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Fox River Fish Passage Feasibility Study

Summary Report

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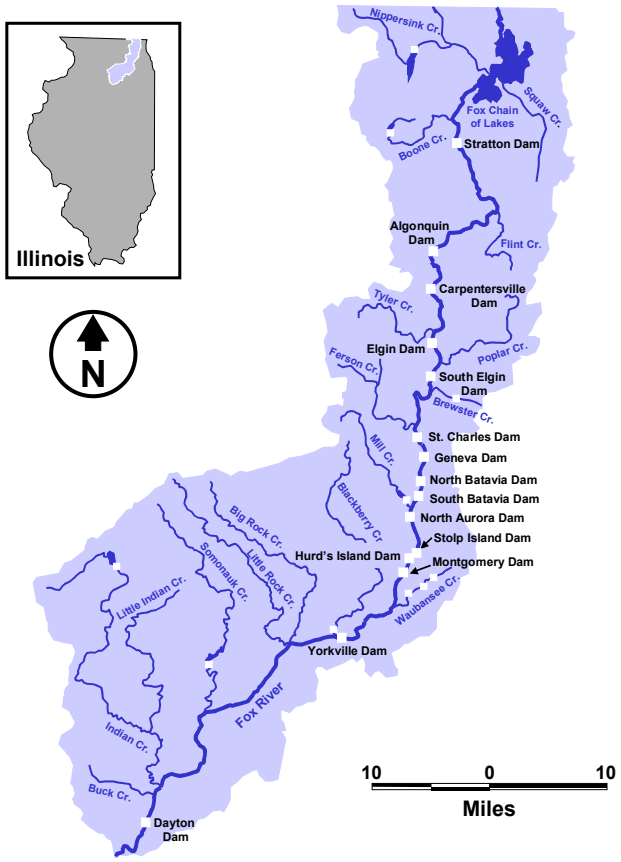
Draft Summary Report

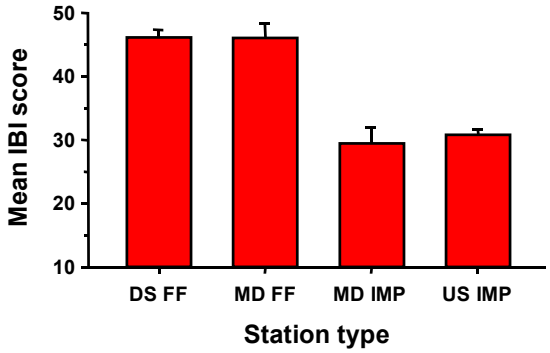


Fox River watershed, tributaries, and dams in Illinois.

The Fox River and its surrounding watershed are highly valued ecological and recreational resources. Currently, there are 15 dams on the river's mainstem in Illinois and numerous smaller dams on tributaries. Many of these dams were originally built in the 1800's to provide mechanical power for grist and lumber mills and have since been rebuilt to maintain the flat water ponds or impoundments that form upstream of the dam. Although extremely important in their time, most dams today serve no functional purpose. The Fox River Ecosystem Partnership (FREP) has identified dam removal or modification as an important watershed management tool to effect recovery of the Fox River ecosystem.

This report presents the results of a two-year study of approximately 100 miles of river and 15 mainstem dams located between McHenry and Dayton, Illinois. The report is divided into two main sections and a series of appendices. In Part A, we used historical and current data to determine the effect of dams on the ecological health of the river. Specifically, we examined fish and invertebrate communities, aquatic habitat, and water quality. In Part B, we discuss 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 results from public seminars and a study evaluating use of the Aurora canoe chute and Stratton fishway by migrating fish.

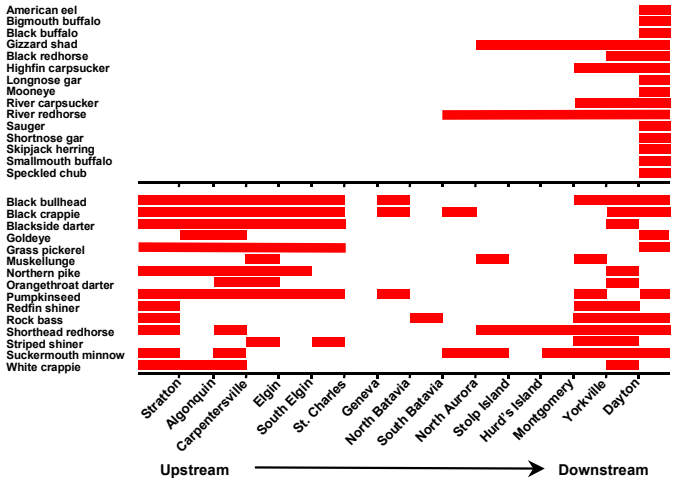
To determine the effects of dams on river ecology, we used IDNR and IEPA approved methodologies to sample fish, macroinvertebrates, and aquatic habitat during July through early September 2000 at 40 stations within the study area. Stations were located directly above (US IMP) and below (DS FF) each of the 15 Fox River dams and at 10 mid segment locations in impounded (MD IMP) and free-flowing (MD FF) areas between dams. Water quality sampling took place during August and September 2001 at 11 free-flowing and 11 impounded stations and 6 to 9 transects spaced throughout four river segments. Sampling included continuous monitoring (readings every 15 min.) of temperature, dissolved oxygen, conductivity, and pH during 16-, 40-, and 960-hour sampling periods, spot sampling to determine horizontal and vertical variation in these measured parameters, and grab sampling to assess nutrients (phosphorus and nitrogen), algal biomass, (chlorophyll a), total suspended solids, and turbidity. In addition, we quantified macrohabitat (impounded reaches, free-flowing reaches, natural pools, riffles, runs, aquatic vegetation, islands, and streamside wetlands) within the study area and determined the quantity, particle size, and toxic chemical characteristics of bulk sediments accumulated behind dams.



Higher quality non-game and sport fish communities occurred in natural flowing portion of the river compared to areas impounded by dams.

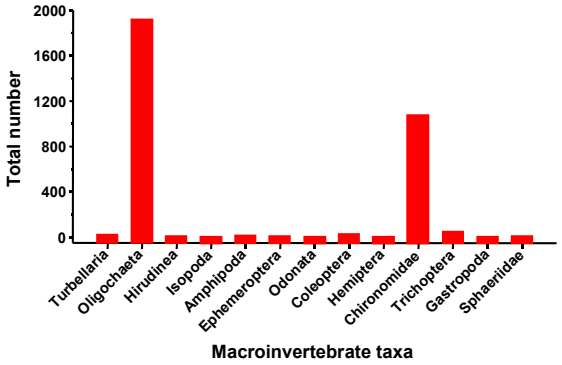
The distribution of fish species among station types during summer indicated that most fishes favored free-flowing portions of river over impounded areas created by dams. Further, we found higher quality fish communities in the free-flowing river. Index of Biotic Integrity (IBI) scores in free-flowing areas averaged 46, which indicates a "B" quality stream or highly valued aquatic resource. In contrast, mean IBI scores for impounded areas were below 31, indicating a "D" quality stream or limited aquatic resource. On average, the natural flowing river had more species, four times the number of individuals, double the number of harvestable-sized sport fish, more suckers, darters, and intolerant fishes (including the state threatened river redhorse), a higher percentage of insectivorous minnows, 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, bluntnose minnow, quillback, and green sunfish. The adverse effects of impoundment on non-game and sport fish communities extended well upstream of the dams. Similarly, high quality fisheries were not confined to reaches immediately below dams but extended throughout free-flowing areas.

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. Data from 1980 to the present showed thirty species of fish having either truncated (only found in the lower river) or discontinuous distributions (absent from the middle river). Sauger, American eel, skipjack herring, mooneye, speckled chub, longnose gar, shortnose gar, and three species of buffalo were collected only below the lowest dam (Dayton), which is located 5.6 miles above the Illinois River confluence. The 15 species with discontinuous distributions were absent from the river between St. Charles and Montgomery. This is a highly urbanized section with 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.).



Dams have restricted distributions of 30% of Fox River fishes.

Free-flowing reaches supported higher quality macroinvertebrate communities than impounded waters above dams. Mean macroinvertebrate condition index scores (MCI; a multimetric index developed for the Fox River) for stations in free-flowing habitat were more than twice as high as scores for stations in impounded areas. Free-flowing areas typically had higher abundance and richness of mayflies and caddis flies (EPT taxa), more intolerant taxa, lower Macroinvertebrate Biotic Index (MBI) scores, and a higher percentage of clinger organisms than the wadable portions of impoundments. Densities of Chironomini midges, hydropsychid caddis flies, baetid mayflies, and the flatworm *Dugesia tigrina* often were extremely high immediately below dams due to nutrient enrichment and high plankton production in impoundments. Differences between free-flowing and impounded habitats were even more pronounced when we considered samples from open-water impounded areas.



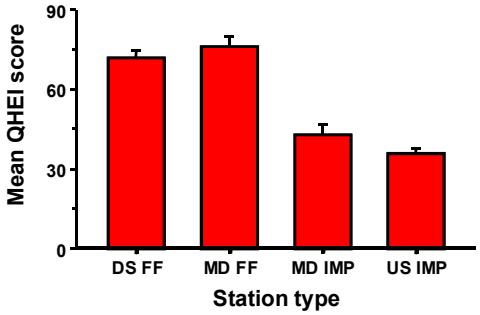
Tolerant aquatic worms and midge larvae were the primary macroinvertebrates found in open water areas of impoundments.

Tolerant chironomid larvae and aquatic worms (Oligochaeta) combined to make up over 95% of the organisms sampled from offshore areas of impoundments.

Dams may be preventing freshwater mussels from reestablishing populations in areas where they once were abundant. Although a few large mussel beds exist in the Fox River today, a recent IDNR survey indicates that freshwater mussel diversity and abundance currently is low compared to historical samples. Most mussel species rely on fish to expand their distributions because glochidia (mussel larvae) attach to fish for a period of time in their development. By fragmenting habitat and restricting fish movement, dams in turn may be restricting distributions of this state and nationally imperiled group of invertebrates.

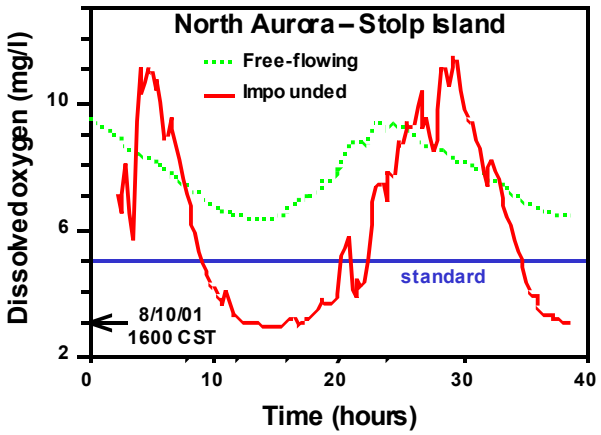
The quality of aquatic habitat available to fish and invertebrate communities differed substantially between free-flowing and impounded portions of river. QHEI and SHAP habitat indices indicated that habitat at free-flowing stations was of good quality whereas habitat in impounded areas was rated as severely degraded by QHEI and fair to poor by SHAP. In free-flowing areas, there were a variety of water depths, current velocities, and substrate types, abundant cover for fish and invertebrates, and good quality riffle and run habitat. Habitat in impounded areas was more lake-like in that water depths were more uniform and deep, current velocity was low, fine silt deposits were high, and riffles and runs were absent. Habitat quality had a strong positive relation to the quality of fish and macroinvertebrate communities underscoring the importance of habitat to aquatic biota in the river.

Impoundments tended to accumulate large quantities of fine sand and silt, particularly downstream of islands, along impoundment margins, and in the region closest to the dam. The volume of fine grain sediments accumulated in impoundments approximately 1,000 ft. above each Fox River dam was estimated to be between 10,500 (Montgomery Dam) and 292,000 (Elgin Dam) cubic yards. Results of core and surface sediment samples showed undetectable or low levels of heavy metals, PCBs, polycyclic aromatic hydrocarbons (PAHs), organochlorine pesticides, cyanide, endocrine disruptors, oil and grease. Upstream reaches of many impounded areas accumulated little silt and maintained substrates typical of the free-flowing river.



Habitat quality was rated "good" in free-flowing reaches and "severely degraded" throughout impounded areas.

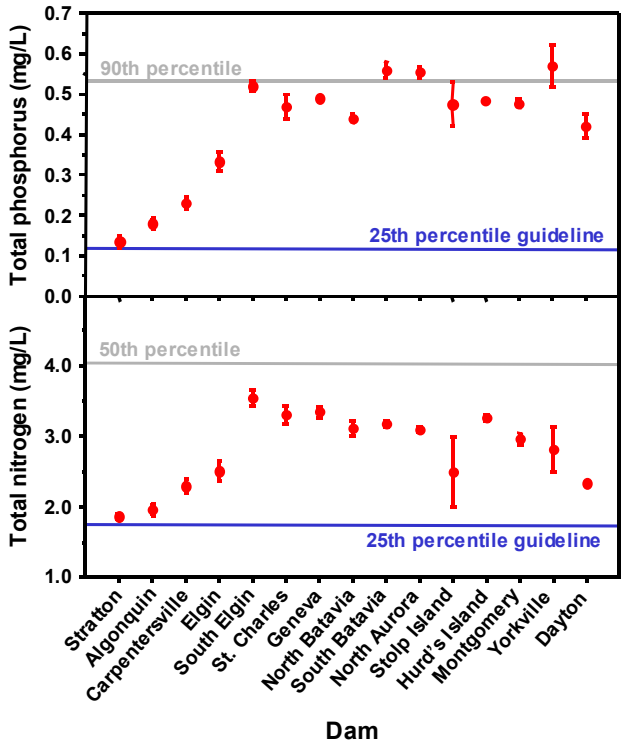
Like habitat, water quality conditions varied between the impounded and free-flowing river. Dissolved oxygen concentrations fluctuated widely on a daily basis in impounded areas (2.5 to >20 mg/L), but not in free-flowing areas (5 to 10 mg/l). These wide fluctuations resulted in violations of the IEPA standard for dissolved oxygen (<5 mg/L) at 9 of 11 impounded stations, but only 2 of 11 free-flowing stations. Substandard 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). Maximum pH values were at or above the upper IEPA standard of 9.0 units at 8 of 11 impounded stations and 4 of 11 free-flowing stations. Maximum pH tended to occur during early evening sampling when oxygen concentrations were at highly supersaturated levels. The duration of



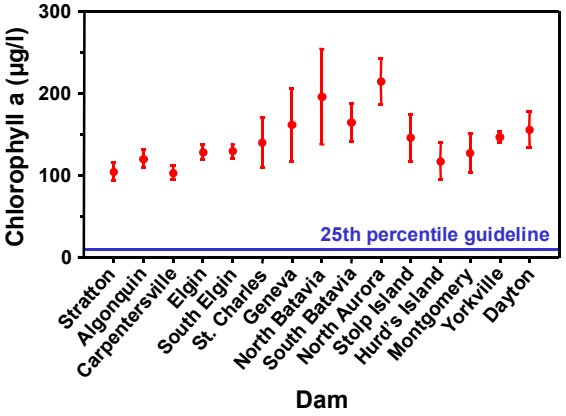
Differences in dissolved oxygen concentrations existed between free-flowing and impounded portions of river. Substandard D.O. was widespread in impoundments, but occurred infrequently in free-flowing areas.

elevated pH in a 24-hour period ranged from less than 1 hour at Stolp Island to 11.75 hours in Yorkville and 24 hours in Dayton.

Although not acting alone, impoundments created by dams played an important role in the widespread occurrence of substandard water quality in the Fox River. Our data indicate that most of the river carries a high nutrient load during low flow periods. Total phosphorus and nitrogen were near recommended 25th percentile guidelines at Stratton Dam (high fertility zone Midwestern streams; 0.11 mg/L phosphorus, 1.75 mg/L nitrogen), but were extremely high at all stations below Elgin (~0.50 mg/L phosphorus or 90th percentile; ~3.0 mg/L nitrogen or 50th percentile). High nutrient levels and the lake-like environments that occurred above dams combined to produce excessive algal biomass. Chlorophyll α, an indicator of algal biomass, was extremely high at all sampling stations (75 to 275 µg/L) relative to recommended 25th percentile guidelines (7.3 µg/L). This high algal biomass, in turn, influenced dissolved oxygen and pH through daytime photosynthesis (oxygen is produced) and nighttime respiration (oxygen is consumed). Decomposition of organic material from sediments accumulated in impoundments also may have contributed to low oxygen levels. Through physical processes dams added oxygen to the river at night and caused oxygen to be released to the atmosphere during the day. However, the overall effect of water flowing over dams during a 24-hour period was a net loss in oxygen from the river.



Elevated nutrient levels occurred in the Fox River below Elgin.



Chlorophyll α (an indicator of algal biomass) was high throughout the river.

Dissolved oxygen did not reach concentrations low enough to kill fish directly, but it may partially explain the predominance of tolerant species of fish and invertebrates in impoundments. Further, highly fluctuating oxygen levels and extended periods of substandard oxygen and pH occurred at a time of year when other stressors, such as high turbidity, low discharge rates, and high water temperatures might adversely affect fish and invertebrates. Whether from single or multiple sources, stress can

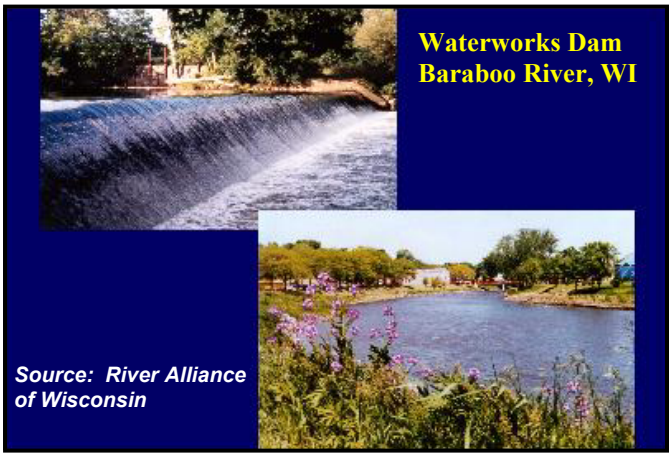
indirectly cause mortality by depressing immune system response and increasing susceptibility to epizootic bacterial or viral infections. A stress-induced epizootic event probably was responsible for a widespread channel catfish die-off that occurred throughout the Fox River during summer 2000.

A Fox River channel catfish with a large lesion and eroded barbells.

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. We found that dams impounded 47% of the river's length and 55% of its surface area between Chain of Lakes and Dayton, Illinois. This high density of impounded habitat suggests that improvements to the ecological health of the river would be realized if some dams were removed and riverine habitat was restored. Further, dams prevented 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. Similarly, the Fox River is the third largest tributary to the Illinois River, yet the Dayton Dam prevents access by Illinois River fish to all but the lower 5.6 miles of this important resource.

Based on the strong and consistent nature of our results, we recommend reconnecting the river through the removal or modification of all mainstem and tributary dams. Benefits of a reconnected river may include: elimination of barriers to canoeists and kayakers, enhanced habitat and water quality conditions and corresponding improvements to fish and macroinvertebrate communities, improved access by Fox River and Illinois River fish to important spawning and nursery habitats in tributaries and stream-side wetlands, repopulation of areas where certain species of fish and mussels no longer exist, genetic mixing in fish and invertebrate populations isolated by dams, and improved recreational fishing opportunities provided by enhanced sport fish populations and seasonal migrations of fishes, such as walleye, northern pike, muskellunge, sauger, white bass, skipjack herring, and large sucker species.

Options to reconnect the river include: removing dams completely, lowering dams and ramping the remaining structure, constructing traditional fishways (e.g., Denil fishways), and constructing fish/canoe bypass channels. In many cases, we present more than one option for individual dams. Dam removal is the best option when the ecological health of the river is of prime consideration because removing dams will eliminate barriers to migration for all types and sizes of fish, restore high quality river habitat, and improve water quality. In addition, dam removal is relatively inexpensive compared to other options presented and it eliminates safety risks (people drown at dams) and maintenance costs because the structure is gone.



Dam removal is the best option to reconnect the river when ecological and safety benefits are of prime importance.

Roughened ramps may be most appropriate in tributary streams when dams must remain in place.

Lowering and ramping dams provides for reconnection of the river by allowing most fishes to pass upstream and paddle craft downstream, but it does little to improve degraded water quality and habitat conditions. This option probably is not feasible at most dams on the Fox River because they are long (>250 ft.) and the amount of fill (small and large boulders) needed to build a ramp at the proper slope (5%) may be cost prohibitive or unacceptable to regulating agencies. Ramping may be a suitable option for small tributary dams when removal is not an acceptable option.

Fishways and bypass channels will allow many (not all) fish to navigate over or around dams, but will do nothing to improve habitat and water quality conditions in the river. Priority species targeted for fishways or bypass channels include channel catfish, flathead catfish, muskellunge, northern pike, white bass, smallmouth bass, sauger, walleye, goldeye, mooneye, skipjack herring, redhorse suckers (golden, silver, shorthead, and the Illinois threatened river redhorse), buffalos (smallmouth, bigmouth, and black), carpsuckers (highfin and river), and northern hog sucker. Fishways have associated operational and maintenance costs and are relatively expensive to build (~$1,600/linear ft. for Denil fishways). Fishways and bypass channels should be considered only when dam removal is ruled out as a fish passage option.

Properly designed Denil fishways will pass fish like those found in the Fox River over dams, but they do nothing to improve habitat or water quality.

Bypass channels look natural and can be designed to pass fish upstream and canoes downstream. Like fishways, bypass channels do nothing to improve habitat or water quality.

The Fox River is an important ecological and recreational resource that is worthy of restoration efforts. Based on past work in Wisconsin, dam removal is likely the most cost effective and practical restoration technique available today. Reconnecting the Fox River with fishways and bypass channels at dams also will provide substantial improvement over existing conditions, but these options are less beneficial than dam removal. Although potential benefits are high, removing and modifying dams will not address all problems affecting the river. Additional watershed management practices, such as incorporating Best Management Practices (BMP's) in rural areas, protecting tributaries and wetlands from development, and reducing input of nutrients and non-point source pollutants, will be necessary to ensure that the Fox River remains a vital natural resource for future generations.