

Buffalo and Niagara Rivers Habitat Assessment and Conservation Framework

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Executive Summary

In 2007-2008, Buffalo Niagara Riverkeeper undertook a project to improve our overall understanding of habitat conditions in the Buffalo and Niagara River Areas of Concern (AOCs) and their tributary areas in order to develop a solid framework of goals, benchmarks and delisting criteria to guide future conservation efforts. Working with a Geographic Information System specialist and a Technical Advisory Group of expert stakeholders, we reviewed and synthesized existing data pertaining to fish and wildlife habitat in the river corridors. We described reference conditions by analyzing historical maps and documents, baseline Remedial Action Plan inventories, and a variety of Great Lakes models for evaluating habitat integrity. We described current conditions utilizing aerial images, maps, databases, field reports along with information provided by the Technical Advisory Group and other habitat experts. On the basis of this research, this report provides the following:

- **For both AOCs:** an assessment of existing habitat conditions, opportunity areas, information needs, and major accomplishments and challenges since the baseline RAP inventories;
- **For the Buffalo River AOC:** specific habitat conservation goals and delisting criteria (adopted by the Buffalo River Remedial Action Committee in November, 2008);
- **For the Buffalo River study area upstream of the AOC:** conservation goals, strategies and benchmarks;
- **For the Niagara River AOC:** generalized habitat conservation goals and delisting criteria (generally adopted by the Niagara River Remedial Advisory Committee in December, 2008); and
- **For the Niagara River Watershed and its sub-basins:** a beginning measure of current amounts of habitat by type, and identification of large-scale conservation opportunity areas.

Beyond the Remedial Action Planning context, this report is intended for use as a basic reference and guide by anyone interested in restoring and conserving the biological health of the Buffalo and Niagara River corridors and tributary areas. Researchers will find—both in the collected information and the identified gaps—a resource for continuing to build an integrated knowledge base of local riverine habitats and species. Local governments and their constituents should be able to supplement what they already know about land uses in the Buffalo and Niagara River bioregion with ecological knowledge, and thus become better managers of the living systems under their jurisdiction.

“Knowing a place is the first step towards sustainable design.”

1. Purpose

In the mid-1980s the International Joint Commission (IJC) listed 42 “Areas of Concern” (AOCs), or severely degraded rivers and harbors across the U.S.-Canada Great Lakes basin. These included the lower 6.2 miles of the Buffalo River and the entire length of the Niagara River. The IJC characterized the damage in terms of 14 possible “beneficial use impairments,” to be confirmed and then addressed by remedial action plans (RAPs). Both the Buffalo River RAP (NYS DEC, 1989) and the Niagara River RAP (NYS DEC, 1994) confirmed that loss of fish and wildlife habitat was an “impaired beneficial use.”

Buffalo Niagara Riverkeeper received a grant from the National Fish and Wildlife Foundation to develop a community-based framework for habitat restoration in the Buffalo and Niagara River Areas of Concern and tributary areas. Specifically, this project had three purposes:

1. To compile and analyze existing habitat inventory and assessment information needed to set community-based quantifiable goals for restoring habitat in both Areas of Concern,
2. To develop and adopt specific strategies, benchmarks and delisting criteria for terrestrial and aquatic habitats in the Buffalo River AOC, and, to the extent possible, for the Niagara River AOC, and
3. To begin this inventory at a coarser scale for the entire Niagara River watershed as a basis for future ecosystem analysis and restoration work.

2. Methodology

2.1 Basic Questions

Our approach focused on the following questions:

- What were the historic habitat and species communities of these two rivers?
- What factors contributed to the initial assessment of fish and wildlife habitat as “impaired” on each river and what is the existing condition?
- What are the community’s goals for habitat and fish and wildlife restoration?
- What are the opportunities and constraints for achieving these goals?

2.2 Tasks

The Lower St. Louis River Habitat Plan, developed by the Citizens Action Committee in 2002 for the Lower St. Louis River Area of Concern in Duluth Minnesota provided a model for our workplan, which we condensed to the following tasks:

- **Review and synthesize historical documents and current research**

The annotated bibliography (Chapter 9) summarizes current and historic research on habitat and species related to the Buffalo or Niagara Rivers. It also includes summaries of habitat objectives, measures and guidelines being used in other Great Lakes communities and programs, as well as recent or ongoing habitat assessments and improvement projects being carried out on both rivers, such as those funded through the relicensing of the Niagara Power Project. In this way the bibliography should serve as a useful tool for those interested in ecosystem restoration within the Buffalo and Niagara River watersheds.

Because this habitat assessment relies on existing research, Buffalo Niagara Riverkeeper developed a Quality Assurance Project Plan with the National Fish & Wildlife Foundation to evaluate data sources for their reliability. Depending on the source, this called for identification of assumptions, limitations, and study methodology; and documentation of metadata for maps, databases or model outputs. The primary sources of habitat and species data used in this report had to meet our QAPP acceptance criteria and are indicated with an asterisk (and with any qualifications) in the bibliography.

- **Use mapped information, aerial images, and Geographic Information System databases to further define current conditions**

Appendix A-1 summarizes the Geographic Information System (GIS) and aerial orthophotography data sources used to prepare maps and summary tables relevant to existing and potential habitat in the Buffalo and Niagara Rivers

study areas and watershed. An inventory of available spatial data, sources of GIS information, and historical mapping was conducted to ensure the most accurate and relevant datasets were used to produce the maps and GIS summary tables. Existing GIS data was utilized where available and applicable, and associated metadata links are included. GIS datasets created by Buffalo Niagara Riverkeeper expressly for this report are noted. Appendix A-2 provides a useful tool for those interested in further analysis and mapping of the Buffalo and Niagara Rivers. GIS analysis and map preparation were completed using ESRI's ArcGIS 9.2 software.

- **Consult with a Technical Advisory Group and community stakeholders**

Buffalo Niagara Riverkeeper established and met with a Technical Advisory Group (TAG) of habitat and wildlife experts, GIS mapping experts, RAP point people and community stakeholders to review existing information, recommend specific GIS coverages needed to assess habitat health, and to help determine habitat conservation goals and benchmarks. TAG members are listed on page 2. We also worked with subgroups (biologists, GIS database managers, birders, anglers) and with individual experts from the TAG.

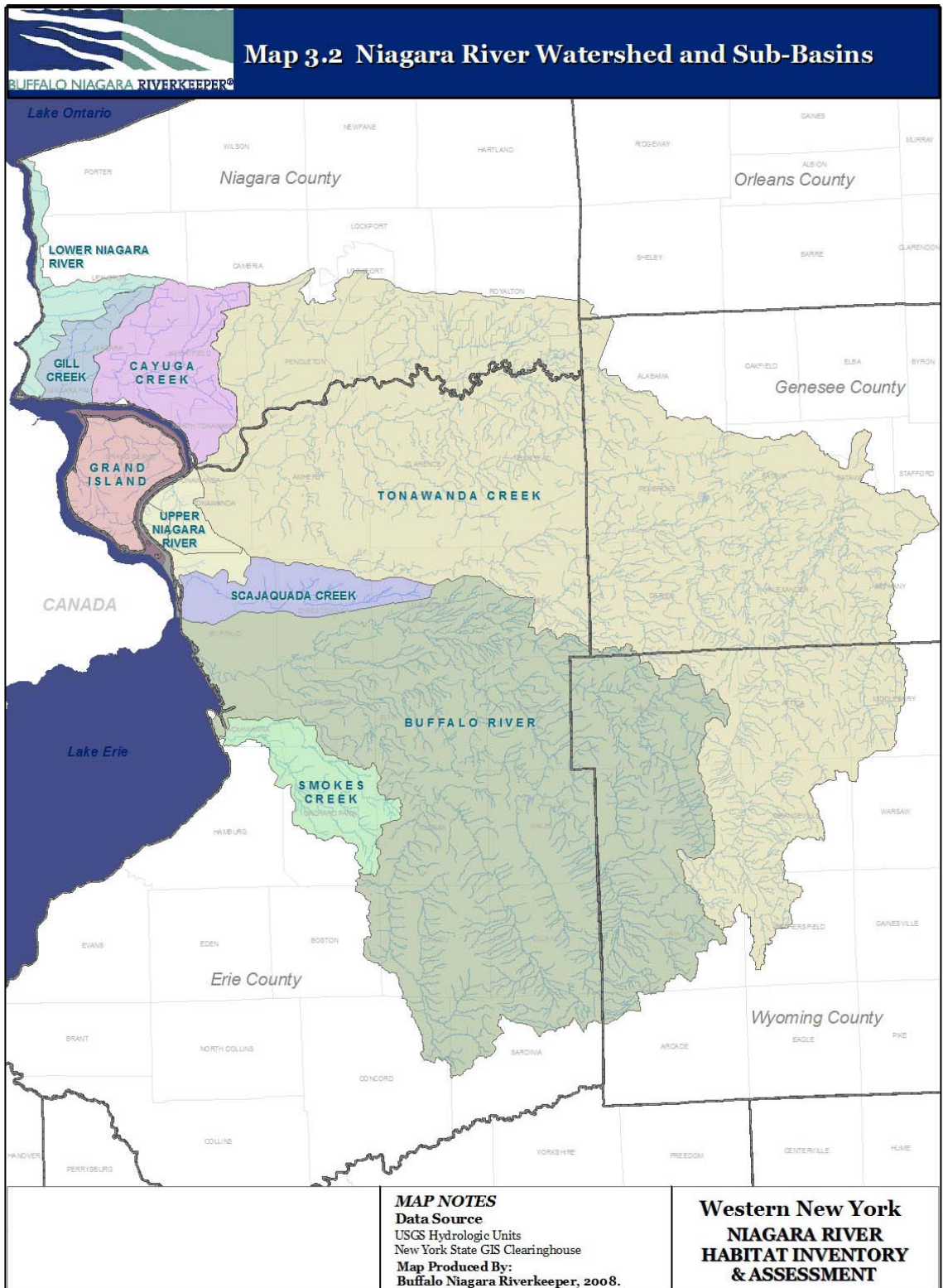
- **Cross-reference goals and recommendations with other Great Lakes and New York State habitat programs and models.**

2.3 Support Great Lakes Programs

Along with “on the ground” opportunities, we sought consistency with local, regional, state and federal programs and incentives that could support and be supported by our Buffalo Niagara River habitat goals and strategies, including:

- **The Great Lakes Regional Collaboration (GLRC) *Strategy to Restore and Protect the Great Lakes*** (GLRC, 2005), represents a consensus of Great Lakes governors, mayors, agencies, industries and conservation groups on ecosystem restoration goals, including:
 - *Open/nearshore waters* should possess a full array of safe and healthy natural habitats required to meet the growth and reproductive needs of fish and wildlife.
 - *Wetland* conditions should be sufficient to provide a full range of ecosystem services including hydrologic retention, nutrient and sediment trapping, spawning, nesting and nursery habitats; and ability to sustain non-endangered populations of all currently listed wetland species. The Great Lakes regional goal is a net gain of 1 million acres of wetland habitat by 2015, excluding mitigation projects that compensate for wetland losses or at former hazardous waste sites (GLRC, 2008).

- *Upland habitats* should be sufficiently large and connected to provide migration corridors; and be managed to emulate natural ecosystems.
- *Riverine/riparian* conditions should: ensure hydrologic connectivity to floodplains and wetlands, sustain native and migratory fish and wildlife, provide barrier-free access to tributary spawning habitats, be adequately buffered, and emulate natural flow regimes.
- **The Great Lakes Fishery Commission’s “Fish Community Goals and Objectives” for Lakes Erie and Ontario** (GLFC 2003 and 2006).
- **The State of the Lakes Ecosystem Conference**, which uses over 80 species, habitat and human use indicators to help establish program priorities and targets (EC and EPA, 2007).
- **The NYS Department of State *Coastal Zone Habitats* program**, which identifies eleven important coastal and aquatic habitats in the Buffalo Niagara region and includes “habitat impairment tests” for proposed projects in or near each site (NYS DOS, 1985).
- **The NYS Department of Environmental Conservation’s *Comprehensive Wildlife Conservation Strategy Plan*** (NYS DEC, 2006), which identifies priority habitats across the state based on the presence of “species in greatest need of conservation,” with the intent of protecting these habitats before the species become threatened or endangered.
- **Environment Canada’s *How Much Habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern*** (EC, 2003), especially for its four guiding principles:
 - Protect first; restore second
 - Use historic conditions to provide direction for restoration
 - Consider habitat needs for species of special concern
 - Consider the greater landscape (surrounding land uses, landforms and habitats)
- **Great Lakes aquatic habitat and species health assessment tools.** Many different evaluation tools have been used in the Buffalo Niagara Watershed, including Bird Studies Canada’s Marsh Monitoring Program, the NYS DEC Stream Biomonitoring Program, EPA’s rapid bioassessment protocols and various Indices of Biotic Integrity (IBIs). One of the major recommendations in this report is for agency, university and other field researchers to coordinate assessment and monitoring programs to the greatest extent possible so that the Buffalo Niagara region has a solid basis for measuring future changes in the biotic community.



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3. Historic Conditions: Buffalo Niagara Watershed

3.1 Geologic Features

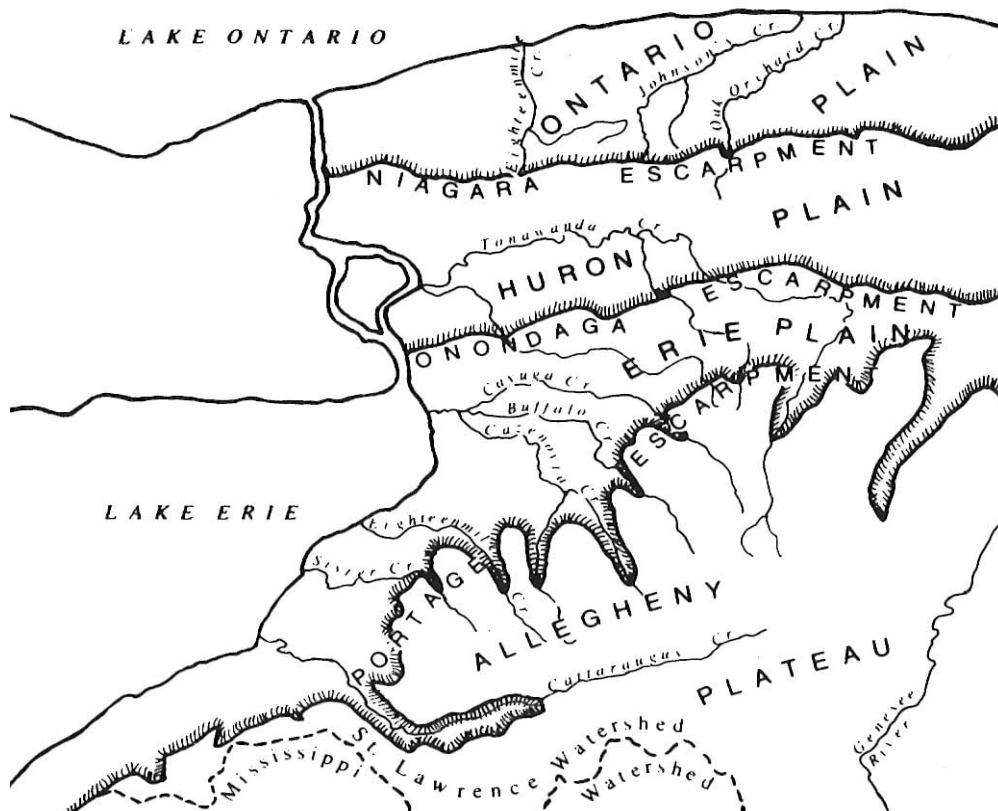
The present course of the Niagara River originated during the last glacial retreat, about 12,000 years ago. As the ice margin moved northward, the Niagara River became the principal drainage between the upper Great Lakes and Lake Ontario. Its name, a French version of the Mohawk *Nyah-ga-rah*, said to mean “neck,” reflects the river’s strait-like character (Marshall, 1880).

As the land rebounded and the Niagara River cut back through the escarpment, it also captured the outflow of glacial Lake Tonawanda that existed between the Niagara and Onondaga escarpments until about 3,000 years ago (Calkin, 1978). Traces of Lake Tonawanda are still present in the many wetlands and swamps across the towns of Amherst, Clarence, Newstead and Alabama, including a major habitat feature of the watershed—the Tonawanda Creek portion of a 20,000-acre complex of state and federal wetlands locally known as “Alabama Swamps.” Other habitat features related to glacier movements are the kettle lakes in the upper watershed, extensive deposits of sand and gravel that shaped drainage patterns and river islands, and the Niagara River corridor itself as a major north-south flyway for migrating birds.

In terms of bedrock geology, the Niagara River watershed descends through three levels, or plains, from the Allegheny Plateau at over 2,000 feet above sea level in southwestern New York to the Lake Ontario Plain at 246 feet above sea level in the north (Figure 3.1). An east-west trending escarpment marks each step down. Southernmost and highest is the Portage Escarpment, the dissected northern border of the Allegheny Plateau. The fast flowing headwaters of Niagara’s main tributaries—Tonawanda, Cayuga, Buffalo and Cazenovia Creeks—originate here, flowing north and west across the Lake Erie Plain.

Ten to twenty miles north of the Portage Escarpment, the Onondaga Escarpment marks a decrease in elevation across the watershed to the level of the Lake Huron Plain. The Onondaga Escarpment creates barriers and waterfalls on several Niagara tributaries including Indian Falls on Tonawanda Creek near Akron, Serenity Falls on Scajaquada Creek in Buffalo, and Glen Falls on Ellicott Creek in the Village of Williamsville. Vernal pools at the base of these escarpments provide critical habitat for amphibians like spotted salamanders (NYS DEC, 2006). The Onondaga Escarpment also marks the rapids between Lake Erie and the upper Niagara River.

Northernmost is the Niagara Escarpment—a defining feature of the Great Lakes basin. The escarpment divides the river into two separate aquatic ecosystems. Thus the Senecas had two names for the river: one for the lower river and Lake Ontario, and another for the upper river and Lake Erie (Marshall, 1880).



3.1 WNY Geography. From Marian E. White, *Iroquois Culture History in the Niagara Frontier Area of NYS*

3.2 Niagara River Watershed

The Niagara River drains approximately 263,700 square miles—the combined watersheds of four of the five Great Lakes. Over its course of 37 miles (measured from the mouth of Smoke’s Creek as the river’s hydraulic head), the river descends from the level of the four inland Great Lakes, at 570 feet above sea level, to the level of Lake Ontario at 247 feet above sea level. Niagara Falls accounts for 160 feet of that drop. The river supplies 83 % of the tributary flow to Lake Ontario. Average daily flow is 212,000 cubic feet per second (cfs), with a range of 90,000 to 347,000 cfs depending on lake levels and wind conditions (NYS DEC, 1994).

Within New York State the Niagara River watershed is approximately 1,270 square miles,* largely made up of eight tributary watersheds; Tonawanda Creek (635 square miles), Buffalo River (446 square miles), Cayuga and Bergholtz Creeks (47 square miles), Grand Island tributaries (34 square miles), Smokes Creek (33 square miles), Scajaquada Creek (29 square miles), Gill Creek (14 square miles) and Two Mile Creek (7 square miles, included in “Upper Niagara” drainage on Map 3.2).

* Note: The 1994 RAP uses 1,225 square miles, not including direct and Grand Island tributary areas.

3.2.1 NIAGARA RIVER

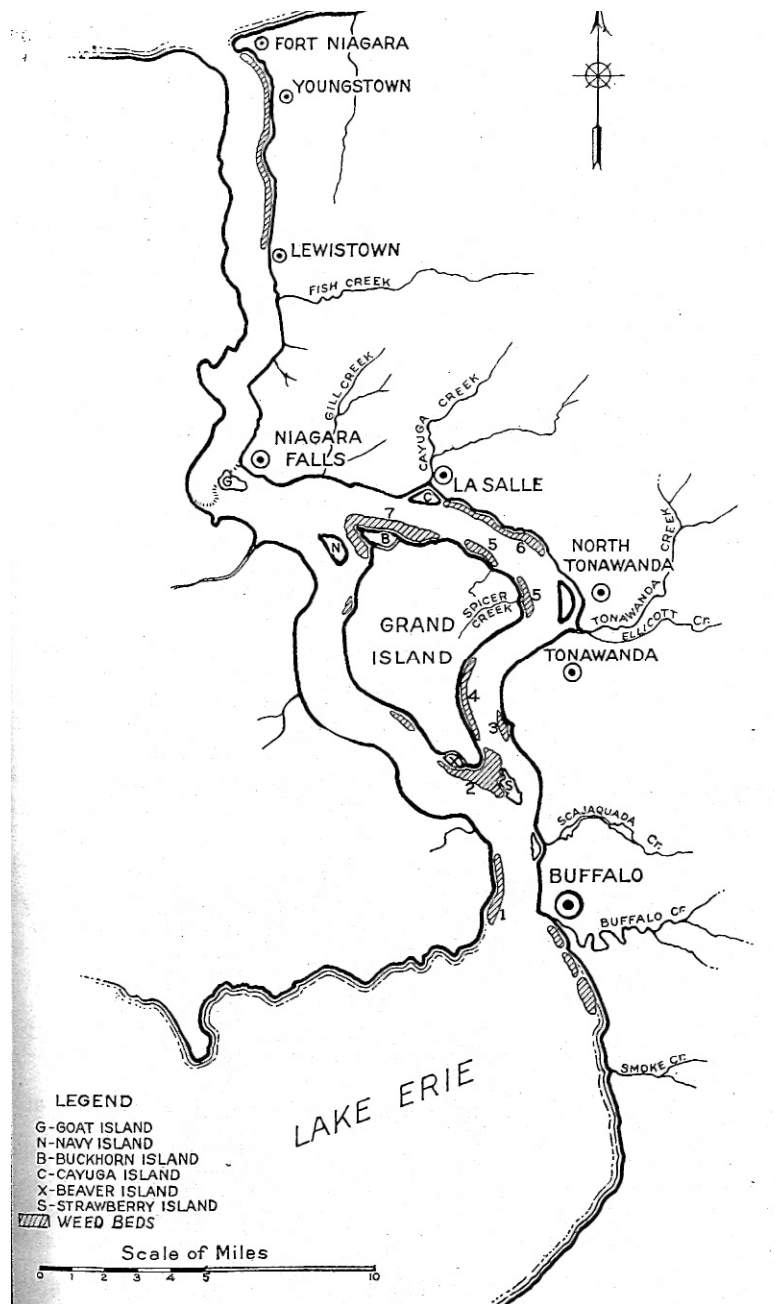
E. M. Kindle's Niagara Folio of the 1913 *Geologic Atlas of the United States* describes the Niagara's historic flows as follows: "Where it flows out of Lake Erie its surface is 572 feet above sea level and it is in places 40 to 50 feet deep and has a swift, even current. At Black Rock Rapids its depth is reduced to 20 feet or less and its fall is somewhat accelerated." The depth of both branches around Grand Island was irregular but averaged 20 feet. North of Grand Island, at the head of the rapids the depth was less than 3 feet nearly all the way across.

Below the falls and in the two-mile section of upper gorge the river was deep—"soundings of 150 to 190 feet have been made." In the next section of gorge, the river narrowed to 360 feet in width for about three-quarters of a mile. "This part of the river called Whirlpool Rapids is rather shallow and very turbulent, with great waves standing here and there along the axis of the current . . . The Whirlpool is about 1300 feet in diameter and its central portion is a grand eddy in which floating objects have been carried around for weeks. The greatest depth . . . is 126 feet."

The third section of gorge, the Devil's Hole Rapids was shallow, swift and turbulent. At Lewiston the river emerged through the escarpment and its channel widened to 2,000 feet all the way to Lake Ontario with a depth of 40 to 80 feet except for "a deep hole at Lewiston [that] gave a sounding of 183 feet" (Kindle et al., 1913).

Aquatic vegetation

A 1928 *Biological Survey of the Erie-Niagara Watershed* revealed a shoreline area severely polluted but still containing massive beds of a limited selection of aquatic plants. Species included wild celery (*Vallisneria americana*), most abundant in Buffalo Harbor, four species of pondweed (*Potamogeton Richardsonii*, *P. gramineus* and var. *graminifolius*, and *P. pectinatus*), and the plant-like algae, *Chara* or stonewort, all favorite foods of ducks and other waterfowl. The most extensive beds of aquatic plants in the upper river occurred in the east channel around Grand Island. The lower river, from its mouth to the Lewiston bridge, included a uniform zone "which began about three to ten meters from the shore and extended over a strip about ten to twenty meters wide, occupying a depth of about one to four meters" (NYS Cons. Dept., 1928).



3.3 Niagara River Aquatic Vegetation. (NYS Conservation Dept., 1929)

Terrestrial vegetation

The hemlock-white pine-northern hardwood forest communities in the watershed were first documented in the 1798 land surveys conducted by the Holland Land Company (Marks et al., 1992). "Witness tree" records along township lines and corners, presumably documenting the largest and/or most abundant trees, show that beech and sugar maple by far dominated most of the Lake Erie Plain forest community, followed by basswood, elm, oak, white ash and hemlock.

Survey notes on township maps further distinguish the lake bottomland basswood-beech- white ash-elm forests of the Buffalo Creek Reservation and north to Niagara Falls, from the beech-sugar maple forests on glacial till soils south of Buffalo to Cattaraugus Creek. White oak and white ash were abundant along the Niagara Gorge. Black ash occurred principally in Niagara and Orleans County wetlands, with a large black ash swamp associated with Tonawanda Creek near Akron.

Botanist Patricia Eckel has identified many remnants of the ancestral forest in the Niagara gorge and along its crest. Overall, the crest was (and is) dominated by an oak-hickory community, with old growth eastern white cedar, some up to 1,000 years old, a major forest tree growing from cracks in the bedrock within the gorge. White pine and hemlock were also historic crest tree species, but are absent today. (Eckel, Nov. 2004)

The Niagara River is a cradle where species of plants found and still find protection throughout changes in climate over the past 8,000 years since glaciation, where boreal and southern species, native and garden varieties take root and persist. The flora had and has an impressive diversity for such a small area. The Gorge provides a variety of habitats that attract different species associations: groundwater seeps; dry, exposed areas gorge crest (such as at Whirlpool Park); and protected areas of late snow-melt (Niagara Glen in Ontario) Within a region where the primary forest cover is a Beech-Maple-Hemlock-Birch association of trees, there are significant areas of Oak-Hickory woodlands, typical of lands to the south of New York State. The woods associated with old DeVeaux College, now owned by Niagara University, is an example of the latter. (Eckel, Jan. 1986)

Fish and wildlife

The historic (pre-1900s) lower Niagara-Lake Ontario fish community included Atlantic salmon, lake trout and blue pike as top predators. Forage fish included lake whitefish, lake herring and sculpins. Nearshore fish communities included lake sturgeon, northern pike and American eel.

However, Atlantic salmon and lake whitefish have not been seen in the river since the 1800s, and blue pike were declared extinct in 1972 (NYS DEC, 1994). Three other species not caught in the river since the 1930s are blackchin shiner, lake chubsucker and three-spine stickleback. American eel and lake sturgeon are NYS species at risk. Of the 91 fish species that have been documented in the Niagara River, at least 36 have been introduced since 1960 (Carlson, 2000; NYS DEC 2001).

The shoreline probably teemed with animals of many species including numerous reptiles, amphibians and mammals. There were thousands of birds, particularly waterfowl, shore and marsh-birds, gulls, terns, and many raptor

species, including bald eagles. During migration times, the huge flocks of ducks, geese, shorebirds and the many song birds that found food and rest in the trees, marshes, mud flats, and the river itself would astound us today. Mink, otter, muskrat, striped skunk, raccoon, rabbit, squirrels, red and gray fox, white-tailed deer, and many other species were no doubt numerous. (NYS DEC, 1994)

The river corridor was a major north-south travel route for many species of migratory birds, from the largest raptors like the bald eagle and osprey to the smallest songbirds. It was, and still is, a wintering and staging area for globally significant numbers of Bonaparte's gull (20% of the world population), herring gull, canvasback and common merganser (over 10% of their world populations); and for many state-listed bird species at risk including common tern, scaup, and common goldeneye. Its wooded wetlands contained rookeries for nesting colonies of heron. Waterbirds nesting along the Niagara River today include ring-billed gull, herring gull, common tern, great blue heron, great egret, and black-crowned night heron (Knapton and Weseloh, 1999).

3.2.2 NIAGARA RIVER ISLANDS

From south to north the Niagara River's main islands included: Bird, Squaw, Rattlesnake, Strawberry, Motor, Beaver, Grand, Buckhorn, Tonawanda, Cayuga, Navy (owned by Canada), Three Sisters (and company), and Goat islands. Historically these islands, formed largely of glacial sands and gravels, provided critical shallows and protected areas for fish and other aquatic life.

Bird Island, says Orasmus Marshall, "was originally several feet above river level, rocky at its lower end and partially covered with tall trees. Corn was cultivated on its upper end by Kenjockety's father [John Scajaquada]. It was called 'Bird Island' by the whites, because of the multitude of gulls and other aquatic birds that frequented it at certain seasons." Bird Island and the nearby outcrop of black rock marked the major historic (canoe/ferry) and present (Peace Bridge) Niagara River crossing place" (Marshall, 1880)

Dyos-daah-ga-eh, the Seneca word for the jut of black rock, "embraces the idea of a place where the lake rests upon or against a rocky bank. Its English name comes from the dark corniferous limestone which outcrops at this locality, and, underlying the bed of the river, composes the dangerous reef at the head of the rapids" (Marshall, 1880). The black rock and Bird Island were blown up and used for construction of the Erie Canal and Buffalo harbor breakwalls that now serve as important waterfowl and fish habitat areas.

Squaw Island was called by the Senecas *De-dyo'-we-no-guh-doh*, signifying a divided island, referring to its division by a marshy creek, Smuggler's Run (Marshall, 1880).

Strawberry and Motor Islands were part of a large shallow water shoals and marsh complex connecting to the southern tip of Grand Island that provided foraging, nesting/spawning and cover habitat for fish, waterfowl, wading birds, passerines, amphibians, and native wetland plant communities. Both islands almost disappeared from the Niagara River due to extensive sand and gravel mining. A third island, sometimes called “Frog Island,” did disappear, though its substrate remains between the other two (NYPA/Kleinschmidt, 2004).

Strawberry island and the shoal water between it and Frog island and Grand island included one of the most extensive and prolific areas of aquatic vegetation in the Niagara river. The series of submerged sandbars were covered with a dense growth consisting mostly of pondweeds. The land area was covered with slough grass (Spartina michauxiana), shore rush (Scirpus americanus) and bulrush (Scirpus acutus). Various species of arrowhead (Sagittaria) and spike rush (Eleocharis) were common in the shallow areas dissecting the islands. (NY Conservation Department, 1928)

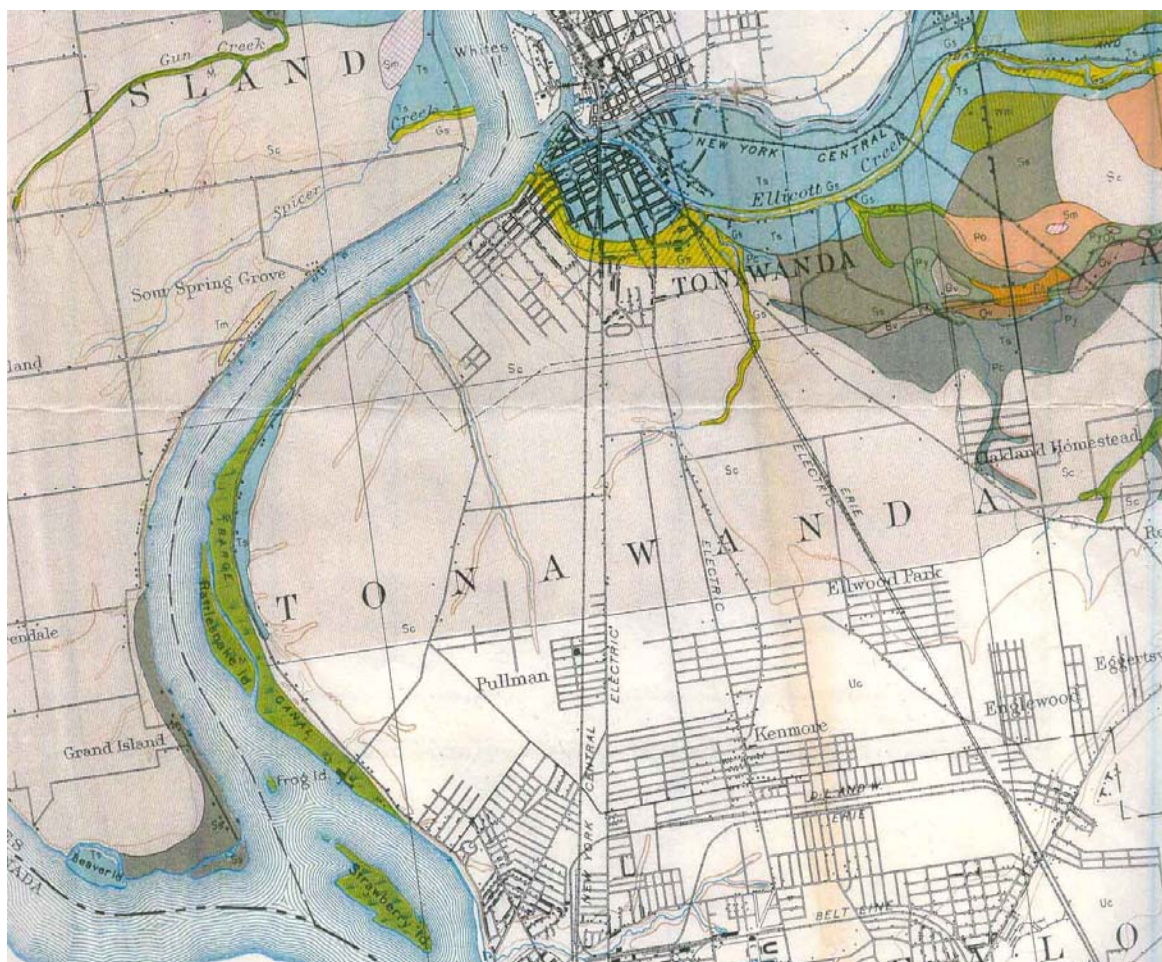
Sheathed pondweed (*Potamogeton filiformis*), a rare species in New York State, was historically found in the channel between Frog and Strawberry Islands (Eckel, correspondence to NYPA Ecological Standing Committee, 2008).

Strawberry Island is one of the two principle spawning grounds for muskellunge in the Niagara River. An 1815 land survey listed Strawberry Island at 100 acres. Sold to a gravel company in 1912, the island was reduced to just 8 acres by 1990 (Sault, 1995).

Motor Island, which once housed a Grand Island motor boat club, was given to NY State in 1998 to protect the heron rookery that established itself there.

Rattlesnake Island (Figure 3.4) was adjacent to what was historically called “the Flats,” the low-lying bulge of eastern shoreline south of Grand Island. The marsh separating Rattlesnake Island from the mainland was part of the largest coastal wetland on the upper Niagara River, extending almost all the way from the mouth of Cornelius Creek to the mouth of Tonawanda Creek. “The small bays above and below Rattlesnake Island contained extensive areas of submerged and emerged vegetation” (NYS Conservation Dept. 1929). Rattlesnake Island was known for its great variety of resident and migratory birds. Yellow rails were observed and historically collected there (NYS DEC 1994).

In the 1830s, Hamilton Cherry established a 300-acre farm along the Niagara River that included Rattlesnake Island, Strawberry Island and land that was later taken over by Wickwire Steel and Buffalo Slag companies. In 1918 the Barge Canal enlargement to the Erie Canal was completed, with the deepened channel running between the marsh and the mainland. By the late 1920s, Rattlesnake Island and the surrounding marsh were largely filled with industrial wastes.



3.4 Rattlesnake Island, from 1929 USDA Soil Map. Note Cornelius Creek at the bottom of the map and Two Mile Creek (with Rattlesnake Creek tributary), near the top (opposite Sour Spring Grove).

Grand Island, by far the Niagara River’s largest island, was predominantly forested. White oak was a dominant specie, largely harvested for ship masts in the 19th century. The island’s many tributaries and Buckhorn Island marsh at its northern end were important spawning areas, teeming with young fish, supporting in turn thriving populations of gulls, terns, ducks, and other fish-eating birds (Goodyear et al.,1982). Of the 31 species of mussel historically found in the Niagara River, field surveys in 2001-2 identified 16 (including 10 rare and 6 common species), mainly in association with Grand Island tributaries (NYPA/Riveredge Associates, 2003).

Goat Island, with its river mist microclimate, its isolation from the mainland (until 1817 when the first bridge was built), and its favorable downstream/downwind location for seed deposition has attracted botanists from around the world since the mid-1700s. Botanists Sir Joseph Hooker and Asa Gray identified 50 species of trees and shrubs on Goat Island in 1877. “Sir Joseph Hooker . . . has said that he found

on Goat Island a greater variety of vegetation within a given space than he had found elsewhere in Europe or east of the Sierras in America,” wrote local historian Augustus Porter in 1900. Others have estimated that more than 1,000 species of flowering plants and ferns were native to the island and falls area (Eckel, 2000).

3.3 Tonawanda Creek

Tonawanda Creek is the Niagara River’s largest New York watershed. From its source waters on the Allegheny Plateau, Tonawanda Creek and its main tributary, Little Tonawanda, flow northeast through steep wooded ravines as far as the Village of Attica. North of Attica, Tonawanda Creek continues for about 12 miles (as the crow flies) to the City of Batavia, meandering through wetlands and farmed mucklands. About 3 miles south of Batavia the two branches join. At Batavia, the creek meets the Onondaga Escarpment and takes a sharp left turn, flowing west to cross the escarpment at Indian Falls. This falls was historically the first major barrier to fish heading upstream from the upper Niagara River.

In the 20-mile stretch from Indian Falls to the Village of Pendleton (where the creek meets the Barge Canal), Tonawanda Creek’s broad floodplain and many wetlands are the remaining imprint of the ancestral, 50-mile-long, glacial Lake Tonawanda.

From Pendleton to its mouth on the Niagara River, the last 11 miles of Tonawanda Creek was a deep slack-water, which accommodated the builders of the Erie-Barge Canal who increased this channel to a depth of 12 feet and a width of 75 feet. A lock at Pendleton controls the flow. When the lock is open in summer, the Niagara River flows in and fills the barge canal all the way to Lockport. When closed, Tonawanda Creek completes its normal run to the river.

Tonawanda’s major tributary, 47-mile-long Ellicott Creek, flows northwest from the Town of Darien in the southwest corner of Genesee County to the City of Tonawanda. Ellicott Creek joins Tonawanda Creek about a half mile above its mouth at the Niagara River. The only protected section of Onondaga Escarpment—The Nature Conservancy’s “Clarence Escarpment Sanctuary”—is within Ellicott Creek’s 110-square-mile watershed.

The Erie-Niagara Basin Gazetteer names 31 other tributaries to Tonawanda Creek. After Ellicott, the largest, by drainage basin, are Ledge Creek at 74 square miles, Murder Creek at 67 square miles, Ransom Creek at 60 square miles, Mud Creek at 41 square miles and Little Tonawanda Creek at 38 square miles (Harding, 1968). On early maps Tonawanda Creek was called “Maskinongez,” the Chippewa name for muskellunge (Marshall, 1880).

Animal species. Rare or historical aquatic species associated with Tonawanda Creek include longear sunfish, redbfin shiner and 19 species of mussels (Carlson, 2000).

3.4 Buffalo River Watershed

3.4.1 TRIBUTARIES

Three major tributaries drain to the Buffalo River. In their upper reaches these streams are generally fast flowing with many rapids and low waterfalls. The average groundwater component of streamflow in these branches is 41-45% (USGS, 1998).

Northernmost is 39-mile-long Cayuga Creek, draining 126 square miles of Erie, Genesee and Wyoming Counties. Semi-protected remnants of its original forest cover include over 400 contiguous acres in Reinstein Woods and Stiglmeier Town Park in the Town of Cheektowaga.

43-mile-long Buffalo Creek drains 149 square miles and joins Cayuga Creek 8 miles above Lake Erie. The Buffalo Creek watershed includes the 324-acre Beaver Meadow Audubon Center landscape of glacial kames, kettle ponds and wetlands, plus several high quality rocky headwater streams such as Hunter Creek, within the Hunter Creek Forest (Hunt et al., 2002).

Cazenovia Creek drains 138 square miles of southern Erie County, joining the Buffalo River about 6 miles above Lake Erie. Its two major branches—18 mile-long West Branch and 24 mile-long East Branch—flow northeast to join in the Village of East Aurora, 17 miles above the confluence with the Buffalo River. At 1820 feet, the source of the East Branch is the Buffalo River basin's highest elevation. The contiguous forest and aquatic communities remaining in Cazenovia Creek's headwaters now have potentially statewide significance (Hunt et al., 2002).

3.4.2 LOWER RIVER AND BUFFALO HARBOR

The lower Buffalo River meandered across the flat Lake Erie plain to the lake, where a sandbar partially blocked its mouth. "Nothing with a draft deeper than a canoe could pass the sandbar" (Sauer, 1979). By 1821, after deepening had begun for the Erie Canal, the river could take ships of 5-foot draft. The average daily flow of the Buffalo River is about 355.5 mgd or about half the amount of precipitation in the watershed. Flows vary widely seasonally, from 50-65 mgd in late summer to 600-950 mgd in early spring, averaged over 40 years (Sauer, 1979).

Seeds of corn, squash, and beans found at archaeological sites like the Buffam St. site (c. 1500) near Cazenovia Creek, reveal that the lower river basin was farmed long before Europeans, or even the Seneca Nation, resided there. (Houghton, 1920).

The Niagara River RAP states that "the Tifft Street area was a large emergent marsh with an estimated area of 785 acres. This marsh likely functioned as a freshwater estuary associated with Lake Erie and was the largest on the eastern end

of the lake” (NYS DEC, 1994) Historical surveys conducted for Tifft Nature Preserve provide further details:

The low terrain south of the Buffalo River was a massive floodplain. Lake waters, driven by seasonal westerly winds, spilled over what is now Fuhrmann Boulevard and inundated the area to as far as the present Hopkins Street . . . The disappearance of the swamp in this area was further accelerated by the construction, in 1903, of the south harbor breakwater. This wall ended the intrusion of lake water into the area. [However], the cattail marsh on the eastern half of the boundary [at Tifft Nature Preserve] endured as a vestige of the natural history of the area. (Ecoplans, 1975)

In his *History of the Buffalo Creek Reservation*, historian/archaeologist Frederick Houghton describes the forests of the Buffalo River above the marsh:

The banks of the creeks and the wide flats bordering them were thickly set with basswoods, the abundance of which along Buffalo Creek caused the Indians to name it Dyosowa, the place of the basswood trees. The surface of the low plains above the creek flat was diversified by low sandy knolls and shallow swampy depressions. Here grew heavy stands of beech, maple, hickory and walnut, all dominated by the sombre pyramids of giant hemlock and pine. (Houghton, 1920)

“Early settlers say that the peninsula bounded by Main Street, Buffalo Creek and the canal was almost exclusively covered with this tree [American basswood], occasionally found more than eighty feet high and four feet in diameter” (Marshall, 1880).

Animal species. Our knowledge of historic wildlife populations in the Buffalo River estuary and harbor is largely anecdotal. Old time anglers remember when lake sturgeon spawned on the sandbars that were once located just off the Outer Harbor (NYS DEC, 1994). Pickerel, lake trout and herring were said to be so plentiful at Bird Island that “three casts of a net would fill a barrel with herring.” As physically, biologically and chemically altered as the Buffalo estuary-harbor area is, the variety and number of fish and wildlife species it supports today indicate its former and potential future quality as habitat.

3.5 Other Niagara River Tributaries

3.5.1 SMOKE’S CREEK

Smoke’s (or Smoke) Creek rises in the Town of Orchard Park and flows west-northwest for 15 miles to its mouth on Lake Erie (on the old Bethlehem Steel site). Its one principal tributary, South Branch, is 12 miles long. The creek is named after “Old Smoke,” a Seneca sachem whose son traditionally carried the fire—the “smoking brand”—from the Haudenosaunee or Iroquois Confederacy Council fire

at Onondaga to light Seneca Nation fire in Western New York. Old Smoke lived his later years and was buried near the creek, which was part of the Buffalo Creek Reservation negotiated at the Treaty of Big Tree in 1797 (Houghton, 1920).

Animal species. Smoke Creek shoals—a 500-acre gravel and rubble shallows in Lake Erie within a half mile of the mouth of Smoke Creek—is a potentially significant spawning area for warm water fish, especially walleye. (NYS DOS, 1987)

3.5.2 SCAJAQUADA CREEK

Fifteen-mile-long Scajaquada Creek rose in spring-fed wetlands in the present town of Lancaster, and flowed almost due west to its mouth on the Black Rock Canal section of the Niagara River. Its course was generally level except for a small falls over the Onondaga Escarpment in present-day Forest Lawn Cemetery in North Buffalo. Historically, the creek was wide, shallow and meandering, surrounded by extensive marshes and meadows before the “Scajaquada Drain” project (completed in 1928) tunneled 3.5 miles of the creek underground, the first of many projects that tied Scajaquada Creek into the City of Buffalo’s sewer system. Springs recharge the creek not only at its source, but also downstream in Forest Lawn Cemetery. These springs are now a major component of the base flow of lower Scajaquada Creek which is otherwise largely diverted through the Delavan Drain directly to Buffalo’s sewage treatment plant on Squaw Island.

Animal species. Marshes at the mouth of Scajaquada Creek would have supported all the historical upper Niagara bird and fish species. However, since major modifications began so early and were so extensive, we have little data on particular species. Fish and wildlife use is severely limited by almost 4 miles of tunneling and over 5 miles of channelization in the Town of Cheektowaga for flood control. A finger dam about a mile upstream from Scajaquada Creek’s mouth blocks fish migration upstream. Snapping turtles, beaver, heron and mink can today be seen on the lower creek (see, for example, www.bnriverkeeper.org, Riverwatch blogspot, 10/08).

3.5.3 CAYUGA CREEK (NIAGARA COUNTY)

Cayuga Creek originates on the Niagara Escarpment (at 620 feet above sea level) and flows south to join the Niagara River 5 miles above Niagara Falls, a descent in elevation of 60 feet. Cayuga Creek’s main stem is about 10.9 miles long. Bergholtz Creek, also flowing south from Cayuga Island from the mainland. Black Creek and Sawyer Creek are other small tributaries. The *Cayuga Creek Watershed Assessment Summary Report* describes the creekbed and surrounding topography as blanketed by deposits of dense, fine-grained lacustrine clays, leveling irregularities in the bedrock. Thus the topography is flat, the stream channel clay-lined, the water turbid and the soils poorly drained. Above Lockport Road a high water table feeds groundwater springs (Gomez and Sullivan, 2006).

Vegetation. The *Cayuga Creek Watershed Assessment* found that “The northern third of the watershed retains the most continuous habitat. . . a mosaic of upland, wetland and mesic vegetative cover types” (Gomez and Sullivan, 2006). Patricia Eckel’s survey of the historic flora on Cayuga Island, at the mouth of Cayuga Creek, concludes that areas like Jayne Park (on the island’s north side) could play an important role in restoring the renowned botanical diversity to the area surrounding Niagara Falls (Eckel, 2003)

Animal species. Historic fish species associated with Cayuga Creek include pirate perch, gizzard shad, grass pickerel, striped shiner and horneyhead chub. In 2001, 18 species of fish were found in Cayuga Creek. A USFWS survey of 2000 acres of grassland at the Niagara Falls Air Force Base (1997-1999) counted 17 species of mammals; 5 species of reptiles and amphibians including eastern box turtle (special concern); and 52 species of birds--including the short-eared owl (endangered); upland sandpiper and northern harrier (threatened); and American bittern, grasshopper sparrow and horned lark (special concern). (Gomez and Sullivan, 2006).

3.5.4 GILL CREEK

7.6 mile-long Gill Creek originates in wetlands on the Tuscarora Nation and flows south to its mouth on the upper Niagara River approximately 1,000 feet downstream of the NY power project water intakes. The watershed is mainly flat—slopes seldom exceed 2%--and underlain by Lockport Dolomite covered by lake clays and silts. The natural creek was mostly shallow (<1 foot) consisting of low gradient riffles, with 1-2 foot glide/run sections separating 1-3 foot pools.

Today, the Lewiston Reservoir occupies over half the upper watershed on Tuscarora Nation land, with a discharge channel to Gill Creek to supplement low flows in summer. The creek is ditched around the reservoir’s southern end until it reaches the original stream bed (at Saint Michael’s cemetery) and turns south. A dam about 1.2 miles upstream from the creek’s mouth creates 30-acre Hyde Park Lake, and is a significant barrier to fish movement upstream. The lower reach flows through heavily urbanized portions of the City of Niagara Falls.

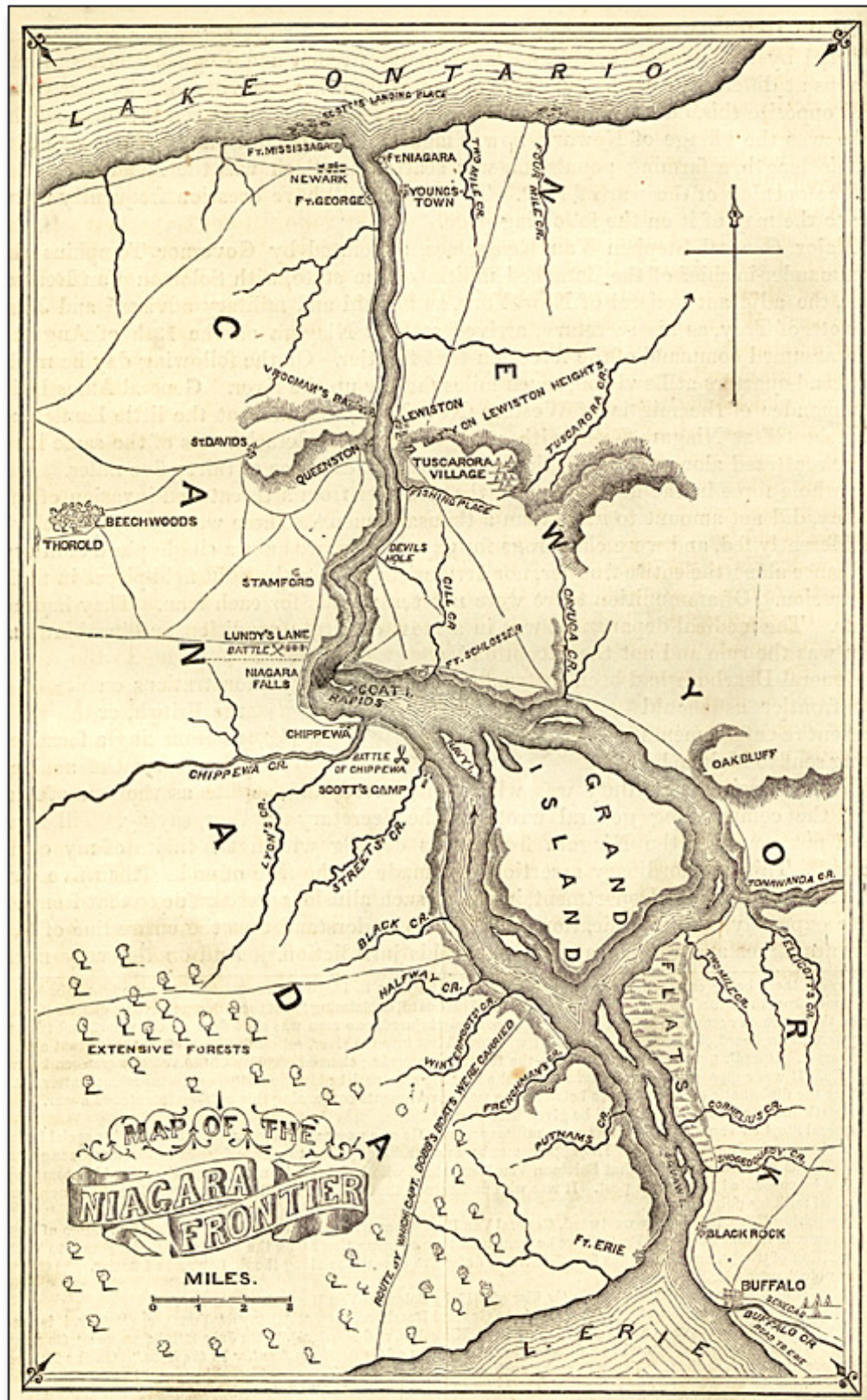
Vegetation. Aquatic vegetation is sparse. Riparian buffers are generally < 25 feet and dominated by invasive species including common buckthorn, tartarian honeysuckle, purple loosestrife, garlic mustard. In residential areas grass is often mowed to the edge of the stream. A natural section with extensive (> 100 feet) riparian buffers exists near the reservoir. (URS, 2004)

Fish species. Gill Creek’s warmwater fish community is dominated by forage fish species like minnows and sunfish. Crappies, bullheads and other panfish are stocked into Hyde Park Lake.

3.5.5 TWO MILE CREEK

Since Two Mile Creek is actually about 3.2 miles long, it may get its name from the fact that its mouth on the Niagara River is about 2 miles upstream from the mouth of Tonawanda Creek. “Wetlands previously covered most of the Two Mile Creek drainage area before development and landfill practices began (ENCRPB, 1976). Two Mile Creek and its tributary Rattlesnake Creek historically provided drainage to the Niagara River “Flats,” which, on some maps stretched all the way from the mouth of Scajaquada Creek to the mouth of Two Mile Creek (Figure 3.5).

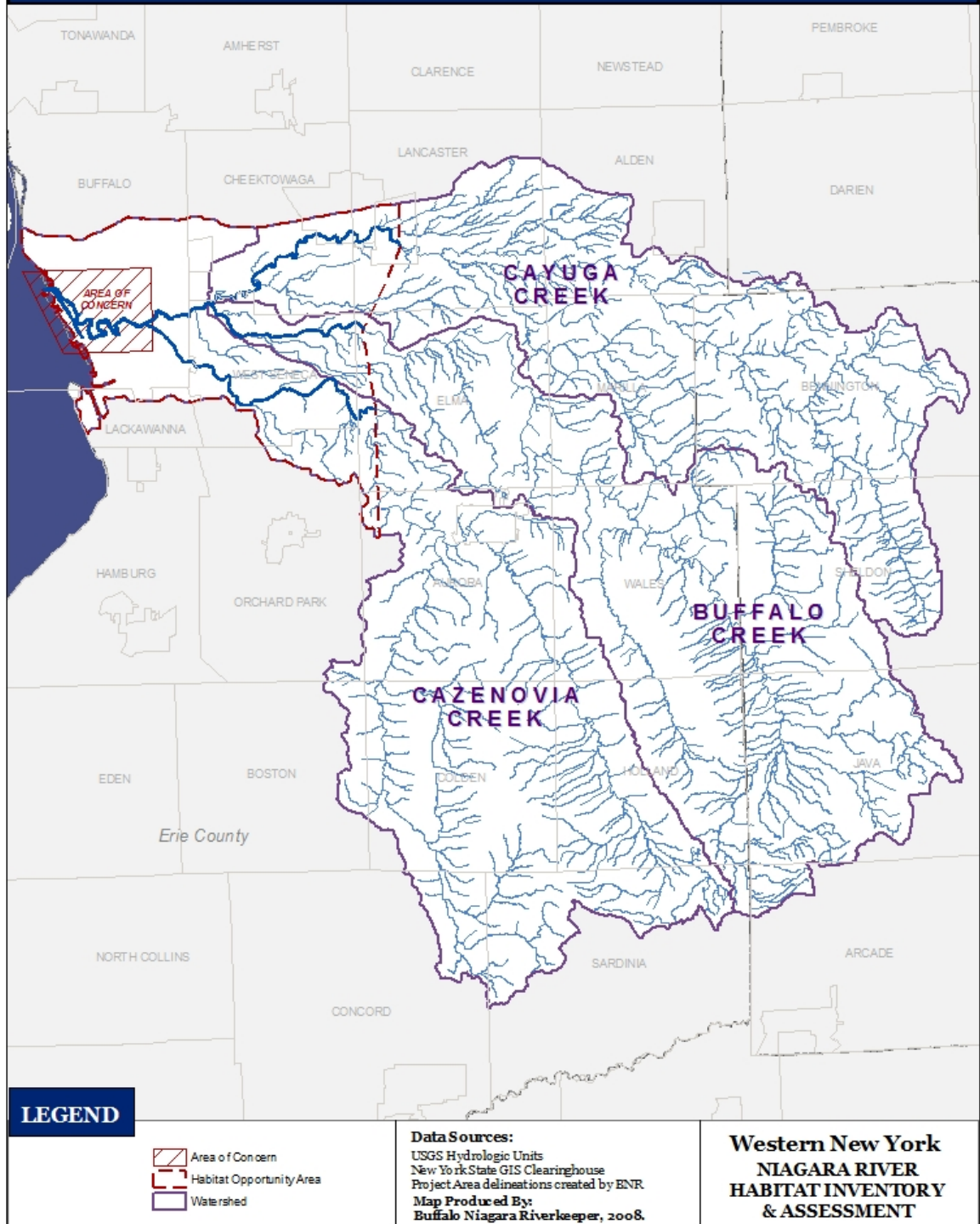
Over the past seven decades, extensive channelization turned the creek into a drainage ditch receiving runoff from industries, landfills and storm sewer systems in the Town of Tonawanda. Municipal, hazardous and radioactive waste disposal became a dominant land use in the Two Mile Creek watershed. However, the creek is also within the Niagara River “Important Bird Area,” which includes the full length of the river plus a 3.5 mile wide corridor in both sides, and it is just downstream from the most productive shoals on the river, extending from Strawberry Island along the southeastern side of Grand Island.



3.5 "The Flats." From *The Pictorial Field-Book of the War of 1812*, Benson J. Lossing, 1869



4.1 Buffalo River Area of Concern, Opportunity Area, and Watershed



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4. Buffalo River Habitat Assessment and Goals

This chapter describes current habitat conditions in the Buffalo River Area of Concern and tributary area compared with the 1993 baseline inventory. It also identifies progress on habitat protection and restoration since 1993, ongoing and new challenges, and information needs. Finally it recommends a set of conservation goals and “delisting criteria” for both the Buffalo River AOC and the tributary area immediately upstream. Maps can be found at the end of the chapter (p.50).

4.1 Boundary

The 1989 Remedial Action Plan defined the Buffalo River Area of Concern as the lower 6.2 miles of industrialized river plus the 1.4-mile-long City Ship Canal. However, in their baseline habitat survey for the RAP—the 1993 *Fish and Wildlife Habitat Inventory and Assessment of the Lower Buffalo River Watershed*—DEC biologists argued that habitat should be addressed at a watershed scale, or at least as far upstream as the first impassable barrier on each major tributary:

Habitat concerns and limitations on fish and wildlife populations logically should include the entire drainage basin and sub-basins to the Buffalo River. Due to time and funding limitations, however, the study area included the sub-basins up to the first impassable barrier on Cayuga Creek, Buffalo Creek and Cazenovia Creek, the three tributaries of the Buffalo River. For Cayuga Creek, the first impassable barrier is the dam at Como Park Lake in the town of Lancaster. For Buffalo Creek it is the falls in the town of Blossom east of Route 78. However, the bed sill structures between Harlem and Union Roads probably impede upstream fish migration during most of the year. For Cazenovia Creek, the falls at Northrup Road, east of Route 78 in the town of Elma is impassable. The dam-like structure in Cazenovia Park probably impeded fish migration during most of the year also. (Mikol et al., 1993)

The Technical Advisory Group agreed to continue this boundary in order to take advantage of opportunities for protecting remaining good quality habitat upstream as a source area for restoration efforts and species recruitment in the AOC. We thus defined the area from the river’s mouth to the first “impassable barrier” on its three major tributaries—Cayuga, Buffalo and Cazenovia Creeks (about 37.2 river miles)—as the Buffalo River study area. Including floodplains, wetlands and other significant tracts of riparian open space, the total study area is 3,861 acres, or about 15% of the entire Buffalo River watershed. **Map 4.1**

This chapter concludes with overall restoration goals for the study area, followed by specific goals and delisting criteria for the AOC.

4.2 Impairment Factors: Baseline and Current

On the basis of 1991 field investigations and analyses of aerial photographs taken in 1972 and 1985, the DEC's 1993 baseline inventory assessed the following factors:

- **Aquatic:** Including in-stream vegetation; channel and bank conditions
- **Terrestrial:** Including riparian wetlands, floodplain forests and stream buffer areas
- **Species:** Focusing mainly on fish and riverine birds.
- **Basic water quality:** Dissolved oxygen, saturation, conductivity and temperature

The following compares current conditions in the Buffalo River Corridor to these baseline assessments.

4.2.1 AQUATIC HABITAT

Baseline condition: Poor - Very poor

The 1993 baseline inventory found that “the manmade shoreline and dredged bottom have the greatest physical limiting effect on the ability of fish species to successfully reproduce and thrive.” Substrate conditions in the AOC were “very poor” due to navigational dredging. Since the 1960s the river has been dredged to a depth of 22 feet to accommodate lake vessels as far up as the Mobil tank farm, just below the confluence with Cazenovia Creek. The baseline inventory found that less than 5% of the AOC was less than 2 meters (6 feet) deep, and only 1-2% had in-stream vegetation.

The shoreline was also found to be 100% modified: 75% with hard structures like bulkheading or riprap, and 25% with softer fill, such as soil and debris. The DEC recommended that the 25% non-hardened shoreline should be restored to natural slope and vegetation.

Upstream from the AOC, aquatic habitat conditions were largely poor due to channelization, widening and loss of substrate and vegetative cover leading to seasonal low flows and high temperatures. Conditions were less impaired in a few areas, including a reach of Cayuga Creek upstream from Clinton Street that had natural vegetation, channel and substrate, and, within the AOC, the north bank around the “Katherine Street Peninsula” where pilings provided the only significant cover for forage and juvenile fish species.

Current condition: Poor

A 2005 *Assessment of Potential Aquatic Habitat Restoration Sites in the Buffalo River AOC* (Irvine et al., 2005) found little or no biotic recovery in the AOC since the 1990s. Benthic invertebrate sampling at 10 shoreline sites found species richness had actually declined from the early 1990s. Sixteen families of benthic

invertebrates were collected with pollution-tolerant sludge worms and midge larvae predominating. Mayfly and stonefly nymphs were absent at the sample sites. The assessment identified legacy industrial pollution, loss of submerged and overhanging vegetation, low DO levels, high turbidity and continued navigational dredging as limiting habitat quality in the AOC. No comparable study has been done in the upstream area.

Habitat restoration efforts since the baseline inventory include three projects undertaken by the Erie County Department of Environment and Planning which cumulatively restored about 2 acres of shallow water habitat and almost 1 mile of natural shoreline at the foot of Smith Street, Bailey Point and Seneca Bluffs (Poole, 1994; Stearns and Wheeler site plans, 1995). Fish habitat improvements were also included in the “Buffalo Color Area D” remediation; however ongoing EPA sediment sampling indicates high levels of contaminants around the perimeter of this site.

Historically, the US Army Corps of Engineers dredged 150,000 cubic yards every other year to keep the navigation channel open. Due to funding constraints, less has been dredged in recent years, resulting in a 750,000 cubic yards accumulation of sediment in the navigation channel as of 2008. Dredging occurs in the areas of greatest accumulation, mainly at the downstream end of the channel and in the areas of greatest commercial need. (Craig Forgette, USACE, personal communication).

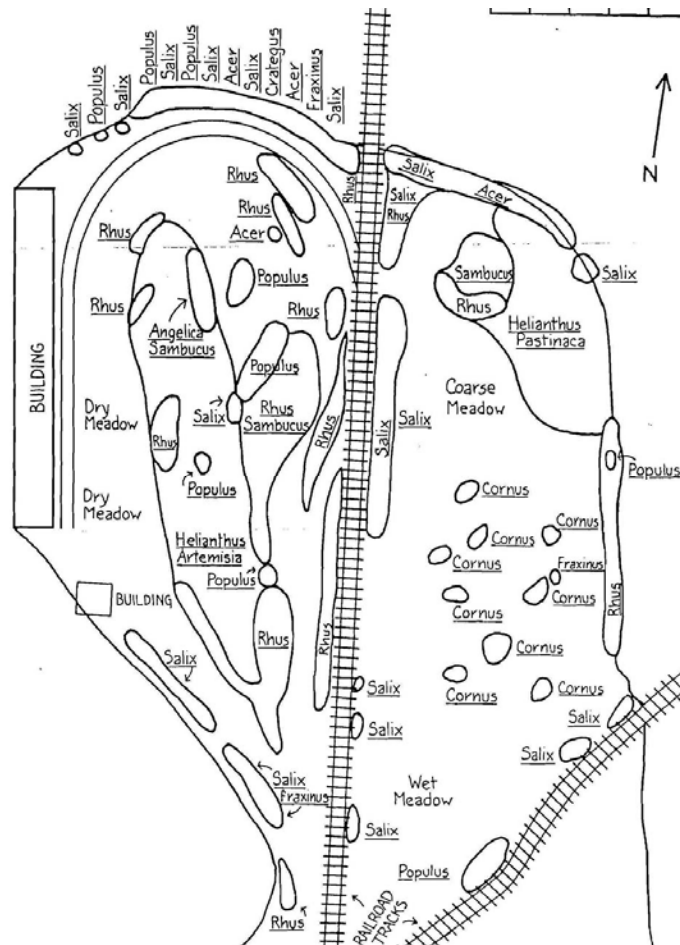
4.2.2 WETLANDS

Baseline condition: Poor

The 1993 inventory identified two wetlands on Buffalo Creek upstream of the AOC, totaling 24 acres and not state-protected. Tifft Nature Preserve and Times Beach wetlands were not included as they were considered part of the Niagara River AOC. The inventory identified one opportunity for restoring AOC riparian wetlands at Concrete Central Peninsula. Several other studies have recommended that this uniquely isolated 44-acre site be protected as a land use consistent with neighboring Tifft Nature Preserve (Makarewicz, 1982; Poole, 1994).

Current condition: Poor

Three state-protected riparian wetlands exist in the study area upstream from the AOC: the recently designated oxbow wetland on Buffalo Creek, BU-17 (14 acres) and two large wetlands on Cayuga Creek in Cheektowaga, LA-6 (140 acres) and LA-7 (23 acres), for a total of 177 acres. This acreage is less than 5 % of the study area which is predominantly underlain by hydric soils, indicating a deficit in protected wetland areas. **Map 4.2**



Vegetation map of summer flora at Concrete Central Peninsula (Makarewicz, 1982)

4.2.3 FLOODPLAIN AND RIPARIAN FORESTS

Baseline condition: Fair

The 1993 inventory identified 410 acres of intact floodplain forest in 35 discontinuous parcels. All but 3-acre Bailey Woods were upstream from the AOC. Seventeen species of trees were identified, with cottonwood and black willow dominant. Nine species of shrub and vine were identified, including one non-native (tartarian honeysuckle) and 21 forbes, including 3 invasives: Japanese bamboo (knotweed), phragmites, and purple loosestrife.

Technical Advisory Group member Roberta Vallone provided the unpublished field notes from NYS Natural Heritage Program botanist Al Shotz, who inspected West Seneca's floodplain forests in 1992 preparatory to the 1993 DEC inventory. He concluded:

Forested corridors along both Cazenovia and Buffalo Creeks warrant protection for their wildlife integrity and perhaps floristic diversity. These

corridors enable wildlife to migrate freely and thus reduce the risk of inbreeding, which would consequently weaken the gene pool . . . These areas exhibit a rich display of flora and fauna, [and] portray pristine-like qualities which are regionally uncommon in the vicinity of Buffalo. (Full notes available from BNR)

Shotz catalogued several rare or uncommon wildflowers including green violet, Virginia bluebell, harbinger-of-spring, goldenseal, and white trillium; and large specimen trees of red oak, black maple and black walnut. He called particular attention to riparian forest diversity along Cazenovia Creek associated with an array of landforms including floodplain terraces, upland ridges and wetland depressions. Both the 1992 and 1993 inventories recommended that the intact floodplain forests along Buffalo and Cazenovia Creeks upstream from the Buffalo River were unique in Erie County and should be protected.

Current condition: Fair

2005 aerial photographs show an increase in the amount of floodplain forest in the study area to approximately 1,000 acres, mainly in the Cayuga Creek corridor. This forest increase appears to be partly due to underestimation in the original inventory, and partly to natural succession. Another 837 acres of non-floodplain but riparian forest also exists, for example at Reinstein Preserve in Cheektowaga and along the Cazenovia Creek gorge bordering the towns of West Seneca and Elma. These riverine forests add great value to habitat connectivity, reinforced by the fact that, upstream of the City of Buffalo, 60 to 70% of the 100-year floodplain remains undeveloped. **Map 4.3**

Although less than 10 acres of floodplain forest exists within the AOC, Concrete Central Peninsula contains a rare 30 acres of open meadow 100-year floodplain on the east side of the railroad lines that bisect the peninsula.

4.2.4 RIPARIAN BUFFERS

Baseline condition: Poor

The DEC baseline inventory recommended the establishment of a continuous natural shoreline where possible in the AOC and upstream tributaries, noting that the existing fragmentation severely reduces wildlife usage. It provided the following guidelines for shoreline restoration:

- Remove dangerous debris such as broken concrete and re-bar
- Remove bulkheading where feasible and replace with a more natural slope
- Establish shoreline vegetation to a minimum of 15 meters (50 feet) in width
- Allow indigenous plants to re-establish, or plant them
- Include trees, shrubs and forbes in planting plans

Current condition: Fair

Buffalo Niagara Riverkeeper analyzed 2005 aerial photographs for naturally vegetated riparian buffers of at least 100 feet in depth from water's edge on each

shoreline. A 100-foot stream buffer is widely used in the Great Lakes region as a minimum standard for runoff filtration, temperature control and other aquatic habitat benefits (Fischer et al., 2000). In the City of Buffalo, about 50% of the Buffalo River shoreline is undeveloped and either vegetated or potentially vegetated to at least 100-feet landward. In the study area upstream from the city line, about 85% of the tributary banks are vegetated to at least 100 feet, though these de facto buffers are not necessarily protected or cultivated as such.

In 2001, the City of Buffalo amended its zoning code to require a development setback of 100 feet for new, non-water dependent uses in the “Upper Buffalo River Corridor,” defined as the Buffalo River shoreline area from the Ohio Street Bridge to the east city line. **Map 4.4** shows opportunity areas within the AOC for establishing a minimum 100-foot buffer of native vegetation within this corridor.

Although the amount of undeveloped shoreline buffer area may have actually increased since the 1993 baseline study, the quality may be reduced. Invasive species like Japanese knotweed now dominate many shoreline areas, such as Bailey Woods, that supported a more diverse community of native understory shrubs back in 1993.

4.2.5 BASIC WATER QUALITY

Baseline condition: Poor

Dissolved oxygen (DO) in the AOC was sometimes as low as 1.5 mg/L. In upstream tributaries the range was 5.3-9.6 mg/L. For walleye spawning DO must be > 5 mg/L. (Lowie et al., 1999) Water temperature range in the tributaries was sometimes high, 20-31° C, due in part to lack of cover. The baseline inventory recommended:

- Evaluate potential for enhancing DO levels for spawning and nursery habitat
- Review/evaluate water quality classification of the basin
- Implement a nonpoint source control program

Current condition: Poor

Both the *Assessment of Potential Aquatic Habitat Restoration Sites in the Buffalo River AOC* (Irvine et al., 2005) and the DEC’s 2005 Buffalo River RIB Study (NYS DEC, 2005) find that DO in the dredged portion of river is often below state guidelines for a Class C river. The *Assessment* concludes that the low (<4 mg/L) DO is related to a combination of stratification in the Buffalo River at low flows, high sediment oxygen demand, background biological oxygen demand (BOD), and long residence time due to system hydraulics created by dredging. Turbidity and *E. coli* levels are high during storm events, reaching 1,000 NTU and 38,000 mo/100mL respectively. Post-storm *E. coli* counts show that the upper watershed is a significant bacteria source (Irvine, 1996 & 2003).

Upstream of their confluence, Cayuga Creek is a Class C stream and Buffalo Creek is Class B. Cazenovia Creek is Class C from its mouth on the Buffalo River to

Cazenovia Park and class B upstream from the park. Water quality in these tributaries is sometimes below state standards due to high coliform and/or low DO levels. Low DO and high summer temperatures may impair fish reproduction and survival. (Kozuchowski et al., 1994; Lowie et al., 1999; Irvine et al., 2005)

4.2.6 SPECIES – FISH

Baseline condition: Poor-Fair

The baseline inventory identified 40 species in the study area, representing about 58% of historic diversity. 75% of these species were in the minnow, sunfish, perch, sucker or catfish families. Drum, walleye and gizzard shad were thought to be entering the Buffalo River from Lake Erie and the Niagara River to spawn, but it was not known if they were reproducing. The presence of 16 larval species (Kozuchowski et al., 1994) was a surprising improvement compared to a study conducted 10 years earlier (Makarewicz, 1982) and the still poor aquatic conditions in the AOC.

Of the priority species identified by the Great Lakes Fishery Commission (2003), the Great Lakes Restoration Strategy (2005), and the NYS Comprehensive Wildlife Conservation Strategy (2006), yellow perch were abundant in the AOC, with few upstream, and a few walleye were found in the AOC, with just 1 observed upstream. The 1993 inventory recommended as long-term goals:

- Restore a successful walleye spawning run in the lower river
- Develop, implement and sustain a fish and invertebrate monitoring plan

Current condition: Poor-Fair

Surveys at 10 AOC sites conducted in June and August of 2003 and 2004 found fewer fish species than documented in the baseline, including only 10 larval species. (Irvine et al., 2005) Adult and larval yellow perch were found in all surveys; adult walleye were found in June 2004 (no larval walleyes). 37% of the adult fish species sampled and 87% of brown bullheads sampled had deformities, eroded fins, lesions or tumors (DELT anomalies). An Index of Biotic Integrity (IBI), based on fish population diversity and individual health, rated 7 of the 10 sites sampled as “poor” and 3 sites as “very poor.” No similar IBI has been done for the tributary areas. However, various surveys have found some rare native species, including black redhorse in Buffalo Creek and longear sunfish in Cayuga Creek—both NYS “Species in Greatest Conservation Need.” The DEC stocked longear sunfish into Cayuga Creek in 2007 with plans to monitor recruitment in 2008.

A 2006-7 SUNY Brockport Buffalo River fish community survey replicated the sampling protocols (dates, collecting methods, sampling sites) used by Makarewicz in his 1981-82 field work. In 1981-82, 31 species were caught, mainly in the minnow, sunfish and catfish families, compared to 48 species in 2006-7, mainly largemouth bass, pumpkinseed, white suckers, gizzard shad and emerald shiners. There was a 51% similarity in fish communities after 25 years, with all but one of

the 1982 native species present in 2006-7. The additional diversity in 2006-7 was partly due to introduced or invasive species (Herbert, 2007). See Table 4.1.

4.2.7 SPECIES – BIRDS

Baseline condition

DEC wildlife biologists conducted field surveys in April, May and June of 1991, by boat up to the river's junction with Cazenovia Creek, and, upstream from that point, by walking the shoreline and floodplain forests (to 30 meters landward) along the tributaries to the first impassable barrier. They identified 20 species of birds in the AOC and 35 species upstream "probably due to the presence of more continuous natural protective cover along the tributary streams, as well as greatly increased acreage of floodplain forest" (Mikol et al. 1993). They found three open water or marsh "species in greatest conservation need" (SGCN) in the AOC and two forest or forest edge SGCN upstream of the AOC. See Table 4.2.

Current condition

The Buffalo Ornithological Society (BOS) conducted avian surveys on the Buffalo River, Buffalo Creek and Cazenovia Creek in May, June, September and January of 2005 and 2006. Seven volunteers conducted 10-minute counts at each of the 30 stations visited two or three times each month. They reported birds within 50 meters of the observer excluding flyovers. The BOS Spring (April, May and June) counts for both years combined identified 58 species in the Buffalo River AOC, and 83 species upstream of the AOC to the first barrier on Cazenovia and Buffalo Creeks. Forest or forest edge species by far dominated the upstream counts, including six species in greatest conservation need (Morris and Hamilton, 2007).

Given the different survey methods used in 1991 and in 2005-06, we cannot necessarily assume that the greater number of species observed in the latter survey is due to a population or habitat rebound over the 15-year interval. However, the field work does give us a good idea of birds using the river corridor, with about 90% of the species seen in at least 2 different years. The research also indicates dominant habitat types along the river, with the lower river/AOC linked more to Lake Erie/Niagara River open water species, while the tributaries support a diverse population of primarily forest and forest edge species, including rarer species like black-billed cuckoo, scarlet tanager, willow flycatcher and wood thrush.

Comparatively fewer marsh and grassland species were found throughout the river corridor indicating the lack of these habitats. Even so, several of the rarer marsh and grassland species were identified, including the black-crowned night heron, pied-billed grebe, American kestrel, bobolink, and eastern meadowlark. See Table 4.2.

Table 4.1 Buffalo River AOC Fish Surveys: 1981-82 and 2006-07

COMMON NAME	81-82	06-07		COMMON NAME	81-82	06-07	
Alewife		X	I	Shorthead redhorse	X	X	N
Bigmouth buffalo		X	N	Silver redhorse		X	N
Black crappie	X	X	N	Smallmouth bass	X	X	N
Bluegill	X	X	N	Smallmouth buffalo		X	N
Bluntnose minnow	X	X	N	Spotfin shiner		X	N
Brook silverside		X	N	Spottail shiner	X	X	N
Brown bullhead	X	X	N	Spotted sucker*		X	N
Brown trout		X	I	Striped shiner		X	N
Channel catfish		X	N	Stonecat	X	P	N
Chinook salmon	X		I	Trout perch	X		I
Coho salmon	X		I	Walleye	X	X	N
Common shiner	X	X	N	Warmouth	X		N
Common carp	X	X	I	White bass	X	X	N
Emerald shiner	X	X	N	White crappie		X	N
Fathead minnow	X	X	N	White sucker	X	X	N
Freshwater drum	X	X	N	Yellow perch	X	X	N
Gizzard shad	X	X	U				
Golden redhorse		X	N	SPECIES RICHNESS	33	48	
Golden shiner	X	X	N				
Goldfish	X	X	I				
Greater redhorse		X	N				
Green sunfish		X	I				
Johnny darter		X	N				
Lake trout	X	X	N				
Largemouth bass	X	X	N				
Logperch		X	N				
Longnose gar		X	N				
Mimic shiner		X	N				
Muskellunge	X	P	N				
Northern hognose sucker	X	X	N				
Northern pike	X	X	N				
Pumpkinseed	X	X	N				
Quillback	X	X	N				
Rainbow trout	X	X	I				
Rock bass	X	X	N				
Round goby		X	I				
Rudd		X	I				
Sea lamprey		X	I				

P = present in the system but not during survey replication.

N = native

I = Introduced

U = Unknown

* = An unusual find in this region; requires further confirmation

Table 4.2a: Buffalo River AOC Spring Bird Surveys—1991 and 2005/2006

OPEN WATER (LAKE/RIVER)	1991	2005	2006	MARSH	1991	2005	2006
Belted kingfisher		X	X	Alder flycatcher		X	X
Canada goose		X	X	Black-crowned night-heron		X	
Common loon (SGCN)		X		Great blue heron		X	X
Common tern (SGCN)		X		Green heron		X	
Double crested Cormorant		X	X	Pied-billed grebe (SGCN)	X		
Herring gull		X	X	Red-winged blackbird		X	X
Horned grebe (SGCN)	X			Wood duck		X	X
Mallard	X	X	X				
Red-breasted merganser	X			GRASSLAND			
Ring-billed gull	X	X	X	American goldfinch		X	X
Rough-winged swallow		X	X	American kestrel			X
Spotted sandpiper		X		Barn swallow		X	X
				Brown-headed cowbird		X	X
				Eastern kingbird			X
FOREST/FOREST EDGE				Eastern phoebe		X	X
Baltimore oriole		X	X	Killdeer	X	X	X
Black-capped chickadee		X	X	Ring-necked pheasant	X		
Chestnut-sided warbler			X				
Common yellowthroat		X	X	MIXED URBAN			
Cooper's hawk (SGCN)		X	X	American crow	X	X	X
Dark-eyed junco	X			American robin	X	X	X
Downy woodpecker		X	X	Blue jay		X	
Least flycatcher		X	X	Cedar waxwing	X	X	X
Northern cardinal		X	X	Chimney swift		X	X
Northern flicker	X	X	X	Chipping sparrow			X
Purple finch	X	X	X	Common grackle	X	X	X
Red-eyed vireo		X	X	European starling	X	X	X
Red-tailed hawk		X	X	Gray catbird	X	X	X
Rose-breasted grosbeak			X	House finch		X	X
Tree swallow	X	X	X	House sparrow		X	X
Turkey vulture		X		House wren		X	X
Warbling vireo		X	X	Mourning dove	X	X	X
White-breasted nuthatch			X	Rock dove		X	X
Willow flycatcher (SGCN)		X	X	Song sparrow		X	X
Yellow warbler	X	X	X	White-throated sparrow			X
Yellow-rumped warbler	X						

Table 4.2b: Buffalo River Tributary Area Spring Bird Surveys—1991 and 2005/2006

OPEN WATER (LAKE/RIVER)	1991	2005	2006	FOREST/EDGE CONT'D	1991	2005	2006
Belted kingfisher	X	X	X	White-breasted nuthatch		X	X
Canada goose		X		White-throated sparrow			X
Double-crested cormorant		X		Willow flycatcher SGCN	X	X	X
Mallard		X	X	Winter wren		X	
Ring-billed gull		X	X	Wood thrush SGCN		X	X
Rough-winged swallow		X	X	Yellow-billed cuckoo		X	X
Spotted sandpiper	X	X	X	Yellow-rumped warbler	X		
FOREST/FOREST EDGE				Yellow warbler	X	X	X
American redstart		X	X	MARSH			
Baltimore oriole	X	X	X	Alder flycatcher			X
Black-billed cuckoo SGCN		X	X	Blk-crowned night heron SGCN			X
Black-capped chickadee	X	X	X	Great blue heron		X	X
Black and white warbler		X	X	Green heron		X	X
Blk-throated blue warb. SGCN		X		Red-winged blackbird	X	X	X
Blk-throated green warbler		X		Wood duck		X	X
Carolina wren		X	X	GRASSLAND			
Common yellowthroat	X	X	X	American goldfinch	X	X	X
Dark-eyed junco	X	X	X	American kestrel	X		X
Downy woodpecker	X	X	X	Barn swallow	X	X	X
Eastern towhee		X	X	Bobolink SGCN		X	X
Eastern wood peewee	X	X	X	Brown-headed cowbird	X	X	X
Great crested flycatcher	X	X	X	Eastern kingbird			X
Hairy woodpecker	X	X	X	Eastern meadowlark SGCN		X	X
Hooded warbler		X	X	Eastern phoebe		X	X
Indigo bunting		X	X	Field sparrow		X	X
Least flycatcher		X	X	Killdeer	X	X	X
Lincoln's sparrow SGCN		X		Ring-necked pheasant	X		
Northern cardinal	X	X	X	MIXED URBAN			
Northern flicker	X	X	X	American crow	X	X	X
Ovenbird			X	American robin	X	X	X
Pine warbler		X		Blue jay	X	X	X
Purple finch	X	X	X	Cedar waxwing		X	X
Red-bellied woodpecker		X	X	Chimney swift		X	
Red-breasted nuthatch		X		Chipping sparrow		X	X
Red-eyed vireo		X	X	Common grackle	X	X	X
Red-headed woodpecker		X	X	European starling	X	X	X
Red-tailed hawk	X	X	X	Gray catbird	X	X	X
Rose-breasted grosbeak		X	X	House finch	X	X	X
Scarlet tanager SGCN	X	X	X	House sparrow		X	X
Swainson's thrush		X		House wren		X	X
Tree swallow	X	X	X	Mourning dove	X	X	X
Tufted titmouse		X	X	Purple martin		X	X
Veery		X	X	Rock dove		X	X
Warbling vireo		X	X	Ruby-throat'd hummingbird		X	X
				Song sparrow	X	X	X

4.3 Accomplishments and Challenges

4.3.1 ACCOMPLISHMENTS

Perhaps the greatest opportunity for habitat improvement in the Buffalo River AOC lies in the “blank slate” of naturally recovering former industrial landscape. Brownfields and transitional urban land offer opportunities to implement habitat restoration plans in conjunction with “green infrastructure” development for stormwater, flood and sewage overflow management.

Habitat acquisition/restoration

- *Buffalo River Urban Canoe Trail.* Opened in the late 1990s, the NYS DEC’s canoe trail is anchored by a small park and launching site at Ohio Street in the AOC and another at Harlem Road near the east city line. River access has contributed to citizen involvement in restoration and monitoring activities such as Buffalo Niagara Riverkeeper’s Riverwatch Program, which deploys 90+ volunteer captains including 26 that monitor the Buffalo River and its tributaries.
- *County habitat/access projects.* Erie County’s Department of Environment and Planning (EC DEP) identified 15 potential habitat restoration sites in or near the Buffalo River AOC (Poole, 1994) and has implemented projects at four of them: the foot of Smith Street, Bailey Point, Seneca Bluffs and the Ohio Street boat launch—a total of about 25 acres of restored habitat. Neighborhood communities, including the Valley Community Center and Southside High School help maintain some of these sites.
- *Bailey Woods.* Identified in the baseline inventory as a priority for protection as one of the only remaining riparian forests in the AOC, these 2.3 acres of black willow and cottonwood were protected from development by a settlement agreement between Friends of the Buffalo River (now Buffalo Niagara Riverkeeper), the City of Buffalo, and the adjacent Iron Mountain records storage facility.
- *Burchfield Nature Park and other floodplain parcels.* In the late 1990s the Town of West Seneca acquired and restored the 55-acre Burchfield Nature Park on Buffalo Creek, including native plantings and interpretive trails. The town has also acquired and developed low density playfields on about 130 acres of Cazenovia Creek floodplain. However, despite the fact that West Seneca’s Environmental Commission recommended it 30 years ago (WSEC, 1978), the town has yet to make floodplain protection official policy.
- *Times Beach, Outer Harbor and Tift Nature Preserve (see Chapter 6).* Although these areas are technically included in the Niagara River AOC, they were part of the historic, biologically-rich Buffalo River/Lake Erie freshwater

estuary. Habitat restoration efforts in the last 10-15 years have included wetlands and upland restoration at the former 55-acre Times Beach confined disposal facility (now a city-owned “nature sanctuary”); shoreline and breakwall habitat improvements in the Outer Harbor; and marsh restoration work at Tifft.

Regulation/zoning/planning

- *DEC Open Space Plan.* The 2008 Open Space plan highlights Buffalo River watershed protection and stream buffer easements as a NYS priority for acquisition/protection.
- *Setback zoning.* The City of Buffalo revised its zoning code (9/17/01), to include a Buffalo River Open Space Corridor for new, nonwater-dependent uses on the river. The “Upstream Corridor” (Ohio St. to east city line) requires a setback of 100 feet (Section 511-67B).
- *Community greenway plans.* All regional waterfront greenway plans recognize the Buffalo River as a critical link between the Niagara River corridor and inland riparian habitat and open space (Wendel Duchscherer, 2007; Poole, 1997). At least one report includes parcel-based acquisition priorities for the Buffalo River Greenway from the confluence with Cazenovia Creek upstream to the east city line (Schneekloth et al., 1993).
- *Critical Environmental Areas.* The Town of Cheektowaga designated Cayuga Creek, its 100-year floodplain, Reinstein Woods, Stiglmeier Park (480 acres) and all wetlands in the town as Critical Environmental Areas under SEQRA. This triggers a higher level of review for any project with the potential to impact these resources. The *Town of West Seneca Open Space and Greenway Protection* plan recommended that all 100-year floodplains and wetlands >1/3 acre should be designated CEAs (FBNR/Poole, 1999), but this has not yet occurred.
- *Oxbow wetland.* In 2008, the DEC designated the historic 14-acre oxbow wetland on Buffalo Creek in the Town of West Seneca as a state-protected wetland. Studies going back to the mid-1970s identified the oxbow as a high quality natural area that should be protected.



Town of West Seneca oxbow wetland

4.3.2 CHALLENGES

- *Upstream development pressures.* Increased residential development along the tributaries immediately upstream from the AOC means loss of stream cover, septic system pollution, and increased contamination and siltation from increased stormwater runoff. As of January 2008, “MS-4” communities such as West Seneca and Cheektowaga who have separate sanitary and storm sewers must comply with new state stormwater runoff regulations. The challenge is to provide a good quantifiable link between stormwater requirements and protected riparian wetlands, floodplain forests, and vegetated buffers as standing green infrastructure.
- *Downstream development pressures.* Redevelopment of vacant land and brownfields in the AOC presents a threat but also an opportunity if carefully coordinated with habitat restoration goals. For example, redevelopment of the Steelfields site offers an opportunity to restore a generous riparian buffer to a significant stretch of shoreline (Map 4.6).
- *Dredging.* Remedial dredging of contaminated sediments from the AOC (scheduled to begin in 2010) has the potential to re-expose biota to contaminants. The use of harbor confined disposal facilities (CDFs) to store dredge spoils physically removes shallow water aquatic habitat and could lead to chemical recontamination of lakeshore areas if the CDF fails.

Both remedial and routine navigational dredging have the potential to destroy or impair aquatic habitat by removing shallows and aquatic vegetation and

affecting basic water quality parameters like DO (Irvine et al., 2005). Thus, whether removing contaminated sediments or accommodating shipping needs, the challenge is how to get the job done with the least amount of dredging. See Janowsky, 1998 for an analysis of Buffalo River aquatic habitats in relation to potential remedial dredging scenarios.

- *Invasive species.* Much of the AOC shoreline, including protected areas like Bailey Woods, is being colonized by invasive species like Japanese knotweed, plants with far less value to wildlife than the native vegetation they replace. Elimination of these hardy invasives is probably unlikely, and control will require a long-term community effort.

However, a Partnership for Regional Invasive Species Management (PRISM) has recently been organized in Western New York through the efforts of the DEC and many volunteers to disseminate information and provide funding support to efforts associated with the prevention, control and management of invasive plants and animals.

4.4 Information Needs

Some Buffalo River habitat improvement projects such as securing land with good existing or potential habitat value, should begin as soon as possible, before these opportunities are lost. Other projects may require data gaps to be filled. Information needs include:

- A model for the lower river comparing the hydrologic regime of the currently maintained channel and Ship Canal through the range of flooding, scouring, and lake seiche effects, to a more naturalized channel through various reduced navigational dredging scenarios. (Building on work done by Green and DePinto, 1999; Williams and Atkinson, 2004; Singer et al, 2006)
- A follow-up study on contaminant levels in the open water and wetland areas of the Times Beach CDF, to evaluate aquatic habitat quality as well as potential impacts of placing Buffalo River remedial dredge spoils in the current CDF near the old Bethlehem Steel plant.
- A monitoring protocol to establish a baseline and measure reductions in sediment and nutrient loads to the river in conjunction with municipal stormwater control efforts (Building on Atkinson, 1994).
- Green infrastructure pilot projects addressing the potential of non-engineering alternatives such as protecting and restoring tributary buffers and undeveloped floodplains to reduce storm and sewage overflows to the Buffalo River.
- Better characterization of bird use of the AOC as part of the Niagara River Important Bird Area, and of the tributaries in conjunction with riparian habitat restoration efforts.
- A coordinated approach to evaluating aquatic habitat in the Buffalo River corridor using one common aquatic habitat quality assessment index. This could supplement New York State's Stream Monitoring Program, which focuses on macroinvertebrate populations and tissue samples (Bode, 2002), with information on the physical characteristics of streams and riparian zones. It could involve training local volunteers for more frequent monitoring through programs like Riverkeeper's "Riverwatch." Bird Studies Canada has summarized and compared the merits of several different aquatic and wetland habitat evaluation indices currently used in the Great Lakes region (Wheeler and Archer, 2008).
- A GIS/remote imaging clearinghouse maintaining current high resolution aerial photography, with standardized land cover analysis, current databases and related reports, and internet sharing capacity.

Table 4.3: Buffalo River Habitat Opportunities on Public Land (See Map 4.5)

Although the public lands listed below are more or less protected as open space, they provide many opportunities for increasing habitat value—from managing invasive species to restoring creek meanders in channelized areas.

<u>Parcels</u>	<u>Acres</u>
City of Buffalo (Buffalo River)	
Ohio St. boat launch	1.8 park-like grass/trees
Foot of Smith Street	3.7 wetland/shrub/forest
Bailey Woods	2.3 urban forest
Bailey Point	4.2 urban forest
Seneca Bluffs	15 meadow/floodplain forest
Stachowski Park	39 playfields/floodplain forest
DEC fishing access at Harlem Rd.	2 park-like
Cazenovia Park	191 golf course/floodplain meadow
Town of West Seneca:	
Burchfield Nature Center	30 floodplain forest/meadow
Oxbow wetland on Buffalo Creek	14 floodplain wetland
Floodplain parcels on Caz Creek	130 playfields/floodplain
Town of Cheektowaga:	
Erie Co. Cayuga Creek Overflow Retention Facility	
(Town leases for passive park)	65 floodplain forest/meadow
Reinstein Woods (inc. LA-6 wetland)	280 forest/wetland
Stiglmeier Park	223 playfields/floodplain forest
LA-7 wetland	23 wetland
TOTAL	1,024 acres

4.5 Buffalo River Study Area Habitat Goals and Strategies

GOAL: RESTORED CONNECTIVITY. Undeveloped floodplains, riparian wetlands, and vegetated buffers are protected and restored.

Strategies:

- Inventory riparian lands for priority sites for acquisition, conservation easements or habitat restoration opportunities. See Table 4.3 and Map 4.5
- Require minimum 100-foot buffers of native vegetation for new, non-water dependent development or redevelopment within the City of Buffalo Upper River Corridor.
- Amend local laws with a “Protected Stream Corridor” zoning overlay or “Critical Environmental Area” designation under SEQRA.
- Develop and implement “best management programs” with shoreline owners.

Benchmarks:

Short term

- Provide information to Buffalo River corridor jurisdictions on habitat goals.
- Develop, with local land use managers, a priority list of significant riparian habitats.
- Review town codes, SEQRA and site plan review practices, floodplain and stormwater management plans to identify regulatory needs and options.

Longer term

- River Corridor municipalities adopt stream corridor-protective land use regulations.
- Priority river/creek habitats are secured through purchase and/or conservation easements.

GOAL: RESTORED HABITAT QUALITY. For tributary reaches above the AOC: Standard measures for aquatic habitat and specie health show scores of at least “good,” AND the *NYS Priority Waterbodies List* finds no reach to be impaired, stressed or threatened for aquatic life.

Strategies:

- Adopt and use an aquatic habitat and species assessment tool to assess and quantify a baseline condition in the AOC and tributaries against which to measure restoration progress.
- Use this tool to supplement the DEC macroinvertebrate monitoring program (Bode, 2002) and to target, implement and adaptively manage aquatic habitat restoration projects.

Benchmarks:

Short term

- Agencies, universities and others involved in biological monitoring, select or coordinate consistent habitat and aquatic health evaluation tools.

Longer term

- Tributaries consistently meet NYS water quality standards for a “B” river.
- Aquatic habitat scores are above average and improving.
- A species monitoring or IBI program is implemented with training provided to ensure long-term use.

GOAL: RESTORED HYDROLOGIC FUNCTION. The scope and/or effects of dredged, channelized, hardened or otherwise modified stream channel is reduced, with natural channel conditions restored in opportunity areas.

Strategies:

- Assess creek banks in the study area for natural slope restoration opportunities.
- Assess stream barriers and channelizations for their potential impacts on aquatic life, and develop options for reducing impacts.

Benchmarks:

- At least 75 % of the study area upstream from the AOC is restored to approximate natural channel conditions. See, for example, Cazenovia Park plan.



Buffalo Olmsted Parks Conservancy Plan for Cazenovia Park: “Protect and enhance Cazenovia Creek. Develop ecological and sustainable systems for managing floods and stormwater. Develop overflow areas along the creek to absorb more flood waters.”

4.6 Buffalo River AOC Habitat Goals and Delisting Criteria

(Adopted by the Buffalo River Remedial Action Committee as part of the Buffalo River AOC delisting document, November, 2008)

GOAL: RESTORED HABITAT CONNECTIVITY See Map 4.6

- A minimum 100-foot buffer of native vegetation on each riverbank for new development is maintained and enforced upstream from the Ohio Street Bridge.
- Significant floodplain, wetland or riparian habitat areas in the AOC are protected and/or restored. (See Table 4.4 for opportunity areas.)
- A minimum 25% of the AOC shoreline is restored to natural slope, shallows and aquatic (emergent and submerged) native vegetation, including naturalizing areas of the City Ship Canal shoreline.

GOAL: IMPROVED STREAM QUALITY INDEX SCORES

- Basic water quality measures (based on NYS RIBS or other monitoring) consistently meet state standards for at least a Class C river.
- Aquatic habitat scores are fair to good AND/OR the lower Buffalo River is no longer listed as “stressed” for aquatic life on the *NYS Priority Waterbodies List*.

GOAL: RESTORED HYDROLOGIC FUNCTION SUPPORTS HABITAT AND SPECIES

- Navigational dredging in the AOC is reduced to support the habitat and species goals adopted for Beneficial Use Impairment (BUI) #3* AND/OR
- Natural channel conditions and stream habitat are restored in river corridor opportunity areas upstream of the AOC.

* BUI #3- Degradation of Fish and Wildlife Populations (Goals and criteria adopted 11/08)

Goal: Restored Fish Populations

- Fish surveys find that the resident fish community is fair to good based on applicable fish community biological indices (IBI) for two consecutive surveys; AND
- The frequency of occurrence of DELT anomalies in bottom-dwelling fish does not exceed recommended levels; AND
- Whole-body concentrations of Endocrine Disruptors (including but not limited to: PCBs, dioxins, and pesticides) in bottom dwelling fish do not exceed critical tissue concentrations for adverse effects on fish; AND
- Water quality measures (based on NYS RIBS or other monitoring) meet state standards for at least a Class C river.

Goal: Restored Wildlife Populations

- Wildlife surveys find that diversity and abundance of birds, mammals, reptiles, and amphibians in the AOC are comparable to a suitable reference site; AND
- Wildlife assessments confirm no significant toxicity from water column or sediment contaminants; AND
- Diversity of amphibian populations in AOC pocket wetlands is similar to upstream and/or Tift marsh levels; AND
- Diversity of benthic populations in the AOC is comparable to upstream levels.

TABLE 4.4: Buffalo River AOC Habitat Opportunity Areas

Foot of Katherine Street – 4.8 acres. Owner: City of Buffalo. One of 15 publicly-owned Buffalo River habitat parcels identified by the Erie County DEP for restoration and the only one of the top 5 not completed. “Approximately 290 m (950 linear feet) of shoreline borders the east and south sides of the parcel. A 100-foot floodplain has been delineated. The area is recognized as valuable fish habitat . . . Many species of birds were observed.” See EC DEP restoration recommendations (Poole, 1994).

Blue Tower turning basin. Owner: CSX RR. This shallow bay was part of the coastal marsh that once occupied the area south of the river from the present Hopkins Street to the lake (Ecoplans, 1975). The DEC baseline inventory identified a large freshwater bryozoan colony here characteristic of unpolluted, unsilted ponds and streams. Well removed from the dredged channel, this is a good candidate site for wetland restoration.

Concrete Central Peninsula (CCP) – 44 acres. Owner: CSX RR. Identified as an important habitat site by Erie Co. DEP because it contains 100-year floodplain, CCP is relatively undisturbed, and a potential habitat asset to Tifft Nature Preserve. Protection of any remaining undeveloped 100-year floodplain along the lower river is highly recommended both for the cost-savings associated with its benefit as “green infrastructure” and for its fish and wildlife habitat values. CCP has been identified in Buffalo River greenway plans and by the USACE as a “refugium for species not generally expected in an urban ecosystem” including peregrine falcon, snapping turtle, painted turtle and leopard frog” with recommendations that it not be disturbed (Markarewicz, 1982).

Steelfields/Buffalo Economic Renaissance Corp. – 117 acres (in 4 parcels). Owner: Multiple. A major brownfield on the river that has been cleared for redevelopment. Depending on the extent of soil contamination, this site provides almost a mile of shoreline where natural slope and 100-200 foot vegetated buffers could be restored.

Old Bailey Woods (south bank) shoreline extension- 2-3 acres. Owners: private. Conservation easements on the shoreline buffer area of parcels downstream from Iron Mountain records storage facility at 100 Bailey Avenue would allow removal of fill, restoration of natural slope and vegetation and better connectivity between Bailey Woods and shoreline habitat downstream.

Buffalo Sewer Authority pumping station – 4.1 + 2 acres separated by Bailey Ave. Owner: BSA. One of EC DEP’s 15 sites. Includes 100-year floodplain and transitional woodland. Could anchor a vegetated shoreline buffer extending from the old RR bridge crossing upstream to W. Seneca.

City Ship Canal. Owners: multiple. Although this is an artificial channel, it has increasing potential value as a habitat link between Lake Erie coastal and Buffalo River habitats, especially for waterfowl and fish in need of nesting and resting places off of Lake Erie. Native shoreline and aquatic vegetation has naturalized the western edge of the canal south of the active (ADM) industrial area. Buffering, removal of debris and slag piles from the eastern bank and sediment remediation would increase the habitat value of the canal.

5. Niagara River Habitat Assessment and Goals

This chapter describes current habitat conditions in the Niagara River Area of Concern compared with the 1994 Remedial Action Plan summary. Like the previous chapter, it identifies progress on habitat protection and restoration since 1994, ongoing and new challenges, and information needs. Finally it recommends a set of conservation goals and generalized delisting criteria for the Niagara River AOC—generalized because much habitat inventory work remains to be done. Habitat inventory maps can be found at the end of this chapter.

5.1 Boundary

The Niagara River Remedial Action Plan (DEC, 1994) defined the Niagara River AOC boundary as the Niagara River from the mouth of Smoke’s Creek in the City of Lackawanna to the river’s mouth at Lake Ontario. This included about 37 miles of mainland river shoreline area on the U.S. side as well as in-river aquatic habitats and islands. Without defining an explicit inland boundary, the RAP addressed land cover and land uses adjacent to or hydrologically connected to the Niagara River such as coastal wetlands, shoreline and gorge rim vegetation, or landfills whose surface or groundwater drained to the river.

For a measurement tool, Buffalo Niagara Riverkeeper defined a study area for the Niagara River AOC made up of land within 1 mile of the river and .5 miles of the lower reach or “estuary” portion of major tributaries, an area of about 59,491 acres or 93 square miles. **Map 5.1**

5.2 General Impairment Factors: Baseline and Current

5.2.1 HAZARDOUS WASTE SITES

Baseline condition

Former industrial uses of the Niagara River and corridor degraded both the quality and quantity of fish and wildlife habitats—especially shallows and coastal wetlands. The Niagara River RAP found that “many former shallow water areas, wetlands and areas of natural shoreline have become disposal sites for hazardous and solid wastes” and that much of the remnant habitat being used by fish and wildlife on the river was “immediately adjacent to banks of waste material.” The RAP listed 31 state superfund hazardous waste disposal sites as “potential sources for contaminant migration to the Niagara River,” (5-12). Of these, 22 sites were Class 2—“a significant threat to public health or the environment—action required.” (5-22)

Current condition

There has been major progress in contaminant remediation since the 1994 RAP. Loadings of 18 priority toxic contaminants to the Niagara River have decreased by over 90% since the early 1990s, and there has also been a 90% decrease in toxic levels in Niagara River herring gull eggs since the Canadian monitoring program began in the 1970s (Environment Canada, 2007).

However, both DEC young-of-year fish studies and Ontario Ministry of Environment caged mussel studies indicate on-going localized sediment hotspot sources of persistent toxics, which are found in biota at levels exceeding criteria for protecting fish eating wildlife (DEC, 2006; MOE, 2003 and 2006). The 2005 *NYS Priority Waterbodies List* identifies the Niagara River and the lower reaches of most of its tributaries as (in descending order of severity) “impaired,” “stressed,” or “threatened” for aquatic life or habitat. It further states that “The contaminant sources are primarily thought to be sediments attributed to inactive hazardous waste sites and historical discharges.”

Table 5.1 Niagara River AOC and the NYS Priority Waterbodies List

The 2005 *NYS Priority Waterbodies List* classifies streams as “precluded,” “impaired,” “stressed,” or “threatened” for aquatic life or habitat, with precluded indicating the worst conditions. Causes—toxic contaminants, nutrients and/or pathogens in sediments, sewage overflows, urban and industrial runoff—are also listed. The following ratings are based on year 2000 macroinvertebrate data from the *NYS Stream Biomonitoring Program*. Blanks indicate no known impairments.

	<u>Habitat</u>	<u>Aquatic life</u>
- Niagara River, Lower, Main Stem	Impaired	
- Niagara River, Upper, Main Stem	Impaired	Stressed
- Black Rock Channel	Impaired	Stressed
- Grand Island tribs.	Threatened	Stressed
- Gill Creek and tribs.		Impaired
- Cayuga Creek and minor tribs.		Impaired
- Bergholtz Creek and tribs.		Impaired
- Tonawanda Creek, Lower, Main Stem		Stressed
- Two Mile Creek and tribs.		Impaired
- Scajaquada Creek, Lower and tribs	Stressed	Impaired
- Buffalo River, Lower		Stressed
- Smoke Creek, Lower	Stressed	
-		

Currently (September 2008) the DEC lists 12 Class 2 state superfund sites in the study area that are, or were, potential sources of contaminants to the river. Two of

these—Hooker Main Plant and Hooker Plant S Area—are also on the federal priorities list, and two others—Bethlehem Steel and Frontier Chemical—are known sources of contaminants to the river. The 20 other closed or partially remediated sites in Table 5.2 are listed as potential sources as they are still undergoing monitoring and/or remedial action. **Map 5.2**

Other potential sources of contaminants in the study area are the FUSRAP (formerly utilized sites remedial action program) sites managed by the US Army Corps of Engineers. These contain radioactive waste residues from uranium ore processing conducted at the Linde (now Praxair) plant in the 1940s for the Manhattan Project. Two of these sites--Linde and the Niagara Falls Storage Site—are outside our study area but hydrologically connected to the river by surface (Two Mile Creek) or groundwater. Within the study area, four sites and Rattlesnake Creek were contaminated with radioactive ore tailings. Some of the radioactive contamination at two of the sites (Ashland 1 and 2) was removed to the Seaway landfill, which the Corps proposes to remediate with on-site containment (USACE, 2008). See Section 3.5, “Two Mile Creek,” for historic conditions in this vicinity.

Physically, remediated hazardous waste sites and brownfields may limit or benefit habitat restoration possibilities, depending on remedial design and planning. On the one hand, places where human access is restricted tend to benefit wildlife. On the other, restoration options, including natural recovery, are often limited by the need to protect *in situ* remedial treatments such as clay caps and leachate collection systems. According to lists provided by the DEC in September, 2008, 26 capped hazardous waste sites and approximately 20 brownfield sites fall into this category. Map 5.3 shows just the capped landfills, some also shown on Map 5.2. Landscaping measures for fish and wildlife—including thick soil covers, use of native plants and shoreline enhancements—were incorporated in some of the remedial designs, for example at the Niagara Mohawk-Cherry Farm site and at Gratwick-Riverside Park. **Map 5.3**

Table 5.1: CHEMICAL CONSTRAINTS - Potential Contaminant Sources in Study Area

SITECODE	NYS SUPERFUND SITES	CLASS	ACRES	LOCALITY	COUNTY
915004	Allied Chemical -Ind. Div.	N	1	Buffalo	Erie
915009	Bethlehem Steel	2	435.6	Lackawanna	Erie
915012	Buffalo Color Area "D"	2	23	Buffalo	Erie
915031	River Road Site	4	23	Tonawanda	Erie
915040	Mobil Oil Corporation	3	3	Buffalo	Erie
915054	Alltift Landfill	2	61.8	Buffalo	Erie
915055	Tonawanda Coke	2	131.9	Tonawanda	Erie
915063	Niagara Mohawk-Cherry Farm	4	160	Tonawanda	Erie
915080	Times Beach	N	57	Buffalo	Erie
915167	Fourth Street Site	2	1.7	Buffalo	Erie
915171	Former Gastown M.G.P. Site	2	1.6	Tonawanda	Erie
915176	ChemCore	2	3.8	Buffalo	Erie
932013	Dupont Plant Site	4	52	Niagara Falls	Niagara
932018	Durez Div. Occidental	4	40	N Tonawanda	Niagara
932019	Hooker Main Plant	2	15.6	Niagara Falls	Niagara
932019A	Hooker Plant - "S" Area	2	6.9	Niagara Falls	Niagara
932020	Love Canal	4	60	Niagara Falls	Niagara
932021	Hooker-Hyde Park Landfill	2	31.5	Niagara	Niagara
932022	Hooker 102nd St. Landfill	4	16.5	Niagara Falls	Niagara
932026	Niagara Co. Refuse Disposal	4	65	Wheatfield	Niagara
932031	102nd St. Landfill (Olin)	4	7	Niagara Falls	Niagara
932040	Occidental Durez Eng. Materials	4	1	Niagara	Niagara
932047	Necco Park	2	25	Niagara Falls	Niagara
932051A	Olin Corp. Parking Lot	3	3.4	Niagara Falls	Niagara
932051B	Olin Corp. Plant Site	3	50	Niagara Falls	Niagara
932052	Bell Aerospace-Textron	4	0.5	Wheatfield	Niagara
932060	Gratwick - Riverside Park	4	52.4	North Tonawanda	Niagara
932063	Charles Gibson Site	4	2	Niagara Falls	Niagara
932080A	Buffalo Avenue	3	25	Niagara Falls	Niagara
932096	Solvent Chemical	4	5.7	Niagara Falls	Niagara
932100	Booth Oil Co.	4	2.9	North Tonawanda	Niagara
932110	Frontier Chemical - Royal Avenue	2	9.9	Niagara Falls	Niagara
US ACE FUSRAP RADIOACTIVE WASTE SITES					
	Asland 1			Tonawanda	Erie
	Asland 2			Tonawanda	Erie
	Seaway/Niagara Landfill Inc.		93	Tonawanda	Erie
	Linde		105	Tonawanda	Erie
	T. Tonawanda Landfill/Mudflats		107	Tonawanda	Erie

Table 5.2: PHYSICAL CONSTRAINTS					
Niagara River Study Area Capped Superfund Landfills					
CODE	SITENAME	CLASS	ACRES	LOCALITY	COUNTY
915012	Buffalo Color Area "D"	2	19	Buffalo	Erie
915018	Dunlop Tire and Rubber	4	25	Tonawanda	Erie
915031	River Road Site	4	23	Tonawanda	Erie
915047	Republic Steel (LTV)	2	110	Buffalo	Erie
915052	Squaw Island Landfill	N		Buffalo	Erie
915054	Alltft Landfill	2	25	Buffalo	Erie
915063	Niagara Mohawk - Cherry Farm	4	56	Tonawanda	Erie
915072	Tifft Farm Nature Preserve	5	264	Buffalo	Erie
915074	Seaway/Niagara Landfill, Inc.	4	100	Tonawanda	Erie
915079	Tonawanda City Landfill	C	35	Tonawanda	Erie
915145	Lehigh Industrial Park	4	5.7	Lackawanna	Erie
932001	Vanadium Corporation of America	2	75	Niagara	Niagara
932018	Durez Div. - Occidental Chemical Corp.	4	40	N Tonawanda	Niagara
932019A	Hooker Plant - "S" Area	2	8	Niagara Falls	Niagara
932021	Hooker-Hyde Park Landfill	2	15	Niagara	Niagara
932022	Hooker-102nd Street Landfill	4	16.5	Niagara Falls	Niagara
932026	Niagara Co. Refuse Disp.-Wheatfield	4	65	Wheatfield	Niagara
932031	102nd Street Landfill (Olin)	4	7	Niagara Falls	Niagara
932035	Union Carbide Corp., Carbon Prod. Div.	4	64	Niagara	Niagara
932042	Niagara Recycling	4	10	Niagara Falls	Niagara
932047	Necco Park	2	25	Niagara Falls	Niagara
932050	Olin Corporation-Industrial Welding	4	9.5	Niagara Falls	Niagara
932053	Stauffer Chemical Plant-PASNY Site	4	23	Lewiston	Niagara
932060	Gratwick - Riverside Park	2	53	N Tonawanda	Niagara
932063	Charles Gibson Site	4	2	Niagara Falls	Niagara
932089	Niagara Town Landfill	N	30	Niagara	Niagara

5.2.2 OTHER RAP-IDENTIFIED IMPAIRMENT FACTORS

The 1994 RAP listed but did not establish a quantifiable baseline for, several other impairments to fish and wildlife habitat for which we report current conditions:

Shoreline hardening (Map 5.4). Currently about 60 % of the US Niagara River shoreline is armored with bulkheading, riprap, or other material. This has not changed much since 1994.

Marine development (Map 5.5). There are 33 marinas and boat launches on the river. The RAP described dredging and loss of shoreline habitat associated with these facilities. DEC fisheries biologists are currently concerned with the potential disturbance to spawning shallows and aquatic vegetation from the wakes generated by increased power boat and commercial jetboat uses of the upper and lower river. (Wilkinson, TAG correspondence. See also, Baird, 2004)

Water diversions. Water diversions may destabilize nearshore habitats for many plants and animals including spawning fish, nesting shorebirds, amphibians and reptiles. By international treaty, the Ontario Hydro and New York Power Authority (NYPA) hydropower plants may divert 50 to 75% of the Niagara River's flow for power generation. Water level drawdowns related to these diversions average 1.5 feet per day just above the intakes, up to 12 feet per day in the gorge above the tailrace, up to 36 feet per week in the Lewiston Reservoir, and .6 feet per day at Lake Ontario (URS, 2003). One NYPA study (Riveredge, 2004), identified 49 rare, threatened or endangered species and three significant natural communities that were likely affected by these fluctuations, including pied-billed grebe, lake sturgeon, and the deep emergent marsh community at Buckhorn State Park.

These fluctuation levels have not changed since the baseline RAP document. However, some mitigation measures have been installed. See section 5.4.

Although not mentioned in the RAP, it is worth noting that water is annually diverted from Niagara in boating season to help fill the Barge Canal. When the Lockport lock is opened, 1,100 cubic feet per second flows into the canal system. Changes in Niagara's water levels influence flow as far as 19 miles upstream on the canal (Gomez and Sullivan, Aug. 2005; URS, 2004).

Barriers to fish and wildlife use (Map 5.6). Current barriers include:

- Bridges, power transmission lines and other infrastructure
- Spoils piles and other fill or "dumping ground" areas in the river and along the shoreline
- Dams and stranded culverts such as those on Gill and Cayuga Creeks (URS, 2004)
- The 22-25 foot deep dredged navigation channel limiting shallow water habitat.

5.3 RAP Priorities by Habitat Type

The 1994 Niagara River RAP listed the following sites as priority habitats to be protected and restored. In this section we group and evaluate these by habitat type for a beginning overview of habitat conditions in the Niagara River study area.

NYS regulated wetlands:

- Tifft Street Wetland (BU-7)
- Tifft Farm Wetland (BU-15)
- Republic Steel Wetland (BU-1)
- Times Beach Wetland (BU-3)
- Beaver Island Wetland (BW-1)
- East River Wetland (BW-2)
- Cherry Farm Wetland (BW-8)
- Spicer Creek Wetland (TW-12)
- Sunken Island Wetland (TW-18)
- Burnt Ship Creek Wetland (TW-19)
- Buckhorn Island State Park Wetland ((TW-20)

Department of State (DOS) significant coastal habitats:

- Smoke Creek Shoals
- Small Boat Harbor
- Tifft Farm Nature Preserve
- Times Beach Diked Disposal Site
- North Buffalo Harbor
- Strawberry Island-Motor Island Shallows
- Grand Island Tributaries
- Buckhorn Island Wetlands
- Buckhorn Island Tern Colony
- Buckhorn Island-Goat Island Rapids
- Lower Niagara River Rapids

Other priority habitats:

- South Harbor area – south of Small Boat Harbor (ducks, geese, snowy owls)
- LaSalle Park (pelagic birds; gulls)
- Sand/gravel spit at end of Donnelly's Pier (tern nesting, possible muskellunge spawning)
- Bird Island Pier (gulls, terns, shorebirds, ducks, marshbirds; bass, pike, muskellunge)
- Black Rock Canal (Bird Island Pier species plus phalaropes)
- Grand Island: open fields and thorn thicket along East River shore
- Cherry Farm landfill
- Gratwick Park landfill, Niagara County landfill, 102nd St. landfill

- Goat Island and Three Sisters Islands (migratory shorebirds, landbirds; wintering gulls)
- Niagara Gorge and DeVeaux Woods
- NYPA Pumped Storage Reservoir
- Fort Niagara State Park woodland (migrating land birds)

5.3.1 AQUATIC HABITAT

The Niagara River RAP focused on aquatic habitat mainly in the upper river. Ten of the 11 “significant coastal habitats” identified by the NY Department of State (DOS) occur in the reach between Smoke’s Creek shoals and the Buckhorn-Goat Island rapids (Map 5.7). Most of the NYPA-identified Habitat Improvement Projects also focus on these upper river aquatic habitats not only for their importance to the upper Niagara River-Lake Erie fishery, but also for the over 300 bird species that use the river corridor. These include 27 species whose survival is at some level of risk, 4 species whose concentrations on the Niagara River are globally significant, i.e., greater than 1% of their global populations (Bonaparte’s gull, herring gull, canvasback duck and common merganser), and several species whose numbers are approaching global significance, including common goldeneye and greater scaup.

Mid-winter aerial surveys of waterfowl abundance for the ten-year period 1976-1985 indicate average concentrations of over 14,000 birds in the upper Niagara River each year (25,371 in peak year), including approximately 8,500 common and red-breasted mergansers (17,470 in peak year), 2,600 goldeneye (8,520 in peak year), 1,900 canvasbacks (5,000 in peak year) and 1,200 scaup (2,306 in peak year) along with lesser numbers of black duck, mallard, bufflehead and oldsquaw. (NYS DOS, 1987)

The following compares baseline to current conditions on RAP-selected sites. It should be noted here that a new baseline inventory of Niagara River aquatic habitat is greatly needed. The Technical Advisory Group identified several significant aquatic habitats that were not included in the RAP, and also several areas where areal coverage of submerged plants appears to have diminished very significantly since the early 1990s. See “Information Needs” below.

- **Smoke’s Creek Shoals**

Baseline condition

The DOS found this 500-acre shallow water habitat to be one of only a few sizeable areas of gravelly shoals in the Erie County portion of Lake Erie. Wave action and inflows from Smoke’s Creek provided adequate water circulation to prevent siltation of the bottom substrate. It was an important spawning area for warm water fish, especially walleye, yellow perch and smallmouth bass, and possibly contributed to the Lake Erie commercial fishery for walleye. The

“habitat impairment test” called for avoidance of any activity that degrades water or substrate quality including: sewage discharges, stormwater or industrial runoff, dredging, breakwall or jetty construction, or thermal discharges. (NYS DOS, 1987)

Current condition

Smoke’s Creek water quality remains at risk from benzene and other contaminants in groundwater at the Bethlehem Steel state superfund site and from siltation and nutrient loading associated with urban and industrial runoff, streambank erosion, and combined sewer overflows (CSOs). On its Great Lakes Habitat Initiative website, the USACE proposes to reroute the mouth of Smoke’s Creek around industrial waste areas to help restore water quality (www.glhi.org).

- **Buffalo Harbor (including lakefront above and below mouth of the Buffalo River, breakwalls and Bird Island Pier)**

Baseline condition

Small Boat Harbor (and South Harbor area). The DOS rated this 165 acres as an important lakeshore habitat, sheltered from wind and waves by a two-mile long breakwall, and supporting submerged aquatic vegetation such as water milfoil, wild celery and pondweeds. It was a nursery area for many harbor and lake fish species, including bass, muskellunge, carp, drum, shiners and yellow perch, with a productive macrobenthic community of snails and clams. It attracted concentrations of waterfowl and other migratory birds including canvasback, scaups, mergansers, common goldeneye and scoters, especially when Lake Erie open waters are rough. The impairment test called for avoidance of any activity that would affect biological productivity including sewage/stormwater discharge or runoff, oil spills and dredging (especially April-July) and dredge spoil disposal. (NYS DOS, 1987)

North Harbor and Breakwalls. The DOS listed the 800-acre open water area extending from the mouth of the Buffalo River to the Peace Bridge as significant because of the importance of the breakwalls and piers to fish and wildlife. Donnelly’s Wall and the North End Light Breakwater were nesting sites for common terns, ring-billed and herring gulls. The open waters were important feeding areas for some of the largest concentrations of wintering and migrating waterfowl in the Lake Erie coastal region. The harbor also supported a major urban fishery of rock bass, white bass, smallmouth bass, yellow perch, walleye, northern pike, brown trout, rainbow trout and coho salmon.

The impairment test called for avoidance of any activity that would negatively affect biological productivity including: pollution discharges from CSOs, industries, ships; oil spills; dredging and dredge spoil disposal; human recreational or maintenance activity near active common tern nesting sites. (NYS DOS, 1987)

Current condition

Many species of fish use the harbor shallows for spawning, nursery areas and browsing, although the extent and quality of these habitats is not well characterized with respect to navigation channels, filling, spoils piles and other alterations. A recent shoreline project on the NFTA Outer Harbor site, for example, included creation of a small pocket of fish habitat at the Bell Slip, while limiting habitat value along the rest of the almost mile-long shoreline property by placing tons of riprap to protect the site from erosion.

North harbor breakwalls remain important stopover and wintering habitat for many duck and gull species of Great Lakes' or global significance. (NYS DOS, 1987) Several restoration and nesting or spawning habitat improvements have been implemented on these structures. See section 5.4 "Accomplishments."

- **Upper Niagara: Strawberry and Motor Island Shallows**

Baseline condition

The Department of State rated this approximate 400-acre area bounded by Strawberry Island, Motor Island and the southern tip of Grand Island as highly significant (65) on the basis of ecosystem rarity—"the largest riverine littoral zone and wetland in the Niagara River, a rare ecosystem type in the Great Lakes Plain ecological region"—and population levels of waterfowl and spawning muskellunge. At the time of the baseline inventory, Strawberry Island had almost eroded away due to several decades of gravel mining. Motor Island had a small colony of nesting great blue herons, with some wintering there.

Current condition

Recent improvements on both islands include filling, planting, shoreline stabilization and fish habitat structures. New York State acquired Motor Island in 1998 to protect and restore its highly productive heron rookery. In 2008 an estimated 100 pairs of great blue herons, great egrets, and black-crowned night herons nested there.

- **Buckhorn-Goat Island rapids**

Baseline condition

The DOS also gave high significance (68) to this wide 850-acre area of fast-moving, shallow (generally below 10-feet) river reach on the basis of ecosystem rarity, species vulnerability (the common tern colony on Buckhorn Island) and waterfowl population levels. This reach was relatively undisturbed by excavation, filling or recreational uses. The habitat impairment test called for improving water quality, protecting Tower Island, and avoiding activities that could result in contaminant spills, thermal discharges or river diversions.

Current condition

By at least one recent measure, a macroinvertebrate Index of Biotic Integrity developed for Great Lakes AOC riverine marshes, Buckhorn scored “fair” with respect to habitat quality (Archer, 2006) See Section 5.4, “Accomplishments,” for a list of specific habitat projects.

- **Lower River**

Baseline condition

“The most apparent habitat usage is the river itself for many species of fish and as feeding and resting waters for huge numbers of migrating and wintering waterfowl and gulls. This unique concentration . . . is increasingly attracting many visitors from the United States and Canada, and even from foreign nations: bald eagles and other raptors are now again fairly regular visitors” (NYS DEC, 1994)

Current condition

One potentially significant change to lower river aquatic habitat since the baseline inventory is the increase in speedboat traffic due to the commercial jet boat business, which runs on average four high-speed, 40+ passenger boats per hour on the lower river, seven days per week, approximately six months per year. No studies have been done concerning the effects on aquatic habitats and species of the wakes and noise generated by the jet boats as currently operated. However, citizens on both sides of the border have formed a coalition calling for studies on such impacts. See www.niagararestoration.com, and Baird, 2004.

5.3.2 WETLANDS (Map 5.8)

The RAP identified 11 state-regulated wetlands in the upper Niagara River corridor—four in Buffalo, one in Tonawanda and six on Grand Island—and noted the need to further identify, map and protect the many valuable smaller and/or submerged riverine wetlands. All five mainland wetlands were either part of or adjacent to hazardous waste sites (NYS DEC, 1994).

In an attempt to quantify existing wetlands in the study area, we find:

- 1,341 acres of state-protected wetlands (2% of the study area)
- 3,621 acres of NOAA-identified wetland (6% of the study area)
- 8,000 acres of USFWS National Wetland Inventory wetlands (13% of the study area) Although the NWI maps have not been ground-truthed, they do indicate a potential for further wetland protection and restoration along the river.

- **Tifft Nature Preserve and adjacent wetlands (BU-15, BU-7 and BU-1)**

Baseline condition

The DOS gave 264-acre Tifft Nature Preserve its highest rating (84) largely because of its 75-acre remnant marsh supporting several rare species or “species of greatest conservation need” in NYS: American bittern, American

woodcock, black-crowned night heron, blue-winged teal, pied-billed grebe, willow flycatcher, Jefferson's salamander, burrowing crayfish, and snapping turtle. Tifft's habitats, including open ponds, brush and thickets, grasslands and forests, hosted 63 species of breeding birds and 190 migratory species. Black terns nested at Tifft until the late 1970s. By 1994, Tifft's classification as a state superfund site (#915072) was downgraded to Class 5: "properly closed, no evidence of present or potential adverse impact—no further action required."

Existing condition

Invasive plants like phragmites have decreased habitat quality in the marsh. Pond water levels fluctuate, possibly affected by surrounding development. Based on Marsh Monitoring Program data, Tifft supports 7 avian "species in greatest conservation need:" black-crowned night heron, belted kingfisher, blue-winged teal, northern rough-winged swallow, pied-billed grebe, sedge wren, and willow flycatcher (1997-2007); and 6 amphibian species: bull frog, chorus frog, green frog, American toad, northern leopard frog, and spring peeper (1995-99).

- **Times Beach (BU-3)**

Baseline condition

55-acre Times Beach Diked Disposal Site (former state superfund site # 915080) was used from 1972 to 1976 by the USACE for disposal of dredge spoils from the Buffalo River and harbor. However, it supported a significant diversity of wildlife, especially migratory birds. The DOS ranked Times Beach a significant coastal habitat because of the diversity and numbers of birds that had been observed there: over 220 species of gulls, terns, shorebirds, dabbling and diving ducks, marsh birds, and passerines, including rarities like the yellow-crowned night heron, cinnamon teal, American avocet, and Acadian flycatcher (NYS DOS, 1987). In 1991 the City of Buffalo began planning for public access to Times Beach.

Current condition

In 2004, public access to Times Beach officially opened, including boardwalk trails and two wildlife viewing blinds overlooking the open water area. However, the use of Times Beach as a CDF for contaminated dredge spoils compromises its value as habitat. "Tests performed to date indicate the site is moderately contaminated with heavy metals and organo-chlorine compounds" (URS, 2002). Recent evidence of vandalism and disrepair also suggest the need for an ongoing monitoring and maintenance plan.

- **Rattlesnake Island/Cherry Farm (BW-8)**

Baseline condition

Located on the Town of Tonawanda shoreline just south of the southern Grand Island Bridge, Rattlesnake Island was once the second largest marsh on the

upper river (see Section 3.) At the time of the baseline inventory it hosted two Class 2 state superfund landfills: Niagara Mohawk/Cherry Farm (# 915063) and INS Equipment or the “River Road Site” (# 915031). Both were filled with “foundry sand, cutting oils, industrial sludges and PCBs.” While the Niagara River RAP noted that these landfills attracted breeding land birds, it also noted that no specific environmental restoration elements were included in remediation plans (NYS DEC, 1994).

Current condition

Both superfund sites are now Class 4, “properly closed but requiring continued management,” which includes pumping groundwater to the sewage treatment plant and ensuring the clay cap is not penetrated. Habitat restoration elements included increased soil covers in areas for greater plant diversity, wetland buffer areas, and fish structures and wildlife cover along the shoreline.

Although the state-protected wetland almost surrounding the site is currently dominated by cattails and phragmites, BN Riverkeeper and Buffalo Ornithological Society site visits in June 2008 found a healthy crop of native meadow plants growing on the cap and nesting grassland and shore birds including bobolink and spotted sandpiper. Great blue herons and great egrets hunted along the river shoreline.

- **Grand Island wetlands and tributary streams**

Baseline condition

The 1994 RAP identified 6 coastal NYS- regulated wetlands on Grand Island, totaling 360 acres. These wetlands, shallow bays and shoals provide spawning and nursery areas for many species of Great Lakes fish (Goodyear, 1982). The DOS identified the lower reaches of four Grand Island tributaries—Woods Creek, Gun Creek, Spicer Creek and Big Six Mile Creek—and a 10-acre wetland at Beaver Island State Park as significant coastal habitats since they were the least developed stream ecosystems draining to the upper river. They provided critical spawning and/or nursery areas for warmwater fish species, especially northern pike. Changes in water levels associated with power plant operations were of particular concern as a barrier to fish movement upstream during low level periods (NYS DOS, 1987).

Current condition:

As a whole, Grand Island currently has 25 state-regulated wetlands, and many more areas of unprotected wetland based on NOAA and National Wetland Inventory coverages. Since the island was never heavily industrialized or used for hazardous waste disposal, its wetlands and their associated streams collectively make Grand Island a significant contributor to river and specie health. The deep emergent marsh community at Buckhorn Island remains at risk from Niagara Power Plant drawdowns. (Riveredge Associates, 2004) Of the 16 mussel species identified in the Niagara River, the majority were found in Grand Island streams (Riveredge Associates, 2003). Grand Island marsh

improvements are described in Section 5.4. Wetland losses include the marshland removed for the Big Six Mile Creek marina.

5.3.3 FORESTS (Map 5.9)

Baseline condition

Niagara's remaining riparian forests were mainly along the lower river: in the gorge, at DeVeaux Woods State Park, and at Fort Niagara State Park. The few small areas in the upper river were mainly at Navy Island, Buckhorn and Beaver Island State Parks, Strawberry and Motor Islands, and an unprotected area just north of Spicer Creek. Shoreline on the upper river was either treeless or with occasional trees with understory removed or mowed. The RAP noted the importance of shoreline forest for many migrating and resident birds associated with the river, especially bald eagle and osprey, and called for preserving wooded areas at Goat Island, Fort Niagara State Park and DeVeaux Woods (NYS DEC, 1994).

Current condition

Currently, about 17% of the study area is forested, based on NOAA 2005 land cover data. Most of that (15.5%) is deciduous forest on Grand Island, including the 32-acre Spicer Creek "thorn thicket," acquired and protected since 2004 by the DEC. Tourism apparatus on Goat Island continues to encroach on its forests. Old growth DeVeaux Woods is not protected.

5.3.4 NIAGARA GORGE

Baseline condition

The RAP called for resisting "improvement" of the gorge and the lower river as it would further impair the native Niagara Gorge forest community including red oak, shagbark hickory, hop hornbeam, paper birch, sugar maple, basswood, white ash, black walnut, bitternut hickory, and the 1000+ year-old dwarf white cedars growing on the cliffs. Since most of the gorge was state park land, the Office of Parks, Recreation and Historic Preservation had a key management role.

Current condition

According to a 2000 analysis of biodiversity in the NYS park system, the Niagara Gorge harbors some of the major rare habitats and species in the state:

*The Niagara Gorge's unique combination of waterfall misting, wet seepage areas interspersed with dry open rock faces, and calcareous bedrock produces one of the most diverse assemblages of rare plants within New York State. The various microhabitats within the Niagara Gorge support 13 rare plant populations representing eight different species. Three of these plants are listed as state endangered and found nowhere else in the state: sky-blue aster (*Aster oolentangiensis*), elk sedge (*Carex garberi*), and slender blazing star (*Liatris cylindracea*). Another rare plant, Kalm's*

St. John's-wort (Hypericum kalmianum), also has its only recorded New York occurrence in Niagara Gorge, but this population is no longer present and the species is considered to be extirpated from the state.

In addition to the rare plants within the Niagara Gorge, the calcareous cliff community and the calcareous talus slope woodland that bisect Niagara Reservation, Whirlpool, and Devil's Hole State Parks are of statewide significance. The plants and animals that live in these habitats are typically restricted to them. These species tend to have small populations which depend on specific characteristics of the rock substrate for survival (Larson et al. 2000). Protecting the calcareous cliff faces and talus slopes at the north end of Goat Island and throughout the gorge therefore will not only protect several rare species, but also a suite of uncommon species that make the Niagara Gorge so biologically diverse. (Evans, 2007)

A NYPA draft study *On the Feasibility of Restoring Native Plants in the Vicinity of the Niagara River Gorge* suggests that community-level restoration of native plants in the gorge is not feasible due both to the deliberate introduction of non-native species through park landscaping and to colonization of disturbed areas by aggressive volunteers (TRC Engineering, 2008). However, efforts by the Niagara Parks Commission over the past 10 years on the Canadian side suggest that large-scale native species restoration is possible and also cost-effective, since mowing and maintenance costs are reduced. In 2008-9, the OPRHP will complete a study to improve ecological management of its land holdings.

Bruce Kershner, a regional expert on old growth forests, envisions a "Binational Niagara Corridor of Forest Antiquity," including a 15-mile-long corridor of 25 old growth forest sites along both sides of the gorge "linked by a necklace of heritage oaks." His maps can be found on the Niagara Heritage Partnership website at www.niagarapartnership.org. See also botanist Patricia Eckel's recommendations for native plant restoration in the Niagara Gorge (Eckel, 2004).

5.3.5 SHRUB AND GRASSLANDS (Map 5.10)

Baseline

The RAP identified several shrub, grassland or meadow areas that should be preserved in as natural condition as possible. These included open fields, shrub and grasslands at Joseph Davis State Park, LaSalle Park and at four landfills: Cherry Farm, Gratwick Park, 102nd Street Landfill, and Niagara County Landfill (NYS DEC, 1994).

Current

2005 NOAA Land Use Land Cover maps show about 743 acres of scrub/shrub and 648 acres of grassland/herbaceous, a total of about 2% cover in the study area. The small amount of natural shrub/grassland habitat remaining in the river corridor suggests why closed landfills, if fully remediated to support healthy wildlife, are an

important opportunity for restoration. Of the four hazardous waste landfills singled out in the RAP, Cherry Farm/Rattlesnake Island restoration efforts have been most successful, owing to the thick soil covers, native seed plantings and limited mowing of the cover area.

The 42-acre Lewiston Plateau or “Spoils Pile,” created from debris excavated from the gorge for the power plant and owned by the Village of Lewiston, is also now partially dedicated to habitat for grassland birds whose populations are dwindling in North America. For a history of that site, see Bob Baxter, “Why I want the Robert Moses Parkway Removed,” at www.niagaraheritage.org.

5.4 Accomplishments and Challenges

Looking back at the 8 specific habitat goals listed in the 1994 RAP, what has been accomplished? What remains to be done?

1. Maintain fish spawning and waterfowl feeding areas.

Accomplishments

- The DEC has implemented several aquatic habitat projects on the river, including fish habitat enhancements at Gratwick Park, Cherry Farm, and 102nd St. Landfill and wetland and shoreline improvements in conjunction with remediations at Petit Cove and Squaw Island. See also the Strawberry Island shoals projects below.
- NYPA- funded HIPs (Habitat Improvement Projects) implemented through 2008 include the creation of fish attraction structures in four river locations and modifications to river and harbor structures for successful tern nesting.
- A Natural Resource Defense Council settlement with Occidental Chemicals will fund habitat restoration on Cayuga Creek and at Joseph Davis State Park. (US FWS, 2005)

Challenges

- Ensure that these gains are not offset by losses in quantity or quality to fish spawning and waterfowl feeding areas in the Niagara River AOC.
- Assess and address the impacts of power boat and jet boat wakes on submerged aquatic plants and fish spawning areas.

2. Preserve the Strawberry Island shallows complex.

Accomplishments

- The Strawberry Island Shoreline Habitat Restoration and Protection Project—began in 1993 by the NYS Office of Parks, Recreation and Historic Preservation (OPRHP) and DEC—now protects 400 acres of the largest shoal area in the river (Kelso, 1995).
- The East River Wetland at Beaver Island State Park was protected from erosion through an OPRHP, DEC and US ACE project completed in 2004.
- NY State acquired Motor Island in 1998 to protect colonial nesting birds.
- Future NYPA Habitat Improvement Projects (HIPs) include:
 - Potential additional Strawberry Island habitat enhancements
 - Motor Island shoreline revegetation and aquatic habitat restoration
 - “Frog Island” aquatic habitat enhancement
 - Beaver Island wetland restoration: removal of historic fill, restoration of hydrology and vegetation, and invasive species management

Challenges

- Ensure long-term management programs are in place to protect these habitats.

- Identify and employ effective, environmentally benign means to control invasive species.

3. Maintain Buckhorn Island State Park as a wild area.

Accomplishments

- OPRHP, DEC and US ACE improvements to Buckhorn marsh included restoration of open water habitat, installation of weirs to mitigate effects of water level drawdowns on marsh plant and animal communities, and loosestrife and phragmites controls.
- NYPA future HIPs include removal of 10 acres of phragmites (2010) and erecting more osprey nesting platforms besides the one installed at Buckhorn marsh in 2007.

4. Preserve significant riparian and adjacent wetland habitats including Grand Island tributary habitats.

Accomplishments

- The DEC acquired the Spicer Creek “thorn thicket” in 2004.
- A future NYPA HIP will remove 10 acres of phragmites in the Tifft Preserve marsh.
- The Buffalo Museum of Science and DEC restored open water habitat at the Tifft marsh as per the 1970s Tifft Nature Preserve master plan.
- Grand Island’s Local Waterfront Revitalization Plan now requires minimum 50-foot vegetated riparian buffers on the town’s creeks.

Challenges

- Update the inventory of significant habitats identified in the 1994 RAP.
- Ensure that municipal plans and policies recognize and protect Niagara River habitats.
- Provide outreach and education to riparian land owners, since private residential land use accounts for about 24% of the study area.

5. Preserve shrub and grassland areas at Joseph Davis SP, LaSalle Park and at the Cherry Farm, Gratwick Park, 102nd Street and Niagara County landfills.

Accomplishments

- The DEC restored riparian habitat at over 100 acres of hazardous waste landfills including Cherry Farm, Gratwick Park and 102nd Street; capping included sufficient soil cover in select areas to allow native grassland/meadow/shrub habitat recovery.

Challenges

- Ensure full implementation of habitat plans for remediated sites, including continued monitoring and maintenance.

- 6. Maintain wooded areas of Goat Island and Fort Niagara State Park.**
- 7. Preserve DeVeaux Woods through purchase or conservation easement.**
- 8. Protect Niagara Gorge and lower river habitat.**

These last three Niagara River habitat goals specified in the 1994 RAP all concern the Niagara Gorge and lower river, areas mainly under the control of the NYS Office of Parks, Recreation and Historic Preservation or private landowners. To date, little has been accomplished on these and the need for greater protection and restoration remains high. Community groups like the Niagara Heritage Partnership have called for expanding these goals—for example, to restore Frederick Law Olmsted’s original “nature reserve” plan for Goat Island and the Niagara Gorge.

5.5 Information Needs

- An evaluation of capped and potentially capped hazardous waste sites and brownfields for their contaminant potential to Niagara River biota and for their physical limitations on future habitat development or recovery.
- Sediment and sewer outlet characterizations in known contaminant hotspots.
- An assessment of best available terrestrial and aquatic habitat restoration models in conjunction with future hazardous waste site remediations, including optimum soil cover depths for different plant communities, techniques for making hardened shorelines more habitat-friendly, and best uses for closed sites where human access is restricted.
- Green infrastructure pilot projects in the watershed assessing the costs and benefits of retaining undeveloped land (habitat) vs. engineering approaches to sewer overflows.
- A comprehensive inventory of aquatic habitats—especially submerged vegetation, rock/ cobble shallows and other valuable fish habitats in the Niagara River and harbor area.
- An analysis of the impacts of high speed motorboat and jet boat traffic on shoreline habitats.
- Better characterization of fish uses of the river and lake areas, particularly key prey species like the emerald shiner, and indicator species like the lake sturgeon, a NYS species at risk.
- Better characterization of key resources and habitats required for IBA bird species as per the following conservation goals: “Establish solid estimates of numbers of IBA species that use the Niagara River Corridor IBA throughout the year;” and “Ensure the sustainability of key resources for IBA bird species, once we have identified these resources/habitats with supporting scientific data” (Niagara River Corridor IBA Working group, 2002).
- A transportation study for the Niagara Gorge corridor that includes evaluation of the impacts of roads and parking lots on gorge rim habitat and aesthetics.
- An assessment of cross-border options and potential to binationally protect the Niagara River’s unique biology (Eckel, 2004).
- A GIS/remote imaging clearinghouse maintaining current high resolution aerial photography, land cover analysis, databases, and internet sharing capacity.

5.6. Niagara River AOC Habitat Goals and Delisting Criteria

(Adopted by the NYS DEC as part of the Niagara River AOC delisting document, November, 2008, except where alternative wording is indicated)

Goal: Restored Habitat Connectivity

- Priority Niagara River AOC habitats (such as the Strawberry Island shallows complex) are protected, with long-term management plans and programs in place.
- Measurable targets are defined for habitat types in the AOC—including submerged aquatic vegetation beds, wetlands, riparian forests, natural sand/gravel beaches and grass/shrublands—and programs are in place for reaching them.

Goal: Restored Habitat Quality

- All known or suspected AOC sources of contaminants found at unsafe levels in aquatic life and fish-eating species are fully remediated, and a program is in place to address newly discovered sources.
[DEC final wording: “All known or suspected AOC areas of sediment contamination at concentrations exceeding NYS Class A sediment quality thresholds (indicating chronic toxicity to aquatic life) are remediated and a program is in place to address newly discovered sources.”]
- The *NYS Priority Waterbodies List* and *Stream Biomonitoring Program* list no reach of the Niagara River AOC as “precluded,” “impaired,” “stressed” or “threatened” for aquatic life or habitat.
[DEC omits “stressed” and “threatened” from this target as these, in the order of descending severity, are considered background conditions.]
- [DEC adds this target: “No additional species listed as extirpated from the River since 1994 as a result of habitat loss, or populations of formerly extirpated species are increasing (with 1994 as baseline).”]

Goal: Protected and Restored Unique Habitats

Note: See Niagara River Ontario RAP “Technical Review of Impairments and Delisting Criteria” for parallel goals on the Canadian side (EC, 2007)

- **Niagara Gorge.** An ecosystem inventory and long-term conservation management plan is adopted and implemented.
- **Outer Harbor/Upper River aquatic habitat.** State and municipal waterfront, harbor and upper river development policies incorporate protection objectives for submerged aquatic vegetation habitats in the Outer Harbor and Upper Niagara River.

6. Niagara River Watershed: A Platform for Future Studies

This chapter is meant to serve as a platform for building a more detailed analysis of habitat and conservation potential of the Niagara River watershed and its major sub-basins. Land use interpretations are based on National Oceanic and Atmospheric Administration (NOAA) 2005 Land Use/Land Coverage data. We have grouped NOAA's 18 land use/land cover classes into 6 general categories for an overview of current conditions. Thus, looking at the Niagara River drainage basin as a whole in New York State, we find the following: about 38% of the land is cultivated; 30% is forested; 16% is "developed" (including low, medium and high density residential and commercial buildings, roads and parking lots); 8% is wetlands, and 3% is in natural grass or shrubs. The remaining 5% is mainly "developed open space," including parks, golf courses and other landscaped areas, but also includes "bare land" such as quarries. The following tables detail the habitat coverages by sub-basin. Maps can be found at the end of the chapter.

6.1 Wetlands (Map 6.1)

Of the 65,220 acres of NOAA-mapped wetlands (8% of the Niagara River watershed), approximately 34,776 acres are NYS-protected or about 4% of the watershed. A Great Lakes benchmark from Environment Canada's *How Much Habitat is Enough* is that a minimum of 10% of a watershed should be protected wetlands—more in historically wet basins like Tonawanda Creek. Among the sub-basins, Tonawanda Creek has by far the most state-protected wetlands, largely due to the Tonawanda Creek Wildlife Management Area and the legacy of glacial Lake Tonawanda (see "Unique Areas" below.) NOAA categories for wetlands include: "palustrine emergent," "palustrine forested," and "palustrine scrub/shrub."

Table 6.1: Wetlands in the Niagara River Watershed and Sub-basins

Watershed	Total Acreage	NOAA Wetlands	State Regulated Wetlands	% NOAA Wetland
Buffalo River	281,413.9	13,248.6	3,592.2	5%
Cayuga Creek	30,450.3	2,117.0	1,194.3	7%
Gill Creek	9,854.0	707.5	402.9	7%
Grand Island	21,628.1	2,026.0	1,147.2	9%
Lower Niagara Creek	11,672.2	794.6	330.2	7%
Scaj Creek Watershed	18,590.0	288.2	0.0	2%
Smokes Creek	20,963.2	1,694.0	294.7	8%
Tonawanda Creek	405,606.3	44,120.9	27,771.3	11%
Two Mile/ Upper Niagara	13,135.7	223.2	43.1	2%
TOTAL	813,313.8	65,220.0	34,775.9	8%

6.2 Forests (Map 6.2)

These include 3 NOAA categories: “deciduous,” “evergreen,” and “mixed.” Of these tree communities, deciduous forest is by far the largest in the watershed at almost 200,000 acres, compared to roughly 17,000 acres of evergreen forest and 29,000 acres of mixed forest.

Table 6.2: Forests in the Niagara River Watershed and Sub-basins

Watershed	Total Acreage	Forested Acreage	% Forested
Buffalo River	281,413.9	114,922	41%
Cayuga Creek	30,450.3	2,867	9%
Gill Creek	9,854.0	1,161	12%
Grand Island	21,628.1	8,970	41%
Lower Niagara River	11,672.2	2,095	18%
Scajaquada Creek	18,590.0	349	2%
Smokes Creek	20,963.2	6,805	32%
Tonawanda Creek	405,606.3	107,741	27%
Two Mile/Upper Niagara	13,135.7	405	3%
TOTAL	813,313.8	245,315	30%

6.3 Grassland and Scrub/Shrub (Map 6.3)

This land cover includes naturally occurring grasses and forbs plus areas dominated by woody vegetation less than 5 meters in height. The lack of this type of habitat in the Niagara River basin may be linked to the general decline in populations of grassland birds in the Northeast, including grasshopper sparrow, bobolink and eastern meadowlark, all listed in New York State as Species in Greatest Conservation Need.

Table 6.3: Grass and Shrub Lands in the Niagara River Watershed and Sub-basins

Watershed	Total Acreage	Grassland/Scrub /Shrub Acreage	% Grassland/Scrub/Shrub
Buffalo River	281,413.9	10,329.7	4%
Cayuga Creek	30,450.3	418.9	1%
Gill Creek	9,854.0	216.1	2%
Grand Island	21,628.1	473.6	2%
Lower Niagara River	11,672.2	472.5	4%
Scajaquada Creek	18,590.0	53.9	0%
Smokes Creek	20,963.2	727.9	3%
Tonawanda Creek	405,606.3	12,710.6	3%
Two Mile/Upper Niagara	13,135.7	65.8	1%
TOTAL	813,313.8	25,469.0	3%

6.4 Cultivated Land, Pasture/Hay (Map 6.4)

Cultivated land includes cropland, orchards, nurseries and vineyards, plus pasture and hay fields. Given the fact that this represents the largest land cover in the Niagara River watershed, managing for habitat and best management practices such as non-toxic weed and pest control could greatly extend the benefits of natural grasslands in the watershed.

Table 6.4: Cultivated Land in the Niagara River Watershed and Sub-basins

Watershed	Total Acreage	Cultivated Land/Pasture/Hay	% Cultivated Land/Pasture/Hay
Buffalo River	281,413.9	102,097.8	36%
Cayuga Creek	30,450.3	13,537.1	44%
Gill Creek	9,854.0	1,344.6	14%
Grand Island	21,628.1	2,540.1	12%
Lower Niagara River	11,672.2	1,572.6	13%
Scajaquada Creek	18,590.0	393.0	3%
Smokes Creek	20,963.2	4,014.4	19%
Tonawanda Creek	405,606.3	181,280.1	45%
Two Mile/Upper Niagara	13,135.7	65.8	1%
TOTAL	813,313.8	306,845.6	38%

6.5 Impervious Surfaces (Map 6.5)

According to Maryland's Center for Watershed Protection, a stream's water quality begins to degrade when its watershed is 10% impervious to rain and snowmelt penetration (causing unfiltered runoff and siltation). Streams are severely degraded whose watersheds have 25% or more of impervious surface. See www.cwp.org.

NOAA correlates "development intensities" with degrees of impervious land surface. Thus "high intensity" developed land is on average 90% impervious; "medium intensity," 65% impervious; and "low intensity," 35% impervious. Totaling the number of acres in each "development intensity" category multiplied by the average percent of impervious surface for that category, we can approximate the amount of impervious surface in each sub-basin and in the watershed.

Table 6.5: Impervious Surfaces in the Niagara River Watershed and Sub-basins

Watershed	Total Acreage	High Intensity	Medium Intensity	Low Intensity	Impervious Cover %
Buffalo River	281,413.9	5,083.0	5,625.0	6,810.0	6%
Cayuga Creek	30,450.3	803.0	1,052.0	2,326.0	14%
Gill Creek	9,854.0	803.0	851.0	842.0	25%
Grand Island	21,628.1	72.0	252.0	978.0	6%
Lower Niagara River	11,672.2	452.7	530.4	743.0	15%
Scajaquada Creek	18,590.0	2,340.0	3,587.0	2,551.0	46%
Smokes Creek	20,963.2	569.6	846.0	1,508.0	14%
Tonawanda Creek	405,606.3	2,512.0	4,310.0	11,413.0	4%
Two Mile/Upper Niagara	13,135.7	1,843.0	2,502.0	1,476.0	44%
TOTAL	813,313.8	14,478.3	19,557.4	28,647.1	8%

6.6 Unique Areas

At least two patterns emerge from the maps and analysis. One is the significant amount of floodplain and wetland in the Tonawanda Creek basin. Another is the amount of forested land along the upper tributaries of the Buffalo River, partly attributable to steep slope areas where logging was difficult.

The Buffalo Niagara region will benefit greatly by recognition and protection of these unique upland areas as functional landscapes—that is, as not simply limited for development, but providing valuable ecological services including stormwater runoff prevention, flood management, water quality protection, and habitat for resident and migratory fish and wildlife.

6.6.1 TONAWANDA CREEK WETLANDS

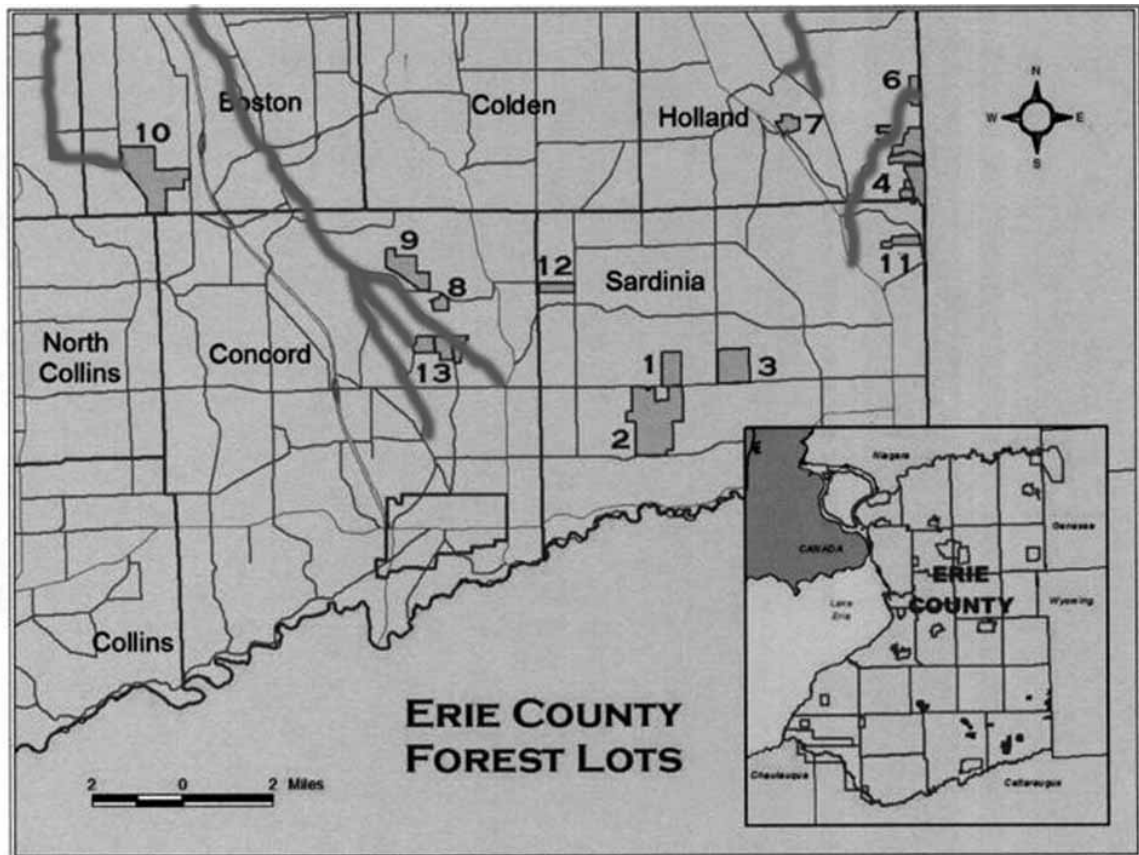
The Tonawanda Wildlife Management Area is a 6300-acre wetland tract between Lockport and Batavia bounded by Tonawanda Creek and the Tonawanda Seneca territory on the south. It is the westernmost of three protected waterfowl areas, including the Iroquois National Wildlife Refuge and the Oak Orchard Wildlife Management Area, that together total nearly 20,000 acres.

These wetland remnants of glacial Lake Tonawanda are a major stop-over for migratory waterfowl, especially in the spring when thousands of ducks, geese, shore birds, marsh waders and songbirds stop here to rest and feed before continuing north or remain to nest in the area. Bald eagles have active nests on the refuge. Impoundments create open water areas and fields of grain cultivated under share cropping agreements with local farmers feed hungry birds. Tonawanda Creek sustains many other species as well, including 19 species of mussels and several rare fish species like redbfin shiner and longear sunfish (NYSDEC, 2001).

6.6.2 BUFFALO RIVER TRIBUTARY FORESTS

Commercial and residential sprawl has fragmented Western New York's forests, severely limiting their habitat value as well as the critical ecosystem services they provide. The health of our native fish and aquatic communities is closely linked to the health of these forests, which protect headwater and mid-reach streams from erosion, siltation and high temperatures.

NOAA maps show 41% of the Buffalo River watershed as forested in 2005. A 2002 biodiversity inventory developed for the New York Natural Heritage Program breaks that down further into the Buffalo Creek sub-basin as 42% forested and the Cazenovia Creek sub-basin as 56% forested. Although these forests have not been systematically assessed for their biodiversity, they are suspected to contain woodland and aquatic communities of statewide significance (Hunt, 2002). However, they are not protected. For example, the 3,500-acre Erie County Forest in 13 separate parcels, mostly within the upper Buffalo Creek and Cazenovia Creek watersheds, is currently managed more for recreation and timbering than for habitat and functional values as recent incidents of clearcut logging have shown. These forests stand today in dire need of ecologically-based management plans and strategic land acquisition for greater habitat connectivity.



Erie County forest and upper branches of Cazenovia and Buffalo Creeks

7. Conclusion

Buffalo Niagara Riverkeeper undertook this habitat assessment for the Buffalo and Niagara Rivers and their tributary areas in the context of the Remedial Action Plans for both rivers and the need to define community-based restoration goals and delisting criteria to address the “loss of fish and wildlife habitat” beneficial use impairment. After two years of research, mapping and meetings, we have completed the following tasks:

- Developed a specific set of habitat conservation goals and delisting criteria for the Buffalo River AOC, adopted by the Buffalo River Remedial Action Committee in October 2008.
- Developed habitat goals and strategies for the Buffalo River Habitat Opportunity Area immediately upstream of the AOC for ongoing conservation work with municipalities, agencies and other stakeholders.
- Developed a set of habitat goals and general delisting criteria for the Niagara River AOC, for the most part adopted by the DEC Niagara River Remedial Action Committee in December, 2008.
- Identified critical information needs and major accomplishments since the baseline RAP, and current challenges facing conservation efforts along the Buffalo and Niagara Rivers
- Begun a habitat inventory for the Niagara River watershed.

Most importantly, this document provides our community with an updated summary of field work and reference materials pertaining to habitat and species in the Buffalo and Niagara River Areas of Concern and their tributary watersheds. Buffalo Niagara Riverkeeper encourages anyone interested in securing the biotic integrity of our globally important Niagara River bioregion to use this summary and the many resources described in the bibliography as a framework for future conservation efforts.

8. Annotated Bibliography

The publications listed and described in this bibliography include a wide range of reports on habitat and species related to the Buffalo Niagara region. Those used in this report are indicated with an asterisk [*] and have met with the Buffalo Niagara Riverkeeper/National Fish and Wildlife Foundation Quality Assurance Program Plan criteria.

For easier reference, the bibliography is organized in three general sections with subsections as follows:

8.1 General

Includes publications on the Great Lakes, on models and guidelines for assessing habitats, and on the general natural history of the region

8.2 Buffalo River, Tributaries and Outer Harbor

- Habitat reports
- Selected reports on toxic contaminants

8.3 Niagara River and Tributaries

- NYPA reports
- Other habitat reports
- Selected reports on toxic contaminants

8.1 General

*Bird Studies Canada. *Marsh Monitoring Program*. birdscanada.org/mmpmain/html

Provides data and trend information as needed on marsh birds and amphibians across the Great Lakes basin. Monitoring records for some sites in the Buffalo Niagara region go back to 1995. Located in Port Rowan, Ontario.

*Bode, Robert W. et al. *Quality Assurance Work Plan for Biological Stream Monitoring in New York State*. Albany: NYS DEC, 2002. See www.dec.ny.gov/docs/water-pdf/narqa02.pdf

Documents the standard operating procedures of the DEC's Stream Biomonitoring Unit. The primary activities are macroinvertebrate community assessment and macroinvertebrate tissue analysis. Data are used to supplement water quality assessments reported in the DEC's Rotating Integrated Basin Studies and Priority Waterbodies List.

*Calkin, P.E. and C. Brett. "Ancestral Niagara River Drainage: Stratigraphic and Paleontological Setting." *Geological Society of America Bulletin*. 89: 1140-54.

Center for Watershed Protection. *Urban Stormwater Retrofit Practices*. Ellicott City MD: CWP, 2007. www.cwp.org

Established in 1992 this not-for-profit organization is a good source of information on policies, techniques and tools for watershed management.

Edinger, Gregory J. et al. *Ecological Communities of New York State*. Albany: NYS DEC, January 2002.

A revised and expanded edition of Carol Reschke's original ecological community classification system, used by the NYS Department of Conservation in current NYS habitat and species inventories.

*Environment Canada. *How Much Habitat is Enough? A Framework for Guiding Habitat Rehabilitation in Great Lakes Areas of Concern*. Second edition, 2004.

A watershed approach to ecosystem function used in many Canadian Great Lakes Remedial Action Plans including the Niagara River RAP. For example, it recommends a minimum of 30% woodland, 10% wetland and 75% riparian cover compared to total land use within the watershed as a first cut at setting quantifiable restoration targets.

*Environment Canada and United States Environmental Protection Agency, *State of the Great Lakes 2007*. See www.epa.gov/glnpo/solec/sogl2007

Updated every two years, assesses ecosystem health based on 81 physical, chemical and biological indicators for each Great Lake and the St. Lawrence River.

*Evans, D.J. and David E. VanLuven. *Biodiversity in New York's State Park System: Summary of Findings*. Albany: NY Natural Heritage Program, January 2007.

Includes findings of rare species and habitats in Niagara's state parks from Woodlawn Beach to Old Fort Niagara and recommendations for prioritizing ecosystem benefits in park management. Cross reference with Ontario's Niagara Parks Commission 2000 Environmental Mission Statement "to refocus priorities on "preserving and enhancing natural landscapes, native biodiversity and environmental quality."

*Fischer, Richard A. and J. Craig Fischenich. "Design Recommendations for Riparian Corridors and Vegetated Buffer Strips" in *Ecosystem Management and Restoration Research Program*. Vicksburg: USACE, April 2000.

Summarizes a vast amount of research on riparian corridors and vegetated buffer strips for habitat, species and water quality goals, noting consensus around a minimum 100-foot vegetated buffer to protect water quality and aquatic habitat from erosion, runoff and sedimentation.

*Great Lakes Fishery Commission. *Fish Community Goals and Objectives for Lake Erie*. Ann Arbor: GLFC, 2003. www.glfc.org

Calls for protection and restoration of coastal and tributary habitats, reductions in invasive species and in the eastern basin, including the Buffalo River and the Upper Niagara River: promotion of harmonic, self-sustaining percid and salmonid communities based on healthy stocks of indigenous top predators including lake trout, burbot, sculpins in deep offshore waters and walleye in near-shore waters.

*Great Lakes Fishery Commission. *Fish Community Objectives for Lake Ontario*. Ann Arbor: GLFC, 2006. www.glfc.org

Conservation targets for Lake Ontario and the lower Niagara include:

- Maintain/expand walleye and yellow perch populations through habitat improvements
- Recover lake sturgeon sufficient to remove from threatened species list
- Support populations of smallmouth bass, largemouth bass and sunfish
- Rehabilitate self-sustaining populations of native prey fish with lake trout as top predator

*Great Lakes Regional Collaboration. *Strategy to Restore and Protect the Great Lakes*. December 2005. Find at www.glrc.us

Supported by Great Lakes governors, mayors, Congressional members, environmental groups and industries, the Strategy proposes a \$26 billion investment to clean up contaminated sediments, upgrade sewage systems, restore habitats and manage nuisance invasive species. See also GLRC implementation documents including EPA's *Great Lakes Regional Collaboration Habitat/Wetland Initiative*. Chicago: EPA-GLNPO, 2008 which defines quantitative habitat restoration targets and technical criteria for what types of projects "count" towards reaching these targets.

*Harding, W.E. and B.K. Gilbert. *Surface Water in the Erie-Niagara Basin, New York*, including “Gazetteer of Named Streams in the Erie-Niagara Basin.” Prepared for Erie-Niagara Basin Regional Water Resources Planning Board. NYS Water Resources Commission, 1968.

*Hunt, David M. et al. *Lake Erie Gorges Biodiversity Inventory & Landscape Integrity Analysis*. Albany: NY Natural Heritage Program, October 2002.

Although mainly focused on the spectacular gorges of streams like Cattaraugus Creek, includes some information on biodiversity along upper Buffalo, Cayuga and Cazenovia Creeks.

*Marks, P.L. and Frank K. Seischab. *Late Eighteenth Century Vegetation of Central and Western New York State on the Basis of Original Land Survey Records*. Albany: NYS Museum, 1992.

Identifies forest communities in WNY in 1798 based on Holland Land Company survey notes along boundaries of ranges and townships.

*Marshall, Orasmus H. *The Niagara Frontier*. Publications of the Buffalo Historical Society, Vol. II. Buffalo: Bigelow Brothers, 1880.

Includes interpretations of Haudenosaunee names for rivers and other natural features. Assumptions not identified. Historical reference only.

*McLaughlin, Robert L. and Nicholas E. Mandrak. *Assessing Gains and Losses of Riverine Habitat in the Great Lakes*. Ann Arbor: Great Lakes Fishery Commission, 2003.

Recommends that the Fishery Commission use four core measures for aquatic habitat quality: water flow, structure, water temperature and connectivity.

Natural Resource Conservation Service. *Stream Visual Assessment Protocol*. NRCS 99-1.

*Niagara River Corridor IBA Working Group. *Niagara River Corridor Important Bird Area Conservation Plan*. Environment Canada, 2002.

*NYS DEC. *Comprehensive Wildlife Conservation Strategy*. Albany: NYS Department of Environmental Conservation, 2006.

This is the precursor to a conservation plan for “species in greatest need of protection.” Rates the overall landscape condition of the “Lake Erie Basin” (including the Niagara River watershed) as “poor” but finds some critical habitats such as the Tonawanda Creek “grassland wildlife zone” and the Buffalo Harbor breakwalls (for nesting common terns).

NYS DEC. *Open Space Plan*. Albany: NYS Department of Environmental Conservation, 2006 and draft, 2008.

Identifies the Buffalo River corridor and Niagara River shorelands as priorities for open space acquisition.

*NYS DOS. *Coastal Fish & Wildlife Habitat Rating Forms*. Albany: NYS DOS, 1987. www.nyswaterfronts.com/waterfront_natural_narratives.asp#GreatLakes

Describes and rate eleven significant coastal habitat in the Buffalo-Niagara region, and includes specific “habitat impairment tests” that projects in or near these sites must address.

*Ohio EPA. *Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index*. Groveport: Ohio EPA, June 2006. www.epa.state.oh.us/dsw/documents/QHEIManualJune2006.pdf

Uses a scoring system and six metrics to evaluate physical habitat characteristics important to fish communities: substrate (type and quality), instream cover, channel morphology, riparian zone and bank erosion, pool/glide and riffle-run quality, and gradient. A total score of over 70 indicates “excellent;” below 30 indicates “very poor.”

*Simon, Thomas P., Douglas M. Carlson, Ronda Dufour. “Development of an Index of Biotic Integrity for Coastal Wetlands of Great Lakes Connecting Channels: with Emphasis on the St. Lawrence and Niagara Rivers” in *Coastal Wetlands of the Laurentian Great Lakes*, eds: T.P. Simon and P.M. Stewart. Bloomington: AuthorHouse Press, 2007.

Develops an IBI based on 13 metrics for assessing fish assemblages and environmental conditions in Great Lakes connecting channels, focusing on the Niagara and St. Lawrence Rivers.

*St. Louis River Citizens Advisory Committee. *Lower St. Louis River Habitat Plan*. Duluth: St. Louis River RAP, 2002. www.stlouisriver.org

A model six-step process for establishing habitat goals and measurable delisting criteria in Remedial Action Plans for impaired Great Lakes rivers and harbors.

Toronto and Region Conservation Authority. *Toronto Waterfront Aquatic Habitat Restoration Strategy*. Toronto and Region RAP, 2003.

Includes 9 aquatic habitat targets such as “improve SAV,” and “reduce carp biomass,” with no specific metrics. Recommended restoration techniques include creating underwater reefs, shoals, log tangles, deep weed walls and constructed islands.

*Wheeler, H. and R.W. Archer. *Environmental Monitoring and Assessment Techniques for Seven Beneficial Use Impairments in Great Lakes Areas of Concern: Summary Descriptions and Information Resources*. Bird Studies Canada, 2008.

Provides a good comparison of a dozen aquatic habitat evaluation tools currently being used in the Great Lakes region.

8.2 Buffalo River, Upper Tributaries and Outer Harbor

*Buffalo Niagara Riverkeeper. *Buffalo River Remedial Action Plan: Status Reports*. Buffalo: Buffalo Niagara Riverkeeper, 2005, 2008.

Note: In 2003 the EPA gave Buffalo Niagara Riverkeeper, formally Friends of the Buffalo Niagara Rivers, responsibility for overseeing implementation of the RAP. Earlier RAP updates are listed under the NYS DEC.

*Carlson, D.M. *Inventories of fishes of Buffalo River, Tonawanda Creek, and Eighteenmile Creek*. May 2003.

On the basis of historical records going back to 1920, identifies 70 fish species historically found in the Buffalo River and its tributaries, including DEC species of concern: Bigeye chub, Black redhorse and Eastern sand darter.

Czarpla et al. *Fish Community Rehabilitation in the Lower Great Lakes Which Had Been Severely Disturbed*. Great Lakes Research Review, Vol 2. , No. 1, July 1995.

Finds the current fish community in the BR comparable to other less impacted Lake Erie tributaries; however, some species are absent or found in very low numbers, including cyprinids and castomids and freshwater drum.

*Diggens, Thomas and Randal Snyder. *Three Decades of Change in the Benthic Macro-invertebrate Community and Water Quality in the Buffalo River AOC, 1964-93*. IAGLER, 2003.

Compares 18 AOC studies over three decades for six parameters: invertebrate family richness, oligochaete abundance, chironomid abundance, DO, TSS and temperature. Concludes that biologic richness and abundance improved (e.g., from 0 to 9 invertebrate families) as did water quality: DO increased from 0 to >5 mg/L, TSS from >100 to <10 mg/L. However, the dominance (90%) of pollution-tolerant tubifids & chironomids indicate need for further rehab.

*Ecoplans, Inc. See “Historic Ecology” in *Master Plan for the Tifft Farm Nature Preserve, Buffalo, New York*. Saratoga Springs: The Saratoga Associates, 1975.

Erie Niagara Counties Regional Planning Board. *Buffalo River/Buffalo Creek Recreation and Open Space Preservation Plan*. Buffalo: ENCRPB, 1975.

Recommends protecting riparian vegetation and floodplain via:

- an 11,000-foot linear park/habitat along both shores of the Buffalo R. from DLW RR bank/Germania St east to city line
- a natural park along the north side of Buffalo Creek (Union to Transit) and an easement along south bank from Blossom to Bowen Rds.
- adding 50 acres to Handy Rd. Park
- a nature preserve at the Clinton Street oxbow (also recommended by Mikol).

*Friends of the Buffalo River/Holman and Wooster. *Buffalo River Greenway Plan and Design Guidelines*. Buffalo: City of Buffalo Division of Planning, March 1996.

Guidelines to make City's LWRP consistent with NYS CZM policies recommend "a minimum 50-foot vegetative buffer and 100-foot setback for new non-water dependent uses on the Buffalo River" for habitat and water quality benefits. Note: The City of Buffalo zoning code (section 511-67B) calls for a Buffalo River Open Space Corridor for new, nonwater-dependent uses on the river, effective 9/17/01, including a Downstream Corridor (Ohio St. to harbor) development setback of 25 feet from river's edge, an Upstream Corridor (Ohio St. to east city line) setback of 100 feet from river's edge, and restoration of natural plant growth in the corridor.

*Friends of the Buffalo Niagara Rivers/Poole. *Town of West Seneca Municipal Open Space and Greenway Protection*. West Seneca Technical Advisory Committee, 1999.

Maps 15 priority areas in the town for open space protection and makes detailed recommendations for including environmental protection in town regulations including zoning, site plan review, subdivision regulations, SEQR compliance and stormwater management.

*Herbert, Patrick. *Fisheries Survey of the Buffalo River*. Unpublished manuscript. SUNY Brockport, 2007.

Replicates and updates Makerewicz's 1981-82 fish surveys of the Buffalo River.

Holman Associates and Margaret Wooster. *Buffalo River Greenway Study: Final Report*. Buffalo: Friends of the Buffalo River, 1994.

*Houghton, Frederick. *History of the Buffalo Creek Reservation*. Publications of the Buffalo Historical Society, Vol. XXIV. Buffalo, Buffalo Historical Society, 1920.

The most comprehensive study of Haudenosaunee and pre-Haudenosaunee uses of the 130-square mile Buffalo Creek Reservation, established by the Big Tree Treaty in 1797 and lost through a series of treaties in the 1830s.

*Irvine, K.N. et al. *Assessment of Potential Aquatic Habitat Restoration Sites in the Buffalo River Area of Concern*. Buffalo: NYSDEC, October, 2005.

Evaluates 10 possible aquatic restoration sites. An IBI rates 7 sites as "poor," 3 sites as "very poor." DELT anomaly scores average 37%. Fewer invertebrate families than early 1990s; shoreline vegetation dominated by invasives. Conclusion: no biotic recovery since early 1990s.

DO in the dredged portion of river is often below state guidelines. From a review of several DO studies (Blair 92, Wight 95, Hall 97, Jalgama 04), concludes that low (<4 mg/L) DO is related to a combination of stratification in the river at low flows, high sediment oxygen demand, background BOD, and long residence time due to system hydraulics created by dredging. High water temperatures another major concern. Post-storm *E coli* counts show upper watershed is a significant bacteria source.

*Irvine, Kim N. *Cazenovia Creek Watershed Management Program: Baseline Water Quality Analysis, 1996*. Buffalo: Erie County Dept. of Environment and Planning, 1997.

Water sample analyses for 25 parameters (nutrients, indicator bacteria, metals, organic halogens) from 12 sites on Caz. Creek show creek to be “in relatively good health” but requiring watershed protection and monitoring. Water quality declines from upstream to down. Fecal coliforms exceeded state guidelines in 70% of samples. Encourages Erie County DEP and communities to develop a Cazenovia Creek Watershed Management Plan.

*Irvine, K.N. et al. *Septic System Pollution Prevention BMPs: Development of Public Outreach Approaches, Assessment, and Decision-Making Tools for Local Government*. Buffalo: Buffalo State College, November, 2003.

Focus is on failing septic systems in the Cazenovia Creek sub-watershed.

*Janowsky, Bill. *Fish and Wildlife Habitat Inventory-Aquatic Macrophyte Survey of the Lower Buffalo River*. Buffalo: USACOE, August 1998. (GIS at SUNY Buffalo)

Will environmental dredging of contaminated sediments effect critical aquatic habitats? Identifies and locates 18 submerged aquatic vegetative beds in the navigation channel suitable for fish & wildlife cover, mainly near shore in 2-4 feet of water. If these turn out to be the most contaminated areas, environmental dredging will remove the little remaining in-stream habitat, and require installation of clean sediments and new vegetation.

*Kozuchowski, Elizabeth, et al. *The Fishes of the Buffalo River: Report on the Results of the 1993 Larval and Adult Fish Survey, and Summary of Two Years of Data*. Amherst, USFWS, 1994.

Inventories of adult and larval fish species in seven reaches of the lower Buffalo River found 43 fish species, 16 in larval stage indicating reproductive success. Over 20% of adult bottom feeders like the brown bullhead showed deformities, fungal growths and other abnormalities “significantly higher than background incidence.”(12) Loss of suitable habitat is the main reason for lack of species and numbers consistent with historic communities and present-day Lake Erie populations. Habitat constraints include: lack of shallow areas, high surface water temps, seasonal low flows, high turbidity/TSS, physical and chemical bottom conditions (dredging, contamination), high rate of sedimentation, low DO, and lack of vegetation or other cover.

*Makarewicz, Joseph et al. *Biological Survey: Buffalo River and Outer Harbor of Buffalo NY*. Buffalo: USACE, June 1982. Preliminary study to Patch, S.P. and M.F. Stoll. *Biological Survey of Buffalo Harbor*. Buffalo: USACE, 1984.

Based on an intensive study of the Buffalo River and harbor, April 1981-May 1982. Examines four sites for potential dredge spoil disposal. Concludes that the CC Peninsula site is the most environmentally sensitive and “a refugium for species not generally expected in an urban ecosystem” including peregrine falcon, snapping

turtle, painted turtle and leopard frog. Recommends not disturbing the site. Contains spring and summer vegetation maps of CCP.

*Mikol, Gerald, et al. *Fish & Wildlife Habitat Inventory and Assessment of the Lower Buffalo River Watershed*. Buffalo: NYSDEC, October 1993.

Building on Roblee's 1991 field surveys, evaluates water quality, physical conditions, fishery resources, aquatic invertebrates, aquatic vegetation and wildlife resources. Concludes: "The manmade shoreline and dredged bottom probably have the greatest physical limiting effect on the ability of fish species to successfully reproduce and thrive." (63) Recommends:

- Preserve sunken piling for habitat benefits, at least until other habitat is restored
- Create shallow areas resembling former sand and gravel bars in river
- Review, modify or discontinue current navigational dredging policies
- Evaluate potential for DO levels enhancement for fish spawning and nursery
- Restore minimum 15 meter native vegetation buffers to 25% of the AOC shoreline
- Evaluate upstream opportunities for continuous natural shoreline
- Protect all existing riparian wetlands in AOC and upstream to first impassable barrier including two unprotected wetlands on Buffalo Creek in West Seneca (24 acres).
- Restore riparian wetlands: e.g., Concrete Central Peninsula; shoreline east of Seneca Street
- Protect two areas of floodplain forest in AOC, and scattered patches upstream to first barrier
- Long-term: restore a self-sustaining walleye population in the lower Buffalo River.

*Morris, Sara and Michael Hamilton, et al. *Avian Species Composition in Disturbed Riparian Environments: A Study of Three Waterways in Western New York*. Unpublished report. Buffalo: Canisius College and Buffalo Ornithological Society, 2007.

*NYS DEC. *Buffalo River Remedial Action Plan*, 1989. Buffalo: NYS DEC, 1989.

This is the Phase 1 document defining "beneficial use impairments" in the Buffalo River Area of Concern as called for by the Great Lakes Water Quality Agreement. Following this report the DEC tracked progress on the Buffalo River RAP through six status reports (1989-2002). In 2003 Buffalo Niagara Riverkeeper took responsibility for RAP coordination and continuing status reports.

*NYS DEC. *Rotating Integrated Basin Studies (RIBS)*. Buffalo: NYS DEC, 2005.

Based on annual sampling of Buffalo River water column through 2001:

- Water quality parameters of concern are iron, ammonia, temperature and DO.
- Macroinvertebrates in water column are considered slightly impacted.
- Fish advisory for carp (eat none) in upper river due to PCBs.

*Poole, Ann et al. *Fish and Wildlife Habitat Restoration on the Buffalo River, Buffalo, New York*. Buffalo: Erie Co. Dept of Environment and Planning, August 1994

This first post-RAP BR fish & wildlife habitat restoration plan includes trend data on aquatic macrophyte, benthic, zooplankton, phytoplankton, fish, herp, bird and mammal populations. Its goal is to increase the “area of habitat capable of supporting a healthy diversity and distribution of fish and wildlife communities, with emphasis on self-sustaining native biota,” with first objective to protect significant natural areas. Identifies 15 potential habitat restoration sites, and includes plans for five, four of which have been completed.

*Poole, Ann. *Buffalo and Cayuga Creeks Corridor Restoration Study: Final Report*. Buffalo: Friends of the Buffalo River, 1997. (Aerial photos and GIS maps, scale: 1 inch = 660 feet)

Maps land uses, significant cultural resources, natural resources, opportunities and constraints for developing continuous riparian greenbelts on creeks in towns of Cheektowaga and W. Seneca. Recommends:

- identify ecologically important areas at finer scale
- obtain ACOE wetland maps for riparian areas
- preserve wetlands, forests, floodplains in Stiglmeier Park and area west
- acquire and preserve Island Park, oxbow wetland and adjacent floodplain (WS)
- evaluate w/ NRCS alternatives to Earsing sills

*Roblee, Kenneth. *Wildlife Habitat Assessment of the Lower Buffalo River*. Buffalo: NYS DEC, April-June 1991.

Field surveys up to the first impassable barrier on Buffalo River tributaries for bird, mammal, reptile and amphibian usage and habitats in stream corridor. See recommended restoration guidelines.

*Sauer, David E. *An Environmental History of the Buffalo River*. Buffalo: Buffalo Color, 1979.

*Schneekloth, Lynda, Barry Boyer, Gary Day. *Controlling Land Use for Water Quality Protection: Buffalo River Greenway Plan*. Syracuse: Great Lakes Research Consortium, 1993.

*Singer, Jill et al. *Fish and Wildlife Assessment of the Buffalo River AOC and Watershed*. Buffalo: Buffalo State College, 1995.

Field studies on siltation rates, fish and invertebrate communities, and bank and channel characteristics, mainly conducted in 1992. Siltation rates appear to have declined; estimated sediment accumulation varies between 1- and 10 feet over 25 years. The larval fish community has increased in number and diversity, from 4 species (1981) to 16 species in 1992. Macroinvertebrate populations have improved from 0 in the 1960s to 13 taxa in 1992, though these are dominated by pollution tolerant-worms and midges. Physical characteristics of the riverbed show sediment furrow fields from both downstream and lake effect flows.

*Stafford, Elizabeth A. et al. *Interim Report: Collation and Interpretation of Data for Times Beach Confined Disposal Facility, Buffalo, NY*. Washington DC: US ACOE, 1991.

Collates the findings of 22 reports analyzing chemical and heavy metal uptake from Buffalo River dredge spoils in the biota at Times Beach CDF, now a nature preserve with public trails on Lake Erie near the Buffalo River mouth. Findings included the role of cottonwoods in cadmium uptake and transport to leaf litter, decreasing concentrations of PCBs and PAHs in upland areas for unknown reasons, and elevated levels of cadmium and mercury in fledgling ducks collected onsite. Recommends better contaminant characterization in wetland and aquatic areas.

Stearns & Wheeler. *Five Sites: Buffalo River Fish and Wildlife Habitat Restoration Demonstration Project, Document Package*. Buffalo and Erie County, 1995.

*Trometer, Betsy. *Fish Utilization of Aquatic Vegetation Beds in the Buffalo River*. Buffalo: USFWS, November, 1998.

Fish data compliments Janowsky *Aquatic Macrophyte* study. Identifies 31 species of fish utilizing the beds of aquatic vegetation, especially juvenile pumpkinseed, gizzard shad, largemouth bass, bluegill, emerald shiner, spottail shiner, white perch, yellow perch who are using this habitat for spawning and/or refuge. “aquatic habitat could be improved by . . . restoring the natural bank and adding overhanging vegetation.”

Weimer et al. *Surveillance for Ruffe in the Great Lakes*. Buffalo: USFWS, March 2002

Trawling for invasive fish species in 2001 found no ruffe in Lake Erie, but did find round goby in the Buffalo Harbor.

*West Seneca Environmental Commission. *Land Use Map and Recommendations*. Town of West Seneca, 1978.

Recommends that the town protect all remaining undeveloped floodplains.

US Fish and Wildlife Service. *Biological Survey of Buffalo Harbor*. Buffalo: US ACE, 1984.

In context of future dredge and fill operations, surveyed three areas—NFTA Small Boat Harbor, Black Rock Canal, Strawberry Island—for baseline biological data in 1983. Identified three areas vital to fish species: the gull nesting area near the north harbor breakwall; Bird Island marsh (a major spawning and nursery area for game fish); and the cove on Strawberry Island. Main concern with future dredging is pollutant resuspension.

URS. *Feasibility Study for Public Access to Times Beach, Buffalo, NY*. Buffalo: US ACE, 2002.

Examines several site designs for safe public access at Times Beach in the context of moderate contamination of wetland and aquatic areas with heavy metals and organo-chlorine compounds.

8.2.1 TOXIC CONTAMINANTS

Atkinson et al. *Model Data Requirements and Mass Loading Estimates for the Buffalo River Mass Balance Study*. Chicago: USEPA GLNPO, 1994.

Collected data to estimate the loading sources and annual amounts for 11 different contaminants. Sediments contain high concentrations of some materials and there is a concern for potential releases resulting from resuspension events. Possible sources of loadings include upstream flows, industrial discharges, groundwater leaching, combined sewer overflows and resuspension of in-place contaminated sediments.

Irvine, K.N. et al. *Contaminated Sediment in the Buffalo River AOC—Historical Trends and Current Conditions*. In “Sediment Quality Assessment and Management: Insight and Progress,” Ecovision World Monograph Series, 2003.

Traces the historical relationship between the change in industrial activity along the Buffalo River and trends in sediment quality (metals, PAHs) as reflected through sediment cores; discusses results of aquatic organism risk assessment as they pertain to new sediment dredging guidelines developed by USACE and the USEPA; and examines the decrease in sediment loadings in AOC. Conclusions of note: sediments may now meet criteria for open lake disposal; annual volume of dredged material has decreased from 261,000 yd³ (1944-55) to 97,000 yd³ (1970-92); remedial action “may be a combination of ‘hotspot’ remediation and ‘no action.’”

*Green, ML and J DePinto. *Development of a Decision Support System for Contaminated Sediment Remediation in the Buffalo River, NY*. Ann Arbor: International Association for Great Lakes Research, 1999.

A GIS-based decision support system providing the capability to overlay, query, analyze and visualize spatial data for river bathymetry, aquatic plants, fish distribution and contaminated sediment chemical data. Applied to the Buffalo River to aid decision-making regarding priority areas and potential impacts of sediment remediation.

Karn, Richard et al. *Sediment Sampling, Biological Analyses and Chemical Analyses for Buffalo River Area of Concern, Buffalo New York*. (2 vols). Buffalo: USACE, 2003.

Loganathan, Bommonna et al. *Isomer-Specific Determination and Toxic Evaluation of PCB's...in Carp*. Environmental Science & Technology, Vol. 29. No. 7, 1995.

Elevated concentrations of PCB isomers other than dioxins and furans suggest the need to protect humans from the consumption of PCB-contaminated carp from the Buffalo River. Noticeable concentrations of PBBEs (polybrominated biphenyl ethers—flame retardant) were also found in carp.

*Passino-Reader et al. *Baseline Risk Assessment for Aquatic Life for the Buffalo River New York Area of Concern*. Chicago: USEPA GLNPO, 1992.

Based on sediment samples (1985, 89) and biota measures (1977, 89), assesses risk to 8 receptor organisms (fish, zooplankton, benthos) from 41 Buffalo River toxic substances (10 metals, 16 PAHs, 15 pesticides, total PCBs) via five exposure pathways. “Typical” and “worst case” exposures show brown bullhead most at risk from PCBs, chlordane, mercury; benthos most at risk from metals and PAHs. Concludes with the need to identify sediment hotspots and continuing sources of contamination such as CSOs and abandoned hazardous waste sites.

SAIC. *Assessment of Sediments in the Buffalo River Area of Concern (ARCS)*. Chicago: USEPA GLNPO, 1995

Assesses nature and extent of bottom sediment contamination in the Buffalo River.

Sikka, Harish. *Field and Laboratory and Support Results- Buffalo River Mass Balance Project*. Chicago: USEPA GLNPO, 1993.

Water column, suspended sediment and CSO sampling (1990-92) showed total PCBs in water below detection, in sediment >8ppt, and highest levels at CSO sites; pesticides low or below detect except at CSO sites; PAHs higher, especially at CSO sites like Hamburg St.; Copper and iron exceed IJC ambient criteria in 100% of samples; lead exceeds criteria in 40%.

Williams, J, Atkinson, J, and Gargeya, D. *Sediment Transport Model for the Buffalo River*. Ann Arbor, IAGLR, 2004.

Differs from earlier sediment transport models for the Buffalo River in that takes into account the stratified nature of the river and the effects of lake seiches. Applies a hydrodynamic/sediment transport model, ECOMSED to evaluate sedimentation characteristics in response to various environmental dredging scenarios.

8.3. Niagara River and Tributaries

8.3.1 NYPA STUDIES

As part of the relicensing process for the Niagara Power Project (NPP), the NY Power Authority commissioned over 40 studies describing the project's impact on the environment. Many of these contain useful information, such as GIS maps and data layers on terrestrial and aquatic habitats. The main reports summarized here are found at: <http://niagara.nypa.gov/studyreports/finalreports.htm> GIS layers are available on request from NYPA's environmental science office at: Edward.Alkiewicz@nypa.gov

Acres International Corporation. *Fish Entrainment and Mortality Study*. NYPA, March 2004.

Includes maps showing aquatic vegetation and river depths. On the basis of comparison w/ other hydro projects but no actual measurement of fish mortality at NPP tailraces, the study concludes that most fish entrained at intakes and turbines are small (< 12 inches), that 70% are likely to survive, and that most would be swept over the falls anyway with 0% survival. Does not consider physical barriers at intakes to be feasible. Study also notes its limits in terms of major dissimilarities between the NPP and other US hydropower plants in size and configuration, suggesting they are not comparable.

Aquatic Science Associates. *Describe Niagara River Aquatic and Terrestrial Habitat Between the NYPA Intakes and the NYPA Tailrace*. NYPA, August 2005.

Describes water level changes in upper and lower river reaches due to NPP operations, and effects on habitat. Above the falls the average change is 1.5 feet daily in tourist season with little or no effect on shoreline habitat (largely hardened with fill, riprap or other armoring). In the lower river near the Falls water levels change by as much as 12 feet per day; at Lewiston the average daily fluctuation is 1.5 feet. The study speculates that water level changes could affect sturgeon spawning habitat downstream from Fosters Rapids, and that stormwater runoff, recreational use and invasives probably impact terrestrial habitat more than water level changes.

*Baird, W.F. & Associates Coastal Engineers Ltd. *Shoreline Erosion and Sedimentation Assessment Study Upstream and Downstream of the Power Project*. NYPA, September 2004.

This visual assessment of shoreline conditions from a boat shows:

- lower river: 14% actively eroding; 37% hardened (bulkheading, riprap, etc.)
- upper river: 3% is actively eroding; 63% is hardened
- tributaries (within NPP impact area) 4% is actively eroding; 40% is hardened

Primary erosive forces are wind-generated and boat-generated waves and river currents.

Conestoga-Rovers and Associates. *Determine if the Ice Boom has Climatic, Aquatic, Land Management or Aesthetic Effects*. NYPA, October 2004.

On the basis of a review of existing studies, concludes that the ice boom has negligible effects on local climate and ice dissipation at the east end of Lake Erie (especially since 1984 when boom removal was moved up to before April 1) and on ecological resources and agriculture. It sees no negative aesthetic effects to adjacent properties from ice boom storage (on Erie shoreline adjacent to Times Beach), but holds open the option of finding an alternative site.

E/PRO Engineering and Environmental Consulting. *Effects of Land Management Practices on Aquatic and Terrestrial Habitats*. NYPA, June 2004.

Looks at management practices on 1,700 upland acres of NYPA's 3,700 acres of project and non-project land. Concludes there may be negative effects on habitat, especially from vegetation management (mowing, herbicides, landscaping with invasive species) and road maintenance (runoff of pollutants and winter salts), but that these practices are widespread throughout the Niagara Region. Should be cross-referenced with studies by P.M. Eckel on the unique vegetation and habitats of the Niagara river and gorge and her "Preliminary Proposals for Relicensing Settlement" (July 2004) for managing these nationally significant biotic resources.

Environmental Standards, Inc. *Extent of Sedimentation and Quality of Sediment in the Lewiston Reservoir and Forebay*. NYPA, August, 2006.

*Gomez and Sullivan Engineers. *Cayuga Creek Watershed Assessment Summary Report*. NYPA, June 2006.

A literature review for the Cayuga Creek watershed in Niagara County, including GIS maps and data on land use, habitats, wetlands, soils, hydrology, etc. See recommendations for creek and habitat restoration. Riverkeeper developed a Cayuga Creek Watershed Report Card on the basis of this report, rating overall water quality "D", and fish and wildlife habitat "C" due to channel alterations, loss of riparian vegetation and wetlands, fragmentation and fish barriers. Cayuga Creek fish evidence continuing toxic contamination (PCBs, mirex, dioxin, dieldrin, chlordane) from Love Canal and the 102nd St. landfill. (3-29)

*Gomez and Sullivan Engineers. *Gill Creek Fish Survey, 2004*. NYPA, April 2005.

Fish sampling (seining and/or electrofishing) at 16 sites along Gill Creek in May, July and September 2004 found 37 species dominated by emerald shiner, bluntnose minnow and pumpkinseed in lower reach, creek chub in middle reach, and brook stickleback, central mudminnow, fathead minnow and white sucker farthest upstream (by Lewiston Reservoir).

*Gomez and Sullivan Engineers. *Mapping of Aquatic and Riparian Habitat of Ellicott and Tonawanda Creeks, and Tributaries to Tonawanda Creek*. NYPA, August 2005.

Aquatic habitats in the lower reaches of Ellicott and Tonawanda Creeks are turbid runs that have been dredged—especially the last 11.6 miles of Tonawanda

Creek, part of the Barge Canal which runs backwards 6 months of the year (May-October) and is dredged to a uniform width, depth and slope. Flood control, dredging and diversion channels have also severely interrupted natural habitat on lower Ellicott Creek. Upper reaches of both creeks are more sinuous with greater habitat variability (run/riffle). Water levels in these creeks and their tributaries (Mud, Ransom, Black, Bull, Sawyer) are potentially influenced by Niagara River water levels.

Gomez and Sullivan Engineers. *Mapping of Submerged Aquatic Vegetation in Lewiston Reservoir*. NYPA, April 2005.

No extensive SAV beds were observed in the reservoir.

*Gomez and Sullivan Engineers. *Use of Buckhorn Marsh and Grand Island Tributaries by Northern Pike for Spawning and as a Nursery*. NYPA, July 2004.

The Buckhorn Marsh Restoration Project includes 2 weirs protecting water levels from NPP river fluctuations. Northern pike and largemouth bass use the marsh for spawning and nursery. High weir prevents pike and bass from migrating in or out of the marsh impoundment; dense cattails prevent migration through Burnt Ship Creek. Study concludes that the best way to increase fish passage in and out of marsh is through creating more open channel through cattails.

*Kleinschmidt Associates et al. *Investigation of Habitat Improvement Projects for the Niagara Power Project*. NYPA, April 2004.

The HIP relicensing settlement provides \$12 million for 8 projects; the Habitat Enhancement and Restoration Fund provides \$1 million per year for 50 years. This report includes design, management and monitoring plans for 17 possible HIPs including:

1. Strawberry Island wetland creation
2. "Frog Island" restoration
3. Motor Island shoreline protection
4. Beaver Island wetland restoration
5. Spicer Creek tributary enhancements
6. Gun Creek tributary enhancements
7. Fish access to Burnt Ship Creek
8. Control of invasive species at Buckhorn and Tifft marshes
9. Shallow water habitat creation near mouth of Burnt ship Creek
10. Feasibility of restoring native terrestrial plants at Goat Island and in the gorge
11. Osprey nesting platforms
12. Black tern nesting (Tifft)
13. Common tern nesting (Buffalo Harbor and upper river)
14. Enhancements to the Motor Island heron rookery
15. Installation of fish habitat/attraction structures (Upper river)
16. Native coregonid (LO whitefish, lake herring, deep water cisco) hatchery
17. American bittern hacking program

Kleinschmidt Associates. *Recreational Facility Use and Capacity Investigation*. NYPA, November 2003.

Investigated 29 recreation sites in PP vicinity, April 02-March 03 showed that 86% of recreational use is focused on Niagara Falls and Reservation SP. 80% involved shoreline use, 20%, boating activity. Overall sites are being used below capacity with 3 exceptions—parking at Ontario St., Lewiston Landing and Ft. Niagara boat launch.

Kleinschmidt Associates. *Addendum to the Recreational Facility Use and Capacity Investigation*. NYPA, July 2004.

Looks at 3 more upper river sites: Tow Path Park, Bird Island Pier and Broderick Park. Broderick Park most heavily used. Use at all sites is within design capacities.

Kleinschmidt Associates. *Recreation Needs Assessment*. NYPA, July 2004.

Conclusions same as 2003 report. Notes need to improve interfaces between recreation sites along the gorge with lower river sites and with downtown Niagara Falls. Notes public access to gorge from adjacent local neighborhoods is constrained and fragmented by the R.M. Parkway.

The Louis Berger Group, Inc. *Describing Contaminant Levels in Fish in the Lewiston Reservoir*. NYPA, August 2005.

Normandeau Associates, Inc. *Recreational Fishing Survey of the Upper Niagara River*. NYPA, March 2004.

Anglers and catch counted April-Nov. 2003. Shore anglers mainly caught y. perch (28%), followed by round goby (25%), rock bass 19% and smallmouth bass (13%). They harvested 43% of total catch (est. 186,000 fish) Boat anglers mainly caught smallmouth bass (48%), followed by largemouth bass (16%), y. perch (13%) and northern pike (8%). Boat anglers harvested 13% of total catch (71,000 fish). Most upper river shore trips were to Buffalo waterfront; most boat trips to Tonawanda Channel. [See table 3.3.1]

*Riveredge Associates. *Assessment of the Potential Effects of Water Level and Flow Fluctuations and Land Management Practices on Rare, Threatened, and Endangered Species and Significant Occurrences of Natural Communities at the Niagara Power Project*. NYPA, January 2004.

Finds 49 rare, threatened or endangered (RTE) species or significant natural communities in the project area that could be affected by NYPA activities including changes to water level and flow. These include lake sturgeon, bald eagle, common tern, least bittern and pied-billed grebe. Also, 3 unprotected species of native mussel, and 3 significant natural communities. Specifically at risk from changes to flows and levels may be pied-billed grebe nesting areas, lake sturgeon spawning areas in the lower river, and the deep emergent marsh community at Buckhorn. Land management activities could effect 3 additional plant species and the calcerous cliff and talus slope woodland communities of the gorge.

*Riveredge Associates. *Occurrences of Rare, Threatened, and Endangered Mussel Species in the Vicinity of the Niagara Power Project*. NYPA, April 2003.

Of the 31 species of mussel historically identified in the Niagara River project area, these 2001-2 field surveys found evidence (spent shells or live animals) of 16—10 rare and 6 common (including zebra mussels). The majority of these were found on Grand Island near Beaver Island, Buckhorn Island and Spicer Creek.

Stantec Consulting Services, Inc. *A Recreational Fishing Survey of the Lower Niagara River in 2002 and 2003*. NYPA, February 2004.

Counts shore and boat anglers and species caught on lower river—May 02-June 03, and Niagara Bar (1 mi out into LO)—Oct. 02- March 03. Shore anglers mainly caught smallmouth bass (28%), followed by rock bass (20%), y. perch (12%), white bass (10%), freshwater drum (9%), round goby (8%), and salmonids (5%). White bass were the most harvested (66%). Shore anglers harvested (presumably ate) 20% of the total catch (est. 360,000). Boat anglers mainly caught smallmouth bass (58 %), except during winter (Oct-Mar) when primary catch was salmonids. Boat anglers harvested 15% of total river catch (est. 74,500 fish); 3% of bar catch.

Stantec Consulting Services, Inc. *A Recreational Fishing Survey of the Lewiston Reservoir in 2002*. NYPA, December 2003.

Anglers and catch counted April-Nov. 2002. Yellow perch was targeted species in spring, smallmouth bass in summer and fall. Y. perch was 68% of total count, followed by smallmouth bass, rock bass, white bass, northern pike and freshwater drum. Anglers harvested 83% of y. perch; 81 % of white bass; 65% of total (est. 23,000 fish).

Stantec Consulting Services, Inc. et al. *Effect of Water Level and Flow Fluctuations on Aquatic and Terrestrial Habitat*. NYPA, February 2004.

Looks at the potential effects of water levels and flow fluctuations on 19 fish species, 15 wildlife, and 3 macroinvertebrates. Concludes that these “could result in changes” to coastal wetland habitat structures, distribution and species in upper river, but there are no coastal wetland habitats in the lower river. Also that these could affect the spawning, egg and larval habitats of several fish species, mayfly nymphs and giant floater mussels, but that suitable habitat exists at greater (unaffected) depth for these species, except white sucker which has a narrow range of spawning depth. Argues the same for green frog, northern leopard frog, common mudpuppy, common snapping turtle, midland painted turtle, Virginia rail, American coot, spotted sandpiper—that suitable habitat exists outside of fluctuation zone.

TRC Engineering and Riveredge Associates. *Feasibility Study for the Restoration of Native Plants in the Vicinity of the Niagara Gorge*. NYPA, January 2008.

Inventories native and invasive plants in the Niagara Gorge from Goat Island to Artpark based on a literature review and 2007 field surveys, to determine the

feasibility of restoring native terrestrial rare, threatened or endangered plants. Finds that about 75% of the vegetation is native, with 11 extant T & E species. Concludes that community-level restoration is not feasible, but pilot-level projects may be possible in selected areas with specific features.

URS Corporation. *Describe the Effects of Project Construction on the Surrounding Environment*. NYPA, July 2004.

Useful for ascertaining pre-power project river conditions, especially around the north end of G.I. Includes maps showing relocation of Fish and Gill Creeks; final placement of sediment, soil and rock (e.g. Goat Island was expanded by 8.5 acres); and location of intakes, tunnels and other infrastructure. How much aquatic and riparian habitat was lost? The report doesn't say, but this may be estimated by comparing pre- to post-NPP topographic maps.

*URS Corporation. *Ecological Condition of Gill, Fish and Cayuga Creeks*. NYPA, May 2004.

“Major issues affecting the ecological condition of Fish, Gill and Cayuga Creeks include sediment contamination, groundwater flow pattern, stream channelization, natural and man-made fish barriers, and land use and management practices” The lower reaches of Gill and Fish Creeks have been diverted, culverted and lined with concrete. Cayuga Creek headwater tributaries have been ditched for farmland drainage; lower reaches are channelized for flood control, and middle reaches realigned and culverted around the Niagara Falls airport. Fish from lower Gill and Cayuga Creeks are contaminated with PCBs and dioxin linked to contaminated sediments near hazardous waste landfills. “Due to the many constraints . . . restorative actions to improve the ecological and geomorphic function of the creeks are not addressed in this study.”

URS Corporation. *First-Stage Consultation Report: Niagara Power Project*. NYPA, December 2002.

Maps 10 wetland communities and deepwater habitats and 11 upland plant community types in the vicinity of the Niagara PP. Field surveys found 15 state-listed endangered or threatened plant species, 1 federally-listed endangered species (bald eagle) and 9 state-listed endangered or threatened animal species, including the peregrine falcon and the short-eared owl.

URS Corporation. *Impediments and Opportunities for the Future Use and Disposition of the Robert Moses Parkway*. NYPA, September 2004.

Should the portion of the Robert Moses Parkway along the east rim of the Niagara Gorge be removed to improve ecology and accessibility? This report does not answer that question but identifies impediments and opportunities associated with the many plans and proposals to enhance, modify or remove the NYPA-constructed Parkway.

URS Corporation. *Niagara River Water Level and Flow Fluctuation Study*. NYPA, November, 2003.

Includes maps and graphs showing the magnitude, frequency and spatial extent of fluctuations associated w/ PP and IJC regulation of Grass Island Pool, permitting daily fluctuation up to 1.5 feet. “Water fluctuation in the lower river. . . upstream of the Project tailrace, can be as high as 12 feet per day.” (3) At LO average is .6 feet/day. In Lewiston Reservoir range is 3-18 feet/day and as much as 36 feet/week.

URS Corporation. *Surface Water Quality of the Niagara River and Its Tributaries*. NYPA, August 2005.

URS Corporation. *Upper Niagara River Tributary Backwater Study*. NYPA, July 2004.

This is a supplement to the above referenced *Niagara River Water Level and Flow* study, looking at the effects of changes in river levels and flows on seven tributaries—three on Grand Island plus Cayuga, Bergholtz, Tonawanda and Ellicott Creeks. Of special note is the discussion of flows in relation to Barge Canal operations on Tonawanda Creek. When the Lockport lock is opened, up to 1100 cfs is diverted from the Niagara River into the canal. Changes in Niagara water levels could thus influence flow as far as 19 miles upstream on the canal.

8.3.2 OTHER NIAGARA RIVER STUDIES

*Archer, Ryan W., Steven Timmermans and Claire Robinson. *Monitoring and Assessing Marsh Habitats in Great Lakes Areas of Concern, Final Project Report*. Bird Studies Canada Marsh Monitoring Project, 2006.

Paired MMP surveys (marsh birds and amphibians) with macroinvertebrate and wetland water quality monitoring over 2 years in 12 Great Lakes AOCs, including the Niagara River, to evaluate wetland biological integrity.

*Calkin, Parker E. and Carlton E. Brett. “Ancestral Niagara River Drainage: Stratigraphic and Paleontologic Setting.” *Geological Society of America Bulletin*, v. 89, Aug. 1978. # 80803.

*Carlson, D.M. *List of Fishes of the Niagara River in New York State*. Draft for NYS DEC, 2001.

This literature search finds 91 different fish species documented in the Niagara River. Four species not caught since the 1930s are blackchin shiner, lake chubsucker, three-spine stickleback, and blue pike. At least 36 species have been introduced since 1960. Atlantic salmon and Lake whitefish once present in the lower river have not been seen since the 1800s.

*Carlson, D.M. *Tonawanda Creek Survey for Rare Fishes*. Draft for NYS DEC, 2001.

Documents redfin shiner and longear sunfish as above, plus 19 species of mussels in Tonawanda Creek up to the barrier of Tonawanda falls over the Onondaga Escarpment. “Six of the 70 fish taxa inhabiting Tonawanda Creek are

probably non-native and most are the result of the Barge Canal disturbance and transport.”

Crombie, David et al. *Niagara River Greenway Facilitation Services Progress Report, September 2005*. Toronto: Canadian Urban Institute, 2005.

Precedent to the adoption of the Niagara River Greenway Plan, this report identified connecting infrastructure and cultural and natural features along the US side of the river that could be integrated into the plan. Appendices contain maps and a comprehensive list of existing assets.

Czapla, Thomas E. et al. *Fish Community Rehabilitation*. NYS DEC, 1995.

Rates Lake Ontario (LO) ecosystem function at 42%. 58% of available energy is diverted or lost because of the following: exotic species (21%), physical habitat loss and barriers (20%), and toxic contamination (17%). Because LO is a cold, oligotrophic lake, lake-connected wetlands are critical to its fish community. LO wetland habitats have been reduced by 50-80%.

DeGruchy, MA et.al. *Natural Recovery and Restoration Potential of Severely Disturbed Talus Vegetation at Niagara Falls: Assessment Using a Reference System*. Restoration Ecology, Vol. 9, No. 3, September 2001.

A sampling of plant community structure at the talus slope at Niagara Falls found a total of 137 species, 62 percent non-native. Historically vegetation was similar to current Niagara Escarpment vegetation, which can be used as a reference community. “We conclude that the trajectory of natural succession at NF is leading to an alternative state, an urban forest dominated by aliens, and that active restoration will be required to return the talus to its original state.”

*Eckel, P.M. *Artpark, Lewiston, NY: Botanical Field Notes from 2001 and 2002*.

Discusses major vegetative features in the gorge including ancient cliff forests with 1800 year-old dwarf white cedars. Also note “bird cherry” *Prunus avium* L. as a major visual component of predominantly oak hickory gorge forest (attributed to aboriginal and pre-colonial activities) Notes at Artpark: Red oak dominance followed by hop hornbeam, paper birch, sugar maple, basswood, white ash, shagbark hickory, black walnut, bitternut hickory. Witch hazel, round-leaf dogwood, thimbleberry and red-berried elder are dominant shrubs. Notes complex hydrology (springs and seeps) at the base of the escarpment, changes in nearshore plants due to lack of ice scouring and to river diversion to power plant.

*Eckel, P.M. *Botanical Evaluation of the Goat Island Complex, Niagara Falls, New York*. 2002.

A detailed survey of Goat Island’s flora and an analysis of the features that led to the island’s botanical richness, including its natural springs, topography and former remoteness. Any vegetation restoration plan should begin with this evaluation and critique of the many management decisions that have diminished Goat Island’s natural heritage.

Eckel, P.M. "Flora of DeVeaux College Woods." *Clintonia*, supplement to Issue 1, Jan. 1986.

*Eckel, P.M. "Flora of a Marsh on Cayuga Island, Niagara County, NY." October 11, 2003. www.mobot.org/plantscience/ResBot/Niag

*Eckel, P.M. "Some Preliminary Proposals for Relicensing Settlement." July 22, 2004. <http://www.mobot.org/plantscience/ResBot/niag/Proposal/MeetingProposals.htm>

Proposes a Joint International Biological Commission to preserve and restore Niagara's unique native biological (botanical) features across the border, and that relicensing settlement funds be used to preserve and restore significant biological resources based on a thorough inventory, master plan and wilderness designation (vs. park) for specific areas of valuable flora.

*Eckel, P.M. *Trees Along the Crest of the Niagara River Gorge from Devil's Hole to DeVeaux (Whirlpool) Steps in New York State*. Nov. 2004. <http://ridgewaydb.mobot.org/resbot/index.htm>

See especially the 9 restoration suggestions at the end, including removal of ecologically inappropriate trees and replacement with native trees and shrubs along the crest of the gorge and the Robert Moses Parkway. Provides lists and appropriate areas for specific species.

Einhouse, Donald et al. *1999 Angler Survey of the Upper Niagara River*. Albany: NYSDEC, April 2002.

This Canada/US creel survey measure of boat and shore fishing activity on the upper Niagara finds smallmouth bass the most sought and caught species, followed by yellow perch. Shore anglers outnumber boat anglers; Bird Island Pier is the largest hub of fishing activity. Recommends that important juvenile nursery areas for these species be identified and protected, and muskellunge-focused management objectives should be revised accordingly.

*Environment Canada. *Technical Review of Impairments and Delisting Criteria: Niagara River (Ontario) Remedial Action Plan*. Final Draft. Ottawa: Environment Canada, 2007.

A technical review of the Beneficial Use Impairments (including habitat and species loss), and delisting criteria and monitoring needs for the Ontario portion of the Niagara River AOC.

Erie County Soil and Water Conservation District. *Scajaquada Creek Watershed Management Plan*. Buffalo: Erie County Legislature, 2002.

Concludes with many recommendations to reduce storm water runoff, increase CSO retention capacity, reduce invasive species, protect remaining wetlands and floodplains (including incentives for landowners), assess toxic contamination, and remove contaminated sediments. See also NYS DEC young-of-year fish study

(1996) and RETEC report describing 1999 remedial dredging project on lower Scajaquada Creek.

ENCRPB. *Cayuga Creek (Niagara County) Water Quality Study*. Buffalo: Erie and Niagara Counties Regional Planning Board, 1975.

A photographic, hydrologic and water sampling survey of the creek to pinpoint problem areas, determine flow characteristics and assess water quality.

ENCRPB. *Ellicott Creek Improvement Project, 1988-9*. Buffalo: Erie and Niagara Counties Regional Planning Board, 1989.

ENCRPB. *Gill Creek: Enhancement of Environmental Quality*. Buffalo: Erie and Niagara Counties Regional Planning Board, 1974

ENCRPB. *Two Mile Creek Water Quality Study*. Buffalo: Erie and Niagara Counties Regional Planning Board, 1976.

Goodyear, Carole D. et al. *Atlas of the Spawning and Nursery Areas of Great Lakes Fishes: Volume X, Niagara River*. Washington DC: Fish and Wildlife Service, 1982. (FWS/OBS-82/52)

Historically, narrow zones of rooted aquatic vegetation lined the lower river; while extensive beds were present in the shallow bays and shoals around Grand Island in the upper river. Upper river tribs. also supported spawning migrations in spring and were important breeding areas for native species. 80 species of fish recorded; information on reproductive habitat available for 24.

*Kelso, J.R.M. and J.H. Hartig. *Methods of Modifying Habitat to Benefit the Great Lakes Ecosystem*. Canada Institute for Scientific and Technical Information, Occasional Paper No.1. Ottawa: National Research Council of Canada, 1995

Case studies on GL habitat restoration projects from creating reef rafts to restoring walleye spawning habitat and including a summary of the first phase of the Strawberry Island Shoreline Habitat Restoration Project.

*Kindle, E.M. and Frank B. Taylor. *Geologic Atlas of the United States: Niagara Falls New York Folio*. US Geological Survey, Washington D.C., 1913.

Describes bedrock and glacial geology, river and tributary morphology.

*Lowie, CE and JM Haynes. *Habitat Requirements of Stream Spawning Walleye: An Evaluation of Habitat Suitability Index (HSI) Information and Lake Erie/Niagara River Tributaries*. IAGLR, 1999, A-73.

In support of the DEC's Lake Erie Walleye Spawning Stream Rehabilitation Plan (1984), a Habitat Suitability Index (HSI) was evaluated comparing model parameters for optimum walleye habitat with local stream conditions where walleye spawn. Substrate, DO and pH variables in the model correlated with actual walleye spawning habitat more than velocity, depth and temperature variables. Ellicott Creek was most similar to national HSI model.

*Mack, Andrew and Geoffrey Verkade. *Natural Heritage Characterization of the Niagara River AOC and Associated Subwatersheds in Relation to Environment Canada's Habitat Rehabilitation Framework*. Niagara Peninsula Conservation Authority, 2004.

A status report on habitat in Ontario's Niagara River watershed (127,506 hectares) compared to Environment Canada's framework finds a deficit of 13,000 ha woodland, 5,700 ha wetland and 7,400 ha riparian vegetation. This is further broken down by subwatershed and various buffer area widths.

McDonnell, DJ. *The Fish Barrier Removal Project-Restoring Fragmented Watercourses*. IAGLR, 2004, p. 104.

The Niagara Restoration Council (Ontario) has developed a technique for identifying, removing and monitoring fish barriers—dams, weirs, crossings, perched culverts—within the Niagara River AOC. “Over 120 km of potential fish habitat has been re-opened to date.”

*Marangelo, Paul J. and David L. Strayer. *The Freshwater Mussels of the Tonawanda Creek Basin in Western New York*. Walkerana, 2000, 11 (25): 97-106.

A 1998 survey found a regionally significant 19 species of unionid mussels of which 16 were alive, and including 2 rare in WNY and eastern L. Erie: *Lamsilis fasciola* and *Truncilla truncate*.

*Niagara Heritage Partnership. See www.niagaraheritage.org for current and historic articles on the Niagara gorge, including Bruce Kershner's maps of gorge old growth forests.

*NYS Conservation Department. *A Biological Survey of the Erie-Niagara System, Supplemental to the Eighteenth Annual Report, 1928*. Albany: JB Lyon Co., 1929.

An early survey of fish, water quality and aquatic plants in the tributaries and along the coasts of the Niagara River and Lake Erie.

*NYS DEC. *Species Accounts for the Rare Fishes of New York*. NYS DEC, April 2001.

Accounts of 33 endangered, threatened or special concern fish species highlight Tonawanda Creek near Millersport Hwy (upstream of Barge Canal channelization) as one of last remaining places where redbfin shiner (special concern) and longear sunfish (threatened) have been found. References D.M. Carlson.

*Sault, Maryellen, Lisa Matthies, John Whitney and Jill Singer. *A Temporal Analysis of Strawberry Island, Niagara River, Tonawanda, New York*. Unpublished paper. East Aurora: USDA Natural Resources Conservation Service, 1995.

A temporal study of erosion changes in Strawberry Island, 1934-1990, based on aerial photograph analysis, and interviews with experts.

*Strayer, David L. Kurt J. Jirka, and Kathryn J. Schneider. *Recent Collections of Freshwater Mussels (Bivalvia: Unionidae) from Western New York*. Walkerana, 1991, 5 (13): 63-72.

A survey of 52 WNY sites (1987-90) found living populations of 23 species, mainly in the Allegheny River basin. Only 4 living species found in the Buffalo River basin, 10 in the Tonawanda Creek basin.

*Veal, D.M. *A Biological Evaluation of the Niagara River*. Ontario Ministry of Environment, 1968.

One of the few early biological surveys of Niagara, this field survey measures benthos at over 100 sites along both sides of the river and into Lake Ontario. In the Upper River the most impacted areas (no macroinvertebrate life) are at the mouth of Buffalo River and at Tonawanda Island (International Paper Co.). Oils and phenols are principal pollutants. Finds the Lower River (below Falls) impaired throughout: no mayfly nymphs, few caddisfly, and a small variety of worms and midges. NF WWTP is a major cause, discharging 75% untreated industrial wastewater. Water quality on Canadian side is generally good; on U.S. side, generally impaired. Identifies some areas of aquatic vegetation.

*Wendel Duchscherer. *Niagara River Greenway Plan*. Buffalo/Albany: Niagara River Greenway Commission, 2007.

Endorsed unanimously by 13 Niagara Greenway communities and approved by NY State Parks in March 2007, the Greenway Plan provides a framework and design guidelines for funding greenway projects using NYPA settlement funds in compensation for the ecological impacts of NPP operations. Find the plan and proposed projects at www.niagaragreenway.org

8.3.3. TOXIC CONTAMINANTS

Niagara River RAP-related Reports

*NYS DEC. *Niagara River Remedial Action Plan*. Albany: NYS DEC, September, 1994.

Phase I document identifying beneficial use impairments in the Niagara River Area of Concern, defined as the 37-mile-long river corridor from Smoke's Creek to Lake Ontario.

***NYS DEC Young-of Year Fish Studies.**

Note: Young-of-year (YOY) fish have a limited home range and are therefore considered effective indicators of local and recent sources of environmental chemical contamination.

- *Chemical Contaminants in Young-of-the-Year Fish from New York's Great Lakes Basin 1984 through 1987*. Albany: NYS DEC, 1989.

YOY spottail shiner, emerald shiner, or bluntnose minnow were collected from 11-17 locations in 1984, 1986 and 1987 and analyzed for PCBs organochlorine pesticides, mercury and hexachlorobenzene. Spottail shiners from the Niagara River, eastern Lake Ontario and the St. Lawrence River exceeded the IJC aquatic ecosystem objective of 100ng/g for protecting fish-eating wildlife. Provides a good explanation of the difference between IJC limits of 100ng/g to protect fish-eating wildlife vs. US FDA limits of 2,000 ng/g for human consumers.

- *Identification of and Changes in Chemical Contaminant Levels in Young-of-Year Fish from New York's Great Lakes Basin*. Albany: NYS DEC, 1994. Spottail shiners were sampled from 24 NY Great Lakes and connecting channel sites and analyzed for PCBs, OC pesticides, mercury, arsenic, PAHs and chlorobenzenes. Highest levels of PCBs were found at Massena (St. Lawrence River). Levels in excess of 100ng/g were found at Niagara River Gratwick Park and in the lower Buffalo River.
- *Contaminants in Young-of-Year Fish from Selected Lake Ontario Tributaries*, 1996. Albany: NYS DEC, 1998. Analyzed bluntnose minnows in 14 Lake Ontario tributaries and two Niagara River tributaries for PCBs, OC pesticides, dioxins and furans. In 10 locations PCB concentrations exceeded IJC aquatic ecosystem objectives, with the highest found in YOY fish near the mouth of Scajaquada Creek.
- *Contaminants in Young-of-Year Fish from Near-shore Areas on New York's Great Lakes Basin*, 1997. Albany: NYS DEC, 2002. Analyzed YOY fish in 34 near-shore areas for PCBs, organochlorine pesticides, mercury, dioxins and furans. High PCB levels were found in lower Gill Creek.
- *PCBs and Organochlorine Pesticide Residue in Young-of-Year Fish from Traditional Near-shore Sampling Areas, NYS's Great Lakes Basin*, 2003. Albany: NYS DEC, 2006. Composite YOY fish samples from 12 sites were analyzed for PCBs, seven organochlorine pesticides and mirex. PCB levels exceeded criteria for protecting fish-eating birds in 8 of 12 sites including Little River and Cayuga Creek. Mirex exceeded criteria at Little River. Both contaminants were linked to ongoing sediment contamination from the nearby 102nd St landfill and Love Canal. Water level changes are thought to have pushed contaminants further upstream in Cayuga Creek system; future dredging efforts should focus there.

***Ontario Ministry of Environment Mussel Studies**

Note: In support of the Niagara River Toxics Management Plan, the Ministry has conducted nine caged mussel biomonitoring studies on the Niagara River that parallel DEC YOY fish studies in the effort to determine local sources of toxic contaminants to biota. Mussel biomonitoring reports include Kauss, 1987; Kauss

and Angelow, 1988; Anderson et al, 1991; Richman, 1992; Richman, 1993; Richman, 1994; Richman, 1997; and Richman 1999. The most recent is summarized here.

- Richman, Lisa A. *Niagara River Mussel Biomonitoring Program, 2000*. MOE, Toronto, 2003.
Deployed caged mussels at 30 stations for 21 days and then analyzed them for organochlorine pesticides, total PCBs, chlorinated benzenes, dioxins and furans. Found trace concentrations of DDE (a metabolite of DDT) at 3 Canadian and 20 U.S. stations; highest levels of organochlorine pesticides at Gill Creek upstream of the mouth; PCBs at all U.S. stations and at Niagara-on-the-Lake (highest levels downstream from a sewer outlet associated with Occidental Chemicals); chlorinated benzenes at the mouth of Bloody Run Creek and Occidental Sewer 003; dioxins and furans at Petit Flume cove, Gill Creek (even though its was remediated in 1998) and at Bloody Run Creek.

Other

*RETEC Engineering, P.C. *Final Engineering Report: Scajaquada Creek Sediment Remediation, Buffalo NY*. Buffalo: National Fuel Gas Distribution Corporation, 2000.

Describes the 1999 remedial dredging project on Scajaquada Creek between the West Ave. and NY Central RR bridges, including removal of 19,000 cu. yards of contaminated sediments; capping with armor stone, geotextile and clay; replanting and long term O & M plan.

*US ACE, *Proposed Plan for the Seaway Site, Tonawanda, New York, (FUSRAP)*, US ACE, Buffalo, 2008.

Explains USACE preferred alternative for final remediation of the Seaway radioactive waste landfill: containment on site. For public comment before a final record of decision.

*USFWS et al. *Restoration Plan and Environmental Assessment for the Love Canal, 102nd Street, and Forest Glen Mobile Home Subdivision Superfund Sites*. Cortland: US Fish and Wildlife Service, 2005.

Describes habitat restoration plan and projects to be funded through Natural Resource Damage Settlements of approx. \$503,000 with Occidental Chemical Company and Olin Corporation for damages from the Love Canal site to Black, Bergholtz and Cayuga Creeks. High concentrations of dioxin (2,3,7,8-TCDD) found in sediments, crayfish and forage fish may have adversely impacted resident and migratory fish, birds and other wildlife in these creek ecosystems. Mirex and other bioaccumulative toxic chemicals also have damaged the entire downstream (Lake Ontario-St. Lawrence River) ecosystem, including the St. Lawrence beluga whales (\$55,000 is set aside for a “Beluga Recovery Plan.”) Thirteen wetland, grassland, creek or specie (walleye, common tern) restoration projects were selected for funding.

Appendix A-1

GIS Data Layer Source Information

SECTION 3 - GIS DATA LAYERS	Figure Numbers	Data Name/Source	Data Download and Metadata Website	Date Created	Data Format	Data Creation Procedure (Data Created by BNR only)
NYS Municipal Boundaries	3.20	NYS Civil Boundaries/NYS Cyber Security Critical Infrastructure Coordination (CSCIC)	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=927	2007	Shapefile	N/A
NYS County Boundaries	3.20	NYS Civil Boundaries/NYS CSCIC	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=927	2007	Shapefile	N/A
Waterways	3.20	NYS Hydrography - 1:24000/NYS CSCIC	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=928	2007	Shapefile	N/A
Watershed Boundaries	3.20	USGS 11-digit Hyrdologic Units/USGS New York Water Science Center	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=983	1994	Shapefile	N/A
SECTION 4 - GIS DATA LAYERS	Figure Numbers	Data Name/Source	Data Download and Metadata Website	Date Created	Data Format	Data Creation Procedure (Data Created by BNR only)
NYS Municipal Boundaries	4.10	NYS Civil Boundaries/NYS CSCIC	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=927	2007	Shapefile	N/A
NYS County Boundaries	4.10	NYS Civil Boundaries/NYS CSCIC	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=927	2007	Shapefile	N/A
Watershed Boundaries	4.10	USGS 11-digit Hyrdologic Units/USGS New York Water Science Center	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=983	1994	Shapefile	N/A
Waterways	4.1, 4.2, 4.3, 4.6	NYS Hydrography - 1:24000/NYS CSCIC	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=928	2007	Shapefile	N/A
Buffalo River Area of Concern (AOC)	4.10	Buffalo River AOC/Buffalo Niagara Riverkeeper	N/A	2008	Shapefile	On-screen digitizing of AOC outline

Buffalo River Habitat Opportunity Area	4.10	Buffalo River Habitat Opportunity Area/ Buffalo Niagara Riverkeeper	N/A	2008	Shapefile	On-screen digitizing of Opportunity Area outline
Habitat Opportunity Areas by Parcel	4.60	Habitat Opportunity Areas by Parcel/ Buffalo Niagara Riverkeeper	N/A	2008	Shapefile	Polygons selected from tax parcel boundary data
Planimetric Basemap	4.2, 4.6	1:24000 Scale Raster Quadrangles/ NYS DOT	http://www.nysgis.state.ny.us/gisdata/quads/about/dot.htm	2005	GeoTIFF Raster	N/A
State Delineated Wetlands	4.20	New York State Regulatory Freshwater Wetlands for Erie County/NYS DEC	http://cugir.mannlib.cornell.edu/bucketinfo.jsp?id=7756	2007	.e00 converted to Shapefile	N/A
Land Use/Land Cover	4.20	Zone 60 2005-Era Land Cover Metadata/NOAA Coastal Services Center	http://nosdataexplorer.noaa.gov/nosdataexplorer/explorer.jsp?goTo=search&north=62&south=20&east=-65&west=-162&keyword=Change Detection Analysis	2005	ERDAS Imagine 30m Raster	N/A
Fairway	4.2, 4.3, 4.6	Electronic Nautical Charts (ENC) Direct to GIS/NOAA Office of Coastal Survey	http://www.nauticalcharts.noaa.gov/csdl/ctp/encdirect_new.htm	2000-2007	Personal Geodatabase	N/A
Floodplain (100-Year)	4.30	Digital Q3 Flood Data/FEMA Map Service Center	http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1	2000-2007	Shapefile	N/A
Floodplain Forests	4.30	Buffalo Niagara Riverkeeper	N/A	2008	Shapefile	Delineations based on interpretation of 2005 orthoimagery.
Forests adjacent to Floodplains	4.30	Buffalo Niagara Riverkeeper	N/A	2008	Shapefile	Delineations based on interpretation of 2005 orthoimagery.

Riparian Buffer	4.40	Buffalo Niagara Riverkeeper	N/A	2008	Shapefile	Delineations based buffering shoreline in ArcGIS and delineation of vegetated areas within buffer, using 2005 orthoimagery
Color orthophotography	4.40	NYS Digital Orthoimagery, 1ft Resolution Natural Color	http://www.nysgis.state.ny.us/gateway/mg/2005/erie/	2005	GeoTIFF Raster	N/A
SECTION 5 - GIS DATA LAYERS	Figure Numbers	Data Name/Source	Data Download and Metadata Website	Date Created	Data Format	Data Creation Procedure (Data Created by BNR only)
NYS Municipal Boundaries	5.1-5.10	NYS Civil Boundaries/NYS CSCIC	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=927	2007	Shapefile	N/A
Waterways	5.1-5.10	NYS Hydrography - 1:24000/NYS CSCIC	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=928	2007	Shapefile	N/A
Parks	5.1,	Local, County, and State Parks/ESRI USADATA	http://www.esri.com/data/data-maps/index.html	2006	Shapefile	N/A
Railroads	5.1,	Railroads/U.S. Census Bureau 2000	http://cugir.mannlib.cornell.edu/datatheme.jsp?id=131	2000	Shapefile	N/A
Roads	5.1-5.10	Erie and Niagara County Roads/U.S. Census Bureau 2000	http://cugir.mannlib.cornell.edu/datatheme.jsp?id=130	2000	Shapefile	N/A
Project Area Boundary	5.1-5.10	Buffalo Niagara Riverkeeper	N/A	2008	Shapefile	Derived 1-mile from Niagara River shoreline, 0.5-miles from major tributaries
Remediation Sites	5.2, 5.3	Remediation Sites in NYS/ NYS DEC Division of Environmental Remediation	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=1097 . * the Brownfield Cleanup Program Sites list regularly changes. See NYSDEC's Environmental Navigator Mapper at http://www.dec.ny.gov/imsmaps/facilities/viewer.htm for most current locations.	2006	Shapefile	N/A

National Priority List (NPL) Sites	5.20	National Priority List (NPL) sites in EPA Region 2/Environmental Protection Agency	http://www.epa.gov/Region2/gis/data.htm	2006	Shapefile	N/A
FUSRAP Sites	5.30	Formally Utilized Site Remedial Action Program Sites/FACTS of Western New York (shapefile created by Buffalo Niagara River from FACTS map)	http://www.factsofwny.org/	2005	Shapefile	N/A
Shoreline Type	5.40	Buffalo Niagara Riverkeeper	N/A	2008	Shapefile	Interpretation of 2007 b/w 10CM resolution aerial imagery, and 2005 1ft orthoimagery. Seven classes of shoreline type used to differentiate constructed and natural shoreline types.
Marinas and Boat Launches	5.50	Water Access Sites/Niagara River Greenway Facilitation Services Report, New York Power Authority	http://www.buffaloboating.com/	2005	Shapefile	N/A
Overhead Cable	5.60	Electronic Nautical Charts (ENC)Direct to GIS/NOAA Office of Coastal Survey	http://www.nauticalcharts.noaa.gov/csdl/ctp/encdirect_new.htm	2000-2007	Personal Geodatabase	N/A
Bridge	5.60	Electronic Nautical Charts (ENC)Direct to GIS/NOAA Office of Coastal Survey	http://www.nauticalcharts.noaa.gov/csdl/ctp/encdirect_new.htm	2000-2007	Personal Geodatabase	N/A
Dumping Ground	5.60	Electronic Nautical Charts (ENC)Direct to GIS/NOAA Office of Coastal Survey	http://www.nauticalcharts.noaa.gov/csdl/ctp/encdirect_new.htm	2000-2007	Personal Geodatabase	N/A
Navigation Channel	5.60	Electronic Nautical Charts (ENC)Direct to GIS/NOAA Office of Coastal Survey	http://www.nauticalcharts.noaa.gov/csdl/ctp/encdirect_new.htm	2000-2007	Personal Geodatabase	N/A

Dam	5.60	Dams Inventory/NYS DEC	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=1130	2007	Shapefile	N/A
Significant Coastal Habitat	5.70	Significant Coastal Fish and Wildlife Habitats/NYS Department of State, Division of Coastal Resources	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=318	1998	Shapefile	N/A
Land Use/Land Cover	5.8, 5.9, 5.10	Zone 60 2005-Era Land Cover Metadata/NOAA Coastal Services Center	http://nosdataexplorer.noaa.gov/nosdataexplorer/explorer.jsp?goTo=search&north=62&south=20&east=-65&west=-162&keyword=Change Detection Analysis	2005	ERDAS Imagine 30m Raster	N/A
State Delineated Wetlands	5.80	New York State Regulatory Freshwater Wetlands for Erie County/NYS DEC	http://cugir.mannlib.cornell.edu/bucketinfo.jsp?id=7756	2007	.e00 converted to Shapefile	N/A
Federal Wetlands	5.80	National Wetlands Inventory/U.S. Fish and Wildlife Service	http://wetlandsfws.er.usgs.gov/wtlnds/launch.html	2005	Shapefile	N/A
Top Priority Habitats	5.9, 5.10	NYS DEC Top Priority Habitats/NYS DEC (shapefile created by Buffalo Niagara Riverkeeper from report map)	N/A - from Niagara River RAP Report	1994	Shapefile	N/A
SECTION 6 - GIS DATA LAYERS	Figure Numbers	Data Name/Source	Data Download and Metadata Website	Date Created	Data Format	Data Creation Procedure (Data Created by BNR only)
NYS Municipal Boundaries	6.1-6.5	NYS Civil Boundaries/NYS CSCIC	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=927	2007	Shapefile	N/A
NYS County Boundaries	6.1-6.5	NYS Civil Boundaries/NYS CSCIC	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=927	2007	Shapefile	N/A
Watershed Boundaries	6.1-6.5	USGS 11-digit Hydrologic Units/USGS New York Water Science Center	http://www.nysgis.state.ny.us/gisdata/inventories/details.cfm?DSID=983	1994	Shapefile	N/A

State Delineated Wetlands	6.10	New York State Regulatory Freshwater Wetlands for Erie County/NYS DEC	http://cugir.mannlib.cornell.edu/bucketinfo.jsp?id=7756	2007	.e00 converted to Shapefile	N/A
Land Use/Land Cover	6.1-6.5	Zone 60 2005-Era Land Cover Metadata/NOAA Coastal Services Center	http://nosdataexplorer.noaa.gov/nosdataexplorer/explorer.jsp?goTo=search&north=62&south=20&east=-65&west=-162&keyword=Change Detection Analysis	2005	ERDAS Imagine 30m Raster	N/A
Floodplain (100-Year)	6.10	Digital Q3 Flood Data/FEMA Map Service Center	http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1	2000-2005	Shapefile	N/A