2023

Fox River Connectivity & Habitat Study
Section 519, Illinois River Basin Restoration

DRAFT Project Implementation Report and Integrated Environment Assessment

Kane & McHenry Counties, Illinois

September 2023

US Army Corps of Engineers®
Chicago District

FOX RIVER STUDY GROUP

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Front cover photos clockwise: Carpenterville Dam / Spike (*Elliptio dilatata*) and Purple Wartyback (*Cyclonais tuberculata*) photo by Mike Hari, Fadeoutfoto/ free-flowing habitat below Algonquin Dam / Greater Redhorse (*Moxostoma valenciennesi*) photo by Dr. Phil Willink, Shedd Aquarium.

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FOX RIVER CONNECTIVITY & HABITAT STUDY
KANE AND MCHENRY COUNTIES, ILLINOIS
SECTION 519, ILLINOIS RIVER BASIN RESTORATION

Draft INTEGRATED PROJECT IMPLEMENTATION REPORT & ENVIRONMENTAL ASSESSMENT

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List of Acronyms

AA	Average Annual
AAHU	Average Annual Habitat Units
BMP	Best Management Practices
CE/ICA	Cost Effectiveness and Incremental Cost Analysis
CFR	Code of Federal Regulations
DO	Dissolved Oxygen
EA	Environmental Assessment
EOP	Environmental Operating Principals
EQ	Environmental Quality
ER	Engineering Regulation
ESA	Endangered Species Act
FCSA	Feasibility Cost Sharing Agreement
FF	Free-flowing
FONSI	Finding of No Significant Impact
FRSG	Fox River Study Group
FWOP	Future Without-Project
FWP	Future With Project
GIS	Geographic Information System
HSI	Habitat Suitability Index
HU	Habitat Unit
IEPA	Illinois Environmental Protection Agency
IHPA	Illinois Historic Preservation Association
ILDNR	Illinois Department of Natural Resources
IMP	Impounded
ISWS	Illinois State Water Survey
IWR	Institute for Water Resources
MCI	Macroinvertebrate Condition Index
NAAHU	National Average Annual Habitat Units
NEPA	National Environmental Policy Act
NED	National Economic Development
NER	National Ecosystem Restoration
NRHP	National Register of Historic Places
O&M	Operations and Maintenance
OSE	Other Social Effects
PA	Programmatic Agreement
P&G	Principles and Guidance
PIR	Project Implementation Report
PMP	Project Management Plan
QHEI	Qualitative Habitat Evaluation Index
RED	Regional Economic Development
SHPO	State Historic Preservation Office
TPC	Total Project Cost
TSP	Tentatively Selected Plan
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
WQ	Water Quality
WRDA	Water Resources Development Act

1 INTRODUCTION

1.1 Report Structure

This Integrated Project Implementation Report and Environmental Assessment (PIR/EA) presents the results of an ecosystem restoration feasibility study for the Fox River between the Algonquin and Montgomery Dams, which are primarily contained within Kane and McHenry Counties, Illinois. It presents the assessment of ecological conditions and potential plans to restore important riverine habitat for transient and migratory mussels, fish, birds and wildlife within a modified, yet restorable riverine environment. This report considers historic and current site conditions, and forecasts future without-project (FWOP) and future with project (FWP) conditions for this reach of the Fox River in relationship to the entire watershed. This report also provides a Tentatively Selected Plan (TSP) for restoring the aquatic ecosystem of the Fox River within the study area.

The report contains the following chapters and appendices. Chapters with an * after them indicate that they are required under the National Environmental Policy Act (NEPA).

<u>Chapter 1</u> – *Introduction**: introduces the project, provides a description of the study area, and summarizes previously completed relevant studies

<u>Chapter 2</u> – *Existing and Future Without-Project Conditions*:* contains an inventory or description of the study area which includes an assessment of pertinent historic, current, and FWOP conditions

<u>Chapter 3</u> – *Plan Formulation and Evaluation:* discusses how plans have been formulated, presents the cost effectiveness and ecological benefits of each alternative, and discusses the evaluation process used to identify the National Ecosystem Restoration (NER) plan and selection of a Tentatively Selected Plan

<u>Chapter 4</u> – *Environmental Effects and Consequences*:* provides a description of potential impacts, both negative and positive, to cultural, ecological, and physical resources within the surrounding environment and their significance

<u>Chapter 5</u> – *Plan Implementation*: discusses construction sequencing, monitoring and adaptive management, project costs, and cost sharing responsibilities

<u>Chapter 6</u> – *Recommendation:* provides the District Commander's recommendation for implementation of an aquatic ecosystem restoration plan

<u>Chapter 7</u> – *References*

1.2 Study Authority

The Rock Island, St. Louis, Chicago, and Detroit Districts of the U.S. Army Corps of Engineers (USACE) along with the Illinois Department of Natural Resources (ILDNR) as the non-federal sponsor (NFS) completed the Illinois River Basin Restoration Comprehensive Plan with Integrated Environmental Assessment in 2007. This plan addressed two complementary authorities investigating the federal and state interests in restoring the aquatic ecosystem within the Illinois River Basin. A Reconnaissance Study identifying a federal interest in restoration was completed in February of 1999. Study efforts were then initiated in the basin through the Illinois River Ecosystem Restoration Feasibility Study conducted under Section 216 of the Flood Control Act of 1970. That Study was initiated pursuant to the provision of funds in the Energy and Water Development Appropriations Act of 1998. Section 216 of the Flood Control Act of 1970, as amended states:

The Secretary of the Army, acting through the Chief of Engineers, is authorized to review the operation of projects the construction of which has been completed and which were constructed by the Corps of Engineers in the interest of navigation, flood control, water supply, and related purposes, when found advisable due to significant changed physical or economic conditions, and to report thereon to Congress with recommendations on the advisability of modifying the structures or their operation, and for improving the quality of the environment in the overall public interest.

Congress provided additional authority for Illinois River Basin Restoration in Section 519 of Water Resources Development Act (WRDA) of 2000, which was subsequently amended by Section 5071 of WRDA 2007. Authority was granted in Sections (b) & (c) of Section 519 of the Water Resources Development Act 2000 (as amended; WRDA 2007) to complete a comprehensive plan and identify, evaluate, and implement critical restoration projects in the Illinois River Basin. Section 519 of the Water Resources Development Act of 2000, as amended states:

(a) ILLINOIS RIVER BASIN DEFINED- In this section, the term `Illinois River basin' means the Illinois River, Illinois, its backwaters, its side channels, and all tributaries, including their watersheds, draining into the Illinois River

(b) COMPREHENSIVE PLAN-

(1) DEVELOPMENT- The Secretary shall develop, as expeditiously as practicable, a proposed comprehensive plan for the purpose of restoring, preserving, and protecting the Illinois River basin.

(2) TECHNOLOGIES AND INNOVATIVE APPROACHES- The comprehensive plan shall provide for the development of new technologies and innovative approaches—

- (A) to enhance the Illinois River as a vital transportation corridor;
- (B) to improve water quality within the entire Illinois River basin;
- (C) to restore, enhance, and preserve habitat for plants and wildlife; and
- (D) to increase economic opportunity for agriculture and business communities.

(3) SPECIFIC COMPONENTS- The comprehensive plan shall include such features as are necessary to provide for—

- (A) the development and implementation of a program for sediment removal technology, sediment characterization, sediment transport, and beneficial uses of sediment;
- (B) the development and implementation of a program for the planning, conservation, evaluation, and construction of measures for fish and wildlife habitat conservation and rehabilitation, and stabilization and enhancement of land and water resources in the basin;
- (C) the development and implementation of a long-term resource monitoring program; and,
- (D) the development and implementation of a computerized inventory and analysis system.

(4) CONSULTATION- The comprehensive plan shall be developed by the Secretary in consultation with appropriate federal agencies, the State of Illinois, and the Illinois River Coordinating Council.

(5) REPORT TO CONGRESS- Not later than two years after the date of enactment of this Act, the Secretary shall transmit to Congress a report containing the comprehensive plan.

(6) ADDITIONAL STUDIES AND ANALYSES- After transmission of a report under paragraph (5), the Secretary shall continue to conduct such studies and analyses related to the comprehensive plan as are necessary, consistent with this subsection.

(c) CRITICAL RESTORATION PROJECTS-

(1) IN GENERAL- If the Secretary, in cooperation with appropriate federal agencies and the State of Illinois, determines that a restoration project for the Illinois River basin will produce independent, immediate, and substantial restoration, preservation, and protection benefits, the Secretary shall proceed expeditiously with the implementation of the project.

(2) AUTHORIZATION OF APPROPRIATIONS- There is authorized to be appropriated to carry out projects under this subsection $100,000,000 for fiscal years 2001 through 2010.

(3) FEDERAL SHARE- The Federal share of the cost of carrying out any project under this subsection shall not exceed $20,000,000.

(d) GENERAL PROVISIONS-

(1) WATER QUALITY- In carrying out projects and activities under this section, the Secretary shall take into account the protection of water quality by considering applicable State water quality standards.

(2) PUBLIC PARTICIPATION- In developing the comprehensive plan under subsection (b) and carrying out projects under subsection (c), the Secretary shall implement procedures to facilitate public participation, including providing advance notice of meetings, providing adequate opportunity for public input and comment, maintaining appropriate records, and making a record of the proceedings of meetings available for public inspection.

(e) COORDINATION- The Secretary shall integrate and coordinate projects and activities carried out under this section with ongoing federal and State programs, projects, and activities, including the following:

(1) Upper Mississippi River System-Environmental Management Program authorized under Section 1103 of the Water Resources Development Act of 1986 (33 U.S.C. 652).
(2) Upper Mississippi River Illinois Waterway System Study.
(3) Kankakee River Basin General Investigation.
(4) Peoria Riverfront Development General Investigation.
(5) Illinois River Ecosystem Restoration General Investigation.
(6) Conservation Reserve Program (and other farm programs of the Department of Agriculture).
(7) Conservation Reserve Enhancement Program (State) and Conservation 2000 Ecosystem Program of the Illinois Department of Natural Resources.

(8) Conservation 2000 Conservation Practices Program and the Livestock Management Facilities Act administered by the Illinois Department of Agriculture.
(9) National Buffer Initiative of the Natural Resources Conservation Service.
(10) Nonpoint source grant program administered by the Illinois Environmental Protection Agency.

(f) JUSTIFICATION-

(1) IN GENERAL- Notwithstanding Section 209 of the Flood Control Act of 1970 (42 U.S.C. 1962-2) or any other provision of law, in carrying out activities to restore, preserve, and protect the Illinois River basin under this section, the Secretary may determine that the activities—
(A) are justified by the environmental benefits derived by the Illinois River basin; and
(B) shall not need further economic justification if the Secretary determines that the activities are cost-effective.

(2) APPLICABILITY- Paragraph (1) shall not apply to any separable element intended to produce benefits that are predominantly unrelated to the restoration, preservation, and protection of the Illinois River basin.

(g) COST SHARING-

(1) IN GENERAL- The non-federal share of the cost of projects and activities carried out under this section shall be 35 percent.

(2) OPERATION, MAINTENANCE, REHABILITATION, AND REPLACEMENT- The operation, maintenance, rehabilitation, and replacement of projects carried out under this section shall be a non-federal responsibility.

(3) IN-KIND SERVICES- The Secretary may credit the value of in-kind services provided by the non-federal interest for a project or activity carried out under this section toward not more than 80 percent of the non-federal share of the cost of the project or activity if such services are provided not more than 5 years before the date of initiation of the project or activity. In-kind services shall include all State funds expended on programs and projects that accomplish the goals of this section, as determined by the Secretary. The programs and projects may include the Illinois River Conservation Reserve Program, the Illinois Conservation 2000 Program, the Open Lands Trust Fund, and other appropriate programs carried out in the Illinois River basin.

(4) CREDIT-
(A) VALUE OF LANDS- If the Secretary determines that lands or interests in land acquired by a non-federal interest, regardless of the date of acquisition, are integral to a project or activity carried out under this section, the Secretary may credit the value of the lands or interests in land toward the non-federal share of the cost of the project or activity. Such value shall be determined by the Secretary.
(B) WORK- If the Secretary determines that any work completed by a non-federal interest, regardless of the date of completion, is integral to a project or activity carried out under this section, the Secretary may credit the value of the work toward the non-federal share of the cost of the project or activity. Such value shall be determined by the Secretary.

(h) Monitoring – The Secretary shall develop an Illinois River basin monitoring program to support the plan developed under subsection (b). Data collected under the monitoring program shall incorporate data provided by the State of Illinois and shall be publicly accessible through electronic means, including on the Internet.

This study is being conducted as a Critical Restoration Project as defined by Section 519(c) of WRDA 2000, as amended. In addition, Section 8202(a) of the National Defense Authorization Act for 2023, PL 117-263, December 23, 2022, 136 Stat 2395 states the following:

> FEASIBILITY STUDIES.—The Secretary shall expedite the completion of a feasibility study for each of the following projects, and if the Secretary determines that the project is justified in a completed report, may proceed directly to preconstruction planning, engineering, and design of the project: . . . (9) Project for ecosystem restoration, Fox River, Illinois, included in the comprehensive plan under section 519 of the Water Resources Development Act of 2000 (114 Stat. 2653).

Similarly, under Section 8397(a) of the 2023 NDAA, it states:

> (a) AUTHORIZED PROJECTS AND STUDIES.—The Secretary shall, to the maximum extent practicable, expedite completion of the following projects and studies: (1) PROJECTS.— . . . (P) Projects for the restoration of the Illinois River Basin, carried out pursuant to section 519 of the Water Resources Development Act of 2000 (114 Stat. 2653; 121 Stat. 1221).

Under Section 8202, USACE may proceed to preconstruction, engineering and design of the tentatively Recommended Plan, if approved. However, authorization of construction appropriations will need to be confirmed prior to implementation. Although Section 519(c)(1), as amended, allows for implementation of critical projects, Section 519 (c)(2) states that: “[t]here is authorized to be appropriated to carry out projects under this subsection $100,000,000 for fiscal years 2001 through 2010.” Congress will need to authorize appropriations for construction after 2010 to implement the project.

1.2.1 Illinois River Basin 519 Authority Ecosystem Objectives

Section 519(c)(1) of WRDA 2000, as amended, identified the following minimum eligibility criteria for critical restoration projects: “If a restoration project for the Illinois River Basin will produce independent, immediate and substantial restoration, preservation and protection benefits, the Secretary shall proceed expeditiously with the implementation of the Project.”

The goals identified in the Illinois River Basin Restoration Comprehensive Plan include:

- Restore and maintain ecological integrity, including habitats, communities, and populations of native species and the processes that sustain them
- Improve floodplain, riparian, and aquatic habitats and functions
- Restore aquatic connectivity (fish passage) on the Illinois River and its tributaries, where appropriate
- Restore or maintain healthy populations of native fish
- Naturalize Illinois River and tributary hydrologic regimes and conditions to restore aquatic and riparian habitat
- Improve water and sediment quality in the Illinois River and its watershed

1.3 Study Purpose & Need

This report documents whether a project is warranted for federal participation based on a feasibility-level assessment of estimated costs, potential benefits, and possible environmental impacts of various alternatives, under the Section 519 authority and following USACE planning and policy guidelines. The main purpose of this effort is to evaluate alternative plans for aquatic ecosystem restoration of the Fox River within the study area and identify the National Ecosystem Restoration (NER) Plan that reasonably maximizes environmental restoration benefits compared to costs and meets the study goals and objectives. By restoring riverine habitats and increasing connectivity, this project would provide essential life history requirements for transient and migratory mussels, fishes, and birds as well as regional aquatic macroinvertebrates, amphibians, reptiles, and small mammals within a mixed, but highly agricultural and urbanized area. If a cost-effective alternative is identified and recommended for implementation through the plan formulation process, USACE would then seek funding to proceed with pre-construction, engineering and design after signing any required agreement with a non-federal sponsor to obtain the required cost share. After authorization to implement is confirmed, through a statutory update or otherwise, USACE would execute a Project Partnership Agreement (PPA) with a non-federal sponsor(s) to implement the TSP. The non-federal sponsors for this study are the Illinois Department of Natural Resources (ILDNR) and the Fox River Study Group (FRSG).

The ILDNR is currently implementing an initiative within the State of Illinois to address dams for the purpose of habitat restoration, fish and mussel recolonization, water quality improvement, and life safety. The ILDNR has requested that USACE initiate a study to ascertain the feasibility of restoring important riverine habitat within the Fox River. The need for riverine ecosystem restoration within the study area is based on extensive habitat, organism, and water quality studies conducted by state, regional and local agencies and groups. The data and results from these studies clearly show that the dams have severely degraded the natural riverine continuum (Vannote et al 2005), both physically and biologically.

Currently, there are 14 dam structures in 13 municipalities on the Fox River in Illinois, three in Wisconsin, and numerous smaller dams on tributaries. Two of the 14 dams in Illinois are in Aurora and are located on either side of Stolp Island, so while they are two separate structures, they function as one impediment to flow and appear as one dam in Figure 1. Hence, the Aurora East and West dams will be referred as a single dam for the remainder of this report. Many of these dams were originally built in the 1800s to provide mechanical power for grist and lumber mills and have since been rebuilt to maintain the flat water impoundments that form upstream. Although important when constructed, today most of these dams serve no functional purpose except for recreation (boating). The ILDNR, Fox River Ecosystem Partnership (FREP), the FRSG, and other groups all have identified addressing dams as an important watershed management tool to effectively recover the riverine biodiversity of the Fox River ecosystem.

Detailed studies by the ILDNR and FRSG have shown that the quality of aquatic habitat available to fish and invertebrate communities differs substantially between the free-flowing and impounded portions of river. The distribution of fish species during the summer indicate that most fishes favored free-flowing portions of river over impounded areas created by dams. The natural flowing river reaches have more species present, four times the abundance, and double the number of harvestable sport fish. Also, there are more sucker: Catostomidae (including state-listed endangered Greater Redhorse (*Moxostoma valensiennesi*)), darter: Percidae, and intolerant fish species, a higher percentage of riverine specialized minnows: Cyprinidae, and a lower proportion of diseased individuals than impounded areas. Impounded stations typically had lower species richness, low overall and sport fish abundance, more diseased fish, and a predominance of tolerant and omnivorous species, such as Common Carp (*Cyprinus carpio*) and Green Sunfish (*Lepomis cyanellus*). In addition to altering habitats, dams appear to have altered distributions of nearly one third of Fox River fishes by acting as barriers to upstream fish movement (Santucci and Gephard 2003; Santucci et al 2005). Free-flowing reaches supported higher quality macroinvertebrate communities than impounded waters above dams. Dams also prevent freshwater mussels from reestablishing populations in areas where they once were abundant. Free-flowing sites had higher catch per unit effort and extant species richness, and lower percent missing species than impounded sites. Data also suggests that dams limit the upstream distribution of 5 mussel species.

Given the adverse effects of impoundments on habitat, water quality, and aquatic biota in the Fox River, the proportion of impounded waters in the system should give an indication of the overall influence of dams on the river's ecological condition. The dams impound 70% of the river's length, and 75% of its surface area in the study area. This high density of impounded habitat suggests that improvements to the ecological health of the river would be realized if dam effects were addressed and riverine habitat was restored. Further, dams prevent access by fish to important spawning and nursery habitats, such as tributaries and wetlands, which were absent from many sections of the river isolated by dams.

1.4 Study Area

The Fox River's headwaters originate near Waukesha, Wisconsin, where the Fox River then flows in a southerly direction across the Illinois-Wisconsin state line south to Aurora, Illinois where it begins to flow in a generally southwesterly direction to its confluence with the Illinois River near Ottawa, Illinois (Figure 1).

The total length of the river is 185 miles and the portion flowing through Illinois is about 115 miles. The Fox River watershed occupies portions of McHenry, Lake, Cook, Kane, DuPage, Dekalb, Lee, LaSalle, Kendall, Grundy, and Will counties in northeastern Illinois. The predominant land cover in the basin is agricultural land (66%) and urban/residential land (18%). The remainder of the watershed consists of woodlands (9.2%), wetlands (4.5%), and lakes and streams (2.3%). The northern portion of the watershed is diverse in the type and distribution of land covers and this area contains most of the basin's lakes and wetlands. The central portion of the basin has the highest concentration of urban/residential land. The southern portion is predominantly row crops and rural grasslands. The watershed is about 130 miles long, from north to south, and generally less than 25 miles wide.

The study area for this PIR/EA includes 10 dams in 10 municipalities within Kane and McHenry Counties from the Algonquin Dam in Algonquin, Illinois to the Montgomery Dam in Montgomery, Illinois. (Figure 2).

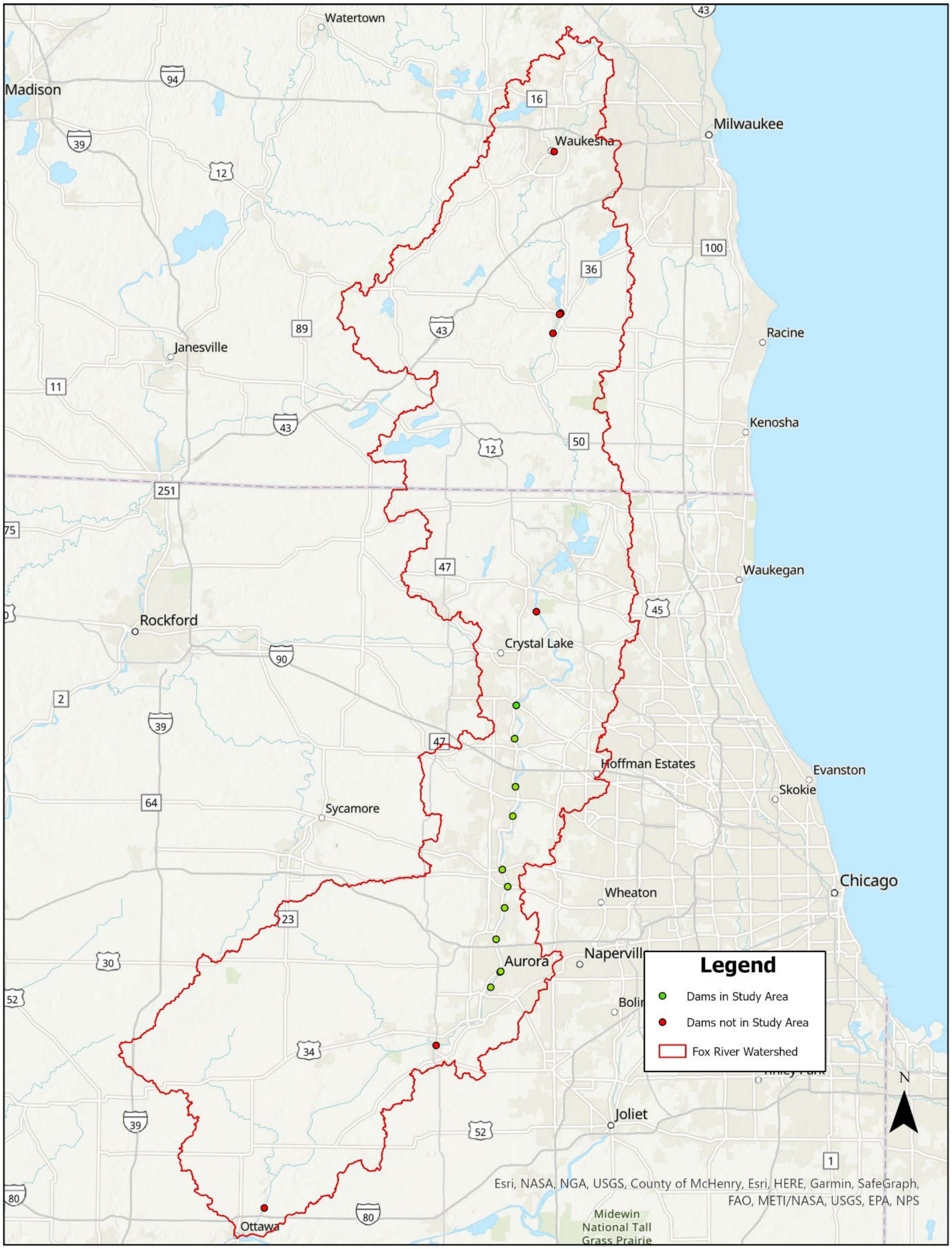


Figure 1: Fox River watershed within the Chicago Region, Wisconsin & Illinois showing dam locations in Illinois and Wisconsin.

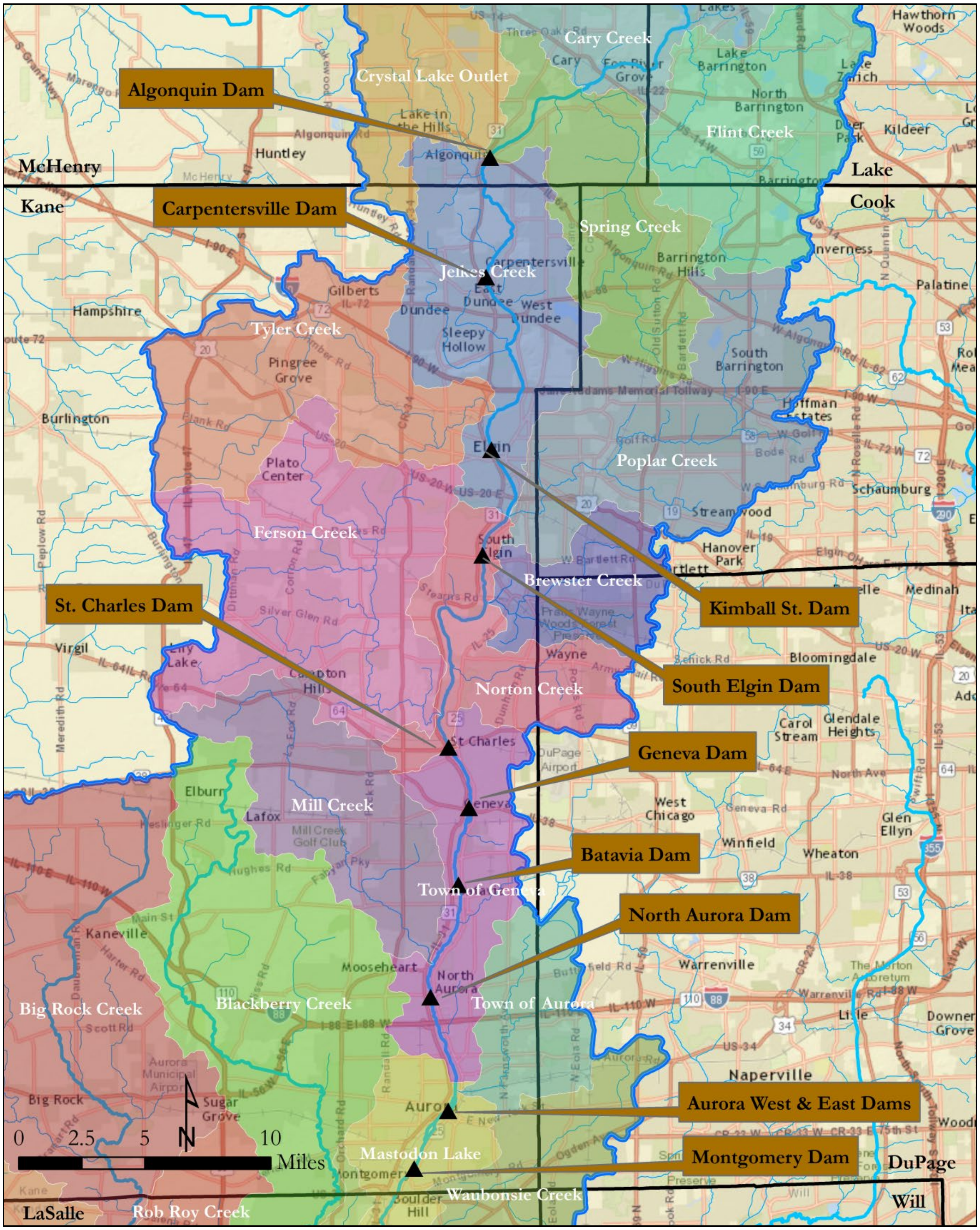


Figure 2: Location of study area dams along the Fox River

1.5 Prior Studies & Projects

This section summarizes the studies, reports, and nearby projects that are pertinent to this study.

1.5.1 Pertinent Reports & Studies

- Fox River Fish Passage Feasibility Study. Illinois Department of Natural Resources. 2003.

This report presents a two-year study of approximately 100 miles of river and 15 (Hurd's Island and South Batavia dams have since been removed since this study was published) mainstem dams located between McHenry and Dayton. The report is divided into two main sections and a series of appendices. In Part A, the ILDNR used historical and current data to determine the effect of dams on the ecological health of the river. Specifically, they examined fish and macroinvertebrate communities, aquatic habitat, and water quality. This section generally provides results summarized across a series of sample stations for the entire study area. In Part B, they discussed fish passage in general and identify specific options for each dam that will facilitate a reconnected river system. Options include complete dam removal and river restoration, dam lowering and in-stream ramping, and the construction of fishways and bypass channels that allow fish to migrate over or around dams. The appendices present site-specific data on fishes, macroinvertebrates, habitat, sediment, and water quality, as well as a results from public seminars and a study evaluating use of the Aurora canoe chute and Stratton fishway by migrating fish. Based on the strong and consistent nature of the results, it was recommended to reconnect the river through the removal or modification of all mainstream and tributary dams.

- Effects of Multiple Low-Head Dams on Fish, Macroinvertebrates, Habitat, and Water Quality in the Fox River, Illinois. 2005. (Santucci, Gephardt & Pescitelli). North American Journal of Fisheries Management 25:975–992, 2005

This study examined the effects of low-head dams on aquatic biota, habitat, and water quality in a 171-km reach of the Fox River that was fragmented by 15 dams into a series of free-flowing and impounded habitats. Dams impounded 70% of the river's surface area within the study reach and influenced distributions of 30 species of fish by restricting upstream movements. Values for the Illinois index of biotic integrity (IBI) were higher in free-flowing areas (mean IBI = 46 out of a possible 60 at below-dam and midsegment free-flowing locations) than impounded areas (mean IBI = 31 for above-dam and midsegment impounded locations). Likewise, scores from a macroinvertebrate condition index (MCI) were higher at stations in free-flowing reaches (mean MCI > 415 out of a possible 700) than in nearshore areas of impounded reaches (mean MCI < 210). Ponar dredge samples taken only from open-water impounded areas showed an offshore invertebrate community that consisted almost entirely of tolerant oligochaetes and chironomid larvae. Qualitative habitat evaluation index (QHEI) scores indicated good-quality habitat in free-flowing areas (mean QHEI > 70 out of a possible 100) and severely degraded habitat at impounded sites (mean QHEI < 45). In impounded reaches, dissolved oxygen and pH showed wide daily fluctuations (2.5–18.0 mg/L and 7.0–9.4 units) and often failed to meet Illinois water quality standards. In free-flowing portions of river, fluctuations in these parameters were less extreme and water quality standards typically were met. Little evidence of cumulative effects of dams was discovered; however, data suggest that low-head dams adversely affect warmwater stream fish and macroinvertebrate communities by degrading habitat and water quality and fragmenting the river landscape. These results should aid river managers and stakeholders in determining appropriate restoration practices for warmwater rivers and streams that contain low-head dams.

- Effects of Low-head Dams on Unionids in the Fox River, Illinois. 2007. (Tiemann, Dodd, Owens & Wahl. Northeastern Naturalist 14(1):125–138

The Fox River was sampled for nine sites (five free-flowing and four impounded) to investigate effects of low-head dams on the habitat characteristics and the freshwater mussel assemblage of the Fox River in Illinois. Two habitat indices were utilized, the QHEI and the Stream Habitat Assessment Protocol (SHAP), to determine effects of low-head dams on habitat quality. Free-flowing sites had higher QHEI and SHAP scores than impounded sites, indicating higher quality stream habitat. Three variables were calculated, catch-per-unit-effort (CPUE), extant species richness, and percent missing species, to establish effects of low-head dams on freshwater mussels. Free-flowing sites had higher CPUE and extant species richness and lower percent missing species than impounded sites. Also, literature reviews and museum collection holdings were examined to determine species distributions within the basin. These data suggest that dams limit the upstream distribution of five freshwater mussel species.

- Spring Creek Valley Section 206 Draft Detailed Project Report & Environmental Assessment. U.S. Army Corps of Engineers, Chicago District. 2016.

This feasibility study investigated the Spring Creek Valley Forest Preserve District of Cook County’s ~4,000-acre holding for ecosystem restoration opportunities. The draft recommendation was to restore about 2,800 acres of wetland hydrology via drain tile removal, stream meandering and channel migration induction, riparian Buckthorn and Honeysuckle eradication, invasive plant species removal, and the establishment of native plant communities over ~2,000-acres. The forest preserve district declined to serve as a non-Federal cost-sharing sponsor for the proposed restoration project, but modified the drain tiles to restore 2,800 acres of wetland hydrology.

- Poplar Creek Section 206 Draft Planning & Design Analysis. U.S. Army Corps of Engineers, Chicago District. 2011

This feasibility study is currently on hold but would investigate a 34-acre parcel owned by the Kane County Forest Preserve and about 100-acres of Illinois State Nature Preserve, known as Bluff Spring Fen. Should this project move forward to implementation, restoration activities may include stream meandering, invasive species removal, floodplain wetland restoration and the establishment of native riparian meadow, wet prairie and wet savanna plant communities.

1.5.2 Pertinent Projects

- Stratton Dam Recreation and Flood Control Project (ILDNR & USACE)

In 1939, the State of Illinois Department of Public Works and Buildings, Division of Waterways (predecessor to the Office of Water Resources), constructed the present dam and gate control structure (Department of Public Works, 1938). Also in 1939, the State of Illinois made the initial land acquisition of 15 acres for McHenry Dam State Park, which became a part of Moraine Hills State Park, which is located on the east side of the Fox River. The present lock was originally constructed in 1960 and significant repairs and improvements were made in 2016. In 2002, under Section 205 of the Flood Control Act of 1948, as amended, USACE installed a hinged crest gate to improve flow conveyance during flooding.

- Algonquin Dam Flood Control Project (ILDNR & USACE)

In 1947 the State Division of Waterways built the Algonquin Dam, a short distance south of an existing dam that was removed as part of the construction. In 2002, under Section 205 of the Flood Control Act of 1948, as amended, USACE installed a hinged crest gate to improve flow conveyance during flooding.

- Waubonsie Creek Section 519 Illinois River Basin Critical Restoration Project (ILDNR & USACE)

The project consisted of modifying three dams through the Village of Oswego for proper fish passage and the removal of two failed dams. The project was completed in 2011 and created fish passage from the mouth of Waubonsie Creek at the Fox River to Waubonsie Lake, upstream for 7.5 miles and restored stream connectivity giving access to aquatic species for breeding, spawning, and foraging resulting in a healthy functioning ecosystem used by numerous wildlife species. ILDNR was the non-Federal sponsor and the Oswegoland Park District, the Village of Montgomery, the Fox Valley Park District, and the Natural Resources Conservation Service were critical stakeholders.

- Nippersink Creek Section 206 Aquatic Ecosystem Restoration Project (MCCD & USACE)

The project restored the natural features of Nippersink Creek and its adjacent natural area by restoring stream and floodplain hydrology, hydraulics and natural habitat, restoring native emergent wetland communities, and restoring native wet/mesic riparian prairie communities. The project was completed in October 2019. Key construction activities include bank grading and installation of cobble riffles to reestablish floodplain hydrology, selective clearing of invasive/non-native trees and shrubs, and seeding and planting of ~500-acres of native vegetation. The McHenry County Conservation District (MCCD) was the non-Federal sponsor.

- Big Rock Creek Fish Passage (ILDNR)

Big Rock Creek is a high quality tributary to the Fox River in Northeastern Illinois, supporting listed fish and mussel species and unique cool-water fish communities. Surveys indicated that two dams on the mainstem of the creek effected distribution of several fish and mussel species. These factors, combined with cooperation by many local partners led to a successful U.S. Fish and Wildlife Service (USFWS) National Fish Passage grant for construction of fish passage structures at both dams, reconnecting over 60 miles of stream. Removal was not a viable option for either dam for socio-political reasons. The Drakes Dam was not removed because it was privately owned and removal was not supported by the owner. In 2005 fish passage structures were completed on two dams on Big Rock Creek, in Kendall County. This effort was part of joint effort by USFWS, ILDNR, The Conservation Foundation, and the Big Rock Creek Watershed Committee. The goal of the project was to protect and enhance one of the highest quality Fox River tributaries. To summarize post project monitoring results, both fish passages structures successfully passed a range of species, including some known to be weaker swimmers.

- Brewster Creek Dam Removal (ILDNR)

Brewster Creek is small tributary to the Fox River near South Elgin with an approximately 18 square mile watershed. The dam pool was used by the YWCA for canoeing and other activities until it became filled with sediment and too shallow for recreational use. The dam also needed repairs. No sources of funding were available for temporary fixes such as dam repairs or dredging. Funds were obtained for removal, which eliminated any future expenditure by the YWCA and created a natural stream on the property. Partners included, ILDNR, IEPA, USGS, USFWS, Kane County, and Friends of the Fox River. In 2004 the dam was removed in phases to allow sediment to move downstream gradually as the new channel formed in the dam pool. The project was closely monitored by USGS, IEPA, and ILDNR. No downstream effects due to sediment movement were reported. Fish communities were monitored in the area downstream of the dam and in the newly formed channel from 2004 to 2013. After removal of the YMCA dam there were only five species present in the new channel and the IBI score was 12 (range 0-60). Since 2004, 22 species have been documented in the new channel upstream of the dam and the IBI has increased to 27. In addition to many small stream species, four species from the Fox River have used the new habitat for spawning runs: Quillback, Smallmouth Bass, Channel Catfish, and Flathead Catfish. The dam removal has not only restored suitable conditions in Brewster Creek, but has also benefited the Fox River system by creating more spawning and nursery habitat for riverine species.

- Ferson-Otter Creek Dam Removal (ILDNR)

The property for Creek Bend Forest Preserve near St. Charles was acquired by Kane County in 2008. One of the first restoration practices identified was the removal of a dam on Ferson-Otter Creek. The dam blocked migration of fish and caused habitat degradation in the upstream area. Pre-project fish sampling resulted in only 46 fish representing 12 species in the segment above the dam, whereas downstream of the dam there were a total of 575 fish and 24 species. Due to the high quality of the creek downstream and the potential miles of habitat restored upstream the project scored well in the USFWS Fish Passage Program, and the dam was funded for removal. Following removal of the dam in 2011, the number of species in the upstream area increased to 18; in the second year after removal, 27 species were found. The overall productivity of the upstream area also improved, as indicated by the number of fish collected, increasing from 47 before the project to 636 in the second year following removal. Several species were found upstream of the former dam for the first time following removal: Mottled Sculpin, a sensitive cool water species; and two migratory sport species, Smallmouth Bass and Channel Catfish. The Forest Preserve site houses an education center which includes a display on the benefits of dam removal.

- Blackberry Creek Dam Removal (ILDNR & ILDOT)

Blackberry Creek watershed covers 71.6 square miles in Kane and Kendall Counties, entering the Fox River in Yorkville, IL. Just upstream from the mouth, a 12 ft high dam constructed around 1856, blocked connection to the Fox River for the entire stream system. Over the years, species were lost due to floods, drought, channelization, and run-off. Migratory fish from the Fox River could not access the creek for spawning, foraging, or summer refuge. The Blackberry Creek Watershed Group identified dam removal as critical to restoration efforts. Studies were conducted to remove the dam, but funds were unavailable until the River Road bridge, which shared an abutment with the dam, was condemned and closed to traffic in 2010. To expedite the bridge replacement ILDNR took over the dam removal project, taking advantage of previous studies conducted by USACE. ILDNR Fisheries Division sampled Blackberry Creek routinely since 1996. Despite good habitat, especially in the lower reaches, fish diversity and stream quality ratings were low compared to other undammed streams in the area. In 2011, prior to removal of the dam, a survey was conducted to provide more detailed information, including one location downstream and three locations upstream of the dam. The first post-project survey was conducted in 2012, two weeks following the dam removal. This survey was conducted in the upper area of the former pool to determine if species from the Fox River known to make spring spawning runs were able to find the new stream habitat and successfully ascend through the project area. Two migratory sucker species were collected in the former dam pool, shorthead redhorse and quillback (Catostomidae: suckers). smallmouth bass and longnose gar were also observed in the upstream area. The response to the dam removal was very rapid, and for the first time in over 170 years, these species had access to Blackberry Creek for spawning and nursery functions. In August 2012, six months after the dam was removed, the 2011 sites were resampled to assess changes in fish assemblages. The most notable difference was found in the former dam pool, which prior to removal yielded only 74 fish, representing eight species. In 2013, at the site just upstream of the former dam, there were 24 species and over 3,000 individuals. The upper pool had a total of 26 species. Many of the species had not been previously collected in the creek included Largescale Stoneroller, Mottled Sculpin, Flathead Catfish, Channel Catfish, Highfin Carpsucker, Banded Darter, and Orangethroat Darter. The number of species found in 2013 also increased at the other upstream sites. Young-of-the-year channel catfish and smallmouth bass were collected at the site four miles upstream of the former dam, indicating successful reproduction in areas where these species were previously absent prior to the dam removal.

2 EXISTING AND FUTURE WITHOUT-PROJECT CONDITIONS

This step of the planning process is to develop an inventory and forecast of critical resources (physical, demographic, economic, social, etc.) relevant to the problems and opportunities under consideration in the study area. This information is used to define and characterize the problems and opportunities. A quantitative and qualitative description of these resources is made, for both current and future conditions, and is used to define existing and future without-project (FWOP) conditions. Existing conditions are those at the time the study is conducted. The forecast of the FWOP conditions reflects the conditions expected during the period of analysis. The period of analysis for this study is 50 years. The FWOP conditions provides the basis from which alternative plans are formulated and impacts are assessed. Since impact assessment contributes to plan evaluation, comparison and selection, clear definition, and full documentation of the FWOP conditions are essential. Gathering information about historic and existing conditions requires an inventory. Gathering information about potential future conditions requires forecasts, which should be made for selected years over the period of analysis to indicate how changes in economic and other conditions are likely to have an impact on problems and opportunities. Information gathering and forecasts will most likely continue throughout the planning process. As such, Chapter 2 contains the following:

- An inventory of relevant historic conditions;
- An inventory of relevant current conditions and the studies that have been completed to identify those conditions; and
- A forecast of FWOP conditions.

2.1 Historic Setting

Before European settlement, the Fox River was a free-flowing, high quality river that provided food, water, and transportation for Native Americans living off the land. The Fox River freely meandered and migrated within its floodplain, where it created or influenced natural systems such as glacial flowage lakes, marshes, fens, wet meadows, oak savannas, and tall grass prairies. Once European settlers began to intensively colonize the watershed, early engineers saw opportunity in the steep valley and the river's strong flow as a good source for industrial waterpower. This led to early industrial development with many dams and mills built on the river. Also, the establishment of industry caused significant development along the Fox River's banks, which not only impacted riverine and floodplain functions and habitat but also set the stage for several wastewater treatment plants.

Today, the grist and lumber mill dams are gone and have been replaced by dams that hold pools primarily for recreational boating. The river is no longer allowed to meander and migrate in its floodplain, so new riverine features such as backwaters and side-channels will no longer be created, and old ones will succeed first into wetlands and then forest via natural sedimentation processes. Instead of flowing through natural plant communities, the river flows primarily through suburban and agricultural lands where it flows over 13 dam structures in 13 municipalities that provide water frontage for municipal, boating, and other anthropogenic uses.

The Fox River was listed among the 10 most endangered rivers in America despite improving water quality (American Rivers 1999). This is due to the chronic stress caused in part by its many dams. Aside from contributing to significant biodiversity decreases, the Fox River dams are now understood to prevent natural riverine processes of sediment transport and water filtration, and they create dangerous conditions that have led to many deaths by drowning.

2.2 Physical Resources

Detailed physical resource descriptions for the watershed may be found in this section of the report, but also in chapter 2 of the Water Quality Issues and Data Report by the Illinois State Water Survey (ISWS) #2004-06 Phase I (ISWS 2004) as included in *Appendix A: Compliance, Coordination & Information*. The following provides information pertinent to riverine connectivity and habitats.

2.2.1 Watershed Hydrography

Detailed hydrology, hydraulics and modeling for the Fox River may be found in *Appendix D: Hydrology and Hydraulic Analyses* and ISWS #2004-06 Phase I (ISWS 2004).

2.2.1.1 <u>The Fox River Catchment</u>

The headwaters of the Fox River watershed are located in Waukesha County, Wisconsin (see Figure 2). The Fox River drains 938 square miles in Wisconsin and 1,720 square miles in Illinois. Within Illinois, the Fox River watershed has distinctive natural segments. The segment of river through McHenry and Lake Counties is relatively flat, with marshes and lakes; however, many of these features are unnaturally formed by the Stratton Dam, such as Chain of Lakes. As the Fox River flows through Kane County, the watershed and river valley narrow. The land becomes hilly with bluffs encroaching on the floodplain, expressing valley wall seeps and fens. South of Geneva, the watershed widens and flattens again. Chain of Lakes is a unique area defined at its downstream point by Stratton Dam. The study reach includes the narrow, relatively hilly, urbanized and urbanizing area between Algonquin and Montgomery. The Stratton Dam/Chain of Lakes presents a complex system that was treated as an upstream boundary condition (ISWS 2004).

2.2.1.2 <u>Fox River Geomorphology & Gradient</u>

Watershed boundaries, land slope, and stream slope are topographic features that significantly influence watershed processes. Traditionally, topographic maps such as those published by the USGS have provided the basis for delineation of watershed boundaries and calculation of land slopes. Digital Elevation Models (DEM) are now commonly used to delineate topography in applications using georeferenced data as Geographic Information Systems (GIS) datasets. The DEM displayed in Figure 3 shows the surface topographical relief (geomorphology) of the Fox River watershed in Illinois, with the highest elevation of 1,183 feet and the lowest elevation of 411 feet (NGVD 1929).

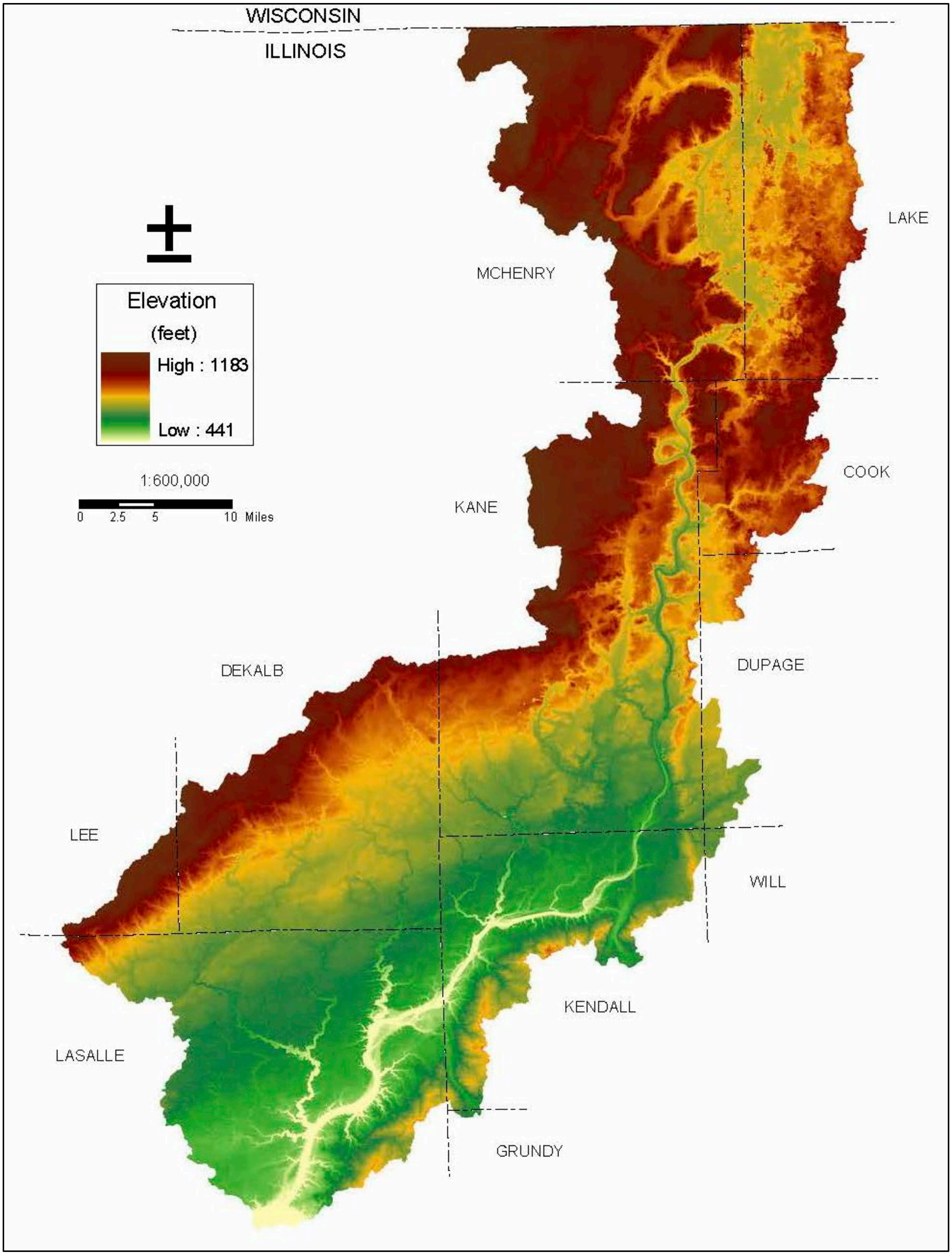


Figure 3: Fox River watershed (Illinois) geomorphology (ISWS 2004)

The Fox River proper is a sixth order stream in Illinois. The total fall of the river from headwaters to confluence is about 460 feet, for an average slope of 2.5 ft/mi. The gradient of the river is atypical in that the slopes are greatest in its downstream reaches (Figure 4). In the northern portion of its Illinois watershed, the river winds through marshy areas and Chain of Lakes and the channel is often undefined or confined by low banks and widen floodplains. Downstream of Algonquin, the channel is straighter and the slope higher as the river is more deeply cut into the bedrock. Limestone outcrops exist in the central portion between St. Charles and Aurora, and in many of the lower reaches, sandstone bluffs exposed on one or both sides of the river leave little or no floodplain area. The river has an average slope of about 0.3 ft/mi over the 33-mile stretch from the state line to Algonquin, 2.0 ft/mi between Algonquin and St. Charles, 4.5 ft/mi between St. Charles and Yorkville, and 2.7 ft/mi between Yorkville and Dayton. The steepest gradient once occurred where the Fox River drained into the Illinois River Valley at Dayton. At this location the river dropped 19.2 feet over a distance of 6,460 feet and formed a succession of rapids as it flowed over the sandstone bedrock and a deposit of large granite boulders (Alexander and McCurdy 1915). The rapids are now inundated by the impoundment formed behind the Dayton Dam.

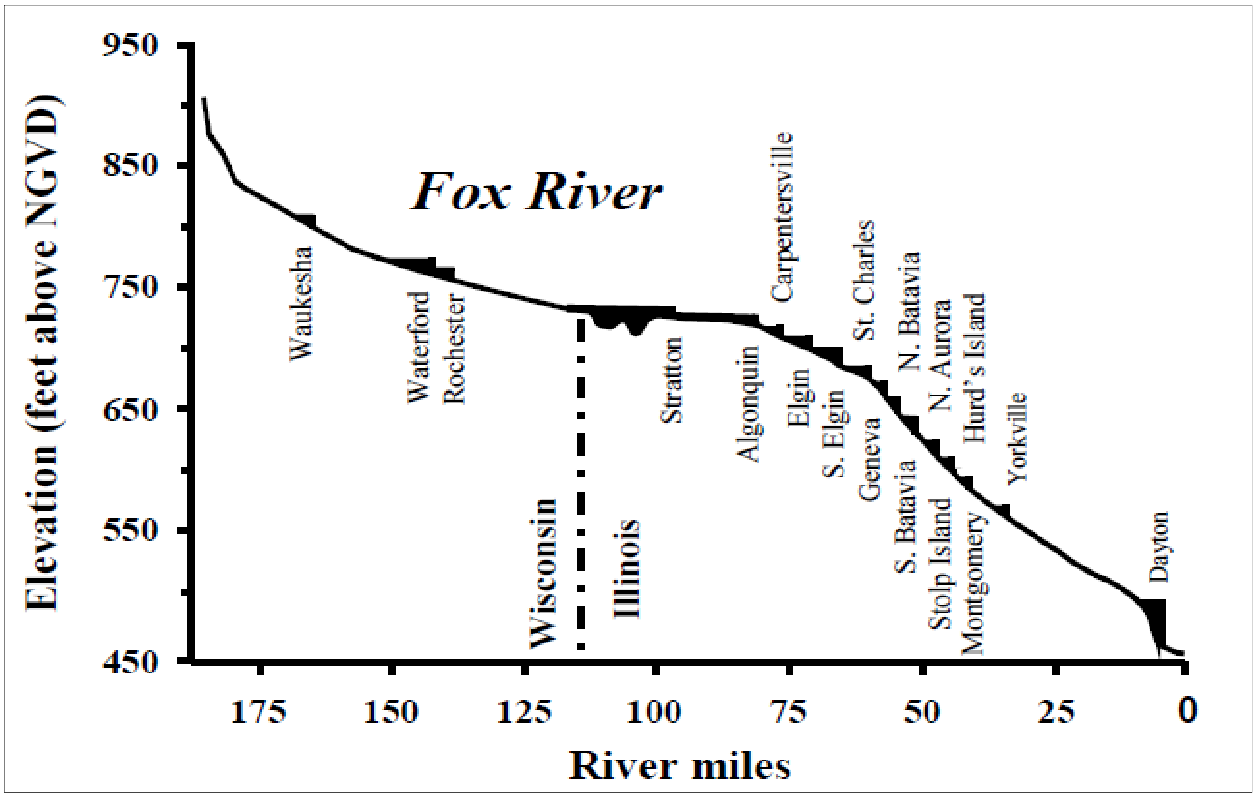


Figure 4: Fox River profile showing gradient and dam locations (modified from Knapp 1988)

2.2.1.3 <u>Fox River Stream Flows</u>

In the study area, just downstream of Stratton Dam, 10 continuous monitoring gauging stations were active during all or part of 1980 through 2000. Three stations are located on the mainstem of the Fox River at Algonquin, Montgomery, and Dayton. The others are located on tributaries. These continuous monitoring stations are operated by the USGS. Stage is recorded at 15-minute intervals and converted to discharge values using rating tables maintained by the USGS.

The Fox River displays a well-defined seasonal streamflow cycle. Flow at the Algonquin and Dayton gages is typically highest during the spring (March - April) and lowest during summer and early fall (July – October) (Table 1). From 1980 through 2000, average daily flow ranged from 77 to 6,130 cubic feet/second (cfs) at Algonquin and 209 to 46,600-cfs at Dayton. The mean annual streamflow is an estimated 1,818-cfs, on the basis of streamflow records for the Fox River at Dayton, Water Years 1915-2002 (USGS 2003a). The highest mean monthly streamflow of all streams and rivers generally occurs during March and April, and the lowest mean monthly flows are in August, September, and October. Like many rivers in watersheds with expanding human population, flows in the Fox River have increased over the past century. Higher flows are due in large part to urbanization within the watershed (more impermeable urban land cover and higher municipal wastewater discharges; ILDNR 1998).

Table 1: Fox River mean monthly & annual flow at Algonquin & Dayton gauges, 1980–2000

Month	Algonquin flow (cfs)	Dayton flow (cfs)
January	916 (265 – 2,880)	1,825 (540 – 11,900)
February	1,143 (380 – 3,700)	2,624 (242 – 33,100)
March	1,663 (263 – 4,340)	3,366 (800 – 24,000)
April	1,912 (81 – 6,090)	3,720 (418 – 20,700)
May	1,397 (254 – 4,960)	2,936 (458 – 16,200)
June	1,167 (117 – 5,060)	2,538 (351 – 19,300)
July	815 (77 – 3,780)	1,912 (286 – 46,600)
August	666 (106 – 2,630)	1,364 (213 – 16,200)
September	695 (112 – 5,790)	1,309 (209 – 9,400)
October	818 (179 – 6,130)	1,369 (352 – 9,750)
November	1,178 (195 – 3,170)	2,200 (592 – 16,200)
December	1,195 (235 – 4,300)	2,425 (384 – 22,800)
Annual flow	1,130 (77 – 6,130)	2,299 (209 – 46,600)

Summer low-flows are largely affected by wastewater discharges and the operation of the Stratton Dam. In 1995, water use in the basin was more than 85 million gallons per day (ILDNR 1998). Most of this water was discharged to the river after being used and treated. During periods of low flow, estimates suggest that wastewater effluents make up more than one-third of the river’s flow in Kane County and downstream areas. The Stratton Dam affects the river during natural low flow periods because it is operated to maintain a minimum flow of 94 cfs, which is slightly higher than the lowest observed natural flows. During medium and high flow conditions, the Stratton Dam and other dams on the river have minimal effect on flow rates and provide no flood control benefit (Knapp and Ortel 1992).

2.2.1.4 <u>Fox River Study Area Dams</u>

There are 14 channel dams in 13 municipalities (Aurora East and West dams are side by side on either side of Stolp Island and function as a single dam resulting in a single impoundment) on the Fox River in Illinois and three in Wisconsin (Table 2). Mainstem dam locations range from 5.7 miles above the Fox/Illinois River confluence at Ottawa (Dayton Dam) to river mile 98.9 near McHenry. The dams range in length from 143 to 600 feet and their height varies from 2.8 to 29.6 feet. Many of the dams on the Fox were originally built in the early to mid-1800’s to provide mechanical power for grist or sawmills. They have been rebuilt over the years and today most function to maintain high pool levels for recreational boat use. Exceptions include the Dayton Dam, a hydropower dam, the Elgin Dam, used to pull water for the municipal drinking water supply, and the Stratton Dam, used to control pool elevations in Chain of Lakes. The dams impound 70% of the river's length, and 75% of its surface area in the study area. All as-built drawings that exist were gathered and are presented in *Appendix B: Civil Design*.

Table 2: Fox River Dams in Illinois

<table>
<tr><th>Dam</th><th>Owner</th><th>River Mile</th><th>Length (ft)</th><th>Height (ft)</th><th>Crest Elevation (ft NGVD)</th><th>Original Function</th><th>Current Function</th></tr>
<tr><td>Stratton*</td><td>State of Illinois</td><td>98.9</td><td>275</td><td>7.0</td><td>736.8</td><td>Navigation</td><td>Recreation</td></tr>
<tr><td>Algonquin</td><td>State of Illinois</td><td>82.6</td><td>308</td><td>10.5</td><td>730.3</td><td>Recreation</td><td>Recreation</td></tr>
<tr><td>Carpentersville</td><td>Kane County</td><td>78.2</td><td>378</td><td>9.0</td><td>720.7</td><td>Milldam/ Hydropower</td><td>Recreation</td></tr>
<tr><td>Kimball Street</td><td>City of Elgin</td><td>71.9</td><td>325</td><td>13.0</td><td>708.4</td><td>Milldam</td><td>Recreation/ Drinking Water</td></tr>
<tr><td>South Elgin</td><td>State of Illinois</td><td>68.2</td><td>357</td><td>8.3</td><td>700.0</td><td>Milldam</td><td>Recreation</td></tr>
<tr><td>St. Charles</td><td>State of Illinois</td><td>60.6</td><td>294</td><td>10.3</td><td>684.6</td><td>Recreation/ Hydropower</td><td>Recreation</td></tr>
<tr><td>Geneva</td><td>State of Illinois</td><td>58.7</td><td>441</td><td>13.0</td><td>675.4</td><td>Milldam</td><td>Recreation</td></tr>
<tr><td>Batavia</td><td>City of Batavia</td><td>56.3</td><td>244</td><td>12.0</td><td>665.1</td><td>Milldam</td><td>Recreation</td></tr>
<tr><td>North Aurora</td><td>State of Illinois</td><td>52.6</td><td>375</td><td>9.0</td><td>646.0</td><td>Milldam</td><td>Recreation</td></tr>
<tr><td>Aurora East</td><td>City of Aurora</td><td rowspan="2">48.9</td><td>E 177</td><td>11.0</td><td>628.4</td><td rowspan="2">Milldam</td><td rowspan="2">Recreation</td></tr>
<tr><td>Aurora West</td><td>State of Illinois</td><td>W 170</td><td>15.0</td><td>628.4</td></tr>
<tr><td>Montgomery</td><td>State of Illinois</td><td>46.8</td><td>325</td><td>8.0</td><td>614.0</td><td>Navigation</td><td>Recreation</td></tr>
<tr><td>Yorkville*</td><td>State of Illinois</td><td>36.5</td><td>530</td><td>7.0</td><td>575.0</td><td>Recreation</td><td>Recreation</td></tr>
<tr><td>Dayton*</td><td>North American Hydro</td><td>5.7</td><td>600</td><td>29.6</td><td>498.8</td><td>Hydropower</td><td>Hydropower</td></tr>
</table>

* Not part of this study

Algonquin Dam (Photo 1) is a low head dam located just south of State Route 62 in downtown Algonquin, McHenry County. As-built drawings provided by ILDNR indicate the dam was built in 1946-47. The dam is approximately 250 feet wide and 10 feet high. Hinged crest gates were added to the dam in 2002.

Photo 1: Algonquin Dam

Carpentersville Dam (Photo 2) is a low head dam located to the east of North Lincoln Avenue in Carpentersville, Kane County. The existing dam is approximately 350 feet wide and eight feet high. This is reported to be a wooden crib dam built in 1916 with head races at each side of the river. The dam was capped with concrete in the 1960s. ILDNR has little additional information on the Carpentersville Dam; however, a 2007 inspection found deterioration of both dam abutments.

Photo 2: Carpentersville Dam

Kimball Street Dam (Photo 3) is just south of Kimball Street north of downtown Elgin in Kane County. This is a low head dam that is approximately 300 feet wide and 10 feet high with head races at each end. According to the ILDNR this dam may date to the early 1900s. The internal structure of this dam is unknown. The dam was capped with concrete in the 1960s. ILDNR has no additional information on this dam.

Photo 3: Kimball Street Dam

South Elgin Dam (Photo 4) is approximately 350 feet wide and eight feet high and is located adjacent to Paton Mill Park in South Elgin, Kane County. As-built drawings provided by ILDNR show that this dam was completely reconstructed in 1960 as a rock filled dam capped with concrete. The as-builts also detail additional extensive repairs in 1992. These repairs included the addition of riprap to the upriver face of the dam to prevent erosion. ILDNR recorded extensive deterioration of this dam in 2007. Erosion was noted along the crest. Both dam abutments exhibited cracks and spalling. The right bank upstream has eroded and the riprap added in 1992 has deteriorated.

Photo 4: South Elgin Dam

St. Charles Dam (Photo 5) is a low head dam located in downtown St. Charles, Kane County. According to the City of St. Charles the current low head concrete dam dates to 1939. The ILDNR has little information on this dam but believes it may have replaced an earlier 1916 wood and concrete dam. The dam is approximately 250 feet wide and 10 feet high. The dam was recapped with concrete and a fish ladder was added to the east end of the dam in the 1960s. A 2007 review by ILDNR found that that a portion of the dams face may have sheared off. The western abutment by Hotel Baker exhibits some spalling. The eastern abutment adjacent to the fish ladder has failed.

Photo 5: St. Charles Dam

Geneva Dam (Photo 6) is a low head dam located just north of State Route 38 in downtown Geneva, Kane County. The dam is approximately 350 feet wide and 9 feet high. As-built drawings provided by ILDNR indicate that this is a rock filled dam that was repaired in 1953 and had a tail race added to the east side. The as-builts also show that the Geneva Dam was reconstructed in 1960 with sheet pile and its wooden facing was replaced with concrete.

Photo 6: Geneva Dam

Batavia Dam (Photo 7) is a low head dam in Batavia, Kane County. The dam extends from the northern tip of Causeway Island Park to the east bank of the Fox River. This is approximately 365 feet wide and 11.5 feet high. As-built drawings provided by ILDNR indicate that this dam is a concrete ogee shaped dam built in 1910. The dam is built on bedrock except for the eastern end. The dam was recapped with concrete in the 1960s. A 2007 inspection by ILDNR found cracking and chipping along the remaining dam crest. The dam is also breached for approximately 35 feet along the eastern abutment.

Photo 7: Batavia Dam

North Aurora Dam (Photo 8) is a step structure low head dam in North Aurora, Kane County. The dam is approximately 300 feet wide and 10 feet high. The existing dam is located just north of State Route 56. As-built drawings provided by ILDNR show that the dam was reconstructed in 1975 with sheet pile and a rock filled core capped with concrete.

Photo 8: North Aurora Dam

Aurora Dam East & Aurora Dam West (Photo 9) are two low head dams that run between the east and west sides of Strop Island and the banks of the Fox River in downtown Aurora, Kane County. Both dams are approximately 150 feet wide and eight feet high and are built on bedrock. As-built drawings provided by ILDNR indicate that the current Aurora East Dam was rebuilt in 1937. The Aurora West Dam appears to have been rebuilt at the same time although no plans exist. Both dams were refaced with concrete in the 1990s. At that time, a fish lock was built, part of the Aurora Dam East was removed, and a canoe /kayak chute was added to the Aurora Dam West. A 2007 inspection of the Aurora East Dam by ILDNR found heavily eroded concrete had undermined the right abutment wall.

Photo 9: Aurora West Dam (Left) and Aurora East Dam (Right)

Montgomery Dam (Photo 10) is a low head dam approximately 325 feet long and seven feet high built on bedrock. The dam is located near the intersection of Marsch Road and North River Road in Montgomery, Kane County. As-built drawings provided by ILDNR indicate this dam was reconstructed in 1967 as a three step dam with sheet pile and rock fill topped with concrete.

Photo 10: Montgomery Dam

2.2.2 Water Quality

The Fox River Fish Passage Feasibility Study (Santucci and Gephard, 2003) summarizes a two-year study of approximately 100 miles of the Fox River and 15 main stem dams located between McHenry and Dayton to determine the effect of dams on the ecological health of the river; the study also identifies options for modifying each dam to facilitate a reconnected river system. Water quality sampling was conducted as part of the study during August and September 2001 at eleven free-flowing stations, eleven impounded stations, and a series of transects spaced throughout four river segments. Sampling included continuous monitoring of temperature, dissolved oxygen, conductivity, and pH, spot sampling to determine horizontal and vertical variation in the measured parameters and grab sampling to assess nutrients (phosphorus and nitrogen), algal biomass, (chlorophyll a), total suspended solids, and turbidity. The mean, minimum, and maximum concentrations of temperature, dissolved oxygen, conductance, and pH reported upstream and downstream of USACE study area dams collected from continuous monitoring are included in *Appendix E: Phase I Environmental Site Assessments*. The mean concentration of water quality parameters found in grab samples collected throughout the study reach, compared to the state water quality standards, is included in the appendix. Results of the study suggest that the impoundments created by dams played an important role in the widespread occurrence of sub-standard water quality in the Fox River.

Water quality sampling results suggest that water quality conditions vary between the impounded sections and free-flowing portions of the river. Dissolved oxygen concentrations fluctuated widely on a daily basis in impounded areas (2.5 to >20 milligrams per milter (mg/L)), but not in free-flowing areas (5 to 10 mg/l). These wide fluctuations resulted in violations of the IEPA standard for dissolved oxygen (<5 mg/L) at nine of 11 impounded stations, but only two of 11 free-flowing stations. Sub-standard dissolved oxygen occurred throughout impounded reaches (not just immediately above dams), lasted for up to 16 hours in a 24-hour period, and occurred when discharge was low and water temperature was high (or potentially from mid-July through mid-October each year). While dissolved oxygen did not reach concentrations low enough to kill fish directly, it may explain the predominance of tolerant species of fish and invertebrates in impoundments. Highly fluctuating oxygen levels and extended periods of sub-standard oxygen and pH occurred at a time of year when other stressors, such as high turbidity, low discharge rates, and elevated water temperatures adversely affect fish and invertebrates. In addition to the dissolved oxygen fluctuations present in the dam impoundments, the Fox River is nutrient enriched and supports high algal biomass, especially during low flow periods. Total phosphorus and nitrogen were elevated at all stations downstream of Elgin Dam. While the reported concentrations of nutrients do not exceed state water quality standards, the nutrient levels present and lake-like environments upstream of the dams combine to produce excessive algal biomass; elevated concentrations of organic nitrogen, suspended solids, and turbidity support this conclusion. Chlorophyll α, an indicator of algal biomass, was elevated at all sampling stations. Therefore, the FWOP water quality in the impounded reaches of the river would continue to be poor as a result of the dams and the resulting impoundments.

2.2.3 Sediment (Substrate) Types & Quality

Sediment quantity, particle size, and chemical characteristics of bulk sediments accumulated upstream of study area dams are documented in the Fox River Fish Passage Feasibility Study (Santucci and Gephard 2003). Grain size analysis was conducted on 28 core and 26 surface sediment samples collected from impounded areas upstream of dams in the study area; grain size analysis was also conducted on four core and 11 surface samples collected from free-flowing areas downstream of the Algonquin dam, Carpentersville dam, and Kimball Street dam.

Results suggest that, on average, medium and fine sand made up between 60% and 65% of core and surface samples by weight and was the predominant particle size in sediment found in the impoundments. Impounded sediments also consisted of coarse sands (20%), gravels (11 %), and silts (4-7%). Sediment particle size distributions were similar for core and surface samples in impounded areas and core samples from free-flowing areas. However, surface samples from free-flowing areas contained higher amounts of gravels and coarse sands (46%) and lower amounts of fine sands and silt. Impoundments tended to accumulate larger quantities of fine sand and silt, particularly downstream of islands, along impoundment margins, and in the region closest to the dam. Table 5 within *Appendix E: Phase I Environmental Site Assessments* summarizes the grain size analysis results in sediment samples collected in the study area. Review of grain size analysis data suggests that less than 20% fines were found in impounded sediments, with the exception of one core sample collected at Kimball Street dam, which measured 21.7 % fines passing a #200 sieve.

Sediment samples (32 core and 52 surface) were collected up- and downstream of the dams in the study area and analyzed for metals, pesticides, polycyclic aromatic hydrocarbons (PAHs), alkyl phenols, polychlorinated biphenyls (PCBs), cyanide, oil & grease, and nutrients. The following observations were made:

- Comparing contaminant concentrations in sediment samples to consensus based sediment quality guidelines for 26 substances in freshwater ecosystems (MacDonald et al. 2000), researchers found that overall sediment pollution level was low in the Fox River. Sediment contaminant levels were characterized as “non-polluted” if the measured concentration of a contaminant was lower than the corresponding consensus based threshold effect concentration (TEC) and “elevated” if the measured concentration of a contaminant was higher than the corresponding probable effect concentration (PEC). Measured concentrations were below threshold effect concentration (TEC) guidelines for 76-92% of analyses in core and surface samples, indeterminate for 8-17% of analyses (between the TEC and PEC) and elevated for 0-9% of analyses.

- Sediment contaminant conditions were generally similar between bulk (core) and surface sediments from impounded areas. Mean concentrations of 86% of measured substances, including all pesticides, PAH’s, PCBs, alkylphenols, most metals, and nutrients, were similar between impoundment core and surface samples.

- Like core and surface sediments in impoundments, most contaminants in surface sediments had similar concentrations in impounded and free-flowing portions of river. 74% of measured substances were either similar between impoundments or free-flowing areas below dams (58%) or were higher in downstream free-flowing areas (16%). Twelve substances, including the pesticide DDE and 11 metals were higher in impounded areas. Mean concentrations of most constituents in impounded surface sediments were below PEC guidelines.

The mean concentrations of contaminants and nutrients found in surface and core sediment samples reported in the 2003 Fox River Fish Passage Feasibility Study report are compared to the Illinois Environmental Protection Agency (IEPA) TACO Tier 1 residential risk remediation objectives for soils in Table 6 of *Appendix E: Phase I Environmental Site Assessments*. In general, the mean concentrations of constituents found in the sediment meet the TACO residential risk remedial objectives or are near background concentrations of constituents found in soils throughout the watershed. Sediment sampling results suggest that there are consistently low and widespread concentrations of constituents in the sediment throughout the watershed typical of sediments found in an urban environment.

2.3 Ecological Resources

Detailed biological resource descriptions for the watershed may be found in Santucci & Gephard 2003 and ISWS #2008-09 Phase II (2008). The following provides information pertinent to riverine connectivity and habitats. This section presents the current conditions for those ecological/biological resources that would be affected by this project should a feasible solution to ecosystem problems be recommended.

2.3.1 Riparian Plant Communities

The 10 dam location sites were each surveyed for plant species richness between September and October 2014. Each site was broken into four quadrants divided by the dam for north & south and each bank for east & west. Although investigating native riparian and riverine plant community degradation is not the goal of this study, it is important to know existing vegetation should areas need to be disturbed for in-stream habitat restoration measures. Also, replacement of invasive plant species with native species indicative to the given habitat is always a positive benefit for fish & wildlife should this opportunity arise under this study. Floristic inventories were recorded for each quadrant, per each dam for floristic species richness, and quality expressed via the Chicago Region Floristic Quality Assessment (FQA/FQI). The St. Charles Dam and Aurora East & West Dams are located in downtown urban areas, and thusly had no riparian vegetation to survey. The following gives brief summary on the native floral condition per each dam site, which all are indicative of highly degraded riparian communities. Full inventories are available upon request.

<u>Algonquin Dam</u> – The FQI for the Algonquin Dam site averages 8.4, which is indicative of a highly disturbed and degraded natural community. The site is primarily dominated by non-native and weedy species such as honeysuckle (*Lonicera* spp.), buckthorn (*Rhamnus cathartica*) and Eurasian shrubs and grasses. A few high quality conservative species were also identified, such as tall swamp marigold (*Bidens coronata*), ninebark (*Physocarpus opulifolius*), and fragrant sumac (*Rhus aromatica*).

<u>Carpentersville Dam</u> – The FQI for the Carpentersville Dam site averages 11.4, which is indicative of a highly disturbed and degraded natural community. The site is primarily dominated by non-native and weedy species such as honeysuckle (*Lonicera* spp.), buckthorn (*Rhamnus cathartica*), reed canary grass (*Phalaris arundinacea*), multiflora rose (*Rosa multiflora*) and other non-native trees, shrubs and grasses. A few high quality conservative species were also identified, such as long-leaved pondweed (*Potamogeton nodosus*), white Grass (*Leersia virginica*), maple-leaved arrow-wood (*Viburnum acerifolium*) and redbud (*Cercis canadensis*).

<u>Kimball St. Dam</u> – The FQI for the Kimball St. Dam site averages 6.8, which is indicative of a highly disturbed and degraded natural community. The site is primarily dominated by non-native and weedy species such as honeysuckle (*Lonicera* spp.), buckthorn (*Rhamnus cathartica*), reed canary grass (*Phalaris arundinacea*), Siberian elm (*Ulmus pumilia*) and other non-native trees, shrubs and grasses. A few high quality conservative species were also identified, such as wild white indigo (*Baptisia leucantha*), bunchberry (*Cornus canadensis*) and redbud (*Cercis canadensis*).

South Elgin Dam – The FQI for the South Elgin Dam site averages 9.5, which is indicative of a highly disturbed and degraded natural community. The site is primarily dominated by non-native and weedy species such as honeysuckle (*Lonicera* spp.), buckthorn (*Rhamnus cathartica*), curly dock (*Rumex crispus*), black locust (*Robina psuedoacacia*) and other non-native trees, shrubs and grasses. The only species of higher conservatism and nativity to Fox River riparian plant communities was the river birch (*Betula nigra*).

St. Charles Dam – The FQI for the St. Charles Dam site averages 0, since there were no patches of riparian plant life discovered.

Geneva Dam – The FQI for the Geneva Dam site averages 9.2, which is indicative of a highly disturbed and degraded natural community. The site is primarily dominated by non-native and weedy species such as honeysuckle (*Lonicera* spp.), buckthorn (*Rhamnus cathartica*), reed canary grass (*Phalaris arundinacea*), Siberian elm (*Ulmus pumilia*) and other non-native trees, shrubs and grasses. A few high quality conservative species were also identified, such as purple prairie clover (*Petalostemum purpureum*), chinquapin oak (*Quercus muhlenbergii*) and fragrant sumac (*Rhus aromatica*).

Batavia Dam – The FQI for the Batavia Dam site averages 14.9, which is indicative of a highly disturbed and degraded natural community. The site is primarily dominated by non-native and weedy species such as honeysuckle (*Lonicera* spp.), buckthorn (*Rhamnus cathartica*), burning bush (*Euonymus alatus*), Siberian elm (*Ulmus pumilia*) and other non-native trees, shrubs and grasses. A few high quality conservative species were also identified, such as lead plant (*Amorpha canescens*), paper birch (*Betula papyrifera*) and Kentucky coffee tree (*Gymnocladus dioica*).

North Aurora Dam – The FQI for the North Aurora Dam site averages 14.0, which is indicative of a highly disturbed and degraded natural community. The site is primarily dominated by non-native and weedy species such as honeysuckle (*Lonicera* spp.), buckthorn (*Rhamnus cathartica*), upright cinquefoil (*Potentilla recta*), Russian olive (*Elaeagnus angustifolia*) and other non-native trees, shrubs and grasses. A few high quality conservative species were also identified, such as witch hazel (*Hamamelis virginiana*), sycamore (*Platanus occidentalis*) and fragrant sumac (*Rhus aromatica*).

Aurora East & West Dams – The FQI for the Aurora East and West Dam site averages 0, since there were no patches of riparian plant life discovered.

Montgomery Dam – The FQI for the Montgomery Dam site averages 9.6, which is indicative of a highly disturbed and degraded natural community. The site is primarily dominated by non-native and weedy species such as honeysuckle (*Lonicera* spp.), buckthorn (*Rhamnus cathartica*), Hungarian brome (*Bromus inermis*), Japanese knotweed (*Polygonum cuspidatum*) and other non-native trees, shrubs and grasses. The only high quality conservative species identified was the sycamore (*Platanus occidentalis*).

2.3.2 Riverine Habitat

The distribution of macro-habitat features varied over the river's length, among river segments formed by dams, and between free-flowing and impounded areas. Macro-habitat features included tributaries, islands, backwaters, side-stream wetlands, submergent aquatic vegetation beds, deep pools, riffles and runs. Major tributaries were absent from seven of 15 segments (includes river outside study area) and occurred most frequently in the lower river below

Yorkville out of the study area. No major tributaries were available to fish in the middle portion of river between St. Charles and Montgomery because six of seven segments lacked tributaries, and access to Mill Creek (South Batavia-North Aurora segment) was blocked by an insurmountable dam a quarter mile upstream of its confluence with the Fox River. Islands were common throughout the study area, but they occurred more frequently in free-flowing areas (83%) than impoundments (17%). Manmade side-stream wetlands were found exclusively above the Algonquin Dam and backwaters were most common in these upper reaches as well due to the impounding effects of the dam, so the hydrology and water elevations in these backwaters are not natural but manmade. Backwaters below Algonquin typically were associated with impoundments, and they all had excessive accumulations of silt due to the unnatural hydrology and hydraulics induced by the dams and the prevention of the Fox River from meandering and migrating within its floodplain. Emergent and floating plants were extremely scarce and submerged forms of vegetation were absent. This is not abnormal for a riverine system that is primarily bedrock and cobble. In-stream vegetation was limited to small islands of water willow (*Justicia americana)* which grows in silted-in rock areas that formed in free-flowing sections from Montgomery to Wedron and small patches of water lily (*Nymphaea* spp.) that grew at five locations between Algonquin and Batavia.

Free-flowing reaches of the Fox River consisted primarily of run habitat (93% of surface area) with the remainder being nearly equal amounts of riffles and natural pools. Riffles occurred intermittently in all free-flowing reaches from Algonquin to Dayton, whereas natural pools were limited almost exclusively to the lower river below Yorkville out of the study area. A consistent pattern in riffle/run/pool development throughout most of the study area was not observed, where riffles rarely extended from bank to bank and pools typically were not well defined. However, there were deep natural scour pools that formed at the bases of sandstone bluffs between Sheridan and Wedron, Illinois. Riffles at elevation breaks, scattered large boulders from glacial deposits, bedrock outcrops, woody debris, and islands were important features creating habitat diversity (depth, structure, current velocity, and cover) throughout free-flowing portions of river.

Although size and frequency of runs, riffles, natural pools, and impoundments varied among river segments, micro-habitat characteristics of each habitat type generally were similar over the length of the study area. As anticipated, mean water depth increased as the river changed from riffles to runs to natural pools and impoundments. Current velocity during the low-flow period that we surveyed was low in natural pools and impoundments (mean = 0.5 ft/s, typically <1.0 ft/s) and several times more rapid in riffles and runs (mean = 1.7 ft/s, typically >2.0 ft/s). Consistent with higher current velocities, riffles and runs had substrates consisting of larger materials (gravels, cobbles, and small boulders) than natural pools and impoundments (typically gravel, sand, and silt). Fast water habitats differed in that riffles contained more large materials than runs (large cobbles and small boulders in riffles vs. gravels and small cobbles in runs). Similarly, natural pools had substrates made up of sands and gravels whereas dam impoundments tended to accumulate large quantities of fine sands and silts, particularly downstream of islands, along the impoundment margins, and in the region closest to the dam. Islands should naturally move downstream as the front of the island is eroded and the downstream end accumulates material, except quite a few islands on the Fox River are armored to prevent their movement for anthropogenic recreational purposes. Upstream reaches of many impounded areas accumulated little silt and maintained substrates typical of the free-flowing river.

2.3.3 Aquatic Macroinvertebrates

The ILDNR sampled free-flowing and impounded river segments within the Fox River study area. About 10,482 individual aquatic insects were collected that represented 128 taxa groups. A detailed aquatic macroinvertebrate list may be found in Santucci and Gephard 2003, Table 16. The most species rich groups included Hemiptera, Coleoptera, and Chironomidae with about 16 different genera. The abundances of Chironomid midges, Hydropsychid caddis flies, Corixids, Baetid mayflies, and the flatworm *Dugesia tigrina* were highest among all macroinvertebrates. There was no preference in overall distribution in about half (54%) of the taxa groups, where they were present in both free-flowing and impounded stations. The remaining 60% to 40% of taxa groups were specific, and either occurred in free-flowing or impounded stations. The taxa found solely in free-flowing or impounded stations are most likely a function of habitat, and not fragmentation by the dams, where those species that prefer lentic (lake) habitat are found in the impounded segments. Lotic (river) habitats typically had a higher macroinvertebrate condition index (MCI) and supported a higher richness and abundance of conservative species, such as mayflies and caddis flies. In eight of 11 stations, Macroinvertebrate Biotic Index (MBI) scores suggest that macroinvertebrate communities are adversely affected just above dams via hydraulic (free-flowing) habitat degradation or elimination.

Macroinvertebrates were sampled by the ILDNR via kick netting and hand picking at 40 stations during July through September 2000. The Macroinvertebrate Condition Index (MCI) was developed with Fox River data following USEPA Rapid Bioassessment procedures (Barbour et al. 1999). Macroinvertebrate taxa did not show strong patterns in their overall distribution among types of sampling stations. About half (54%) of the taxa occurred at stations in both free-flowing and impounded habitats and the remaining taxa were split 60% to 40% in favor of free-flowing stations (see Table 16, Gephard & Santucci 2003). Certain families or genera were found in only one habitat type, which reflects specific habitat needs (lentic or lotic) of individual groups or genera. Hydrachnidia, burrowing mayflies, certain dragonflies, and the Ceratopogonid and Stratiomyiid dipterans were found only in impounded (lentic) areas. Taxa found only in free-flowing (lotic) areas included among others, eight dipterans, six coleopterans, five mollusks, and three ephemeraopterans, hemipterans, and trichopterans. This disparity shows the niche specificities of aquatic macroinvertebrates to either lentic (impounded/still water) or lotic (free-flowing) habitats; the Fox River is a lotic system.

Free-flowing habitat supported higher quality macroinvertebrate communities than impounded waters above dams (Figure 5). Mean MCI scores were similar for stations within free-flowing or impounded habitats but scores for downstream free-flowing (DS FF) and mid-segment free-flowing (MD FF) stations were more than twice as high as scores from mid-segment impounded (MD IMP), and upstream impounded (US IMP) stations ($P < 0.001$). Free-flowing stations typically had higher abundance and richness of mayflies and caddis flies (EPT taxa), more intolerant taxa, lower MBI scores, and a higher percentage of clinger organisms than the wadable portions of impoundments. Differences between FF and IMP habitats were even more pronounced when considering samples from open-water impounded areas. Ponar samples showed an open-water impoundment community of few taxa and a numerical predominance (mean ± 1SE = 96.4±0.8%) of tolerant aquatic worms (Oligochaeta) and chironomid larvae.

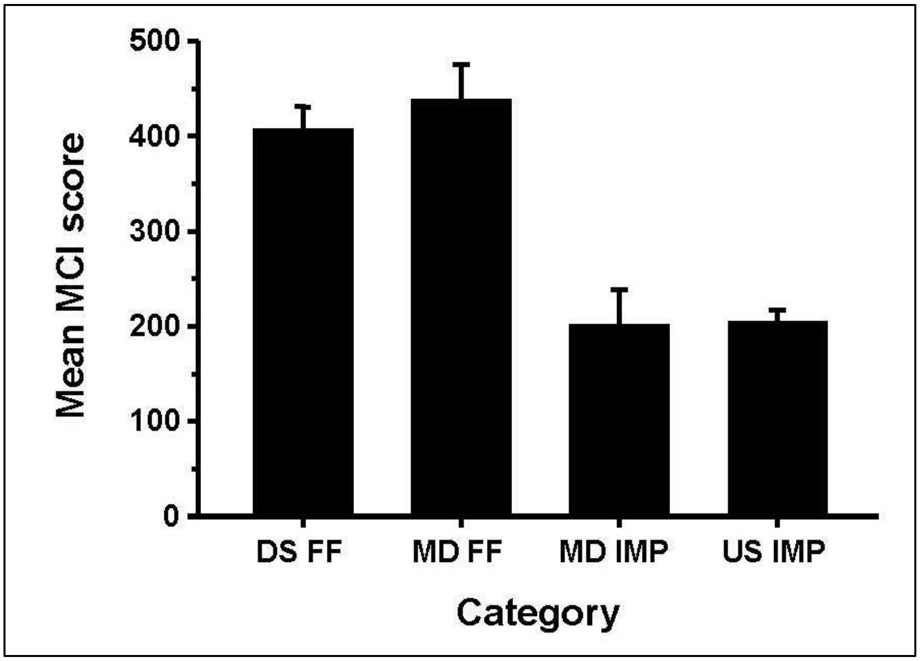


Figure 5: Fox River mean MCI scores (Gephard & Santucci 2003)
Downstream free-flowing (DS FF)
Mid segment free-flowing (MD FF)
Mid segment impounded (MD IMP)
Upstream impounded (US IMP)
Stations on the Fox River between McHenry and Dayton, Illinois. Vertical lines represent 1 SE.

Individual metric scores reveal additional patterns in the quality of macroinvertebrate communities within impounded and free-flowing habitats. For example, individual station macroinvertebrate biotic index (MBI) scores indicated limited or restricted invertebrate communities immediately above certain dams; eight of 11 stations with MBI scores ≥7.5 were US IMP stations. In free-flowing habitats, higher mean numbers of intolerant taxa at MD FF than DS FF stations suggest that dams may have had an adverse effect on invertebrate communities in areas directly below dams as well.

2.3.4 Freshwater Mussels

This section is paraphrased from the publication Effects of Lowhead Dams on Unionids in the Fox River (Tiemann et al 2007) and work completed by the Illinois Natural History Survey Center for Biodiversity. Nine sites, five free-flowing and four impounded, were sampled to investigate effects of low-head dams on the habitat characteristics and the freshwater mussel (Bivalvia: Unionidae) assemblage of the Fox River in Illinois. Catch-per-unit-effort (CPUE), extant species richness, and percent missing species were calculated to establish effects of lowhead dams on freshwater mussels. 104 individuals of six freshwater mussel species were collected at the five free-flowing sites; however, no live individuals were found at the four impounded sites. An additional eight species were represented as valves at free-flowing sites, and four species were collected as valves at impounded sites (Table 3). Two state threatened species, the purple wartyback (*Cyclonais tuberculata*) and spike (*Elliptio dilatata*), were collected as valves were found only at free-flowing sites. The state endangered rainbow (*Villosa iris*) had previously been recorded at a free-flowing site within the study area but was not collected during this survey. Free-flowing sites had higher CPUE, higher extant species richness, and lower percent missing species than impounded sites.

Table 3: Mussels observed within the Fox River (Tiemann et al 2007)

Scientific Name	Common Name	GVFF	GVIMP	NBFF	NBIMP	SBFF	NAFF	NAIMP	AUFF	AUIMP
Anodontinae										
Alasmidonta marginata	Elktoe	*		*		*			*	
Lasmigona complanata	White Heelsplitter						1		10	v
Lasmigona costata	Flutedshell			V			V			
Pyganodon grandis	Giant Floater	3		V	V	36	2	V	*	V
Utterbackia imbecillis	Paper Pondshell		*			V	V			
Ambleminae										
Amblema plicata	Threeridge	V		*						
Cyclonaias tuberculata	Purple Wartyback			V			*		*	
Elliptio dilatata	Spike	V		V		V	V		*	V
Fusconaia flava	Wabash Pigtoe	V		V			V			
Pleurobema sintoxia	Round Pigtoe	V		V			*			
Quadrula pustulosa	Pimpleback			*						
Quadrula quadrula	Mapleleaf						20		3	V
Lampsilinae										
Actinonaias ligamentina	Mucket	*		V		*	7		V	
Lampsilis cardium	Plain Pocketbook	1		1		3	7		6	V
Lampsilis siliquoidea	Fat Mucket	*								
Toxolasma parvus	Lilliput					2				
Venustaconcha ellipsiformis	Ellipse	*		*			V		V	
Villosa iris	Rainbow			*						

FF = Free-flowing; IMP = Impounded; GV = Geneva Dam; NB = North Batavia Dam; SB = South Batavia Dam (removed 2003); NA = North Aurora Dam; AU = Aurora Dam

Examination of seven manuscripts and over 2,000 specimens from museum collection holdings by the INHS indicated that lowhead dams limit the upstream distribution of five species of freshwater mussels within the basin (Tiemann et al 2007). The distribution of fragile papershell (*Leptodea fragilis*), pink heelsplitter (*Potamilus alatus*), pink papershell (*Potamilus ohiensis*), pistolgrip (*Tritogonia verrucosa*), and fawnsfoot (*Truncilla donaciformis*) was related to the presence of dams in the Fox River. These five species are widespread and fairly common in the upper midwest (Cummings and Mayer 1992), and all have been collected live at several locations in the Illinois River basin both upstream and downstream from its confluence with the Fox River and in neighboring systems.

Reductions in the freshwater mussel assemblage are likely due to the result of modifications in habitat in the impounded areas. The freshwater mussel assemblage habitat variables for the free-flowing areas were within the ranges reported by Schanzle et al. (2004) for the Fox River mainstem (Table 4). Free-flowing sites had higher CPUE and extant species richness and lower percent missing species than impounded sites. Although valves occur at impounded sites, live specimens were not found; therefore, 100% of Fox River mussel species are missing at all impounded sites. The six species collected at free-flowing sites are widespread and common in the Fox River (Schanzle et al. 2004), yet they were not collected in impounded areas. Reductions in freshwater mussel abundance and/or extant species richness are common in impounded areas, as reported for both large dams (Combes and Edds 2005) and run-of-the-river dams (Dean et al. 2002).

Table 4: Current freshwater mussel species richness and abundance of the Fox River

Mussels	GVFF	GVIM	NBFF	BIM	BFF	NAFF	NAIM	AUFF	AUIM
Live Individuals	4	0	1	0	43	37	0	19	0

CPUE	2	0	0.3	0	10.8	9.3	0	9.5	0
Species Richness (current)	2	0	1	0	4	5	0	3	0
Species Richness (historic)	10	1	13	1	8	12	1	9	4
% Missing Species	80	100	92	100	50	58	100	67	100

* FF = free-flowing, IM = impounded; GV=Geneva, B=Batavia, NA=North Aurora; A=Aurora

Given the large number of run-of-the-river dams in the Fox River, their negative effects on the stream ecosystem could be widespread. Run-of-the-river dams might contribute to the overall reduction of the freshwater mussel fauna by not only creating unsuitable and fragmented habitat, but also by artificially restricting freshwater mussel distributions. The five species that appear to have distributions limited by dams in the Fox River basin have been collected in the headwaters of neighboring unimpounded systems, including the Mazon River and Aux Sable Creek (INHS Mollusk Collection), both of which are Illinois River tributaries that is within the same physiographic region as the Fox River basin.

The five species listed above are expanding their ranges in the Illinois River basin (Cummings and Mayer 1997, Sietman et al. 2001; INHS Mollusk Collection). However, colonization of upstream portions of the Fox River is unlikely due to run-of-the-river dams. Watters (1996) reported that the distributions of fragile papershell and pink heelsplitter might be restricted because run-of-the-river dams prohibit upstream movement of their host fish, freshwater drum (*Aplodinotus grunniens*). These patterns also might occur for pink papershell and fawnsfoot because they also rely on freshwater drum and sauger (*Sander canadensis*) as glochidial host (Watters 1994). Watters (1996) suggested that the distribution pattern of the mapleleaf (*Quadrula quadrula*) might be limited due to run-of-the-river dams prohibiting the upstream movement of its glochidial host fish the flathead catfish (*Pylodictis olivaris*). The state endangered rainbow also requires flathead catfish or channel catfish (*Ictalurus punctatus*) as a host. Because the 5 freshwater mussel species listed above are not distributed throughout the Fox River, or are in small, isolated populations, their chances of parasitizing host fishes are low. Even if the host fishes do become parasitized, the run-of-the-river dams act as physical barriers and impede the upstream movement of the fishes, and thus limit freshwater mussel distribution and range expansion within the watershed. Therefore, restricted dispersal capabilities, coupled with suboptimal habitat in inundated areas, limit the potential of freshwater mussels for sustaining their populations in portions of the Fox River.

2.3.5 Fishes

The ILDNR sampled fish from about 20% of the mainstem Fox River between Stratton and Dayton dams and captured 30,290 individuals from 68 species. A detailed fish list may be found in Santucci and Gephard 2003. The distribution of species among station types indicates that most fishes favored the free-flowing segments of the river over impounded segments created by dams. Except for one Goldfish (*Carassius auratus*) and Pugnose Minnow (*Opsopoeodus emiliae*), all species captured at impounded stations also were found at free-flowing stations and species taken from both habitats typically were more abundant in free-flowing habitats. Further, there were 24 species (35% of the total) found only in free-flowing portions of the river. Species captured only at free-flowing stations included important game species, such as the Sauger (*Sander canadensis*) and Muskellunge (*Esox masquinongy*), several intolerant minnows, darters, suckers (including the state threatened River Redhorse), Gars, Bowfin, Mooneye, Stonecat, and Smallmouth Buffalo. In addition to the higher overall abundance, free-flowing stations typically had more species that are intolerant of poor water and habitat quality, a higher percentage of insectivorous minnows, and a lower frequency of deformities, erosion, lesions, and tumors (DELTs). Impounded areas show the opposite effect in that they have lower species richness, low overall abundance, more DELTs, and more omnivorous tolerant species of fish. Various species populations have become fragmented within the system due to the presence of dams and some species will be present on one side and not the other. Much of this information shows that, overall, the free-flowing habitats are of a better quality as compared to the impoundments and is expressed in the higher IBI scores seen at all free-flowing stations. 15 species were found to have a truncated distribution only being found downstream, with another 15 with discontinuous distributions that were typically absent from the middle portions of the river. 10 of the species found only in the lower portion were found solely below the first dam in Dayton.

The ILDNR sampled fish from about 20% of the mainstem Fox River between Stratton and Dayton dams utilizing standard protocols for calculating IBI scores. Fish were sampled by boat electrofishing, backpack electrofishing, and seining at 40 stations during July through early September 2000.The quality of the fish community as determined by IBI scores was higher in free-flowing reaches of river than in impounded areas above dams, but communities did not differ between station types within each habitat. Scores for DS FF and MD FF stations each averaged 46, which indicates a “B” quality stream or highly valued aquatic resource. In contrast, mean IBI scores for MD IMP and US IMP stations were below 31, indicating a “D” quality stream or limited aquatic resource. Individual IBI scores for above and below dam stations (excluding mid segment sites) showed a consistent pattern throughout the river of higher quality fish communities in natural flowing reaches and lower quality communities in impoundments (Figure 6).

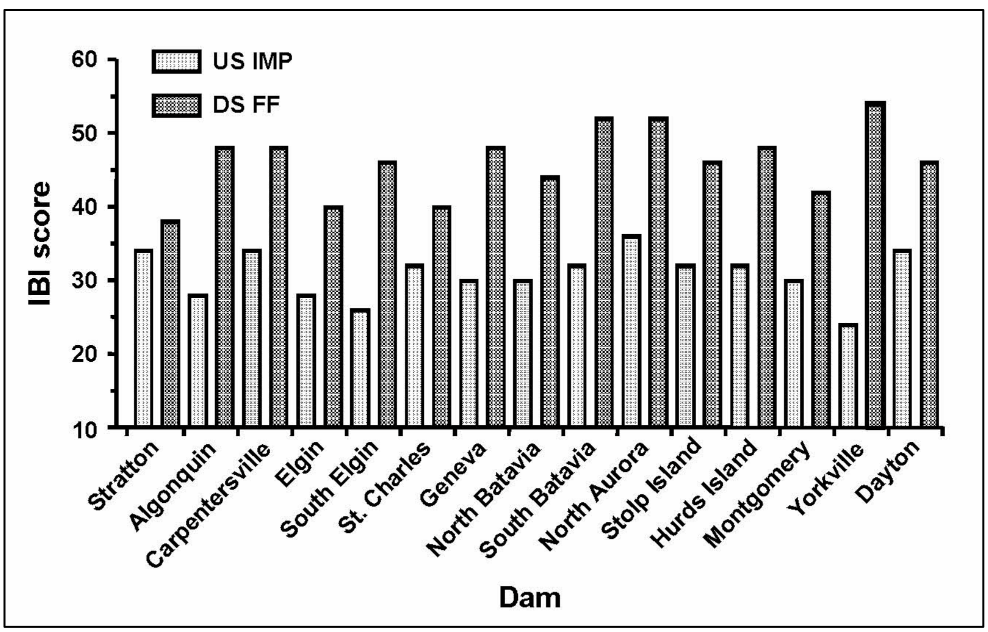


Figure 6: Fish index of biotic integrity scores at Fox River dams (Gephard & Santucci 2003)

Santucci and Gephard (2003) examined mean scores for individual IBI metrics across station types to characterize differences in the fish community between free-flowing and impounded habitats. Compared to impounded stations, free-flowing stations typically had higher species richness, substantially higher overall abundance, and more species of suckers, darters, and fishes that are intolerant of poor water quality and habitat conditions. Samples from these areas also had a higher percentage of insectivorous minnows, such as Spotfin Shiner (*Cyprinella spiloptera*) and Sand Shiner (*Notropis stramineus*), and a lower proportion of individuals with deformities, eroded fins, lesions, and tumors (DELT) anomalies. In contrast, impounded stations typically had lower species richness, low overall abundance, more fish with high DELT anomalies, and a predominance of tolerant and omnivorous species, such as Common Carp, Bluntnose Minnow, Quillback, and Green Sunfish.

Sport species were more abundant at stations in free-flowing habitats than impounded habitats. Mean catch rates for harvestable-sized sport fish were higher at DS FF and MD FF stations than at MD IMP and US IMP stations. Sport fish catch rates were similar for stations within free-flowing habitats and within impoundments. Popular sport species like Channel Catfish and Smallmouth Bass also were more abundant in the free-flowing river. Mean catch rates for Channel Catfish differed statistically between free-flowing and impounded stations.

The dams have altered distributions of nearly one third of Fox River fishes by acting as barriers to upstream fish movement. Santucci & Gephard (2003) identified 15 species of fish that had truncated distributions in the basin and another 15 species with discontinuous distributions (Figure 7). Species with truncated distributions were found only in the lower portions of the river. Ten species were found only below the lowermost dam in Dayton, Illinois. This group includes important sport species such as Sauger, commercial species such as the Buffalo (*Ictiobus* spp.; bigmouth, black, and smallmouth), and highly migratory species such as the American eel, Mooneye, and Skipjack Herring. Five additional species, including the state threatened River Redhorse, have populations that persist above the Dayton Dam, but they are limited to the lower river in Illinois and in a few spots Wisconsin. Species with discontinuous distributions were found in the upper and lower Fox River, but occasionally or not at all in the central river between the St. Charles and Montgomery dams. This section of river has a particularly high density of dams (eight dams in 14 river miles) compared to other parts of the Fox River in Illinois (an average of one dam every 9.5 mi.).

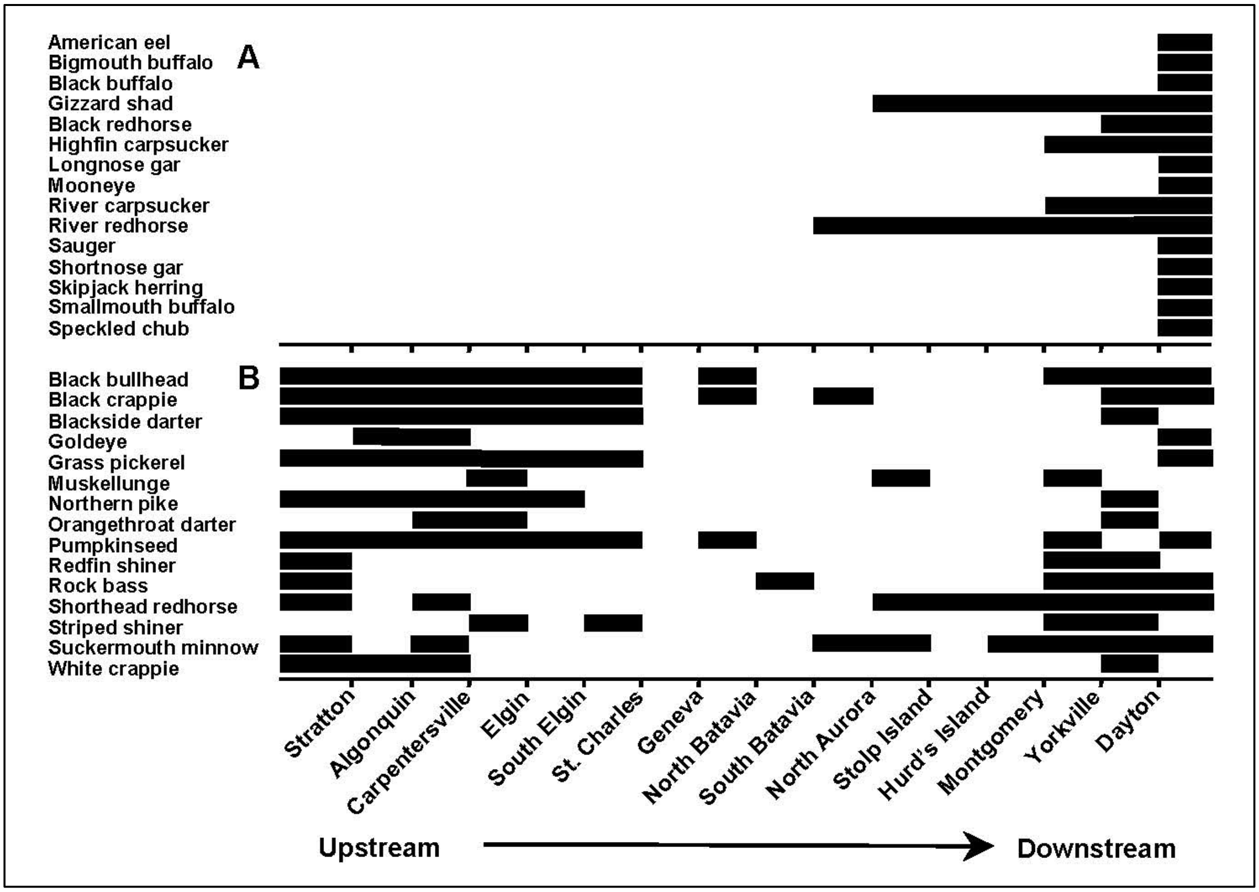


Figure 7: Fox River fish species fragmentation chart (Santucci & Gephard 2003)
Fishes with (A) truncated distributions (restricted to the lower portion of the watershed) and (B) discontinuous distributions (typically absent from the middle portion of the watershed).

Many studies have assessed the effects of large dams on larger bodied transient and migratory fishes, but few have examined the effects of run-of-the-river dams and small benthic fishes. Tiemann et al (2004) sampled fishes, macroinvertebrates, habitat, and physicochemistry monthly from November 2000 to October 2001 at eight gravel bar sites centered around two run-of-the-river dams on the Neosho River, Kansas. Sampling included a reference site and a treatment site both upstream and downstream from each dam. Multivariate analysis of variance indicated that habitat varied immediately upstream and downstream from the dams, with resultant effects on macroinvertebrate and fish assemblages. Fish species richness did not differ among site types, but abundance was highest at downstream reference sites and evenness was highest at upstream sites. The abundance of some benthic fishes was influenced by the dams, including that of the Neosho Madtom (*Noturus placidus*), which was lowest immediately upstream and downstream from dams, and those of the Suckermouth Minnow (*Phenacobius mirabilis*), Orangethroat Darter (*Etheostoma spectabile*), and Slenderhead Darter (*Percina phoxocephala*), which were highest in downstream treatment sites. Although limited to one system during a 1-year period, this study suggests that the effects of run-of-the-river dams on fishes, macroinvertebrates, and habitat are similar to those reported for larger dams, providing important considerations for riverine ecosystem conservation efforts.

2.3.6 Reptiles & Amphibians

A comprehensive list of reptiles and amphibians was assembled for the Fox River watershed utilizing publications and available data (Table 5). The most abundant riverine reptiles and amphibians within the Fox River include, but are not limited to: green frog, northern leopard frog, snapping turtle, painted turtle, spiny softshell turtle, northern map turtle, musk turtle, northern water snake, and queen snake.

Table 5: Amphibians & reptiles known to occur within the Fox River watershed

Species Name	Common Name	Species Name	Common Name
Ambystoma laterale	Blue-spotted Salamander	Chrysemys picta	Painted Turtle
Ambystoma maculatum	Spotted Salamander	Emydoidea blandingii	Blanding's Turtle
Ambystoma texanum	Small-mouthed Salamander	Graptemys geographica	Northern Map Turtle
Ambystoma tigrinum	Tiger Salamander	Trachemys scripta	Pond Slider
Hemidactylium scutatum	Four-toed Salamander	Sternotherys odoratus	Eastern Musk Turtle
Nectrus maculosus	Mudpuppy	Apalone spinidera	Spiny Softshell
Notophthalmus viridescens	Eastern Newt	Clonophis kirtlandii	Kirtland's Snake
Anaxyrus americanus	American Toad	Coluber constrictor	Eastern Racer
Anaxyrus fowleri	Fowler's Toad	Elaphe vulpina	Western Foxsnake
Acris blanchardi	Blanchard's Cricket Frog	Lampropeltis triangulum	Milksnake
Hyla chrysoscelis	Cope's Grey Treefrog	Nerodia sipedon	Northern Watersnake
Pseudacris crucifer	Spring Peeper	Opheodrys vernalis	Smooth Greensnake
Pseudacris maculata	Boreal Chorus Frog	Regina septemvittata	Queen Snake
Lithobates catesbeianus	American Bullfrog	Storeria dekayi	Dekay's Brownsnake
Lithobates clamitans	Green Frog	Storeria occipitomaculata	Redbellied Snake
Lithobates pipiens	Nothern Leopard Frog	Thamnophis radix	Plains Gartersnake
Chelydra serpentina	Snapping Turtle		

2.3.7 Birds

Approximately 235 species of breeding birds have been documented throughout the Fox River Watershed in Illinois (Bird Conservation Network database). See *Appendix A: Compliance, Coordination & Information* for comprehensive species list. The Fox River Valley is part of the globally significant Mississippi Flyway. Approximately 40% of all migratory birds of North America use the Mississippi Flyway in some facet such as accessing important nesting, feeding, and resting habitat along their migration.

2.3.8 Mammals

A comprehensive list of mammals was assembled for the Fox River watershed utilizing publications and available data (Table 6). The most likely native mammals that would use the Fox River's immediate riparian zone include, but are not limited to: little brown bat, northern long-ear bat, silver-haired bat, eastern pipistrelle, big brown bat, eastern red bat, hoary bat, evening bat, white-footed mouse, ground hog, muskrat, American beaver, river otter, coyote, red fox, white-tailed deer, and opossum.

Table 6: Mammals known to occur within the Fox River watershed

Species Name	Common Name	Species Name	Common Name
Myotis lucifugus	little brown bat	Sciurus niger	fox squirrel
Myotis septentrionalis	northern long-eared bat	Sciurus carolinensis	eastern gray squirrel
Pipistrellus subflavus	eastern pipistrelle	Tamiasciurus hudsonicus	red squirrel
Eptesicus fuscus	big brown bat	Glaucomys volans	southern flying squirrel
Lasiurus borealis	eastern red bat	Ondatra zibethicus	muskrat
Lasionycteris noctivagans	silver-haired bat	Castor canadensis	American beaver
Lasiurus cinereus	hoary bat	Scalopus aquaticus	eastern mole
Nycticeius humeralis	evening bat	Didelphis virginiana	Virginia opossum
Mus musculus	house mouse	Procyon lotor	racoon
Peromyscus maniculatus	deer mouse	Vulpes vulpes	red fox
Peromyscus leucopus	white-footed mouse	Canis latrans	coyote
Rattus norvegicus	Norway rat	Neovison vison	American mink
Tamias striatus	eastern chipmunk	Lontra canadensis	river otter
Spermophilus tridecemlineatus	thirteen-lined ground squirrel	Mephitis mephitis	striped skunk
Spermophilus franklinii	Franklin's ground squirrel	Lynx rufus	bobcat
Marmota manax	ground hog	Odocoileus virginianus	white-tailed deer
Microtus pennsylvanicus	meadow vole		

2.4 Cultural & Social Resources

2.4.1 Life Safety Risk

Low-head run-of the-river dams pose a risk to life safety. Water flowing over the top of the dam often appears calm and does not give an appearance of danger from the upstream side, however, as the water plunges into the water below, it often creates a circular underwater current often referred to as a roller. People and small vessels can become trapped in this current, which doesn't allow the victim to resurface for extended periods. Drownings near dams on the Fox River are not uncommon, and multiple lives have been lost in a single incident as bystanders jump in to assist and become trapped themselves. In addition to drowning in the circular roller current, boats have gotten stuck on or crashed over the dams. Multiple municipalities on the river have swift water rescue teams to respond in emergencies, but loss of life still occurs.

2.4.2 Land Use History

Western settlement in the Fox River Valley began in the early 1830s, as farmers primarily from New England, New York, and Pennsylvania moved into the area. By the mid-1840s a number of grist mills, sawmills, and textile mills had been established along the Fox River. Virtually all of the existing communities along the Fox River originated as early mill towns. By the 1850s industry along the Fox River focused less on agricultural products and more on industrial production.

The communities tended to specialize in their industrial output. Aurora became a major manufacturer of railroad cars. Brick and glass works were in East and West Dundee. Elgin became known for the manufacturing of watches, precision instruments, and the development of condensed milk. St. Charles was home to an ironworks, piano factory, and paper mills. Geneva developed as a manufacturing center of agricultural machinery. Batavia was home to three major windmill factories that were so productive that by 1890, Batavia was the leading windmill manufacturing city in the world, earning the nickname, “The Windmill City.” From the beginning Algonquin has served as a recreational area for Chicagoans. Today most of the local industry is gone and the communities along the Fox River primarily serve as bedroom communities as part of the greater Chicago metropolitan area.

The general project area is comprised of southeastern McHenry County and eastern Kane County. This area contains 10 incorporated communities with a combined diverse middle-class to upper middle-class population of approximately 500,000 inhabitants.

2.5 Forecasting Habitat Quality

The purpose of this study is to evaluate alternative plans for aquatic ecosystem restoration of the Fox River. To predict change in habitat quality, the level of habitat suitability was estimated by developing a Habitat Suitability Index (HSI). HSI is an algebraic function that typically uses various habitat structure components as indicators, such as cover, food, and natural processes, or biological components of species richness, abundance, evenness, etc. The Qualitative Habitat Evaluation Index (QHEI) is one HSI that has been certified by USACE’s Center of Expertise for Ecosystem Restoration and reflects the river’s physical habitat quality. The QHEI was utilized to quantify existing, FWOP, and FWP conditions for the Fox River study area. Fishes and mussels are highly indicative of habitat quality for riverine aquatic organisms, being highly responsive to primary (hydrology/hydraulics/geomorphology) and secondary (plants/habitat structure) ecosystem driver changes. Changes in habitat will directly affect the richness, abundance and distribution of riverine organisms, and in particular fishes and freshwater mussels.

2.5.1 Qualitative Habitat Evaluation Index (QHEI)

The QHEI is a physical habitat index designed to provide an empirical, quantified evaluation of the lotic macrohabitat characteristics that are important to fish communities (Ohio EPA 2006; see *Appendix A: Compliance, Coordination & Information* for protocol publication). A detailed analysis of the development and use of the QHEI is available in Rankin (1989) and Rankin (1995). The QHEI is composed of six principal metrics each of which are briefly described below. The maximum possible QHEI score is 100, and the lowest (0) zero; however, the likelihood that even the most impaired drain would not achieve a (0) zero. Each of the metrics are scored individually and then summed to provide the total QHEI segment score. This was completed at least once for each sampling site during each year of sampling. The QHEI protocol also standardizes definitions for riverine habitats, for which a variety of existing definitions and perceptions exist. Consistency for these was derived from Platts et al. (1983). The ILDNR utilized the Ohio EPA protocol to collect data and score QHEI sites for the Fox River, and in particular for the impounded and free-flowing segments of the river.

2.5.1.1 QHEI Riverine Habitat Metrics

1. **Substrate:** This metric includes two components, substrate type and substrate quality and notes the presence of all substrate types present in pools/glides and riffles/runs that each comprise sufficient quantity to support species that may commonly be associated with that substrate type. This metric awards points to those sites with a diversity of high quality substrate types, including concepts of siltation and embeddedness (the degree that cobble, gravel, and boulder substrates are surrounded, impacted in, or covered by fine materials). Maximum points are 20.
2. **In-stream Cover**: This metric scores presence of in-stream cover types and amount of overall in-stream habitat cover. These features include, but are not limited to deep pools, undercut banks, islands, large boulders, large woody debris, aquatic vegetation, over hanging vegetation, etc. Maximum points are 20.
3. **Channel Morphology**: This metric emphasizes the quality of the stream channel that relates to the creation and stability of macrohabitat. It includes channel sinuosity, channel development, channelization, and channel stability. Maximum points are 20.
4. **Riparian Zone and Bank Erosion:** This metric emphasizes the quality of the riparian buffer zone and quality of the floodplain vegetation. This includes riparian zone width, floodplain quality, and extent of bank erosion. Each of the three components requires scoring the left and right banks (looking downstream). The average of the left and right banks is taken to derive the component value. Maximum points are 10.
5. **Pool/Glide and Riffle-Run Quality:** This metric emphasizes the quality of the pool/glide and/or riffle/run habitats. This includes pool depth, overall diversity of current velocities (in pools and riffles), pool morphology, riffle-run depth, riffle-run substrate, and riffle-run substrate quality. Maximum points are 20.
6. **Reach Gradient**: Local or map gradient is calculated from USGS 7.5 minute topographic maps by measuring the elevation drop through the sampling area. Gradient classifications (Table V-4-3 found in Ohio EPA 2006) were assigned by stream size category after examining scatter plots of IBI vs. natural log of gradient in feet/mile (see Rankin1989). Maximum points are 10.

The principal theory underlying the QHEI model is that the integrity and structure of a riverine fish community is partially related to the physical characteristics of the habitat. The QHEI provides an indicator of habitat quality by measuring those physical factors which are known to affect fish communities. Rankin (1989) examined the relationship between the QHEI and the IBI. The analysis resulted in a significant positive relationship between QHEI and IBI scores further supporting the underlying assumptions of the model (Rankin 1989; Santucci et al 2005). The individual metrics in the model are all supported by fluvial geomorphologic principles as reported by literature and supported by empirical evidence; thusly painting a picture of habitat conditions for the Fox River study area (Table 7).

Table 7: QHEI scores per each study area dam for upstream impounded (US IMP) and downstream free-flowing (DS FF) segments

				Component Metrics						
Station	**Type**	**RM**	**QHEI**	**Substrate**	**Stream Cover**	**Morphology**	**Riparian**	**Pool/Glide**	**Riffle/Run**	**Gradient**
Stratton	DS FF	97.7	53.0	10.0	12.0	8.0	4.0	7.0	0.0	6.0
Algonquin	US IMP	81.9	19.0	2.0	4.0	4.0	2.0	1.0	0.0	6.0
Algonquin	DS FF	81.2	66.5	16.0	10.0	10.5	3.0	10.0	7.0	10.0
Carpentersville	US IMP	77.5	41.5	9.0	12.0	6.0	6.5	2.0	0.0	6.0
Carpentersville	DS FF	76.8	76.5	16.0	15.5	11.0	5.0	11.0	8.0	10.0
Kimball St.	US IMP	71.3	30.3	5.0	9.0	4.0	5.3	1.0	0.0	6.0
Kimball St.	DS FF	70.6	65.5	16.0	12.0	10.5	3.0	8.0	6.0	10.0
South Elgin	US IMP	67.5	31.5	9.0	7.0	5.0	2.5	2.0	0.0	6.0
South Elgin	DS FF	66.4	84.8	19.0	18.0	14.0	4.8	11.0	8.0	10.0
St. Charles	US IMP	60.0	29.3	6.0	9.5	5.0	1.8	1.0	0.0	6.0
St. Charles	DS FF	59.4	58.5	19.0	8.5	5.0	2.0	8.0	6.0	10.0
Geneva	US IMP	58.0	33.8	12.0	7.0	4.5	3.3	1.0	0.0	6.0
Geneva	DS FF	57.5	72.8	19.0	13.0	10.0	2.8	11.0	7.0	10.0
Batavia	US IMP	55.7	38.8	8.0	11.0	5.0	7.8	1.0	0.0	6.0
Batavia	DS FF	55.1	71.3	17.0	13.0	12.0	2.3	11.0	6.0	10.0
North Aurora	US IMP	52.0	38.3	9.5	10.0	5.5	6.3	1.0	0.0	6.0
North Aurora	DS FF	51.5	77.8	16.0	16.0	14.0	4.8	11.0	6.0	10.0
Aurora	US IMP	48.6	30.0	7.0	8.5	4.5	3.0	1.0	0.0	6.0
Aurora	DS FF	48.1	55.5	16.0	7.0	6.0	1.5	9.0	6.0	10.0
Montgomery	US IMP	46.5	34.8	12.0	4.0	7.0	3.8	1.0	1.0	6.0
Montgomery	DS FF	46.0	65.3	16.0	10.5	9.5	3.8	8.5	7.0	10.0

Since the QHEI model output is a score between 0-100, it is easily indexed to a score between 0 to 1.0; this provides uniform and useful information across USACE ecosystem studies. Existing HSI scores for the Fox River segments are presented in (Table 8). The equation to normalize the QHEI score is:

- QHEI Score / 100 = HSI

Table 8: QHEI scores conversion to habitat suitability index (HSI) for existing conditions (EX)

Station	Type	QHEI	EX_HSI	Station	Type	QHEI	EX_HSI
Algonquin	US IMP	19.0	0.19	Geneva	US IMP	33.8	0.34
Algonquin	DS FF	66.5	0.67	Geneva	DS FF	72.8	0.73
Carpentersville	US IMP	41.5	0.42	Batavia	US IMP	38.8	0.39
Carpentersville	DS FF	76.5	0.77	Batavia	DS FF	71.3	0.71
Kimball St.	US IMP	30.3	0.30	North Aurora	US IMP	38.3	0.38
Kimball St.	DS FF	65.5	0.66	North Aurora	DS FF	77.8	0.78
South Elgin	US IMP	31.5	0.32	Aurora	US IMP	30.0	0.30
South Elgin	DS FF	84.8	0.85	Aurora	DS FF	55.5	0.56
St. Charles	US IMP	29.3	0.29	Montgomery	US IMP	34.8	0.35
St. Charles	DS FF	58.5	0.59	Montgomery	DS FF	65.3	0.65

2.5.2 Stream Length as Quantity Measure

USACE planning guidelines require that there be a quantity component to the habitat assessment for determining FWOP and FWP project conditions. Stream miles, feet and acres are typically utilized for river restoration studies. The ILDNR calculated affected stream lengths and acres of impoundment (IMP) and free-flowing (FF) (Table 9) (Santucci & Gephard 2003). The ten study area dams on the Fox River impound 70% of 55 river miles between the Stratton and Montgomery Dams. Impoundments ranged in length from 0.3 to 15.8 miles long with the largest ones formed behind the Algonquin and St. Charles dams. Impoundments were typically double the width of free-flowing segments. Free-flowing areas ranged in length from 0.3 to 3.6 miles long between the Stratton and Montgomery Dams.

Table 9: Length, acres, and stream width of free-flowing (FF) and impounded (IMP) segments

	Length (mi)			Area (ac)			Mean Width (ft)	
River Segment	**FF**	**IMP**	**Total**	**FF**	**IMP**	**Total**	**FF**	**IMP**
Stratton-Algonquin	0.6	15.8	16.4	19.5	836.1	855.6	268.1±25.7	429.0±12.3
Algonquin-Carpentersville	3.1	1.4	4.5	74.2	73.7	147.9	201.1±9.7	442.0±31.6
Carpentersville-Kimball St.	2.7	3.6	6.3	76.3	196.6	272.9	273.8±22.4	463.9±20.4
Kimball St.-South Elgin	0.4	3.2	3.6	12.5	169.1	181.6	297.9±7.8	413.4±18.9
South Elgin-St. Charles	3.6	3.9	7.5	178.7	240.9	419.6	417.6±16.5	510.4±17.5
St. Charles-Geneva	1.1	0.9	2.0	37.7	53.9	91.6	298.3±11.9	503.9±25.2
Geneva-Batavia	0.1	3.6	3.7	36.4	90.5	126.9	330.3±14.4	541.1±25.6
Batavia-North Aurora	1.9	2.8	4.7	47.5	70.7	118.2	446.7±33.3	620.1±47.7
North Aurora-Aurora	2.4	1.1	3.5	103.6	62.9	166.5	463.5±25.3	562.5±30.6
Aurora-Montgomery	0.8	2.0	2.8	23.1	25.9	49	595.2±92.1	415.4±39.0
All Segments	16.7	38.3	55.0	609.5	1,820.30	2,429.80		
Percent of Total	30%	70%		25%	75%			

Since stream length remains constant whether impounded (IMP) or free-flowing (FF), a derived stream length unit equivalent to an acre of habitat was used for this study (Table 10). The average width of all the free-flowing habitat sections of the river is about 300-feet wide. Since an acre is 43,560 ft^2, the length to achieve 1 acre of habitat on the Fox River would be about 145.2 feet (43,560/300 = 145.2). Since acres alone would not remain constant and are not indicative of restorative measures under this study, units of length would be static and meaningful. Acres within the impoundments would actually decrease should measures be taken to return riverine structure and function. This is counterintuitive to most habitat assessment methodologies where increases in acres of habitat are beneficial.

Table 10: Derived length unit for quantity assessment

River Segment	Miles	Derived Length Units*
Stratton-Algonquin	15.8	574.5
Algonquin-Carpentersville	1.4	50.9
Carpentersville-Kimball St.	3.6	130.9
Kimball St.-South Elgin	3.2	116.4
South Elgin-St. Charles	3.9	141.8
St. Charles-Geneva	0.9	32.7
Geneva-Batavia	3.6	130.9
Batavia-North Aurora	2.8	101.8
North Aurora-Aurora	1.1	40.0
Aurora-Montgomery	2.0	72.7

* this unit is calculated by river feet/145.2 = Derived Length Units

2.5.3 Average Annual Habitat Units (AAHUs)

In order to equally assess measures, alternatives or plans, the benefit portion of the analysis must be annualized just as the costs are. The method per USACE planning guidelines typically assigns benefits over a 50-year period of analysis, or project life. This study will use 50-years as a reasonable period of analysis, noting that the benefits may actually be accrued in perpetuity. The main mechanism of habitat restoration for a river is to return free-flowing conditions to allow connectivity, channel hydraulics and substrate sorting to restore riverine habitats and species distributions naturally. Based on experience with several completed river connectivity projects such as the Hoffman Dam on the Des Plaines River, substrates and habitat are nearly fully restored after the first few large flood events (channel forming events) following reestablishment of free-flowing conditions. To be conservative, this analysis utilized the 2-year mark as achieving maximum habitat benefits, which would give more than enough time for the river channel to adjust and create habitat again. HUs are calculated by:

- HSI x Derived Length Unit Affected = Habitat Units (HUs)

FWOP and FWP Average Annual HSI is calculated by:

- HSI_{n50} / 50 years = AAHSI

Average Annual Habitat Units (AAHUs) are calculated by:

- AAHSI x Derived Length Unit Affected = AAHUs

Even though there may be apparent benefits to be gained, there are still minor benefits existing in the future without-project condition within the impoundments (IMP), as evident by the QHEI scores. To ensure that existing benefits are not claimed by potential actions, only the net benefits gained are utilized. This unit is called the Net Average Annual Habitat Unit (NAAHU), which is represented as:

- FWP AAHUs – FWOP AAHUs = Net Average Annual Habitat Units (NAAHUs)

2.6 Future Without-Project (FWOP) Conditions / No Action

Figure 8 presents habitat quality forecasted via the QHEI. The results shows that the existing and FWOP conditions for riverine habitat within the impounded segments of river are considered degraded as compared to the free flowing segments. This is directly related to the presence of the dams impeding riverine hydraulics, sediment transport and substrate sorting, resulting in a loss of structural habitat heterogeneity. Table 11 presents the FWOP AAHUs for both the impounded and free flowing river segments; it should be noted that the free flowing segments provide a frame of reference for healthy river segments.

Figure 8: FWOP habitat suitability index scores per river segment for upstream impounded (US IMP) and downstream free flowing (DS FF) segments

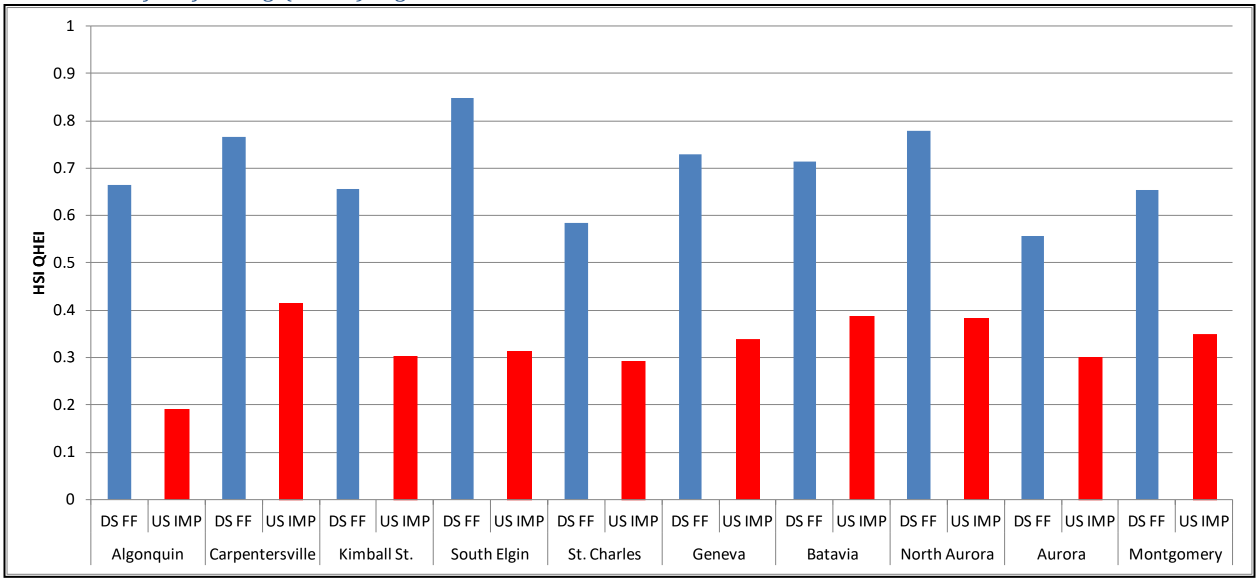


Table 11: FWOP average annual habitat unit forecasting over 50-years

Station	Type	QHEI	FWOP_HSI	Derived Length Units	FWOP AAHUs
Algonquin	US IMP	19.0	0.19	574.5	109.16
Algonquin	DS FF	66.5	0.67	112.7	74.96
Carpentersville	US IMP	41.5	0.42	50.9	21.13
Carpentersville	DS FF	76.5	0.77	98.2	75.11
Kimball St.	US IMP	30.3	0.30	130.9	39.67
Kimball St.	DS FF	65.5	0.66	14.5	9.53
South Elgin	US IMP	31.5	0.32	116.4	36.65
South Elgin	DS FF	84.8	0.85	130.9	111.01
St. Charles	US IMP	29.3	0.29	141.8	41.55
St. Charles	DS FF	58.5	0.59	40.0	23.40
Geneva	US IMP	33.8	0.34	32.7	11.06
Geneva	DS FF	72.8	0.73	3.6	2.65
Batavia	US IMP	38.8	0.39	130.9	50.79
Batavia	DS FF	71.3	0.71	69.1	49.26
North Aurora	US IMP	38.3	0.38	101.8	39.00
North Aurora	DS FF	77.8	0.78	87.3	67.90
Aurora	US IMP	30.0	0.30	40.0	12.00
Aurora	DS FF	55.5	0.56	29.1	16.15
Montgomery	US IMP	34.8	0.35	72.7	25.31
Montgomery	DS FF	65.3	0.65	316.4	206.59

In general, the Fox River system was transformed from a naturally diverse, free-flowing river, into a homogenized system of impoundments. The native species richness, abundance and health was severely degraded from the natural state. Other than this study, there are no other plans for large scale connectivity and habitat restoration along the Fox River. Other known restoration efforts primarily focus on water quality, riparian zone and tributary restorations and improvements; these activities would continue in the future. There are no legal mandates or requirements by any state or federal agencies to remove any of the study areas dams. In terms of large river habitat, the impounded segments of river are already highly degraded. There could be loss of additional mussel and fish species if some natural event or man induced accident would adversely affect one of the fragmented segments of river; however, these events are unpredictable. The existing conditions (EX HSI), therefore, would be indicative of the FWOP conditions (FWOP HSI). It is suspected with a high degree of certainty based on the river's history and scientific studies that riverine connectivity and habitat quality would remain static within the affected Fox River study area over the next 50-years. In addition, FWOP conditions would continue to pose life safety risk from drownings and incidents where vessels crash over or get stuck on the dams.

3 PLAN FORMULATION AND EVALUATION

Plan formulation is an iterative process resulting in the development, evaluation, and comparison of alternative plans to address identified study problems. Plan formulation for ecosystem restoration presents a challenge because alternatives have non-monetary benefits. To facilitate the plan formulation process, the Study Team used the methodology outlined in USACE Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook. The steps in the methodology are:

1. Identify a primary project purpose. For this study, aquatic ecosystem restoration (AER) is identified as the primary purpose.
2. Formulate and screen management measures to achieve planning objectives and avoid/minimize planning constraints. Measures are the building blocks of alternative plans.
3. Formulate, evaluate, and compare an array of alternatives to achieve the primary purpose and identify cost-effective plans.
4. Perform an incremental cost analysis on the cost-effective plans to determine the National Ecosystem Restoration (NER) plan.

Risk–Informed Planning

This feasibility study followed an iterative six-step planning process as outlined in ER 1105-2-100 and depicted in Figure 9:

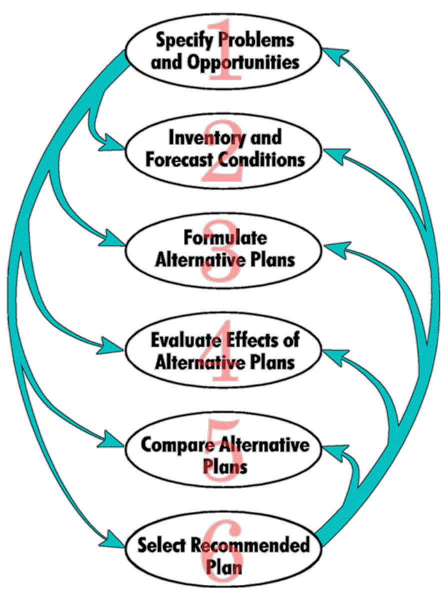


Figure 9: USACE six-step planning process

Identification of problems and opportunities begins at the outset of the study and forms the foundation of the planning process. The identified problems and opportunities for this study are described in Section 3.1. Developing a detailed inventory of existing conditions and forecast of future conditions, Step 2, creates a comprehensive picture of the study area, as described in Chapter 2. Forecasted conditions provide a basis for the comparison and evaluation of alternative plans. Management measures are identified based on the study objectives, screened based on various criteria, and then combined to form an Initial Array of Alternatives.

USACE risk-informed planning (as described in IWR Publication 2017-R-03) pays careful attention to uncertainty and uses a set of risk-performance measures, together with other considerations, to *inform* planning. Risk-informed planning is an analytic-deliberative process that aims to progressively reduce uncertainty but acknowledges that it can never be eliminated entirely. The goal is to efficiently reduce uncertainty by gathering only the evidence needed to make the next planning decision and to manage the risks that result from doing so without more complete information. Under risk-informed planning, the six-step planning process may be demonstrated more effectively as shown in Figure 10 below.

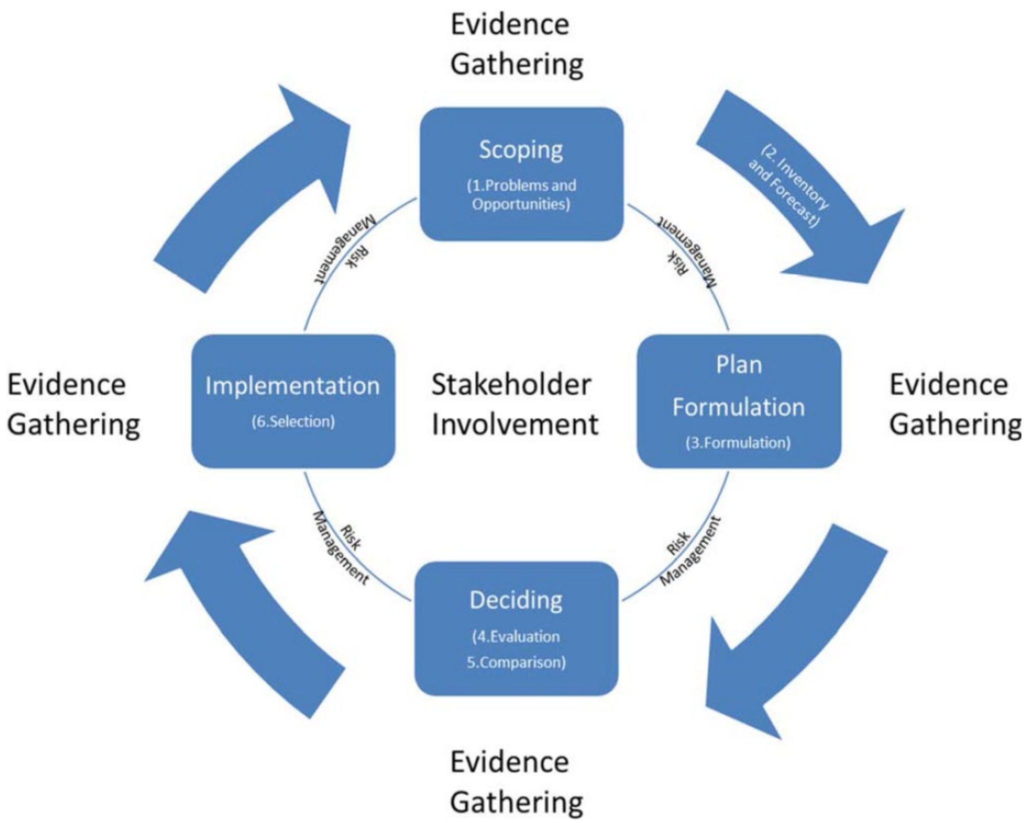


Figure 10: USACE risk-informed planning process

Stakeholder involvement is at the center of the planning process, which takes place within a continuous process of evidence gathering and uncertainty reduction. The thread that unites the steps, surrounds the stakeholder engagement, and mirrors the evidence gathering is risk management. The cyclical nature of the figure depicts the iterative nature of the planning process.

3.1 Problems and Opportunities

3.1.1 Problems

Human activity over the past two centuries has altered the hydrology, hydraulics, sediment transport, groundwater recharge/discharge, geomorphology, and plant communities historically present within the watershed, floodplain and river channel of the Fox River. These modifications have subsequently caused structural habitat degradation, fragmentation, pollution, and invasive species issues, all of which are intertwined. These alterations have reduced species richness, abundance and distribution of native plant and animal assemblages, and currently threaten the future sustainability of the Fox River aquatic ecosystem. As a result, river fragmentation, impounded hydraulic conditions and water quality degradation have become a great concern for the watershed.

Based on site qualitative and quantitative investigations, and study results provided by state agencies and academia presented above, the main aquatic resource problems within the Fox River in which a Section 519 aquatic ecosystem restoration project has the opportunity to address are as follows:

- Limited passage of mussel and fish species within the Fox River proper
    - Mussels depend on fish passage for dispersal, fish being glochidial (larval) hosts
- Lack of tributary access in certain impounded segments
    - Many species of transient fishes such as suckers and catfish require tributary connectivity to provide access to spawning habitat of smaller connected streams
- Lack of riverine (lotic/flowing) velocities and forces that riverine species require
- Lack of natural sediment (substrate) transport
    - Impaired substrate composition and sorting
    - Lack of natural macro-habitat features in impounded segments
        - Islands, deep pools, riffles, native aquatic vegetation, bars, undercut banks
    - Eliminated ability to naturally filter and clean water and sediments (substrates)
        - Moving water facilitates cleansing as substrates (sediment) move through the river becoming exposed to saprophytes (animals, bacteria, fungi) and oxygen
- Water Quality Degradation
    - Impoundment causes water to warm up and lose dissolved oxygen
    - Impoundment allows for the accumulation of fine sediments that typically store nutrients, further lowering dissolved oxygen through algal blooms; further decreasing dissolved oxygen
    - Super-critical flows (waterfall conditions) can strip nitrogen from the water column or super saturate water with dissolved gases

3.1.2 Opportunities

Reestablish **quality** and **connectivity** of riverine habitats.

The Fox River has experienced channel fragmentation and significant loss of habitat due to the presence of the dams in the study area. These impairments include impeding riverine hydraulics, sediment transport, channel development (riffles/pools) and substrate sorting, and result in a loss of structural habitat heterogeneity (geomorphology). These opportunities seek to reestablish hydrologic connectivity, natural fluvial-geomorphic parameters (velocities/substrates) and structure (morphology/habitat) to support, sustain and connect riverine habitats within the study area. The targeted location of these effects would be within river/stream channel. These effects would be sustained over the life of the project (50-year period of analysis) and, optimistically, in perpetuity. Improvement would be measured via the predicted increase in quality of riverine habitat as evaluated by the QHEI for Midwestern streams and rivers.

3.2 Objectives and Constraints

The primary goal of this feasibility study is to determine a cost-effective restoration plan that solves identified problems, is acceptable to the non-federal sponsor and stakeholders, and meets the federal goal and objectives.

3.2.1 Objectives

3.2.1.1 Federal Ecosystem Objectives

The federal objective of water and related land resources planning is to contribute to national economic and/or ecosystem development in accordance with national environmental statutes, applicable executive orders, and other federal planning requirements and policies. The use of the term “federal objective” should be distinguished from planning/study objectives, which are more specific in terms of expected or desired outputs whereas the federal objective is considered more of a national goal. Water and related land resources project plans shall be formulated to alleviate problems and take advantage of opportunities in ways that contribute to study objectives and to the federal objective. Contributions to national improvements are increases in the net value of the national output of goods, services and ecosystem integrity. Contributions to the federal objective include increases in the net value of those goods, services and ecosystems that are or are not marketable.

Restoration of the Nation’s environment is achieved when damage to the environment is reversed, lessened, eliminated or avoided and important cultural and natural aspects of our nation’s heritage are preserved.

3.2.1.2 Study Objectives

As part of the USACE Civil Works mission, the federal objective of aquatic ecosystem restoration projects is to restore the structure, function, and dynamic processes of degraded ecosystems to a less degraded, more natural condition. Study objectives are statements that describe the desired results of the planning process by addressing the problems and realizing the opportunities. Objectives must be clearly defined and provide information on the effect desired, the subject of the objective (what will be changed by accomplishing the objective), the location where the expected result will occur, the timing of the effect (when would the effect occur) and the duration of the effect.

Two planning objectives were identified by the study team, the non-federal sponsors, and various stakeholders. These will be used as targets for addressing aquatic resource problems identified within the study area:

Objective 1 – Reestablish Fluvialgeomorphic Processes to Support Riverine Habitat

Currently, the Fox River within the study area is impaired by 10 run-of-the-river dams, and therefore there is no natural recovery mechanism. These impairments are specific to impeding riverine hydraulics, sediment transport and substrate sorting, resulting in a loss of structural habitat heterogeneity. The effects desired by meeting this objective are to return these riverine functions to restore and sustain habitat. The targeted location of these affects would be in the segments of river that are currently impounded. These affects would be sustained over the life of the project and optimistically in perpetuity. This objective seeks to reestablish natural fluvialgeomorphic parameters and processes to support riverine and riparian habitats within the

Fox River study area over the period of analysis. Improvement is measured via the predicted increase in quality of riverine habitat (QHEI).

Objective 2 – Reestablish Connectivity for Riverine Animal Assemblages

Currently, the Fox River study area has 70% of its river miles impounded by run-of-the-river dams. Aside from imparting adverse fluvialgeomorphic and water quality (habitat) impacts on the system, these dams also effectively block the migration of fish, mussel, and certain macroinvertebrate species. The effect desired by meeting this objective is to return passage for all riverine organisms that require it. The targeted location of these affects would be in the segments of river that are currently impeding the passage of aquatic organisms. These affects would be sustained over the life of the project and optimistically in perpetuity. This objective seeks to reestablish passage for riverine organisms within the Fox River study area over the period of analysis. Improvement is measured via the predicted increase in distribution in species richness of fishes as depicted in Figure 8.

3.2.2 Constraints and Considerations

Planning constraints are items of consideration that limit the planning process and are used along with the objectives in the formulation and evaluation of solutions. The establishment of planning constraints is done in concert with the entire study team and in cooperation with stakeholders. A list of planning constraints for the AER purpose follows.

Any measures/alternatives implemented should:

- Avoid flooding impacts to offsite landowners and public roads

The following planning considerations were identified for this study:

1. Avoid adverse effects to existing mussel beds in free-flowing segments of the river
2. Avoid construction disturbance during spawning season of endangered and rare fishes
3. Minimize adverse short-term effects to water quality
4. Minimize adverse effects to human recreational uses of the river
5. Avoid and minimize adverse effects to municipal infrastructure such as water intake structures, transportation, reclamation facilities, utilities, etc.

3.3 Formulation Strategy/Conceptual Model

USACE typically follows a conceptual ecosystem/habitat model (Figure 11) that breaks down components into functions of hazard(s), performance and consequences. These three concepts are utilized to illustrate models of change, which focus the effectiveness of potential ecosystem restoration alternatives under consideration for federal investment.

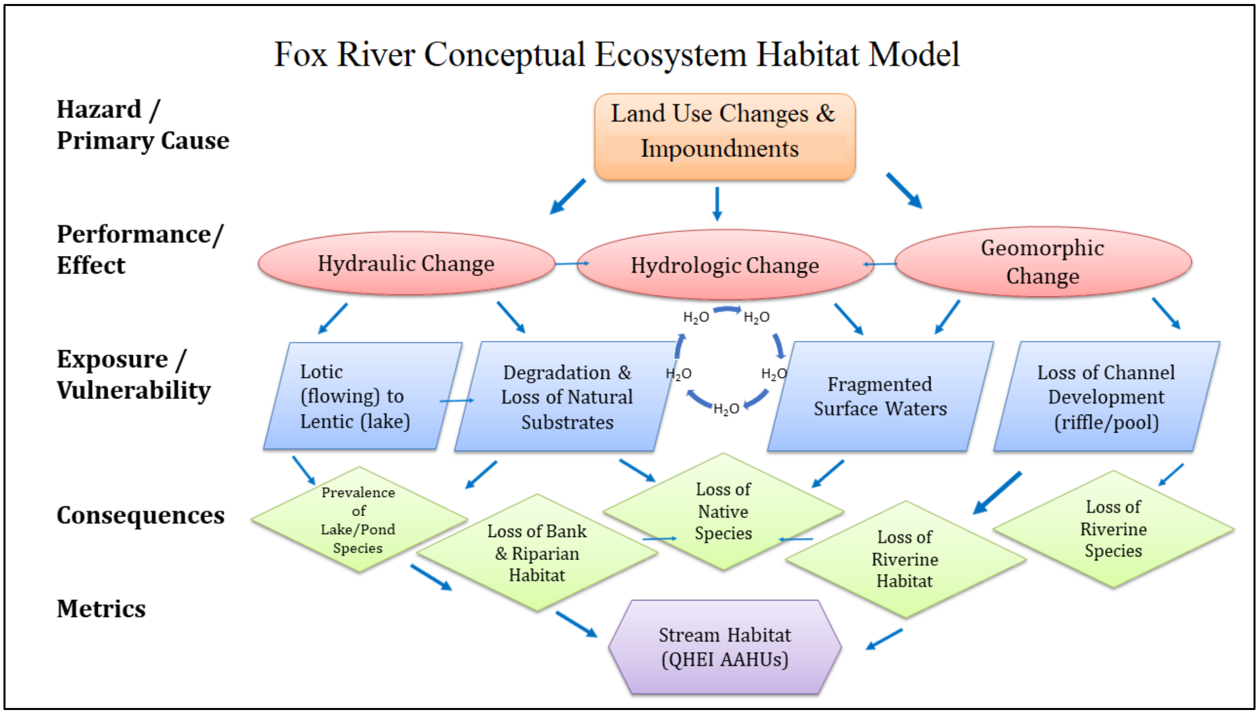


Figure 11: Conceptual ecosystem model for the Fox River study area

3.3.1 Hazard

The hazard, or potential cause for harm, refers to the major changes made to the river channel through construction of the dams for human use. Although the original purpose of most of the dams was to harness power for grist mills, the dominant purpose is now recreational boating.

3.3.2 Performance

Performance refers to the system's reaction to the hazard, or how the Fox River ecosystem changed, or is anticipated to change based on major land use, hydrologic and geomorphic changes. Performance in this study is primarily tied to the presence of the dams. A description of the existing system's performance in terms of ecological function is presented in Chapter 4 Affected Environment & Effects Determination. Performance has been impaired in terms of riverine habitat and subsequent native species composition, richness, and abundances.

3.3.3 Consequence

Consequences are measured in terms of metrics such as prevalence of tolerant species, loss of riparian and riverine habitat, and loss of riverine specialists. This study specifically looks at the consequences of lost riverine habitat and connectivity. The consequence of lost habitat would specifically be measured by QHEI, whereas connectivity is a "yes or no" concept.

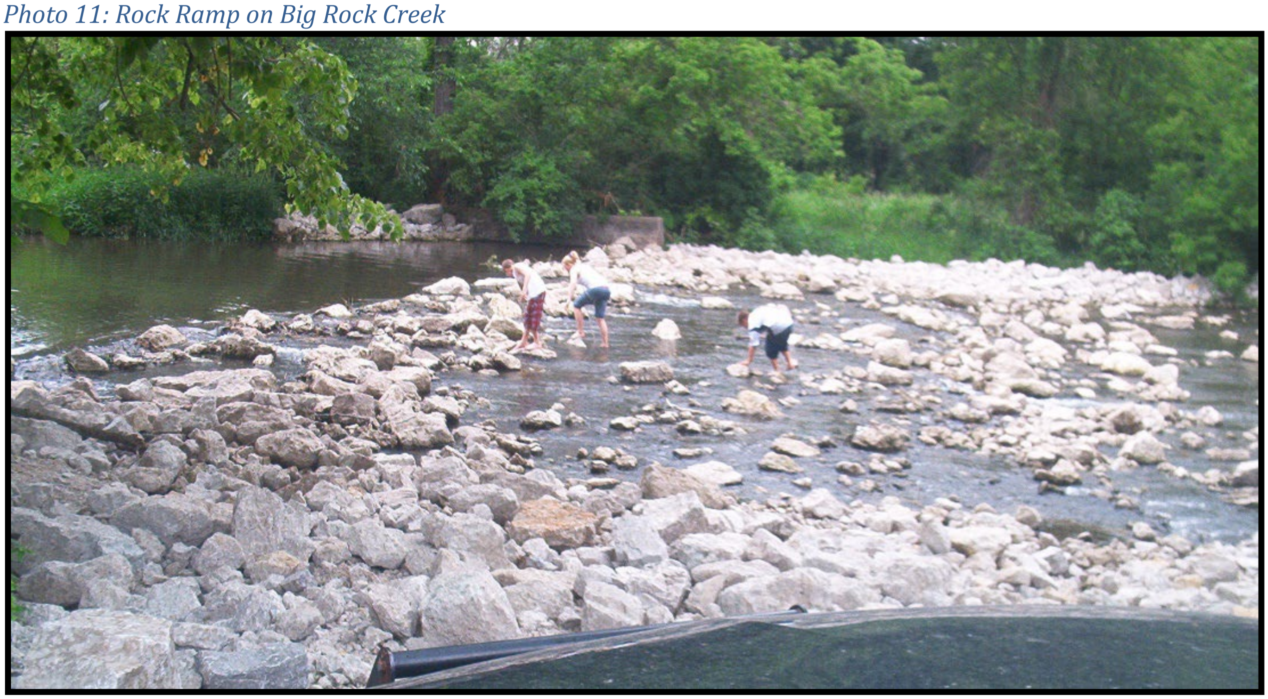
3.4 Habitat Measures & Screening

The alteration, fragmentation, and finally loss of natural habitats are major causes of the increasingly rapid decline in biotic diversity on Earth (Burgess & Sharpe 1981; Harris 1984; Saunders et al. 1987; Marzluff & Ewing 2001). To solve such problems one must consider not only the dynamics of the target species, but also the changes in the abiotic structure and processes surroundings (Per Angelstam 1992). Therefore, the following measures specifically address the resource problems by taking the opportunity to target the abiotic conditions of the Fox River fluvialgeomorphic setting.

3.4.1 Measures

Rock Ramps – This measure can effectively pass a certain subset of fishes from the entire riverine fish assembly, but do not provide for small native fishes such as juveniles, minnows, madtoms, darters, etc (Photo 11). In addition, this measure does not restore riverine habitat. Rock ramps also may need to continually be adjusted after large flood events due to movement of rock below the crest of the dam. Due to the large amount of rock required to attain proper water velocities and black water pockets (fish cannot swim in white water), cheap quarried riprap not indicative of the stream's geology is normally employed; however, the continual addition of rock and in-stream maintenance activities requiring machines in the stream makes this measure not palatable to regulatory agencies and natural area managers. Also, the Fox River dams are considerably long, and to achieve acceptable hydraulics over the ramp for fish passage would require a high volume of stone. For example, to rock-ramp the Kimball Street Dam, about 22,500 cubic yards of riprap placed into the river that would extend about 350 feet along the dam crest, and several hundred feet downstream to achieve required slopes for fish passage. Material and placement costs alone would exceed ~$3.5M, which is not inclusive of annual maintenance to repair slumping and crest movement after large flood events, which could be up to $25,000 a year.

Photo 11: Rock Ramp on Big Rock Creek



Fish Ladders – This measure can effectively pass a certain subset of fishes from the entire riverine fish assembly, but tend to not provide for small native fishes such as juveniles, minnows, madtoms, darters, etc. Also, this measure would not restore or improve habitat and water quality conditions in the river. Priority species targeted for fish ladders include large bodied, powerful swimming fish such as bass, sucker and catfish. One of the main issues with these structures is clogging with natural and unnatural riverine debris, usually after every storm. These engineered features, especially ladders, breakdown relatively quick and need to be cleaned and repaired annually to maintain full functionality. While initial cost is relatively low in comparison with other measures, the continual maintenance required is high resulting in the structures becoming non-functional over time, as is the case with the ones existing on the Fox River (Photo 12).

Photo 12: Non-functional fish ladder on St. Charles Dam

Bypass Channels – This measure can more effectively pass a larger suite of fishes from the entire riverine fish assembly than ramps and ladders (Photo 13), but still has issues with fish finding them due to hydraulic and other unknown sensory queues, and the larger the dam, the more difficult. Also, this measure would not restore or improve habitat and water quality conditions in the river. This measure would require a large area of land adjacent to the dam to create a small stream channel, which is limited at the dam sites within the study area. This lack of space causes the bypass channel to become steeper and more engineered as opposed to having a shallow slope with a more natural stream design, in turn lessening the effectiveness for fish passage. Previously constructed bypass channels have shown potential to fill with sediment and clog with riverine debris. These bypass channels will also attract canoe and kayak activities, which then has safety implications that may drive design changes more for boats than fishes, such as the canoe shoot on the Aurora West dam.

Photo 13: Bypass channel on Big Rock Creek

Full Dam Removal – This measure effectively passes the entire riverine animal assembly and allows the river to restore habitat (Photo 14). Previous dam removals conducted USACE have had no ongoing maintenance costs and nor any associated ecological issues. Since the river is returned to a free-flowing state and there are no structures to maintain, maintenance issues with aging infrastructure have been eliminated and there no operation activities to engage in.

Photo 14: Full dam removal on Little Calumet River, Red Mill Pond

Partial Dam Removal – This measure can effectively pass the entire riverine animal assembly just as full dam removal given the notch is wide enough to accommodate required velocities for passage (Photo 15). This measure would also allow the river to restore habitat on its own. There is no need for this measure unless historic preservation of the dam is warranted to provide monument to what was there. Since there are no anticipated cultural and historic resource issues with removing the study area dams, or any other scientific reasons to retain fragments of the dams, this measure is not being considered for this study. This measure will cause upstream power boating activities to be limited or eliminated, whereas canoe, kayak and small powered fishing boats would still be able to operate.

Photo 15: Partial dam removal on the Des Plaines River, Hofmann Dam

3.4.2 Measure Screening

The preceding measures are traditional means to pass or attempt to pass fish over a fragmenting structure within a riverine system. Some measures, however, are not effective if the goal is to pass fish species other than large bodied, strong swimmers, which are typically commercial or game fishes; (Knaepkens et al 2006; Noonan et al 2011; Bunt et al 2012; Kemp 2012) yet there are still issues passing these species effectively (Brown et al 2013). Also, some studies have shown that the pool behind the dam can also impede fish passage due lack of riverine hydraulics and habitat (Raymond 1979; Agostinho et al 2002; Pelicice & Agostinho 2008). In addition to not effectively passing fish and associated mussels that require fish for transport, some of these measures do not restore riverine habitat. Therefore, some methods do not meet either of the study objectives of passing riverine organisms and restoring riverine habitat. Along with these short comings, some of the measures also have intensive operation and maintenance issues and high costs due to mechanical breakdown of parts, slumping and sedimentation, and clogging with debris. Finally, adding more manmade structures to the river can cause additional habitat degradation, safety issues and flooding concerns.

The following matrix (Table 12) summarizes the efficacy of the identified measures that have all been traditionally used to target ecosystem degradation associated with dams. The measure's efficacy for meeting the planning objectives are as follows:

- Would the measure meet study objectives 1 and 2? (columns 1 and 2)
- Would the measure violate planning considerations 1 through 5? (column 3)
- What is the magnitude of construction costs? (column 4):
  - High ($3-5M), Mid ($1-3M), Low (<$1M)
- What is intensity of operations and maintenance (O&M) activities? (column 5)
- What is the magnitude of average annual O&M costs? (column 6)
  - High (>$30 – 20K), Mid ($20 – 10K), Low (<$10K)
- Would the measure provide incidental water quality improvements? (column 7)
- Would the measure provide incidental public safety improvements? (column 8)

Measures that do not fully meet either of the study objectives will be screened from further coordination.

Table 12: Measure screening matrix

	1	2	3	4	5	6	7	8
Measure	Obj #1 Habitat	Obj #2 Passage	Const. Cost	O&M Activity	O&M Cost	WQ	Safety	Retained
Rock Ramp	No	Partial	High	High	High	No	Yes	No
Fish Ladder	No	Partial	Low	High	High	No	No	No
Bypass Channel	No	Partial	High	High	High	No	No	No
Full Removal	Yes	Yes	Mid	Low	Low	Yes	Yes	Yes
Partial Removal	Yes	Yes	Mid	Low	Med	Yes	Yes	No

Based on the above qualitative assessment of measures derived from academic studies and experience with similar projects implemented by USACE, ILDNR and others, full removal appears to be the only measure that adequately addresses aquatic resources problems within the Fox River and sustainably restore habitat and connectivity in a cost-effective manner. Rock ramps, fish ladders, and bypass channels are not reliable or sustainable features, and do not restore habitat. Partial removal is an option should historic preservation or other valid needs arise, such as sediment stabilization as used for the Hofmann Dam Section 206 project; however, leaving wings of the dam in place could cause O&M issues of snagging objects and inducing scour points. Since partial removal provides the same benefits as full removal but at a higher O&M cost, it will not be carried forward as a standalone alternative. Rather, it may be a suitable avoidance or mitigation measure moving forward if conditions necessitate.

3.5 Habitat Measures Cost & Assumptions

Feasibility-level cost estimates were prepared for full removal of each dam, which were developed in conjunction with the non-federal sponsors (Table 13). These cost estimates do not represent Total Project Cost (TPC) estimates, but rather individual restoration measures that are the building blocks of a complete plan. These cost estimates were developed using data from similar construction contracts, cost data and publications, and informal discussions with vendors. Costs include construction, preliminary real estate estimates, adaptive management, monitoring, and operations & maintenance (O&M). These estimated costs were used to provide a monetary basis for the assessment of project alternatives.

Annualizing costs is a method whereby the project costs are amortized over a period of analysis. The period of analysis selected for this project is 50 years. The present value method was used to discount future costs to FY2023 price levels. The discount rate was determined by the appropriate Economic Guidance Memorandum Economic Guidance Memorandum 23-01, Federal Discount Rates for Corps of Engineers Projects, which is 2.5%. The construction period for each dam was estimated to be 3 years for removal and adaptive management. Calculation of the measures average annual cost (AA Cost) was computed via IWR's Planning Suite Annualization Calculator (Table 13).

Table 13: Total and average annual costs per measure (2023 Price Levels)

Code	Measure	Measure Cost*	IVE LERRD	Adpt. Mgm.†	Monitoring††	Total Measure	AA O&M	AA Cost
QD	Algonquin Dam	$ 982,000	$ 31,000	$ 235,000	$ 45,000	$ 1,293,000	$ 500	$46,000
CD	Carpentersville Dam	$ 1,027,000	$ 77,000	$ 235,000	$ 12,000	$ 1,351,000	$ 500	$48,000
KD	Kimball St. Dam	$ 1,078,000	$ 93,000	$ 235,000	$ 17,000	$ 1,423,000	$ 500	$51,000
ED	South Elgin Dam	$ 999,000	$ 122,000	$ 235,000	$ 10,000	$ 1,366,000	$ 500	$49,000
SD	St. Charles Dam	$ 1,005,000	$ 33,000	$ 235,000	$ 20,000	$ 1,293,000	$ 500	$46,000
GD	Geneva Dam	$ 1,173,000	$ 56,000	$ 235,000	$ 5,000	$ 1,469,000	$ 500	$52,000
BD	Batavia Dam	$ 1,061,000	$ 144,000	$ 235,000	$ 10,000	$ 1,450,000	$ 500	$52,000
ND	North Aurora Dam	$ 953,000	$ 90,000	$ 235,000	$ 13,000	$ 1,291,000	$ 500	$46,000
AD	Aurora Dam(s)	$ 1,643,000	$ 29,000	$ 235,000	$ 10,000	$ 1,917,000	$ 500	$68,000
MD	Montgomery Dam	$ 976,000	$ 63,000	$ 235,000	$ 8,000	$ 1,282,000	$ 500	$46,000

† likely unnecessary, but assumed the same for all dams
†† based on 5 years of monitoring per length of river segment

3.6 Habitat Measure Benefits

The evaluation of habitat benefits is a comparison of the FWOP HSI and FWP HSI conditions for each measure (Table 14). The difference between the FWOP and FWP conditions for this project are simply with or without the dams in place. Environmental outputs are the desired or anticipated results of restoration measures and/or alternatives. The term "outputs" is often used interchangeably with "benefits" or "habitat units (HUs)". Aquatic ecosystem restoration plans may possess multiple output categories, as well as other effects that may need to be considered. At a minimum, the evaluation must address cost and outputs that have been determined to represent reasonable aquatic ecosystem restoration benefits. A comparison of the FWOP and FWP net gain in HUs was performed to determine if a measure, or group of measures (alternative), would have beneficial effects to the Fox River ecosystem.

Table 14: Net average annual (50-years) habitat units per measure

Code	Measure	EX_HSI	AAFWOP_HSI	AAFWP_HSI	NAA FWP_HSI	Length*	NAAHUs
QD	Algonquin Dam	0.19	0.19	0.67	0.48	574.5	275.8
CD	Carpentersville Dam	0.42	0.42	0.77	0.35	50.9	17.8
KD	Kimball St. Dam	0.30	0.30	0.66	0.36	130.9	47.1
ED	South Elgin Dam	0.32	0.32	0.85	0.53	116.4	61.7
SD	St. Charles Dam	0.29	0.29	0.59	0.30	141.8	42.5
GS	Geneva Dam	0.34	0.34	0.73	0.39	32.7	12.8
BD	Batavia Dam	0.39	0.39	0.71	0.32	130.9	41.9
ND	North Aurora Dam	0.38	0.38	0.78	0.40	101.8	40.7
AD	Aurora Dam(s)	0.30	0.30	0.56	0.26	40.0	10.4
MD	Montgomery Dam	0.35	0.35	0.65	0.30	72.7	21.8

*Derived Length Units

The FWOP and FWP scenarios were evaluated using the QHEI methodology (Section 2.5). Santucci & Gephardt (2003) provided the calculation sheets for the QHEI, which was utilized for FWOP and FWP Average Annual HSI over the 50-year period of analysis. The FWP conditions assume the same QHEI scores as the free-flowing, downstream segments of stream adjacent to the given pool that is impounded (Table 14). NAAHUs are calculated by multiplying the FWP HIS and the derived length units. Based on similar dam removal projects, the habitat in the previously impounded areas will rebound quickly and essentially be the same as downstream free-flowing sections within months of the dam removal.

3.7 Formulation and Evaluation of Alternatives

Measures to remedy the habitat and fish passage problems were formulated and screened in Section 3.4. The only measure retained to meet objectives and address problems is full dam removal, while retaining the ability to partially remove dams in order to avoid, reduce, or minimize significant project impacts on natural or cultural resources, as applicable. A full range of alternative plans were generated and evaluated using IWR Planning Suite software. The software was used to conduct a cost-effectiveness and incremental cost analysis (CE/ICA) on the alternative plans generated. The estimated costs and benefits of full removal of nine dams along the Fox River were input into the IWR Planning Suite as shown in Table 15. There were no dependencies between measures since each dam could be removed on its own and provide that reach of river with necessary habitat restoration. Based on these inputs and criteria, the software generated 512 alternative plans. The results are presented in the following sections.

Table 15: Measure average annual (AA) Costs & Net AA Habitat Units (NAAHUs)

Code	Measure	AA Cost	NAAHUs
CD	Carpentersville Dar	$41,889	17.8
KD	Kimball St. Dam	$47,876	47.1
ED	South Elgin Dam	$38,630	61.7
SD	St. Charles Dam	$39,180	42.5
GD	Geneva Dam	$58,645	12.8
BD	Batavia Dam	$46,020	41.9
ND	North Aurora Dam	$33,189	40.7
AD	Aurora Dam(s)	$64,917	10.4
MD	Montgomery Dam	$35,549	21.8

3.7.1 Screening of Algonquin Dam from Study Alternatives

Based upon further analysis and discussions with the non-federal sponsors, it has been determined that removal of the Algonquin Dam is not supported and, as such, this measure was removed from the list of study alternatives. The reasons for its omission are as follows:

- The dam still serves its primary purpose (recreation)
- ILDNR Office of Water Resources (OWR) does not support removal of the dam

3.8 Cost Effectiveness/Incremental Cost Analysis

Cost effectiveness and incremental cost analysis (CE/ICA) are two distinct analyses that must be conducted to evaluate the effects of alternative plans in accordance with USACE policy for conducting aquatic ecosystem restoration studies. First, it must be shown through a cost effectiveness analysis that a restoration plan's output cannot be produced more cost effectively by another alternative. *Cost-effective* means that, for a given level of non-monetary output, no other plan costs less and no other plan yields more output at a lower cost.

Incremental cost analysis means that the subset of cost-effective plans are examined sequentially to ascertain which plans are most efficient in the production of environmental benefits. Those most efficient plans are called "best buy" plans. As a group of measures, they provide the greatest increase in output for the least increase in cost. In most analyses, there will be a series of best buy plans, in which the relationship between the quantity of outputs and the unit cost is evident. As the scale of best buy plans increases (in terms of outputs produced), average costs per unit of output and incremental costs per unit of output will increase as well. The incremental cost analysis by itself will not point to the selection of any single plan. The results of the incremental analysis must be synthesized with other decision-making criteria (i.e., significance of outputs, acceptability, completeness, effectiveness, risk and uncertainty, reasonableness of costs, etc.) to help the study team select and recommend a particular plan.

3.8.1 Cost Effectiveness

The cost effectiveness analysis was used to screen out alternative plans that produced the same amount or less output at a greater cost than other options with a lesser cost. Of the 512 alternative plans generated, 29 were determined cost-effective. Of the 29 cost-effective alternative plans, 10 were identified as best buy plans (Figure 12). By default, the No Action plan is always deemed cost-effective. The remaining 483 alternatives were screened out as non-cost effective.

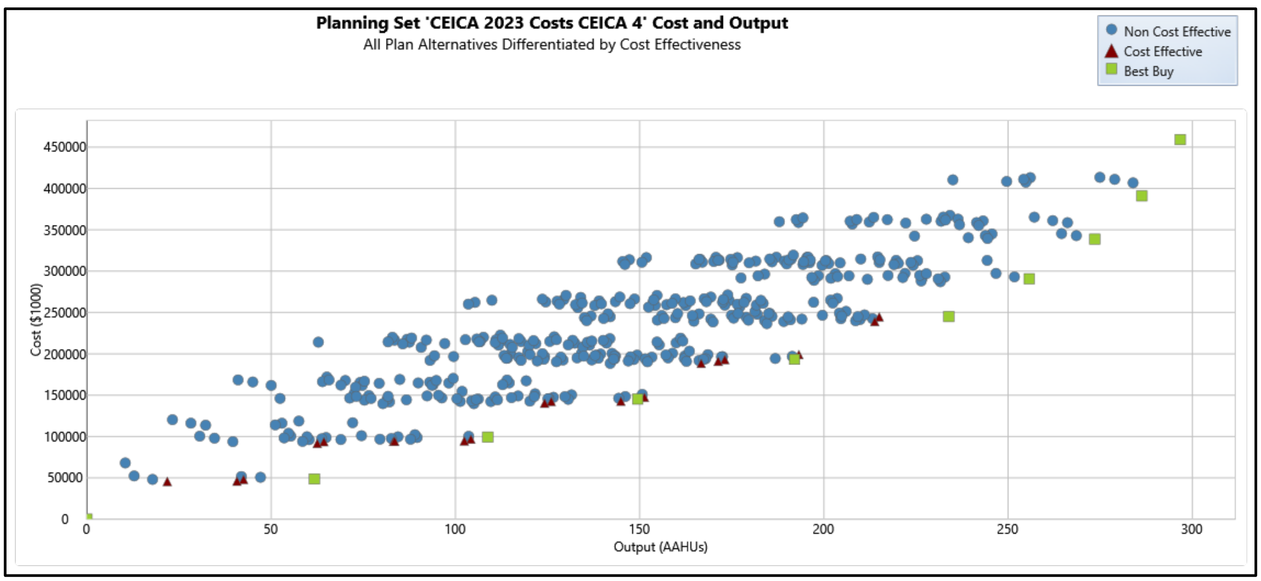


Figure 12: Cost-effectiveness analysis on 512 alternative plans generated

3.8.2 Incremental Cost Analysis

An incremental cost analysis was performed on the 10 best buy plans identified from the cost effectiveness analysis, including the No Action plan. The objective of the incremental cost analysis is to assist in determining whether the additional output provided by each successive plan is worth the additional cost. This incremental cost analysis (Table 16 and Figure 13) compares the alternatives for ecological restoration that were considered for selecting as the National Ecosystem Restoration (NER) Plan.

Table 16: Summary of CE/ICA "best buy" alternative plans

#	Plan Alternative	HU	AA Cost	AA	Inc.	Inc. HU	Inc. Cost/HU
1	No Action Plan	0.0	$ -	$ -	$ -	0	$ -
2	ED	61.7	$ 48,670	$ 789	$ 48,670	62	$ 789
3	KD, ED	108.8	$ 99,332	$ 913	$ 50,662	47	$ 1,076
4	KD,ED,ND	149.5	$145,340	$ 972	$ 46,008	41	$ 1,130
5	KD,ED,SD,ND	192.0	$193,428	$ 1,007	$ 48,088	43	$ 1,131
6	KD,ED,SD,BD,ND	233.9	$245,038	$ 1,048	$ 51,610	42	$ 1,232
7	KD,ED,SD,BD,ND,MD	255.7	$290,701	$ 1,137	$ 45,663	22	$ 2,095
8	CD,KD,ED,SD,BD,ND,MD	273.5	$338,824	$ 1,239	$ 48,123	18	$ 2,704
9	CD,KD,ED,SD,GD,BD,ND,MD	286.3	$391,146	$ 1,366	$ 52,322	13	$ 4,088
10	CD,KD,ED,SD,GD,BD,ND,AD,MD	296.7	$459,191	$ 1,548	$ 68,045	10	$ 6,543

CD – Carpentersville dam, KD – Kimball Street dam (Elgin), ED – South Elgin dam, SD – St. Charles dam, GD – Geneva dam, BD – Batavia dam, ND – North Aurora dam, AD – Aurora dams, MD – Montgomery dam

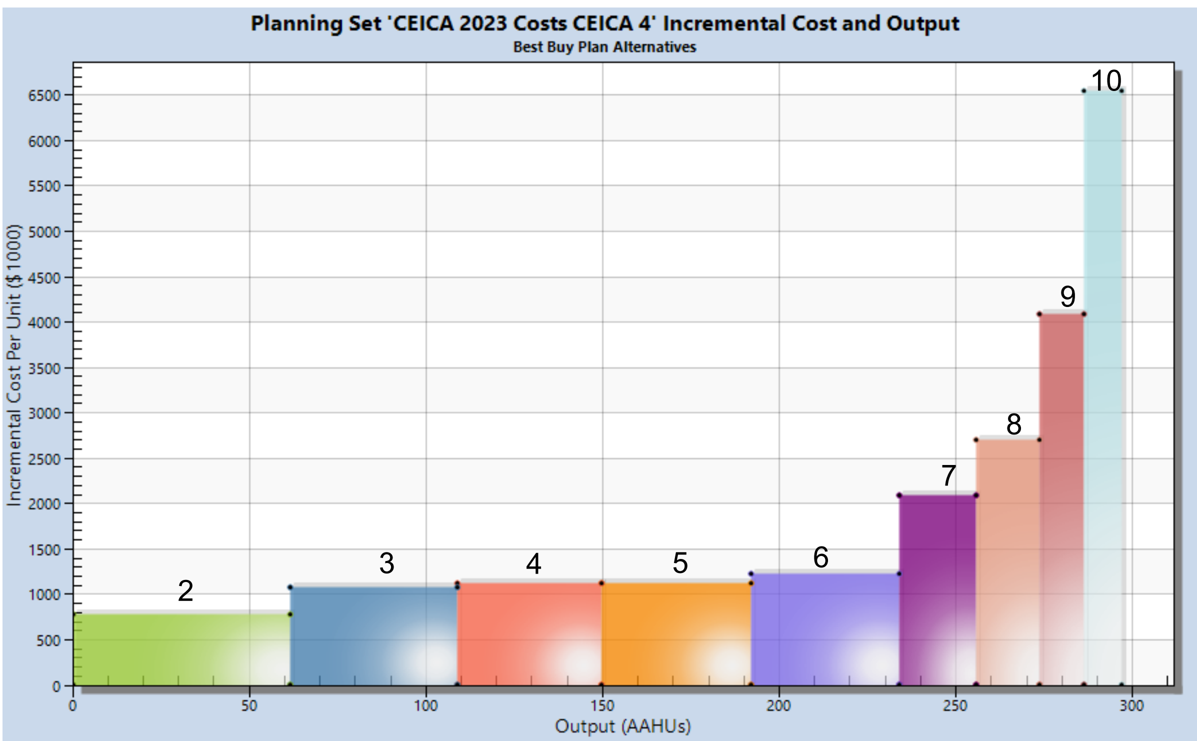


Figure 13: Incremental costs and outputs of "best buy" alternative plans

3.8.3 Preliminary Screening of Alternatives

The CE/ICA presented above shows that dam removal produces positive net benefits for each dam in the study area and that the benefits associated with each dam do not rely upon the removal of any other dams to be realized. This analysis is also helpful for identifying cost effective and best buy plans in the study area in the event that funding for implementation is limited such that only a subset of the dams could realistically be removed (see Figure 12 and Table 16). However, since this study seeks to reasonably maximize ecosystem benefits, and since the overall cost of dam removal is modest compared to many more intensive ecosystem restoration approaches (planting, grading, building habitat structures, etc.), then removal of all individually justified dams would appear to best meet that criterion. This is a reasonable assumption given that the combined cost estimates presented in Table 14 would fall below the study authority's federal limit of $20 million. Lastly, the CE/ICA also provides value in this application as a potential prioritization tool for implementation; all other variables being equal, prioritizing dams with lower average annual cost per habitat unit gained would further maximize ecosystem benefits by removing the most impactful dams first.

The other major consideration when it comes to individual dam removals is non-federal sponsor, local municipal and public support. If a community decides not to remove a dam that it currently owns, then that dam would likely be removed from further consideration for this study. In this situation, federal funding would not be applied in a cost-shared construction project to remove these dams, ecosystem and life safety benefits would not be realized, and long-term maintenance obligations and costs would continue to be borne by the community.

Based on the discussion above, alternative plans numbered 2 through 9 in Table 16 are screened out from further consideration. This may be revisited in the future if implementation funding is insufficient to cover removal of all dams in the study area. If any communities decide not to participate in removal of a dam they own, then the CE/ICA would need to be re-run with those dams removed from consideration due to being infeasible to implement.

3.9 Plan Comparison & Tentatively Selected Plan (TSP) Recommendation

3.9.1 Final Array of Alternative Plans

The following alternative plans were derived for further analysis pursuant to the USACE planning process, NEPA compliance, and garnering federal and state agency as well as public input/support for final determination of the recommended plan. These alternative plans were derived utilizing:

1. Measures of cost effectiveness & incremental cost analysis
2. Significance of the ecosystem outputs in terms of:
    - Institutional (statutory, executive orders, policies)
    - Public recognition (watershed plans, groups)
    - Technical merit (scarcity, connectivity, limited habitat, habitat trends)
3. How well the plans meet the concepts of:
    - Completeness (accounting for all aspects of potential project)
    - Acceptability (federal, state, county, municipal, non-federal sponsor support)
    - Effectiveness (addressing problems, opportunities, goals, objectives)
    - Efficiency (plan cost effectiveness, interagency effectiveness)
4. Risk management

The final array of alternative plans are as follows:

<u>Alternative Plan 1 – No Action</u>

This alternative plan assumes the FWOP condition, which is described in the Section 2.6. There are no foreseeable natural means of the river repairing its own habitat without intervention. Also, once an impoundment is created, the habitat is quickly changed and static. Therefore, the current conditions described are likely to persist over the 50-year period of analysis.

Alternative Plan 2 – Removal of All Study Area Dams

This alternative plan is the most effective and efficient at achieving high levels of riverine habitat restoration and widespread connectivity benefits. It was developed according to current USACE planning policies and concepts and meets the federal and non-federal partner objectives for this study.

Alternative Plan 3 – Removal of Some Study Area Dams Based on Public & Agency Review

This alternative plan will be the direct result of public and agency review of the Draft Integrated PIR/EA. The support of municipalities and river users is important in addressing the problems associated with any one dam. A 60-day pubic and agency review period will allow sufficient time for the public and resource agencies to review and comment on the final array of alternatives. If after that time, because of public input, either the State of Illinois or any of the respective local municipalities do not support removal of any subset of dams, then those dams may be removed from the final recommended plan. Long-term real estate ownership and responsibility for maintenance and upkeep costs on any remaining dams would have to be worked out between these parties.

3.9.2 The Four Accounts - Comprehensive Benefits Analysis

The January 2021 USACE Policy Directive on Comprehensive Documentation of Benefits in Decision Document supplements the guidance provided in ER 1105-2-100 by requiring comprehensive consideration of total project benefits including economics (NED/NER/RED), environmental (EQ), and social categories (OSE). Studies must identify and analyze benefits in total and equally across a full array of benefit categories. The level of the analysis will vary based on the magnitude of the change, its relevance to decision-making, and the availability of data, tools, and procedures to quantify or monetize the benefit or impact.

3.9.2.1 National Ecosystem Restoration (NER)

USACE planning guidance requires that ecosystem restoration planning contribute to national ecosystem restoration (NER), which is measured in terms of increases in the net quantity and/or quality of desired ecosystem resources. In accordance with the federal objective, water and related land resources project plans are formulated to alleviate problems and take advantage of opportunities in ways that contribute to NER outputs. Contributions to national improvements are typically increases in the net value of the national output of marketable or non-marketable goods (food, medicine, timber, etc.), services (flood mitigation, water quality, etc.) and ecosystem integrity (fish & wildlife, habitat, etc.)

Table 17shows the monetary investment and benefits gained towards the federal objective. Alternative 2 (full dam removal) clearly maximizes benefits towards the federal objective, has the lowest federal and non-federal expenditure. Alternative 3 is targeted removal of some dams. Some dams may be eliminated from the TSP as a result of issues raised during public and agency review. Dam removals retained as part of the TSP following public and agency review would comprise Alternative 3. An assessment of Alternative 3 will be provided in the Final Report, subsequent to public and agency review.. The values for Alternative 3 would be less than or equal to Alternative 2 in all rows.

Table 17: Summary of NER benefits for final array of alternatives ($1000s)

	Alternative 1: No Action	Alternative 2: Removal of All Dams	Alternative 3: Removal of Some Dams
Total Project First Costs	$ 0	$ 503	TBD
Interest During Construction	$ 0	$ 12	TBD
Total Investment	$ 0	$ 515	TBD
AA Cost of Total Investment	$ 0	$ 18	TBD
Annual OMRR&R Costs	$ 0	$ 5	TBD
Total AA Costs	$ 0	$ 23	TBD
Net NER Benefits (NAAHUs)	$ 0	572.5	TBD
Total NER Benefits (AAHUs)	$ 0	959	TBD
Cost Per Habitat Unit	$ 0	$ 0.04	TBD
CE / ICA Cost Effective	Yes	Yes	TBD

All monetary values are in Fiscal Year 2023 price levels
All annualized values are discounted using a Fiscal Year 2023 Federal discount rate of 2.5 percent; 50-year period of analysis

3.9.2.2 Environmental Quality (EQ)

A summary of EQ benefits (Table 18) is provided to help decision makers evaluate whether the condition of the resources affected by alternative plans are improved or not. The environmental benefits of the alternative plans analyzed may be considered as non-supportive = 0; partial support = 1; or fully supportive = 2.

Table 18: Environmental quality benefit summary table

EQ Benefit Categories	Alternative 1: No Action	Alternative 2: Removal of All Dams	Alternative 3: Removal of Some Dams
Climate Change	0	1	TBD
Riverine Habitat	0	2	TBD
Riverine Connectivity	0	2	TBD
Native Riverine Species	0	2	TBD
Riverine Wetlands	0	2	TBD
Geology	0	2	TBD
Water Quality	0	2	TBD
Sediment Quality	0	2	TBD
Hydrology	0	2	TBD
Flooding	0	1	TBD
Human Health & Safety	0	2	TBD
Total EQ Points	0	20	0

Climate Change – Removal of all dams partially supports mitigation of climate change impacts. Long-term climate trends indicate that the Chicago area will see increased flooding in urban areas due to more intense precipitation events. Removal of all dams could provide benefits through reduction of flooding in areas upstream of the dam locations since the water level would be lower after dam removal.

Riverine Habitat – Removal of all dams fully supports riverine habitat since the impounded areas would become free-flowing, which would provide improved habitat for native riverine species.

Riverine Connectivity – Removal of all dams fully supports riverine connectivity by removing impediments to hydrologic and riverine habitat connectivity.

Riverine Wetlands – Removal of all dams fully supports riverine wetlands by restoring hydrology in side-stream fens, sedge meadows, and marshes since water levels would no longer be artificially elevated.

Geology – Removal of all dams fully supports geologic features and processes, and their impacts on riverine habitat. The Fox River has a rocky substrate and some portions flow across bedrock. These features create riffles and runs, which are important riverine habitat components.

Water Quality – Removal of all dams fully supports improved water quality by reducing impounded areas which tend to be warmer and support lower water quality.

Sediment Quality – Removal of all dams fully supports improved sediment quality by restoring riverine hydrology, which sorts sediment bedload by grain size and reduce embeddedness.

Hydrology – Removal of all dams fully supports hydrology by reestablishing natural riverine hydrologic periods and surficial hydrologic footprints.

Flooding – Removal of all dams fully supports flood reduction by lowering the surface water elevations in areas upstream of removed dams.

Human Health and Safety - Removal of all dams fully supports human health and safety by eliminating the risk of swimmers and boaters going over a dam and being stuck in the underwater circular current, or roller, on the downstream side of the dam.

3.9.2.3 Regional Economic Development (RED)

The project contributes to the regional economy by way of expenditures associated with construction. The regional economic impacts of Alternative 2 were evaluated using the USACE Regional Economic System (RECONS) 2.0 model; an RED analysis, using RECONS, for Alternative 3 is forthcoming and will occur after the completion of agency and public reviews, but prior to the release of the Final Project Implementation Report. Alternative 3 is targeted removal of some dams. Some dams may be removed from the TSP as a result of issues raised during agency and public review. Dam removals retained as part of the TSP following agency and public review would comprise Alternative 3.

RECONS is a USACE-certified regional economic model, designed to provide accurate and defensible estimates of regional economic impacts and contributions associated with USACE projects, programs and infrastructure. Regional economic activity is measured as economic output (sales), jobs, income, and value added. Estimates are provided for three levels of geographic impact area: local, state, and national. These activities and resulting estimates of regional economic activity are summarized below. Dollar values are presented in Fiscal Year (FY) 2023 price levels; job estimates are presented as full-time equivalence (FTE). The local impact area is defined as the Chicago-Naperville-Elgin, IL-IN-WI Core Based Statistical Area (CBSA). The state impact area is defined as Illinois, Wisconsin, and Indiana.

Project construction expenditures are assumed to occur over 36 months from FY25-FY27 at a total project cost of $14.1 million (FY23 price levels) for Alternative 2. These estimates include costs of preconstruction engineering and design activities, as well as real estate, construction, and monitoring activities. Construction activity would result in spending on goods and services (e.g., materials and labor), and is a stimulus to the regional economy.

In total, construction expenditures associated with Alternative 2 would support about 225 full-time equivalent jobs, $16 million in labor income, $17 million in the value added, and $29 million in economic output for the Chicago-Naperville-Elgin, IL-IN-WI CBSA local impact area. At the state impact area level, construction expenditures associated with Alternative 2 would support about 245 full-time equivalent jobs, $17 million in labor income, $18 million in the value added, and $31 million in economic output for the Chicago-Naperville-Elgin, IL-IN-WI CBSA local impact area. Nationally, these expenditures would support 323 full-time equivalent jobs, $22 million in labor income, $25 million in value added, and $45 million in economic output.

The economic activity supported by the selected project alternative during its construction is proportional to project expenditures in a given year (e.g., if 20% of expenditures are in incurred in FY25, approximately 20% of the total economic activity is attributed to FY23). The expected RED benefits from construction expenditures are temporary and only expected to last the duration of construction.

3.9.2.4 Other Social Effects (OSE)

The existing dams functionally do not provide any flood storage, therefore, there will be no noticeable impacts to base flows or flood flows because of dam removal. However, low-head dams pose a life safety risk of drowning in the circular current (roller) below the dam, so dam removal would have a beneficial impact to life safety risk by eliminating the circular current.

The proposed alternatives impacts on increased traffic and noise during construction would be highly localized and temporary. In addition, multiple local government entities currently spend taxpayer funds to maintain the structural integrity of the dams. This burden on taxpayers would be lessened in the event that removing the dams requires no further O&M or lessens the amount of O&M funds needed in the future.

Alternative 2 will have a negative impact for some recreational motor boating as more fully discussed in section 4.3.5.4, but it will also have potentially beneficial impacts to recreation by increasing other forms of recreation such as paddling, bird watching, wading, and floating. It is anticipated that this shift in recreational uses will provide greater access to a greater number of recreators.

The implementation of the proposed project would remove significant fish passage obstructions on the Fox River, which would eliminate the dense concentration of fish above the dams that anglers take advantage of. However, this would also open passage for these fish to travel upstream to additional fishing locations. Bedrock could potentially be exposed in the immediate vicinity of the dams, upstream of the dams in the newly exposed riparian zones. This will provide an extended area for fly fishing that was previously unavailable.

3.9.3 Significance of Ecosystem Outputs

Because of the challenge of dealing with non-monetized benefits, the concept of output significance plays an important role in ecosystem restoration evaluation. Along with information from cost effectiveness and incremental cost analyses, information on the significance of ecosystem outputs can help determine whether the proposed environmental investment is worth its cost and whether a particular alternative should be recommended. A summary of significance points (Table 19) is provided to help decision makers evaluate whether the value of the resources of any given restoration alternative are worth the costs incurred to produce them. The significance of the Fox River Habitat and Connectivity Study outputs are herein recognized in terms of institutional, public, and technical importance. Scoring is 0 = non-supportive; 1 = partial support; 2 = most supportive. Full discussion of the points discussed in Table 19 are included throughout Chapters 3 and 4.

Table 19: Institutional, public, and technical significance of alternatives

Points of Significance	Alternative 1: No Action	Alternative 2: Removal of All Dams	Alternative 3: Removal of Some Dams
Institutional			
National Ecosystem Restoration	0	2	1
Environmental Quality	0	2	1
Regional Economic Development	0	2	1
Other Social Benefits	0	2	1
Public			
Stakeholder Support	1	1	1
Community Organizations	1	1	1
Technical			
Natural Hydrology	0	2	1
Natural Geomorphology	0	2	1
Scarce & Limiting Habitats	0	2	1
Habitat Connectivity	0	2	1
Habitat for T&E Species	0	2	1
Species Biodiversity	0	2	1

3.9.4 Acceptability, Completeness, Effectiveness & Efficiency

Acceptability, completeness, efficiency, and effectiveness are the four evaluation criteria USACE uses in evaluating alternative plans. Alternatives considered in any planning study, not just ecosystem restoration studies, should meet minimum subjective standards of these criteria to qualify for further consideration and comparison with other plans.

3.9.4.1 Acceptability

An aquatic ecosystem restoration plan should be acceptable to state and federal resource agencies and local governments. There should be evidence of broad-based public consensus and support for the plan. The plan must also be acceptable to the non-federal cost-sharing sponsor(s) as well. *Note: portions of this section cannot be completed until the 60-day agency and public review is completed and are denoted in italics.*

Federal Agencies

Coordination with the U.S. Fish and Wildlife Service (USFWS) commenced with an initial project scoping letter in November 2014 and subsequent scoping letter was sent in June 2022. Pursuant to Section 7 of the Endangered Species Act of 1973, as amended, USACE determined the recommended alternative would have 'no effect' on federally listed species or their designated critical habitat. Pursuant to the Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661-666(e)), any comments or recommendations received during the public and agency review period will be reviewed, considered, and incorporated into the final EA, as appropriate. Coordination with the USFWS is ongoing. *USFWS will have an opportunity to provide comments during the 60-day agency and public review.*

The U.S. Environmental Protection Agency (USEPA) provided a response to the November 2014 scoping letter. The response outlined necessary items to be discussed within this report, which have been included. An additional scoping letter was sent to USEPA in June 2022. The USEPA responded stating that their previous comments from 2014 are still applicable. *USEPA will have an opportunity to provide comments during the 60-day agency and public review.*

State Agencies

The Illinois Department of Natural Resources, Impact Assessment Section provided response to the November 2014 scoping letter. The response stated that the Department supports the removal of dams as long as careful consideration has been given to natural resources and recreational impacts, and agreement is expressed from local communities. *IL DNR will have an opportunity to provide comments during the during the 60-day agency and public review.*

The Illinois State Historic Preservation Office (SHPO) and USACE signed a Programmatic Agreement (PA) in 2002 regarding implementation of Illinois River Basin Restoration Section 519. However, USACE is pursuing normal coordination under Section 106 of the National Historic Preservation Act for this study in keeping with the stipulations set forth in the PA. A finding of No Historic Properties Affected was previously submitted to the Illinois State Historic Preservation Office (SHPO) on May 11, 2015. The affected dams in the project area were determined not eligible for listing on the National Register of Historic Places (NRHP). The SHPO responded on June 15, 2015 stating that they have no objections to the finding of no historic properties affected. However, this finding only remains in effect for two years and is now expired. As such, and since there have been no substantive changes to the TSP or potential impacts to historic properties, the draft IPIR/EA will be sent to the SHPO along with a resubmittal of the finding of effects during the agency and public review.

The Illinois Environmental Protection Agency (IEPA) did not respond to the November 2014 scoping letter. IEPA provided a response to the 2022 scoping letter stating that the report should 1) assess cumulative impacts to all water uses, 2) determine the extent of sediment contamination behind the dams, and 3) close coordination with ILDNR is recommended if mussel surveys indicate sensitive species could be found in locations where significant flow regime changes are expected. Based on IEPA 303d listing criteria (e.g. hydrodynamic flow alterations/poor water quality induced by dams) and the guidance they have provided the Fox River Study Group to improve the conditions of the Fox River, it is expected that removal of all dams or some dams would be acceptable. *IEPA will have an opportunity to provide comments during the 60-day agency and public review.*

Non-Federal Sponsor

The non-federal sponsor for this study and potential project is ILDNR Fisheries and Office of Water Resources and the FRSG. One of ILDNR's primary missions is to maintain diverse and healthy streams and rivers. The ILDNR also has a specific program to support partnership projects for fish passage and dam safety aspects. Based on the ILDNR's letter of support, and continued involvement through the plan formulation process, for this study, the removal of all or some Fox River dams is acceptable. The FRSG is a diverse coalition of stakeholders, including numerous local governments, public entities and non-profits, using science to improve the Fox River. The mission of the Fox River Study Group is to enhance the health and vitality of the Fox River for the benefit of the citizens in the Fox River Valley. The FRSG uses research, data, and collaboration to support sustainable policies and development across the Fox River watershed.

3.9.4.2 Completeness

Removal of each dam in the study area is independently justified based on resulting habitat benefits realized when the artificially impounded stretch of river is restored to a free-flowing, dynamic riverine channel with restored function and habitat. The best-case scenario would be to removal all of the dam structures in the study area to provide the greatest habitat improvement, but in the event that one or more of the dams in this study are screened out due to lack of non-federal sponsor support or some other unforeseen reason, the other dams would still be justified for removal. Where there is uncertainty concerning the functioning of certain restoration features an adaptive management plan should be proposed and must be accounted for in the implementation plan.

3.9.4.3 Efficiency

An aquatic ecosystem restoration plan must represent a cost-effective means of addressing the restoration problem or opportunity. It must be determined that the plan's restoration outputs cannot be produced more cost effectively by another agency or institution.

Cost Effectiveness

The cost effectiveness analysis was used to ensure that certain options would be screened out if they produced the same amount or less output at a greater cost than other options with a lesser cost, refer to section 3.8 Cost Effectiveness/Incremental Cost Analysis. 512 alternatives were analyzed for cost effectiveness based on habitat restored. Of these, 29 cost-effective combinations were identified (see Figure 12). By default, the No Action Plan is deemed cost effective. 483 alternatives were screened out as non-cost effective. The 10 best-buy plans that moved forward for further evaluation were all deemed cost effective.

Efficiency of other Agencies

Other federal agencies also have aquatic ecosystem restoration programs. Some of these agencies administer grants for fish passage and riverine restoration, requiring the non-federal partner(s) to plan, design and implement projects themselves. USACE, on the other hand, has congressional authority and in-house capability not only to engage in larger scale projects but also to plan, design, acquire necessary permits, oversee implementation, and perform monitoring under its aquatic ecosystem restoration authority. It is recognized that USACE is an agency of high efficiency in terms of riverine restoration and dam removal.

3.9.4.4 Effectiveness

An aquatic ecosystem restoration plan must make a significant contribution to addressing the specified restoration problems or opportunities (i.e., restore important ecosystem structure or function to some meaningful degree). The avenue of addressing problems and taking advantage of opportunities are through the two main study objectives. To determine the effectiveness of plans, the two study objectives are discussed as follows:

Objective 1 – Reestablish Fluvialgeomorphic Processes to Support Riverine Habitat

Currently, the Fox River study area has 70% of its river miles impounded by run-of-the-river dams within the study area, meaning the river is limited to supporting native riverine organisms in only 30% of its river miles. This condition strongly limits the amount of available free-flowing riverine habitat to support significant species such as Threatened and Endangered Fishes and Mussels and sought after sport/food fishes. The plan that would maximize the restoration of meaningful habitat would be to remove all of the dams within the study area. This would in essence provide 100% free-flowing habitat within the study area for those significant resources identified above. The removal of all dams, as illustrated by the quantity portion of the cost vs. habitat unit analysis, would restore about 1,393 acres of riverine habitat within the main channel of the Fox River. This illustrates the highly effective nature of removing dams in terms of restoring habitat.

Objective 2 – Reestablish Connectivity for Riverine Animal Assemblages

Currently, the Fox River is highly fragmented within the study area, including the blockage of important habitat areas within the main channel and confluent tributaries. The Fox River within the study area has about 38.3 miles of fragmented main channel, and in addition, about 607 miles of confluent tributary (Table 20). Figure 14 illustrates the cumulative effects of removing all the main channel dams for tributary streams only. This figure was created utilizing the IWR Planning Suite software to show that in terms of opening up tributary streams, removing all of the dams is the only “best buy” Plan, with subsequent removal of fewer dams all being cost effective. This illustrates the highly effective nature of removing dams in terms of providing passage and access to large areas of important existing habitat.

Table 20: Cumulative tributary access via removing dams sequentially upstream

Fox River Pool	Fox Tributary	Trib. Length Feet	Trib. Length Miles	Per Dam AA Cost	Cumulative AA Cost	Cumulative Length*
Carpentersville	Jelkes Creek	348,760	66.1	$ 48,123	$ 459,191	417.3
Kimball St.	Tyler Creek	308,522	58.4	$ 50,662	$ 411,068	351.2
South Elgin	Poplar Creek	339,354	64.3	$ 48,670	$ 360,406	292.8
St. Charles	Brewster Creek Ferson Creek Norton Creek	117,088 502,015 166,819	22.2 95.1 31.6	$ 48,088	$ 311,736	228.5
Batavia & Geneva	Town of Geneva	155,401	29.4	$ 103,932	$ 263,648	79.7
North Aurora	Mill Creek	155,437	29.4	$ 46,008	$ 159,716	50.2
Aurora & Montgomery	Town of Aurora	109,841	20.8	$ 113,708	NA	NA

*river miles

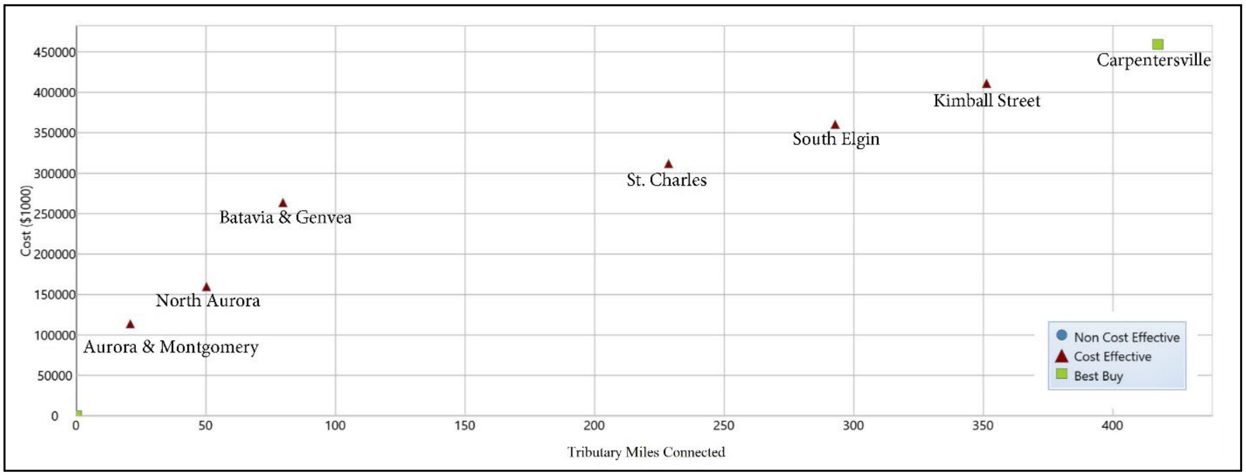


Figure 14: Cumulative average annual costs vs. tributary miles connected

3.9.5 Risk and Uncertainty

When the costs and outputs of alternative plans are uncertain and/or there are substantive risks that outcomes will not be achieved, the selection of a recommended alternative becomes more complex. It is essential to document assumptions and uncertainties during planning analyses. Risk management was incorporated into every phase of this study by maintaining a risk register and communicating study risks at all review milestones.

The suite of alternatives is generally broken down into 1) No Action, 2) Remove All Dams, or 3) Remove Some Dams. Uncertainty or the risk of not gaining predicted benefits in terms of dam removal is very low. Past dam removals show there is an immediate biological response to restored hydraulics and habitat structure of the affected area. There is also very low risk that removing a dam would induce flooding because a) removing a dam restores channel and floodplain storage, b) run-of-the-river dams do not provide flood attenuation downstream, and c) run-of-the-river dams do not provide storage because the impoundment (reservoir) is already at capacity during low flows. Hydrology and hydraulic analyses of a range of flows confirmed that removal of dams would not induce flooding but reduce water surface profiles during flood events. However, the level of analysis conducted during the study does not fully consider potential impacts to existing infrastructure (such as water intakes), but this will be further evaluated during the design phase. The greatest risk and uncertainty is the level of public and agency support for removing certain dams, which in turn could result in some dams being eliminated from further consideration (Alternative 3).

3.9.6 Tentatively Selected Plan

When selecting a single alternative plan to recommend for implementation from the final array of alternatives for an ecosystem restoration study, USACE is required to identify, and typically selects, the National Ecosystem Restoration (NER) plan. The NER Plan is the alternative plan that reasonably maximizes environmental restoration benefits compared to costs and meets the study goals. Selecting the NER plan also requires careful consideration of the planning objectives and constraints while passing tests of cost effectiveness and incremental cost analyses, significance of outputs, acceptability, completeness, efficiency, and effectiveness.

The NER Plan for this study is identified as Alternative Plan 2 – Removal of All Study Area Dams and is deemed the Tentatively Selected Plan.

4 ENVIRONMENTAL EFFECTS AND CONSEQUENCES

This chapter assesses the direct, indirect, short-term, long-term, and cumulative environmental effects of the final array of alternative plans.

4.1 Alternatives Considered

The following alternative plan(s) were derived for further analysis in terms of Environmental Assessment and NEPA compliance and garnering federal and state agency and public input/support for final determination of the TSP.

<u>Alternative Plan 1 – No Action</u>

This alternative plan assumes the FWOP condition, which is described in the Section 2.6. Once an impoundment is created, the habitat quickly becomes changed and static. Therefore, the current conditions described are likely to persist over the 50-year period of analysis.

<u>Alternative Plan 2 – Removal of All Study Area Dams</u>

This alternative plan is the most effective and efficient at achieving high levels of riverine habitat restoration and widespread connectivity benefits. It is supported by all USACE planning policies and concepts and provides high levels of achievement towards the federal and non-federal sponsor(s) objectives. Alternative Plan 2 – Removal of All Study Area Dams is the TSP.

<u>Alternative Plan 3) Removal of Some Study Area Dams Based on Agency & Public Review</u>

This alternative plan assumes that a certain subset of dams may not be removed based on a lack of non-federal sponsor and/or local support. In these cases, long-term ownership responsibilities and O&M costs for these dams would be negotiated between the State of Illinois and the respective local municipalities. Since Alternative Plan 3 is essentially an unknown combination of Alternative Plan 1 and Alternative Plan 2, this document will assume all dams are being removed (i.e. the same as Alternative 2) in order to conservatively estimate the maximum potential effects associated with dam removals in the study area for the purpose of completing a potential effects analysis under NEPA. If, in the future, a subset of dams is removed from Alternative 2, then the associated potential impacts for that dam would revert to those described in the No Action Plan (Alternative Plan 1).

4.2 Affected Environment

A detailed description of the affected environment can be found in Chapter 2. Based on data collection, analysis, and modeling conducted under this feasibility study and coordination with federal, state and local governmental agencies and published studies by academia, it was determined that the physical, chemical and biological conditions of the Fox River system are in a state of habitat degradation. As a result, dominant species present at the site are tolerant to habitat loss, anthropogenic disturbance and poor water quality, yet, remaining free-flowing segments of the river harbor threatened, endangered, rare and sensitive native riverine species. Slight improvements in water quality and some vegetation patches that have occurred are not enough for native plant and animal communities to reestablish, with critical structural habitat components and processes remain absent. The No Action Plan conditions are synonymous with the FWOP conditions, which are presented in Section 2.6.

4.3 Effects of the Study Alternatives

4.3.1 Resources not Evaluated Further

Natural and cultural resources that have no potential to be affected by the TSP are identified below. To streamline the NEPA analysis and increase accessibility of this EA document, limited time and effort is expended on these resources, with the primary focus being on the natural and cultural resources that have potential to be, or are likely to be, affected by implementation of the TSP.

4.3.1.1 Aesthetics

Aesthetic preferences are highly subjective. However, there are no protected aesthetic resources present in the study area such as national/state scenic byways or Wild and Scenic Rivers. Potential aesthetic impacts to significant cultural or historic resources are captured in those respective sections below.

4.3.1.2 Navigation

The Fox River does not serve a navigation purpose within the study area. Recreational boating makes up the bulk of traffic on the river. A discussion of potential impacts to recreation can be found in section 4.3.5.4.

4.3.2 Physical Resources

4.3.2.1 Geology

The geology of the Fox River is diverse, where the main channel flows over bedrock, glacial sands and gravels, and lacustrine silts depending what segment of river is discussed. Rivers erode, sequester and move substrates from these sources, thusly sorting grain size and spatially depositing these into habitat formations, such as riffles, point bars, aquatic macrophyte beds, and deep pools. The natural condition of the river formerly eroded, sequestered, sorted and distributed these geologic materials to create habitat within the river channel. Development of the confined floodplain and riverbanks is partially the cause of impacts to this natural condition; however, the installation of the dams is the primary cause. Also, various dams are drowning out geologic features that were exposed in the natural condition.

Under the No Action Plan there would be change to geologic resources in the study area. Certain features would continue to be unnaturally inundated, affecting background rates of erosion and distribution of geological material downstream. Effects resulting from implementation of the TSP include reestablishing the natural condition of mobile geologic material and exposed geologic features within the river channel. No direct or indirect, short-term or long-term adverse effects to Fox River watershed geology are anticipated as a result of implementation of the TSP.

4.3.2.2 Soils

The soils of the Fox River watershed are diverse and expansive. Primary soil types within the active floodplain of the Fox River are classified as fluvaquents, or those materials created by deposited alluvium that is subject to continual movement, therefore never forming typical soil horizons and characteristics. This natural condition of fluvaquent soils and more complex terrace soils (fen, meadow) were disrupted by installation of the dams. As a result, areas of natural fluvaquents movement were halted and mucky soils started to form (evident by side-stream cattail stands). Drier fen and meadow soils were also changed by the inundation caused by the dams.

Under the No Action Plan there would be no change to soil dynamics in the study area. Dams would continue to sequester fine grained (mucky) material and contributing to a sediment starved condition downstream. Effects resulting from implementation of the TSP include reestablishing the natural condition of mobile fluvaquent soil types within the river's active floodplain and dewatering of those former terrace soils that were not fluvaquents. No direct or indirect, short-term or long-term adverse effects to Fox River soils are anticipated as a result of implementation of the TSP.

4.3.2.3 River Geomorphology and Gradient

Geomorphology of the Fox River's bed is dictated by underlying bedrock and glacial materials, and how the slope of the land creates more or less waterpower to move these materials around. The upper segments of the study area, which include the Algonquin impoundment, have a flat slope and are siltier (more wetland-like) in the natural condition. The middle reaches of the river have steeper slopes, and exhibit bedrock, boulder, cobble/gravel riffles and sand/gravel bars in the natural condition. The lowest reaches of the river are steep, and exhibit rapids and canyon features through the bedrock in the natural condition. Installation of dams altered the slope of the river and has made over 70% of the main channel a lake-like condition within the study area.

Under the No Action Plan there would be no change to current river geomorphology and gradient. Dams would continue to alter the natural flow of the river, resulting in large impounded areas throughout he study area. Effects resulting from implementation of the TSP include reestablishing natural riverine gradients which in turn would restore natural geomorphic conditions of the riverbed. Sinuosity because of channel meandering and migration would not be induced by the TSP. Implementation of the TSP would not restore the Algonquin impoundment since that dam was screened out due to lack of non-federal sponsor support. No direct or indirect, short-term or long-term adverse effects to Fox River geomorphology and river gradient are anticipated as a result of implementation of the TSP.

4.3.2.4 Riverine Hydrology

Hydrology of the Fox River was formerly dictated by a great store of steady groundwater inputs, flashy spring freshets, and large summer thunderstorms; all of these tempered and filtered by watershed vegetation, soils and geologic materials. This natural condition was changed, where groundwater sources were reduced or removed and surficial runoff from agriculture and urban lands no longer filtered by vegetation and soils. To compound the situation, steady flow inputs of municipal waste waters affect natural hydrologic periods and elevations. The final impacts to the natural hydrology of the Fox River channel and floodplain were caused via the installation of the dams. This current condition has more than doubled the surface hydrology footprint of the river channel (see Table 9). The dams also homogenized the hydrologic period of the river channel and floodplain by maintaining a continual flat pool, which eliminated areas of diverse emergent, fen, and meadow plant communities dependent on the hydroperiod.

Under the No Action Plan riverine hydrology would continue to be altered. The surface hydrology footprint would continue to be increased and the hydrologic period would continue to be homogenized since the dams maintain continual flat pools. In addition, emergent, fen, and meadow communities that are dependent on natural riverine conditions would remain absent. Effects resulting from implementation of the TSP include reestablishing natural riverine hydrologic periods and surficial hydrologic footprints. No direct or indirect, short-term or long-term adverse effects to Fox River hydrologic parameters are anticipated as a result of implementation of the TSP.

4.3.2.5 Riverine Hydraulics

Channel hydraulics of the Fox River were formerly that of a free-flowing river, which were allowed to drive processes such as cut and fill alluviation (meandering), channel migration, sediment transport and substrate sorting, and morphological habitat feature creation (riffles/backwaters/oxbows/woody debris sequestering, etc). Although development of the confined floodplain and riverbanks is one of the causes ceasing these natural conditions; the installation of the dams is also a major contributor. About 55% of the entire Fox River is impounded, rising to 70% within the study area. This leaves about 30% of the river with functioning riverine hydraulic parameters in terms of sediment transport, substrate sorting and morphological habitat creation.

Under the No Action Plan riverine hydrology would continue to be altered. The surface hydrology footprint would continue to be increased and the hydrologic period would continue to be homogenized since the dams maintain continual flat pools. In addition, emergent, fen, and meadow communities that are dependent on natural riverine conditions would remain absent.

Effects resulting from implementation of the TSP include reestablishing natural riverine hydraulics within impounded segments of the river. No direct or indirect, short-term or long-term adverse effects to Fox River hydrologic parameters are anticipated as a result of implementation of the TSP.

4.3.2.6 Sediment Quality

Natural sediments/substrates still exist within the Fox River; however, the processes that make them available as habitat to a suite of different riverine organisms was interrupted by installation of the dams. Diverse hydraulic forces are needed to transport, clean and sort substrates into different patches of different grain sizes, thus creating a healthy and diverse habitat along the bottom of the river. Data in Appendix E: Phase I Environmental Site Assessments suggests that the overall sediment pollution level in the Fox River sediments is low. Sediment sampling results suggest that there are consistently low and widespread concentrations of constituents in the sediment throughout the watershed typical of sediments found in an urban environment. Comparison of sediment data with state voluntary remedial objectives suggest that the sediment quality is within the residential remedial objective or near background concentrations of constituents found in urban soils. Additional sediment sampling is not proposed; however, the release of sediment downstream during dam removal would be coordinated with the IEPA to determine if any sediment management measures will be required.

Under the No Action Plan riverine hydrology would continue to be altered. Sediment quality would continue to be embedded and dominated by fine-grained sediment because of the dams and their impacts on flow velocities.

Effects resulting from implementation of the TSP include reestablishing natural riverine hydraulics within impounded segments of the river. This would cause coarser substrates to be sorted and exposed. No direct or indirect, short-term or long-term adverse effects to Fox River sediments/substrates as habitat are anticipated as a result of implementation of the TSP.

4.3.2.7 Water Quality

Water quality within the Fox River is generally rated as poor, albeit still suitable for primary contact uses. Impairments to current water conditions include wastewater discharge, agriculture, impervious surfaces, and the presence of dams. It is widely documented how dams impair water quality, and in the specific instance of the Fox River, these dams aid in algal biomass production, decreases in dissolved oxygen and increase in water temperature.

Section 303(d) of the Clean Water Act requires states to develop a list of water quality limited waters (i.e. waters where uses are impaired), the pollutants causing impairment to those waters, and a priority ranking for the development of Total Maximum Daily Load (TMDL) calculations. IEPA has designated the Fox River in the study area a 303(d) impaired waterway. Portions of the Fox River are listed as impaired for aquatic life, fish consumption, and/or primary contact recreation uses. The potential causes of aquatic life impairment in the Fox River include one or more of the following: dissolved oxygen, suspended solids, nitrogen and/or phosphorous concentrations found in the River, alterations in stream side or littoral vegetative cover, flow regime modifications, sedimentation/siltation, algae, and the presence of hexachlorobenzene (a persistent bioaccumulating chemical that is a byproduct from manufacturing pesticides or other chlorine containing compounds often found in chlorination treatment of water and wastewater). Fish consumption impairments include one or more of the following: PCBs, mercury, pesticides, or insecticides found in fish tissue. Primary recreation contact is impaired due to the presence of fecal coliform in the waterway.

Under the No Action Plan Fox River water quality would continue to be impaired, partially resulting from the dams. Increased water temperatures, lower dissolved oxygen levels, and increased algal biomass production would likely continue to occur.

Effects resulting from implementation of the TSP include reestablishing natural riverine hydraulics within impounded segments of the river. This would cause water to no longer be impounded and slowed, allowing the water to flow over substrates and other riverine materials (trees, aquatic vegetation) and pass through turbulent riffle zones. This would result in improved water quality. No direct or indirect, short-term or long-term adverse effects to Fox River water quality is anticipated as a result of implementation of the TSP.

4.3.2.8 Floodplains

In the northern portion of its Illinois watershed, the river winds through marshy areas and Chain of Lakes and the channel is often undefined or confined by low banks and wide floodplains. Downstream of Algonquin, the channel is straighter and the slope higher as the river is more deeply cut into the bedrock. Limestone outcrops exist in the central portion between St. Charles and Aurora, and in many of the lower reaches, sandstone bluffs exposed on one or both sides of the river leave little or no floodplain. In areas where the floodplain is wide and the banks are low there are side-stream wetlands, sedge meadows, fens, and marshes which are dependent on natural flooding and drawdown cycles.

Under the No Action Plan riverine habitat and connectivity would not be restored. Floodplain wetlands, fens, sedge meadows, and marshes would continue to be impaired by altered hydrology.

Effects resulting from implementation of the TSP include riverine habitat and connectivity restoration. Implementation of the TSP would include dam removal, resulting in more natural hydrology and floodplain inundation regimes. This would be beneficial for floodplain function and processes that rely on natural inundation cycles.

4.3.2.9 Wetlands

EO 11990 Protection of Wetlands – each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands.

The construction of run-of-the-river dams do not create or sustain riverine wetlands, in fact, they destroy them. The most imperiled wetland type within the Fox River valley are side-stream fens. These fens are formed at the base of the valley walls where the groundwater discharges. Some of these areas have been flooded out by the current dams' upstream impounding effects. Another wetland type that has been erased by the dams is side-stream marsh. Although it may seem like there are side stream marsh patches in the impounded sections, these are merely monotypic cattail stands that appear hemi-marsh like. The floristic quality within these induced cattail stands is extremely low and although they probably provide minimal spawning habitat for Esocid (pike) species; they are primarily occupied by tolerant and invasive green sunfish (*Lepomis cyanellus*), common carp (*Cyprinus carpio*) and goldfish (*Carassius auratus*). False backwaters are created by the impounding effects of dams, once where sedge meadow, fen or wet prairie occurred. Native riverine depth dependent aquatic beds (pondweeds: *Potamogeton* spp., eel grass: *Valisneria* and water willow: *Justicia americana*) are also erased by the dams hydrologic effects, typically inducing non-native Eurasiatic milfoil (*Myriophyllum spicatum*) beds in the impoundment pools. Simply removing all of the dams within the study area would maximize natural resurgence of hydrogeomorphically native wetland systems within the Fox River floodway. This expected change was not spatially quantified for this study but is expected to occur based on system geology. This expected change was observed with the removal of a dam at Red Mill Pond at the headwaters of the Little Calumet River, Westville, Indiana. Spring, seep, fen and aquatic bed habitat were exposed and restored from within the impoundment zone.

All of the dams within the study area could be removed to maximize compliance with this Act. Subsequent plans to provide longer stretches of native riverine wetland resurgence should any of the dams remain in place is still considered highly beneficial.

Under the No Action Plan dams would remain in place and would continue to negatively impact riverine wetlands including side-stream fens, sedge meadows, and marshes.

Effects resulting from implementation of the TSP include long-term beneficial impacts to wetlands through restored hydrology in side-stream fens, sedge meadows, and marshes since water levels would no longer be artificially elevated.

4.3.2.10 Climate

The climate of the study area is predominantly continental with some modifications by Lake Michigan. The National Oceanic and Atmospheric Administration's (NOAA) Online Weather Data was queried for the Chicago Area since the closest local climatology reporting locations to the project areas are in eastern Illinois. Daily and monthly normal for temperature, precipitation, and snowfall between 1981 and 2010 were available (NOAA 2022) Figure 15. The mean winter high temperature is 31.0°F while the mean winter low temperature is 16.5°F (January). The mean summer high temperature is 84.1°F while the mean summer low temperature is 63.9°F (July). Annual total precipitation normal for the Chicago area is 36.9 inches. In winter, total snowfall is generally heavy with an annual total snowfall normal of 36.3 inches. Most snowfall occurs between December and February with total snowfall normal ranging from 8.2 inches (i.e., December) to 9.1 inches (i.e., February) during this timeframe.

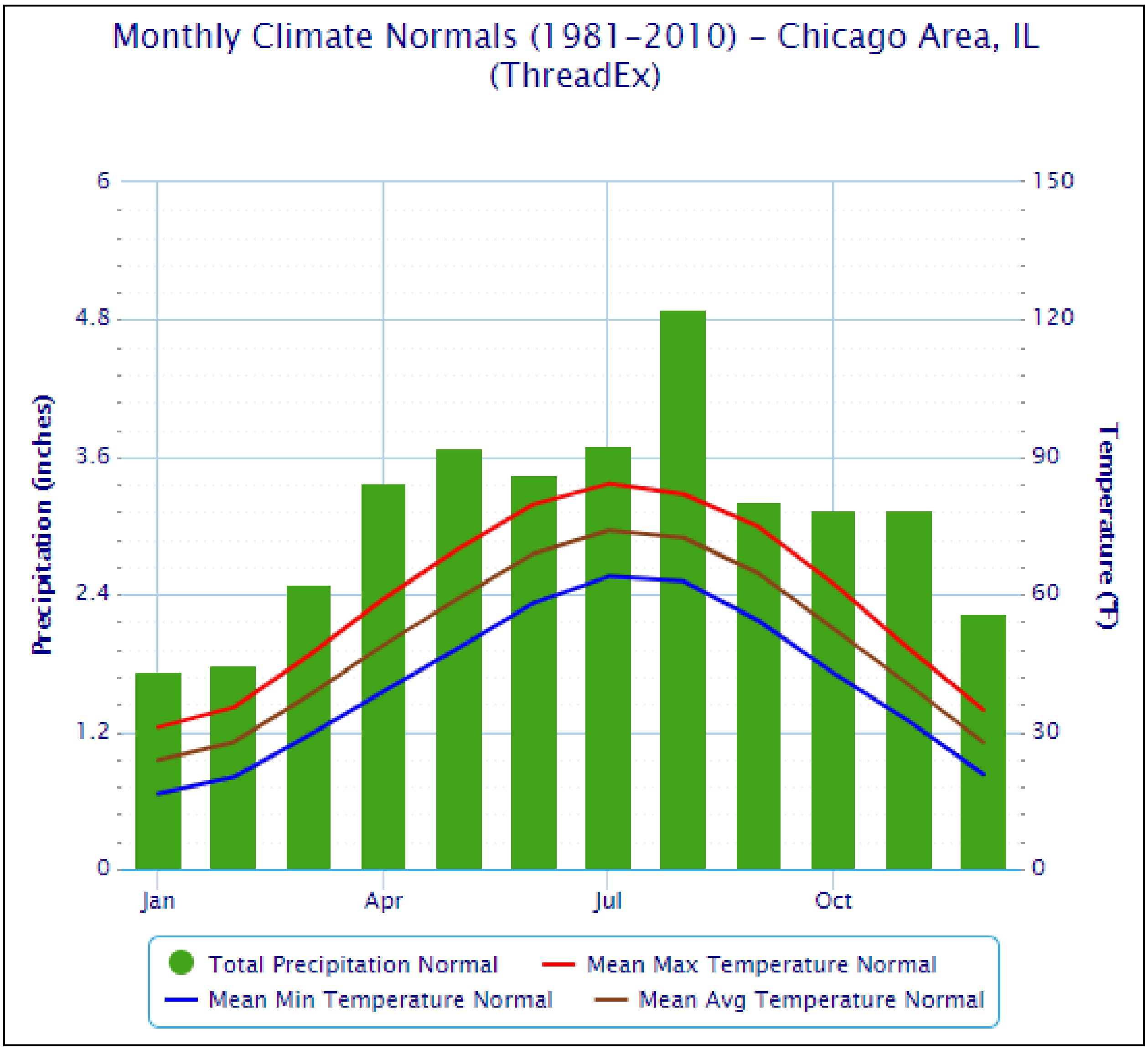


Figure 15: Normal precipitation and temperature for the study area, 1981–2010 (NOAA 2022).

Only short duration, minor discharges of carbon-based pollutants would occur during construction activities that could contribute to greenhouse gases. Long-term climate trends indicate that the Chicago area will continue to see increased flooding in urban areas due to more intense precipitation events. Implementation of the TSP would not adversely impact climate, but removal of dams could provide benefits through reduction of flooding in areas upstream of the dam locations since the water level would be lower after implementation of the TSP.

Under the No Action Plan the dams would not be removed. The No Action Plan would not adversely impact climate or climate change, but low lying areas near the impoundments would continue to receive flooding during high water events. The No Action Plan would not help to offset the impacts of a changing climate.

Under the No Action Plan the dams would remain in place, which would have minimal impacts on climate.

Effects resulting from implementation of the TSP include minor temporary increases in greenhouse gases from construction (demolition) activities. These impacts would be temporary and less than significant.

4.3.2.11 Air Quality

The Clean Air Act requires the U.S. Environmental Protection Agency (USEPA) to set national ambient air quality standards (NAAQS) for six criteria pollutants (carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, and sulfur oxides) which are considered harmful to public health and the environment. Areas not meeting the NAAQS for one or more of the criteria pollutants are designated as “nonattainment” areas by the USEPA. Kane County is considered moderate “nonattainment” for ozone under the Clean Air Act. This status is typical for the region, due to the large population living between Milwaukee, Wisconsin south through Chicago, Illinois, and into the northern Indiana industrial belt. See Table 21 for a history of NAAQS nonattainment status. According to the USEPA’s Air Quality Index Summary Report, in 2022 Kane County had 214 days of good air quality, 68 days of moderate air quality, and three days where the air quality was considered unhealthy (USEPA, 2022).

Table 21: Air quality status, Kane County, Illinois

NAAQS	Area Name	Most Recent Year of Nonattainment	Current Status	Classification
1-Hour Ozone (1979) – NAAQS revoked	Chicago-Gary-Lake County, IL and IN	2004	-	Severe-17
8-Hour Ozone (1997) – NAAQS revoked	Chicago-Gary-Lake County, IL and IN	2011	Maintenance (since 2012)	Moderate
8-Hour Ozone (2008)	Chicago-Naperville, IL, IN and WI	2021	Maintenance (since 2022)	Serious
8-Hour Ozone (2015)	Chicago, IL, IN and WI	2023	-	Moderate
PM-2.5 (1997) – NAAQS revoked	Chicago-Gary-Lake County, IL and IN	2012	Maintenance (since 2013)	Former Subpart 1

No impacts to air quality are expected under the No Action Plan.

Implementation of the TSP will be neutral in terms of effects to air quality, with no features that either emit or sequester air pollutants to a large degree. Due to the small scale and short duration of these projects, the main sources of emissions would be vehicle emissions and dust associated with the construction activities. The project does not include any stationary sources of air emissions and a General Conformity Analysis was not completed. The temporary mobile source emissions from this project is de minimis in terms of the National Ambient Air Quality Standards. The project is not expected to be a significant source of Green House Gas emissions. All construction vehicles will comply with federal vehicle emission standards. USACE and its Contractors comply with all Federal vehicle emissions requirements. USACE follows EM 385-1-1 for worker health and safety and requires all construction activities to be completed in compliance with Federal health and safety requirements.

4.3.3 Hazardous, Toxic, and Radioactive Waste (HTRW)

USACE conducted an initial Phase I Environmental Site Assessment (ESA) in accordance with ASTM E-1527-13. According to ER 1165-2-132, non-HTRW environmental issues that do not comply with federal, state, and local regulations should be discussed in the HTRW evaluation along with HTRW issues. The HTRW assessment included in Appendix E was completed using a review of existing information, historical documents and aerial photographs, a database research, and a site visit. One recognized environmental condition (REC) HTRW issue was identified in the investigation:

- The environmental database report suggests that the former Elgin Public Works yard, listed in multiple environmental databases, and located within the proposed temporary work easement for the Kimball Street Dam, has unresolved remedial action status. This site should be investigated further in the design stage of the project to confirm the status of the site. If remedial activities have not been completed at the site, an alternative temporary work area may need to be considered to avoid HTRW at the site. USACE will not use any parcels for temporary storage and staging that have unresolved HTRW issues.

No impacts to HTRW contaminated areas are expected under the No Action Plan.

Implementation of the TSP is not expected to result in a release of HTRW. The risk of encountering HTRW in the project area has been reduced with the completion of a HTRW Phase I Environmental Site Assessment. The status of the temporary work area for the Kimball Street dam will be investigated further during design phase and an alternate location identified to reduce the risk of releasing HTRW at the site, if required. Erosion and sediment controls will be maintained during construction to reduce movement of soil and sediment from upland construction activities. No HTRW response actions are anticipated or required prior to project implementation.

Impacts resulting from the unintended release of hazardous or toxic construction equipment fluids, including fuel and oil spills or leaks during project implementation, would be mitigated by requiring construction contractors to develop an accidental spill prevention and response plan for all hazardous materials that may be used onsite, develop a solid and hazardous materials and waste management plan prior to starting work, and comply with all applicable local, regional, state, and Federal laws, policies, and regulations regarding the transportation, storage, handling, management, and disposal of hazardous materials and wastes. In the event of a spill or release of hazardous substances at the construction site, the contaminated soil would be immediately contained, excavated, and treated per Federal and state regulations developed by the USEPA, as well as local hazardous waste ordinances.

4.3.4 Ecological Resources

4.3.4.1 Riparian Plant Communities

Natural plant communities along the Fox River channel and floodplain consisted of diverse woodland, savanna, meadow, fen, and marsh. Past manipulation to hydrogeomorphic features, riverine hydrology and hydraulics, land use change, point source pollution and introduction of invasive plant species have all contributed to the degradation of riparian plant communities of the Fox River.

Under the No Action Plan dams would remain in place and would continue to negatively impact riverine wetlands including side-stream fens, sedge meadows, and marshes.

Effects resulting from implementation of the TSP include reestablishing natural riverine conditions within impounded segments of the river. Restored conditions would result in long-term beneficial impacts to wetlands through restored hydrology in side-stream fens, sedge meadows, and marshes since water levels would no longer be artificially elevated. No adverse, long-term effects to Fox River riparian plant communities are anticipated as a result of implementation of the TSP.

4.3.4.2 Riverine Habitat

Channel habitats of the Fox River were formerly that of a free-flowing river, which were created and sustained by processes such as cut and fill alluviation (meandering), channel migration, sediment transport and substrate sorting, and morphological feature creation (riffles/backwaters/oxbows/woody debris sequestering, etc). Although development of the floodplain and riverbanks is one of the causes ceasing these natural conditions; the installation of the dams is a major cause as well. All hydraulic parameters and functions of a free-flowing river ceased when the dams were installed, creating a series of impoundment lakes. About 55% of the entire Fox River is impounded, with 70% of the Fox River impounded within the study area. This leaves about 30% of the river with functioning riverine habitat creation and sustainment.

Under the No Action Plan dams would remain in place and would continue to negatively impact riverine wetlands including side-stream fens, sedge meadows, and marshes.

Effects resulting from implementation of the TSP include reestablishing natural riverine conditions within impounded segments of the river. Restored conditions would result in long-term beneficial impacts to wetlands through restored hydrology in side-stream fens, sedge meadows, and marshes since water levels would no longer be artificially elevated. Short-term affects due to habitat movement, primarily sand bars and islands, induced by dam demolition would be similar or less than those natural channel forming events during spring and summer thunderstorms. No direct or indirect, short-term or long-term adverse effects to Fox River habitat parameters are anticipated as a result of implementation of the TSP.

4.3.4.3 Macroinvertebrates

Natural macroinvertebrate communities within the Fox River channel adapted to varying flowing water conditions over diverse substrates. The installation of the dams eliminated about 70% of these natural conditions within the study area. Specific studies (Santucci and Gephard 2003) show that about 60% of the macroinvertebrate taxa are affected by these conditions. Flowing segments typically had a higher macroinvertebrate condition index (MCI) and supported a higher richness and abundance of conservative species, such as mayflies and caddis flies. In eight of 11 stations, Macroinvertebrate Biotic Index (MBI) scores suggest that macroinvertebrate communities are adversely affected just above dams via hydraulic (free-flowing) habitat degradation or elimination.

Under the No Action Plan macroinvertebrate habitat would continue to be degraded. Dams would continue to alter hydrology resulting in embedded substrates dominated by fine grain sediments.

Effects resulting from implementation of the TSP include reestablishing natural riverine hydraulics within impounded segments of the river. This would cause riverine habitat and hydraulics to be created and sustained once again, as was the natural condition. Short-term affects due to habitat movement, primarily sand bars and islands, induced by dam demolition would be similar or less than those natural channel forming events during spring and summer thunderstorms. No direct or indirect, short-term or long-term adverse effects to Fox River macroinvertebrate communities are anticipated as a result of implementation of the TSP.

4.3.4.4 Freshwater Mussels

The natural conditions of the Fox River channel were prime for freshwater mussel richness and abundance. There are 26 extant species out of the 34 historically known to once occur in the Fox River system (Tiemann et al 2007) as a whole. Primarily due to the installation of the dams, only six species were recently observed within the study area. Although shells occur at impounded sites, live specimens were not found; therefore, 100% of Fox River mussel species are missing at all impounded sites (or missing from 70% of the river within the study area). The six species collected at free-flowing sites are widespread and common in the Fox River (Schanzle et al. 2004), yet they were not collected in impounded areas either. Reductions in freshwater mussel abundance and/or extant species richness are common in impounded areas, as reported for both large dams (Combes and Edds 2005) and run-of-the-river dams (Dean et al. 2002). Also, the dams affecting fish indirectly affect mussels, since fish are required for the glochidal life stage and subsequent distribution.

Under the No Action Plan riverine connectivity would not be restored. Mussel habitat would continue to be degraded. Dams would continue to alter hydrology, creating impoundments and resulting in embedded substrates dominated by fine grain sediments.

Effects resulting from implementation of the TSP include reestablishing natural riverine hydraulics and substrates within impounded segments of the river. This would restore natural riverine conditions favored by freshwater mussels. Short-term affects due to habitat movement, primarily sand bars and islands, induced by dam demolition would be similar or less than those natural channel forming events during spring and summer thunderstorms. Preliminary to dam removal, assessment would be made by the Illinois Natural History Survey (INHS) as to whether mussel beds should be temporarily relocated or monitored during demolition activities. No direct or indirect, short-term or long-term adverse effects to Fox River freshwater mussel communities are anticipated as a result of implementation of the TSP.

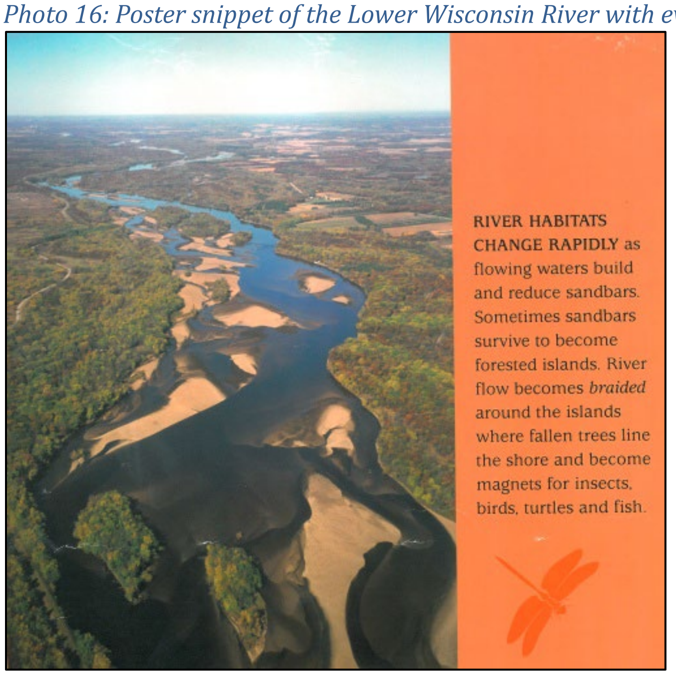
4.3.4.5 Fishes

The natural condition of the Fox River fish assemblage formerly was evenly distributed through the entire river system, including tributary streams. Due to the installation of the dams, both connectivity and habitat were eliminated from large segments of the river, over 70% within the study area. Much of this information shows that overall the free-flowing habitats are of a better quality as compared to the impoundments and is expressed in the higher IBI scores seen at all free-flowing stations. 15 species were found to have a truncated distribution only being found downstream, with another 15 with discontinuous distributions that were typically absent from the middle portions of the river (see Figure 8).

Under the No Action Plan riverine connectivity would not be restored and impounded areas would remain intact. Fish habitat and fishes' ability to access suitable habitat would continue to be degraded. Access to tributaries would continue to be limited to fish within the impoundment with the tributary mouth.

Effects resulting from implementation of the TSP include reestablishing connectivity of the main channel and tributary streams, while restoring 70% of the impaired habitat to natural riverine habitat (free-flowing). This would restore natural riverine conditions favored by native fishes. Short-term affects due to habitat movement, primarily sand bars and islands, induced by dam demolition would be similar or less than those natural channel forming events during spring and summer thunderstorms. This mechanism would not disrupt fish habitat, but create more diverse habitats. The lower 92 miles of the free-flowing Wisconsin River is example of this natural condition, which boasts 98 species of native freshwater fishes, including Shovelnose Sturgeon, Paddlefish, Shoal Chub and Western Sand Darter to name a few (Photo 16). No direct or indirect, short-term, or long-term adverse effects to Fox River freshwater fish communities are anticipated as a result of implementation of the TSP.

Photo 16: Poster snippet of the Lower Wisconsin River with ever moving sand bars



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4.3.4.6 Reptiles & Amphibians

The most abundant riverine reptiles and amphibians within the Fox River include, but are not limited to Green Frog, Northern Leopard Frog, Snapping Turtle, Painted Turtle, Spiny Softshell Turtle, Northern Map Turtle, Musk Turtle, Northern Water Snake, and Queen Snake. Due to the installation of the dams, some of these species have had preferred habitats drowned out by the resulting impoundments.

Under the No Action Plan riverine hydrology would continue to be altered, resulting in degradation of side-stream fens, sedge meadows, and marshes. These habitats are critical for many reptiles and amphibians, which rely on side-stream habitats near the river.

Effects resulting from implementation of the TSP include reestablishing connectivity of the main channel and tributary streams, while returning 70% of the impaired habitat to natural riverine habitat (free-flowing). Amphibians and reptiles easily avoid the short-term affects due to sediment transport and movement. Sand bars and islands induced by dam demolition would be similar or less than those natural channel forming events during spring and summer thunderstorms and would create more diverse habitats for amphibians and reptiles. No direct or indirect, short-term or long-term adverse effects to Fox River amphibian and reptile communities are anticipated as a result of implementation of the TSP.

4.3.4.7 Birds

Approximately 235 species of breeding birds have been documented throughout the Fox River Watershed in Illinois (Bird Conservation Network database). The Fox River Valley is part of the globally significant Mississippi Flyway, in which about 40% of all migrating birds of North America use the Mississippi Flyway in some facet. These birds use the flyway to make it to important nesting, feeding, and resting habitat as they migrate thousands of miles. Few effects to residential and migrating birds have occurred due to the installation of the Fox River dams.

Under the No Action Plan riverine habitat and connectivity would not be restored. Important nesting, feeding, and resting habitat would continue to be degraded.

Effects resulting from implementation of the TSP include reestablishing connectivity of the main channel and tributary streams, while restoring 70% of the impaired habitat to natural riverine habitat (free-flowing). This would restore natural riverine conditions for birds in terms of increasing aquatic food sources and riparian wetlands. No direct or indirect, short-term or long-term adverse effects to resident Fox River and migratory bird communities are anticipated as a result of implementation of the TSP.

4.3.4.8 Mammals

The most likely native mammals that would use the Fox River immediate riparian zone include, but are not limited to Little Brown Bat, Northern Long-Ear Bat, Silver-Haired Bat, Eastern Pipistrelle, Big Brown Bat, Eastern Red Bat, Hoary Bat, Evening Bat, White-Footed Mouse, Ground Hog, Muskrat, American Beaver, River Otter, Coyote, Red Fox, Racoon, White-Tailed Deer, and Opossum. Effects to riverine and riparian mammals primarily stem from the conversion of tree habitats to permanently flooded impoundments that have resulted due to the installation of the Fox River dams.

Under the No Action Plan riverine habitat and connectivity would not be restored. Side-stream habitat utilized by mammals would continue to be degraded by altered riverine hydrology.

Effects resulting from implementation of the TSP include reestablishing riparian plant communities via removal of the flooded impoundments. This would restore natural riverine conditions for mammals in terms of increasing aquatic food sources (fish, mussels, insects) and migration corridors within and along the side of the river channel. No direct or indirect, short-term or long-term adverse effects to Fox River mammal communities are anticipated as a result of implementation of the TSP.

4.3.4.9 Threatened and Endangered (T&E) Species

Federal T&E Species:

A query of the USFWS IPaC (IpaC Consultation Code: 2023-0110788) identified several threatened or endangered species that may be present at the sites. These species include: the endangered northern long-eared bat (NLEB) (*Myotis septentrionalis*), endangered Indiana bat (*Myotis sodalis),* proposed endangered tricolored bat (*Perimyotis subflavus*), endangered rusty patched bumble bee (RPBB) (*Bombus affinus*), and threatened eastern prairie fringed orchid (*Platanthera leucophaea*) Table 22.

Table 22: Federal T&E species information

Species Name	Federal Status	Habitat	Potential to Occur
Indiana bat (Myotis sodalis)	Endangered	Hibernates in caves and mines – swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods during the summer.	Not expected to occur; lack of suitable habitat.
Northern long-eared bat (Myotis septentrionalis)	Endangered	Hibernates in caves and mines – swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods during the summer.	Not expected to occur; No known hibernacula. Wooded riparian areas may provide opportunities for summer roosting.
Tricolored bat (Perimyotis subflavus)	Proposed Endangered	Hibernates in caves and mines – swarming in surrounding wooded areas in autumn. Roosts and forages in upland forests and woods during the summer.	Not expected to occur; lack of suitable habitat.
Rusty patched bumble bee (*Bombus affinus)*	Endangered	Natural and semi-natural upland grassland, shrubland, woodlands and forests	Potential to occur; project within the high potential dispersal zone (USFWS).
Eastern prairie fringed orchid (*Platanthera leucophaea*)	Threatened	Moderate to high quality wetlands, sedge meadow, marsh, and mesic to wet prairie	Potential to occur in high quality stream-side wetlands.

State T&E Species:

The Illinois Natural Heritage Database was queried on 31 August, 2023 for important resource areas and state listed species. An ILDNR EcoCAT report (ILDNR Project Number 2404102) was submitted and processed for the study area. The EcoCAT report and full list of state listed species can be found in *Appendix A: Compliance, Coordination & Information*, with the results summarized below as follows:.

Results indicate the Shaw Fen, Woods INAI and Natural Heritage Landmark, Ferson Creek Nature Preserve, and Norris Nature Preserve are within the study area. In addition, Results indicate the state threatened Peregrine Falcon (*Falco peregrinus*), the state threatened River Redhorse (*Moxostoma carinatum*), and the state threatened Northern Starhead Topminnow (*Fundulas dispar*) may be present in the study area. The Northern Star Topminnow was formerly abundant in the Fox River wetland complex now called the Chain of Lakes. This species prefers glacial lakes and glacial flowage wetland habitats with abundant high quality macrophytes. The Fox River area of affect for this study is atypical of the habitat *Fundulus dispar* prefers and any records of occurrence are individuals likely washed down from the Chain of Lakes. It is known from INHS surveys that the state threatened Purple Wartyback and Spike occur in this reach in free-flowing sections.

Based on the information listed above and site assessments, federally endangered and threatened species or their critical habitats, with the exception of the rusty patched bumblebee, are not expected to occur within the study area. The USFWS indicates that portions of the study area are in the high potential to occur zone, but side-channel habitat would not be disturbed under the TSP and access to water would not be restricted. For the eastern fringed prairie orchid, there is the potential for this species to occur in some of the higher quality stream-side wetlands and sedge meadows, but implementation of the TSP would restore riverine hydrology in these side-stream wetlands and is likely to have beneficial impacts rather than adverse impacts. For the NLEB, Indiana bat, and the tricolored bat there are no known hibernacula within the vicinity of the project area and the species is not expected to be in the area during hibernation. These bat species could potentially be in the vicinity of the project area during the summer as there is potential habitat in the project area. In addition, the TSP does not include any tree removal.

Therefore, USACE determined the TSP would have ‘no effect’ on the NLEB, Indiana bat, tricolored bat, RPBB, or eastern fringed prairie orchid. If scope of work changes and impacts to trees located near the project site would occur, the following items would be complied with to minimize any potential impacts to northern long-eared bat roosting habitat:

- No cutting of any trees suitable for bat roosting (i.e., greater than 5 inches diameter at breast height (DBH), living or dead, with loose hanging bark, or with cracks, crevices, or cavities) from April 1 through September 30.

Under the No Action Plan riverine habitat and connectivity would not be restored. Conditions for the eastern fringed prairie orchid and the state listed species would continue to be degraded. The four state listed species are all riverine specialist species, meaning they require flowing water with diverse substrates for feeding and reproduction. Installation of the Fox River dams has eliminated these species from all impoundment sections due to habitat (flow and substrate) degradation.

Effects resulting from implementation of the TSP include reestablishing natural riverine hydraulics and substrates within impounded segments of the river. This would restore natural riverine conditions favored by the federally listed eastern fringed prairie orchid and the four T&E species listed. Short-term affects due to habitat movement, primarily sand bars and islands, induced by dam demolition would be similar or less than those natural channel forming events during spring and summer thunderstorms. No direct or indirect, short-term or long-term adverse effects to federal and state T&E species are anticipated as a result of implementation of the TSP. It is expected that the TSP will increase the abundance and distribution of all four State T&E species.

4.3.4.10 Invasive Species

Executive order 13112 calls for actions "to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause..." This EO utilizes the laws of the United States of America, including the National Environmental Policy Act of 1969, as amended (42 U.S.C.§ 4321 et seq.), Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, as amended (16 U.S.C.§ 4701 et seq.), Lacey Act, as amended (18 U.S.C.§ 42), Federal Plant Pest Act (7 U.S.C.§ 150aa et seq.), Federal Noxious Weed Act of 1974, as amended (7 U.S.C.§ 2801 et seq.), Endangered Species Act of 1973, as amended (16 U.S.C.§ 1531 et seq.), and other pertinent statutes. Executive Order 13112 also includes specific duties for federal agencies in regard to invasive or nuisance aquatic species. Excerpts from the order relating to federal agencies are contained in the following paragraphs:

(a) Each federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law,

(1) identify such actions;

(2) subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them; and

Under the No Action Plan riverine connectivity and habitat would not be restored. Invasive fished including the Eurasiatic common carp (*Cyprinus carpio*) and Asiatic goldfish (*Carassius auratus*) would continue to thrive in the impoundments created by the dams, which is their preferred habitat.

Effects resulting from implementation of the TSP include restoration of riverine habitat and connectivity. Removal of any of the dams that are under consideration in this study would not induce or promote the dispersal of non-native, invasive and/or aquatic nuisance species including the two Sharpbelly species Silver Carp(*Hypopthalmichthes molitrix*) and Bighead Carp (*Hypopthalmichthes nobilis)*, which currently do not occur in the Fox River system above the Dayton Dam. This project would have beneficial effects in terms of reducing the Eurasiatic Common Carp (*Cyprinus carpio*) and Asiatic Goldfish (*Carassius auratus*) by removing their preferred habitats, which are created by the impounded segments of river. The abundance of Eurasiatic milfoil (*Myriophyllum spicatum*) within the currently impoundment pools would also be significantly reduced or eliminated.

4.3.4.11 Nature Preserves

Shaw Fen and Woods INAI – Cannot be located. Inquired to ILDNR Nature Preserve's Commission and Impact Assessment Section and did not receive response.

Ferson Creek Nature Preserve – This natural area is owned by the St. Charles Park District and provides healthy and unique fen, sedge meadow and floodplain forest. Ferson Creek borders the site to the south and Crane Road to the north. Currently, the hydrology of the Fox River bordering the natural area is not the same hydrology that was present when the natural was formed by the river carving out the Fox River valley. This floodplain terrace that the sedge meadow and fen sit upon was partially drowned by the installation of the St. Charles dam. Effects resulting from implementation of the TSP include reestablishing natural riverine hydrology periods and elevations within impounded segments of the river. This would increase the size of the former floodplain terrace that is currently drowned out, which would increase the acres of fen and meadow; however, the impounding effects at St. Charles are minimal to river width, meaning after removal, the river would not shrink in width all that much. Hydrology of the fen and meadow are dependent upon ground water discharge through the Fox River valley wall, meaning that Fox River hydrology does not drive the system. The implementation of the TSP would also lower flood elevation in close proximity, which includes the Ferson Creek Nature Preserve, which means there will be less impacts from flooding to native vegetation within the site. Finally, implementation of the TSP would restore the mouth of Ferson Creek and the small rivulets exiting the fen by removing the backwater effects, in which riffles and pools would most likely form again, as such occurred at Salt Creek with the removal of the Hofmann Dam. No adverse, long term effects to Ferson Creek Nature Preserve are anticipated as a result of implementation of the TSP. It is expected that the TSP will restore the natural conditions that existed before the impoundment was created.

Norris Nature Preserve – This natural area is owned by the St. Charles Park District and provides floodplain forest habitats, most likely intermingled with vernal pools and rivulets. It is quite apparent from the aerial view that the current impoundment has homogenized the shoreline of the floodplain forest, removing any transitional terrace/bank habitats from the river to the forest. Effects resulting from implementation of the TSP include reestablishing natural riverine hydrology periods and elevations within impounded segments of the river. No adverse, long term effects to Norris Nature Preserve are anticipated as a result of implementation of the TSP. It is expected that the TSP will restore the natural conditions that existed before the impoundment was created.

4.3.5 Cultural and Social Resources

4.3.5.1 Environmental Justice EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

All of the proposed alternative plans would not cause adverse human health effects or adverse environmental effects on minority populations or low-income populations. Executive Order 12898 (environmental justice) requires that, to the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each federal agency make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.

USACE conducted an evaluation of potential environmental justice impacts to ensure that no minority and/or low-income populations in the area were disproportionately affected due to activities from this project.

In terms of environmental justice and evaluating potential impacts, it was analyzed whether construction of the TSP would have a disproportionate impact to minority communities or low-income communities. To evaluate potential disproportional impacts to minority populations or to low-income households, the USEPA's Environmental Justice Screening and Mapping tool (EJSCREEN) and the Climate and Economic Justice Screening Tool (CEJST) were consulted to determine if the project area was in an environmental justice census block.

As defined in Executive Order 12898 and CEQ guidance, a minority population occurs where one or both of the following conditions are met within a given geographic area:

- The American Indian, Alaskan Native, Asian, Pacific Islander, Black, or Hispanic population of the affected area exceeds 50 percent.
- The minority population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographic analysis.

A minority population also exists if more than one minority group is present, and the aggregate minority percentage meets one of the above conditions. The selection of the appropriate unit of geographic analysis could be a governing body's jurisdiction, a neighborhood, census tract, or other similar unit. Note that the Hispanic/Latino population represents a multi-racial ethnicity, which may overlap with other minority groups.

Executive Order 12898 does not provide criteria to determine if an affected area consists of a low-income population. For this assessment, the CEQ criteria for defining a minority population has been adapted to identify populations in an affected area that constitute a low-income population. An affected geographic area is considered a low-income population (i.e., below the poverty level, for purposes of this analysis) where one or both of the following conditions are met within a given geographic area:

- The poverty rate of the total population is above 50 percent.
- The percentage of individuals in poverty is meaningfully greater than in the general population or other appropriate unit of geographic analysis.

A search of the EPA Environmental Justice Screening and Mapping tool revealed that within a two-mile buffer of the Fox River from Algonquin to Montgomery, 22% (43rd percentile when compared to the state's low-income population) of the population is considered below the poverty line and 43% (62nd percentile when compared to the state's minority population) of the population is considered a minority (

Table 23). Since the overall project is considered ecosystem restoration and will only benefit the surrounding environment and communities, no adverse effects to any low-income populations and/or minority populations are expected. Overall, the proposed project is in full compliance with this executive order.

Table 23: USEPA EJSCREEN data (USEPA, 2023)

SELECTED VARIABLES	VALUE	STATE AVERAGE	PERCENTILE IN STATE	USA AVERAGE	PERCENTILE IN USA
POLLUTION AND SOURCES					
Particulate Matter ($\mu g/m^3$)	9.37	9.44	44	8.08	81
Ozone (ppb)	63.4	63.6	39	61.6	65
Diesel Particulate Matter ($\mu g/m^3$)	0.241	0.358	36	0.261	55
Air Toxics Cancer Risk* (lifetime risk per million)	28	28	0	28	3
Air Toxics Respiratory HI*	0.2	0.29	0	0.31	4
Toxic Releases to Air	2,900	6,000	40	4,600	78
Traffic Proximity (daily traffic count/distance to road)	61	200	39	210	44
Lead Paint (% Pre-1960 Housing)	0.19	0.44	27	0.3	47
Superfund Proximity (site count/km distance)	0.06	0.095	57	0.13	49
RMP Facility Proximity (facility count/km distance)	0.15	0.72	21	0.43	45
Hazardous Waste Proximity (facility count/km distance)	0.96	1.7	50	1.9	60
Underground Storage Tanks (count/km^2)	4	8.6	46	3.9	73
Wastewater Discharge (toxicity-weighted concentration/m distance)	0.089	38	44	22	81
SOCIOECONOMIC INDICATORS					
Demographic Index	32%	34%	58	35%	55
Supplemental Demographic Index	13%	14%	54	14%	52
People of Color	43%	39%	62	39%	61
Low Income	22%	29%	43	31%	40
Unemployment Rate	7%	7%	68	6%	72
Limited English Speaking Households	3%	4%	68	5%	68
Less Than High School Education	14%	11%	72	12%	69
Under Age 5	6%	6%	57	6%	58
Over Age 64	12%	17%	36	17%	36
Low Life Expectancy	18%	20%	39	20%	40

*Diesel particulate matter, air toxics cancer risk, and air toxics respiratory hazard index are from the EPA's Air Toxics Data Update, which is the Agency's ongoing, comprehensive evaluation of air toxics in the United States. This effort aims to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that the air toxics data presented here provide broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. Cancer risks and hazard indices from the Air Toxics Data Update are reported to one significant figure and any additional significant figures here are due to rounding. More information on the Air Toxics Data Update can be found at: https://www.epa.gov/haps/air-toxics-data-update.

Executive Order 14008 was signed in 2021 and ordered the Council on Environmental Quality (CEQ) to develop a new tool called the Climate and Economic Justice Screening Tool (CEJST). The tool provides information to identify disadvantaged communities experiencing burdens in eight different categories, climate change, energy, health, housing, legacy pollution, transportation, water and wastewater, and workforce development. Census tracts appear shaded on the website's mapping tool if they are experiencing these burdens. Figure 16 is a screenshot from the CEJST website and indicates that one census tract along the river in Carpentersville is disadvantaged, and that several census tracts in both Elgin and Aurora are disadvantaged.

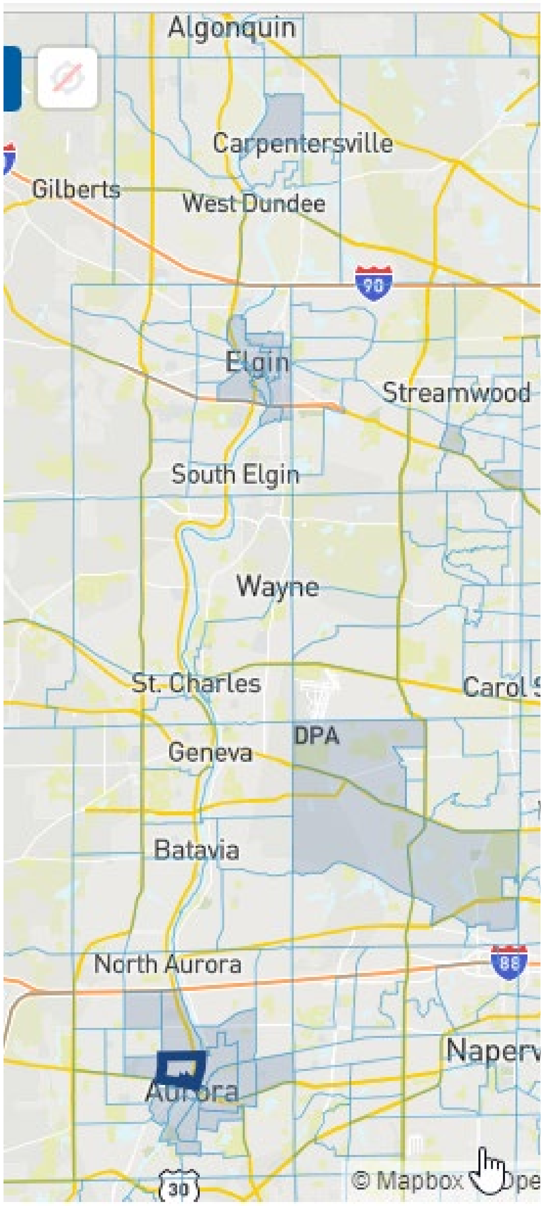

Figure 16: Screenshot of study area from the CEJST website

Under the No Action Plan no changes to the river would occur and no impacts to minority or low-income populations are expected.

Effects resulting from implementation of the TSP include reestablishing natural riverine hydraulics within impounded segments of the river by removing dams. Implementation of the TSP would not adversely impact low-income and minority populations that utilize the Fox River dams as the focus of religious or social practices. Subsistence fishing would improve due to the anticipated increase in fish species richness and abundance throughout the study area. In addition, as discussed in section 4.3.5.4., implementation of the TSP would likely result in a shift in recreational boating use from deeper draft motorboating (such as wake boats) to shallower draft motorboats (such as pontoons and fishing boats) and paddling. Motorboating has a higher economic barrier to entry than paddling due to the cost of purchasing and maintaining motorized boats, the vehicle required to haul the boat, and other associated costs including maintenance and storage. Conversely, paddling has a much lower economic barrier to entry since canoes and kayaks are cheaper than motorboats, maintenance is less expensive or non-existent, storage requires less space, and the state of Illinois does not require annual registration of non-motorized watercraft. Therefore, implementation of the TSP is expected to provide minor long-term beneficial impacts for low-income communities by providing more recreation opportunities with a relatively low economic barrier to entry.

4.3.5.2 Land Use

Current and historical land use in the Fox River Watershed is discussed in section 2.4.2.

Under the No Action Plan no changes to land use are expected to occur.

Effects resulting from implementation of the TSP include reestablishing natural riverine hydraulics within impounded segments of the river by removing dams. Minor impacts to land use are expected to occur in some areas immediately adjacent to the channel where water levels recede and expose more land. This land would likely remain as natural open space since flooding would occur on a regular basis due to low lying position in the landscape and close proximity to the channel. FWP inundation mapping in the H&H Appendix shows reduced flood elevations in the areas upstream of the dam locations, but this study was not formulated for flood risk mitigation (FRM) and these are feasibility level models. Flood insurance rates are tied to FEMA floodplain mapping, and local governments would need to petition FEMA to update floodplain mapping to reflect new conditions following dam removal.

4.3.5.3 Noise

Under the No Action Plan no changes to noise are expected to occur.

Effects resulting from implementation of the TSP include reestablishing natural riverine hydraulics within impounded segments of the river by removing dams. Ambient noise levels within the project area would be increased due to demolition and removal activities and increased truck traffic. Many of the dams are located in the downtown area of municipalities nearby busy roads with truck traffic, so increase noise from demolition and removal activities are not expected to significantly rise above ambient levels. Noise attenuates fairly rapidly, and construction activities would be restricted to between 7:00 a.m. and 4:30 p.m. Any noise impacts would be negligible and temporary, lasting only the duration of construction.

4.3.5.4 Recreation

Recreation is the dominant public use on the Fox River. Activities include fishing (from shore, piers, vessels, and by wading in shallow areas), paddling, bird watching, swimming, and power boating activities such as water skiing.

Paddling is extremely popular on the Fox River. In 2023, the U.S. Department of the Interior designated the Fabulous Fox Water Trail as a National Water Trail. The trail is 158 miles long and begins near Waukesha, Wisconsin and ends at the confluence with the Illinois River in Ottawa, Illinois. The trail offers paddlers the opportunity to paddle the length of the river and experience the different landscapes and habitats of the Fox River. However, paddlers must portage around each of the dams, and there are not clear portage routes around some of the dams.

Motor boating is popular in some impoundments in the study area, especially in Elgin, South Elgin, St. Charles, and Aurora. There are numerous boat ramps along the Fox River in the study area, and many are clustered in the abovementioned municipalities. Recreational motorized vessels operated in the study area range from small fishing vessels to pontoon boats to ballast-holding wake boats. In addition, the St. Charles Park District operates the St. Charles Belle and the Fox River Queen, which are large passenger carrying paddlewheel riverboats. While motorboating is common in the study area, the sections of the Fox River most heavily used by motorboat recreators are upstream of the study area in the Algonquin impoundment and in Chain of Lakes.

Under the No Action Plan there would be no expected change to recreation on the Fox River. Fishing opportunities would remain static. Motorboating opportunities would remain viable in the deeper impoundments. Paddlers would continue to portage around dams when paddling longer stretches of the river. Birding and swimming opportunities would remain relatively static.

Effects resulting from the TSP would result in a shift in recreation types and would provide benefits to some recreational users and would have adverse impacts to others. Beneficial impacts include improved connectivity and safety for paddlers on the Fabulous Fox Water Trail since they would no longer need to portage around dams and would not be at risk of going over or getting stuck on a dam. In addition, paddling and other lower-cost activities have a lower barrier to entry than motorboating and can therefore be pursued by a wider swath of the public. Sport fish species and sport fishing is expected to remain the same. Birding opportunities would likely improve as more species return to the river corridor seeking food in the more diverse free-flowing river. Adverse impacts to power boating would be expected since the river would be shallower. However, as shown in Figures 21 through 29 in *Appendix D: Hydrology and Hydraulic Analyses*, many of the pools would maintain water depths of three to six feet at the 25% exceedance level, which is similar to the ordinary high water mark (or average conditions). These water depths would allow operation of shallow draft motorboats including pontoon boats and many fishing boats, which usually draft 12 to 24 inches. Wake and ski boats, which can draft as deep as 36 inches when holding ballast, may not be able to operate safely in many portions of the study area should the TSP be implemented. However, reaches upstream of the Elgin and Carpentersville dams would maintain depths of six to nine feet, which would allow for most types of motorboats to operate. Motorboating opportunities upstream of Algonquin into Chain of Lakes would not be affected by the TSP. Some piers and boat ramps may also need to be retrofitted as a result of the TSP to accommodate a more narrow and shallow river conditions.

4.3.5.5 Archaeological & Historical Properties

Of the 64 properties listed on the National Register of Historic Places in Kane County, 61 of the listed properties and all seven of the listed historic districts are located within communities bordering the Fox River. The North Geneva Historic District (listed 1982) and the Central Geneva Historic District (listed 1971) both border the Fox River. The Dundee Township Historic district straddles the Fox River.

The Stolp Island Historic District in Aurora (listed 1986) sits in the middle of the Fox River. Aurora Dam East is located between Strop Island and the east bank of the Fox River. Aurora Dam West is located between Strop Island and the west side of the Fox River. Neither dam is a contributing feature of the historic district.

The St. Charles Dam crosses the Fox River in downtown St. Charles. The Hotel Baker (listed 1978) is located adjacent to the west end of the Dam. The art deco St. Charles Municipal Building (listed 1991) is adjacent to the east end of St. Charles Dam. The dam itself is not listed on the National Register of Historic Places.

McHenry County has one historic district and 12 properties listed on the National Register. One property, the Greister, Christian House (listed 2007), is in the Village of Algonquin, but is not located near the project area.

The general project area within Kane and McHenry Counties is comprised of the 9 existing dam locales. All of the 9 dam locations within the project area have been heavily modified by dam construction, repeated dam repairs, and the reconfiguration of adjacent areas through residential and industrial, and commercial development.

Under the No Action Plan riverine habitat and connectivity would not be restored. No impacts to archaeological and historical properties would be expected.

Effects resulting from implementation of the Tentatively Recommended Plan include removal of dams, resulting in restoration of riverine habitat and connectivity. No short or long-term adverse impacts to archaeological and historical properties are expected.

4.3.5.6 Tribal Trust Resources

Letters were mailed to the following Native American tribes in November 2014 regarding the proposed ecosystem restoration along the Fox River. Tribes contacted by letter included Kickapoo Tribe of Oklahoma, Kickapoo of Kansas, Miami Tribe of Oklahoma, Citizen Potawatomi Nation, Forest County Potawatomi Executive Council, Nottawaseppi Huron Potawatomi Tribal Office, Hannahville Potawatomi Comm., Council, Pokagon Band of Band of Potawatomi Indians, and the Miami Nation in Indiana. No responses were received. Letters were sent to the tribes again in June 2022 to let them know that the study is active again and to request comments or information regarding the study. The Miami Tribe of Oklahoma and the Kickapoo Tribe of Oklahoma both responded that they have no objections to the proposed project, but request that they be contacted in the event that burial remains or artifacts are discovered. Mailing list and coordination letters are provided in *Appendix A: Compliance, Coordination & Information*.

Under the No Action Plan riverine habitat and connectivity would not be restored. No impacts to tribal trust resources would be expected.

Effects resulting from implementation of the TSP include removal of dams, resulting in restoration of riverine habitat and connectivity. No short or long-term adverse impacts to tribal trust resources are expected. However, the Miami Tribe of Oklahoma and the Kickapoo Tribe of Oklahoma both request that they be contacted if burial remains or artifacts are discovered.

4.4 Cumulative Effects

Consideration of cumulative effects requires a broader perspective than examining just the direct and indirect effects of a proposed action. It requires that reasonably foreseeable future impacts be assessed in the context of the past and present effects to important resources. Often it requires consideration of a larger geographic area than just the immediate “project” area. One of the most important aspects of cumulative effects assessment is that it requires consideration of how actions by others (including those actions completely unrelated to the proposed action) have and will affect the same resources. When assessing cumulative effects, the key determinate of importance or significance is whether the incremental effects of the proposed action will alter the sustainability of resources when added to other present and reasonably foreseeable future actions.

Cumulative environmental effects for the proposed infrastructure project were assessed in accordance with guidance provided by the President's Council on Environmental Quality. This guidance provides a for identifying and evaluating cumulative effects in NEPA analysis.

The overall cumulative impact of the project is considered to be beneficial environmentally, socially, and economically.

The cumulative effects issues and assessment goals are established in this environmental assessment, the spatial and temporal boundaries are determined, and reasonably foreseeable future actions are identified. Cumulative effects are assessed to determine if the sustainability of any of the resources are adversely affected with the goal of determining the incremental impact to key resources that would occur should the proposal be permitted. The spatial boundary for the assessment encompasses the parkland and the associated facilities and surrounding streets served by the infrastructures to be improved. The temporal boundaries are:

1. Past-1834, when settlement and development of the area began.
2. Present-2023, when the selection plan was being developed.
3. Future-2073, the year used for determining project life end.

Projecting reasonably foreseeable future actions is difficult at best. Clearly, the proposed action is reasonably foreseeable, however, the actions by others that may affect the same resources are not as clear. Projections of those actions must rely on judgment as to what are reasonable based on existing trends and where available, projections from qualified sources. Reasonably foreseeable does not include unfounded or speculative projections. In this case, reasonably foreseeable future actions include:

- Further improvements in water quality due to large-scale projects lead by the FRSG
- Further improvements in aquatic and riparian habitat in and along the Fox River
- Further improvements in connectivity within tributary streams
- Continued use of the Fox River to discharge wastewater
- Continued use of the Fox River for drinking water and food fishes
- Continued use of the Fox River for recreational purposes

Cumulative Effects on geology and soils: The TSP would have no effects on geology but would reduce soil deposition in the streambed by reducing impoundments where sediment often becomes embedded in the streambed substrate.

Cumulative Effects on Water Quality and Aquatic Communities: The TSP would have beneficial effects on water quality by reducing the length of impoundments on the river and would also have a beneficial effect on aquatic communities by creating improved riverine connectivity and habitat.

Cumulative Effect of Terrestrial Resources: The TSP would have beneficial effects on terrestrial resources including wildlife that depends on a healthy Fox River ecosystem for food.

Cumulative Effects on Air Quality: The project will have no long-term cumulative effect on air quality.

Cumulative Effects on Land Use: The project will have no cumulative effect on land use.

Cumulative Effects on Aesthetic Values: The project will have no cumulative adverse effects on the aesthetics of the project area.

Cumulative Effects on Public Facilities: The project will have no cumulative adverse effects on public facilities.

Cumulative Effects on Cultural Resources: This project will have no significant cumulative adverse effects on cultural resources.

Cumulative Effects Summary: Along with direct and indirect effects, cumulative effects of the proposed project were assessed following the guidance provided by the Presidents' CEQ (Table 24). There have been numerous effects to resources from past and present actions, and reasonably foreseeable future actions can also be expected to produce both beneficial and adverse effects. The effects of the proposed project are mostly beneficial or insignificant.

Table 24: Cumulative effects summary

Potential Impact Area	Past Actions	Proposed Direct Impacts TSP Implementation	Cumulative Impact
Geology & Soils	Adverse	Insignificant effects	No impact
Hydrology	Adverse	Beneficial effect	No impact
Water Quality	Adverse	Beneficial effect	No impact
Sediment Quality	Adverse	Beneficial effect	No impact
Aquatic Resources	Adverse	Beneficial effect	No impact
Terrestrial Resources	Adverse	Beneficial effect	No impact
Air Quality	No impact	Insignificant effects	No impact
Land Use	Adverse	No impact	No impact
Aesthetics	No impact	Insignificant effects	No impact
Cultural Resources	No impact	Insignificant effects	No impact

4.5 Compliance with Environmental Statutes

The TSP presented is in compliance with appropriate statutes and executive orders including the Endangered Species Act of 1973, as amended, 16 U.S.C. 1531; the Fish and Wildlife Coordination Act of 1934, as amended, 16 U.S.C. § 661, et seq.; the Coastal Zone Management Act of 1972, 16 U.S.C. § 1451, et seq.; the National Historic Preservation Act, as amended, 54 U.S.C. § 300101, et seq.; the Clean Water Act of 1972, as amended, 33 U.S.C. § 1251, et seq.; the Clean Air Act as amended, 42 U.S.C. § 7401, et seq.; the Rivers and Harbors Act of 1899, as amended, 33 U.S.C. § 403; the National Environmental Policy Act of 1969, as amended, 42 U.S.C. § 4321, et seq.; Executive Order 12898 (*Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*); Executive Order 13045 (*Protection of Children from Environmental Health and Safety Risks*); Executive Order

11990 (*Protection of Wetlands*); Executive Order 11988 (*Floodplain Management*); and Executive Order 13751 (*Safeguarding the Nation from the Impacts of Invasive Species)* as summarized in Table 25*.*

Table 25: Environmental compliance summary.

Federal Policy	Compliance*
Archeological Resources Protection Act, 16 U.S.C. 470, et seq.	Full Compliance
Clean Air Act, as amended, 42 U.S. C. 7401, 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.	Partial Compliance
Environmental Justice (Executive Order 12898)	Full Compliance
Farmland Protection Policy Act, 7 U.S.C. 4201, et. seq.	Not Applicable
Federal Water Project Recreation Act, 16 U.S.C. 460L-12, et seq.	Full Compliance
Fish and Wildlife Coordination Act, 16 U.S.C. 661, et seq.	Partial Compliance
Floodplain Management (Executive Order 11988)	Full Compliance
Invasive Species (Executive Order 13122)	Full Compliance
Migratory Bird Treaty Act, as amended, 16 U.S.C. 703-712, et seq.	Full Compliance
National Environmental Policy Act, 42 U.S.C. 4321, et seq.	Partial Compliance
National Historic Preservation Act, as amended, 54 U.S.C. 300101, et seq.	Partial Compliance
Protection & Enhancement of the Cultural Environment (Executive Order 11593)	Partial Compliance
Protection of Wetlands (Executive Order 11990)	Full Compliance
Rivers and Harbors Act, 33 U.S.C. 403, et seq.	Full Compliance
Watershed Protection and Flood Prevention Act, 16 U.S.C. 1001, et seq.	Full Compliance
Preparing the United States for the Impacts of Climate Change, as per instructions provided in Preparing Federal Agency Climate Change Adaptation Plans in Accordance with EO 13653 (Executive Order 13653)	Full Compliance
Tackling the Climate Crisis at Home and Abroad (Executive Order 14008)	Full Compliance

4.5.1.1 EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

All of the proposed alternative plans would not cause adverse human health effects or adverse environmental effects on minority populations or low-income populations. Executive Order 12898 (environmental justice) requires that, to the greatest extent practicable and permitted by law, and consistent with the principles set forth in the report on the National Performance Review, each Federal agency make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States and its territories and possessions, the District of Columbia, the Commonwealth of Puerto Rico, and the Commonwealth of the Mariana Islands.

As discussed in section Cultural and Social Resources implementation of the TSP would be compliant with EO 12898.

4.5.1.2 Clean Air Act

The local air qualities within the Fox River watershed (Kane and McHenry County) are considered 'non-attainment' under the Clean Air Act for 8-hour ozone as a marginal rating. All other parameters are within attainment. Once implemented, the project itself will be neutral in terms of air quality, with no features that either emit or sequester air pollutants to a large degree. During the project construction, heavy equipment would cause minor, temporary air quality impacts, however all equipment will be in compliance with current air quality control requirements for diesel exhaust, fuels, and similar requirements. A general conformity analysis was not conducted due to the short and temporary nature of any air quality effects.

4.5.1.3 Section 404 & 401 of the Clean Water Act

The TSP would not result in any discharge into wetlands, navigable waters, or waters of the US, therefore, the TSP is compliant with sections 404 and 401 of the Clean Water Act.

4.5.1.4 USFWS Coordination

Coordination with the USFWS commenced with a project scoping letter in November 2014. An additional scoping letter was sent in June 2022. Pursuant to section 7 of the Endangered Species Act of 1973, as amended, the U.S. Army Corps of Engineers determined the TSP would have 'no effect' on federally listed species or their designated critical habitat. As a result, consultation under section 7 is complete. Pursuant to the Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661-666(e)), any comments or recommendations received during the public and agency review period will be reviewed, considered, and incorporated into the final EA, as appropriate. Coordination with the USFWS is ongoing.

4.5.1.5 State of Illinois Department of Natural Resources Coordination

Coordination with the ILDNR commenced with a project scoping letter in November 2014. An additional scoping letter was sent in June 2022. A copy of the draft Integrated Project Implementation Report and Environmental Assessment will be provided to ILDNR during the public and agency review.

4.5.1.6 Illinois State Historic Preservation Office

Pursuant to section 106 of the National Historic Preservation Act of 1966, as amended, USACE determined that historic properties would not be affected by the recommended plan. A finding of No Historic Properties Affected was previously submitted to the Illinois State Historic Preservation Office (SHPO) in May 2015. The affected dams in the project area were determined not eligible for listing on the National Register of Historic Places (NRHP) at that time. The SHPO responded in June 2015 stating that they have no objections to the finding of no historic properties affected. However, this finding only remains in effect for two years and is now expired. As such, the draft IPIR/EA will be sent to the SHPO along with a new finding of effects during the 60-day public and agency review.

5 PLAN IMPLEMENTATION

This chapter outlines details for implementing the TSP, which is full removal of nine dams on the Fox River. Plan implementation details include sequencing, environmental assessment findings, mitigation requirements, permit requirements, agency and stakeholder views, project schedule, total project costs, and cost sharing requirements.

5.1 NER Plan Implementation & Sequencing

The number and order in which dams are removed is not relevant since 1) the functionality of the each dam is not dependent on, nor does it influence the other dams; and 2) each dam is an individually-justified separable element. In addition, the implementation and sequencing at each dam will vary slightly due to differences in construction and material type at each dam, and as a result of available work area, proximity of nearby structures, access, and other aspects related to removal. The paragraphs below discuss the general aspects of implementation at each dam, but *Appendix B: Civil Design* provides a more detailed discussion of the implementation and sequence of events specific to each dam.

5.1.1 Site Preparation

The first actions for construction would be to properly alert local agencies and the area community that work is starting. This would be followed by the contractor setting up staging and access areas and then mobilizing equipment and materials to the site. The construction site and any staging/storage areas would have exclusionary fencing, depending on local requirements and necessities. The construction site and supporting areas would also have signage to indicate the federal project, as well as agencies and contractors participating.

5.1.2 Dam Demolition

Dam removal procedures typically start by creating a shallow notch at the top of the dam to slowly draw the water down. Hydraulic equipment such as excavators (equipped with a breaker or jack hammer) would be used to break and remove dam material while maintaining a low draw through the structure. This process of breaking and removal would continue until the dam has been removed down to the channel bottom.

5.1.3 Recycling & Disposal

All debris associated with the dam removals will be disposed of or recycled offsite.

5.1.4 Best Management Practices

Soil erosion and sediment control measures will be tailored during the design phase and will comply with local, state, and federal environmental requirements. Typically, a sediment and wastewater plan is developed by the contractor that complies with state regulations. The minimum measures required at the project site may include:

- Installation of silt fences around graded slopes and stockpile areas
- Surface water isolation of areas utilized to manage removed materials
- Stabilization of construction entrances to limit soil disturbance at the ingress/egress from the site

- Installation of erosion blankets over unprotected finished grades that are to be unplanted for at least two weeks, but not within the river's flood zone as the blankets would be washed away.

5.2 Real Estate Considerations

The current non-federal land, easements, rights of way, relocations and disposal (LERRD) credit is estimated to be $984,100. Details are provided in *Appendix G: Real Estate*.

5.3 Permit Requirements

The following required permits are anticipated to be needed and will be obtained prior to implementation:

401 Water Quality Certification – The TSP would not result in any discharge into wetlands, navigable waters, or waters of the US, therefore, a section 401 water quality certification is not required.

5.4 Monitoring & Adaptive Management Plan

Section 2039 of WRDA 2007, 33 U.S.C. § 2330a, as amended, directs the Secretary to ensure that when conducting a feasibility study for a project (or a component of a project) for ecosystem restoration that the recommended project can include a plan for monitoring the success of the ecosystem restoration for a period of up to ten years from completion of construction of an ecosystem restoration project. This monitoring shall be cost-shared:

(a) In General - In conducting a feasibility study for a project (or a component of a project) for ecosystem restoration, the Secretary shall ensure that the recommended project includes, as an integral part of the project, a plan for monitoring the success of the ecosystem restoration.
(b) Monitoring Plan - The monitoring plan shall--
(1) include a description of the monitoring activities to be carried out, the criteria for ecosystem restoration success, and the estimated cost and duration of the monitoring; and
(2) specify that the monitoring shall continue until such time as the Secretary determines that the criteria for ecosystem restoration success will be met.
(c) Cost Share - For a period of 10 years from completion of construction of a project (or a component of a project) for ecosystem restoration, the Secretary shall consider the cost of carrying out the monitoring as a project cost. If the monitoring plan under subsection (b) requires monitoring beyond the 10-year period, the cost of monitoring shall be a non-federal responsibility.

(d) Inclusions - A monitoring plan under subsection (b) shall include a description of--
(1) the types and number of restoration activities to be conducted;
(2) the physical action to be undertaken to achieve the restoration objectives of the project;
(3) the functions and values that will result from the restoration plan; and
(4) a contingency plan for taking corrective actions in cases in which monitoring demonstrates that restoration measures are not achieving ecological success in accordance with criteria described in the monitoring plan.
(e) Conclusion of operation and maintenance responsibility - The responsibility of a non-Federal interest for operation and maintenance of the nonstructural and nonmechanical elements of a

project, or a component of a project, for ecosystem restoration shall cease 10 years after the date on which the Secretary makes a determination of success under subsection (b)(2).
(f) Federal obligations - The Secretary is not responsible for the operation or maintenance of any components of a project with respect to which a non-Federal interest is released from obligations under subsection (e).

5.4.1 Monitoring Objectives

To evaluate the overall effectiveness of the project and to determine if the specific planning objectives are met, the following monitoring specifics are proposed which are focused on fish species and habitat aspects of the restoration. All restored segments of river would be monitored as specified below, one time every other year, and for ten years (5 times) following completion of the project.

5.4.1.1 Objective 1 – Reestablish Fluvialgeomorphic Processes to Support Riverine Habitat

Currently, the Fox River within the study area is impaired by 10 run-of-the-river dams, and therefore there is no natural recovery mechanism. These impairments are specific to impeding riverine hydraulics, sediment transport and substrate sorting, resulting in a loss of structural habitat heterogeneity. This objective seeks to return these riverine functions to restore and sustain habitat within the Fox River study area. The targeted location of these effects would be in the segments of river that are currently impounded. These effects would be sustained over the life of the project and optimistically in perpetuity. Improvement is measured via the predicted increase in quality of riverine habitat (QHEI).

The QHEI methodology for this study is described in Section 2.5.1. The ILDNR will utilize the protocol developed by Ohio EPA to collect data and score QHEI sites for the impounded and free-flowing segments of the river. Data parameters that would be assessed for this portion of the monitoring include:

1. Substrate
2. In-stream Cover
3. Channel Morphology
4. Riparian Zone and Bank Erosion
5. Pool/Glide and Riffle-Run Quality
6. Reach Gradient

5.4.1.2 Objective 2 – Reestablish Connectivity for Riverine Animal Assemblages

Currently, the Fox River study area has 70% of its river miles impounded by run-of-the-river dams. Aside from imparting adverse fluvialgeomorphic and water quality (habitat) impacts on the system, these dams also effectively block the migration of fish, mussels, and certain macroinvertebrate species. The effect desired by meeting this objective is to increase passage for all riverine organisms that require it. The targeted location of these effects would be in the segments of river that are currently impeding the passage of aquatic organisms. These effects would be sustained over the life of the project and optimistically in perpetuity. This objective seeks to reestablish passage for riverine organisms within the Fox River study area. Improvement is measured via the predicted increase in distribution and species richness of fishes as depicted by Figure 8.

Fish Assemblage

Fish species richness, abundance, and distributions would be monitored for this objective by the ILDNR utilizing State of Illinois protocols for the IBI. Special attention would be paid to the two listed fish species, the Greater Redhorse and River Redhorse.

Mussel Assemblage

Mussel species richness, abundance, and distribution would be monitored for this objective by the Illinois Natural History Survey in conjunction with the ILDNR. Methods, locations and time will be replicative of those conducted for the pre-restoration survey as outlined in Tiemann et al 2007. Special attention would be paid to the two listed mussels, the Purple Wartyback and Ellipse.

Adaptive Management

Adaptive management measures are not the same as typical operation and maintenance activities described in the following section. These measures are response actions to changes that adversely affect how the system was predicted to respond. By taking an adaptive approach, no absolute measures can be defined prior to issues arising. The primary concerns for this project are restoration of riverine connectivity and habitat. Descriptions of adaptive management measures below are brief and will be further detailed during the design phase. This is necessary since the adaptive management measures will need to be based upon contracting bid items, final feature designs, and predicted adverse responses. It is also noted that these measures have relatively low costs to regain lasting benefits.

Options would be placed in the contract for future adaptive management measures that could be exercised at any point of the contract duration, but most likely in years 2 and 3. These may include but are not limited to changing or adjusting features to achieve the required hydrology, hydraulics and/or geomorphology; additional native plant treatments; or other improvements. All adaptive management decisions and exercising of contract options would be driven by monitoring. To be conservative, three adaptive management options would be included under this measure for high, medium and low adaptive adjustment needs. Potential adaptive management actions may include constructing cobble bars, woody deflectors, rock vanes, j-hooks, or other structures that would abate problematic erosion caused by the removal of the dams, yet still facilitate improved upstream fish passage. These would be Option A – for more intensive adjustments of geomorphology or hydrology $150,000; Option B – for more moderate adjustments of habitat and/or additional plantings $75,000; Option C – for minor habitat adjustments or additional plantings $10,000.

5.5 Operation & Maintenance

A detailed O&M manual containing all the duties required to maintain the completed project would be provided to the non-federal sponsor after construction is closed out. The O&M requirements are anticipated to be minimal due to initial project design efforts and design targets for naturalization and sustainability. Most O&M activities are no different than those activities that would take place during construction. The O&M described here is not the same as the Adaptive Management measures described in the previous section. The O&M costs of the project are estimated to an average annual cost of $500 per dam with a 2.5% interest rate over 50 years; There are no specific O&M activities anticipated, but minimal costs have been included to address unforeseen minor issues.

5.6 NEPA Compliance

The CEQ guides public participation opportunities with respect to feasibility reports and environmental assessments, engineering regulations, and procedures for implementing NEPA. The study was determined to be in compliance with NEPA and all other appropriate statutes, executive orders and memoranda. Coordination and compliance for this feasibility study and integrated environmental assessment included comprehensive public involvement, agency coordination, and review of compliance with applicable federal statutes.

5.6.1 Mitigation Requirements

No mitigation is required to implement the TSP.

5.6.2 Public/Agency Comments & Views

5.6.2.1 Public and Agency Review of the Draft EA (60-days)

The draft IPIR/EA will be available for public and agency review from September 5, 2023 until November 5, 2023. Comments will be addressed in this section of the report and will be included in the *Appendix A: Compliance, Coordination & Information*.

5.6.2.2 Public Meetings on the Draft EA

Public meetings will be held within the study area to provide an opportunity for the public to provide comments and ask questions about the planning process and the TSP.

5.6.2.3 Publication of the Finding of No Significant Impact (FONSI)

Upon completion of the public and agency review and public meetings, and if no significant impacts are anticipated as a result of the TSP, the FONSI would be signed and published on the District webpage.

5.7 Project Schedule & Costs

Table 26: Tentative project schedule

Schedule Item	Completion Date
Feasibility Report Approved	January 2025
Project Partnership Agreement (PPA) Signed*	April 2025
Develop P&S	May 2025 – October 2026
Contract Award	January 2027
Implementation Complete	January 2030

* Implementation dependent on authorization of construction appropriations for the project.

5.7.1 Total Estimated Project Costs

Total estimated project costs include costs for study, design, implementation, contingencies, construction management, engineering during construction (EDC) and project management. Costs for design and management are estimated based on a percentage of estimated implementation costs and contingencies. These costs will be revised prior to the execution of a Project Partnership Agreement (PPA) and actual costs for these activities will be used to conduct final cost sharing accounting during project close-out. Total project costs were escalated to the mid-point of estimated construction using factors contained in EM 1110-2-1304, Civil Works Construction Cost Index System (CWCCIS). Table 27 provides a summary of the fully funded project costs for the TSP. Using the fully funded escalated costs and the implementation schedule, a summary of funding requirements by fiscal year was developed as presented in Table 28.

Table 27: TSP total estimated costs ($1,000s)

Item	Cost
Planning	$600
Design	$450
Construction	$14,100
Monitoring and Adaptive Management	$75
Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas	$909
Total	$15,834
Feasibility Study Breakout	
Federal Share	$390
Non-Federal Share	$210
WIK	$0
Cash	$210
Ecosystem Restoration Breakout (Design, Construction, Monitoring)	
Federal Share	$9,165
Non-Federal Share	$4,935
WIK	$UNK
LERRDs	$909
Cash	TBD
OMRR&R*	$0.5

Table 28: TSP cost apportionment ($1,000s)

Item	Cost	FY22	FY23	FY24	FY25
Integrated Feasibility Report	$ 600	$ 200	$ 250	$ 150	
P&S	$ 450	-	-	$ 200	$ 250
Construction	$ 14,400	-	-	-	$ 14,400
Monitoring	$ 75	-	-	-	$ 75
LERRDs	$ 909	-	-	-	$ 909
Total	$ 18,078	$ 200	$ 250	$ 350	$ 17,278
Total Fed	$ 11,751	$ 130	$ 163	$ 228	$11,231
Total Non-Fed	$ 6,327	$ 70	$ 87	$ 122	$ 6,047

5.7.2 Financial Capability of Non-Federal Sponsors

In accordance USACE Planning Guidance, where the non-federal sponsor's capability is clear, as in the instances where the sponsor has sufficient funds currently available or has a large revenue base and a good bond rating, the statement of financial capability need only provide evidence of such. The non-federal sponsors are committed to their specific cost share of the design and implementation phases and have expressed willingness to share in the costs of construction to the extent that can be funded.

5.7.3 Items of Local Cooperation

As established in PL 99-662, as amended, project costs are shared with the non-federal sponsor in accordance with project outputs. The Illinois Department of Natural Resources has agreed to serve as the non-Federal cost-sharing sponsor for the project through design and implementation. Prior to signing a Project Partnership Agreement (PPA), authorization of federal construction appropriations for the project must occur. The cost-sharing requirements and provisions will be formalized with the signing of the PPA prior to initiation of design and implementation activities. Federal implementation of the final recommended plan includes, but is not limited to, the following required items of local cooperation to be undertaken by the non-federal sponsor in accordance with applicable federal laws, regulations, and policies:

a. Provide the non-federal share of project costs including 35 percent of construction costs allocated to ecosystem restoration, as further specified below:

   i. Provide, during design, 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

   ii. Provide all lands, easements, and rights-of-way, including those required for relocations and placement areas, and perform all relocations determined by the Federal Government to be required for the project; and

   iii. Provide, during construction, any additional contribution necessary to make its total contribution equal to 35 percent of construction costs.

b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function;

c. Ensure that the project or lands, easements, and rights-of-way required for the project shall not be used as a wetlands bank or mitigation credit for any other project;

d. Operate, maintain, repair, rehabilitate, and replace the project or functional portion thereof at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal laws and regulations and any specific directions prescribed by the Federal Government;

e. Hold and save the Federal Government free from all damages arising from design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project, except for damages due to the fault or negligence of the Federal Government or its contractors;

f. Perform, or ensure performance of, any investigations for hazardous toxic, and radioactive wastes (HTRW) that are determined necessary to identify the existence and extent of any HTRW regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. §9601-§9675, and any other applicable law, that may exist in, on, or under real property interests that the Federal

Government determines to be necessary for construction, operation, and maintenance of the project.

g. Agree, as between the Federal Government and the non-federal sponsor, to be solely responsible for the performance and costs of cleanup and response of any HTRW regulated under applicable law that are located in, on, or under real property interests required for construction, operation, and maintenance of the project, including the costs of any studies and investigations necessary to determine an appropriate response to the contamination, without reimbursement or credit by the Federal Government;

h. Agree, as between the Federal Government and the non-federal sponsor, that the non-federal sponsor shall be considered the owner and operator of the project for the purpose of CERCLA liability or other applicable law, and to the maximum extent practicable shall carry out its responsibilities in a manner that will not cause HTRW liability to arise under applicable law; and

i. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. §4630 and §4655) and the Uniform Regulations contained in 49 C.F.R. Part 24, in acquiring real property interests necessary for construction, operation, and maintenance of the project including those necessary for relocations, and placement area improvements; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

6 RECOMMENDATION

I have considered all significant aspects of the problems and opportunities as they relate to restoring natural riverine processes within the Fox River study area for native fish, wildlife, and plant communities. Those aspects include environmental, social, and economic effects, as well as engineering feasibility.

I recommend *Alternative Plan 2 - Full Dam Removal*, which consists of establishing diverse self-sustaining and connected reaches of the Fox River. Alternative 2 is the National Ecosystem Restoration (NER) Plan. The recommended plan has an estimated total project cost of approximately $15,834,000 (2023 price levels) and provides 297 net average annual habitat units over approximately 55 miles of riverine habitat. All costs associated with the Fox River Connectivity and Habitat Restoration project have been considered.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch.

Kenneth P. Rockwell
Colonel, U.S. Army
District Commander

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