2 BACKGROUND

2.1 Natural History of the Illinois River Basin and the Hennepin Levee District

2.1.1 Climate, Geomorphology and Hydrology

Climate

The Illinois River Basin climate is humid continental with cold, relatively dry winters and warm, wet summers. Continental climate occurs in areas far from large weather modifying physical features such as oceans or mountains ranges. From 1961 to 1990 the annual precipitation in the basin was 35 to 37 inches, the average low 39 to 40 F, the average high 59 to 61 F, the average snowfall 22 to 28 inches and the growing season lasted 165 to 185 days from May to October. However, significant deviations from the average precipitation and temperature may occur in any given year (Figure 2.1.1-1).[1] The climate of the Illinois River Basin encourages agricultural production and little additional irrigation is required for optimal growth of agricultural crops.

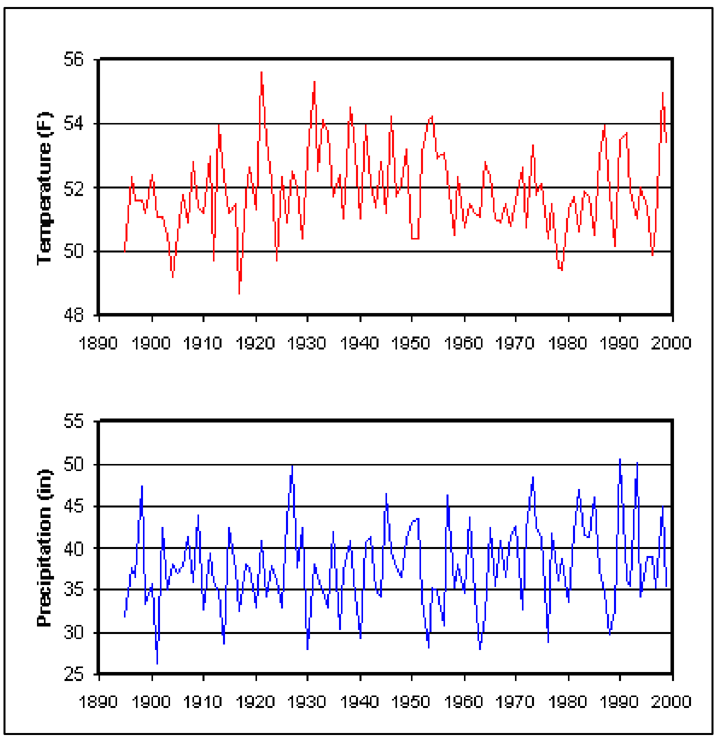

Figure 2.1.1-1
Average annual temperature (upper) and precipitation (lower) trends in Illinois.[2]

Geomorphology

The topography of the Illinois River Basin is relatively flat with the surface altitude ranging from 600 to 800 feet above sea level. With altitudinal variations ranging from 200 to 400 feet, the Illinois River Valley is the area of greatest topographic relief.[3] Glacial features, originating in the Pleistocene Epoch, are the major landforms in the Illinois River Basin. Two glacial advances, the Kansan and the Illinois, covered central Illinois. An additional glacial advance, the Wisconsian, failed to reach the area, yet profoundly influenced the character of the region's river valleys. Tremendous outwash deposits developed from glacial melt-water streams carrying upland loess accumulations. Wisconsian glacial deposits created outwash plains consisting of moderately well-sorted sand and gravel. Cahokia Alluvium (deposits of poorly sorted sand, silt and/or clay containing localized pockets of sandy gravels) overlies the glacial outwash. The alluvium is, in turn, covered by Richland loess (deposit of wind-blown, fine-grained clayey-silt). Because of the glacial influence, silt-loam and silty-clay are the dominant soil types on central Illinois floodplains and bottomland prairie.[4]

Hydrology

Illinois River Basin

The Illinois River begins at the confluence of the Des Plaines and Kankakee Rivers, approximately 50 miles southwest of the city of Chicago, Illinois. The river then flows 273 miles south-southwest until merging with the Mississippi River, 31 miles northwest of St. Louis, Missouri. In total, the Illinois River watershed drains 18,500,000 acres of land.[5] A watershed or river basin is the sum of all the land whose surface area drains into a particular water body, in this case the Illinois River.

The Illinois River Basin experiences annual spring flooding during the months of March, April and May and sometimes lesser flooding follows during the autumn. The water level in the river is usually lowest during the months of August through October.[6] Prior to human alteration, the Illinois River Basin contained some 1,813 square kilometers of flood storage area, which annually flooded to a depth of a few meters. The shallow slope of the Illinois River Basin slows the velocity of the floodwater. Also slowing the floodwater velocity, at least prior to anthropogenic changes in the Illinois River Basin, were the large amounts of woody and leafy debris that often accumulated in the river. Slow moving floodwaters fan out broadly over the land surface resulting in a longer period of inundation on the floodplains.[7] Long periods of inundation provide critical habitat for fish and other species in the Basin.

The HLD is a riverine floodplain within the Tall Grass Prairie Bioregion.[8] The Prairie Bioregion is immense, covering over one million square miles in the center of continental North America. Rich, fertile soil, lush grasses, infrequent trees and drought resistant plants characterized the area. Because of the fertility of the land, however, Euro-American settlers converted the vast majority of the land within the bioregion to fields of row crops by draining wetlands and installing on-field drainage (tile drains and drainage ditches). Consequently, the intensive agriculture and massive engineering projects drastically altered the hydrology of the Illinois River Basin. Levees, a necessity for current floodplain agricultural practice, isolate floodplains from the river. Around half of the original Illinois River Basin's 400,000 acres of floodplain are now behind levees and drained, while the remaining floodplains retain some of their natural hydrology.[9]

Once harvested, farmers must transport their crops to markets and one of the major routes is barging on the Illinois River. Barging also plays a major role in Illinois as a transportation route for coal. Maintaining the main channel at a constant depth of at least 2.7 meters (9ft) makes the Illinois River suitable for barging.[10] Navigation dams constructed along the river include two in relatively close proximity to Hennepin, the upstream Starved Rock Dam and the downstream Peoria Dam (Figure 2.1.1-2).

Floodplains

Spring storm events and snow melt release water into the system, overwhelming the storage capacity of the river channels and thereby causing flooding. The excess water fans out over the land surface. Floodplains are those riparian areas, areas proximal to riverine channels, which become inundated with water during floods. During the flood, the floodplain becomes part of the river. Depending upon one's definition, the term floodplain can refer to a range of land areas. For example, a particular river's floodplain can include any land flooded in a rare storm event, e.g., the one hundred year flood, or merely delineate the land that is annually flooded.[11] For the HLD, the land in the levee district does not function as a

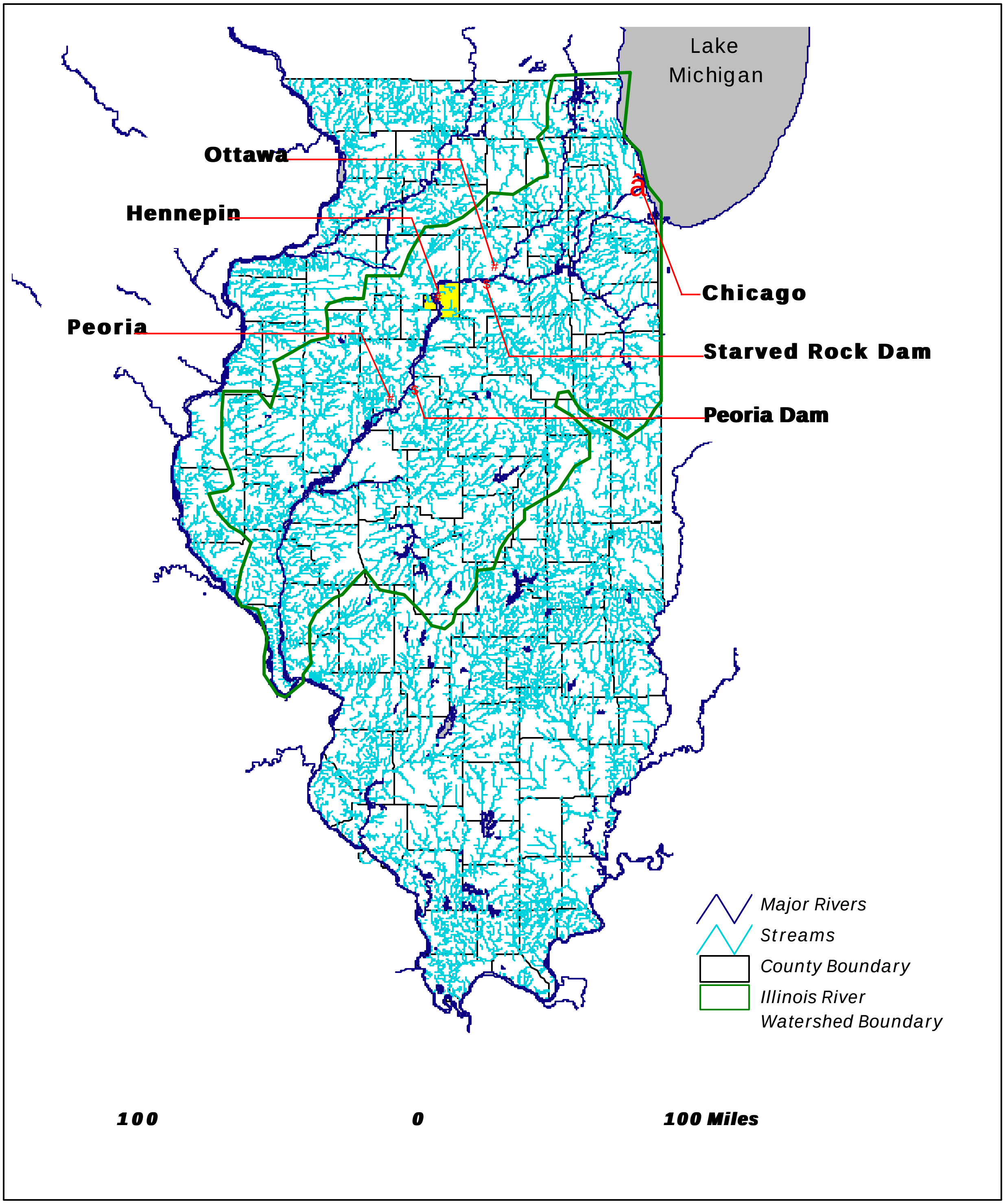

Figure 2.1.1-2 A map showing the location of Hennepin and its nearby cities and dams in the Illinois River watershed region.

floodplain because the river-floodplain connections were severed. The floodplain will include, after TWI breaches the levee, the land seasonally inundated with water (i.e., most of the land within the district). TWI plans to breach the levee when it accumulates sufficient funding for the project, probably within one to two years. From the time of the breach onward, it is expected that the Illinois River floodwaters will enter the HLD in roughly 80% of flooding events and that the water contained within the HLD floodplain will return to the Illinois River in roughly 15% of flooding events.[12]

Water enters the floodplain ecosystem as precipitation, surface water flow or groundwater flow and exits through evapotranspiration or as surface water flow or groundwater flow. Consequently, hydrology functions not only as a network inter-connecting each element such as soil, flora, and fauna within landscapes, but also functions holistically, connecting the watershed and its water cycle. The water cycle describes the cycling of the water input and output of the system. As a result, a riparian ecosystem must be viewed in three spatial dimensions where connection and interactions occur between the river channel and its floodplains and uplands (X axis), between the surface water and groundwater (Y axis), and between upstream and downstream districts of the river continuum (Z axis) (Figure 2.1.1-3).[13]

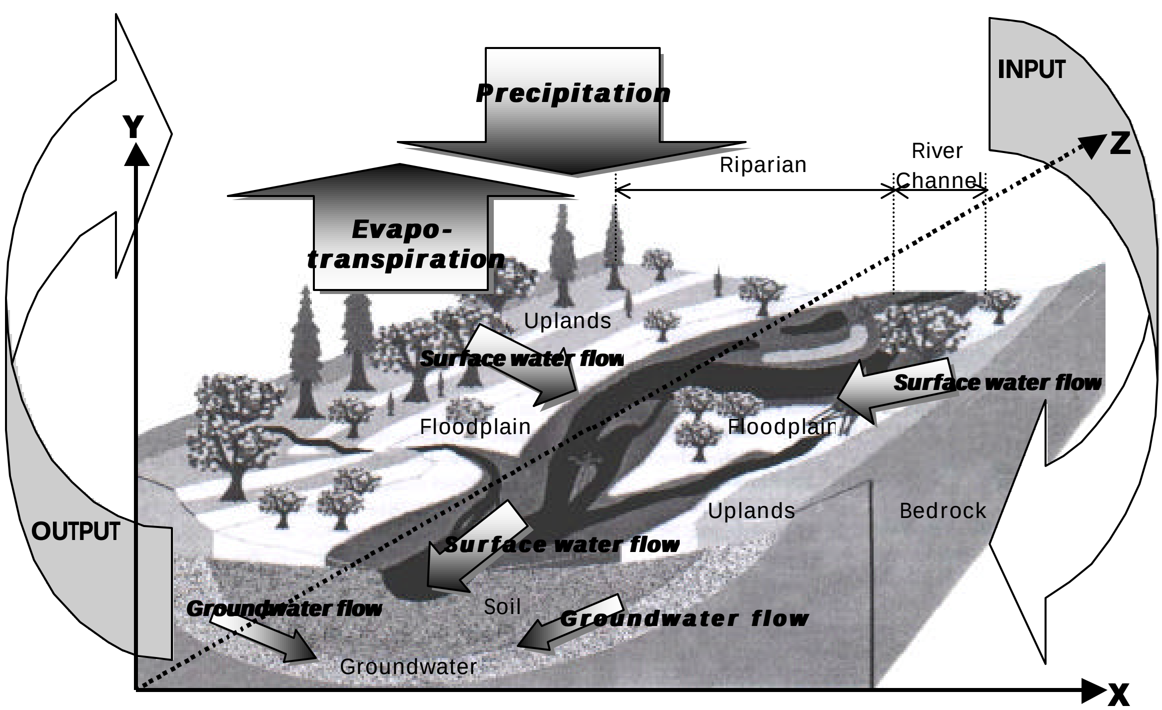

Figure 2.1.1-3 Hydrological function of water flow and water cycle in a riparian watershed ecosystem

Hennepin Levee District

The Peoria navigation dam combined with the rerouting of the Chicago River to flow away from Lake Michigan and eventually into the Illinois River, significantly alter the hydrology of the HLD.[14] The surface elevation of water in the Illinois River (440 feet above mean sea level) is now higher than the surface elevation in the HLD (below 440 feet). Because of this disparity, hydrologic pressure forces groundwater from beneath the river into the floodplain. A pumping station actively pumps out the water, thereby preventing constant inundation. The elevation of the levee, designed to prevent a one-hundred-year flood, is 460.8 feet at the upstream end and 460.6 feet at the downstream end. 460 feet delineates the one-hundred-year flood zone elevation, set by the Illinois Department of Natural Resources and based on Federal Emergency Management Agency (FEMA) and National Flood Insurance Program (FIRM) maps.[15]

2.1.2 Illinois River Basin Floodplain Ecosystems

Floodplain Wetlands

Floodplain wetlands result from river flood pulses along with groundwater and precipitation inputs. The high water table interacts with the surface strata and often standing water results. The standing water and saturated soil in these ecosystems restricts certain types of vegetation, while allowing other types to survive. Riparian wetlands are transitional lands between terrestrial and open water aquatic ecosystems. In other words, wetlands are edges for both terrestrial and aquatic ecosystems. Forman explains, “edges are often biological cornucopias.” Denser biodiversity and more biomass production than inner, patch communities occur in wetland edges.[16] As a result, wetland ecosystems are recognized as some of the most biologically productive ecosystems on earth.[17] Furthermore, wetlands are open systems allowing energy and element exchange between interior and external spaces and, therefore, are heavily influenced by external environmental conditions (e.g., solar energy, precipitation, water flows and nutrient input). Even small alterations in a wetland’s complexity might lead to a significant decline in its productivity.[18]

Three main wetland elements are hydrology, soils (abiotic environment), and vegetation (biotic community). These elements are influenced by the climate and geomorphology of the region (Figure 2.1.2-1). Annual variations in hydrology (e.g., water depth, flood frequency and duration of inundation) modify and control components of the abiotic environment (e.g., water availability, nutrient availability, aerobic and anaerobic soil conditions, soil particle size, soil chemistry and water chemistry). Subsequently, the biotic communities respond to these environmental stimuli. Fauna, flora, and microbes, in turn, modify the hydrology and abiotic environment.[19]

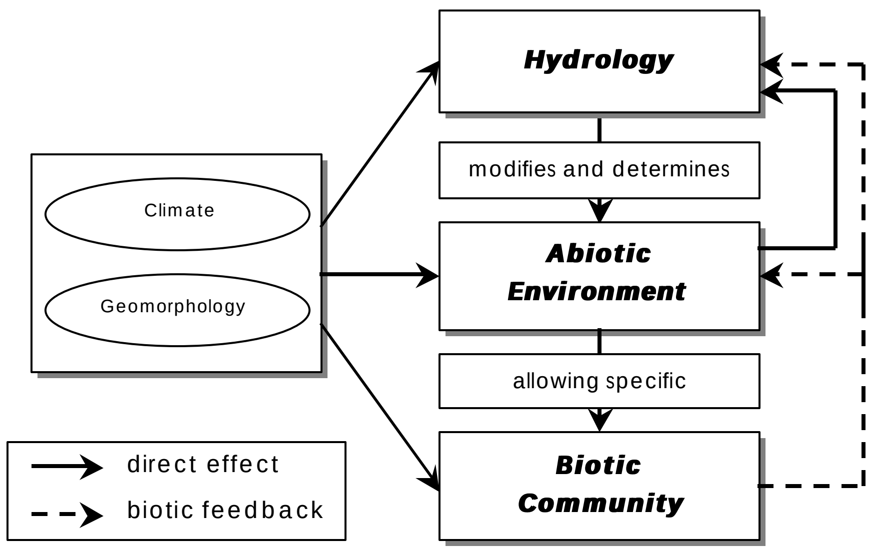

Figure 2.1.2-1 A conceptual diagram, illustrating the effects of hydrology on wetland abiotic and biotic environments that, in turn, have feedbacks on the modification of hydrology.[20]

Floodplain Soils

Hydric soils are an essential element of a floodplain wetland. Inundation restricts soil aeration, which is the capacity to transmit oxygen from the atmosphere to the root zone. Under saturated conditions, an anaerobic layer forms in the upper part of the soil. In a riparian floodplain, anaerobic conditions occur within a few days after inundation; they also quickly revert to aerobic conditions when the flood recedes. The saturated and anaerobic conditions interrelate with biogeochemical reactions and subsequently influence the vegetation establishment and wetland development.

Floodwater, the moving littoral zone, flows much slower than the water in the main river channel due to a greater degree of friction caused by less depth and greater surface area. Carrying suspended sediment, organic matter and dissolved nutrients from the river channel onto the floodplain, the floodwater also dissolves nutrients mineralized in the dry parts of the floodplain strata making these inputs available to organisms living in the floodplain. As the floodwater recedes and/or evaporates, the suspended sediment, nutrients and organic matter precipitate and add to the structure and fertility of the floodplain soils.[21] Other soil properties influenced by the flood pulse include soil texture, organic matter content, ground water elevation, and the degree of compaction.[22]

Floodplain Biogeochemistry

Nutrient cycling, the movement of elements and molecules such as nitrogen, oxygen, and carbon between the physical world and organisms, is an essential biogeochemical function in an ecosystem. The amount of nutrient storage in wetlands depends on the climate, duration of inundation, topography, anthropogenic modifications, vegetation and the nutrient loading in the river channel. Wetlands may function as a nutrient sink, source, or transformer. When nutrient input is greater than output, wetlands act as sinks. They act as sources when the nutrient output is greater than the input. When the amount of nutrient input equals output, nutrients change form; these wetlands are considered nutrient transforming wetlands rather than a source or sink.[23]

Human activity within the past 100 years significantly disrupted the biogeochemical cycling in the Illinois River Basin. Notably, agricultural practices add to the nutrient loading of the Illinois River. Because certain crops require nitrogen, phosphorus and potassium to thrive on agricultural land, farmers apply these nutrients to their fields. Precipitation leaches nutrients from the field's surface and subsurface. Leached nutrients move through surface water flow and groundwater flow into drainage ditches and streams and finally into the Illinois River. Farmers apply approximately 4 million tons of agricultural fertilizer per year to Illinois farmlands, including 962,000 tons of nitrogen and 391,000 tons of phosphorus.[24] A significant percentage of these nutrients make their way into the Illinois River.

Publicly owned waste treatment facilities are another major source of anthropogenic nutrient pollution. These facilities process waste effluent from municipal areas, treating both residential effluent and industrial effluent. Processed water from these treatment facilities is then reintroduced into Illinois rivers.

Floodplain Habitat

Countless organisms depend on the Illinois River Basin for habitat. In addition, the State of Illinois and the Federal Government recognize numerous threatened and endangered species of plants and animals that depend on the Illinois River for some part of their life history (Table 2.1.2-1).[25] One species of concern, the yellow monkey flower (*Mimulus glabratus*), lives in one area of the HLD. TWI hopes to protect the yellow monkey flower in addition to creating usable habitat for other species such as canvasback, black crappie, and various species of mussels.

Table 2.1.2-1 State and Federal Threatened and Endangered Species of the Illinois River Basin

	Illinois State Threatened and Endangered	Federal Threatened and Endangered
Plants	43	8
Insects	6	3
Fish	3	0
Amphibians	1	1
Reptiles	4	3
Birds	10	3
Mammals	2	1

Vegetation

Water depth is the predominant factor influencing the ability of plants to survive in a floodplain wetland. Many wetland plants are adapted to withstand water level variations. Based on their form and growth habits, wetland vegetation is categorized as emergent, submerged, floating attached, and floating unattached (Figure 2.1.2-2).[26]

Emergent plants are plants whose roots and basal portions grow underwater but whose leaves and stems grow mostly in the air (e.g., cattail (*Typha* spp.), bulrush (*Scirpus* spp.), rush (*Juncus* spp.), sedges (*Carex* spp.) and bog mosses (*Sphagnum* spp.)). Submerged plants are those with stems and leaves mostly or entirely underwater, excepting the flowering stage for certain species. Fine, long, thin, complex and compound clustered leaves maximize leaf surface areas in capturing light even in turbid water. Submerged plants typically occur in water depths of 0.5 -1.0m (e.g., bladderwort (*Utricularia* spp.), pondweed (*Potamogeton* spp.), wild celery (*Apium* sp.), watermilfoil (*Myriophyllum* spp.), elodea (*Elodea* spp.), and coontail (*Ceratophyllum* spp.)). Floating attached plants have leaves suspended on the surface of water with roots fastened in the substrate. The flexible and slender stems connecting their leaves and roots may extend to 1.8m long, allowing them to exist in deeper water and survive fluctuating water levels. Water lily (*Nymphaea* sp.) is a typical example for this category. Floating unattached plants are those growing on the water surface with loose roots unanchored in the substrate (e.g., duckweed (*Lemnaceae* spp.), water hyacinth (*Eichhornia* sp.), and water lettuce (*Pistia* sp.)).[27]

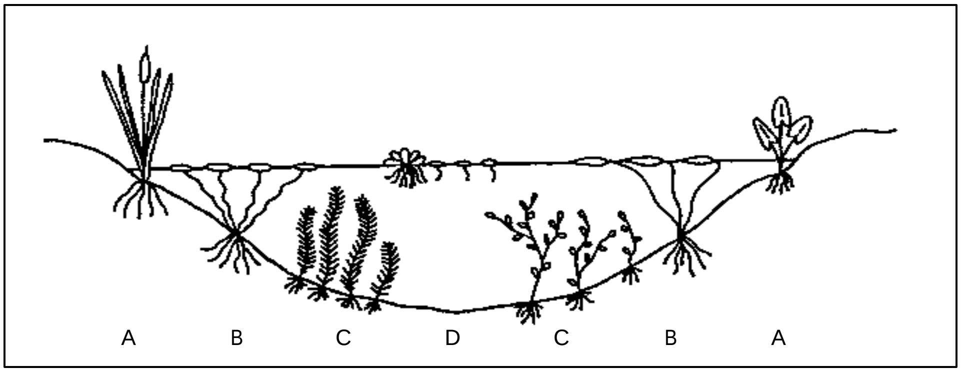

Figure 2.1.2-2 Types of aquatic vegetation based on form and growth habits. (A= emergent, B= floating attached, C= submerged, D= floating unattached plants)[28]

Marsh-like conditions existed in the HLD one hundred years ago. In shallow, hydrologically variable wetland areas, emergent marsh dominated. Vegetation in such marshes is herbaceous, except for a bordering fringe of shrubby and woody plant growth. While marsh vegetation varied greatly from one area to another, the most prevalent species included: American lotus (*Nelumbo lutea*), river bulrush (*Scirpus fluviatilis*), marsh smartweed (*Polygonum coccineum*), cattails, duck potato/arrowhead (*Sagittaria latifolia*), and spike rushes (*Eleocharis* spp.).[29] The dominant plants in the surrounding prairie were big bluestem (*Andropogon gerardii*), Indian grass (*Sorghastrum nutans*), switch grass (*Panicum virgatum*), and little bluestem (*Andropogon scoparius*).

Waterfowl

The Illinois River Basin and consequently the HLD is situated on the principal route of Mississippi flyway (Figure 2.1.2-3). Thousands of waterfowl and other migrant birds travel this route in the spring to reach their breeding grounds, and then make the return trip in the autumn on the way to their wintering habitats. Illinois River floodplain wetlands provide important resting and foraging sites for the migrant birds. In fact, declines in migrant bird populations are often attributed in part to dwindling flyway habitat. TWI plans to create habitat for waterfowl species including the canvasback (*Aythya valisineria*), a species with declining populations (Figure 2.1.2-4).

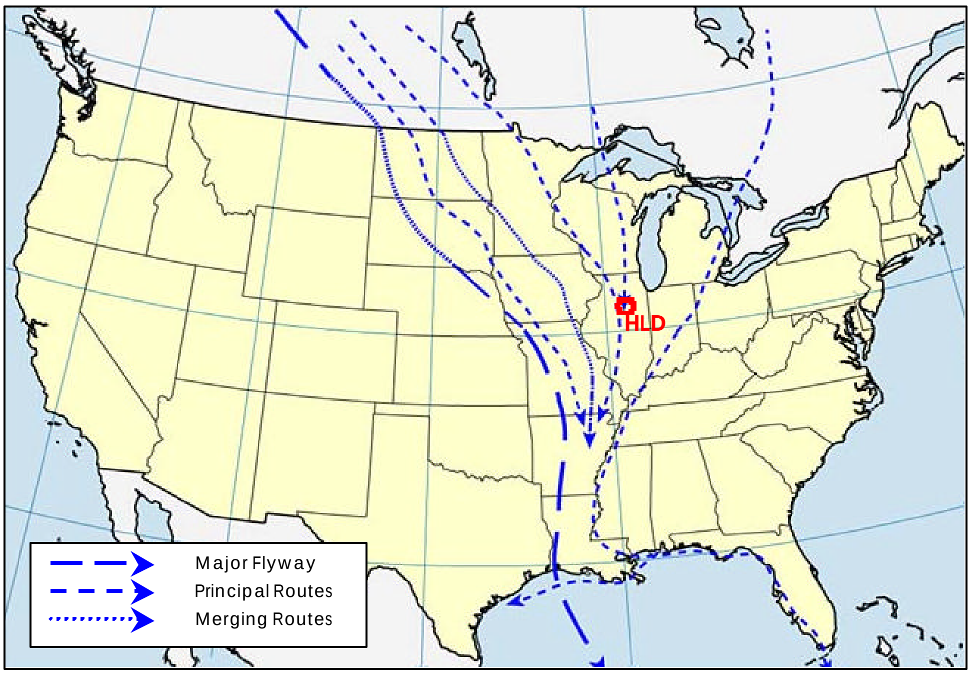

Figure 2.1.2-3 Location of the HLD on the Mississippi flyway[30]

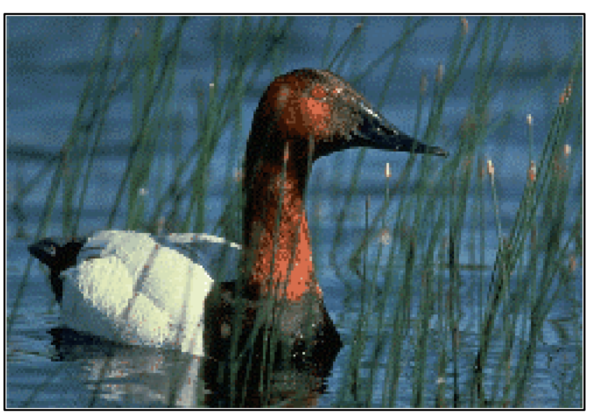

Figure 2.1.2-4 Canvasback

(Aythya valisineria)[31]

Fish

In 1908, the Illinois River fishery produced a higher percentage of the U.S. harvest of freshwater fish, excluding anadromous species, than any other North American river. The river supported more than 2,000 commercial fishermen and produced an annual commercial catch of 24 million pounds.[32] However, changes in the Illinois River led to drastic reductions in fish populations. By the 1920's, many believed that above Starved Rock Dam, the river was devoid of fish.

Recent trends show increasing populations of pelagic (open water feeding) fish, such as bluegill and smallmouth bass, and a decrease in the populations of benthic (bottom feeding) fish, notably the invasive carp and goldfish. The fish community is more diverse now than in the 1960's, likely due to the implementation of water-quality legislation.[33]

Some species of Illinois River fish require the backwater areas of floodplains for spawning and rearing their young. Fish that use backwater areas often require a sustained flood of six or more weeks for successful breeding and rearing of their offspring. However, changes in the river, such as levees and dredging, cause the floodwater to drain from the Illinois River faster than in the past and floods rarely last six to eight weeks.[34] TWI expects that restoring the floodplain-river connectivity will recreate quality spawning and rearing habitat for native Illinois River fish species.

Creating quality habitat for native fish species often also creates habitat for unwanted or pest species. For example, the prevalence of carp (*Cyprinus carpio*) concerns Illinois River fish biologists (Figure 2.1.2-5). Although the population of carp declined in recent decades, carp are still a concern to biologists due to their feeding habits. Carp uproot plants when digging in the substrate for food, a process that compromises the ability of the substrate to then serve as breeding habitat for other fish. Carp also increase turbidity, or cloudiness, in the water, which can negatively affect the feeding ability of some fish and can reduce the primary productivity of the ecosystem. Primary productivity is the production of organic matter by photosynthetic plants and bacteria. TWI hopes to alleviate these potential problems in the HLD by attaching carp mesh to test plots. The purpose of the mesh is to interfere with the ability of the carp to feed, leaving the plants and the substrate undisturbed and therefore useful to other fish species. If fish species such as pike and bass are encouraged to live in the HLD, they may become predatory on young carp.[35]

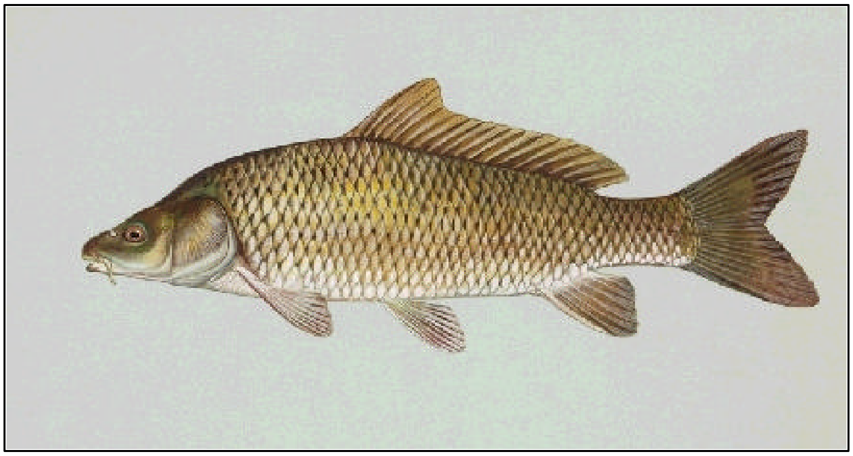

Figure 2.1.2-5
Common Carp
(Cyprinus carpio)[36]

Mussels

Freshwater mussels are another group of organisms of concern to conservationists and scientists. In the Illinois River, 50% of the mussel species disappeared from the river in the past 100 years. Major reasons for the declining mussel populations include siltation, habitat loss, channelization and dredging, pollution from agriculture, industry and municipalities, and finally competition from invasive species such as the zebra mussel.[37] Carp are one possible impediment to reversing the decline in mussel populations; carp are bottom feeders and tend to dig up the substrate, thereby making attachment more difficult for mussels. However, mussels have shown the ability to attach to carp mesh and to burrow into the substrate in holes cut into the carp mesh.[38] TWI is optimistic that mussel populations will rebound in the restored floodplains and their attendant wetlands.

Beaver

Other populations of animals also experienced precipitous declines since Euro-Americans settled in Illinois. One notable example is the beaver (*Castor canadensis*) (Figure 2.1.2-6). Illinois and the land in the Upper Mississippi Basin historically provided quality habitat for an estimated 10 to 40 million beaver. These industrious animals built dams 400 to 500 feet apart on small streams; dams that, during storms, delayed the movement of rainwater to the main channels. Hey estimates that the cumulative water storage capacity of the previously prevalent beaver ponds could have averted the 1993 flood. Unfortunately, following Euro-American settlement, demand for beaver pelts and reduction of their habitat drastically reduced North American beaver populations. While the beaver could provide flood control in Illinois, not everyone would welcome back the beaver, as they would build dams and flood areas regardless of human property rights. Most people are averse to flooded yards not to mention flooded houses.[39]

Figure 2.1.2-6
Beaver
(Castor canadensis)[40]

[1] Illinois State Water Survey. 2000.
[2] Ibid. and Illinois State Climatologist Office. http://www.sws.uiuc.edu/atmos/statecli/
[3] Roper, D. C. 1979.
[4] USGS. 2001. The Lower Illinois River Basin Information.
[5] Sparks, R.E., et al. 1998.
[6] USGS. 2000.
[7] Galat, D.L., et al. 1998. Interestingly, because of overlap between the flooding on the Upper Mississippi River and the Illinois River, Illinois River floodwater is often prevented from freely flowing into the Mississippi River. This overlap may cause the Illinois River floodwater to back up on itself at the confluence of the two rivers. This additional flooding at the confluence of the two rivers allows more time for inundated agricultural fields to lose nutrients to the floodwater.
[8] Kindscher, K. 1987.
[9] Interagency Floodplain Management Review Committee (U. S.). Scientific Assessment and Strategy Team. 1994.
[10] Ibid.
[11] Dunne, T. and L.B. Leopold. 1978
[12] Hey, D.L. 4/2001. Personal Communication.
[13] Stanford, J. A. 1998.
[14] Hey, D.L. 4/2001. Personal Communication.
[15] Clark, D.C. 10/2000. Personal Communication.
[16] Forman, T.T. 1995. p96-97.
[17] Molles, M.C. Jr. et al. 1998., and Mitsch, W. J. and J. G. Gosselink. 2000. p261.
[18] Mitsch, W.J. and J.G. Gosselink. 2000. p155., and Hammer, D. A. 1996. p43.
[19] Mitsch, W.J. and J.G.Gosselink. 2000. p108-109.

[20] Adapted from Mitsch, W.J. and J.G. Gosselink. 2000. p109.

[21] Interagency Floodplain Management Review Committee (U. S.). Scientific Assessment and Strategy Team. 1994.

[22] Gregorich, E. G. et al. No Date.

[23] Mitsch, W.J. and J.G. Gosselink. 2000. p196-197.

[24] Illinois Department of Agriculture and the U.S. Department of Agriculture. 2000.

[25] Interagency Floodplain Management Review Committee (U. S.). Scientific Assessment and Strategy Team. 1994.

[26] Reimer, D. N. 1984.

[27] Hammer, D. A. 1997. p54-58., and Reimer, D. N. 1984., and Weller, M. W. 1981. p18-21.

[28] Reimer, D. N. 1984.

[29] Asch, N.B. and D.L. Asch. 1986.

[30] The Nutty Birdwatcher. 2000.

[31] Vinjie, W. 3/2001. (Photo: Canvasback). United States Fish and Wildlife Service National Image Gallery. http://images.fws.gov/page1.cfm.

[32] Interagency Floodplain Management Review Committee (U. S.). Scientific Assessment and Strategy Team. 1994.

[33] Lerczak, T.V. and R.E. Sparks. 1999.

[34] Bayley, P. B. 1995

[35] Anderson, R.V. 1999.

[36] Raver, D. 3/2001. (Photo: Common Carp). United States Fish and Wildlife Service National Image Gallery at http://images.fws.gov/page1.cfm.

[37] Illinois Department of Natural Resources Webpage. 2001.

[38] Hey, D. L. 4/2001. Personal Communication

[39] Hey, D.L. and N. S. Philippi. 1995.

[40] Burke Museum of Natural History and Culture website. 8/2001.

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