacts will be covered completely.

The management of vegetation along the shoreline has a direct impact on natural resources in the study area. Current vegetation modification permit processes and the potential vegetation buffer policies proposed under the action alternatives are described in detail in Section 2.4. The existing vegetation management policies would be the same as the future condition under the No Action Alternative. Under each of the action alternatives, one of two shoreline vegetation management policies would be implemented—baseline or extended. Under the extended vegetation management policy, implemented in Alternatives 1 and 2, wider buffers would be established in comparison to the baseline buffers implemented under Alternatives 3 and 4. Larger buffers are expected to protect a greater amount of existing shoreline habitat, which has the potential to support larger populations of resident species.

The potential for impacts on natural resources varies depending on alternative due to the amount of habitat disturbance each allows. The No Action Alternative would reflect the existing condition and, except for additional development adjacent to already designated Limited Development areas, would leave the shoreline relatively unchanged. Alternatives 1 and 2 with their emphasis on natural resource conservation would likely see an increase in the quality and quantity of habitats resulting from an increase in the shoreline acreage designated Protected. Protected shorelines would favor native species best adapted to occupy core habitat zones. The quality and quantity of habitats would decrease slightly under Alternative 3 and would decrease further under Alternative 4, as more shoreline miles currently allocated as Protected would convert to Limited Development and/or Public Recreation. In the discussion of potential impacts of these alternatives, shoreline development would not include residential development, as this occurs on private lands adjacent to the government-owned shoreline. Therefore, shoreline development refers to dock construction, dock access, and vegetation management. Under these alternatives, habitat conditions would likely favor edge species and those best able to adapt to human disturbance.

7.2.1 No Action Alternative

Potential impacts of the No Action Alternative on the Arkansas River shiner would likely result in a future condition similar to the existing condition described in Section 4.2.1.1. Potential impacts to shallow littoral zone waters, as described in Section 5.1.2., have the ability to affect shiner populations. However, the existing condition within the study area provides few areas of suitable shiner habitat; therefore, under the No Action Alternative, Arkansas River shiner populations are expected to continue their slowly declining trend and inhabit suitable habitat at the currently observed low densities.

Potential impacts of the No Action Alternative on paddlefish would likely result in a future condition similar to the existing condition described in Section 4.2.1.2. Populations would likely continue to remain at low densities and would slowly increase primarily due to annual stocking efforts.

Potential impacts of the No Action Alternative on all common and popular game species would likely result in future conditions similar to the existing conditions outlined in Section 4.2.1.3. Overall threats to Eufaula Lake's fisheries introduced within that section would unlikely change under the No Action Alternative.

Aquatic invasive and nuisance species can also threaten the diversity and stability of fish community structure within the Eufaula Lake study area. Asian carp are the invasive fish species most likely to cause significant impacts on native fish. The potential for Asian carp introduction and establishment can be used as a proxy to estimate the effects of each alternative on the introduction potential of any invasive or exotic fish species. Future conditions under the No Action Alternative would most likely follow existing trends with moderate to high potential of Asian carp introduction.

Continued slow rates of development expected under the No Action Alternative on shorelines allocated as Limited Development would likely result in a small increase in habitat fragmentation as compared to the existing condition. For terrestrial wildlife, increased habitat fragmentation would likely sever travel corridors. Travel corridors are essential to maintaining connectivity between disparate populations; thereby, enabling gene flow and providing access to additional suitable habitat and food resources.

In general, potential impacts of the No Action Alternative would likely result in a future reptile community similar to that described under the existing condition in Section 4.2.2.1. The likely future condition includes trends that favor reptile species adapted to low levels of development and seasonally-high levels of human recreation, especially during the summer breeding season.

Under the No Action Alternative, potential impacts would likely result in levels of amphibian diversity and population trends similar to those described for the existing condition in Section 4.2.2.2. Some amphibian decline would likely continue due to potential conversion of wetland habitats and from altered water level fluctuation cycles. In addition, existing fire suppression practices could increase the percentage of forested wetlands, thus favoring species adapted to wet woodlands over those adapted to herbaceous emergent wetlands. However, these fire suppression practices are largely outside of USACE control.

For both mammal species of special concern, the river otter and long-tailed weasel, the No Action Alternative would result in population structure and numbers similar to the existing condition described in Section 4.2.3. Recent status reports indicate that populations of both species within Oklahoma are expanding into unoccupied areas of suitable habitat. Therefore, the No Action Alternative may result in higher otter and weasel populations than currently observed due to the existing trend toward range expansion and the presence of suitable habitat within the study area.

Under the No Action Alternative, potential impacts on most mammal populations would result in a future condition similar to that described for the existing condition and observed rates of increase or decline would most likely continue. Likewise, the No Action Alternative would likely result in deer populations similar in size and characterized by the existing stable or slightly increasing trend described under the existing condition.

As discussed in prior sections, land use changes and human disturbance within the Eufaula Lake study area can significantly impact the likelihood of invasive species introduction and establishment. Small, invasive rodents such as the house mouse and Old World rats are specifically adapted to human disturbance and often rely on urban sprawl to spread into new areas. Under the No Action Alternative these species would likely experience little change, with significant populations present only in the most urban areas. The feral hog is a habitat generalist and can adapt to increases in human disturbance. However, feral hogs have

been present within the study area for over four decades and continue to exist at moderate densities. Therefore, under the No Action Alternative, feral hog populations would likely remain stable with the continuing trend of slow northward range expansion. Although documented in nearby areas, there is no evidence that the susceptibility of the study area to invasion by nutria would increase under the No Action Alternative.

Due to a variety of suitable habitats within the study area, the alternatives have the potential to impact the future condition of rare bird species. Potential impacts of the No Action Alternative would likely result in bald eagle populations and trends similar to those described under the existing condition in Section 4.2.4.1. This future condition would be characterized by the presence of a small number of resident breeding pairs with a larger migrant population present during winter months.. In the future, as bald eagle populations recover both statewide and nationwide, the likelihood exists that populations of both resident and migratory birds would increase.

Potential impacts of the No Action Alternative would likely result in future tern population densities and trends similar to those described for the existing condition in Section 4.2.4.2. The future condition would be characterized by the presence of a small breeding population that utilizes river sand and gravel bars and lakeshore beaches to nest. However, high levels of recreational activity on sandbars and sandy beaches, including heavy use by off-road vehicles, could threaten local populations.

The future condition of the threatened piping plover under the No Action Alternative would likely be similar to the existing condition described in Section 4.2.4.3. The combination of poor habitat quality and an absence of confirmed observations make it unlikely that piping plovers utilize the Eufaula Lake study area and conditions expected under the No Action Alternative are unlikely to support plover populations.

The endangered whooping crane is extremely sensitive to human disturbance and frequently utilizes wetland and prairie habitats during its annual migration. Critical habitat is designated in the western part of Oklahoma and, while suitable habitat exists within river systems upstream of Eufaula Lake, the study area and adjacent lands have had no recorded crane observations since reservoir construction. Therefore, impacts associated with the No Action Alternative should have no effect on whooping crane populations and the future condition should be similar to that described under the existing condition in Section 4.2.4.3.

Several species of special concern potentially inhabit that study area and could be impacted by shoreline reallocation. While the potential exists for peregrine falcons to be found within the Eufaula Lake study area at low densities during migration periods, no falcon observations have been recorded in the area. Therefore, potential impacts associated with the No Action Alternative are likely to result in future peregrine falcon conditions similar to those described under the existing condition in Section 4.2.4.3.

Sprague's pipit is a non-breeding winter resident and passage migrant in Oklahoma and would most likely be observed in the study area during spring and fall migrations. While suitable prairie habitats, croplands, and pastures exist within the study area, they occupy a relatively small percentage of shoreline habitats and are much more likely to be found to the north and west of the study area. Those found within the study area often exist in a degraded condition and are dominated by invasive species. These existing conditions are expected to persist under the No Action Alternative, and the future condition of the Sprague's pipit would likely be similar to descriptions found in Section 4.2.4.3.

The potential future condition of the Bell's vireo within the Eufaula Lake Study area under the No Action Alternative would likely be similar to that described under the existing condition in Section 4.2.4.3. This

condition is characterized by small summer resident populations experiencing population decline due to habitat loss and degradation.

Bachman's sparrow, a summer resident of southeastern Oklahoma, has declined due to urban encroachment and fire suppression practices that have transformed oak-pine woodland habitat. Several areas of pine forest and savanna exist within the study area, yet are apparently devoid of Bachman's sparrow populations. Therefore, under the No Action Alternative, the future condition would likely see the decreasing trend continue, as described under the existing condition in Section 4.2.4.3.

Similar to the Bachman's sparrow, the prothonotary warbler is a summer resident, and although a species of conservation concern, it has been routinely documented and observed throughout the study area. The status of this warbler is intimately connected to the availability of nesting cavities within mature forested habitat. Since much of the shoreline would remain forested, the future condition under the No Action Alternative would likely contain warbler populations similar to those described under the existing condition in Section 4.2.4.3.

Under the No Action Alternative, potential future impacts on the birds of prey community would likely be similar to those described under the existing condition, resulting in similar species diversity and population numbers. This condition is characterized by a community dominated primarily by habitat generalists that can tolerate limited human disturbance.

Under the No Action Alternative, potential impacts would likely result in a future songbird condition similar to the existing condition outlined in Section 4.2.4.3 and would result in songbird distributions that mirror current extents, trends, and population numbers. Under the No Action Alternative, potential impacts would likely result in a future ground bird community condition similar to that described under the existing condition in Section 4.2.4.3. However, ground birds are reliant on fires to maintain relatively open habitats, and continued fire suppression practices would likely favor future forest encroachment and a loss of open habitat. While some ground birds, such as the wild turkey, can adapt to forest environments, other ground birds including the greater roadrunner cannot. Therefore, under the No Action Alternative, some ground bird species adapted to open habitats would likely experience population decline.

Under the No Action Alternative, potential impacts would likely result in a future condition of woodpecker, crow, and swallow distributions, populations, and community composition similar to that described for the existing condition in Section 4.2.4.3.

The availability, dispersion, and quality of habitats influence waterfowl and waterbird concentrations, movements, energy budgets, and pairing processes; thereby, affecting reproductive potential (Heitmeyer and Vohs, Jr. 1984). Therefore, the potential impacts of each of the alternatives on aquatic habitats have potentially profound effects on waterfowl and waterbird populations. Several species have preferred habitat types, and study area populations would likely be impacted by the potential effects of alternatives on these habitats. Therefore, potential alternative impacts should be combined with those described for wetland habitats to adequately address the full suite of potential impacts on individual waterfowl and waterbird species.

The No Action Alternative and associated impacts would likely result in a future condition that maintains waterfowl and waterbird distributions and continues observed population trends as described under the existing condition in Section 4.2.4.3. However, one major difference between waterbirds and most waterfowl species is that many waterbirds including herons, egrets, pelicans, gulls, and terns are

piscivorous. Therefore, potential impacts to fish species as described in Section 5.2.1 would also likely impact the health and stability of waterbird populations.

As the largest and most diverse group of organisms found within the Eufaula Lake study area, the potential exists for the No Action Alternative and any of the four action alternatives to impact resident invertebrate populations. However, the status of most invertebrates within the study area cannot be determined and relatively few studies exist that evaluate the impacts of increased development or recreation activities on specific invertebrate groups. Therefore, the potential impacts of the four action alternatives will be assessed for invertebrates on which information is known including the endangered American burying beetle and freshwater mussels.

Under the No Action Alternative, the future condition of American burying beetle populations within the study area would be expected to be similar to the distributions and trends described under the existing condition in Section 4.2.5.1. Under the No Action Alternative, the future condition is characterized by potential adverse impacts to beetles and their habitats within areas already scheduled for development and within areas where future development is allowed.

Aquatic macroinvertebrate communities, both in the water column and in the benthos, vary widely depending on substrate and nutrient availability. Therefore, the species composition of benthic macroinvertebrates and pelagic zooplankton would likely be influenced by factors that impact these habitat parameters. Similarly, the plankton community generally exhibits cyclic stability and varies in composition in relation to changes in light, temperature, and nutrient availability (Walsh 1978). Pollutants and nutrients can affect both population size through changes in growth rate and species composition through selection. As the base of the aquatic food web, any change in the plankton community would likely impact local fish species.

In addition to benthic macroinvertebrates and plankton, freshwater mussels are highly susceptible to changes in water quality because they are filter feeders and depend on relatively clean waters for respiration and reproduction. Individual observations of pink papershell, giant floater, and fragile papershell mussels were made in several locations. In contrast to many freshwater mussel species, all three species are known to reach high densities in reservoirs and can tolerate silt substrates that many other mussel species cannot.

Under the No Action Alternative, potential impacts would likely result in a future condition for all aquatic invertebrates similar to that described under the existing condition in Section 4.5.3. However, over time, continued development would likely increase sediment and nutrient inputs, which would slowly shift species composition to favor species that can tolerate poorer water quality in eutrophic systems.

Two invasive mussel species, the zebra mussel and Asian clam, are recognized as threats to the stability of the Eufaula Lake ecosystem. While changes to the littoral zone and benthic environments have the potential to influence the risk of establishment of both species, the predominant factor involved in introduction is the level of human lake usage. Adult mussels attach to boats and trailers and their microscopic larvae can be transported in bait buckets, live wells, and moisture on carpets and ropes (Laney 2010). In January 2010, sampling documented zebra mussels within the study area. Once established, spread of zebra mussels may be inevitable. However, the construction of more boat docks could provide additional attachment points for zebra mussels and facilitate spread throughout the lake.

Under the No Action Alternative, potential impacts would likely result in a future condition of invasive aquatic invertebrates similar to that described under the existing condition in Section 4.2.5.3. However, the recent discovery of zebra mussels within the Eufaula Lake study area indicates that establishment has occurred and, under the No Action, future range expansion throughout the study area would be likely.

7.2.2 Alternative 1

Alternative 1, with the increase in designated Protected shoreline and establishment of extended shoreline buffers within remaining areas of Limited Development, would likely maintain Arkansas River shiner populations in portions of the study area where they currently exist and may expand its distribution due to a future reduction of impacts associated with human disturbance.

Under Alternative 1, paddlefish populations would likely increase as stocked populations mature and find protected spawning habitat and improved water quality resulting from the increase of protected lands and a decrease in development. In addition, nutrient inputs from lawn fertilizers and stormwater runoff would also likely decrease with an increase in Protected shoreline. The combination of reduced sediment and nutrient inputs would likely result in increased water quality; therefore, benefiting paddlefish.

Under Alternative 1, the reduction in areas designated Limited Development and the protection of forested shorelines would likely reduce sediment and nutrient input levels resulting in improved water quality and a reduction in anoxic conditions. While some species such as catfish and bullhead can thrive under poor water quality conditions, most fish are acutely sensitive to even a small decline in water quality. In addition, boat dock construction would be limited, which would reduce littoral zone shading and direct habitat alteration during construction resulting in improved conditions for fry and small forage species. Finally, the protection of shoreline areas and reduced development would reduce the likelihood of potential competing water uses including water withdrawals needed to support large developments, and would reduce the likelihood of invasive species establishment and disease often associated with high levels of recreational activity.

The future condition of the black bass fishery, which includes both largemouth and smallmouth bass, is likely to reflect the No Action Alternative under Alternative 1. However, the expected adequate population numbers do not necessarily result in healthy bass populations. Largemouth Bass Virus (LMBV) has been documented within the Eufaula Lake study area, and water quality improvements likely to be realized under Alternative 1 could reduce the occurrence of LMBV and other fish diseases.

A reduction in erosion and sedimentation rates under Alternative 1 would likely have little potential impact on the spawning success of largemouth and smallmouth bass. However, fewer expected boat docks may actually negatively impact both species as bass often utilize docks as habitat structures. The conservation of shorelines would likely improve littoral habitats on which bass prey species depend, thus improving food availability for bass populations. Overall, these habitat generalists likely already occupy the majority of available habitat and would see a negligible increase in population numbers under natural resource conservation alternatives. For all action alternatives, potential impacts to white bass and spotted bass would be similar to those described for black bass and common fish species.

Under Alternative 1, crappie populations are likely to be similar in size and structure to those described for the No Action Alternative for many of the same reasons listed for black bass. However, several factors related to riparian conservation may improve crappie size structure and expand crappie distribution. The increased protection of shoreline habitats and limited dock construction could prevent the removal of

underwater structure that crappie prefer, leading to colonization of additional littoral areas. Conservation of natural shorelines would also likely result in larger populations of prey species such as threadfin shad. Larger prey bases support both larger populations and larger individuals.

Under Alternative 1, the catfish fishery would likely be similar, in size and structure, to the No Action Alternative. The emphasis on shoreline conservation under these alternatives would likely have little impact on these habitat and forage generalists that can survive in water bodies with marginal water quality. However, the conversion of shoreline from Limited Development to Protected would likely conserve optimal catfish nesting habitat and could increase the rate of natural recruitment.

In comparison to the No Action Alternative, Alternative 1 would likely lower the introduction potential of Asian carp and other aquatic invasive species due to expected lower recreation rates associated with a decrease in areas designated Limited Development. Fewer recreationists lessen the probability of introduction from nearby infested rivers and reservoirs.

In comparison to the No Action Alternative, Alternative 1 would likely result in a decrease in levels of shoreline development due to more areas allocated as Protected and fewer areas allocated as Limited Development. Therefore, Alternative 1 would likely result in a decrease in habitat fragmentation as compared to the No Action Alternative. For terrestrial wildlife, a decrease in habitat fragmentation would likely preserve travel corridors. Travel corridors are essential to maintaining connectivity between disparate populations; thereby, enabling gene flow and providing access to additional suitable habitat and food resources.

In comparison to the No Action Alternative, Alternative 1 would likely increase populations of semi-aquatic and terrestrial reptiles. Terrestrial reptiles would benefit from the conservation of forests, woodlands, and prairies and would thrive in conditions associated with less development including less road construction, herbicide use, and road traffic. The implementation of wide shoreline buffers on lands designated as Limited Development would help filter out sediments, nutrients, and additional pollutants that could impair water quality. Finally, an increase in shoreline designated Protected would protect more hibernation habitat, including hollow logs and burrows, from disturbance and would protect fragile nesting areas, especially emergent wetlands and sandy shorelines. For the imperiled alligator snapping turtle, observed along the sandy shoreline of Sycamore Bay, Alternative 1 would reject individual zoning request # 10. While this rejection would allow existing boat docks and development to remain, new shoreline vegetation management policies in this area would protect some habitat from disturbance.

In comparison to the No Action Alternative, under Alternative 1 amphibian diversity would be maintained and populations would be expected to increase and expand due to the protection of shoreline habitats and establishment of expanded shoreline buffers. More than any other group of animals, amphibians are significantly impacted by the effects of water pollution. Any alternative that reduces adjacent development and associated pollutant-laden runoff would benefit amphibian populations. In addition to improving water quality, Alternative 1 would likely protect areas of secure thermal refuge from shoreline disturbance. The protection of shoreline habitats would especially benefit salamanders that seek out woody debris within forested riparian wetlands, which tend to be significantly impacted by clearing of bottomland hardwoods or selective removal of downed trees to establish parkland.

Alternative 1 would likely facilitate increasing numbers of both the long-tailed weasel and river otter. Alternative 1, with its extended shoreline buffers, would likely improve water quality conditions in lake,

stream, and wetland habitats; therefore, improving populations of amphibian and fish prey species and reducing turbidity resulting in improved hunting success. Wide buffers and an increase in Protected shoreline would conserve habitat utilized by both species. In particular, due to exclusive use of shoreline areas for denning, potential impacts of Alternative 1 would likely include increased otter den site availability. In comparison to the river otter, the impact of Alternative 1 could be less beneficial to the long-tailed weasel as the amount of slightly disturbed and edge habitat preferred by the weasel would likely be reduced.

Under Alternative 1, the size and structure of populations of most small- to medium-sized mammal species would likely be similar to that described under the No Action Alternative. Larger-bodied mammal species, especially carnivores like coyotes, and species requiring specialized or undisturbed habitats would likely see population increases due to the establishment of wide extended buffers and a decrease in development on lands adjacent to the shoreline. A greater proportion of bat roost sites would likely be preserved and larger predators would have larger areas of contiguous habitat in which to hunt. The establishment of wide riparian buffers would particularly improve the quality of aquatic habitats; therefore, likely increasing local beaver and muskrat populations.

Under Alternative 1, white-tailed deer populations would likely be similar to that described under the No Action Alternative. While increased natural resource conservation would undoubtedly preserve optimal deer habitat, white-tailed deer occur in all major habitat types in the Eufaula Lake study area, including those with moderate levels of human disturbance. The major benefit to deer from alternatives emphasizing natural resources would be to lessen the likelihood of establishment of introduced forages such as tall fescue and Old World bluestem.

Under Alternative 1, the likelihood of introduction and establishment of invasive mammal species would be similar to that described under the No Action Alternative. Small, invasive rodent species would not be expected to spread outside of urban areas and the chances of nutria introduction would likely be low. Feral hog populations would likely remain stable at moderate densities with a continuing trend of slow, northward expansion.

With an emphasis on natural resource protection, Alternative 1 is likely to maintain or expand populations of rare bird species. Alternative 1 is likely to result in a small but stable population of bald eagles consistent with the No Action Alternative but with an increasing population trend due to benefits of buffer implementation and land protection. In addition, Alternative 1 is likely to maintain interior least tern populations where they currently exist, and could facilitate range expansion into other areas of the lake if sandbar and beach habitat is protected. Indirect impacts of Alternative 1 would likely include water quality improvements due to a decrease in impervious surfaces contributing to runoff. Increased water quality would benefit the small fish species that terns prey upon.

Under Alternative 1, piping plovers and whooping cranes are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the unlikelihood of the piping plover being present within the study area and the scarcity and low quality of preferred plover habitat, it is unlikely that activities associated with Alternative 1 would have an adverse impact on this species. Similarly, the absence of recorded whooping crane observations in recent history and the absence of preferred habitat within the study area would make it unlikely that activities associated with Alternative 1 would have an adverse impact on this species.

Under Alternative 1, the future condition of peregrine falcon, Sprague's pipit, and Bachman's sparrow populations in the Eufaula Lake study area would be similar to the condition described under the No Action Alternative. Due to the absence of peregrine falcon observations and the ability of this species to occupy both altered and un-altered habitats, it is unlikely that activities associated with Alternative 1 would have an adverse impact on this species. Likewise, a lack of presence data and limited suitable habitat within the study area would make it unlikely that activities associated with Alternative 1 would have an adverse impact on the Sprague's pipit and Bachman's sparrow.

Under Alternative 1, the future condition of Bell's vireo and prothonotary warbler populations in the Eufaula Lake study area would likely increase in comparison to the No Action Alternative. The establishment of extended buffers under Alternative 1 would likely preserve forested wetland habitats and would contribute to the health and stability of vireo and warbler populations. Under this alternative, the increase in Protected shoreline and decrease in human disturbance would likely limit habitat degradation, conserve warbler nest cavities, and reduce edge habitats favored by nest parasites.

In comparison to the No Action Alternative, the action alternatives are unlikely to impact birds of prey populations but may impact distributions. Under Alternative 1, an increase in protected shoreline and the establishment of extended vegetation management policy buffers would likely increase the quantity of relatively undisturbed natural habitats. This would favor species such as the red-shouldered hawk and the barred owl, which prefer relatively dense forests. Alternative 1 would also likely limit development and the creation of edge habitats, which are exploited by species such as the red-tailed hawk. As habitats mature, especially forested habitats, it is likely that birds of prey would simply shift their distribution in order to occupy the most suitable areas for each species. Therefore, future changes to the birds of prey community would be unlikely under Alternative 1, but localized relative abundances could shift as a result of observed habitat conditions.

Similar to birds of prey, the action alternatives are unlikely to impact songbird species richness by causing the disappearance of certain species, but would potentially impact species evenness by selecting for species best adapted to resulting environmental conditions. For example, under Alternative 1, an increase in protected forest habitats, in comparison to the No Action Alternative, would likely lead to an increase in mature trees. The resulting high canopy and understory densities would displace birds of the open woodland and savanna such as the savannah sparrow, which would be replaced by birds adapted to closed canopies such as the white-breasted nuthatch. Therefore, under Alternative 1, the future condition is likely to see a change in species' distributions within the study area, but the loss of any one species is unlikely.

Alternative 1, which emphasizes natural resource conservation, would likely benefit populations of ground birds such as the wild turkey and American woodcock that prefer forests and bottomland hardwoods. While vegetation buffers and protection of shoreline from the impacts of potential future development would likely benefit all ground birds in the short-term, without fire, large areas of open ground bird habitat would likely convert to woodland. Therefore, species diversity under Alternative 1 would likely be similar to the No Action Alternative, and populations of all ground bird species would likely increase in the short-term. Over the long-term, species able to adapt to forest systems would likely benefit to the detriment of species adapted to open habitats.

Under Alternative 1, natural resource conservation through land reallocation and the establishment of extended buffers would likely preserve areas of mature forest and the snags contained within. Therefore,

species composition of cavity-nesting birds would likely reflect the No Action Alternative but their distribution would likely expand and populations would likely increase.

Due to the magnitude of influence human disturbance has on aquatic habitats, Alternative 1, which establishes extended buffers to conserve shoreline habitat, would likely improve water quality resulting in an increase in the quantity of optimal habitat suitable for waterfowl and waterbirds. Water quality improvement would likely bolster populations of aquatic vegetation, invertebrates, and fish on which most waterfowl and waterbirds feed. Conservation management implemented under Alternative 1 would likely increase the amount of protected littoral zone and wetland habitat, which would likely improve individual fitness and reproductive success. Increasing the amount of shoreline designated Protected would also limit the potential for dock construction and development on adjacent lands. This conservation of natural habitats has been shown to be more beneficial to waterfowl than attempting to enhance areas associated with large reservoirs.

In addition to limiting wetland losses, Protected shorelines would likely limit disturbance associated with development including increased potential for human-waterfowl interaction. Human activities including boating, fishing, and swimming often initiate escape behavior, which is detrimental to waterfowl and waterbird fitness required for breeding and successful migration.

For all potential American burying beetle populations, the potential impacts of each individual action alternative would vary depending on habitat type and extent of development. Alternative 1 would likely preserve existing beetle populations and could facilitate range expansion. The implementation of extended management policy buffers and the emphasis on natural resource conservation would likely limit habitat alteration and fragmentation. This, combined with reduced edge effects, would benefit potential carrion species, preserve preferred American burying beetle habitats, and reduce predator and competitor densities.

The results of field surveys conducted in May 2012, as documented in Section 4.2.5.1 and Appendix D, indicate that the American burying beetle is present within the shoreline areas of the Carlton Landing site. Therefore, proposed revisions to the SMP and MP classifications would likely affect resident American burying beetle populations. Under Alternative 1, the development at Carlton Landing would largely be the same as that described under the No Action Alternative; however, the Limited Development on the south side of Longtown Arm would be reallocated to Protected. While development of approximately 170 lots would still occur, potential direct and indirect impacts to beetle populations and habitats increase exponentially with the magnitude and extent of land disturbance. Therefore, compared to the other proposed alternatives, Alternative 1 would result in the fewest potential impacts to local American burying beetle populations.

The current benthic macroinvertebrate community is likely made up of tolerant species that are adapted to fine-sediment, eutrophic reservoir systems with significant organic inputs. While Alternative 1 would not likely change the existing condition in many parts of the lake, the implementation of extended buffers and an increase in Protected shoreline could reduce sediment and nutrient inputs resulting in localized improvements to water quality. An increase in water quality could shift the composition of the benthic macroinvertebrate community away from tolerant species to more sensitive species including beetles (Coleoptera), mayflies (Ephemeroptera), caddisflies (Trichoptera), and dragonflies and damselflies (Odonata). The macroinvertebrate mollusk community would also likely shift from fairly tolerant gastropods to more sensitive pelecypods.

While the species composition of the plankton community would be unlikely to change under Alternative 1, the expected water quality improvements would likely affect plankton populations. A reduction in suspended solids from lower rates of erosion would facilitate plankton growth, and reduced nutrient inputs from a decrease in development would likely reduce potential algal blooms. The reduced nutrient input would also decrease zooplankton impairment and mortality, leading to higher populations and a larger fish forage base.

Increased water quality and protection of shoreline habitats under Alternative 1 would likely result in the expansion of localized freshwater mussel populations. Several species, which have been documented to exist within the study area, including the giant floater, are adapted to reservoir conditions. Therefore, if sedimentation rates and nutrient inputs associated with development are kept low, as they would be in Alternative 1, an expansion in the range of the resident freshwater mussel community would be likely.

Under Alternative 1, the probability of introduction, ease of establishment, and extent of expansion of the invasive zebra mussel and Asian clam would likely be similar to the future conditions described under the No Action Alternative. The designation of more shoreline as Protected with limits on dock construction could lower lake usage and lower the probability of additional zebra mussel or Asian clam introduction, but would do little to reduce the susceptibility of the Eufaula Lake study area to invasion.

7.2.3 Alternative 2

The future condition of all fish species under Alternative 2, including the Arkansas River shiner, paddlefish, and popular game species, would likely be similar to the condition described under Alternative 1. However, the extent of improvements to water quality, spawning habitat, and food availability would likely be less due to fewer shoreline miles being reallocated from Limited Development to Protected.

In comparison to the No Action Alternative, Alternative 2 would likely lower the introduction potential of Asian carp and other aquatic invasive species due to expected lower recreation rates associated with a decrease in areas designated Limited Development and a decrease in dock construction. Fewer recreationists lessen the probability of introduction from nearby infested rivers and reservoirs. However, the introduction potential would be higher than that expected under Alternative 1 because fewer shorelines are designated as Protected under Alternative 2.

In comparison to the No Action Alternative, Alternative 2 would likely result in a small decrease in levels of shoreline development due to more areas allocated as Protected and fewer areas allocated as Limited Development. Therefore, Alternative 2 would likely result in a small decrease in habitat fragmentation as compared to the No Action Alternative. For terrestrial wildlife, a decrease in habitat fragmentation would likely preserve travel corridors. Travel corridors are essential to maintaining connectivity between disparate populations; thereby, enabling gene flow and providing access to additional suitable habitat and food resources.

Although Alternative 2 designates less shoreline as Protected as compared to Alternative 1, it would likely have similar potential impacts on the future condition of reptile and amphibian communities due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Alternative 2 would likely have similar potential impacts on the future condition of the two mammal species of special concern, the river otter and long-tailed weasel, as described for Alternative 1, except for

slight increases in preferred weasel habitat and slight decreases in preferred otter habitat. Likewise, the future condition of common mammal species under Alternative 2 would likely be similar to that described under Alternative 1 due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Under Alternative 2, the likelihood of introduction and establishment of invasive mammal species would be similar to that described under the No Action Alternative. Small, invasive rodent species would not be expected to spread outside of urban areas and the chances of nutria introduction would likely be low. Feral hog populations would likely remain stable at moderate densities with a continuing trend of slow, northward expansion.

The future condition of bald eagle and interior least tern populations under Alternative 2 would likely be similar to the condition described under Alternative 1, but fewer positive impacts on water quality and nesting habitat would likely be realized due to fewer shoreline areas being designated Protected.

Under Alternative 2, piping plovers and whooping cranes are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the unlikelihood of the piping plover being present within the study area and the scarcity and low quality of preferred plover habitat, it would be unlikely that activities associated with Alternative 2 would have an adverse impact on this species. Likewise, the absence of recorded whooping crane observations in recent history and the absence of preferred habitat within the study area would make it unlikely that activities associated with Alternative 2 would have an adverse impact on this species.

Although Alternative 2 designates less shoreline as Protected than Alternative 1, it would likely have a similar potential impact on the future condition of all five bird species of conservation concern. The future condition under Alternative 2 would likely result in populations of peregrine falcon, Sprague's pipit, and Bachmann's sparrow, similar to those described for the No Action Alternative. Although the increase would be smaller than under Alternative 1, populations of Bell's vireo and prothonotary warbler would likely increase slightly under Alternative 2 due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Although Alternative 2 designates less shoreline as Protected than Alternative 1, the future condition of the birds of prey, songbird, ground bird, woodpecker, waterfowl, and waterbird communities would likely be similar to that described under Alternative 1 due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development.

Under Alternative 2, the future condition of American burying beetle populations would likely be similar to the condition described under Alternative 1 due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development. Under Alternative 2, the potential scope of future development at Carlton Landing would be the same as that described for the No Action Alternative. Therefore, the potential impacts associated with this alternative would likely be similar to those described for the No Action Alternative, with the caveat that the installation of extended buffers would protect American burying beetle habitat close to the shoreline.

Although Alternative 2 designates less shoreline as Protected as compared to Alternative 1, the future condition of the aquatic invertebrate community would likely be similar to that described under Alternative 1 due to the establishment of extended buffers and the likely decrease in development on adjacent lands associated with fewer areas of shoreline designated Limited Development. The decrease in development would likely improve water quality, which is essential for the survival of many aquatic invertebrate species.

Under Alternative 2, the probability of introduction, ease of establishment, and extent of expansion of the invasive zebra mussel and Asian clam would likely be similar to the future conditions described under Alternative 1.

7.2.4 Alternative 3

Alternative 3 emphasizes shoreline development in that it would allow an increase in dock construction, dock access, and vegetation clearing due to a conversion of Protected shoreline to Limited Development. Dock construction would degrade littoral habitats and development of adjacent lands would remove vegetation; thereby, increasing sediment and nutrient inputs into aquatic habitats. The Arkansas River shiner needs specific stream flow regimes in order to successfully spawn and feed, and increased development has the potential to alter flows through stream channelization, water withdrawal, erosion, and sedimentation (USFWS 2001). Therefore, in comparison to the No Action Alternative, the future condition under Alternative 3 would likely see a gradual decrease in the population of Arkansas River shiners.

Under Alternative 3, potential impacts on paddlefish are likely to result in a future condition similar to that described under the No Action Alternative. Depending on the percentage of Limited Development lands actually developed, the influx of sediment and nutrients associated with erosion, landscaping, and stormwater runoff could degrade water quality (Mims *et al*. 1999). The baseline buffers implemented under Alternative 3 would likely filter out fewer water pollutants than the extended buffers implemented in Alternatives 1 and 2. Finally, increased recreational opportunities could increase the number of paddlefish snagged by anglers.

Alternative 3 would establish a baseline buffer that would protect more shoreline than under the No Action Alternative, but less than the extended buffers under Alternatives 1 and 2. The presence of the baseline buffers would provide essentially the same water quality and habitat benefits to common fish species as those in Alternatives 1 and 2 but on a smaller scale. Despite increased shoreline conservation as compared to the No Action Alternative, changing land use designations under Alternative 3 would likely facilitate increased shoreline use and human disturbance. While additional dock construction could provide overhead cover and habitat structure for some species, the benefits of buffers and dock construction would likely be offset by the degradation in water quality and littoral habitats that would be associated with increased levels of development and recreation. In addition, the probability of invasive species establishment increases with the high levels of recreational activity expected under Alternative 3.

Under Alternative 3, increased development and recreational opportunities would likely have little potential impact on black bass and crappie populations overall, and the primary impact to these fisheries would be increased angling pressure. Increased development and recreational opportunities would likely result in more anglers. Increased angling pressure often disrupts normal age structure and could result in a population dominated by small, young individuals. While increased sedimentation and nutrient inputs associated with human development could smother preferred spawning substrates and decrease water quality, black bass are remarkably adaptable to moderate habitat disturbance. The deposition of finer

sediments would be beneficial to crappie as they prefer to spawn on silt, clay, or sand substrates. Although it would disturb natural littoral habits, increased boat dock construction under Alternative 3 would likely provide black bass with increased habitat structure and result in little potential impact to bass populations. Therefore, the future condition of the black bass and crappie fisheries would likely resemble conditions described under the No Action Alternative.

The catfish fishery is the fishery least likely to be adversely impacted by increased shoreline development and recreation expected under Alternative 3. Catfish often utilize turbid waters and disturbed aquatic habitats to feed, rest, and nest. Within the Eufaula Lake study area, catfish take shelter near boat ramps, submerged roadways, and abandoned underwater culverts. Under Alternative 3, increased dock and infrastructure construction (*e.g.*, power lines and bridges) associated with increased residential development could provide underwater structure and increase available catfish habitat. A potential adverse impact of Alternative 3 could be overharvesting. Noodling, allowed for flathead catfish, is growing in popularity throughout the study area, and specifically targets large and nesting catfish. Specifically targeting reproducing individuals can cause population decline and may be a reason for the observed decline in flathead catfish.

Alternative 3 would not make aquatic habitat conditions any more susceptible to Asian carp establishment because carp have invaded many quality aquatic habitats throughout the Mississippi River basin. However, the expected rise in people utilizing the study area would likely increase the potential for accidental Asian carp introduction. Once introduced, eradication efforts are difficult, if not impossible on a lake the size of Eufaula and could lead to a severe decline to managed fisheries and other native species.

A greater amount of shoreline development would be expected under Alternative 3 as more areas would be allocated as Limited Development and fewer areas would be allocated as Protected. Therefore, Alternative 3 would likely result in an increase in shoreline habitat fragmentation as compared to the No Action Alternative. For terrestrial wildlife, an increase in habitat fragmentation would likely sever travel corridors. Travel corridors are essential to maintaining connectivity between disparate populations; thereby, enabling gene flow and providing access to additional suitable habitat and food resources.

Generally speaking, Alternative 3, with its emphasis on reallocation of Protected shoreline to Limited Development, would likely result in localized adverse impacts to most reptile populations within the study area. Baseline management buffers would improve water quality and conserve some riparian habitat as compared to the No Action Alternative, and the creation of open edge habitats as a result of development may favor species like the racer and common garter snake that are well adapted to human disturbance. However, for most reptile species, the potential for an increase in development has the opposite effect as conservation measures described for Alternatives 1 and 2. Aquatic habitat and wetland degradation is likely to increase along with clearing and conversion of adjacent upland habitats to make room for home sites and associated infrastructure. Roads and construction activities could contribute directly to increased mortality and indirectly by fragmenting habitat and eliminating sources of thermal refuge. Finally, development also provides avenues for predators and makes habitats more susceptible to invasive species, which could replace native reptile food sources.

While the proposed baseline vegetation management policy buffers established under Alternative 3 would improve amphibian condition over the No Action Alternative, the conversion of Protected shoreline to Limited Development would likely negatively impact amphibian diversity and amphibian populations overall. Studies have shown that increased habitat fragmentation due to development is directly

correlated with a decrease in amphibian diversity (Beasley *et al*. 2002). Increased development would not likely result in the direct mortality of many wetland-dwelling amphibians because the majority of development is located in dry uplands. However, adults of some species, especially salamanders and toads spend significant time in upland areas and could be adversely impacted by land disturbance activities. Indirect effects of development would likely adversely impact amphibian populations regardless of habitat preference. Development would lead to increased water pollutants in stormwater runoff coming from impervious surfaces and landscaped areas. Additionally, increased development often leaves aquatic habitats more susceptible to aquatic invaders and amphibian diseases and parasites (Beasley *et al*. 2002).

In comparison to the No Action Alternative, Alternative 3 would likely have a positive impact on long-tailed weasel populations; whereas, it would likely reduce the amount of suitable river otter habitat. The implementation of baseline buffers would improve water and habitat quality, but would have a lesser potential impact than the extended buffers in Alternatives 1 and 2. Additionally, the conversion of Protected shoreline into Limited Development would reduce the quantity of preferred natural habitats for both species. Potential impacts related to dock construction and development on adjacent lands would have additional negative impacts on the river otter, a species intricately tied to the health of aquatic and wetland systems. An influx of water pollutants near developments could make hunting unsuitable, decrease prey populations, and impact individual fitness. Increased recreation would likely increase human-otter interaction resulting in stress, decreased hunting success, and potentially more trappers during the winter season (ODWC 2011f). Unlike the river otter, the long-tailed weasel has been known to thrive in edge habitats and in areas with moderate human disturbance.

Under Alternative 3, populations of bats, larger predators like bobcats and coyotes, and habitat specialists like beaver and muskrat, would likely decrease due to removal or disturbance of roosting sites, direct human conflict, and degraded habitats. For several of these species direct human conflict refers to heightened animal control policies and an increase in recreational trapping that often result from increases in human populations in rural areas.

Despite the potential for adverse impacts on predators and habitat specialists, under Alternative 3, small rodents and medium-sized opportunists such as mice, squirrels, raccoons, and skunks would find increased levels of low-level human disturbance advantageous due to increased food availability, decreased predation, or a preference for edge habitats.

Due to existing high population densities and the ability for deer to thrive in areas of human disturbance, Alternative 3 would likely have little impact on deer populations. Increasing the number of edge and open habitats may benefit deer populations, which thrive in open woodlands historically managed by fire. However, any observed increase is likely to be offset by a reduction in mature oak and pine stands, which provide deer with winter food and cover. Shoreline buffers, identified as a key tenet of good deer management strategy, would be established under Alternative 3 but would provide less benefit in comparison to the extended buffers in Alternatives 1 and 2 (Masters *et al*. 1996).

Under Alternative 3, the likelihood of introduction and establishment of invasive mammal species would be similar to that described under the No Action Alternative. However, the creation of large residential communities facilitated by the reallocation of shoreline to Limited Development could facilitate the spread of small, invasive rodent species. The potential for introduction and establishment of nutria in the study area would likely remain low under Alternative 3. Feral hog populations would likely remain stable at moderate densities with a continuing trend of slow, northward expansion.

Under Alternative 3, future population and distribution trends of bald eagles within the study area would be similar to those described under the No Action Alternative. The implementation of baseline management buffers would likely result in water quality improvements benefiting eagle prey species, but to a lesser extent than the larger extended management buffers. Increased shoreline designated as Limited Development would likely increase home and dock construction, making some areas of potential eagle habitat unsuitable. Localized effects may result in eagle relocation to more remote areas. However, 2012 surveys observed eagle activity in residential areas; therefore, limited development activity may not disrupt eagle behavior at Eufaula Lake to the extent reported elsewhere.

The future condition of interior least terns under Alternative 3 would likely to be similar to that described under the No Action Alternative due to the fact that the majority of observed tern populations currently exist on protected shorelines that would not be reallocated. Implementation of baseline buffers would likely result in reduced disturbance of shoreline habitats and a modest increase in water quality compared to the No Action Alternative. However, increased development, dock construction, and recreational activity associated with Alternative 3 would also be likely to inhibit range expansion of terns into other portions of the study area.

Under Alternative 3, piping plovers and whooping cranes are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the unlikelihood of the piping plover being present within the study area and the scarcity and low quality of preferred plover habitat, it would be unlikely that activities associated with Alternative 3 would have an adverse impact on this species. Likewise, the absence of recorded whooping crane observations in recent history and the absence of preferred habitat within the study area would make it unlikely that activities associated with Alternative 3 would have an adverse impact on this species.

Under Alternative 3, the future condition of peregrine falcon, Sprague's pipit, and Bachman's sparrow populations in the Eufaula Lake study area would be similar to the condition described under the No Action Alternative. Due to the absence of peregrine falcon observations and the ability of this species to occupy both altered and un-altered habitats, it would be unlikely that activities associated with Alternative 3 would have an adverse impact on this species. Similarly, a lack of presence data and limited suitable habitats within the study area would make it unlikely that activities associated with Alternative 3 would have an adverse impact on the Sprague's pipit and Bachman's Sparrow.

The future condition of both the Bell's vireo and prothonotary warbler under Alternative 3 would likely be characterized by a slight population decrease in comparison to the No Action Alternative. The increased development and recreation expected under Alternative 3 would likely increase urban encroachment; therefore, increasing fragmentation and the quantity of edge habitats. While the baseline buffers established under Alternative 3 would preserve some bottomland hardwood forest, an increase in limited development would likely increase the susceptibility of shoreline areas to nest parasites, snag removal, and invasive species.

In comparison to the No Action Alternative, Alternative 3, which emphasizes development and would result in greater recreational activity, would likely select for birds of prey species best suited to human disturbance. With increased development, edge habitats would increase resulting in higher populations of vultures and well-suited hawk species. This would also result in decreasing populations of species suited to dense forested habitats.

Under Alternative 3, the establishment of baseline buffers would likely benefit songbird species of all habitat types, but to a lesser extent than extended buffers implemented under Alternatives 1 and 2. Similar to future conditions described under Alternatives 1 and 2, some songbird groups would benefit and some would decline due to land use changes associated with shoreline reallocations under Alternative 3. The increase in future potential development would likely increase birds tolerant of increased human disturbance. Species like the American robin, blue jay, and northern cardinal are staples at backyard feeders and often nest within human structures. Therefore, Alternative 3 should have a beneficial impact on songbird communities tolerant of disturbed, edge habitats and an adverse impact on songbird communities that prefer core habitats.

Another widespread potential impact of increased development on songbirds, and all native birds in general, is the increase in invasive competitors and nest predators. Invasive songbirds such as the European starling and house sparrow are aggressive, superb competitors that displace native cavity-nesting songbirds like the northern parula and brown creeper as well as most woodpeckers. While at home in most open habitats, starlings and house sparrows often use human development and disturbance to access new areas of core, interior habitat. Therefore, implementation of Alternative 3 would likely result in an expansion of invasive species distributions and an increase in starling and house sparrow populations in areas of development.

Under Alternative 3 the ground bird community would likely resemble the future condition described for the No Action Alternative. In addition to fire suppression and forest encroachment, ground birds in open habitats, particularly bobwhite quail, would likely be impacted by invasive forage species introduction. An increase in development and recreational opportunities would likely increase the potential for the introduction of new invasive plants and the spread of established invasive species.

Alternative 3, with its emphasis on development, would likely result in a species composition of cavity-nesting birds similar to that described for the No Action Alternative but distributions and populations would likely shrink and decrease with the removal of mature forests. Even where mature forests are only thinned, as is often the case with rural residential development, selective management often prioritizes snag removal for safety and aesthetic reasons. In addition, because they play a role in the control of forest pests, a decline in insectivorous cavity-nesters could spark an overall decline in forest health.

Despite the likely decrease in woodpecker abundance, Alternative 3 would likely have beneficial impacts on several common bird species. Populations of crows and swallows generally increase with human disturbance, as swallows often nest on structures like bridges and barns and crows, as generalists, take advantage of foraging opportunities associated with edge habitats.

In comparison to the No Action Alternative, Alternative 3 reallocates approximately 96 miles of shoreline habitat from Protected to Limited Development. The potential development of these shoreline areas would likely have an adverse impact on the future condition of waterfowl and waterbird species. While the establishment of baseline buffers would likely improve water quality and wetland habitat, the likely effect would be less than that realized by the extended buffers implemented under Alternatives 1 and 2. The likely increase in dock construction, recreation, and development on adjacent lands as a result of Alternative 3 would likely impact certain waterfowl and waterbird species differently depending on preferred habitat type and the level of human disturbance and interaction each is willing to tolerate. While populations of wary species such as teal and pintail may decline, development could expand populations of

generalist waterfowl species that adapt well to human disturbance such as mallard, great blue heron, and Canada goose.

For the majority of waterfowl and waterbird species likely to be found within the study area, increased areas of development and associated human disturbances would likely lower forage quality, reproductive success, and available optimal habitat. Lowered reproductive success would include failed nest attempts and increased nestling mortality due to increases in nest predators adapted to human settlement like raccoons, red fox, and domestic cats. While the response by sensitive species would likely be a shift in distribution to lesser developed portions of the study area, the concentration of waterfowl and waterbird populations into smaller areas of optimal habitat is likely to place additional stress on these areas. It would also increase the probability that significant natural impacts, such as disease, could reduce large percentages of existing populations.

Under Alternative 3, an increase in additional boat dock construction would be likely. While several species of waterfowl and waterbirds use floating docks for refuge, construction of these structures impacts littoral zone areas where these species not only take refuge, but feed and nest as well. Therefore, while creating some waterfowl and waterbird habitat, boat dock construction does so by eliminating productive natural habitats resulting in no net benefit.

Under Alternative 3, the implementation of baseline buffers would likely conserve American burying beetle habitat not protected under the No Action Alternative. However, increased development and recreational opportunities within the study area would likely lead to decreases in beetle populations in areas where shoreline reallocation occurs. In addition to direct land disturbance, development increases artificial lighting, which has been linked to decreases in populations of nocturnal insects such as the American burying beetle. Additionally, the potential for increased development and recreation increases the potential for habitat fragmentation and degradation. Habitat alterations often result in increases in disturbed and edge habitats, which favor beetle predators and carrion competitors.

While artificial lighting and habitat fragmentation can affect American burying beetle populations, adverse impacts generally result from ground disturbance. Potential direct impacts to these beetles during inactive and active periods may occur as a result of vegetation clearing, heavy equipment operation, fuel and chemical contamination of the soil, grading, soil excavation, and filling and reseeding of disturbed areas (FHWA 2009). Under Alternative 3, the probability of ground disturbance increases; therefore, American burying beetle populations within the study area would be more likely to suffer potential impacts.

In comparison to the No Action Alternative, under Alternative 3, additional shoreline within the proposed Carlton Landing site would be designated Limited Development. While the increase in Limited Development would allow for more dock construction, the scale and extent of the proposed Carlton Landing development would be similar to that described under the No Action Alternative. Therefore, potential impacts to local American burying beetle populations would likely be similar to those described under the No Action Alternative with direct adverse impacts associated with areas where current or potential future development is allowed.

The future condition of the aquatic invertebrate community under Alternative 3 would likely be similar to conditions described under the No Action Alternative. While a localized increase in water quality due to the implementation of baseline buffers is expected, this increase would likely be offset by increased sediment and nutrient inputs associated with increased levels of dock construction, recreation, impervious

surfaces, and development on adjacent lands. An Increase in suspended solids would likely inhibit plankton growth, and an increase in nutrients would likely result in algal blooms and significant zooplankton impairment.

In addition, the future condition under Alternative 3 would likely result in increased lake usage. Shoreline activities, including dock construction and recreational boating and swimming, would likely result in direct take of mussels and could impact water quality to the extent that even the most tolerant species would be adversely impacted. However, the levels of development proposed in these alternatives would unlikely degrade water quality of the entire Eufaula Lake study area to that point; although, localized extirpation would be possible in heavily developed areas.

In comparison to the No Action Alternative, the increase in lake usage under Alternative 3 would likely lead to an increased probability of initial Asian clam introduction and subsequent zebra mussel introductions from nearby infested waters. Once introduced, an increase in the number of boat docks under Alternative 3 would likely provide attachment points for adult zebra mussels and could contribute to range expansion throughout the study area.

7.2.5 Alternative 4

Alternative 4, which would increase shorelines designated both Limited Development and Public Recreation, would likely have similar impacts on the Arkansas River shiner as Alternative 3 but would increase the amount of recreational use substantially. Increased boat traffic and swimming in littoral zones could lead to substrate disturbance and the removal of aquatic vegetation. Therefore, Alternative 4 would likely decrease the quality of shiner habitat in areas of heavy development and high recreational activity, leading to a decrease in currently established populations.

The close proximity of a confirmed Arkansas River shiner observation to the Carlton Landing development proposal indicates that planned development at that site could potentially impact the Arkansas River shiner. While potential impacts to adjacent shiner population s under Alternatives 1, 2, and 3 would likely reflect the No Action Alternative, under Alternative 4, which would allow full build-out, the construction of boating facilities and other recreational uses could significantly transform the shoreline and impact adjacent shallow water habitats. Additionally, proposed channel dredging would likely alter currents and substrate.

The future condition of paddlefish and common fish species under Alternative 4 would likely be similar to the condition described under Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an expected increase in recreation and an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation.

Under Alternative 4, the future condition of game fish species would likely be similar to the condition described under Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due an expected increase in recreation and an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation. Also, the removal of standing dead timber to improve navigation for recreational activities would eliminate some of the underwater structure that makes Eufaula Lake a trophy crappie fishery. Under Alternative 4, the proposed Carlton Landing development would be allowed to remove dead timber, which could result in

additional removal requests. In areas in which underwater structure is removed, these actions would likely result in large reductions in populations of crappie and other game species.

Under Alternative 4, the potential for Asian carp establishment would likely be similar to that described under Alternative 3. However, in comparison to Alternative 3, the potential for introduction would likely be magnified and more widespread due to an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation. The reallocation would have the indirect effect of increasing recreation levels within the study area, therefore increasing the chances that Asian carp could be transported and released into Eufaula Lake.

In comparison to Alternative 3, Alternative 4 would likely result in an even greater increase in the amount of shoreline development due to an increase in length of shoreline allocated as Limited Development and a decrease in shoreline allocated as Protected. Therefore, Alternative 4 would likely result in an increase in shoreline habitat fragmentation as compared to Alternative 3 and would be much greater compared to the No Action Alternative. For terrestrial wildlife, a large increase in habitat fragmentation would likely sever travel corridors. Travel corridors are essential to maintaining connectivity between disparate populations; thereby, enabling gene flow and providing access to additional suitable habitat and food resources.

In comparison to Alternative 3, Alternative 4 converts even more Protected shoreline to Limited Development and increases the acreage of Public Recreation lands. A significant portion of this reallocation would take place at Carlton Landing, where fence lizards, eastern box turtles, and racers were observed. These reptiles, while adapted to edge habitats, would likely find little available suitable space if full build-out of proposed recreational facilities and parklands occurs. Increased recreational opportunities would lead to degraded shallow water habitats as this is where most recreational activity takes place and most semi-aquatic reptiles reside. Increased recreational activity would particularly affect the state imperiled alligator snapping turtle, as they require sandy beaches and sandbars often popular with recreationists for nesting habitat (Heck 1998). Finally, an increase in human population and lake access could result in increased reptile collection. Collection concerns contribute to the state imperiled designation of the Mississippi map turtle and collection is also a threat to eastern box turtles.

Under Alternative 4, the future condition of the amphibian community would likely be similar to that described under Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an expected increase in recreation and an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation. The increase in areas designated Public Recreation would only likely impact those amphibian populations located along the eight miles of converted shoreline. In these areas, especially within the proposed Carlton Landing development, shoreline conversion would likely eliminate most shallow water habitat in favor of deepwater channels, revetments, and swimming beaches. Throughout the rest of the study area, increased recreational activities can degrade shallow water habitats due to high volumes of human traffic. This is often visually evident from the piles of trash and debris that congregate in backwaters or in driftwood piles.

In comparison to Alternative 3, potential impacts to river otter and long-tailed weasel populations under Alternative 4 would likely be magnified and more widespread due to an increase in recreation and an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation. In contrast to the negative impacts of shoreline conversion on river otters, increased development could have a positive impact on long-tailed weasel populations as any loss of natural habitats

would be replaced by equally-preferred edge and slightly disturbed habitats. Low levels of human disturbance would also likely increase populations of small mammals, the favored prey of long-tailed weasels. While an increase in shoreline designated Limited Development could potentially assist weasel populations, the increase in shoreline designated as Public Recreation would likely lead to an increase in human-weasel interaction. As prolific raiders of chicken coops, weasels could be increasingly targeted during the trapping season (ODWC 2011f). The absence of a trapping limit on weasels could potentially have significant localized population impacts.

In comparison to Alternative 3, potential impacts of Alternative 4 would likely be magnified and more widespread due to an increased level of recreational activity and an increased number of shoreline areas being rezoned from Protected to Limited Development. Alternative 4 would likely see an increase in residential and community development, which would decrease the number of areas where deer hunting is allowed. In particular, the approval of the proposed Carlton Landing lease under Alternative 4 would permit community development activities on Roundtree Landing; an area known as one of the most popular deer hunting areas within the study area. Also, increased levels of development would likely increase road-building and vehicular traffic, resulting in additional vehicle collisions. Finally, the increased development and increased recreational opportunities of Alternative 4 are likely to increase the total number of deer hunters. While increased hunting pressure is unlikely to significantly reduce deer populations, it could impact age structure and reduce trophy potential, especially in heavily used public hunting and recreation areas.

Under Alternative 4, the likelihood of invasive mammal species introduction and establishment would be similar to that described under the No Action Alternative. However, the creation of large residential communities facilitated by the reallocation of shoreline to Limited Development and the increase in recreational opportunities could facilitate the spread of small, invasive rodent species. The potential for introduction and establishment of nutria in the study area would likely remain low under Alternative 4. Feral hog populations would likely remain stable at moderate densities with a continuing trend of slow, northward expansion.

Compared to Alternative 3, potential habitat and water quality impacts under Alternative 4 could be more pronounced due to higher levels of development and recreation. Therefore, the future condition of bald eagles and interior least terns under Alternative 4 would likely be characterized by habitat loss and population declines. Full build-out of the Carlton Landing proposed development would likely displace any eagles and terns that may frequent the area. While no eagle activity was observed during 2012 surveys, suitable habitat conditions exist, particularly on Roundtree Landing, and USACE staff report frequently observing eagle activity there. However, the lack of observed nests in the area makes it likely that displaced eagles would be migrants that would relocate to more suitable lake habitats. Along the northern shoreline of Roundtree Landing, and in other suitable tern habitats, increased development and recreational opportunities provided by Alternative 4 would likely result in increased lake usage and human disturbance, thereby, confining tern populations to existing protected areas.

Under Alternative 4, piping plovers and whooping cranes are not expected to utilize the Eufaula Lake study area, a condition similar to the future condition described under the No Action Alternative. Due to the unlikelihood of the piping plover being present within the study area and the scarcity and low quality of preferred plover habitat, it would be unlikely that activities associated with Alternative 4 would have an adverse impact on this species. Similarly, due to the absence of recorded whooping crane observations in

recent history and the absence of preferred habitat within the study area, it would be unlikely that activities associated with Alternative 4 would have an adverse impact on this species.

Although Alternative 4 designates more shoreline as Limited Development and increases shoreline designated Public Recreation as compared to Alternative 3, it would likely have similar potential impacts on all five bird species of conservation concern. The future condition of populations of the peregrine falcon, Sprague's pipit, and Bachmann's sparrow, would likely be similar to that described under the No Action Alternative. However, decreases in Bell's vireo and prothonotary warbler populations would likely be greater than those under Alternative 3 due to habitat degradation and other impacts associated with a likely increase in development on lands adjacent to the shoreline. Only the prothonotary warbler was observed within or adjacent to the proposed Carlton Landing development property. Therefore, activities associated with full build-out, including tree removal and increased human traffic, could impact local warbler populations.

The future condition of birds of prey and songbird populations under Alternative 4 would likely be similar to the future condition described under Alternative 3. However, compared to Alternative 3, potential impacts associated with development and public recreation would likely be magnified and more widespread due to an expected increase in recreation and an increased number of shoreline miles being reallocated from Protected to Limited Development. The increase in areas designated Public Recreation would likely impact only those populations located along the eight miles of converted shoreline, resulting in displacement of some local individuals to more suitable environments.

Under Alternative 4, especially under full build-out on the proposed Carlton Landing development, increased development of residential and recreational areas, and associated increased use of herbicide application, is likely to alter songbird composition. Herbicide application impacts songbird populations by selecting for species adapted to open parkland settings created by residential communities. On treated sites, species including the eastern bluebird, Bewick's wren, and indigo bunting replaced species that require dense forests such as the black-and-white warbler. Therefore, areas of intense residential development, such as that proposed at Carlton Landing, would result in the likely replacement of species adapted to dense forests or closed canopy systems with species at home in open park-like settings and maintained landscapes.

Compared to Alternative 3, under Alternative 4, potential impacts would likely be magnified and more widespread due to an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation. Most ground bird species do not tolerate high levels of human disturbance, and increased residential development often converts suitable habitat and decreases nesting success due direct ground nest destruction and predation by raccoons and domestic cats. Therefore, under Alternative 4, full build-out of the proposed Carlton Landing development would likely displace many ground birds from the area.

Compared to Alternative 3, Alternative 4 would likely result in magnified and more widespread impacts to woodpecker, crow, and swallow populations due to an expected increase in recreation and an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation.

The reallocation of shoreline would likely result in increased recreational lake usage from an increase in boat dock construction. It is this substantial increase in expected recreational activity that sets likely

impacts resulting from Alternative 4 apart from the other action alternatives. The increase in recreational activity on the lake would likely result in energy costs to waterfowl and waterbirds associated with fleeing response. It also increases the likelihood of disturbance to aquatic habitats, including nest sites. Areas of significant development and shoreline conversion, such as would be allowed under the full build-out at the proposed Carlton Landing development, would likely eliminate those areas as habitat for sensitive species. However, it could possibly benefit adaptable species by increasing forage opportunities and eliminating competition.

Another potential impact on waterfowl due to increased lake usage under Alternative 4is increased hunting pressure. Waterfowl hunting is extremely popular within the Eufaula Lake study area and an increase in the local human population as a result of increased development and recreational opportunities would likely increase the number of hunters. In addition, there would likely be fewer areas where hunting is allowed due to an increase in private development. Therefore, a greater number of hunters would be concentrated into fewer hunting areas. While hunting activity is closely regulated and is not expected to reach high enough levels to cause a significant decline in waterfowl populations, it could potentially compound the impact to localized populations of species already stressed by habitat reduction.

Compared to Alternative 3, potential impacts of Alternative 4 on American burying beetle populations would likely be magnified and more widespread due to increased land disturbance associated with an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation.

Alternative 4 would allow for the reallocation of shoreline located at the proposed Carlton Landing development, which would enable full build-out including the development of approximately 2,570 homes and associated community facilities. Full-build out would likely result in the development of approximately 1,650 acres of confirmed American burying beetle habitat. This level of land disturbance, especially if conducted during the underground, inactive period in the lifecycle of the species, would likely result in direct beetle mortality and the destruction of suitable beetle habitat. Planned recreation activities along the lake shoreline would also likely result in adverse impacts to beetle populations as protected buffers in these areas would not be required. Increased recreational activity would also likely drive potential carrion species from the area, depriving American burying beetles of necessary food and reproductive sources.

Compared to Alternative 3, potential impacts of Alternative 4 on aquatic invertebrate populations and communities would likely be magnified and more widespread due to an expected increase in recreation and an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation. These potential impacts would be magnified at the Carlton Landing location, as planned shoreline disturbances and landscaping activities within the enclosed inlet known locally as Ski Cove would likely provide the nutrient and environmental conditions conducive to algal population explosions.

Concerning the invasive zebra mussel and Asian clam, the future condition under Alternative 4 would likely result in a probability of introduction, ease of establishment, and extent of expansion similar to that described for Alternative 3. However, in comparison to Alternative 3, potential impacts would likely be magnified and more widespread due to an expected increase in recreation and an increased number of shoreline miles being reallocated from Protected to Limited Development and Public Recreation. The allowance of additional boat dock construction would likely result in a faster and more complete expansion of the zebra mussel's range within the Eufaula Lake study area.

Chapter 8
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Chapter 9
Glossary

Anoxic: The total deprivation of oxygen.

Anthropogenic: Caused or produced by humans.

Anuran: Any amphibian of the order Anura, comprising the frogs and toads.

Benthic: The bottom surface of an aquatic environment.

Canopy: The uppermost layer of vegetation in a terrestrial biome.

Colloidal Clay Soils: Finely divided clay of montmorillonite, kaolinite, or illite class; prepared for foundry purposes as in sand bonding.

Cuesta: A long, low ridge with a relatively steep face or escarpment on one side and a long, gentle slope on the other.

Disjunct Population: A completely separate and removed population of individuals in a species.

East-West Zonation of Vegetation: The strong east-west zonation of vegetation and climate in Oklahoma significantly influences the distribution of fauna, including reptiles, mammals, and insects. The western boundary of deciduous forest limits the westward extension of many eastern species. Southern Rocky Mountain fauna species intergrade with Great Plains species on Black Mesa in the western Panhandle. Great Plains fauna are found in intervening districts.

Ecoregion: An area defined by its environmental conditions, especially climate, landforms, and soil characteristics.

Ecosystem: All the organisms in a given area as well as the abiotic factors with which they interact; a community and its physical environment.

Ecotone: The transition from one type of habitat or ecosystem to another, such as the transition from a forest to grassland.

Ectotherm: An animal, such as a reptile (other than birds), fish, or amphibian that must use environmental energy and behavioral adaptations to regulate its body temperature.

Emergent Wetland: The Emergent Wetland Class is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. This vegetation is present for most of the growing season in most years. These wetlands are usually dominated by perennial plants. All water regimes are included except subtidal and irregularly exposed.

Endemic: Referring to a species that is confined to a specific, relatively small geographic area.

Fauna: The animal community characteristic of a region, period, or special environment.

Fecundity: The potential reproductive capacity of an organism, measured by the number of gametes produced.

Fetch: The distance along open water or land over which the wind blows; the distance traversed by waves without obstruction.

Forage Species: A species that provides a primary food source for higher-order species. This term is usually in reference to minnows and other small fish that serve as primary prey for popular game species.

Forb: Vascular plant without significant woody tissue above or at the ground. Forbs and herbs may be annual, biennial, or perennial but always lack significant thickening by secondary woody growth and have perennating buds borne at or below the ground surface. Graminoids are excluded but ferns, horsetails, lycopods, and whisk-ferns are included.

Hard Mast: Acorns, nuts and other "hard" fruits produced by a tree or scrub. They are eaten by animals and insects (and sometimes man).

Herbaceous: Referring to non-woody plants.

Karst: An irregular limestone region with sinkholes, underground streams, and caverns.

Lacustrine: Of, or relating to, a lake including associated wetlands and deepwater habitats.

Landscape Sink: Often referring to wetlands, it is a landscape feature that accumulates debris, sediments, water, and nutrients from the surrounding environment.

Laydown Timber: Large, woody debris such as the trunks of fallen trees.

Lentic System: A non-flowing or standing body of fresh water, such as a lake or pond.

Limnetic: All deepwater habitats within the Lacustrine System; many small Lacustrine Systems have no Limnetic Subsystem.

Littoral: Shallow water zone of aquatic systems. Extends from the shoreward boundary of the system to a depth of 2 m (6.6 feet) below low water or to the maximum extent of non-persistent emergents, if these grow at a depth greater than 2 m.

Loam: A mixture of sand, silt and clay particles. Loam contains between 7 and 26% clay, between 28 and 41% silt and between 24 and 52% sand.

Lotic System: A flowing body of fresh water, such as a river or stream.

Non-matrix Habitat: Landscape cover that differs from the dominant, surrounding habitat type known as the matrix. Often referred to as habitat patches or islands.

Noodling: Fishing for catfish using only bare hands. The fisherman places his hand inside a likely catfish hole, usually within the bank or underwater structure, and pulls the catfish out when it bites down.

Palustrine: Of, or relating to, a marsh including shallow, non-tidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses or lichens.

Passage Migrant: Refers to a bird that occurs in an area for short durations between its migration origin and destination.

Passerine: Of or relating to the largest order (Passeriformes) of birds, which includes over half of all living birds and consists chiefly of altricial songbirds of perching habits.

Pelagic: The area of the ocean past the continental shelf, with areas of open water often reaching to very great depths.

Physiography: Physical geography. The branch of natural science that deals with the study of processes and patterns in the natural environment like the atmosphere, biosphere, and geosphere. Subfields include hydrology, geomorphology, climatology, biogeography, and landscape ecology.

Playa: The flat-floored bottom of an undrained desert basin that becomes at times a shallow lake.

Prairie Pothole: Prairie potholes are depressional wetlands found most often in the Upper Midwest. These depressions were often formed during glacial retreat and fill with snowmelt and rain in the spring. Some prairie pothole marshes are temporary, while others may be essentially permanent. Submerged and floating aquatic plants exist in deeper water while bulrushes and cattails thrive closer to shore.

Scarp: A steep slope or long cliff that occurs from erosion or faulting and separates two relatively level areas of differing elevations.

Scouring Flow: Flow consisting of swiftly moving water that removes sediment. Scouring flows are a major cause of stream bank and shoreline erosion.

Sub-canopy: The plant stratum composed of all woody plants and palms, exclusive of the canopy, with a trunk or main stem with a DBH between one and four inches, except vines.

Tailwaters: Water below a dam.

Take (as defined in the ESA): The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect a listed species, or to attempt to engage in any such conduct.

Thermal Refuge: A structure or habitat condition such as a den or deep water in which the temperature is higher than the surrounding ambient air temperature. Thermal refuges are extremely important to ectotherms such as fish, reptiles, and amphibians during cold winter periods.

Thermocline: A narrow stratum of rapid temperature change in the ocean and in many temperate-zone lakes.

Transect: A sample area usually in the form of a long continuous strip.

Understory: An underlying layer of vegetation; specifically: the vegetation layer and especially the trees and shrubs between the forest canopy and the ground cover.

Vernal: Of, relating to, or occurring in the spring.

Wetland: Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation

typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.