Rathbun Lake Aquatic Ecosystem Restoration
Section 1135
Appanoose County, Iowa

Draft Integrated Feasibility Report/Environmental Assessment
U.S. Army Corps of Engineers, Kansas City District
June 2021

This report presents the findings of a feasibility report and environmental assessment conducted under the Continuing Authorities Program, Section 1135 Authority. Section 1135 of the Water Resources Development Act of 1986, as amended, provides the Corps of Engineers the authority to restore a degraded ecosystem through modifications to Corps structures, operations or implementation of measures in affected areas.

The feasibility report and environmental assessment conducted for this study are integrated into a single decision document that fulfills the requirements of the National Environmental Policy Act (NEPA) of 1969, as amended.

DEPARTMENT OF THE ARMY
KANSAS CITY DISTRICT, CORPS OF ENGINEERS
600 FEDERAL BUILDING
KANSAS CITY, MISSOURI 64106-2896

Finding of No Significant Impact

Section 1135 Rathbun Lake Fisheries Emigration Aquatic Ecosystem Restoration Project Appanoose County, Iowa June 2021

The U.S. Army Corps of Engineers Kansas City District (Corps), has conducted an environmental analysis in accordance with the National Environmental Policy Act of 1969, as amended. The final Integrated Feasibility Report and Environmental Assessment (IFR/EA) in cooperation with the project sponsor, Iowa Department of Natural Resources (IDNR), propose the Rathbun Lake Aquatic Ecosystem Restoration Project under the authority of Section 1135 of the Water Resources Development Act of 1986, as amended. The IFR/EA dated June 2021, for the Rathbun Lake Aquatic Ecosystem Restoration Project addresses degraded fish spawning and nursery habitat and the downstream emigration of native fish species, opportunities and feasibility in Rathbun Lake, Appanoose County, Iowa.

The final IFR/EA, incorporated herein by reference, evaluated various alternatives that would restore, protect, and sustain the Rathbun Lake fisheries in the study area. The Recommended Plan is the National Ecosystem Restoration (NER) Plan and includes:

- Grading and sloping eroded banks, the placement of rock to stabilize restored areas, vegetation at top of bank to prevent erosion, the use of rock extensions to direct silt movement and the placement of a floating electric boom barrier at the lake intake tower to prevent downstream fish emigration.

Monitoring and adaptive management is addressed in section 9.3. Monitoring would be conducted by the IDNR during routine annual fish sampling and associated activities. The need for and type of adaptive management measures will depend on fish sampling results.

Potential aquatic habitat restoration measures to restore embayments were formulated that would stabilize the shoreline from wave and wind action and fluctuating water level, direct silt movement and achieve the project objective of restoring fish spawning and nursery habitat. Trophic balance measures to prevent the downstream emigration of native fish for holistic ecosystem restoration included the assessment of a variety of deterrence barriers. Proposed embayment restoration measures include:

- Grading and sloping eroded banks
- Bank armoring with rock
- Rock extensions
- Geotextile erosion control
- Vegetation establishment at top of bank

Proposed trophic balance restoration measures include:

- Intake gate screens
- Netting
- Bioacoustic Sound/Air Curtain (Bubbler)/Strobe Light Barrier
- Electrical Barrier
- Carbon Dioxide Injection

In addition to a "No Action" Best Buy plan, cost effective analysis identified which action alternatives were cost effective and which were "Best Buy" action plans. The Institute of Water Resources Planning Suite generated 2,500 total plans, of which eight were "best buy" plans, including the No Action plan, and 56 were "cost effective", including the No Action plan. Restoration alternatives brought forth from this analysis included combinations of shoreline rock placement, rock placed for silt direction, vegetation established at the top of bank and the installation of a floating electric boom barrier at the lake intake tower. All action alternatives that include shoreline rock placement would also include some grading and sloping prior to rock placement.

For all alternatives, the potential effects were evaluated, as appropriate. A summary assessment of the potential effects of the Recommended Plan are listed in Table 1.

Table 1. Summary of Potential Effects of the Recommended Plan

	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Aesthetics	☒	☐	☐
Air quality	☒	☐	☐
Aquatic resources/wetlands	☐	☐	☒
Invasive Species	☐	☐	☒
Fish and wildlife habitat	☒	☐	☐
Threatened/Endangered species/critical habitat	☒	☐	☐
Historic properties	☐	☐	☒
Other cultural resources	☐	☐	☒
Floodplains	☐	☐	☒
Hazardous, toxic & radioactive waste	☐	☐	☒
Hydrology	☐	☐	☒
Land use	☐	☐	☒
Navigation	☐	☐	☒
Noise levels	☒	☐	☐

	Insignificant effects	Insignificant effects as a result of mitigation*	Resource unaffected by action
Public infrastructure	☐	☐	☒
Socio-economics	☒	☐	☐
Environmental justice	☐	☐	☒
Soils	☒	☐	☐
Tribal trust resources	☐	☐	☒
Water Quality	☒	☐	☐
Climate change	☐	☐	☒
Geology	☐	☐	☒
Riparian Vegetation	☒	☐	☐
Recreation	☒	☐	☐
Safety	☐	☐	☒

All practicable and appropriate means to avoid or minimize adverse environmental effects were analyzed and incorporated into the Recommended Plan. Best management practices (BMPs) as discussed in Section 8.0 of the IFR/EA will be implemented, if appropriate, to minimize impacts. BMPs to prevent potential water quality impacts include the placement of straw bales, trenching of silt fencing and any other appropriate BMPs to be put into place prior to construction to prevent soil from entering the lake during earthwork activities. Additionally, previous restorations at the lake were conducted in the winter timeframe along a frozen shoreline, which helps to contain excavated soils and prevent windborne soil particles. Similarly, the current restoration would be scheduled within the winter timeframe.

No compensatory mitigation is required as part of the Recommended Plan. Public and agency review of the draft IFR/EA and FONSI will be completed on June 30, 2021. All comments submitted during the public and agency review period were responded to in the final IFR/EA and FONSI.

Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined that the Recommended Plan is not likely to adversely affect the northern long-eared bat and the Indiana bat two federally listed species and will have no effect on prairie bush clover and the western prairie fringed orchid as the habitat of these species is not located within or adjacent to the project area. The U.S. Fish and Wildlife Service concurred with the Corps' determination on June 13, 2019.

Pursuant to section 106 of the National Historic Preservation Act of 1966, as amended, the U.S. Army Corps of Engineers determined that the Recommended Plan has no potential to cause adverse effects on historic properties. The Iowa State Historic Preservation Officer concurred with the determination on January 15, 2019.

Pursuant to the Clean Water Act of 1972, as amended, the discharge of dredged or fill material associated with the Recommended Plan has been found to be compliant with section 404(b)(1) Guidelines (40 CFR 230).

The project will be conducted under Nationwide Permit 27, which provides for aquatic habitat restoration, enhancement and establishment activities. In accordance with Section 401 of the Clean Water Act, the Iowa Department of Natural Resources has issued Section 401 Water Quality Certification for a variety of NWPs, including NWP 27. The project will comply with NWP 27 general permit conditions and State of Iowa regional permit conditions.

All applicable environmental laws have been considered and coordination with appropriate agencies and officials has been completed.

Technical, environmental, and cost effectiveness criteria used in the formulation of alternative plans were those specified in the Water Resources Council's 1983 Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies. All applicable laws, executive orders, regulations, and local government plans were considered in evaluation of alternatives. Based on this report, the reviews by other Federal, State and local agencies, Tribes, input of the public, and the review by my staff, it is my determination that the Recommended Plan would not cause significant adverse effects on the quality of the human environment; therefore, preparation of an Environmental Impact Statement is not required.

Date	Travis J. Rayfield Colonel, Corps of Engineers District Commander

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ACRONYMS

AAHU	Average annual habitat unit
BMPs	Best Management Practices
CE	cost-effectiveness
CEQ	Council on Environmental Quality
CY	Cubic yards
E.O.	Executive Order
FPPA	Farmland Protection Policy Act
Ft	Feet
FWOP	Future without project
FWP	Future with project
HEP	Habitat Evaluation Procedures
HSI	Habitat suitability index
HTRW	Hazardous, toxic, and radioactive waste
HU	Habitat units
ICA	Incremental cost analysis
IDNR	Iowa Department of Natural Resources
INAI	Iowa Natural Areas Inventory
LERRD	Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NFS	Non-federal Sponsor
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
NWP	Nationwide Permit
O&M	Operation and maintenance
OMRR&R	Operation and Maintenance, Repair, Replacement, and Rehabilitation
OSA	Office of State Archaeologist
PPA	Project Partnership Agreement
REP	Real Estate Plan
SHPO	State Historic Preservation Office
SWPPP	Stormwater pollution prevention plan
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
WHAG	Wildlife Habitat Appraisal Guides
WRDA	Water Resources Development Act

1.0 INTRODUCTION

This Integrated Feasibility Report and Environmental Assessment presents alternatives development, analyses, and recommendations for the Rathbun Lake Aquatic Ecosystem Restoration project located in Appanoose County, Missouri. The purpose of this feasibility report is to examine the problems contributing to ecosystem degradation, use opportunities to develop alternative restoration solutions and evaluate alternatives for habitat benefits and cost-effectiveness. Supporting information is provided in the appendices. This document was prepared in accordance with National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) regulations as reflected in the Corps of Engineers' Engineering Regulation, ER 200-2-2.

1.1 Study Authority

This study is authorized under Section 1135 of the Water Resources Development Act of 1986 (WRDA), as amended. Section 1135 provides for the restoration of a degraded ecosystem through modification to Corps structures, operation or implementation of measures in affected areas when it is determined that such modifications are feasible, consistent with the authorized project purposes, and will improve the quality of the environment in the public interest. The project non-Federal Sponsor (NFS) is the Iowa Department of Natural Resources (IDNR).

1.2 Purpose and Need

The project purpose is to restore degraded habitat and to minimize the downstream emigration of native fish species including apex predators. Rathbun Lake was constructed in 1970 for the purposes of flood control, water supply, water quality, recreation, navigation, and fish and wildlife management. The 11,000-acre lake is located in an area of dissected glacial materials including loess, till and alluvium, and is therefore subject to degradation from erosion and flooding. Erosion and sedimentation have resulted in adverse impacts to aquatic habitats including fish spawning and nursery habitat.

Loss of juvenile and adult fishes including predators through dam emigration are well documented within scientific literature. Fish emigration from Rathbun Lake was documented as a problem in the 1990s during operations under the 1980 water control manual (WCM), which limited releases to seasonal outflows. The IDNR placed screens in front of the Rathbun Lake intake tower gates to prevent fish kills that resulted from fish emigration downstream into the Chariton River during winter months (USACE 2016a). Although these screens were useful as physical barriers during low flow conditions, moderate and high flows resulted in fish impingement on screens and significant mortality. The screens were subsequently removed and never reinstalled.

As a result of fish emigration, tailrace fish sampling and capture/recapture has been conducted regularly by the IDNR since 1996 and these activities have resulted in the collection of a variety of fish species and a high number of predators such as white bass, hybrid striped bass, walleye and largemouth bass that keep the predator/prey relationship of the lake ecosystem balanced. In response to the high numbers of fish emigrating, the IDNR increased stocking rates of white bass, hybrid striped bass and walleye and continue to capture/recapture fish and relocate them to areas of the lake away from the outlet to prevent emigration.

Recent revisions to the 1980 WCM provide for increased flexibility and allowable increased releases over and above previous release rates. The synergistic impacts of long-term habitat degradation and the loss of fish from downstream emigration has resulted in predator/prey trophic ecosystem imbalance from a loss of fish including top predators. Therefore, the project purpose is twofold: 1) Restore and prevent the continued sedimentation of degraded fish spawning and nursery habitat and 2) Decrease downstream fish emigration. Detailed information is provided in Section 3.1 Future Without Project Conditions.

1.3 Location and Description of the Project Area

Rathbun Lake is located near the confluence of the Chariton and South Fork Chariton Rivers in south-central Iowa, just north of the Iowa-Missouri border (Figures 1-1 and 1-2). During normal operation, water leaves the lake via a concrete intake tower, passes through the dam in a concrete pipe, and discharges to a stilling basin to dissipate energy before re-entering the Chariton River. The surface area at normal pool (mean sea elevation of 904 feet) is approximately 11,000 acres, which nearly doubles to 21,000 acres at peak flood storage (mean sea elevation of 926 feet).

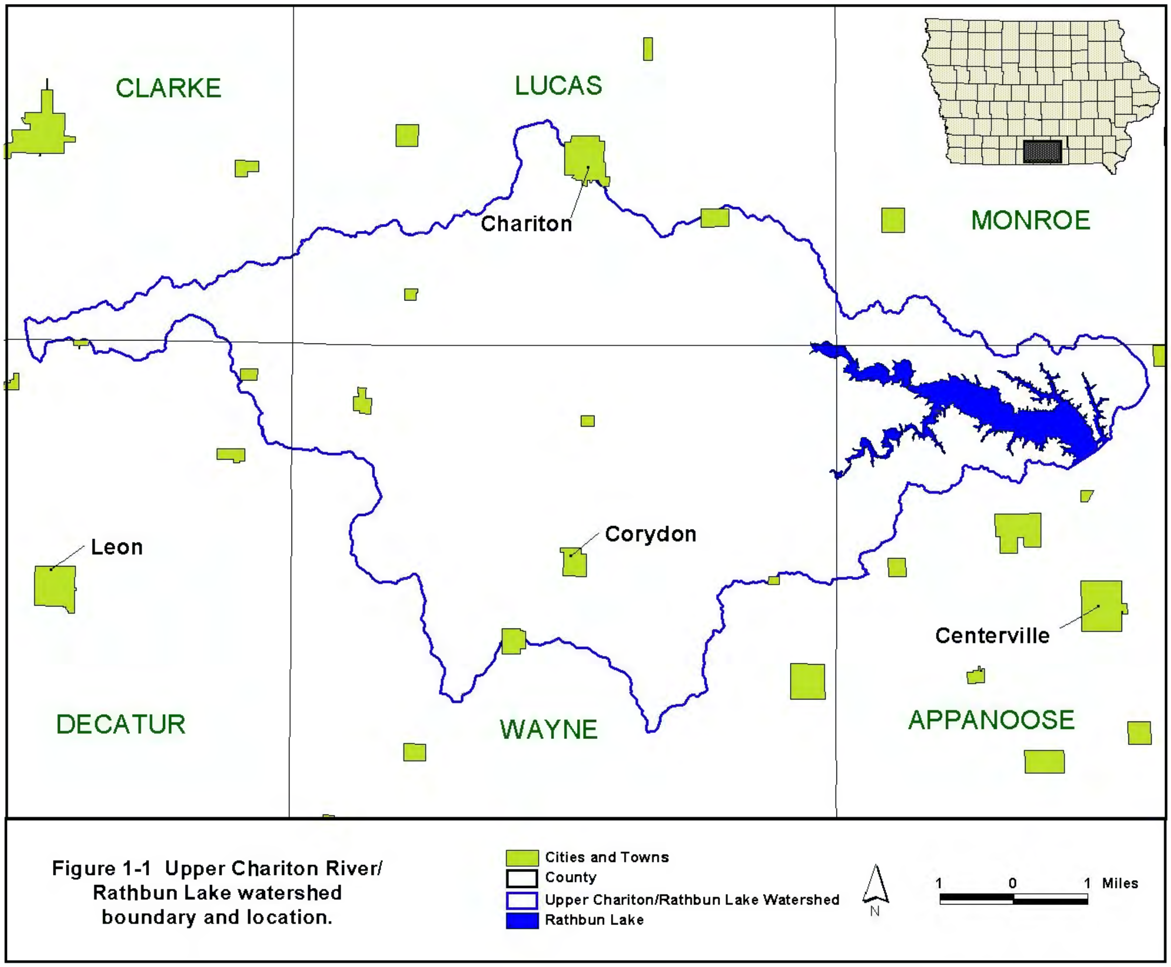


Figure 1-1. Project Area Vicinity

Figure 1-2. Project Area Location

1.4 Prior Studies and Reports

The Rathbun Lake South Fork Wetlands Section 1135 Ecosystem Restoration Project is located on the South Fork Chariton River within the upper portion of the flood control pool of Rathbun Lake. The restoration project consisted of approximately 210 acres of seasonal wetland during the spring/summer, 125 acres of emergent wetland, and 75 acres of oxbow/riparian habitat. This restoration project comprised a total of 410 acres of habitat for migrating waterfowl, shorebirds, and other wildlife associated with wetlands. The project also links up existing IDNR wetlands with the Rathbun Lake shoreline, thereby restoring a valuable contiguous corridor of wildlife habitat with features ranging from deep water to historic oxbow escarpments and riverine channels, and associated floodplain habitats including seasonal and emergent wetlands.

The Section 1135 Rathbun Lake Shoreline Aquatic Ecosystem Restoration Project investigated alternatives to prevent the sedimentation of littoral spawning and nursery habitat in Rathbun Lake. Ecosystem restoration was conducted 2007-2013 in numerous locations along the Rathbun Lake shoreline. Restoration measures included grading and sloping eroded areas, quarry run rock placement including rock extensions and native vegetation plantings to prevent erosion.

Rathbun Lake Water Control Manual Revision - The 1980 Water Control Manual limited seasonal flows to 1,500 CFS from December - March, 800 CFS for the period of April - June and September - November, and 1,200 CFS for the July-August period. WCM revisions approved in July 2016 eliminated seasonal constraints on water releases and maximum discharge rates were significantly increased. These changes resulted in allowable increased release rates of 1,500, 2,200 and 3,000 CFS throughout the year depending on pool elevation. Release rates were increased to allow downstream inundation to wetlands that were formerly in agriculture. Additionally, a fall pulse up to 2,700 CFS is permitted annually in coordination with stakeholders.

Section 22 Planning Assistance to States (PAS) Studies - Due to concerns over the high rate of fish emigration from the lake, the USACE and IDNR partnered on two projects under the Section 22 authority in 2012 and 2013 to assess current options for limiting emigration from Rathbun Lake instead of using screens. Walleye was used as a surrogate species as they are an apex predator known to emigrate from the lake in high numbers and they are available from the Rathbun Fish Hatchery. Results from these studies showed a behavioral barrier system (bioacoustic sound, bubble curtain and strobe lights) reduced walleye escapement rates by approximately 50% from treatment ponds (Flammang et al. 2014), and an electric barrier reduced escapement rates by up to 80% (Weber et al. 2016).

2.0 EXISTING CONDITIONS/AFFECTED ENVIRONMENT

The existing conditions and future without project (FWOP) conditions analysis was performed to assess the existing biological, physical, social and economic conditions of an area subject to change as a result of proposed human action. This information provides baselines for evaluating ecosystem restoration alternatives and associated impacts.

2.1 Climate

The climate of the Chariton River basin is considered temperate continental, which is marked by cold winters and hot summers with wide variations in temperature and precipitation. Rainfall is usually of short duration and high intensity over small areas or of light to moderate intensity for longer durations over large areas. Average annual precipitation varies from about 32 to 36 inches from north to south and at Chariton, Iowa, the maximum annual precipitation recorded was 55.9 inches in 1902 and the minimum was 13.8 inches in 1910 (USACE, 1980). About 170 days per year have a trace or more of rain; 105 have at least 0.01 inch; 62 have 0.10 or more; and 25 have half an inch or more (USDA, 1977).

About 70% of the annual rainfall occurs during the six-month growing season, April through September, and the average annual snowfall of about 25 inches generally occurs from November through March (USACE, 1980). Average high summer temperatures are in the mid-80s for July and August and average low temperatures in January and February are between 10 to 15 degrees

Fahrenheit (deg F). A record high of 106 deg F was recorded in 1956 and the record low temperature of -38 deg F was set in 1996. The average length of the frost-free growing season is approximately 167 days (USDA, 1977).

USACE climate change guidance and most climate change references for the Midwest agree that future climate trends likely include increased temperatures and precipitation (Appendix A). USACE climate tools and some other sources point towards increased streamflow trends as well. The increased temperatures are likely to result in earlier spring snowmelt, decreased snowmelt season duration, and decreased peak snow-water equivalent. Increased air temperatures could also have impacts on water temperatures and water quality. Rainfall events are likely to become even more sporadic and large rain events are likely to become more frequent and interspersed by longer relatively dry periods. Extremes in climate will also magnify periods of wet or dry weather resulting in longer, more severe droughts and increased extensive flooding.

2.2 Land Use

Row crop production is one of the principal land uses in the Upper Chariton River/Rathbun Lake Watershed, with corn and soybeans the most commonly grown crops (Table 2-1). Pasture and hayland comprise over one third of the land use and consist primarily of cool season grasses. Woodland in the watershed includes upland and bottomland species and consists of oak, hickory, eastern cottonwood, silver maple and additional species.

Table 2-1. Land Use in the Upper Chariton River/Rathbun Lake Watershed

	Cropland	Cropland in the Conservation Reserve Program	Pasture & Hayland	Woodland	Other (Urban, Water Road, Etc.)
Percent of Watershed	30	12	38	13	7
Acres	106,910	40,985	135,685	44,183	26,297
Source: Rathbun Land and Water Alliance, 2018.					

2.3 Geology, Soils, and Prime Farmland

Rathbun Lake is located in the Southern Iowa Drift Plain, which is characterized by loess. Deep loess deposits overlay bedrock characterized by Pennsylvanian limestone and shale. All of the soils mapped within the project areas are typically formed on loess in uplands and are classified as erodible or highly erodible by the Natural Resources Conservation Service (NRCS). The Farmland Protection Policy Act (FPPA), 7 USC 4201 et seq., and USDA's implementing procedures (7 CFR § 658) require federal agencies to evaluate the adverse effects of their actions on prime and unique farmland, including farmland of statewide and local importance. None of the soils within the areas proposed for shoreline restoration are mapped as prime or unique farmland by the NRCS. All proposed shoreline restoration locations are located within the flood control pool of Rathbun Lake.

2.4 Wetlands

The purpose of Executive Order (E.O.) 11990 is to "*minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands*". To meet these objectives, the E.O. requires federal agencies to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. Most of the wetlands that once occurred along the floodplain of the Chariton River no longer exist due to the alteration of watershed hydrology by land use practices and stream channel alteration. The Chariton River arm in the northwestern section of Rathbun Lake contains several wetlands that are managed to provide diverse wildlife benefits. These include Hickory Hollow Marsh, Goodwater Marsh, Brown's Slough, and a waterfowl management area. The South Fork arm of Rathbun Lake contains Coffey Marsh, Woodpecker Marsh, and the Rathbun/South Fork Section 1135 restored wetlands.

Wetlands adjacent to Rathbun Lake are generally limited to areas of lower elevation, primarily within drainages and tributaries. A fluctuating pool and winter ice shear causes the mortality of vegetation around the lake with the exception of established oak-hickory that grows at higher elevations. No wetlands were observed within or adjacent to the areas of proposed restoration during shoreline restoration assessments conducted as recently as April 4, 2019. Restoration areas will be assessed for the presence of wetlands prior to construction.

2.5 Riparian Vegetation

Similar to wetlands, riparian vegetation is generally limited to areas of lower elevation, primarily within drainages and tributaries, and landward of some shallow coves due to a fluctuating pool and winter ice shear that cause vegetation mortality around the lake.

2.6 Water Quality

According to the IDNR, Rathbun Lake has four impaired segments on the 2016 303(d) list (IDNR 2016). The impaired uses include primary contact recreation and / or support of aquatic life. The cause of impairment is poor water transparency due to excess sediment and turbidity. Past assessments indicated that algal blooms have also impaired water clarity, but no algal impairments are included in the most recent assessments. Downstream releases from Rathbun Lake aid in maintaining the water quality of the Chariton River downstream.

2.7 Fish and Wildlife

2.7.1 Fish
Rathbun Lake has a typical fish population for the region, including game and nongame species. Fish population sampling is conducted by IDNR within Rathbun Lake using electrofishing gear and Fyke nets. Dominant species generally counted during electrofishing include gizzard shad, white crappie, white bass, carp (*Cyprinus carpio*), and bluegill (*Lepomis macrochirus*). Fyke netting typically results in white crappie, channel catfish (*Ictalurus punctatus*), river carpsucker (*Carpiodes carpio*), black crappie, carp and bluegill. Fall gill netting is conducted to assess walleye and white bass. Fish sampling within the tailrace indicates significant emigration of white bass, hybrid striped bass, walleye, largemouth bass, black and white crappie, gizzard shad, carp, and bluegill.

2.7.2 Wildlife
The land directly adjacent to Rathbun Lake is primarily comprised of oak-hickory forest and includes common wildlife species known to occur in the region such as white-tailed deer (*Odocoileus virginianus*), wild turkey, red and gray fox (*Vulpes vulpes* & *Urocyon cinereoargenteus*), coyote (*Canis latrans*), bobcat (*Lynx rufus*), raccoon (*Procyon lotor*), beaver (*Castor canadensis*), mink (*Mustela vison*), opossum (*Didelphis virginiana*), fox and gray squirrels (*Sciurus niger* & and *Sciurus carolinensis*), eastern cottontail rabbit (*Sylvilagus floridanus*), eastern chipmunk (*Tamias striatus*), striped and eastern spotted skunks (*Mephitis mephitis* & *Spilogale putorius*), long-tailed weasel (*Mustela frenata*) and numerous bat and small rodent species. Over 250 bird species occur at Rathbun Lake including species known to inhabit lakes [mallard (*Anas platyrhynchos*), belted kingfisher (*Megaceryle alcyon*)], oak-hickory forests [eastern wood pewee (*Contopus virens*), great crested flycatcher (*Myiarchus crinitus*)] and migratory birds with various habitat needs. Amphibians and reptiles include northern water snake (*Nerodia sipedon*), American toad (*Bufo americanus*), painted turtle (*Chrysemys picta*), eastern tiger salamander (*Ambystoma tigrinum*) and others.

2.8 Threatened and Endangered Species

2.8.1 Federal Listed Species
The United States Fish and Wildlife Service (USFWS) information for planning and consultation (IPaC) was queried May 13, 2019 for federal listed threatened and endangered species that may occur within the proposed project area (Appendix B). According to the IPaC, the Indiana bat (*Myotis sodalis*), Northern long-eared bat (*Myotis septentrionalis*), prairie bush clover (*Lespedeza leptostachya*) and western prairie fringed orchid (*Plantanthera praeclara*) occur within Appanoose County (Table 2-2).

The Indiana bat and Northern long-eared bat roost underneath bark, in cavities or in crevices of both live and dead trees in summer and hibernate in winter in caves or mines in areas of constant temperatures, high humidity and with no air currents. Prairie bush clover and the western prairie fringed orchid primarily occur in tallgrass prairies and mesic to wet unplowed tallgrass prairies and meadows, respectively.

2.8.2 State Listed Species

The Iowa Natural Areas Inventory queried May 13, 2019 indicated 44 state listed species located within Appanoose County (Table 2-2).

Table 2-2. Threatened and Endangered Species

Summary by Species Report S=Special Concern T=Threatened E=Endangered

Total Unique Listed Species In This County: 48

Common Name	Scientific Name	Class	State Status	Federal Status
Crawfish Frog	*Rana areolata*	AMPHIBIANS	E	
Bald Eagle	*Haliaeetus leucocephalus*	BIRDS	S	
Barn Owl	*Tyto alba*	BIRDS	E	
Henslow's Sparrow	*Ammodramus henslowii*	BIRDS	T	
King Rail	*Rallus elegans*	BIRDS	E	
Northern Harrier	*Circus cyaneus*	BIRDS	E	
Red-shouldered Hawk	*Buteo lineatus*	BIRDS	E	
Chestnut Lamprey	*Ichthyomyzon castaneus*	FISH	T	
Creek Heelsplitter	*Lasmigona compressa*	FRESHWATER MUSSELS	T	
Pistolgrip	*Tritogonia verrucosa*	FRESHWATER MUSSELS	E	
Byssus Skipper	*Problema byssus*	INSECTS	T	
Edwards' Hairstreak	*Satyrium edwardsii*	INSECTS	S	
Hickory Hairstreak	*Satyrium caryaevorum*	INSECTS	S	
Striped Hairstreak	*Satyrium liparops*	INSECTS	S	
Wild Indigo Dusky Wing	*Erynnis baptisiae*	INSECTS	S	
Zabulon Skipper	*Poanes zabulon*	INSECTS	S	
Indiana Bat	*Myotis sodalis*	MAMMALS	E	E
Least Shrew	*Cryptotis parva*	MAMMALS	T	
Northern Long-eared Bat	*Myotis septentrionalis*	MAMMALS		T
Southern Bog Lemming	*Synaptomys cooperi*	MAMMALS	T	
Downy Woodmint	*Blephilia ciliata*	PLANTS (DICOTS)	T	
Earleaf Foxglove	*Tomanthera auriculata*	PLANTS (DICOTS)	S	
Frost Grape	*Vitis vulpina*	PLANTS (DICOTS)	S	
Golden Corydalis	*Corydalis aurea*	PLANTS (DICOTS)	T	
Hortulan Plum	*Prunus hortulana*	PLANTS (DICOTS)	S	
Lance-leaf Ragweed	*Ambrosia bidentata*	PLANTS (DICOTS)	S	
Pinesap	*Monotropa hypopithys*	PLANTS (DICOTS)	T	
Prairie Bush Clover	*Lespedeza leptostachya*	PLANTS (DICOTS)		T
Purple Coneflower	*Echinacea purpurea*	PLANTS (DICOTS)	S	
Ragwort	*Senecio pseudaureus*	PLANTS (DICOTS)	S	
Rough Buttonweed	*Diodia teres*	PLANTS (DICOTS)	S	
Spring Avens	*Geum vernum*	PLANTS (DICOTS)	S	
St. John's Wort	*Hypericum canadense*	PLANTS (DICOTS)	S	
Western Prairie Fringed Orchid	*Platanthera praeclara*	PLANTS (DICOTS)		T
Winged Monkey Flower	*Mimulus alatus*	PLANTS (DICOTS)	T	
Broom Sedge	*Andropogon virginicus*	PLANTS (MONOCOTS)	S	
Bush's Sedge	*Carex bushii*	PLANTS (MONOCOTS)	S	
False Hellebore	*Veratrum woodii*	PLANTS (MONOCOTS)	T	
Foxtail	*Setaria geniculata*	PLANTS (MONOCOTS)	S	
Glomerate Sedge	*Carex aggregata*	PLANTS (MONOCOTS)	S	
Grass Pink	*Calopogon oklahomensis*	PLANTS (MONOCOTS)	S	
Great Plains Ladies'-tresses	*Spiranthes magnicamporum*	PLANTS (MONOCOTS)	S	
Pale Green Orchid	*Platanthera flava*	PLANTS (MONOCOTS)	E	
Slender Ladies'-tresses	*Spiranthes lacera*	PLANTS (MONOCOTS)	T	
Slim-leaved Panic Grass	*Dichanthelium linearifolium*	PLANTS (MONOCOTS)	T	
Virginia Spiderwort	*Tradescantia virginiana*	PLANTS (MONOCOTS)	S	
Diamondback Water Snake	*Nerodia rhombifer*	REPTILES	T	
Slender Glass Lizard	*Ophisaurus attenuatus*	REPTILES	T	

2.9 Recreation

Rathbun Lake and its surrounding area provides many recreational opportunities. There are 22,900 acres of public land surrounding over 150 miles of shoreline. Recreational opportunities include camping, lodging, boating, fishing, bicycling, golf, picnic shelters, playgrounds, swimming areas, equestrian, snowmobile and hiking trails.

2.10 Socioeconomics and Environmental Justice

E.O. 12898, Federal Actions to Address Environmental Justice in Minority Population and Low-Income Populations directs Federal agencies to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority population and low-income populations.

CEQ guidance defines "minority" as individual(s) who are members of the following population groups: American Indian or Alaskan native, Asian or Pacific Islander, Black, not of Hispanic origin, and Hispanic (CEQ 1997). The CEQ defines these groups as minority populations when either the minority population of the affected area exceeds 50% of the total population, or the percentage of minority population in the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis.

Low-income populations are identified using statistical poverty thresholds from the Bureau of the Census (U.S. Bureau of the Census, 2012). In identifying low-income populations, a community may be considered either as a group of individuals living in geographic proximity to one another, or a set of individuals (such as migrant workers or Native Americans), where either type of group experiences common conditions of environmental exposure or effect. The threshold for 2012 was an income of $11,945 for an individual and $23,283 for a family of four (U.S. Census Bureau 2012).

The median family income for a household in Appanoose County was $41,890, and the per capita income for the county was $19,907. Approximately 15.8% of the population had an income that was considered below the poverty line (U.S. Bureau of the Census, 2013).

Appanoose County is less ethnically diverse than Iowa as a whole with 97.7% white, 0.5% black or African American, 0.3% Asian Indian, and 0.2% American Indian. State-wide Iowa reports 91.3% white, 2.9% black or African American, 1.4% Asian, and 0.4% American Indian (U.S. Bureau of the Census 2013).

2.11 Historic and Cultural Resources

A Phase I Intensive Archaeological Investigation was conducted by the University of Iowa Office of the State Archaeologist at restoration and barrier placement locations on July 16, 2018 and October 23-24, 2018 (Appendix B). No artifacts or archaeological features were identified in the survey. All areas were either previously disturbed and lack the potential for intact archaeological deposits or no archaeological deposits were identified during the survey. No further archaeological investigation of the areas surveyed is recommended by the University of Iowa Office of the State Archaeologist (OSA). The Kansas City District Archaeologist concurs with this recommendation.

2.12 Hazardous, Toxic, and Radioactive Waste

ER 1165-2-132 identifies that the USACE policy is to avoid the use of project funds for Hazardous, Toxic and Radioactive Waste (HTRW) removal and remediation activities by avoiding any areas where environmental contamination is known or suspected.

An environmental database assessment of Rathbun Lake was conducted in September 2019 to determine the environmental conditions and risk of HTRW associated with the proposed Section 1135 Rathbun Lake Ecosystem Restoration Project (Appendix C). No notable activities or potential HTRW hazards are located within or adjacent to restoration areas or the proposed barrier location.

2.13 Air Quality and Noise

Determining Conformity of General Federal Actions to State or Federal Implementation Plans) dictates that a conformity review be performed when a Federal action generates air pollutants in a region that has been designated a non-attainment or maintenance area for one or more National Ambient Air Quality Standards (NAAQS). Monitored criteria pollutants monitored include carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide, particulate matter (inhalable PM_{10} and fine inhalable $PM_{2.5}$), and lead. For Appanoose County, all six criteria pollutants are in attainment of the air quality standards (USEPA 2012).

Noise within the vicinity of areas to be restored is generally seasonal and primarily results from boating and fishing on the lake, and vehicle noise from adjacent roadways. Secondary noise results from periodic mowing and associated maintenance within the vicinity of areas to be restored.

The study area is in attainment for all criteria and pollutants according to NAAQS. Air quality may be temporarily affected by construction projects and activities within the study area.

2.14 Aesthetics

In addition to the lake, aesthetics around the shoreline primarily includes upland terrestrial vegetation, eroded shoreline, and existing rock placed along the shoreline and within the lake for habitat restoration and to direct silt movement. Some existing rock placed for habitat restoration and to protect the shoreline has been in place for more than 25 years.

2.15 Floodplain

E.O. 11988 requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

The Chariton River is dammed at the southeast portion of Rathbun Lake. The River's floodplain up- and downstream of the Lake is primarily characterized by agriculture, and primary and secondary roads.

3.0 PLAN FORMULATION

Plan formulation for this study was conducted in accordance with the USACE's six-step planning process:

1) Identify the water and related land resources problems and opportunities of the study area
2) Inventory and forecast existing conditions
3) Formulate alternative plans
4) Evaluate alternative plans
5) Compare alternative plans
6) Select the Recommended Plan

3.1 Future Without Project Conditions

The forecast of the future without-project condition over the period of analysis provides the basis from which alternative plans are formulated and impacts are assessed and indicate how changes are likely to have an impact on problems and opportunities. The future without project conditions include adverse impacts to fish spawning and nursery habitat, increased emigration of fish from the lake including apex predators and increased trophic imbalance.

3.1.1 Fish Spawning and Nursery Habitat

The sedimentation of fish spawning and nursery habitat is recognized as a long-term problem for Rathbun Lake. Early observations following the start of multi-purpose operations documented significant shoreline erosion. Surveys conducted by the Iowa Geological Survey 1979-1980 showed recession of the shoreline exceeded 250' in multiple locations. While this erosion resulted in the destruction of roads, parking areas, and amenities (Black 1980) a lack of recruitment of many native fishes was also observed and resulted from egg mortality due to siltation and reduction in suitable spawning substrate (USACE 1975).

A joint project conducted 2016-2017 by the local US Army Corps of Engineers Rathbun Lake Project and the IDNR conducted a new bathometric survey of the entire 11,000-acre reservoir. The survey revealed that at least 74 acres of terrestrial habitat points were eroded, thus eliminating and often filling the embayments and coves they produced.

Erodible soils would continue to deposit in embayments and gradually start filling in deeper habitats as embayments become full of sediment. Solids would continue to be re-suspended within the water column causing turbid conditions and reducing light penetration. The continued loss of aquatic habitat and impacts to fish and macroinvertebrate species will occur. As previously mentioned in Section 1.4 Prior Studies and Reports, restoration consisting of the grading and sloping of cut banks, quarry run rock placement including rock extensions to break the erosive energy of water waves against the shoreline (i.e. wave fetch) and to direct sediment away from embayments and native vegetation plantings to prevent erosion was conducted in 2007-2013 in numerous locations along the lake shoreline to prevent the erosion of embayments and coves. Monitoring of previously restored shoreline showed that in addition to preventing the siltation of fish spawning and nursery habitat, restored areas were observed to have significantly decreased turbidity, increased zooplankton taxa and increased abundance of white crappie, black crappie, largemouth bass and gizzard shad compared to areas of unrestored shoreline (Krogman 2015).

3.1.2 Fish Emigration

While fish escapement rates are variable among lakes, routine collections of various fish species within the tailrace and downstream of Rathbun Lake since 1996 under the 1980 WCM documented that numerous fish species have a high frequency of emigration, including apex predators that are juveniles that have not reached productive age which results in reduced recruitment and also adult reproductive aged adult fishes. Fish that emigrate through the intake tower and downstream into the Chariton River are subject to mortality due to extreme cold temperatures in the winter and low dissolved oxygen in the summer. The Chariton River downstream of Rathbun Lake is generally inhabited by invasive carp (Hypophthalmichthys spp.).

In Weber et al. (2013), previous work by Flammang (2009) documented that in 2001, high spring and summer releases (mean = 33 m3/sec) resulted in an 80 percent decline in walleye catch within Rathbun Lake during fall gill-net sampling. Extensive walleye emigration from the Lake has been well documented by IDNR through a mark recapture study at a minimum annual rate of 13.6 percent and a conservative 21-month rate of 26 percent (Weber et al. 2013).

IDNR published and unpublished modeling estimates of the percent change in emigration probabilities of walleye as related to lake release discharge increases dramatically (USACE, 2016). At around 1,200 cfs, there is a noted 14 percent increase in walleye loss from the 800 cfs baseline. Discharges above 1,200 cfs start having a significant influence on emigration, and sustained discharges through the intake tower and tailrace at 2,000 cfs and above have a substantial adverse impact on fish populations. At a release of 3,000 cfs, which is the new highest allowable release rate, there is an approximately 850% percent chance of increased walleye loss. These probabilities are based on published mark-recapture field sampling and empirical modeling (Weber et al., 2013), as well as further unpublished modeling estimates by IDNR. Based on tailrace survey observations and captures, other important resident piscivores including white bass and hybrid striped bass, are emigrating at similarly high loss probability rates to that of walleye as shown in Figure 3-1. The end result of moderate to high release events is an unsustainable fishery.

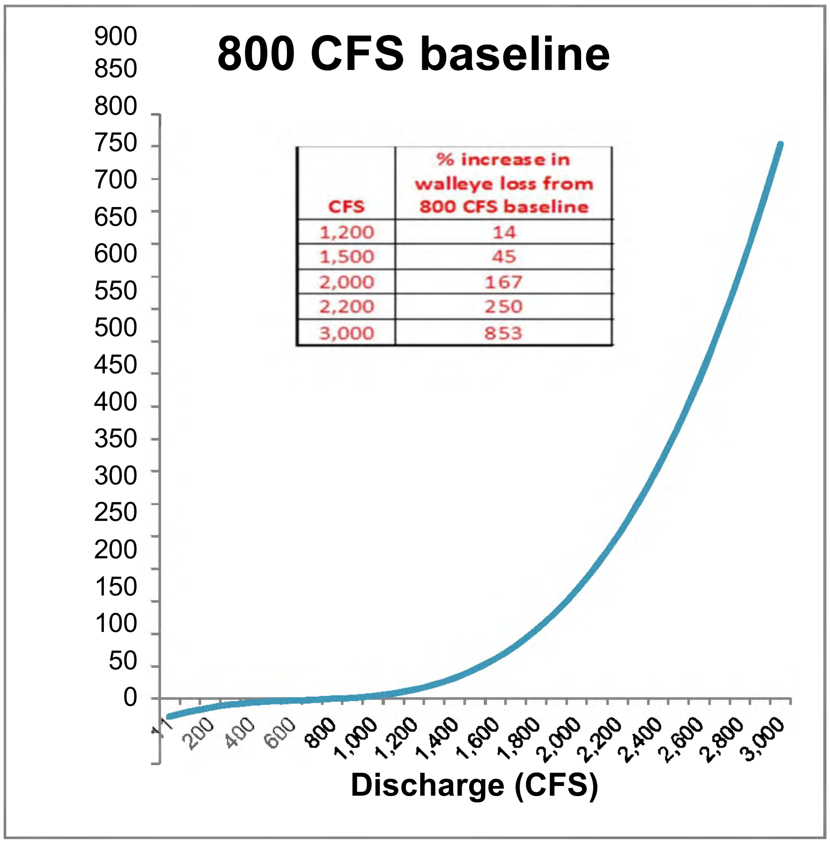


Figure 3-1. Relationship Between Walleye Loss and Lake Discharge

This is further supported by continued declining catches of walleye and white bass in IDNR fish surveys within Rathbun Lake and the inability of stockings to sustain predator species such as walleye and hybrid striped bass (Morone saxatilis x M. chrysops) to supplement the white bass fishery within the Lake (Mark Flammang, personal communication). Walleye year class strength, the number of fish spawned or hatched in a given year, remains highly variable and the lack of catches during routine surveys suggest numbers continue to decline and similar trends have been reported for hybrid striped bass (Mark Flammang, personal communication).

As emigration is greater than total annual mortality of walleye and hybrid striped bass, increased regulation of anglers would not sufficiently alter walleye density and increased stocking rates of walleye and hybrid striped bass to supplement the white bass fishery within the lake will not impact predator density due to emigration. Fish emigration is a long-term documented issue that impacts the trophic balance of Rathbun Lake and increased rates of fish emigration from the Lake will increase due to recent WCM revisions that provide for increased allowable releases as described in Section 1.4 Prior Studies and Reports.

3.1.3 Trophic Balance

In support of the need for predator retention through the installation of a fish barrier, gizzard shad present unique issues to reservoir ecology as they have a myriad of effects including impacts on nutrients, phytoplankton, zooplankton, and fish and many of their effects vary with ecosystem productivity (Vanni 2005). They exhibit diet ontogeny, shifting from planktivorous diets, to detritus-based food chains, depending on the season or prey availability (Vanni et al. 2005). The shift of gizzard shad to detritus diets results in the translocation of nutrients from the benthic habitats, to the water column. This shift can result in increased phytoplankton abundance and reduced water clarity (Schaus 2007). Overly abundant gizzard shad can reduce growth of young of the year stages of piscivorous fishes (e.g. largemouth bass, temperate basses, and walleye) which would, in turn, feed on gizzard shad (Garvey and Stein 1998, Garvey et al. 1998). This will result in reduced predator density, exacerbating issues associated with gizzard shad abundance (Garvey et al. 1998) such as reductions in water clarity (Vanni et al. 2005). Thus, predators are imperative to maintaining top-down control gizzard shad, particularly in reservoir habitats (Stein et al 1995). Predator management can impact gizzard shad abundance and trophic impacts associated with gizzard shad abundance. Specifically, walleye (Bethke et al. 2012) and hybrid striped bass (Stein et al 1996) have been shown to control age-0 gizzard shad, increasing zooplankton density and size, thus improving water clarity and conditions for all sportfishes.

In regard to the risk of overpopulation of crappie versus the need for additional crappie habitat, Mitzner (1981; 1991) quantified the importance of spring water levels in crappie production. Approximately 90% of the variability in density of age-0 crappie was accounted for by spring / summer floodwater storage. Thus, crappie production is dependent on the elevation of water levels above conservation pool which places spawning fish in what have become "limited" spawning habitats. IDNR research has further documented the negative influence of turbidity on crappie survival (gizzard shad abundance is tied to turbidity, e.g. Vanni et al 2005), exclusive of water level (Mitzner 1991; 1995). Thus, high water yields increased crappie production unless turbidity is high. All 150 miles of the Rathbun Lake shoreline were evaluated, and habitat was quantified for spawning value (Mitzner 1987; 1991). These data were utilized to identify critical spawning locations around the lake. Shorelines and critical points immediately protecting these locations have been identified for restoration and protection to ensure the future availability of these habitats and habitat restoration incidentally reduces sediment turbidity and improves water quality in these locations. As previously mentioned, shoreline restoration in previous Section 1135 work has been shown to improve fish and invertebrate habitat and water quality in these locations (Krogman 2015). The importance of these habitats increases as the reservoir ages and the shoreline becomes less dendritic due to shoreline erosion and the filling of coves.

In addition, predation on crappie is important when extremely strong year classes are produced which may result during wet cycles like the reservoir has experienced in the last 13 years. Predatory percids have been shown to reduce crappie density and positively impact crappie quality and growth. Walleye and saugeye (walleye X sauger hybrids) have been shown to consume black crappie and increased percid density has been associated with increased growth rates and size structure of black crappie (Flammang 1994; Pope et al. 1996, Galinat 2001). However, the primary benefit of the habitat restoration portion of this project for crappie is the protection of existing and disappearing spawning and nursery habitat in this aging reservoir.

WCM revisions as finalized on July 6, 2016 and as annotated in Section 1.4 Prior Studies and Reports, have exacerbated the existing long-term issues with predator / prey balance in the reservoir and fish emigration due to increasing allowable release rates up to 1,500, 2,200 and 3,000 CFS throughout the year depending on pool elevation and providing a fall pulse of 2,700 CFS. This is extremely detrimental to predator populations in the system. Weber et al. (2013) and Weber and Flammang (2019) identified an exponential relationship between walleye emigration and April discharge. Currently, walleye are up to 800% more vulnerable to emigration with floodwater discharge allowed under the revised WCM, than under the 1980 manual (Weber and Flammang 2019). Weber and Flammang (2019) identified emigration as more important than mortality in determining walleye abundance in many years. However, this was prior to these increased discharge rates which are even more detrimental to predator populations. Predator species and important gamefish species (e.g. hybrid striped bass, white bass, and largemouth bass) exhibit similar vulnerability to emigration with increased discharge as evidenced by ongoing tailrace sampling conducted regularly by the IDNR since 1996. Loss of important game fish species will continue to negatively impact predator / prey balance and lake trophic status (Flammang 2019). Gizzard shad manipulation through the maintenance of top-level predators (e.g. walleye and hybrid striped bass) remains an important tool to amelioration of trophic impacts brought upon by unchecked gizzard shad abundance.

Maintenance of an influential predator population that can maintain ecosystem balance is feasible with the installation of a fish barrier. As emigration is greater than total annual mortality for many predators, increased regulation of anglers would not sufficiently alter predator density and increased stocking rates will not impact predator density due to emigration.

3.1.4 Summary

• Predators do impact prey populations

• Gizzard shad are highly fecund and negatively impact other fish populations

• Gizzard shad affect the trophic status of lakes, especially reservoirs. They exhibit both planktivorous diets that impact other fish populations directly, and they are effective detritivores which have indirect negative impacts on water clarity and game fish populations.

• Crappie abundance and their role in the ecosystem is dependent on protecting what habitat sites remain. Loss of these sites is caused by reservoir erosion and reservoir aging but shoreline restoration will protect remaining habitat.

• WCM revisions increased release rates have been shown to negatively impact predators on a large scale with much supporting research. Without a mechanism in place to minimize fish emigration, trophic imbalance and cascading effects will continue to occur in the lake ecosystem with increasing losses of top-level predator and also prey fish species through the intake tower structure.

3.2 Problems and Opportunities
3.2.1 Problems

1. Erosion and deposition causes:
    a. Decreased fish spawning and nursery habitat.
    b. Egg mortality due to siltation and decreased fish recruitment.
    c. Continued deposition fills in deeper habitat.
    d. Resuspension of solids and reduced light penetration

2. Fish Emigration:
    a. Increased emigration over historical rates due to WCM revisions resulting in increased flows.
    b. High loss of fish including apex predators of juvenile and reproductive age.
    c. Negatively impacts predator / prey balance and lake trophic balance.

3.2.2 Opportunities
Erosion and Deposition: Restoring embayment shorelines, reducing wave fetch and directing sediment can reduce shoreline erosion, restore and protect spawning and nursery habitat, prevent egg siltation, increase fish recruitment and incidentally decrease water turbidity in localized areas. Shoreline restoration measures generally consist of grading and sloping banks, geotextile fabric installation, quarry run rock placement, rock extensions to break the erosive energy of water waves against the shoreline (i.e. wave fetch) and to direct sediment away from

embayments and native vegetation plantings to prevent erosion. Monitoring of previously restored shoreline showed the prevention of fish spawning and nursery habitat siltation, decreased turbidity, increased zooplankton taxa and increased abundance of centrarchids compared to areas of unrestored shoreline.

Fish Emigration: A consideration to prevent fish emigration and restore trophic is the installation of a fish barrier. Barrier types commonly include intake gate screens, netting, bioacoustics sound/air bubble curtain/strobe light barrier, electrical barriers and carbon dioxide injection. Intake screens are known to result in impingement and fish mortality due to intake velocities which are too high to allow the fish to escape. Various barriers are used on USACE projects in many districts to limit emigration or restrict access of native and non-native fishes to undesired locations (USACE 2016a).

3.3 Planning Goal and Objectives

Based on the resources to be restored, the existing condition of these resources and in coordination with the IDNR, one project goal and two objectives were established. The objectives, while distinct, have interdependencies and synergies that provide localized and lake-wide ecosystem benefits. Both objectives are long-term, with an estimated 50-year benefit.

Goal	Objectives
Restore, protect, and sustain the Rathbun Lake fisheries	• Restore embayment spawning and nursery habitat at all evaluated sites • Restore trophic balance across the food chain/web

3.4 Planning Constraints and Considerations

Individual or combined constraints and considerations to achieving the project goal and associated objectives were assessed to guide plan formulation and the evaluation of alternatives:

- Compliance with all applicable laws, regulations, and policies
- Construction should preferably take place during winter when the shoreline is frozen as there is a lower chance of soil sloughing and disturbance to fish and wildlife when construction takes place during this timeframe.
- Control soil erosion during construction and post-construction from restored areas.
- Stay within the footprint of the areas to be restored.
- Avoid impacts to natural resources such as threatened and endangered species and their respective habitat and cultural resources.

- Balance earthwork cut and fill to avoid the cost of transporting soils from restoration areas.
- Existing access to restoration areas such as roads and trails should be used to avoid or minimize new access construction.
- The placement of a fish emigration barrier should not adversely affect lake infrastructure such as the intake tower.
- The placement and operation of a fish emigration barrier would address public safety as barrier designs include the use of electricity, carbon dioxide and other materials.
- Restoration measures should not adversely impact lake operation.

3.5 Assumptions Guiding Plan Formulation

The following assumptions were developed to guide plan formulation:

- Habitat unit values are calculated for existing conditions, FWOP conditions at 50 years, and future with project alternatives at 50 years. An interpolation formula was used to estimate habitat value at all points in time in between.
- The Design and Implementation Phase would include development of plans and specifications following the feasibility phase.
- The period of project analysis is from 2020 through 2070.
- October 2020 (FY21) prices, 50-year period of analysis, FY21 Federal Interest Rate of 2.50%.

3.6 Habitat Restoration Measures

Aquatic habitat restoration measures to restore embayments were considered that would stabilize the shoreline from wave and wind action, fluctuating water levels and achieve the project objective of restoring embayment spawning and nursery habitat. These restoration measures were used in previous, successful habitat restorations. Trophic balance measures to prevent the downstream emigration of native fish included the evaluation of deterrence measures.

Proposed embayment restoration measures include:

- Grading and sloping eroded areas
- Bank armoring with rock
- Rock extensions
- Geotextile erosion control
- Vegetation establishment at top of bank

Trophic balance restoration measures include:

- Intake screens

- Netting
- Bioacoustic Sound/Air Curtain (Bubbler)/Strobe Light Barrier
- Electrical Barrier
- Carbon Dioxide Injection

3.6.1 Bank Armoring with Rock

Rip rap and quarry run rock are effective habitat structures for fish and as geotechnical measures to prevent erosion. Quarry run rock has a history of use and viability as an effective shoreline erosion prevention solution at Rathbun Lake. Placing quarry run rock would be more cost effective than rip rap as quarry run is cheaper to purchase and the fines included in quarry run would forego the need to place a gravel layer below the rip rap to prevent erosive undermining of the rip rap. Grading slopes and the placement of quarry run rock on areas of shoreline erosion above and below multi-purpose pool elevation 904 feet (ft) would stabilize the shoreline and protect it against wind and wave action and fluctuating water levels. Based on previous ecosystem restoration work at Rathbun Lake, upper elevation limits on rock placement may be necessary to minimize costs; therefore, graded slopes above rock will be stabilized with vegetation for erosion control. Fluctuating water levels, ice, wind and wave action has not affected the performance of previous bank armoring. This measure is carried forward for further consideration.

3.6.2 Rock Extensions

Rock extensions are effective habitat structure for fish and geotechnical measures that can be used to break the erosive energy of water waves against the shoreline (i.e. wave fetch) and to direct sediment away from embayments. Quarry run rock would be used to construct rock extensions. This measure is carried forward for further consideration.

3.6.3 Geotextiles

Geotextile erosion control material (i.e. fabric and/or netting) could be installed at eroded shoreline locations. Geotextile materials would bind to the soil, thereby resulting in decreased soil erosion and sedimentation. Geotextiles are generally not used as a solution for aquatic habitat structure, or as a sole solution for erosion on steep sloped, highly erodible soils subjected to fluctuating water levels and prolonged inundation. For some lake applications, geotextiles are appropriate under certain environmental conditions such as shallow slopes and limited water level fluctuation and may be combined with rip rap, quarry rock, and/or herbaceous vegetation establishment. This measure is carried forward for consideration.

3.6.4 Vegetation Establishment

The vegetation establishment measure consists of planting native prairie grasses at the top of bank on graded slopes. Switchgrass (*Panicum virgatum*), Indiangrass (*Sorghastrum nutans*) and big bluestem (*Andropogon gerardii*) are example prairie grasses that are used at top of bank seeding as plants will need to establish in full sun and these grasses have fibrous roots that will effectively bind the soil. Natural vegetative colonization would also occur over time and provide increased stabilization and erosion control. Establishing prairie grasses as vegetation is only recommended for graded, non-armored upper bank slope areas, as fluctuating pool levels and extended durations of higher pool elevations cause vegetative mortality during establishment and post-establishment. Willow stakes and containerized plantings are not recommended due to winter ice shear. This measure is carried forward for consideration.

3.7 Restoration Site Selection

Five priority embayments consisting of 10 proposed shoreline habitat restoration sites were selected by IDNR based on previous Mitzner (1991) reproductive habitat research. Sites were visited by the project team on October 27, 2016, September 28, 2018 and April 4, 2019 by NWK and IDNR, and follow-up monitoring of sites is conducted seasonally by IDNR. Embayment site names and acreages are presented in Table 3-1.

Table 3-1. Proposed Aquatic Habitat Restoration Sites Information

Embayment Site Names (Name is a combo of two restoration sites)	Embayment Acreage
A – B1	12.8
B2 – B3	7.8
B Alt.1 – B Alt. 2	14.2
C1 -C2	9.4
D - E	388.2
TOTAL	**432.4**

3.8 Trophic Balance Restoration Measures and Screening

The purpose of this section is to evaluate a range of fish barrier trophic restoration measures to reduce native fish emigration through Rathbun Lake's intake tower (Figure 3-1), thereby contributing to long-term trophic balance and lake ecosystem restoration.

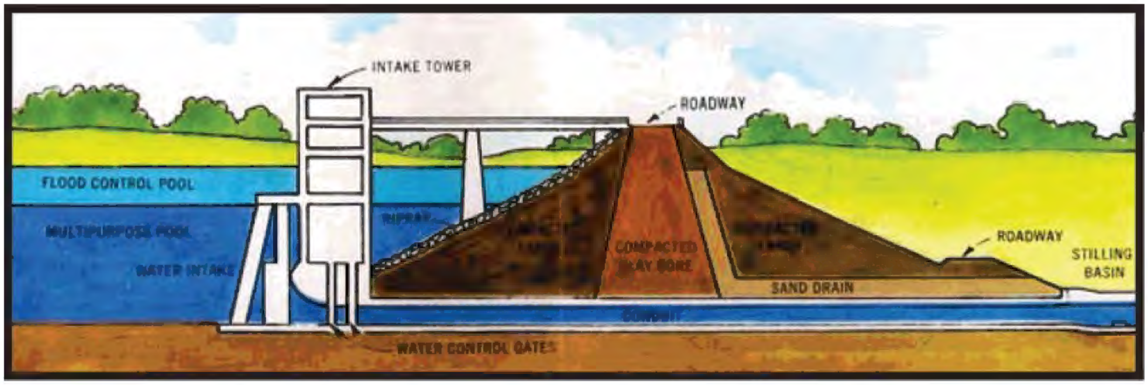


Figure 3-2: Rathbun Lake Intake Tower and Dam Section View

Trophic imbalance is a current condition at Rathbun Lake that will worsen over time in the absence of a Federal project as habitat would continue to be adversely impacted and fish would continue to migrate downstream. A barrier would reduce the likelihood of a top-down trophic cascade from greatly reduced populations of primarily top-level predatory fish. Overpopulation of crappie and gizzard shad, which can cause disease and stunted growth rates, is a density-dependent response common in ponds and lakes and can be indicative of variety of causes, including lack of predators. A barrier that retains many more predatory fish would help offset potential overpopulation of prey species such as gizzard shad and juvenile crappie. Barrier placement combined with habitat restoration would collectively contribute to a more balanced ecological trophic structure and help maintain fish species diversity and a more self-sustaining fisheries resource.

3.9 Fish Emigration Deterrence Barriers and Trophic Performance Evaluation

Barrier technologies fall under two broad categories: physical (positive behavioral) barriers and negative behavioral barriers. Positive behavioral barriers, such as screens or nets are passive physical barriers that separate and prevent fish from moving through an intake tower. Negative behavioral barriers, such as electricity or sound, are non-structural means that provide non-physical negative stimuli to repel or deter fish approaching an intake tower. The USACE and IDNR reviewed the feasibility, cost and performance of barrier system technologies to reduce emigration. A general technical description of each system is provided below; and where available, cost and operation and maintenance (O&M) information are also provided.

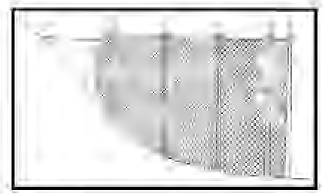
3.9.1 Intake Gate Screen – Physical Barrier

Screens are physical barriers on a lake intake that allow water to pass, while excluding passage of all but very small fish and other small aquatic life. IDNR placed screens in front of the Rathbun Lake intake tower gates about 15 years ago to prevent fish kills that resulted from fish emigration downstream into the Chariton River

during winter months (USACE 2016a). Although these screens were useful as physical barriers during low flow conditions, moderate and high flows resulted in fish impingement on screens and significant mortality, presumably from a dramatic high pressure change near the intake tower that disrupted swim bladder function and prevented fish from escaping. The screens were subsequently removed and never reinstalled. Due to the expected future continuance of lake level fluctuations and increased flows, new screens would result in impingement and mortality. This measure is eliminated from further consideration as it would offset any trophic balance benefits.

3.9.2 Netting – Physical Barrier

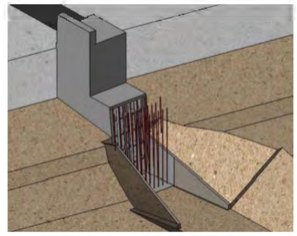
Net barriers typically made of strong fibers woven of varying thickness and opening dimensions with varying anchoring systems were considered. In November 2016, Kansas City District USACE staff visited with an Ameren UE consulting engineer about the netting system in place at the Bagnell Dam hydroelectric site on Lake of the Ozarks. The fish barrier at Bagnell is composed of 3 individual nets placed in parallel above the hydroelectric dam intakes. It is made of Dyneema® polyethylene fiber with an installed life rating of 10 years. The nets collectively cost about $5,000,000 and have been in place for 8 years. The nets measure about 900 feet along their length and extend to a depth range of 25 to 100 ft. The mesh sizes are 1 and 2 inches. The nets are stabilized by a chain attached to the bottom and are also anchored down by cables connected to 8 separate 20,000-pound blocks. The nets are inspected quarterly with a remote control submarine (cost of $50,000), and it takes 3 days to complete the inspection. Video taken by the submarine is reviewed by Ameren UE to check the integrity of the net. Divers fix tears in the net using cable ties. Annual O&M cost ranges from $7,000 - $10,000, which includes downstream monitoring for dead fish. According to Ameren UE's consulting engineer, fish mortality is not an issue and fish do not get caught in the net by their spines, fins or gills. Logs occasionally rip the nets and debris such as leaves impedes flow.

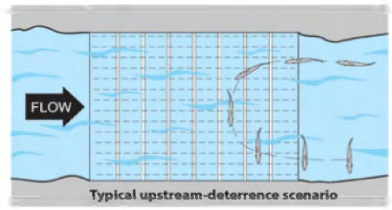


According to the consulting engineer, debris is the biggest challenge for this type of fish barrier. Trapped debris eventually settles out of the nets due to changes in flow. O&M is relatively high, and nets need to be replaced every 10 years. Assuming the same multiple net system is deployed at Rathbun Lake in a 3-sided rectangular configuration, three 450-ft long nets would be used and cost approximately $2,500,000. Over a 50-year project life, non-inflationary costs for initial netting without anchoring mechanisms and replacement every ten years netting would be $15,000,000. Annual O&M would range between $3,500 and $5,000 not including the $50,000 cost of a remote-control submarine and associated underwater camera computer software. This would be extremely cost-prohibitive for the IDNR and increased flows will result in increased debris and net repair and obstructed flow could compromise downstream minimum releases to help maintain the water quality of the Chariton River. Net barriers are eliminated based on high cost, high maintenance and downstream water quality concerns.

3.9.3 Electrical – Negative Stimuli Barrier

Electrical current in a barrier system produces negative stimuli to discourage or repel fish from entering an area. Example electrode rod and floating boom barrier concepts and deterrence scenarios are shown at right. Electrodes are anchored in front of the dam intake tower gates in an array configuration. The FEBB uses the same concept as the electrode rod array, but instead of anchoring solid steel rods in concrete or substrate, hollow steel pipes are suspended from steel debris boom cables and placed out away from an intake tower (Smith-Root 2015). A flexible steel cable "rat tail" may be attached to the end of each pipe to provide flexible barrier coverage with fluctuating water depth. The ends of each cable are fixed in place with anchored or piled moorings away from the intake tower. A small (8 ft. x 12 ft.) climate-controlled building would house and protect electronic components. This building can be placed on a concrete pad adjacent to the lake tower bridge per the Rathbun Lake Operations Manager (Phil Brown, personal communication).



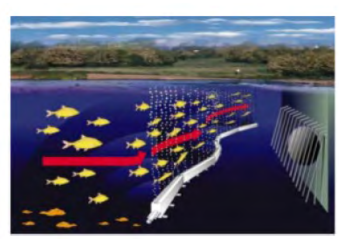


As mentioned in Section 1.4 Prior Studies and Reports, laboratory tests have been conducted by IDNR on walleye as a surrogate species using electrical pulsed direct current as a behavioral barrier under the PAS authority. Results of the tests demonstrated that pulsed direct current was successful at reducing approaches and increasing deflections of walleyes. Walleye escapement reduction of approximately 80 percent was achieved during testing (Weber et al. 2016). Various voltages and pulse widths were assessed for effectiveness but did not influence escapement rates. Mortality was low, ranging from 0.5 to 5.7 percent, and was greatest at the highest pulse and voltage setting. Lower pulse and voltage settings effectively minimized walleye mortality. Based on laboratory testing, the use of electrical deterrence would be a very effective barrier.

Total cost to purchase and install a FEBB is estimated at approximately $1.9M with non-inflationary annual O&M estimated at $8,275 over the 50-year project life. It may be possible that only a single boom line system is needed; thereby reducing equipment and O&M costs. The number of boom lines would be determined in design. This electric barrier type measure is retained for further consideration.

3.9.4 Bioacoustic Bubbler Strobe Light – Negative Stimuli Barrier

Sound (bioacoustics), air bubblers, and lights are behavioral barriers that individually or in combination produce negative stimuli to discourage or repel fish from entering an area. Laboratory tests conducted under the PAS program on walleye as a surrogate species showed maximum deterrence of about 45%



with the operation of a bioacoustic bubbler when deployed in combination. Deterrence decreased substantially with the addition of strobe lights as walleye appeared to be attracted by the lights. Flammang et al. (2014) concluded that barrier design, fish species and environmental conditions are highly variable and have a tremendous influence on the success of this type of deterrent. Results of testing concluded that bioacoustics bubbler technology is significantly less effective at reducing fish emigration compared to an electric barrier and would not likely achieve the project goal and objectives. Therefore, this measure is removed from further consideration.

3.9.5 Carbon Dioxide Injection – Negative Stimuli Barrier

Carbon dioxide (CO_2) infusion into water bodies is being experimentally developed at the University of Illinois Champagne-Urban (U of I) in controlled ponds (see photo) as a non-physical barrier to help control the movement and behavior of invasive carp in the Great Lakes basin. Various governmental agencies are considering CO_2 infusion as a redundant measure used in combination with the current electric barrier in the Chicago area's Calumet-Sag Channels to deter small invasive carp that could penetrate the electric barrier currently in place. Under controlled experimental conditions, CO_2 has shown promise for field applications. Results from studies (Donaldson et al. 2016 and Dennis et al. 2015) have identified the need for different levels of CO_2 concentrations to be used for different species and age classes of fish. Research done to date has involved closed and non-flowing systems. Published research is not available yet to support CO_2 effectiveness in a flowing system. Temperature fluctuations influencing CO_2 concentrations have also not been studied in lake systems. The CO_2 concentrations that water can hold will vary with time of year and even time of day and depth due to temperature variations in the water column. Researchers at U of I indicated that the U.S. Geological Survey (USGS) is working with the U.S. Environmental Protection Agency (USEPA) to get CO_2 registered as a piscicide (Stuewe 2016). Field trial research would be needed in a lake system similar to Rathbun Lake in order to determine if a CO_2 barrier is sufficient to deter movement of fish when under stress or biologically driven (e.g. predation, breeding, migrations) during increased flows.

Additional considerations with CO_2 include the potential impacts to non-target and lower trophic level organisms within and below Rathbun Lake and potential acidification that may negatively impact plankton, plants, mollusks and less mobile invertebrate species. Therefore, this measure is removed from further consideration.

4.0 HABITAT and TROPHIC BENEFITS MODELING

Habitat modeling was conducted to determine the ecological and habitat benefits associated with screened restoration alternatives using white crappie as an indicator species for reproductive, nursery and forage habitat. To evaluate trophic benefits associated with the FEBB, habitat modeling was conducted using walleye as a surrogate species to assess the ecological responses to changes in prey abundance and spawning habitat. Trophic benefits were also assessed by evaluating changes in predator abundance using walleye again as the indicator species. Shoreline habitat modeling is discussed first below, followed by FEBB habitat and trophic benefits modeling.

4.1 Shoreline Habitat Restoration Modeling

A USACE certified white crappie Habitat Suitability Index (HSI) model was used to evaluate the ecological and habitat benefits of habitat restoration alternatives at the five embayment sites. This species model was selected because the embayments targeted for restoration are historically important spawning sites (Mitzner 1991) and represent other centrarchid and native fish species. This model was developed in 1982 as a USFWS Habitat Evaluation Procedure (HEP) to document habitat impacts or habitat benefits with and without-project conditions.

The white crappie HSI model (Edwards et al. 1982) evaluates habitat quality aspects of cover, food, water quality, and reproduction variables are relatively influenced by restoration alternatives. A white crappie HSI model spreadsheet with variables and formulas was developed and used to calculate HSI outputs. The habitat restoration modeling technical report is included as Appendix D.

4.1.1 Model Variables

The following variables are included in the white crappie model:

- Percent Cover
- Percent Littoral Area
- pH Range
- Average Water Temperature within Epilimnion – Adults/Juveniles (mid-Summer)
- Average Water Temperature within Epilimnion – Fry (mid-Summer)
- Average Water Temperature within Epilimnion – Spawning (Spring-midsummer)
- Minimum Dissolved Oxygen Levels (Summer)
- Dissolved Oxygen Littoral Areas (Spring-midsummer)
- Maximum Monthly Average Turbidity (Summer)
- Ionic Concentration of Sulfate-Chlorides Exceed Carbonate-Bicarbonates
- Average Total Dissolved Solids (Midsummer)
- Salinity Problems

4.1.2 Model and Variable Assumptions

- Each restoration alternative was modeled in each of the five embayments.

- A series of TYs within this 50-year setting were developed including TY0 (baseline conditions), TY2 (2 years) establishment), TY5 (5 years), TY25 (25 years) and TY50 (50 years).
- Modest changes averaging about a 10% decrease in percent cover due to sedimentation were made at TY25 and TY50.
- Modest changes averaging about a 10% increase in percent littoral area due to sedimentation of the embayments were made at TY25 and TY50.
- A 25% decrease in maximum monthly average turbidity was assumed at TY2, TY5, TY25, and TY50 to account for decreased localized sedimentation from stabilized shorelines.
- The model generates Cumulative, Gross, and Net AAHUs to determine the NER plan and for use in the Cost Effective – Incremental Cost Analysis.

4.1.3 Shoreline Habitat Restoration Modeling Results

Habitat quantity as measured by embayment area was factored into an equation with HSI to derive a habitat unit (HU) for each alternative applied at each site and over interval project life target years (TY) of TY=0, TY=2, TY=5, TY=25, and TY=50. HU's were annualized to determine Cumulative HUs, and Gross and Net Average Annual HU's. Net Average Annual HU's (Net AAHU) reflect the net increase or decrease in habitat over existing and FWOP conditions. Cumulative HUs, Gross AAHU and Net AAHU results for alternatives are shown below in Table 4-1. Shoreline habitat restoration benefits were determined independent of the FEBB.

Table 4-1. Aquatic Habitat Outputs by Site for With-Project Measures and No-Action

Measures[1]	Cumulative HU	Gross AAHU	Net AAHU[2]
Site A-B1			
Measure 1 – Rock, Vegetation	433.92	8.68	0.68
Measure 2 – Rock, Geotextiles	433.92	8.68	0.68
Measure 3 – Rock, Vegetation, Geotextiles	433.92	8.68	0.68
Measure 4 – Rock, Vegetation, Rock Extensions	440.32	8.81	0.81
Measure 5 – No Action	400.00	8.00	0.00
Site B2-B3			
Measure 1 – Rock, Vegetation	231.27	4.63	0.34
Measure 2 – Rock, Geotextiles	231.27	4.63	0.34
Measure 3 – Rock, Vegetation, Geotextiles	231.27	4.63	0.34
Measure 4 – Rock, Vegetation, Rock Extensions	237.90	4.76	0.47
Measure 5 – No Action	214.50	4.29	0.00
Site B1Alt.-BAlt.2			
Measure 1 – Rock, Vegetation	485.64	9.71	0.75
Measure 2 – Rock, Geotextiles	485.64	9.71	0.75
Measure 3 – Rock, Vegetation, Geotextiles	485.64	9.71	0.75
Measure 4 – Rock, Vegetation, Rock Extensions	492.74	9.85	0.89
Measure 5 – No Action	448.01	8.96	0.00
Site C1-C2			
Measure 1 – Rock, Vegetation	323.36	6.47	0.59
Measure 2 – Rock, Geotextiles	323.36	6.47	0.59
Measure 3 – Rock, Vegetation, Geotextiles	323.36	6.47	0.59
Measure 4 – Rock, Vegetation, Rock Extensions	328.06	6.56	0.69
Measure 5 – No Action	293.75	5.88	0.00
Site D-E			
Measure 4A – Rock Extensions	13,587.00	271.74	3.88
Measure 5 - No Action	13,392.90	267.86	0.00

[1] Measures were evaluated for shoreline habitat benefits independent of the Floating Electric Boom Barrier.
[2] Net AAHUs are over and above the No Action Measure AAHUs

4.1.4 White Crappie HEP HSI Results

Modeling results for the various restoration measures applied at respective embayment sites indicated habitat quality improvement over existing conditions for each site and action alternative. Results indicate that Site D-E Measure 4A – Rock Extensions would provide the greatest Net AAHU (3.88) over the life of the project. Rock extensions were proposed as the most practical alternative to protect shorelines from wave fetch and erosion. For Site D-E, the shoreline habitat in this large embayment is relatively stable and less eroded than the other restoration areas but is just as important for fish spawning as other sites to be restored. Therefore, substantive shoreline habitat restoration with rock and other material as proposed for the other restoration sites is not merited.

These results were followed by Site B1Alt – B2Alt (Measures 1 – 4) with Net AAHUs ranging between 0.75 and 0.89. Site A-B1 (Measures 1 – 4) and Site C1-C2 (Measures 1 – 4) had Net AAHU increases ranging between 0.68 and 0.81 and 0.59 to 0.69 respectively. Site B2 – B3 (Measures 1 – 4) had the least Net AAHUs of 0.34 to 0.47. Results generally indicate that embayments with proposed shoreline habitat restoration and rock extensions, those being Sites A-B1, B2-B3, B1Alt.-B2Alt., and C1-C2 would produce higher Net AAHUs than restoration of shoreline habitat only. There is no change in Net AAHU's for Measures 1 – 3 for these same four sites, which suggests geotextiles and vegetation have no direct aquatic habitat benefit. However, geotextiles are generally used to prevent erosion from underneath of rock and vegetation established at top of bank also prevents erosion, which is why these are viable measures for habitat restoration. The fines in quarry run rock provide a gravel layer that prevents erosion similar to geotextile fabric.

4.2 FEBB Habitat and Trophic Benefits Modeling

Two modeling approaches were used to evaluate the ecological changes (i.e. trophic benefits) of the FEBB. The first approach used a USACE certified walleye HSI ecological model developed originally as a USFWS HEP to document habitat impacts or habitat benefits from with- and without-project conditions over a 50-year project life. The walleye HSI model (McMahon 1984) was selected to represent all top trophic piscivorous fish susceptible to emigration at Rathbun Lake. The second approach was a logic based Trophic Benefit Assessment (TBA) model developed by HDR Engineering, Inc. specifically for this project. This approach logically estimates the change in predator (walleye) population abundance, with and without a FEBB in place using historic fall walleye gill net sampling data as a baseline. The fish emigration barrier trophic benefit modeling technical report is included as Appendix E.

4.2.1 Walleye HEP HSI Model Intent and Variables

The walleye HSI model (McMahon 1984) was used to determine the trophic and ecological benefits of a FEBB at the dam intake. The intended use of the walleye HSI model was to focus on how walleye food (or trophic) sources and reproduction variables are influenced by previous and current WCM changes to discharges at the three release discharge levels. The 1980 WCM allowed seasonal discharges at various times of the year at 800, 1,200, and 1,500 cfs rates. Under the revised WCM, discharges have increased to 1,500, 2,200, and 3,000 cfs respectively with a fall pulse of 2,700. The area modeled for walleye HSI outputs was the area comprising the lower 1/3 of the lake (102.1 ac) near the dam and intake tower that is considered a critical habitat area for walleye especially during spring and summer. Spring flow is a spawning cue that that attracts piscivores including walleye. The dam's riprap, flooded shoreline vegetation and deep water also attracts piscivores putting them in a position where they are most susceptible to emigration through the dam intake tower. A walleye HSI model spreadsheet, with variables and formulas, was developed and used to calculate HSI outputs. The following variables are included in the walleye model:

- Average Transparency
- Relative Abundance of Small Forage Fish
- Percent of Water Body with Cover
- Least Suitable pH
- Minimum Dissolved Oxygen above Thermocline (Summer)
- Minimum Dissolved Oxygen Along Shorelines (Summer-Fall)
- Minimum Dissolved Oxygen (Spring) Spawning Areas
- Mean Weekly Water Temperature Above Thermocline (Summer)
- Mean Weekly Water Temperature Shoreline (Spring-Summer)
- Mean Weekly Water Temperature During Spawning
- Degree-Days between 4 - 10°C.
- Spawning Substrate
- Percent Littoral Area 0.3 but < 1.5 meters
- Water Level during Spawning and Embryo Development
- Trophic Status of Lake

4.2.2 Model and Variable Assumptions

- Three levels of relative prey abundance and water discharges are directly correlated based on IDNR observations and include low, medium, and high. Data inputs for relative prey abundance will change under the 1980 WCM and revised WCM conditions at the three operating levels respectively. The 1980 WCM is the existing without project condition, while the revised WCM represents the with project conditions of a FEBB.
- The area modeled for walleye HSI outputs includes the lower 1/3 of Rathbun Lake near the dam and intake tower, which is considered a critical habitat area as previously mentioned.
- Habitat units were derived from multiplying HSI scores by the 102.1 ac critical area. Those habitat units were then factored to reflect the important walleye habitat of the critical area. Factoring consisted of taking 33 percent of the lake's conservation pool (11,000 acres), which equals 3,630 acres, and multiplying 3,630 acres by the respective HSI scores of with and without project conditions at the 0, 2, 5, 25, and 50 TY's to generate Cumulative, Gross, and Net AAHUs for use in Cost Effective/Incremental Cost Analysis. The acreage of the conservation pool was used because it is the USACE water management target throughout the year for managing fish and wildlife populations,

navigation, water quality and other important uses. Long-term trophic outcomes to piscivorous fish with and without project conditions are reflected in these HU outputs.

- Six HSI scores were generated; three under the 1980 WCM operations relative water levels, and three under the revised WCM operations relative water levels. An average HSI was calculated for both 1980 and revised WCM operations to reflect the with-and-without project conditions under a full range of relative water levels and discharges. These two average scores were used to calculate AAHUs for the lower 1/3 of Rathbun Lake.
- Percent of Water Body with Cover - This variable is influenced by the low, moderate and high-water levels and discharges in the critical habitat area encompassing the dam.
- Spawning Substrate, Percent Littoral Area and Water Level During Spawning variable inputs are influenced by the relative low, moderate and high water levels and discharges under both of the 1980 and revised WCM conditions in the critical habitat area along the dam.
- Various water quality and water temperature related variables were held constant.

4.2.3 Walleye HEP HSI Results

Results of walleye HSI modeling indicate the overall average HSI score for the without project 1980 WCM operations is 0.275, while the with project revised WCM operations is 0.42, a 65 percent increase. These changes are attributable to increases in forage and reproductive habitat that result from both a FEBB operation and increases in discharge rates that lower water surface elevations at moderate and high discharges under with project conditions to create shallower littoral zone areas in rock and vegetated shoreline areas. Habitat unit outputs are shown in Table 4-2. Results indicate the FEBB will provide 526 Net AAHUs to the lower 1/3 of the lake over the life of the project.

Table 4-1: Outputs for No-Action and With Project FEBB Alternative

Alternative	Cumulative HU	Gross AAHU	Net[1] AAHU
Existing Conditions/Future Without No Action Alternative	49,913	998	0
With Project Conditions – Floating Electric Boom Barrier Alternative	76,230	1,525	526[2]

[1] Net AAHUs are over and above the No Action Alternative AAHUs

[2] Net AAHU value is rounded down to nearest whole number

4.3 Trophic Benefit Assessment Model

When top-level predators are reduced significantly, a downward trophic cascade can develop. Predator numbers decline significantly, while prey numbers increase. This decline, or indirect effects thereof, can be estimated over time. In Rathbun Lake, crappie and gizzard shad populations are prey to walleye and known to be very explosive in years of high spring water levels (Flammang, 2016). These population explosions at the lake may in part be attributable to fewer predatory fish being available throughout the year to prey upon fry and juvenile crappie and gizzard shad that eventually turn into reproductive adults.

In fisheries management science, population levels of specific age-class of fish, typically adult brood size fish, can be used to estimate population size directly or indirectly. Direct means are typically mark-recapture studies using population estimation formulas. Indirect means is through estimating catch per unit effort (CPUE), which is an estimate of the relative abundance of a target species, based on defined sampling protocols and sampling effort. The CPUE is often the preferred means of estimating the abundance of fish species because it's much less costly and time consuming, while yielding valuable population trends information. Changes in CPUE are inferred to signify changes in a target species true abundance. A decreasing CPUE in fisheries management can indicate over-harvesting or emigration, while an unchanging CPUE can indicate sustainable harvest or population levels attributable to such things as good water quality, sufficient prey availability, and good reproduction. Increasing CPUE above sustainable management levels can indicate over population trends emerging.

Most state fisheries agencies across the U.S. have developed management guidelines for game species (Stuewe, 2016) with a goal of sustainable fish populations. These guidelines generally include success evaluation criteria for determining whether sustainable fisheries levels, as measured by abundance, are being maintained. Success evaluation is determined by whether annual sampling efforts meet pre-determined CPUE management objectives for stocking frequency and annual sampling methodology type. For example, in black and white crappie in Illinois using the biological survey method of hoop nets and assuming five previous years of stocking > 5" fingerlings, the target success objective for crappie would be 25 /net night (ILDNR, 1994). Stocking and sustainability objectives are generally being met if multiple net samples indicate about 25 crappie/net night, on average, are being sampled. The IDNR is currently developing statewide fish management guidelines for walleye.

A Trophic Benefit Assessment (TBA) model method was developed by HDR using Illinois fish management guidelines (ILDNR, 1994) success evaluation objectives for walleye to evaluate the effectiveness of the FEBB on predatory fish populations. Illinois has many reservoirs with walleye and similar piscivores, and comparable environmental conditions similar to Iowa, which makes using their guidelines a logical proxy for use at Rathbun Lake.

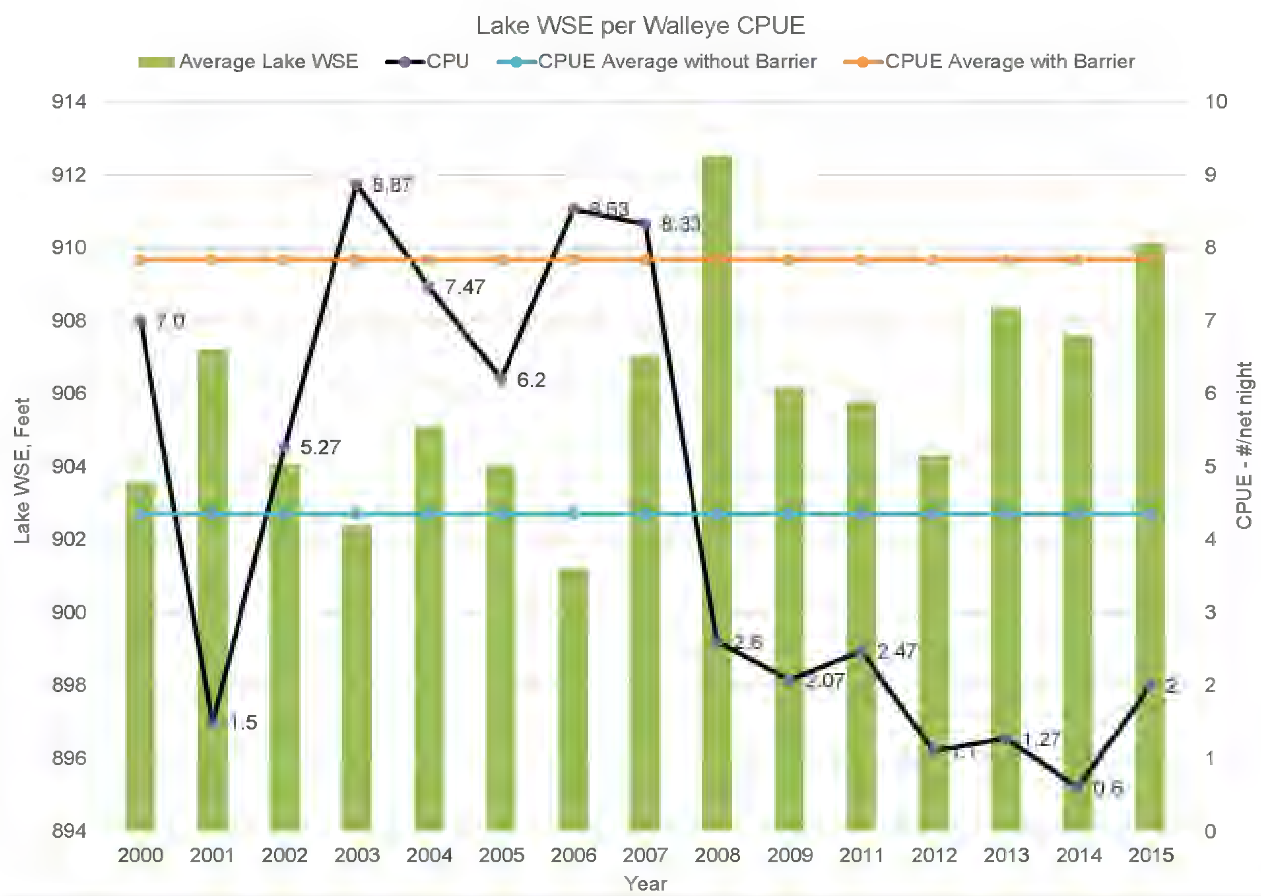
4.3.1 Trophic Benefit Method

A simple formula was developed to detect theoretical changes in walleye CPUE with and without FEBB project conditions. Long-term fall walleye gill net sampling CPUE data was used to determine an average CPUE rate for the without FEBB project conditions. A percent deterrence effectiveness value of 80 percent (Weber et al., 2016) for the FEBB was applied to the long-term CPUE average to determine the with project CPUE. IDNR provided fall walleye sampling CPUE data for Rathbun Lake from 2000 – 2015 collected in the lower 1/3 of the lake that was used to establish the baseline without-out project condition. The without and with project CPUE rates were compared to success evaluation objectives of 5-10 walleye/net night (all size classes) with fall gill netting and supplemental stocking 4 out of 6 years, found in the Illinois guidelines (ILDNR, 1994). Average CPUE from Rathbun Lake was then compared to these objectives.

4.3.2 Trophic Benefit Results

The results of the TBA are as follows and shown in Figure 3-2. From 2000 – 2015, a 15-year period of record in which no FEBB is present to deter emigration of fish through the dam intake, actual CPUEs varied from 0.6 net/night in 2014 to 8.87 net/night in 2003 as shown by the black line in Figure 3-2. The CPUE trend has been markedly downward since 2008. A statistically significant inverse correlation relationship (R2 = -.71) exists between water surface elevation and CPUE in the 15-year period of record. The average annual CPUE for that period is 4.35 CPUE as shown by the blue line in Figure 4-1. This is below the Illinois objectives of 5-10/net night. With a FEBB in place at the dam intake over the same period of record, and with 80 percent deterrence performance, the long-term average CPUE increases to 7.83 fish/net night, which is within acceptable levels of a more sustainable fishery.

Figure 4-1: CPUE Performance



Conclusions

The walleye HSI model indicates increases in forage and reproductive habitat that result from both a FEBB operation and increase in discharge rates under the new WCM operation plan. Although the HSI model doesn't account for more walleye brood stock being retained, more adult fish would be available to spawn. HSI model results also indicate the FEBB will provide 526 Net AAHUs to the lower 1/3 of the lake over the life of the project. The TBA model indicates that populations of walleye and other piscivores will increase to more sustainable levels with the FEBB in place and operating.

5.0 SELECTION PROCESS

Measures at each site were combined to formulate alternatives. Alternatives evaluation is based on a comparison of the future without project (FWOP) condition to each of the with-project alternative conditions. The benefits of each alternative are measured as the net gain in habitat units (HU) over the fifty-year period of analysis. The total average annual costs and net average annual benefits of each alternative are initially evaluated using cost-effectiveness to determine which alternatives are cost effective; and then secondly to determine which of the cost-effective alternatives are the most efficient in producing benefits (incremental cost analysis). In accordance with Engineer Regulation 1105-2-100, E-36 results of the cost effectiveness/incremental cost analysis (CE/ICA) coupled with decision making guidelines affordability, effectiveness, and efficiency were used as tools to better inform the recommended plan selection process. USACE software program from the Institute for Water Resources (IWR) Planning Suite II version 2.0.9, USACE certified April 2017, was used to conduct the analyses.

Ecosystem outputs, quantified as HUs, were calculated using a USACE certified white crappie HSI model. This model was used because the embayments selected for restoration are important spawning sites according to the USFWS HEP. Habitat quantity was factored into an equation with HSI to derive a HU for each alternative. HUs were annualized to determine the Cumulative HU, Gross AAHUs and Net AAHUs. The Net AAHUs were used in the cost/benefit analysis. More detailed discussion of the AAHU calculations can be found in Section 4.1 Shoreline Habitat Restoration Modeling.

The software combined solutions for each site within the project and generated the range of plausible combinations. Solutions for each site were mutually exclusive, due to the variance in scale between sites. Habitat outputs and costs for each solution were calculated first and then input into the model. Each site was entered as a solution with the four possible measures entered as scales. The cost estimates for each restoration measure were provided in FY15 dollars. The cost estimates included construction, construction contingency, planning and engineering during design (PED), construction management, engineering during construction, and land, easements, right-of-way, utility relocation and disposal (LERRD). Although specific LERRD costs will not be necessary, the cost account was added for screening purposes. Costs were updated to the FY21 price level using the Civil Works Construction Cost Index System (CWCCIS) composite average of all accounts index factor. The update factor is similar to the specific 06 account for Fish and Wildlife Facilities. Costs were annualized using the FY21 Federal Discount Rate of 2.50% over a 50-year period of analysis. Interest during construction was not calculated because construction is estimated to take less than one year. Annual OMRR&R costs were considered and added to the average annual cost of each alternative. The PDT determined that the annual cost for each embayment area was $1,275 and the floating electric boom barrier has an annual cost of $7,000. Monitoring will be conducted during routine annual fish sampling. The need for and type of adaptive management measures will depend on IDNR fish sampling results. Therefore, monitoring and adaptive management costs were not included in the cost estimate. Table 5-1 displays the combination of measures that compose the alternatives as well as the average annual costs per measure and the net average annual habitat unit.

Table 5-1. CE/ICA Solutions and Scales-Round 1				
IWR PLANNING SUITE INPUTS-INITIAL ARRAY-ROUND 1				
Solution	**Code**	**Number of Scales**		
Site A-B1	AB	4		
Site B2-B3	BB	4		
Site B1Alt-BAlt2	BA	4		
Site C1-C2	C	4		
Site D-E	D	1		
FEBB	F	1		
Name	**Code**	**Scale Number**	**ANNUALIZED COSTS***	**Output (NET AAHU)**
AB	0	No Action	0.00	0
AB	1	Rock, Vegetation	41.70	0.68
AB	2	Rock, Geotextile Fabric	42.00	0.68
AB	3	Rock, Vegetation, Geotextile Fabric	42.03	0.68
AB	4	Rock, Vegetation, Rock Extension	45.59	0.81
BB	0	No Action	0.00	0
BB	1	Rock, Vegetation	28.08	0.34
BB	2	Rock, Geotextile Fabric	28.35	0.34
BB	3	Rock, Vegetation, Geotextile Fabric	28.36	0.34
BB	4	Rock, Vegetation, Rock Extension	35.94	0.47
BA	0	No Action	0.00	0
BA	1	Rock, Vegetation	42.54	0.75
BA	2	Rock, Geotextile Fabric	43.27	0.75
BA	3	Rock, Vegetation, Geotextile Fabric	43.31	0.75
BA	4	Rock, Vegetation, Rock Extension	50.90	0.89
C	0	No Action	0.00	0
C	1	Rock, Vegetation	37.60	0.59
C	2	Rock, Geotextile Fabric	37.94	0.59
C	3	Rock, Vegetation, Geotextile Fabric	37.96	0.59
C	4	Rock, Vegetation, Rock Extension	40.32	0.69
D	0	No Action	0.00	0
D	1	Rock Extensions	50.00	3.88
F	0	No Action	0.00	0
F	1	Floating Electric Boom Barrier	81.75	526
*Cost estimates were provided in FY15 dollars. Price level was updated to FY21 using the CWCCIS Composite Index Factor and annualized using the FY21 Federal Interest rate of 2.50% over a 50-year period of analysis. Costs are displayed in $1,000s.**Costs include the following cost categories: Construction, Construction Contingency, PED, Construction Management, Engineering during Construction and LERRD				

5.1 COST EFFECTIVENESS and INCREMENTAL COST ANALYSIS

Cost effectiveness and incremental cost analyses allow decision makers to weigh the monetary cost of alternatives with the environmental benefit they generate. Analyzing the cost effectiveness of each alternative identifies alternatives that do not efficiently utilize resources and allows decision-makers to eliminate those alternatives and focus on ones that generate significant benefits relative to the cost. Cost effective alternatives generate the most benefits for the least cost. These alternatives produce more benefits than alternatives at the same or less cost level and no other alternative produces the same level of benefit for less cost. Alternatives found to be cost ineffective were screened from further consideration.

Once alternatives are culled through analyzing the cost effectiveness, the remaining alternatives are analyzed through the incremental cost analysis. This process generates “best buy” and “cost effective” alternatives. Best Buy alternatives generate the greatest increase in benefits relative to the increase in costs, thereby having the lowest incremental cost per benefit. Showing the progressive levels of cost relative to output provides decision-makers with means to decide if the costs from one alternative to another are justified by the change in benefits.

The Planning Suite generated 2,500 total plans, of which eight were “best buy” plans, including the No Action plan, and 56 were “cost effective”, including the No Action plan. Additional information regarding habitat modeling, cost effectiveness, and incremental cost analysis is included in Appendix F.

5.2 REFINED SCREENING PROCESS

One of the project objectives is that a final plan would restore embayment at all evaluated areas in include restoration actions at each site within the project area. After further evaluation of the cost effective and best buy plans to meet the project objectives and overall goal, eleven alternatives (including the No Action) were carried forward for further screening. These efficient solutions are the alternatives presented below in Table 5-3, along with the No Action alternative.

Table 5-2. Final Array of Alternatives

	Final Array of Alternative Number	**Best Buy or Cost Effective**	**Action Alternatives**	**Output**	**Average Annual Cost (FY21)**	**Average Cost/Net AAHU**
				(Net AAHUs)	**($1000)**	**($)**
	1	Best Buy	No Action	0.00	0.00	0.00
	2	Best Buy	AB4BB4BA4C4D1F1	532.74	$304.5	$0.57
	3	Cost Effective	AB1BB1BA1C4D1F1	532.34	$284.39	$0.53
	4	Cost Effective	AB4BB1BA1C1D1F1	532.37	$285.56	$0.54
	5	Cost Effective	AB4BB1BA1C4D1F1	532.47	$288.28	$0.54
	6	Cost Effective	AB1BB1BA4C4D1F1	532.48	$292.75	$0.55
	7	Cost Effective	AB4BB4BA1C1D1F1	532.5	$293.42	$0.55
	8	Cost Effective	AB4BB1BA4C1D1F1	532.51	$293.92	$0.55
	9	Cost Effective	AB4BB4BA1C4D1F1	532.6	$296.14	$0.56
	10	Cost Effective	AB4BB1BA4C4D1F1	532.61	$296.64	$0.56
	11	Cost Effective	AB4BB4BA4C1D1F1	532.64	$301.78	$0.57

The above eleven alternatives are considered to be the final array of alternatives. Table 5-3 displays the average annual costs and the net AAHU that were input into IWR Planning Suite for the second round of screening.

Table 5-3. IWR Planning Suite CE/ICA Inputs

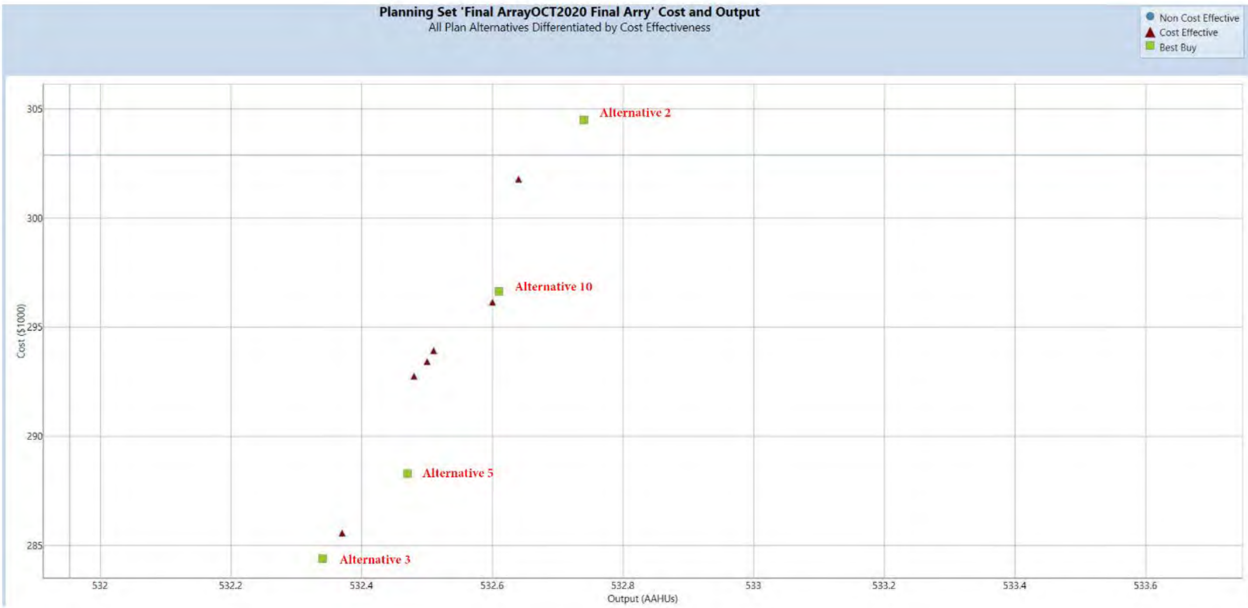
Plan Name	Plan Description	FY21 Average Annual Cost ($1000s)	Output (Net AAHUs)
No Action Plan	Default No Action Plan	0	0
Alternative 2 (BB)	AB4BB4BA4C4D1F1	$304.5	532.74
Alternative 3 (CE)	AB1BB1BA1C4D1F1	$284.39	532.34
Alternative 4 (CE)	AB4BB1BA1C1D1F1	$285.56	532.37
Alternative 5 (CE)	AB4BB1BA1C4D1F1	$288.28	532.47
Alternative 6 (CE)	AB1BB1BA4C4D1F1	$292.75	532.48
Alternative 7 (CE)	AB4BB4BA1C1D1F1	$293.42	532.5
Alternative 8 (CE)	AB4BB1BA4C1D1F1	$293.92	532.51
Alternative 9 (CE)	AB4BB4BA1C4D1F1	$296.14	532.6
Alternative 10 (CE)	AB4BB1BA4C4D1F1	$296.64	532.61
Alternative 11 (CE)	AB4BB4BA4C1D1F1	$301.78	532.64
*Costs in FY21 price level; annualized using the FY21 Fed discount rate of 2.50% over a 50-year period of analysis			

IWR Planning Suite was run again with the final eleven alternatives. Of the eleven final alternatives, eleven plans were "Cost Effective" (including the No Action), and of the cost-effective plans five alternatives (including the No Action plan) were "Best Buy". Table 5-4 displays the outcome of the final CE/ICA run. Figure 5-1 displays both cost effective plans and best buy plans.

Table 5-4. Final Array CE/ICA Run

Net Output and Average Cost/Net AAHU Cost Effective and Best Buy Plan Alternatives						
	Name	**Best Buy or Cost Effective**	**Action Alternatives**	**Net AAHU**	**Average Annual Cost (FY21)**	**Average Annual Cost/Net AAHU**
				(AAHUs)	**($1000)**	
	No Action Plan	Best Buy		0.00	$0.00	$0.00
	Alternative 3	Best Buy	AB1BB1BA1C4D1F1	532.34	$284.39	$0.53
	Alternative 4	Cost Effective	AB4BB1BA1C1D1F1	532.37	$285.56	$0.54
	Alternative 5	Best Buy	AB4BB1BA1C4D1F1	532.47	$288.28	$0.54
	Alternative 6	Cost Effective	AB1BB1BA4C4D1F1	532.48	$292.75	$0.55
	Alternative 7	Cost Effective	AB4BB4BA1C1D1F1	532.50	$293.42	$0.55
	Alternative 8	Cost Effective	AB4BB1BA4C1D1F1	532.51	$293.92	$0.55
	Alternative 9	Cost Effective	AB4BB4BA1C4D1F1	532.60	$296.14	$0.56
	Alternative 10	Best Buy	AB4BB1BA4C4D1F1	532.61	$296.64	$0.56
	Alternative 11	Cost Effective	AB4BB4BA4C1D1F1	532.64	$301.78	$0.57
	Alternative 2	Best Buy	AB4BB4BA4C4D1F1	532.74	$304.5	$0.57

Figure 5-1. Final Array Cost Effective and Best Buy Plans



6.0 SELECTED PLANS

The five best buy plans were brought forward to assist in plan selection. The annualized cost and corresponding AAHUs for these plans are presented in Table 6-1 and an incremental cost table is presented as Table 6-2. Although the No Action alternative is a Best Buy plan it does not meet the project purpose and need, project goal or objectives.

Table 6-1. Selected Plans

	Annualized Cost	Net AAHUs
Alternative 1 (No Action)	**$0.00**	**0.00**
Alternative 3	$ 248,390	532.34
Alternative 5	$ 288,280	532.47
Alternative 10	$ 296,640	532.61
Alternative 2	$ 304,500	532.74

October 2020 (FY21) prices, 50-year period of analysis, FY21Federal Interest Rate of 2.50%

Table 6-2. Incremental Cost Table

	Annualized Cost	Net AAHUs	Incremental Cost	Incremental Output	Incremental Cost / Incremental Output
Alternative 1 - No Action	$ -	$ -	$ -	0	$ -
Alternative 3	$248,390	532.34	$248,390	532.34	$467
Alternative 5	$288,280	532.47	$39,890	0.13	$306,846
Alternative 10	$296,640	532.61	$8,360	0.14	$59,714
Alternative 2	$304,500	532.74	$7,860	0.13	$60,462

October 2020 (FY21) prices, 50-year period of analysis, FY21 Federal Interest Rate of 2.50%

6.1 Acceptability, Completeness, Effectiveness, and Efficiency

Acceptability, completeness, effectiveness, and efficiency are the four evaluation criteria the USACE uses in evaluating alternative plans. Plans considered for recommendation in any planning study including ecosystem restoration studies, need to meet these criteria in order to qualify for further consideration and comparison with other plans.

6.1.1 Acceptability

An ecosystem restoration plan should be acceptable to state and federal resource agencies and local governments with evidence of broad-based public consensus and support for the plan. The Recommended Plan must be acceptable to the cost-sharing NFS.

The suite of habitat restoration measures and plans outlined within this report were developed, screened and retained for further consideration with input from stakeholders and the NFS. The No Action Alternative provides no ecosystem improvements and is not acceptable in meeting the stakeholder, federal and NFS goals and stakeholder objectives. The action alternatives considered provide for habitat restoration. However, Alternative 2 is the most acceptable in terms of meeting aforementioned goal and objectives as it provides for restoring all proposed sites, restoring lake trophic balance and provides more AAHUs than other action alternatives considered.

6.1.2 Completeness

A plan must provide and account for all necessary investments or other actions needed to ensure the realization of the planned restoration outputs. The No Action Alternative does not provide any action to restore degraded habitats and therefore is incomplete in realization and is incomplete because it does not include restoration measures at the lake. Alternative 2 includes implementation of holistic habitat restoration measures that would provide habitat restoration and a fish emigration barrier to benefit fish and other aquatic species which rely on the diversity and quality of lake aquatic habitat. Compared to the other action alternatives considered, Alternative 2 provides a complete plan for ecosystem restoration at the lake and is consistent and compatible with current and future NFS plans for continued ecosystem restoration activities.

6.1.3 Effectiveness

The problems identified for this study as stated earlier generally include shoreline erosion resulting in the sedimentation of fish spawning and nursery habitat and the loss of native fish downstream as a result of emigration. Problems and opportunities were considered when addressing study goals and objectives and the No Action Alternative and action alternatives considered do not provide for overall effective aquatic ecosystem restoration. Alternative 2 provides for the most effective measures to restore aquatic habitat and restore trophic balance compared to the other alternatives considered and provide for an effective and substantial contribution to aquatic habitat ecosystem restoration and ecosystem lift.

6.1.4 Efficiency

An ecosystem restoration plan must represent an efficient means of habitat restoration to improve the environment and a Recommended Plan should produce more restoration outputs that cannot be produced more cost efficiently than other plans. An array of restoration measures was formulated to address site specific opportunities focusing on previously identified areas in need of restoration and the emigration of native fish downstream of Rathbun Lake. Through cost effectiveness and incremental cost analysis, cost effective and Best Buy plans were identified as having the least incremental increase in cost per unit habitat output and were retained for consideration. All inefficient options were removed from further consideration. The No Action Alternative does not meet the study's planning objectives. Alternative 2 generates the most efficient and greatest contribution towards accomplishing the project objectives (i.e. largest increase in AAHUs) compared to the action alternatives considered and is also a Best Buy plan (i.e. least increase in costs as units of AAHU are progressively increased).

7.0 RECOMMENDED PLAN

Habitat analysis and CE/ICA were used to inform a Recommended Plan. The Recommended Plan is Alternative 2, which consists of grading and sloping degraded banks, the placement of rock to stabilize restored areas, vegetation at top of bank to prevent erosion, the use of rock extensions to direct silt movement and the placement of a FEBB at the lake intake tower. Embayment restoration engineering plans and a FEBB illustration are in Appendix G.

Alternative 2 provides a net benefit of 532.74 net AAHUs and achieves the ecosystem restoration project purpose and need of restoring degraded habitat, preventing the continued sedimentation of fish spawning and nursery habitat and decreasing downstream fish emigration to restore lake trophic balance at the lowest incremental cost of the alternatives proposed. The project would result in restoration of approximately 432 acres of embayment spawning and nursery habitat following construction and FEBB placement to minimize fish emigration and restore trophic balance.

7.1 Economics of the Recommended Plan

A cost estimate was developed for the Recommended Plan and is summarized below in Table 7-1. Table 7-2 shows the economic summary of the Recommended Plan, Alternative 2.

Table 7-1. Recommended Plan First Cost Estimate

Item	Cost
Planning, Engineering and Design	$1,307,000
Construction	$5,556,000
Construction Management	$267,000
Contingency	$2,281,500
Recommended Plan Estimated Cost	**$9,411,500**

FY21 Price Level
*Slight discrepancy in total is due to rounding

Table 7-2. Economic Summary of the Recommended Plan's First Cost Estimate

Item	Cost
Total Estimated Project Cost (FY21)	$9,411,500
Interest During Construction[1]	$0
Total Investment Costs	**$9,411,500**
Total Annualized Investment Costs[2]	$331,831
Annual Operations and Maintenance Costs	$13,375
Total Annualized Costs	**$345,206**
Net Average Annual Habitat Units	532.74
Annualized Cost per Net Average Annual Habitat Unit	**$647.98**

[1]Construction is not expected to last longer than one year.
[2]Costs annualized using the Fiscal Year 2021 discount rate of 2.50 over a 50-year period of analysis%.
Costs are in FY21 Price Level

8.0 ENVIRONMENTAL CONSEQUENCES

The Recommended Plan (Alternative 2) and the No Action alternative are carried forward in the analysis of environmental consequences. The No Action alternative is a consideration under NEPA and serves as the baseline for the assessment of future conditions and impacts. Although the No Action alternative is a Best Buy plan, this alternative does not meet the ecosystem restoration project purpose and need, or established goals and objectives of restoring habitat and trophic balance at Rathbun Lake.

Potential impacts are described using the following terms:

- Beneficial or Positive: A positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition.

- Adverse or Negative: A change that moves the resource away from a desired condition or detracts from its appearance or condition. Adverse impacts can be mitigated by different means such as through avoidance or minimization of adverse impacts.
- Direct: An effect on a resource by an action at the same place and time.
- Indirect: An effect from an action that occurs later or perhaps at a different place and often to a different resource but is still reasonably foreseeable.
- Short-term: Impacts generally occur during construction or for a limited time thereafter, generally less than two years, by the end of which the resources recover their pre-construction conditions.
- Long-term: Impacts last beyond the construction period and the resources may not regain their pre-construction conditions for a longer period of time.

8.1 Resources Considered but not Carried Forward for Analysis

Section 2 evaluated resource categories within the existing and FWOP conditions. Land use was not carried forward for analysis as land use within the restored areas would not change. No adverse impacts would occur to geology and prime or unique farmland as geology would not be impacted by any restoration activity and no prime or unique farmland is located within or adjacent to restoration areas. Similarly, no impacts would occur to wetlands, historic or cultural resources, hazardous waste, the Chariton River floodplain or environmental justice. These resources or their habitat and minority or low-income populations are not located within or adjacent to restoration areas or the area of barrier placement and would therefore not be impacted by the Recommended Plan.

8.2 Climate

No Action

More sporadic and frequent large rain events would be anticipated to result in minor short- and long-term adverse impacts to the Rathbun Lake shoreline and habitat areas that need restoration due to the potential increased erosion and sedimentation of these areas as a result of climate change. Similarly, increased precipitation could result in increased water releases from Rathbun Lake and result in increased minor, short-term and long-term trophic imbalance due to increased fish emigration.

Recommended Plan

The Recommended Plan would result in protecting areas prone to erosion from further eroding into fish spawning and nursery habitat as a result of anticipated climate change and result in short-term and long-term beneficial impacts. The project would be designed to be resilient to climate change as the ledges used for quarry run rock are chosen based on exposure to previous freeze/thaw cycles. The placement of a FEBB at the lake intake tower would result in reduced fish emigration downstream. The FEBB would be resilient to climate change as weather resistant materials are used in manufacturing and/or the FEBB can be removed seasonally to prevent potential damage from ice.

8.3 Soils

No Action

The No Action alternative would result in minor, long-term adverse impacts to soils as increased erosion and sedimentation would continue to occur along the lake shoreline. Additionally, more sporadic and frequent large rain events due to climate change would exacerbate soil erosion.

Recommended Plan

The Recommended Plan would result in the protection of soils in areas of habitat restoration. The existing precipitation received at the lake and increased precipitation as a result of climate change would continue to result in minor, long-term increased erosion in unrestored areas. A floating barrier placed at the intake tower is not anticipated to adversely impact soils as it would be anchored in the water.

8.4 Riparian Vegetation

No Action

The No Action alternative would likely result in no riparian vegetation impacted in the locations of embayments to be restored.

Recommended Plan

The Recommended Plan would result in minor, long-term adverse impacts to approximately 25 trees and shrubs due to selective tree clearing to provide an approximate 15 foot access for 300 feet to restore embayment C1-C2. Existing access roads and trails would be used for access to the extent practicable. The access to C1-C2 would be left in place following construction for monitoring and maintenance purposes. An additional ten individual trees located lakeward and downslope from embayment dense vegetation would also be removed to facilitate restoration.

8.5 Water Quality

No Action

The No Action alternative would continue to result in minor, long-term, adverse water quality impacts to fish spawning and nursery embayments. Water quality impacts include sediment deposition within viable spawning and nursery habitats resulting in unsuitable habitat for spawning and egg development and the suspension/resuspension of solids resulting in increased turbidity.

Recommended Plan

The Recommended Plan would result in long-term, minor beneficial impacts to water quality as the Recommended Plan would prevent erosion and the resulting sediment deposition within spawning and nursery habitats and the suspension/resuspension of solids resulting in increased turbidity. As mentioned in Section 2.1 Purpose and Need, the monitoring of previously restored areas by IDNR showed that in addition to preventing the siltation of fish spawning and nursery habitat, areas of shoreline restoration were observed to have decreased turbidity. A barrier placed at the intake tower could result in localized, short-term, minor water quality impacts during barrier placement as sediment may be resuspended during anchor placement.

The project will be conducted under Nationwide Permit 27, which provides for aquatic habitat restoration, enhancement and establishment activities (Appendix H). In accordance with Section 401 of the Clean Water Act, the Iowa Department of Natural Resources has issued Section 401 Water Quality Certification for a variety of NWPs, including NWP 27. The project will comply with NWP 27 general permit conditions and State of Iowa regional permit conditions.

In addition to general and regional permit conditions, best management practices (BMPs) such as the placement of straw bales, trenching of silt fencing and any other appropriate BMPs would be in place prior to construction to prevent soil entering the lake during earthwork activities. Previous restorations at the lake were conducted in the winter timeframe along a frozen shoreline, which helps to contain excavated soils and prevent windborne soil particles. Similarly, the current restoration would be scheduled within the winter timeframe.

8.6 Fish and Wildlife

No Action

The No Action alternative would continue to result in short-term and long-term minor adverse impacts to fish and wildlife and potential, long-term major adverse impacts to fish and wildlife due to the continued erosion of soil and the sedimentation of spawning and nursery habitat in embayments to be restored, and additional, unprotected embayments, particularly with the anticipated adverse effects of climate change. The sloughing of banks, particularly within the northern portion of Rathbun Lake, has resulted in upland wildlife habitat including oak and hickory stands to slough into the Lake. Without a barrier in place to prevent fish emigration, the trophic balance and the cascading effects of native fish emigration downstream would result in the continued decline of native species diversity and fish populations within the lake and adverse, synergistic effects combined with the absence of, and need for habitat restoration to prevent embayment sedimentation.

Recommended Plan

The Recommended Plan would result in minor, long-term and potential major, long-term positive impacts to fish and wildlife. Beneficial impacts from the sloping of banks, quarry run rock placement and vegetation establishment at the top of banks would result in preventing the sloughing of banks composed of upland wildlife habitat into fish spawning and nursery habitat. The Recommended Plan would result in beneficial impacts to a variety of centrarchids in addition to white crappie. As mentioned in Section 3.1.1, the monitoring of previously restored shoreline and adjacent habitat showed that in addition to preventing the siltation of fish spawning and nursery habitat, areas of restoration were observed to have decreased turbidity, increased zooplankton taxa and increased abundance of white crappie, black crappie, largemouth bass and gizzard shad compared to unrestored areas (Krogman 2015).

No downstream impacts to native fish are anticipated as a result of the proposed project as the Chariton River downstream of Rathbun Lake is currently heavily populated with invasive carp species and barrier effectiveness would likely measure approximately 80%, which would allow native fish species to continue to enter the Chariton River downstream.

8.7 Threatened and Endangered Species

No Action
The No Action alternative would be anticipated to result in no short-term adverse impacts to threatened and endangered species. Potential, long-term, minor adverse impacts to bats including threatened and endangered species could occur due to the sloughing of oak-hickory habitat into the lake due to bank erosion, particularly in the northern portion of the lake where steep cut banks are located.

Recommended Plan
Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the USACE determined that the Recommended Plan may affect but is not likely to adversely affect the Northern long-eared bat or Indiana bat as approximately 300' x 15'of minimal tree clearing would occur to facilitate embayment access for restoration. An estimated 25 trees would be removed for access and an additional 10 individual trees located lakeward and downslope from embayment dense vegetation would be removed to facilitate restoration. Tree clearing could result in a minor, long-term adverse impact to the Northern long-eared bat and Indiana bat, although trees would be removed during the non-maternity period between October 1 and March 31, and tree removal would not appreciably change the character of the available Northern long eared bat and Indiana bat summer habitat for returning bats as hundreds of acres of upland oak-hickory and riparian vegetation is located adjacent to the embayments to be restored and additional locations within the vicinity of Rathbun Lake. No caves, mines or designated critical habitat for bat species is located within or adjacent to the areas to be restored. Construction will be conducted in the winter and therefore the provisions of the 4(d) rule that apply to the Northern long-eared bat will be met. The USFWS concurred with the USACE determination on June 13, 2019 (Appendix B). The Recommended Plan would result in no effect to the prairie bush clover or western prairie fringed orchid as there is no viable habitat for these species within the areas to be restored due to erosion and no tallgrass prairie is located within or adjacent to the areas to be restored.

8.8 Recreation

No Action

The No Action alternative will continue to result in minor, short- and long-term adverse impacts due to the siltation of embayments that provide spawning, nursery and foraging habitat for numerous fish species. In addition to habitat degradation, the emigration of fish will also continue to result in minor short- and long-term adverse impacts to recreation within Rathbun Lake proper. Fishing would continue to occur within areas of viable fish habitat within the lake and the Outlet Park just below Rathbun Lake.

Recommended Plan

The Recommended Plan would be anticipated to provide minor, long-term positive impacts to recreation. Areas designated for recreation would be unavailable for recreation during construction, although restoration conducted during the winter would lessen or alleviate this impact. Positive impacts to recreation as a result of habitat restoration and the placement of a barrier would be incidental to habitat restoration and restoring trophic balance to the lake ecosystem. A FEBB is anticipated to result in an 80% reduction of downstream fish emigration based on previous PAS studies and consultation with Smith-Root, Inc. Therefore, fishing in the Outlet Park just below Rathbun Lake would not be anticipated to be adversely impacted by barrier placement.

8.9 Socioeconomics and Environmental Justice

No Action

The No Action alternative would be anticipated to result in no adverse impacts to minority or low-income populations within or adjacent to the project area as minority and low-income populations are not located within the vicinity of the project area. The State of Iowa would continue to receive minor, long-term adverse economic impacts as they would continue to culture and stock large numbers of fish and conduct fish recapture in the tailrace to relocate fish back into the lake in the absence of fish barrier placement. These costs are anticipated to decrease as a result of habitat restoration and fish barrier placement.

Recommended Plan

Habitat restoration would be expected to temporarily increase employment in the region. The contracting mechanism for all previous Rathbun Lake restorations was small business, invitation for bid. Therefore, the Recommended Plan is anticipated to result in a minor, positive short-term economic impact for a small business construction contractor. In the long-term, habitat restoration would result in increased fisheries abundance and trophic balance, which will result in increased long-term economic benefits for the State of Iowa. Minor to major long-term, positive socioeconomic benefits would result for the State of Iowa and the IDNR due to the decreased costs of fish culture, stocking and fish recapture and relocation attributed to ecosystem restoration. The Recommended Plan is anticipated to provide benefits for the project life of 50 years.

8.10 Air Quality and Noise

No Action
The No Action alternative would result in no changes to existing air quality and noise within and adjacent to the project area.

Recommended Plan
Short-term, minor adverse impacts to air quality and noise would occur during construction due to earthwork and placing quarry run rock. Construction would result in the generation of common air quality pollutants including nitrogen oxides and ground level ozone. Temporary air quality impacts are not anticipated to affect attainment status as previous habitat restorations have not resulted in impacting attainment status. Short-term, minor noise would result from the operation of construction equipment including excavators, graders and haulers. However, construction during the winter would likely result in very minimal noise impacts as the only recreation that generally occurs within the vicinity of restored areas is snowmobiling.

BMPs such as watering construction sites and access routes during construction could be implemented if needed to minimize fugitive dust emissions. Disturbed sites would be seeded concurrent with restoration or immediately following restoration to prevent erosion and dust and windblown particles.

8.11 Aesthetics and Safety

No Action
The No Action alternative would result in minor, long-term adverse aesthetic impacts due to continued erosion in areas that need be restored. Boater and swimmer safety would remain static.

Recommended Plan
The Recommended Plan would result in a minor, long-term positive aesthetic impacts to areas in need of restoration. Previous habitat restorations have resulted in sloping degraded banks and the placement of quarry run rock in numerous areas along the shoreline, which prevents further shoreline degradation and improves the aesthetics of eroded shoreline and also provides aquatic habitat. The placement and operation of a floating electric barrier with orange buoys used for demarcation would result in a minor, long-term adverse impact to existing aesthetics and not adversely impact boater or swimmer safety based on the history of electric barriers in public waters. The presence of buoys in public waters for demarcation and exclusion is relatively common.

The only recreation that takes place near the vicinity of the intake tower is boating and fishing within Rathbun Lake proper and fishing about 0.13 miles downstream of the intake tower in the stilling basin at Outlet Park. Otherwise, the nearest boat ramp is located 0.36 miles to the northwest and the nearest swimming beach and campground is the Island View Area located about 1.6 miles northwest of the intake tower. As discussed in Section 2.14, boats can safely pass through fish barrier electric fields including metal-hulled boats as hulls distort the electrical field and in the event that a boat occupant or swimmer would enter the water near the FEBB, the electric field is applied to the lower level of the water column and would not result in injury.

8.12 Summary of Environmental Consequences

The Recommended Plan would primarily result in short- and long-term positive impacts to natural resources. The Recommended Plan would result in minor, long-term positive impacts to soils and water quality as a result of stabilizing eroding areas. Minor, long-term and potential major, long-term positive impacts to fish and wildlife are anticipated due to preventing the erosion of terrestrial habitat into aquatic habitat, restoration of eroded areas and the placement of a barrier to prevent downstream fish emigration and restore lake trophic balance. Minor, long-term positive impacts to recreation would occur incidentally with habitat and trophic balance restoration. A minor, short-term positive economic impact would occur for a construction contractor.

The Recommended Plan would result in a minor, long-term positive impact to aesthetics as eroded areas would be restored. The Recommended Plan would also result in a minor, long-term negative impact to aesthetics due to the placement of buoys at the location of an FEBB. However, the buoys would support the FEBB, concurrently provide safety demarcation and are relatively common in public waters. Typical, short-term, minor adverse impacts from construction would include air quality and noise. A long-term, minor impact to riparian vegetation would occur due to selective clearing of approximately 25 trees to access embayment C1-C2 as an approximate 300 ft. x 15 ft. access would be cleared and left in place following construction for maintenance purposes. Ten individual trees would also be removed downslope of embayment locations to facilitate restoration. Tree clearing could result in a minor, long-term adverse impact to the Northern long-eared bat and Indiana bat, but construction would be conducted in winter to minimize impacts to bat summer habitat. The project is designed to be climate resilient as the ledges chosen for quarry run rock are based on exposure to previous freeze/thaw cycles and the FEBB can be manufactured using weather resistant materials and/or removed prior to ice over.

8.13 Cumulative Impacts

CEQ regulations define cumulative impacts as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time” (CEQ, 1997). These actions include on-site and off-site projects that are affecting or would affect the same environmental resources as would be affected by the Recommended Plan.

The No Action Alternative would continue to result in the sedimentation and degradation of embayments that provide fish and macroinvertebrate spawning, nursery and foraging habitat. Coupled with the emigration of native fish downstream, the trophic balance of Rathbun Lake would continue to be adversely impacted. IDNR would continue to spend numerous funds and manpower on fish culture, restocking and the recapture of fish in the tailrace and their associated relocation into areas away from the intake tower vicinity.
The Recommended Plan would result in no project impacts and no cumulative impacts to land use, geology, prime or unique farmland, wetlands, historic or cultural resources, hazardous waste or floodplain as these resources are not located within or adjacent to restoration areas or the area of barrier placement. A buoy system to support and demarcate a fish barrier for safety would result in a single minor, long-term negative impact, but would not result in a cumulative adverse aesthetic impact.

The Recommended Plan would primarily result in long-term, positive cumulative impacts to the aquatic ecosystem of Rathbun Lake and contribute to the positive impacts of past, present and reasonably foreseeable future actions at Rathbun Lake. Cumulative impacts primarily include the positive impacts resulting from previous aquatic ecosystem restoration projects designed to prevent the degradation of habitat and restore habitat viability within adversely impacted fish spawning embayments. Positive impacts that will contribute to overall cumulative impacts include the prevention of soil erosion that can result in the sloughing of oak and hickory stands comprising wildlife habitat and the associated siltation and sedimentation of fish spawning, nursery and foraging habitat. A cumulative, incidental benefit to recreation also occurs due to restoration activities as fish and wildlife and their associated habitats benefit from restoration activities.

Benefits to water quality from the project associated with restoration efforts that prevent the erosion of soil into embayments would also contribute to overall positive cumulative impacts. A cumulative benefit to overall lake water quality includes the efforts by local stakeholders within the watershed to improve water quality using best management practices (BMPs). BMPs include the construction of sediment control basins, terracing, grass buffers, filter strips and cereal rye cover crops to settle and filter sediment and pollutants including sediment and total phosphorous. These combined efforts have also resulted in cumulative positive impacts to fish and wildlife due to decreasing the erosion of upland habitat and associated sediments and deleterious chemicals into Rathbun Lake.

The combined adverse effects of habitat degradation and fish emigration downstream have resulted in a cumulative adverse socioeconomic effect for the State of Iowa and the IDNR which include the cost of increased fish culture, stocking, sampling, recapture and the relocation of fish to areas away from the lake intake structure. Therefore, the culmination of habitat restoration and the inclusion of a fish barrier for a holistic approach to aquatic ecosystem restoration as numerous fish species including apex predators would be prevented from emigrating through the lake outlet and restore trophic balance to the lake ecosystem, will contribute a long-term, positive cumulative impact to state and agency socioeconomics. Additionally, a short-term, minor positive cumulative impact would result from contracting construction to a small business as all previous habitat restoration contracting actions have resulted in small business awards.

Minor, short-term construction related impacts such as noise and air quality are inherent with restoration and other activities within the watershed. These activities are cumulative, but generally short-term in nature within the lake rural watershed and have not impacted the NAAQS attainment status of the project area or vicinity. Selective tree clearing has also been conducted to facilitate the construction of ecosystem restoration projects within the vicinity of the lake including the South Fork Wetlands restoration and previously completed section 1135 aquatic ecosystem restoration projects, which has resulted in both minor, short-term and long-term adverse impacts to riparian vegetation, but long-term ecosystem benefits. These projects, and additional activities within the watershed including agriculture, have resulted in an overall decrease in habitat for threatened and endangered species including bats. Ecosystem restoration projects have also resulted in minor, long-term, positive cumulative impacts to vegetation, threatened and endangered species and aesthetics due to sloping and stabilizing tree covered steep banks, particularly in the northern portion of Rathbun Lake, prone to erosion and sloughing into the lake and protecting restored areas from sedimentation. A buoy system to support and demarcate a fish barrier for safety would result in a minor, long-term negative aesthetic impact, but would not result in a cumulative adverse aesthetic impact as a buoy system would provide for public safety and buoys are not currently in place within Rathbun Lake.

9.0 PLAN IMPLEMENTATION

This section presents the requirements for implementing the Recommended Plan, including cost sharing and federal and non-federal responsibilities.

9.1 Cost Sharing

In accordance with the requirements under Section 1135 the Federal government is responsible for 75% while NFS is responsible for 25% of the total project costs during the design and implementation of the project (Table 9-1). The NFS is also responsible for all required lands, LERRDs and the operation, maintenance, repair, replacement and rehabilitation (OMRR&R) of the constructed project. A real estate plan is included in Appendix I. The cost agency technical review certification statement is located in Appendix J.

Table 9-1. Fully Funded Cost Estimate for Design and Implementation

Item	Federal (75%)	Non-Federal (25%)
LEERD	$0	$0
Planning, Engineering and Design	$1,050,000	$350,000
Construction	$4,575,500	$1,525,250
Construction Management	$225,750	$75,250
Contingency	$1,872,750	$624,250
Subtotal Shared Project Costs	**$7,725,000**	**$2,575,000**
Total Project Cost	**$10,300,000**	

9.2 Operation and Maintenance, Repair, Rehabilitation and Replacement

The Recommended Plan includes earthwork, the placement of quarry run rock along the shoreline and in areas adjacent to restored embayments to direct silt away from restored areas, the establishment of native vegetation at top of bank and the placement of a FEBB at the lake intake. An O&M manual for the FEBB design would be provided by Smith-Root, Inc. A similar barrier design provided by a manufacturer other than Smith-Root would also provide an O&M manual as this is standard industry practice. An O&M manual would be provided by the Kansas City District (NWK) for graded and sloped banks, rock placed to stabilize restored areas and the placement of rock to direct silt movement.

- Quarry run rock placed for stabilization and directed silt movement would not be anticipated to require any O&M, repair, rehabilitation or replacement following construction. This is based on information provided by the Rathbun Lake Operations Manager as quarry run rock and rip-rap placed for shoreline stabilization and habitat restoration has been in place for more than 25 years with no required OMRR&R (Phil Brown, personal communication), including restorations conducted 2007-2013.

- Weed control and/or reseeding but would be conducted if needed, although weed control and/or reseeding has never been conducted following restoration. Weed control and reseed is based on estimated square footage at top of bank (estimated five acres total for all sites). A three-year timeframe was chosen for this O&M item as it can take up to two years for native plant species to become established due to deep rooting in the first two years. Weed control would consist of applying herbicide to weedy forbs and woody vegetation at a cost of $400 per acre for the first two years following construction.

  Reseeding would only occur in the third year in limited areas where plants did not become fully established. Therefore, the estimated cost of reseeding ($875), is only included for one year (the third establishment year) and the area to be reseeded is conservatively estimated at a total of 0.5 acres, which provides for reseeding of 0.1 acres at each restored embayment or a total of 0.5 acres, if needed.

- FEBB annual operation cost is based on information provided by Smith-Root, Inc. and IDNR in 2020. IDNR has operated and maintained an electric barrier since 2013 at Spirit Lake, Iowa located about 300 miles north/northwest of Rathbun Lake. The estimated annual O&M cost for the FEBB totals $7,000, which includes an annual O&M manufacturer inspection of the entire barrier system including the control building and software/firmware upgrades, field testing and electrode inspection ($6,000), plus an annual electricity and internet connectivity cost ($1,000).

Table 9-2. Estimated Annual Operation & Maintenance Cost

Activity	Estimated Annual Cost
Weed Control & Reseed/Per Site	$1,275 x 5
FEBB Operation and Maintenance	$7,000
Total Estimated Cost	**$13,375**

9.3 Monitoring and Adaptive Management

The IDNR Fisheries Bureau will continue to conduct annual fish sampling throughout the entire open water period (prior to ice cover) within Rathbun Lake to obtain fisheries data as described below. Visual inspection of restored areas and the FEBB buoy system would occur during routine annual fish sampling. Therefore, “monitoring” is not a separate cost in addition to routine sampling and visual inspection. The FEBB would also be subject to annual inspection as part of operations and maintenance. Annual estimates of population abundance of adult walleye will be completed and annual trends in recruitment of young fish into the population will be evaluated in both Rathbun Lake and in the Chariton River below Rathbun Lake. Angler trends will be evaluated using an annual roving creel survey that will be conducted throughout the open-water season.

- The Iowa DNR will conduct annual spring and fall sampling of the fishery within Rathbun Lake to assess changes and improvements in year class strength of representative fish populations. Annual surveys using gill net, fyke net and electrofishing surveys will be used to measure changes in recruitment of crappie, walleye, and white bass / hybrid striped bass. As these are long-term data sets, extending back more than 25 years, the data collected will be compared to results from previous sampling events and add to the existing long-term data set.

- Annual gill net sampling of walleyes during early spring when walleye move to the dam to spawn will provide additional data and allow a comparison to previous annual population estimates. The hypothesis being, with consistent angler harvest (as measured by creel survey), reductions in emigration made possible by the installation of an electric barrier will improve long-term survival and increase walleye and other fish species abundance over time. All adult fish collected during this time period receive passive integrated transponder (PIT) tags, which allow the IDNR to estimate annual recruitment, growth, mortality and emigration from the population.
- Spring and fall angler harvest (creel surveys) data collection includes information about the effort, harvest and size distribution of fish species, which will be compared to previously collected data to measure changes in angler catch following Recommended Plan completion. These data are also part of a long-term dataset that can effectively evaluate the response of the public to improved ecosystem conditions and provide information for fish culture, stocking density and schedule to enhance ecosystem restoration.
- Water quality data will continue to be collected annually from early spring through fall. This data will primarily include secchi disc transparency monitored at multiple sites throughout the lake each day during creel surveys. These data are used to evaluate changes in water quality (primarily turbidity) resulting from habitat restoration. Restored habitat and the incidental benefit of improved water quality is expected to result in improved recruitment of fish species including crappie and walleye.
- Electric barrier effectiveness will be evaluated upon completion. Routine sampling both within Rathbun Lake and the Chariton River immediately below Rathbun Lake will allow the IDNR to further perfect existing models that explain the negative impact of the rate of floodwater discharge on fish loss (Weber et al. (2013), Weber and Flammang (2019) and will allow the IDNR to develop new models that evaluate improvements in fish retention and survival resulting from FEBB placement.

The need for, and type of adaptive management will depend on fish sampling results. Adaptive management could include further restrictions to control the harvest of individual species as well as total harvest. Examples of fisheries management techniques that can be modified or put into place include:

- Restrictions on recreational fishing gear includes line fishing methods (e.g. limited number of rod/reel combinations and hook numbers) and the use of small nets.
- Daily allowable catches (bag limits) limit the total harvest of certain species to sustainable levels.
- Setting minimum size or slot limits ensure that the majority of fish in a population are able to grow to breeding size and spawn (reach reproductive age) at least once before they are caught. This management technique is used to ensure juvenile fish in following seasons can mature and enter the adult population.

- Maximum size limits may also apply to certain species because larger fish often breed more efficiently than smaller fish (e.g. anglers may only keep two largemouth bass above 15 inches in length, per day).
- Closures on fishing in certain areas and closed seasons (e.g. walleye fishing closed at the Rathbun Dam or during their spawning season).

As these adaptive management measures are considerations based on sampling results, not labor intensive and primarily administrative in nature, there is no cost associated with these measures.

10.0 PUBLIC and AGENCY COORDINATION

A notice of availability (NOA) for the Environmental Assessment (EA) and draft Finding of No Significant Impact (FONSI) dated XXXX, 2021, with a 30-day comment period ending on XXXX, 2021, was posted on the USACE Regulatory webpage. The Notice included contact information to obtain a hard copy of the EA and draft FONSI and in order to provide comment. Coordination with the Iowa SHPO began in 2017 with the USACE initiating Section 106 coordination. SHPO coordination concluded December 18, 2018 with concurrence from the Kansas City District Archaeologist, Iowa Office of State Archaeologist and Iowa SHPO that the project will have no effect on historic properties. A USFWS IPaC query was conducted on May 13, 2019 with a Corps determination of “not likely to adversely affect” the northern long-eared bat and Indiana Bat. The USFWS concurred with this determination on June 13, 2019. Tribal consultation will be initiated in the public notice. Additional agency coordination and comments received from the public will be included in Appendix B of the final report following the 30-day public notice.

11.0 ENVIRONMENTAL COMPLIANCE

Table 11-1 summarizes federal environmental laws and project compliance for this project.

Table 11-1. Federal Policies and Project Compliance.

Federal Policies	Compliance
Archeological Resources Protection Act, 16 U.S.C. 470, et seq.	Full Compliance
Bald and Golden Eagle Protection Act, 16 U.S.C. 668 et seq	Full Compliance
Clean Air Act, as amended, 42 U.S. C. 7401-7671g, et seq.	Full Compliance
Clean Water Act (Federal Water Pollution Control Act), 33 U.S.C. 1251, et seq.	Full Compliance
Coastal Zone Management Act, 16 U.S.C. 1451, et seq.	Not Applicable
Endangered Species Act, 16 U.S.C. 1531, et seq.	Full Compliance
Estuary Protection Act, 16 U.S.C. 1221, et seq.	Not Applicable
Fish and Wildlife Coordination Act, 16 U.S.C. 661, et seq.	Full Compliance
Land and Water Conservation Fund Act, 16 U.S.C. 4601-4, et seq.	Not Applicable
Marine Protection Research and Sanctuary Act, 33 U.S.C. 1401, et seq.	Not Applicable
Migratory Bird Treaty Act, 16 U.S.C. 703 et seq.	Full Compliance
National Environmental Policy Act, 42 U.S.C. 4321, et seq.	Full Compliance
National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470a, et seq.	Full Compliance
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Full Compliance
Wild and Scenic River Act, 16 U.S.C. 1271, et seq.	Not Applicable
Farmland Protection Policy Act, 7 U.S.C. 4201, et. seq.	Full Compliance
Protection & Enhancement of the Cultural Environment (Executive Order 11593)	Full Compliance
Floodplain Management (Executive Order 11988)	Full Compliance
Protection of Wetlands (Executive Order 11990)	Full Compliance
Environmental Justice (Executive Order 12898)	Full Compliance
Full compliance. Having met all requirements of the statute for the current stage of planning (either preauthorization or post-authorization).	
Partial compliance. Not having met some of the requirements that normally are met in the current stage of planning.	
Noncompliance. Violation of a requirement of the statute.	
Not applicable. No requirements for the statute required; compliance for the current stage of planning.	

12.0 RECOMMENDATION

In making the following recommendation, I have given consideration to all significant aspects in the overall public interest, including environmental, social, and economic effects, and engineering feasibility and compatibility of the project with policies, desires, and capabilities of the IDNR.

I recommend that the selected plan for ecosystem restoration within Rathbun Lake as fully detailed in this integrated feasibility report and environmental assessment, be approved as a Federal project for ecosystem restoration under Section 1135 of the Continuing Authorities Program.

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Travis J. Rayfield
Colonel, Corps of Engineers
District Commander

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