Overview of the Fox River and the ecological consequences of dams on the Fox River ecosystem

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In the following presentation, I would like to accomplish two main tasks:
1) provide an overview of Fox River ecology, and
2) describe the threats the Fox River faces, including an in-depth discussion of the ecological effects of dams on the Fox River.

An overview of Fox River ecology

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Many of these facts came from the publication "Critical trends in Illinois Ecosystems" by the Illinois Department of Natural Resources in 2001
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Basic facts

The Fox River runs through the states of Wisconsin and Illinois – it originates in southwest Wisconsin, near Menomonee Falls, Wisconsin (70 river miles in Wisconsin) and joins the Illinois River in Ottawa, Illinois (115 river miles in Illinois)

- it is the third largest tributary of the Illinois River

- the watershed drains an area of 940 square miles in Wisconsin and 1,720 square miles in northeastern Illinois (drains 1,092,871 acres in Illinois)

- the watershed includes the counties: McHenry, Lake, DeKalb, Kane, Cook, DuPage, LaSalle, Lee, Kendall, Will, and Grundy

What is a watershed?

- a watershed is the land that water flows over and through on its way to a stream, river, or lake.

The Fox River watershed in Illinois can be divided into many smaller watersheds

Minor watersheds of the Fox River

Tributary	*Drainage area (square miles)*
Nippersink	205
Squaw	46
Boone	23
Flint	37
Poplar	44
Tyler	40
Brewster	
Ferson/Otter	54
Mill	31
Waubonsee	30
Blackberry	73
Big Rock/Little Rock	194
Somonauk	88
Indian/Little Indian	264
Buck	41

The majority of the Fox River watershed is used for agriculture and there is rapid expansion of urban areas taking place.

Compared to the rest of the state, the Fox River watershed has less forest and agricultural land and more wetland.

- There is a large number of bog communities in the watershed

- Four of the state's five types of fen communities are found in the watershed (e.g., Nelson Lake Marsh in Batavia).

- Land cover is 50% cropland, 17.3% urban/built-up, 17% grassland, 10.3% upland and bottomland forest, and 5.4% non-forested wetlands and other water.

a) The Fox River has three major segments: upper, middle, and lower

b) The upper portion of the watershed contains the most diverse land cover and the most lakes and wetlands. It is the most pristine part of the watershed

c) The middle portion of the watershed contains the most urban land and development. It flows through six Kane County cities with populations ranging from 15,000 to 100,000

d) The lower portion contains the most row crops and grasslands

-The major population centers along the Fox River are Elgin and Aurora.

The Fox River watershed is a valuable natural resource

Fox River watershed contains 48 nature preserves & 118 natural areas comprising over 20,000 acres

The Illinois portion of the Fox River watershed supports a substantial and diverse plant and animal community

For example,

Of the ~1,400 species of native plants in Illinois, 40% are found within the watershed

- 102 species are listed on the state's endangered or threatened list and there are two federally threatened species

- plants range from the carnivorous pitcher plants and sundews to white and yellow lady's slipper orchids

Of the ~300 species of breeding birds in Illinois, 50% breed in the watershed including 30 state threatened or endangered species

- birds range from king rail to sandhill crane to red shouldered hawk

Many mammals found in the watershed are common throughout the state, but the pygmy shrew has only been collected in the Fox River area

96 species of fish have been found in the Fox River watershed, including two state endangered species (weed shiner and greater redhorse) and one state threatened species (river redhorse); sportfishing is plentiful

32 species of freshwater mussels have been found in the Fox including five state endangered or threatened species: spike, slippershell, sheepnose, wavy-rayed lampmussel, and rainbow

The Fox River watershed contains 18 lakes and stream segments that have been recognized as biologically significant because they support threatened or endangered species or have high mussel and fish diversity

- Biologically significant Tributaries include: Buck Creek, Morgan Creek, N. Branch Nippersink Creek, and Yorkville tributary

- Biologically significant Glacial Lakes include: Bangs, Cedar, Cross, Crystal, Deep, E. Loon, Grays, Lily, McCullom, Round, Sullivan, Turner, W. Loon, and Wooster

The northern region of the Fox River watershed containing Chain O' Lakes is considered a "Resource Rich Area"

- The Chain O' Lakes encompasses the area of most recent glaciation in Illinois.

a) Natural features include glacial landforms, natural lakes, and many types of wetlands.

b) Some rare species and communities are limited to this part of the state.

Current Protection

The Fox River watershed is receiving protection for this natural resource

- Over 20,000 acres of natural areas and nature preserves

- Governments and citizens are developing watershed-based approaches to evaluate and reduce impacts of human activities on Fox River habitats (i.e., Fox River Ecosystem Partnership, local watershed groups [Batavians for a Healthy River Committee])

- Citizens groups are monitoring the Fox River and its tributaries (i.e., Illinois Ecowatch, Friends of the Fox River)

Concerns for the Fox River Ecosystem

In 1999, American Rivers, a nonprofit conservation organization dedicated to protecting and restoring rivers nationwide, listed for a single year the Fox River as the 7th most endangered river in the United States.

- While water quality in the Fox River has improved since the 1960's, it was placed on the list partially as a result of predicted suburban/urban sprawl

In 2002, the Illinois Environmental Protection Agency categorized the entire Fox River as "impaired."

- In 1999, only 3 stretches of the Fox River totaling less than 20 miles were added to the impaired list

Threats to the Fox River Ecosystem

Human population

- about 11% of Illinois' human population lives in Fox River basin

- 8 million people live within 100 miles of the Fox River's banks

- from 1990 to 2010 there is expected to be a 74% increase in population of Kane County, and 34% increase in entire Fox River Valley

Increased human population leads to

1) increasing paved surfaces and other impermeable structures - deliver more flood waters to the Fox and its tributaries

   - During the last 20 years, nearly 1,100 miles of new roads have been built and urbanized acreage has expanded 25% in the last 10 years in the Chicago Metropolitan area

   - increasing volume and velocity of water, in turn, tears up stream banks, covering stream bottoms with sediment (as a result of increased erosion and stream bank destabilization)

2) increasing polluted runoff comes from these same impermeable surfaces such as roads, rooftops, and parking lots, as well as lawns and animal wastes. Siltation occurs as a result of erosion from construction activities.

- impermeable structures lead to high nutrient loss from the soil because rainwater is not absorbed by soil, rather it flows to river

- the effect of polluted runoff is intensified by a lack of riparian/floodplain vegetation surrounding the river

3) increasing traffic volume leads to increases in oil, gas, and salt runoff

- In the last 20 years, vehicle miles traveled have grown 75% in the Chicago metropolitan area

4) increasing industrial discharges and polluted sewage wastewater being released directly into rivers and streams

- wastewater treatment standards have greatly improved the quality of the river since the early 1960's, reducing phosphorous concentrations. However, if wastewater treatment is not changed in the upcoming decades, it is likely that the growing amount of effluents may halt or reverse declining trends in phosphorous

Polluted runoff, industrial discharges, and sewage wastewater are forms of nutrient enrichment

- Nutrient enrichment or eutrophication is the addition to surface waters of nutrients previously present in low amounts

- in the form of nitrates and inorganic phosphates

a) comes from sewage effluent (point source of pollution), and lawn fertilizers, agricultural runoff, manure, and rain- and wind-borne deposits associated with the burning of fossil fuels (non-point source of pollution)

- The Fox River carries a high nutrient load during low flow periods from July - October

- Total phosphorous and nitrogen were near recommended guidelines at Stratton Dam, but become extremely high below Elgin

- High levels of nutrients make Fox River more susceptible to algae blooms

Dams along the Fox River

Another threat to the Fox River is its dams

In Illinois, the Fox River has 15 dams, and numerous smaller tributary dams

- The first dam is the Stratton Dam in Chain O' Lakes

- The last dam is the Dayton Dam in Dayton

- Other dams are located in Algonquin, Carpentersville, Elgin, South Elgin, St. Charles, Geneva, Batavia, North Aurora, Aurora, Montgomery, and Yorkville

- Many of these dams were built in 1800's to power grist and lumber mills but no longer serve that function

a) The Dayton Dam is the only dam to produce hydro-electric power

b) Elgin dam is used to store water for the municipal drinking water supply

c) None of 15 the dams serve in flood control except perhaps the Stratton dam in low-flow periods

- Most dams serve no functional purpose except to maintain an impoundment upstream

Ecological consequences to dams

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For more information about the effects of dams see:

August 2002 issue of BioScience published by American Institute of Biological Sciences contains a special section on dam removal and river restoration

American Rivers publication "The ecology of dam removal: a summary of benefits and impacts" which summarizes a peer-reviewed article by Angela Bednarek in Environmental Management

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Dams have impounded 47% of the river's length and 55% of its surface area between Chain O' Lakes and Dayton

- impoundments effectively 1) create alternating lake and river habitat changing the physical and biological features of the river's channel and floodplain, 2) alter the flow of the river and fragment its continuity, and 3) alter species composition in the river

Multiple studies have been conducted on the ecological consequences of dams along the Fox River including studies by Vic Santucci of Max McGraw Wildlife Foundantion and Steve Pescitelli of the Illinois Department of Natural Resources

- Santucci studied a 160 km reach of the Fox River from Algonquin to Dayton.

a) Sampled 40 sites located either in free-flowing river directly below dams, impounded river directly above dams, or free-flowing or impounded mid-segment areas between dams from July-September 2000 and August-September 2001

b) Pescitelli sampled at three stations above and two stations below the Yorkville dam in 1990's

There are seven major ecological consequences of dams along the Fox River

1) Higher quality sport fish and non-game fish communities in free-flowing portions of the river compared to areas impounded by dams

- free-flowing portions of the river have more fish species, 4 times the number of individuals, and double the number of harvestable-sized sport fish

- lower fish populations in impounded areas may be a result of lower water quality, poorer habitat, and limited food sources

2) Dams alter the distribution of Fox River fishes preventing fish movement from pool to pool

- 30 fish species are only found in the lower Fox River or are absent from stretches of the middle Middle Fox River

- dams on small tributaries block spawning migrations of fish species such as suckers and smallmouth bass)

3) Higher quality macroinvertebrate communities are found in free-flowing portions of the river compared to impounded areas (macroinvertebrates include aquatic insect larvae)

- Mean macroinvertebrate condition index scores were more than twice as high as scores for impounded areas (i.e., there is a higher abundance and richness of intolerant macroinvertebrates such as midges and aquatic worms that can withstand degraded environmental conditions in impounded areas compared to free-flowing areas)

- Why the lower macroinvertebrates in impounded areas?

a) reduced current upstream of dams causes increased deposition of sediments and organic material creating poor habitat

- Macroinvertebrates are important because they are a food source for fish

Note: The Fox River is not a major breeding ground for mosquitos. While it is true that mosquitos would be more likely to breed in slow-moving - stagnant areas such as that found in impoundments (mosquito larva develop in water with no flow), propagation of mosquito-borne disease such as West Nile Virus in the Fox River is not a major concern compared to other locations.

4) Mussel dispersal is limited by a lack of fish dispersal thereby preventing freshwater mussels from reestablishing populations in areas where they once were abundant

- Thus, if fish can't pass through a dam, either can mussels

- Lower abundance and species diversity of freshwater mussels have been found in the impoundment of the Yorkville dam compared to the area just downstream of the Yorkville dam

a) Freshwater mussels may not be able to survive in nutrient-rich waters found in impounded areas as gills are used in both feeding and respiration.

- Freshwater mussels, as a group, are one of the most endangered groups of organisms in the world

5) Higher quality habitat for fish and invertebrate communities is found in free-flowing portions of the river compared to impounded areas

- Free-flowing areas have a variety of water depths, current velocities, and substrate types. They have thinner silt deposits and coarser bed materials

- Impounded areas are more lake-like. They are more uniform and deep, with a low current velocity, and fine silt deposits.

a) Furthermore, heavy siltation discourages fish spawning, and trapped sediment cannot be used to create habitat in free-flowing regions

6) Higher water quality is found in free-flowing areas compared to impounded areas

- Dissolved oxygen levels were below IEPA standards at 9 of 11 sample sites at impounded areas and 2 of 11 sites at free-flowing areas

- pH levels were at or above the upper IEPA standard at 8 of 11 sample sites at impounded areas and 4 of 11 sites at free-flowing areas

- Both low dissolved oxygen and high pH levels are indicators of high algae concentration (along with chlorophyll a concentrations which also were found to be at high levels)

a) a large algae population is partially a result of nutrient enrichment

- Low dissolved oxygen and high pH can increase stress of aquatic life and possibly mortality as a result of a depressed immune system and greater susceptibility to bacterial or viral infections

a) in addition less tolerant fish species may avoid areas with low dissolved oxygen levels

Note: Detected dissolved oxygen levels were not low enough to cause widespread fish kills

7) Impounded areas promote algae blooms

- An algae bloom is an exponential increase in algae population

- Increased algae upstream of a dam is a result of slow moving water, high nutrients and increased temperature (increased temperature is correlated with water velocity, high nutrients are a result of settling in slow moving water)

- Algae block sun underneath to detriment of other aquatic plants

- Algae blooms cause wide swings in dissolved oxygen concentrations – photosynthesis increases oxygen during day, but respiration decreases oxygen at night

- When algae run out of resources, population crashes, and decomposition of algae by bacteria removes oxygen from the water.

- Thus, algae blooms can result in loss of aquatic animal and plant life, fluctuating oxygen levels, and increased turbidity (cloudiness of the water)

a) Algae blooms in freshwater ecosystems (although not necessarily the Fox) have been known to cause fish kills, have foul odors, and unpalatable tastes in drinking water

Conclusion – What are the ecological consequences to dam removal

Dam removal may be an important river restoration tool

Based upon the above ecological consequences, dam removal should result in:

1) enhanced habitat and water quality conditions

- i.e., dissolved oxygen levels should stabilize above standards previously impounded areas will again vary in depth, velocity, and substrate type

2) improvements to fish and macroinvertebrate communities

- improved recreational fishing opportunities provided by enhanced sport fish populations

- repopulation of areas where species of fish and mussels no longer exist

However, there is limited scientific knowledge of the effects of dam removal, and dam removal involves tradeoffs

- dam removal represents an ecological disturbance with possible short and long-term consequences

Possible negative consequences of dam removal

- Riverine species should increase at the expense of reservoir species because you are taking a lake ecosystem and replacing it with a river ecosystem

a) involves both flora and fauna

- Organisms present in reservoir prior to removal may be washed downstream or stranded during removal

- Release of sediments and nutrients

a) sediment could contain toxic substances

b) nutrients released may cause nutrient enrichment in downstream areas

c) suspended sediment in water increases greatly during and after removal and may last for months (could result in localized mortality of freshwater mussels)

- Changes in channel formation as a result of shifts in patterns of sediment movement

- Exposed riverbanks may be colonized by invasive species such as stinging nettle and reed canary grass

Prior to dam removal, stakeholders should consider the relative costs and effectiveness of mitigating the ecological consequences of existing dams compared to the consequences of dam removal

- For example, is it less costly and easier to remove invasive species such as stinging nettle and reed canary grass from newly exposed riverbanks or prevent sediment build-up behind dams, which in turn promotes algae blooms?

If dam removals occur along the Fox River they should be studied

- Through careful scientific studies before and after removal, decision makers may be more effective in using dam removal as a river restoration tool