Removal Recommendation

Beneficial Use Impairment 14: Loss of Fish and Wildlife Habitat

Photo of Thomas F. Higgins Natural Habitat Park Restoration Site on August 30th, 2020

Buffalo River Area of Concern

Date

Prepared by Buffalo Niagara Waterkeeper

Contents

1. Introduction and Report Purpose

The purpose of this report is to remove the Beneficial Use Impairment (BUI) 14: "Loss of Fish and Wildlife Habitat" from the Buffalo River Area of Concern (AOC). See figure 1 below for a map of the AOC boundary. The Buffalo River Remedial Advisory Committee (RAC) proposes changing the status of this BUI from "Impaired" to "Not Impaired." Included in this document are the assessments and actions which support the removal targets for this BUI.

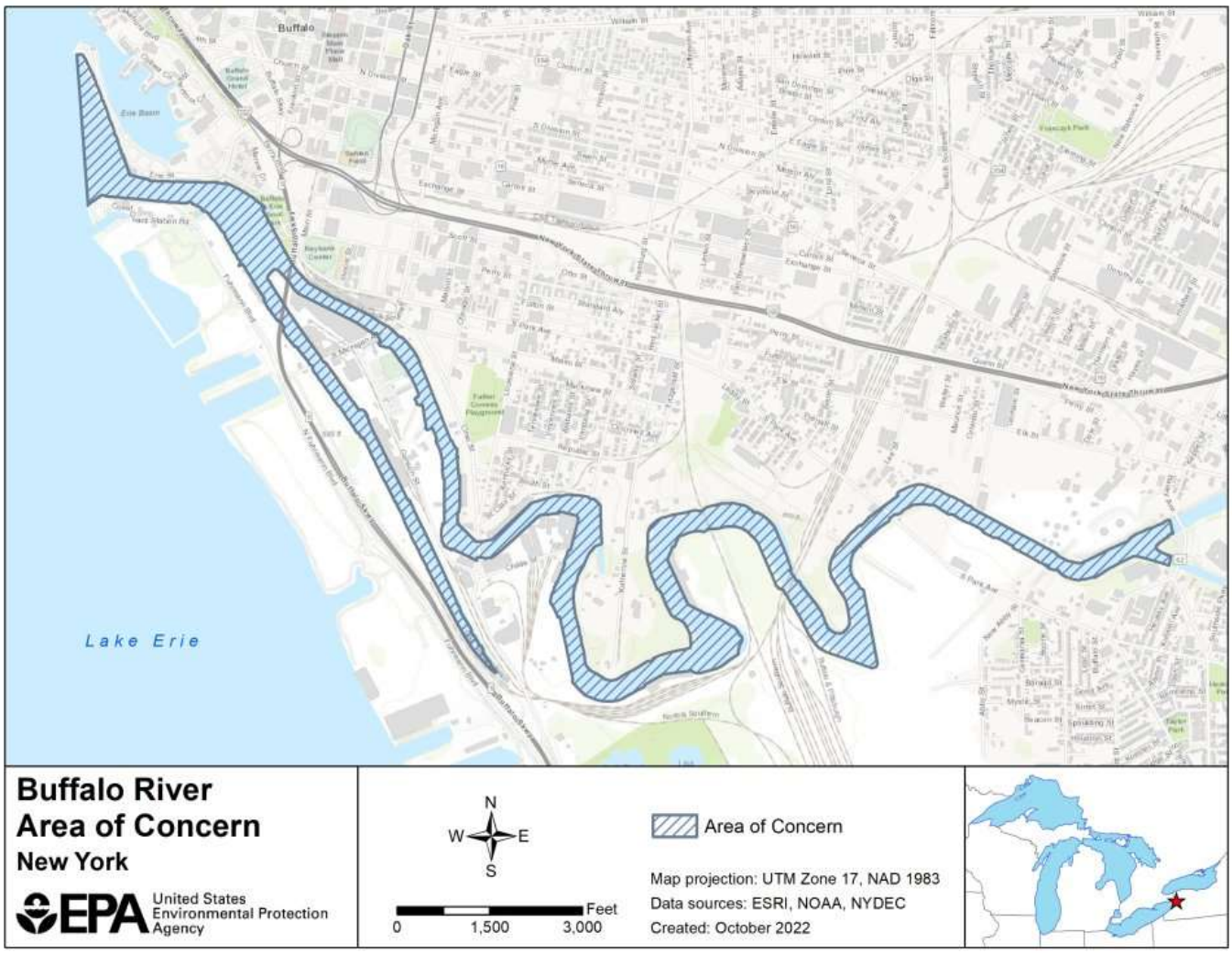

Figure 1: Map of AOC Boundary

Under the Great Lakes Water Quality Agreement (GLWQA), the International Joint Commission (IJC), working with the Governments of the United States and Canada, along with State and Provincial Governments, identified 43 AOCs in the Great Lakes Basin as, *"geographic areas designated by the Parties* [IJC] *where significant impairment of beneficial uses has occurred as a result of human activities at the local level*." As identified in Annex 1 of the GLWQA in 1987, up to 14 BUIs, or indicators of

degraded water and habitat quality, are used to evaluate the condition of an AOC. [1] Originally the Buffalo River AOC had 9 out of 14 potential BUIs, and as of 2022, it has 7 out of 14 potential BUIs.

Buffalo River AOC BUIs:

- Restrictions on Fish & Wildlife Consumption
- Tainting of Fish and Wildlife Flavor (Removed)
- Degradation of Fish & Wildlife Populations
- Fish Tumors & Other Deformities
- Bird or Animal Deformities or Reproductive Problems
- Degradation of Benthos
- Degradation of Aesthetics (Removed)
- Restrictions on Dredging
- **Loss of Fish & Wildlife Habitat**

The removal criteria for the Buffalo River AOC BUI 14: Loss of Fish & Wildlife Habitat are as follows[2]:

Table 1. Removal Criteria

BUI Indicator	**Known or Likely Causes of BUI**	**BUI Removal Criteria**
Loss of Fish & Wildlife Habitat	Physical disturbance such as bulk heading, dredging and steep slopes, and lack of suitable substrate.	1) Restore Habitat Connectivity; AND a) Enact the City of Buffalo's new unified development ordinance, the City of Buffalo Green Code, which contains explicit zoning provisions imposing a minimum 100-foot development setback and a 50-foot vegetative buffer (5.5.3.A.5. C-W-100 Standards). b) Implement the Buffalo River Habitat Action Plan (2013) 2) Improve Water Quality a) Major anthropogenic causes of low DO, including navigational dredging and CSOs, are not a limiting factor for supporting aquatic life.

Further discussion about removal criteria can be found in 2.3 of this report.

[1] USEPA, 2018
[2] BNW, 2014

Glossary of Abbreviations and Key Terms

AOC	Area of Concern
BNW	Buffalo Niagara Waterkeeper
Benthic	Associated with or occurring at the bottom of a body of water
BSA	Buffalo Sewer Authority
BUI	Beneficial Use Impairment
CSO	Combined Sewer Overflow, an event where a mix of raw household wastewater and stormwater is discharged into a waterway untreated
CSS	Combined Sewer System, a sewer system where both raw household wastewater and rainwater are combined
DO	Dissolved Oxygen
EV	Emergent Aquatic Vegetation, plants that live in the water and extend a part of the plant above the water surface such as leaves or flowers
Fragmentation	Process where large, connected areas of habitat are divided into smaller, unconnected areas
Forbes	An herbaceous (not woody) flowering plant that is not a grass, sedge, or rush
GLC-NOAA	Great Lakes Commission National Oceanic and Atmospheric Administration
GLLA	Great Lakes Legacy Act
GLRI	Great Lakes Restoration Initiative
GLWQA	Great Lakes Water Quality Agreement
IJC	International Joint Commission
In-line Storage Facilities	Storage within the existing sewer pipe network created by installing gates in pipes that have extra capacity, allowing wastewater and stormwater to be stored until there is sufficient downstream capacity to send the flow to the treatment facility.
LTCP	Long Term Control Plan
Macrophytes	Aquatic plants that are large enough to be visible to the naked eye
NYSDEC	New York State Department of Environmental Conservation
Off-line Detention Facilities	Purpose-built storage tanks next to the existing sewer pipe network where wastewater can be stored and then once there is sufficient downstream capacity.
RAC	Remedial Advisory Committee
RAP	Remedial Action Plan
Refugia	An area in which a population can survive throughout a period of otherwise adverse conditions
Retention Time	Retention time is the amount of time water stays in waterway before flowing out
River (when capitalized)	Buffalo River
SAV	Submerged Aquatic Vegetation, plants that live in the water and prefer to live entirely below the water's surface
Stratification	Division or separation of water column into layers, often referring to thermal stratification, or change of temperature at different depths
Seiche	A seiche is a standing wave in an enclosed or partially enclosed body of water. A seiche in Lake Eire causes water levels to rise temporarily at the western and/or eastern ends.
Turning Basin	A section of the river a large ship uses to turn around
UDO	Unified Development Ordinance
USACE	United States Army Corps of Engineers
USDAFS	United States Department of Agriculture Forest Service
USEPA	United States Environmental Protection Agency
USPC	United States Policy Committee
WWTF	Wastewater treatment facility
WNY	Western New York State

2. Background and BUI Removal Criteria

The Buffalo River AOC is located wholly within the City of Buffalo, Erie County, New York. It extends along the historically industrialized portion of the river, beginning at the mouth of the river at Lake Erie and continuing approximately 6.2 miles upstream to the Bailey Avenue Bridge. See figure 1 on page 2 for a map of the AOC boundary. It also contains the entire 1.4-mile City Ship Canal, located adjacent to the river.[3] The modern Buffalo River drainage area is 446 mi^2 (1155 km^2). The primary upstream tributaries which feed the Buffalo River are Buffalo Creek, Cazenovia Creek, and Cayuga Creek. The Buffalo River AOC is located within the ancestral lands of the Haudenosaunee people. For further background information, see the Draft Restoration Plan and Environmental Assessment for the Buffalo River.[4]

The original Buffalo River Remedial Action Plan (RAP), from 1989, identifies industrial facility wastewater discharges, municipal wastewater discharges, inactive hazardous waste sites, groundwater contamination, combined sewer overflows (CSO), and bottom sediments as the major sources of contamination and physical disturbances including bulkheading, dredging which has resulted in a lack of shallow areas for ponding, wetlands and riparian vegetation as a major contributor to habitat loss.[5] Through the generous support of the Great Lakes Legacy Act (GLLA), Great Lakes Restoration Initiative (GLRI), Erie County, NY, and private contributions, the Buffalo River has undergone source contaminant and contaminated sediment clean up, along with acres of habitat and shoreline habitat restoration.

2.1 Background

Prior to the 1820s, the Buffalo River was less than four feet deep and surrounded by marsh habitat. As the City of Buffalo grew, the river was extensively widened and deepened to accommodate shipping and industry.[6] The once-wetland habitat was transformed into a river large enough for ships, making it an ideal location for industries dependent on shipping through the 1800s and 1900s. The Buffalo River was the center of the industrial and manufacturing economy of Buffalo as early as 1825. Industrial pollutants discharged into the river and hardening of the shoreline for industrial use contributed to poor water quality and degraded ecological health. The Buffalo River had four water-based fires, due to ignition of surface chemicals, between 1928 and 1968.[7] Residents held long-standing concerns about water pollution in Lake Erie and the Buffalo River and these issues gained national attention in 1966. In 1973, USEPA conducted research on industrial discharges on urban waters using the Buffalo River as a model. They found dissolved oxygen (DO) levels were virtually nonexistent, and the river was not biologically suitable for fish and wildlife.[8] Today, the majority of the lower Buffalo River

[3] Buffalo Niagara Riverkeeper, 2005
[4] U.S. FWS, 2019
[5] NYSDEC, 1989
[6] Sauer, 1979
[7] Buffalo Courier Express Archives, 1828-1982
[8] Sargent, 1975

was, and remains, designated a federally navigable waterway and dredged to 22 feet below low water surface.

Between the 1960s and early 2000s, studies were conducted within the Buffalo River AOC to continue to assess the health of the ecosystem. The information listed below provides background information that guided restoration activities within the Buffalo River AOC.

2.1.1 Wastewater and Stormwater

The Buffalo River's industrial past was characterized by discharges of chemical contaminants, untreated wastewater and urban stormwater runoff directly into the waterway. Notable industries on the river included Buffalo Color Corporation (formerly a part of Allied Chemical Corporation), Mobil Oil, Donna-Hanner Coke, and Republic Steel. These companies were the dominant sources of pollution to the Buffalo River and Lake Erie as they disposed aniline-based dyes, oil, and other chemicals directly into the river. [9]

Industrial pollutants discharged into the river contributed to poor water quality and degraded ecological health. The suite of contaminants commonly referred to as chemicals of concern for the Buffalo River AOC include polychlorinated biphenyls, polycyclic aromatic hydrocarbons, lead, and mercury. See table 4.1 from the original RAP attached in Appendix A as Table 4, for the full list of contaminants found in Buffalo River bottomland sediment. Table 5.7 from the original RAP, attached in Appendix A as Table 5, shows the metals and cyanides found in the Buffalo River water column. Additional pollutants included: oil slicks, thermal pollution from industrial cooling, pesticides (such as chlordane, dichlorodiphenyltrichloroethane (DDT) and its metabolites, ammonia), and acids leading to low pH. During the 1900s, the river had a documented pH level of 3.5, well below the ideal water quality for freshwater aquatic life, which is a pH between 6.5 – 9.[10]

In addition to past industrial pollutants, the City of Buffalo's combined sewer system (CSS) contributed to the degradation of water quality in the AOC. Within the City of Buffalo combined stormwater and untreated household wastewater are both conveyed to the Buffalo Sewer Authority's (BSA) Bird Island Treatment Facility in the same pipes. During wet weather, the flows in these pipes can exceed their maximum capacity and the original combined sewer outfalls are used to relieve the sewers as CSOs to the Buffalo River and other waterbodies rather than causing basement and street flooding. This system remains in place today and continues to impact water quality because sewer outfalls discharge directly into the Buffalo River and its tributaries. In a 2015 report, based on average precipitation, the BSA estimated 1.75 billion gallons of untreated wastewater enter the river and over 69 CSO events occur, in an average year. This is based on Buffalo's historic average precipitation of 40 inches of rain and 94 inches of snow.[11] Stormwater runoff from buildings, roads, bridges, parking lots, industrial waste disposal sites, brownfields, and golf courses have poured directly into the River and its tributaries during rain or snow-melt events. Wastewater and stormwater have been recognized as a main contributor to poor water quality since 1969, before the AOC program started, when Robert A.

[9] Sauer, 1979
[10] National Recommended Water Quality Criteria - Aquatic Life Criteria Table, 2022
[11] Raincheck 1, 2018

Sweeney of the Buffalo State College Great Lakes Laboratory noted impacts of CSOs, both in the Buffalo River but also upstream in its tributaries, must be addressed to improve water quality.[12]

The BSA, using approximately $50 million in 2022 dollars in federal grants, implemented a major project from 1974 through 1982 to bring sanitary sewer flows from the Outer Harbor into BSA's system for treatment. This project replaced failing septic systems and direct discharges from many industrial sites in this area.[13] The removal of these sanitary sewer flows was significant to improving the water quality in the Buffalo River.

2.1.2 Dredging and Low Dissolved Oxygen (DO)

Historically, the U.S. Army Corps of Engineers (USACE) dredged 150,000 cubic yards every other year to keep the navigation channel in the Buffalo River open. Less had been dredged in the years just prior of 2008, resulting in a 750,000 cubic yards accumulation of sediment in the navigation channel.[14] Dredging occurs in the areas of greatest accumulation, mainly at the downstream end of the channel and in the areas of greatest commercial need.

After the initial dredging of the Buffalo River in the late 1800s to create a navigation channel its current was slow moving and had a long retention time and remains this way today. The increased depth and width of the river resulted in the river flowing slowly and becoming stagnant. The Erie Canal was completed in 1825, connecting the Great Lakes to the Atlantic Ocean and increasing shipping traffic through Buffalo. A section of the river, from the Ohio Street Bridge to the mouth of Cazenovia Creek, was notoriously noted by the community for "swamping" or "pooling" or being generally stagnant. This stagnation was supported by research conducted to assess the River's flow. The section between the Riverbend Phase II and the Turning Basin (Sites 11 and 7 respectively in figure 2) was noted to have the lowest oxygen levels. The deep depth of the river and water being pushed upstream from Lake Erie at this location resulted in slow flows and stratification causing the low oxygen levels.[15] In extreme weather events, seiches also occur that push water from Lake Erie into the Buffalo River and causing river levels to fall and then rise two meters in 24 hours which results in flooding, damage to coastal habitats, and could cause dramatic shifts in DO levels of the River in a very short period of time.[16]

Historic reports showed that DO levels were low, below 4 milligrams per liter (mg/L), during the spring when fish would be spawning.[17] Ideal water quality for freshwater aquatic life has a DO in the range of 4-6.5 mg/L.[18] A compilation of data prior to 1995 showed that the average annual DO of the entire Buffalo River AOC was only above 4mg/L in four out of nine studies conducted between 1962 and 1992, and the average annual DO never exceeded 6 mg/L.[19] All studies showed the lowest levels of DO occurred in the center section of the AOC which creates a potential dispersal barrier for fish traveling from the mouth of the River to headwaters. In addition, the River lacked refugia outside of the navigation channel to allow for movement of fish even when DO might be low in the dredged channel.

[12] Sweeney, 1970
[13] Rosaleen Nogel, BSA, personal communication, 2022
[14] Craig Forgette, USACE, personal communication, 2022
[15] Sweeney, 1970; Singer et al.,1992; Diggins & Snyder, 2003; Irvine et al., 2005
[16] Singer et al., 2011 and Sommer, 2022
[17] Sweeney, 1970; Mikol et al., 1993
[18] National Recommended Water Quality Criteria - Aquatic Life Criteria Table, 2022
[19] Diggins and Snyder, 2003

In addition to thermal stratification of water (layering of different water temperatures) and slow flow, DO was also depleted due to the industrial, household wastewater, and stormwater discharges mentioned previously. Discharges that settled into the bottom sediments led to high oxygen demand. Stormwater and sanitary wastewater discharge can be high in temperature, phosphorous, and nitrogen, causing eutrophication and lowering oxygen levels.[20] Mikol et al. 1993 found a strong correlation between changes in temperature and oxygen levels in the Buffalo River. Water temperature was further affected by changes in land use which eliminated shade from tree cover thereby increasing surrounding air temperature.

2.1.3 Habitat

Pre-Industrial Habitat

The Buffalo River is the ancestral lands of the Seneca Nation. This traditional area was a marshy floodplain.[21] In one description historian and archaeologist Frederick Houghton described 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 included 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*[22]

History known about wildlife populations in the Buffalo River estuary and harbor was largely anecdotal. Anglers remembered when lake sturgeon spawned on the sand and fine cobble bars that were once located just off the Outer Harbor before the River became an AOC.[23]

Post-Industrial Habitat

A New York State Department of Environmental Conservation (NYSDEC) 1993 baseline inventory found that "the 'man-made' [hardened] shoreline and dredged bottom probably have the greatest physical limiting effect on the ability of fish species to successfully reproduce and survive".[24] Since the 1960s, the river has been dredged from the mouth to just below the confluence with Cazenovia Creek to a depth of 6.7 meters (22 feet) to accommodate lake vessels to just below the confluence with Cazenovia Creek. The baseline inventory found that less than 5% of the AOC portion of the river was less than 2 meters (6 feet) deep, and only 1-2% had instream vegetation. Limited areas existed with less impaired conditions. For example, the north bank around the Katherine Street Peninsula had some aquatic habitat. Pilings, however, provided the only significant cover for forage and juvenile fish species.

A 2005 "Assessment of Potential Aquatic Habitat Restoration Sites" in the Buffalo River AOC found little or no biotic recovery in the AOC since the 1990s.[25] 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.

[20] Irvine et al., 2005
[21] Sauer, 1979
[22] Houghton, 1920
[23] Wooster and Mathies, 2008
[24] Mikol et al, 1993
[25] Irvine et al., 2005

Wetlands

The industrial era eliminated significant wetlands from the lower Buffalo River watershed. A 1982 inventory identified wet meadow habitat with wetland plants near Concrete Central Peninsula and a 1993 study also noted this site as a wetland restoration opportunity.[26] It was also noted that the depth of the river and contaminated sediment hindered emerging wetland restoration. In 1997, across from Concrete Central a site now called Red Jacket River Front Park, a small wetland habitat was preserved and enhanced.[27]

Floodplain and Riparian Forests

The 1993 Buffalo River Watershed Inventory identified a mere three acres of floodplain forest in the AOC; located at Old Bailey Woods and Bailey Peninsula.[28] Seventeen species of trees were identified, with the dominant species being native trees such as cottonwood (*Populus sp.*) and black willow (*Salix nigra*), but also found were invasive plant species such as Japanese knotweed (*Reynoutria japonica*), phragmites (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*). Although plant diversity was of note upstream of the AOC, rare plants were not identified within these properties. Despite a lack of floodplain forest within the AOC, Concrete Central Peninsula contained a rare 30 acres of open meadow floodplain on the east side of the railroad lines that bisect the peninsula. [29]

Riparian and Shoreline Habitat

In a 1981 survey by the USACE of four river locations and one City Ship Canal sample station, the shoreline was described as "steep and formed of gravel and trash…shoreline vegetation consists of three trees, sparse grasses, weeds and bushes", "steep and sandy with staghorn sumac", "steep with crushed cement and boulders…shoreline vegetation consists of several trees hanging over the river", and "the bank is steep with cement chunks, logs and trash rising to a parking lot…no…terrestrial vegetation was observed".[30]

The NYSDEC 1993 baseline inventory recommended the establishment of a continuous natural shoreline where possible in the AOC and upstream tributaries because the existing fragmentation was found to severely reduce wildlife usage.[31] 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 forbs (herbaceous plants) in planting plans

Buffalo Niagara Riverkeeper (the former name of Buffalo Niagara Waterkeeper) analyzed 2005 aerial photographs for vegetated riparian buffers of at least 100 feet in depth from water's

[26] Makarewicz, 1982, Mikol et al., 1993
[27] Mason, 2006
[28] Mikol et al., 1993
[29] Wooster and Matthies, 2008
[30] Makarewicz et al., 1982
[31] Mikol et al., 1993

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.[32] 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.

Aquatic and Riparian Vegetation

Since industrialization and modification of the river channel for navigational purposes, the Buffalo River AOC had very little aquatic vegetation and highly degraded riparian vegetation due to continued sediment removal, dredging, channelization, and land use. In the 1981 survey by the USACE, macrophytes were noted to be absent in much of the river with only one location having sparse aquatic vegetation and another noting presence only in the summer.[33] The sediment of the deep river was devoid of vegetation and mostly consisted of black gelatinous detritus sediment associated with nutrient rich waterbodies called gyttja, and some dark clay. The NYSDEC also noted in 1991 that emergent aquatic vegetation (EV) was virtually absent from the AOC and terrestrial vegetation diversity was limited.[34] The riparian habitat was described as a "rapid drop-off along the muddy shore," "steep and sandy," "concrete walls," and, "boulders with sunken pier posts" below the water line. In 1998 a total of twelve EV species were found in the Buffalo River AOC. The highest diversity at one site was eight species within the river and most of that was invasive Eurasian Watermilfoil (*Myriophyllum spicatum*) and various pondweeds.[35] A 1998 report identified 31 species of fish utilizing the beds of aquatic vegetation in the Buffalo River despite the limited abundance and diversity of aquatic vegetation.[36]

2.1.4 Fish and Wildlife

The alterations to the river for the Erie canal and the input of raw household wastewater into the river made it uninhabitable for aquatic organisms.[37] Buffalo River Improvement Corporation (BRIC) started in 1966 with an aim to improve water quality for industrial use and was thought to have the possibility of also improving aquatic habitat by pumping in cooler and more oxygen rich water from Lake Erie.[38]. The BRIC was used throughout the 60s and 70s, but little evidence exists that it had a significant impact of habitat improvement.

The following summaries of the fish and wildlife communities prior to the implementation of the Buffalo River RAP are a brief compilation of anecdotal evidence and population studies. A future report about the "Degradation of Fish & Wildlife Populations" BUI will summarize the fish and wildlife populations in the River more extensively. What is compiled in this section is summary of what is known as it pertains to loss of habitat.

Fish

In 1928, the New York State Conservation Department (NYSCD—precursor to today's NYSDEC) conducted a complete biological survey of the Lake Erie/Upper Niagara River Basin,

[32] Fischer & Fischenich, 2000
[33] Makarewicz et al., 1982
[34] Mikol et al., 1993
[35] Janowsky, 1998
[36] Trometer, 1998
[37] Diggins and Snyder, 2003
[38] Diggins and Snyder, 2003

including the Buffalo River and its tributaries. Thirty-one species were identified in the Buffalo River watershed; however, no fish were found in the lower 13 km (8 mi). The authors stated, the "lower Buffalo Creek is obviously unfit for eggs or young of fish and seemed to contain no form of fish life."[39] Between 1928 and the early 1970s, no fish surveys took place in the AOC portion of the Buffalo River and the status of the fish communities was unknown. In 1973 and 1974, NYSDEC documented some adult fish inhabiting portions of the river from the mouth to 13 km (8 mi) upstream, including the Buffalo Ship Canal (Appendix A: Table 3).[40] A biological survey conducted from April 1981 to January 1982 revealed more diversity than the study ten years prior. Yellow perch were found in most months; however, only as far up as 2.5 km (1.5 mi), to the Ohio St. bridge; and smallmouth bass and panfish (primarily rock bass) were found from May to September, indicating possible year-round residency (Appendix A: Table 3). Spawning fish were noted and larval emerald shiner (ship canal only), carp and yellow perch were collected in the river, but at much lower densities than expected based on the number of spawners collected.[41] Subsequent fish surveys conducted in 1984 and 1988 found similar species with a few additions as shown in Appendix A: Table 3.

Wildlife

Reports from the 1970s through the early 1980s found only isolated patches of viable habitat along the AOC but reports did observe notable species like Peregrine falcons. Peregrine falcons, a NYS Endangered Species, were observed at Concrete Central Peninsula. [42] This little wildlife refuge was bordered by a grain elevator, rail yards, and Tifft Farm.

By 1991, the NYSDEC did not observe any peregrine falcons along the Buffalo River. In the 1990s peregrine falcons, were listed as a Federally endangered species in recovery. Although the Peregrine falcons were missing, osprey were observed as part of a NYSDEC study. Osprey were State-threatened at the time and were the only State-endangered or threatened species of bird recorded within the Buffalo River study area in 1991. The study also found a much lower diversity of birds in the AOC, 20 species, than upstream or nearby surveyed areas where 53 species were observed. This difference in diversity was attributed to absence of habitat and fragmentation. This NYSDEC study also noted only 12 species of mammals were observed, 2 species of amphibians, and 2 species of reptiles. [43] Although habitat value within the AOC was low and available habitat was limited and fragmented, pre restoration, the AOC did provide refuge for some notable birds.

2.2 Buffalo River AOC Designation

The Buffalo River was designated a Great Lakes AOC in 1985. At that time, Great Lakes United and other public constituencies suggested that governmental agencies form citizen advisory committees to participate in the RAP drafting process. Locally, the NYSDEC accepted that suggestion and the Buffalo River Citizens Committee first met in March of 1987. This group of concerned citizens, scientists, and

[39] NYSCD, 1928
[40] Mikol et al., 1993
[41] Makarewicz et al. 1982
[42] Makarewicz et al., 1982
[43] Mikol et al., 1993

stakeholders, along with the NYSDEC, wrote a combined Stage I and II RAP for the Buffalo River AOC. After the RAP was drafted, a RAC was formalized to participate in the detailed planning for the restoration. The goal of the RAP is "*to restore and maintain the chemical, physical, and biological integrity of the Buffalo River ecosystem in accordance with the [GLWQA].*" The combined Stage I and II RAP identified BUIs, their likely causes, and presented remedial actions to address them. Once all BUIs have been removed, the Stage III RAP will be prepared, documenting that all necessary remedial actions have been taken and recommending the delisting of the Buffalo River AOC.

2.3 BUI 14 History: Impairment Designation and Removal Criteria Evolution

In the Stage I/II RAP, the listed causes of the Loss of Fish and Wildlife Habitat BUI are bulkheading, dredging, and loss of suitable substrate.[44] Dredging was included because it physically alters substrate and habitat. The criteria were finalized with the Remedial Advisory Committee during their regular occurring meetings.

The Stage I/II RAP outlined many potential remedial actions as applied to the individual BUIs; the following three apply to the Loss of Fish and Wildlife BUI at issue in this report:

a. Determine whether low DO in the Buffalo River is likely to impair the fishery.
b. Ensure that CSOs do not significantly contribute to impairment of the fishery or aquatic life (via carrying out system modeling to determine where improvements can be made to increase flow within the system and minimize overflows and develop and carry out improvements as necessary).
c. Carry out an assessment of habitat conditions and the potential for improvement in the AOC; Develop a habitat improvement plan; Acquire necessary land; and, Design and carry out specific habitat improvement projects.

A 2005 Status Report included, "Invasive plant species, including Japanese knotweed and Purple loosestrife will be managed at levels that do not disrupt the sustainability of native, upland, and aquatic plant communities." Lacking sufficient habitat data to establish quantitative targets resulted in removal of this remedial action, but invasive species management has been, and continues to be, a focus for the Buffalo River AOC. Regarding remedial action b. above, abatement of sewer discharges is anticipated through implementation of the BSA's Long Term Control Plan (LTCP).

2.3.1 Current BUI 14 Removal Criteria

The current, and final, removal criteria for BUI 14 is presented in Table 1 and as discussed below. In order to remove BUI 14 both habitat connectivity (criteria 1) "AND" water quality (criteria 2) needed to be restored. The Buffalo River Monitoring Plan set out how restoration efforts would be measured and what action steps needed to be taken. The desired outcomes are listed below.[45]

[44] NYSDEC, 1989; NYSDEC 2011
[45] BNW, 2014

This is an excerpt from the 2014 Buffalo River AOC Monitoring Plan.

Delisting Criteria 1a & 1b

Desired Outcome:

Loss of wildlife habitat and connectivity will be restored over time through the implementation of the Buffalo River Habitat Action Plan and the enactment of the City of Buffalo's Green Code. The Buffalo River Habitat Action Plan has identified priority opportunities to increase habitat and the Buffalo Green Code will help further establish and protect critical connective corridors for wildlife.

Delisting Criteria 2

Desired Outcome:

Water Quality and aquatic (fish) habitat will be improved by continuing to diminish anthropogenic causes of low DO and increasing aquatic vegetation. Current hypoxic and sometimes anaerobic conditions in the AOC are primarily the result of pollution, eutrophication, and low flow. Implementation of the BSA's Long-Term Control Plan (LTCP) will significantly decrease CSO inputs, a major source of pollution and nutrient loading, and therefore greatly improve water quality and DO conditions. Aquatic habitat restoration is included in the GLLA Project and the Buffalo River Habitat Restoration Action Plan, further improving Aquatic Habitat.

Navigational dredging significantly impacts the flow conditions of the Buffalo River and therefore negatively impacts DO levels. However, it is understood that current dredging by the USACE is meant to maintain the navigational channel and prevent flooding from occurring upstream. Every attempt to minimize the effects of dredging on the flow regime of the Buffalo River should be made.

2.3.2 Removal Scenario

In December 2001, the Restoring United States AOC: Delisting Principles and Guidelines document developed by USEPA was adopted by the United States Policy Committee (USPC). This document was intended in part to "guide the restoration and maintenance of beneficial uses and the subsequent formal delisting in order to achieve a measure of consistency across the basin".[46] This document describes multiple scenarios under which a BUI can be removed. These include:

A. A delisting target has been met through remedial actions which confirms that the beneficial use has been restored.
B. It can be demonstrated that the BUI is due to natural rather than human causes.
C. It can be demonstrated that the impairment is not limited to the local geographic extent, but rather is typical of lakewide, region-wide, or area-wide conditions (under this situation, the beneficial use may not have been originally needed to be recognized as impaired).
D. The impairment is caused by sources outside the AOC. The impairment is not restored but the impairment classification can be removed or changed to "impaired-not due to local sources." Responsibility for addressing "out of AOC" sources is given to another party.[47]

[46] USPC, 2001
[47] USPC, 2001

Beginning in 2019, the Buffalo River RAC reviewed the status of the Loss of Fish and Wildlife Habitat BUI. Based on an assessment of the relevant restoration actions conducted in the Buffalo River AOC, the RAC decided that the appropriate removal scenarios for this BUI was a combination of A and D.

A combination approach was used because the removal criteria for this BUI best fit under different scenarios. Removal criteria 1 falls under scenario A because specific targets listed to restore habitat connectivity have been met:

1: Restore Habitat Connectivity

> 1.a: Enact the City of Buffalo's new unified development ordinance, the City of Buffalo Green Code, which contains explicit zoning provisions imposing a minimum 100-foot development setback and a 50-foot vegetative buffer (§ 5.5.3.A.5. C-W-100 Standards).
>
> 1.b: Implement the Buffalo River Habitat Action Plan (2013).

Removal criteria 2, improve water quality, falls partially within both scenario A and D because remediation actions have been completed but water quality concerns remain that are caused by sources outside of the AOC program and work is to be completed by another responsible party:

2: Restore Water Quality

> 2.a: Major anthropogenic causes of low DO, including navigational dredging and CSOs, are not a limiting factor for supporting aquatic life.

Where habitat restoration projects have been completed, water quality is expected to be improved and these areas could serve as refugia for fish and wildlife. Anthropogenic causes of low DO remain for reasons beyond the limit of the AOC program and beyond the Buffalo River. The BSA has a final and approved LTCP for CSOs, but while the plan is being implemented, permitted discharges continue in the Buffalo River that can degrade water quality. Responsibility for increasing sewage and stormwater capture and treatment was given to the BSA as they implement their plan. Dredging of the Buffalo River, which deepens the river which may result in pockets of low oxygen levels, must be maintained because the Buffalo River is a designated shipping channel. However, the process has been modified by USACE to reduce impacts on fish populations. Any mitigation of dredging activities in the Buffalo River is beyond the AOC program and would be addressed by another party if at all. Further details are provided in the following sections to support the two removal scenarios for the BUI criteria.

3. Assessments and Management Actions Supporting BUI Removal

The desired outcome of removal criteria 1 were met with the implementation of the Buffalo River Habitat Action Plan and the enactment of the City of Buffalo's Green Code. The desired outcome of removal criteria 2 has been met because of the ongoing implementation of the BSA's Long Term Control Plan, completion of the GLLA Project, and completion of the Habitat Action Plan. In addition, every attempt has been made to minimize the effects of dredging on the Buffalo River fish and wildlife.

3.1 Buffalo River Habitat Restoration Action Plan

Prior to the Buffalo River Habitat Action Plan, habitat restoration efforts began in the 1990s and included three projects undertaken by the Erie County Department of Environment and Planning which cumulatively restored about two acres of shallow water habitat and almost one mile of natural shoreline

at the foot of Smith Street, Bailey Point and Seneca Bluffs.[48] Fish habitat improvements were also included in the "Buffalo Color Area D" remediation.[49]

In 2013, the habitat action plan was developed, and the completion of which meets the management action for removal criteria 1 "restore habitat connectivity". Implementation began in 2015 and was completed in 2021. The habitat action plan set a target of a minimum of 25% (19,941 linear feet) of the AOC Shoreline to be restored to natural slope, shallows, and aquatic (EV and submerged aquatic vegetation (SAV)) native vegetation, including naturalizing areas of the City Ship Canal shoreline.[50] This target was based on NYSDEC recommendation made in a baseline report conducted in 1993 and a riparian corridor and buffer recommendations published in a U.S. Army guidance document.[51] The action plan assessed the potential sites along the river considering ownership, accessibility and habitat value. After initially considering twenty locations in or just upstream of the AOC. Fourteen sites were settled upon which would meet the goal. The sites are listed in Table 2, and the work completed at each site is further described in Appendix B. Ultimately, the restoration at the 14 sites exceeded the 25% goal and 20,622 linear feet of shoreline habitat was restored.

Complementary projects listed below were not completed in order to meet the BUI 14 linear feet removal metric but contribute to the holistic habitat health of the river so are included in this report.

Table 2: A Summary of Habitat Restoration Projects

Map site #	Site Name	Linear Feet of Project	Project Information	Funding Source	Upland restoration (acreage)
12	Riverbend Phase 1	1200	Shoreline and riparian/upland restoration	USEPA, US Department of Agriculture Forest Service (USDAFS) GLRI, GLC-NOAA	3.5
11	Riverbend Phase 2	1520	Shoreline and riparian/upland restoration	USEPA, USDAFS GLRI, Great Lakes Commission National Oceanic and Atmospheric Administration (GLC-NOAA)	3.5
1	Buffalo Motor and Generator Corp. (BMGC)	331	In-water, shoreline and riparian/upland restoration	GLC-NOAA	0.2
7	Blue Tower Turning Basin	1700	In-water habitat restoration	GLC-NOAA	0
13	Old Bailey Woods	807	Shoreline and riparian/upland restoration	GLC-NOAA	3.25
4	NYSDEC Ohio Street Boat Launch	332	Shoreline and riparian/upland restoration	GLC-NOAA	1.62
6	Toe of Katherine St.	1243	Shoreline and riparian/upland restoration	GLC-NOAA	7.3
6	Katherine St Peninsula Extension	450	Shoreline and riparian/upland restoration	GLC- NOAA	3.7
9	Buffalo Color Peninsula	2,645	Shoreline and riparian restoration	GLC-NOAA	1.5
16	City Ship Canal	3,454	EV/SAV, in-water habitat structures	Honeywell	0

[48] Poole, 1994; Stearns and Wheeler site plans, 1995
[49] Wooster and Matthies, 2008
[50] BNW, 2019
[51] Mikol et al, 1993, Fischer and Fischenich, 2000

Map site #	Site Name	Linear Feet of Project	Project Information	Funding Source	Upland restoration (acreage)
9	Red Jacket Riverfront Park	745	Shoreline and riparian/upland restoration	USEPA/GLRI	7
13	Thomas F. Higgins Natural Habitat Park	1,050	Shoreline and riparian/upland restoration	USEPA/GLRI	4
9	NFTA/Smith St.	1,080	Shoreline and riparian/upland restoration	USEPA/GLRI	6
8	NE Shoreline of Katherine St. (formerly Linde)	1,775	In-water, shoreline, and riparian/upland restoration	USEPA/GLRI	2.5
2,4,5	SAV alternative sites	2,290	SAV work at 3 sites which will achieve 2300 lineal feet goal	USEPA/GLRI	0
Total linear feet for remedial goal		**20,622**			
Complementary Restoration Sites					
15	Seneca Bluffs	3,000	Shoreline and riparian/upland habitat – Not counted in final projects because it is outside of AOC	USEPA/GLRI	3.2
3	Ohio Street	2,41	EV/SAV restoration – Linear feet accounted for in BNW projects	Honeywell	0
6	Katherine St. Peninsula	1,192	EV/SAV, in-water habitat structures – Linear feet accounted for in BNW projects	Honeywell	0
10	Buffalo Color Peninsula	2,303	EV/SAV, in-water habitat structures, and unplanted shoreline improvements – Linear feet accounted for in BNW projects	Honeywell	0
11, 12	Riverbend in water	1,905	EV/SAV, in-water habitat structures – Linear feet accounted for in BNW projects	Honeywell	0

** The table above and figure below summarize the contents of Appendix B.: Buffalo River Habitat Restoration Site Summary: Action Plan and GLLA. The map site numbers above correlate with the location of the restoration site on the map below only.*

Figure 2: A Summary Map of Habitat Restoration Projects

3.2 Enacted the City of Buffalo's Unified Development Ordinance and Green Code

In January 2017, Mayor Byron W. Brown signed the Unified Development Ordinance (UDO or "Green Code") into law. This overhaul of the City of Buffalo's zoning code was the first major set of changes since 1953.[52] Under the UDO Section 5.3.3, all development on waterfront lots within the C-W zone must provide a waterfront yard or setback from the waterway. A waterfront yard is defined as, "the area of a waterfront lot measured from the mean high-water line of the adjacent water body that must be maintained clear of all permanent structures and vehicular access and parking except where necessary to facilitate water dependent uses" [(GC Section 5.3.3(A)(1)]. The majority of the parcels abutting the Buffalo River are in the C-W zone and thus require both a setback ("waterfront yard") and vegetated buffer. The requirements under the Green Code meet the remedial goal set forth above by providing a 100-foot setback and 50-foot vegetated buffer for the majority of the shoreline of the Buffalo River AOC.

Specifically, the parcels along the Buffalo River are zoned as: D-ON (Natural), D-OG (Green), D-C (flex commercial), D-IL (Light industrial) and D-IH (Heavy industrial). These areas must meet C-W-100 standards. This standard requires a 100-foot waterfront yard. This type of setback is intended for less urbanized waterfronts, "where a shoreline buffer or native vegetation protects and restores wildlife habitat and ecosystem services." Second, C-W-100 zone requires, "a shoreline buffer, consisting of undisturbed, native, or naturalized vegetation, must be provided for a minimum depth of 50 feet from the mean high-water line. Grading, filling, excavation, clear cutting, and removal of vegetative cover are prohibited within this shoreline" but for a limited number of exceptions. (GC Section 5.3.3.(A)(5)(a-b). This means that unless the zoning along the Buffalo River is changed, which must be requested from and

[52] Unified Development Ordinance, 2017

approved by the City of Buffalo Common Council, 100 feet of shoreline of the Buffalo River will be protected from development.

Limited parcels within the AOC are zoned as N-2E (Mixed-Used Edge) and N-1C (mixed use Core). These parcels require only a 25-foot waterfront yard or setback from the waterway. This type of waterfront yard is intended for intensely urbanized areas that enable public engagement with the water's edge. This limited area applies to preexisting commercial business and a City Park. This limited area with less strict zoning does not pose a threat to the health or success of the remedial actions taken in the Buffalo River AOC. The zoning Code Map as well as the full text of Section 5.3.3. have been attached as Appendix C.

3.3 Buffalo Sewer Authority (BSA) Long-Term Control Plan (LTCP)

The City of Buffalo has a CSS to collect and treat wastewater. In a CSS, all sanitary waste from buildings and stormwater run-off from streets, parking lots, structures, and porous surfaces are sent to a wastewater treatment facility (WWTF) through the same collection system. Typically, combined waste is treated at the Bird Island WWTF to undergo treatment before being discharged into the Niagara River. However, in times of heavy rain or snowmelt, the system becomes inundated and outfall pipes are utilized to divert excess volume of water directly into waterways without treatment. Currently the City of Buffalo has 52 CSOs, 16 of which are located along the Buffalo River and 11 of which are along its tributary, Cazenovia Creek.[53]

Under the 2014 LTCP, the City of Buffalo has set goals to reduce the volume of CSO discharges by 73% and to create the capacity to capture 0.9 inches of rain from 1,315 acres of impervious surface throughout the City.[54] To accomplish this, the LTCP sets out both green and gray infrastructures strategies to improve stormwater management, and thereby reduce frequency and volume of CSO events that do occur. Proposed tactics to reduce CSO events include use of off-line detention facilities and in-line storage within the existing oversized sections of the sewer system to store stormwater during a storm event until the WWTF has capacity to treat more volume, weir modifications, and increased green infrastructure. The BSA Raincheck initiative is the green infrastructure program designed to meet implementation targets of the LTCP. In the 2019 Raincheck 2.0 report, the BSA outlined ambitious outfall volume and frequency of deployment goals as well as priority CSO basin areas to target for green infrastructure improvements.[55] Four of those outfall basin areas were prioritized CSO outfalls are along the Buffalo River.

Over the next 12 years, these efforts will reduce the frequency of CSO events in the Buffalo River and Cazenovia Creek to approximately six annual events in contrast to the current mean of 33 events. Completion of the LTCP was estimated to cost approximately $380 million over a 20-year period on a staggered schedule in 2012. Further improvements in water quality aesthetics are expected as the LTCP progresses.

3.4 Supporting Work within the Buffalo River AOC

In addition to the management actions completed to address the Loss of Fish and Wildlife Habitat BUI, concurrent work was also being completed to improve the River habitat and water quality

[53] BNW Water Quality Testing, 2021
[54] LTCP, 2014
[55] Raincheck 2, 2019

by removing and capping contaminated soil and sediments.. This included NYSDEC Source Control Brownfield cleanups, as well as contaminated sediment dredging and aquatic habitat restoration funded by the GLRI through the GLLA.

The NYSDEC manages a Brownfield Cleanup Program to ensure the timely and efficient cleanup and redevelopment of contaminated properties. Through the combination of reduced industrial contributors, mitigation of contamination and contaminant sources entering the ecosystem, and continual remediation of designated hazardous waste sites, the number of sources and amount of contaminants entering the Buffalo River AOC has been significantly reduced. More information about this work within the AOC at sites including Buffalo Color, PVS Chemical, Mobil Oil, Republic Steel, and Donner Hanna Coke, as noted in the original RAP (1989), is available in the Source Identification Report, Buffalo River (2012) and the DECinfo Locator. The 2012 Source Identification Report stated that the NYSDEC committed reducing both contamination and the sources of contaminants to Buffalo River AOC and is confident that the Buffalo River AOC is unlikely to suffer significant further or renewed contamination from sources of pollutants causing sediment contamination.[56]

Under the GLLA and the USACE Operation & Maintenance programs, approximately 1,000,000 cubic yards of contaminated sediment were removed from the Buffalo River in a two-phase dredging effort. Contaminated sediment was also capped in place at the end of the City Ship Canal, which provided the basis for the largest aquatic habitat restoration area of the City Ship Canal EV/SAV restoration project[57] As part of the GLLA project, 9,095 linear feet of in-water habitat restoration was conducted at five sites in the River. For all 5 habitat restoration areas combined, approximately 29,500 EV plants and approximately 47,500 SAV plants were installed. Monitoring and maintenance activities, such as supplemental planting and herbicide treatments, were implemented over a five-year timeframe and concluded in 2020.

Remediation efforts as a part of the Great Lakes Restoration Initiative and the GLLA Project have proven to be a sound financial investment, particularly for the Buffalo River and Western New York State (WNY). Hartig et. al. found that “cleaning up the Buffalo River has spurred improving public access that has contributed to waterfront economic revitalization, including more than $428 million (U.S.) of waterfront development between 2012 and 2018.”[58]

4. Assessments and Actions that Support Removal

Management actions have been completed and support the removal of BUI 14. In this section anecdotal evidence and summaries of draft reports will be presented that support of the return of fish and wildlife to the Buffalo River AOC. A future report about the BUI 3 “Degradation of Fish & Wildlife Populations” will provide a summary of biological monitoring surveys that were conducted to assess the impact of habitat restoration projects highlighted in this report. Although assessments of fish and wildlife have been completed to monitor the Buffalo River AOC that support habitat improvement, assessments were not required to meet BUI 14 removal criteria.

[56] NYSDEC et. al., Source Identification Report, Buffalo River, 2012
[57] NYSDEC, 2020
[58] Hartig et. al., 2020

4.1 Fish and Wildlife

The implemented Buffalo River Habitat Action Plan resulted in 29,870 linear feet of restored shoreline totaling 26.5% of the AOC's total shoreline (112,326.96 ft). This result exceeds the 25% of shoreline restored goal. The restoration efforts focused on softening and regrading shorelines, removal of invasive plants, and establishing diverse and dense vegetation both in the water and upland. Approximately 100,000 plants native to the lower Great Lakes were installed including SAV, EV, grasses, shrubs, trees, and perennials. These plants were monitored by project managers for three years to during a period of establishment and corrective measures were taken or project periods were extended if needed. Alongside the installation of plants, wildlife shelters and nesting features were also installed including in-water features for fish and other aquatic wildlife (submerging root wads, wooden bulkheads, porcupine cribs), bat boxes and bird houses for winged wildlife, logs and beaches for turtles, and lastly wetlands and soil stabilization elements to improve habitat for macroinvertebrates.

The Buffalo River Wildlife Survey conducted in 2012, 2019, 2020 and 2021 found evidence of nesting turtles and the presence of spiney soft-shelled turtles (*Apalone spinifera*).[59] A U.S. Geological Survey crew found several spotted suckers (*Minytrema melanops)*, adults and juveniles, during a 2021 sampling effort of the Buffalo River.[60] Spotted suckers are an indicator of good water quality (see Appendix A: figure 3).

Wildlife have moved into the habitat restoration sites immediately. Monitoring observations of the sites include successful turtle and hawk nesting activity Appendix A: (figure 4), visiting bald eagles and nesting osprey, monarch butterfly caterpillars and adults (Appendix A: figure 5), the presence of beaver Appendix A: (figure 6), mink, fox and river otters.[61] In addition, anglers have noted the improvement in both fish and wildlife diversity.[62] The wildlife survey conducted to monitor the AOC restoration sites recorded nesting pairs of red-headed woodpeckers (*Melanerpes erythrocephalus*), which are a New York State Species of Concern Appendix A: (figure 7), at the AOC reference site of Seneca Bluffs and an increase in breeding bird pairs from 63 in 2012 and 71 in 2021. Song sparrows (*Melospiza melodia*) and yellow warblers (*Setophaga petechia*) doubled in nesting pairs observed from 2012 to 2021. The wildlife survey also captured acoustic evidence of the return of red and hoary bats (*Lasiurus borealis* and *L. cinereus*) at three locations within the AOC 2021. These bat species were not observed in 2012. Increased diversity in mammals and increased diversity in nesting birds are strong indicators of improved food sources from the base of the food chain to the bird and mammal predators that live along the shores on the River. The increase in nesting birds is a strong indicator of improved habitat quality.[63]

4.2 Dissolved Oxygen (DO)

Pockets of low DO and seasonal low DO levels are likely to continue to persist in the Buffalo River.[64] However, all possible actions, within the influence of the Buffalo River AOC program, have been taken to improve DO levels. Both natural factors (e.g., seiches) and social or economic factors (e.g., the necessity to dredge navigational channels) prevent the full restoration of impaired water quality.

[59] RES, 2023
[60] RAC Presentation, 2020
[61] RES, 2023
[62] Friends of Seneca Bluffs, 2021
[63] RES, 2023
[64] Kaur et al., 2007; United States Geological Survey, 1987–2019

Previous studies of the Buffalo River have stated that low DO levels are primarily a result of the Buffalo River being a deep basin that collects a large volume of warm nutrient rich water. The river is inundated with cool lake water but this is not a constant source of oxygen.[65] Further, the BRIC noted above is still in operation today. The BRIC discharge of water from Lake Erie into the Buffalo River, however, has decreased along with the waterfront manufacturing industries and there is very little evidence that it had a big impact on fish and wildlife.

Dredging of the Buffalo River will continue because it is federally designated shipping channel which requires the USACE to dredge every two years. USACE has taken measures to reduce the impacts of dredging on fish and wildlife such as a strategic dredging pattern that avoids fish spawning season. [66] As a result of dredging, and despite all of the restoration work, the lower section of the Buffalo River remains a "lake-like river" predominately characterized by steep slopes, deep waters, and slow flow. In addition to geomorphology, watershed inputs and seiches increase the risk of water stagnation in the central portion of the Buffalo River AOC which results in low DO.[67]

To address the large volume of nutrient rich waters, vegetation buffers have been added to the River shoreline, combined sewer overflows will be significantly abated, and community-wide practices have been encouraged to capture stormwater. The work outlined in the LTCP has already begun and is proposed to be completed by March 2034 resulting in 97% of wet weather flows being captured. Decreasing sewer overflow events into the Buffalo River will significantly improve water quality and reduce sediment oxygen demand.[68] In-line storage technology has been installed as of August 2022. As of September 2022, BSA has[69]:

- Upgraded the Babcock Pumping Station with Smart Sewer Technology to pump and store based on overall system capacity
- Finished construction of the Smith Street Smart Sewer project to divert flows downstream of existing overflow regulators back into the CSS
- Finished construction for the Smith St. at E. Eagle St. Smart Sewer project to store wastewater within the existing system
- Began construction at the Broadway at Oak St. and Mill Race (Larkin Street near Roseville Street) Smart Sewer projects to store combined sewage in the existing system
- Separated storm and sanitary sewers throughout the Valley neighborhood
- Brought the Hamburg Screen facility online to screen out debris and floatable materials from the Hamburg Drain before discharging the combined sewage and groundwater from this pipe into the Commercial Slip

The locations of the sites mentioned above are mapped in Appendix A: figure 8. Unfortunately, outside of the AOC, but within the Buffalo River watershed, there remains limited stormwater capture, high levels of erosion, and wastewater inputs.[70]

[65] Diggins and Snyder 2003; Irvine et al. 2005
[66] USACE, 2010
[67] Diggins and Snyder, 2003
[68] Jaligama et al., 2004
[69] Rosaleen Nogel, BSA, personal communication, 2022 and BSA, 2021
[70] Irvine et al., 2005

The in-water Buffalo River habitat restoration sites were designed to create a connected system of habitats that increase the capacity of aquatic life in the Buffalo River. Increases in temperature and nutrients could result in low DO levels, but the connected Buffalo River habitat refugia will help wildlife survive extreme weather events. Habitat refugia are areas within the landscape which are naturally buffered from extreme variation in environmental conditions, such as the Buffalo River habitat restoration sites that provide stable environments for fish to use when water temperatures and nutrient levels rise.[71] The aquatic plants established at restoration sites, provide cover for small young fish to hide and improve both water and sediment quality by taking in nutrients and producing oxygen.

Aquatic and terrestrial wildlife will benefit from connected upland and in-water habitat. The upland plantings provide vegetative buffers protecting the fragile and recently restored riparian habitat. The trees provide shade, and the native plants have deep roots that stabilize the shoreline and soak up stormwater.[72] The upland soils and in-water sediment of the AOC has been significantly improved and are no longer toxic to terrestrial and benthic macroinvertebrates that are a primary source of food for birds and fish.[73] Certain contaminants can cause low levels of DO by absorbing the oxygen in the water and the oxygen absorbing contaminants in the Buffalo River sediment have been removed.[74]

5. Conclusions

1) Restore Habitat Connectivity; AND

a) Enact the City of Buffalo's new unified development ordinance, the City of Buffalo Green Code, which contains explicit zoning provisions imposing a minimum 100-foot development setback and a 50-foot vegetative buffer (5.5.3.A.5. C-W-100 Standards).

As noted above and contained below in the Appendices, the 2017 City of Buffalo Unified Development Ordinance/Green Code includes the mitigation measures called for in the BUI removal criteria. The river shoreline in the AOC requires a 100-foot setback and a 50-foot vegetated buffer. Any new development will be more protective of the shoreline and will no longer be built right to the waterline as was done in the past to accommodate the shipping industry. This ordinance will minimize future degradation of the Buffalo River Shoreline.

b) Implement the Buffalo River Habitat Action Plan (2013)

The initial habitat action plan identified up to twenty sites that were viable for restoration. Of those, fourteen were restored exceeding the linear feet and restoration percentage metric set by the DEC and RAC. The linear feet of shoreline goal set out by the Habitat Action Plan was met and exceeded. Specifics of the restoration sites are available in Appendix B to this report.

2) Improve Water Quality

a) Major anthropogenic causes of low DO, including navigational dredging and CSOs, are not a limiting factor for supporting aquatic life.

[71] Morelli & Millar, 2018
[72] USEPA, 2022
[73] USACE, Buffalo District, 2019
[74] USACE 2010

The Buffalo River is and will continue to be a working River, yet all feasible and meaningful mitigation measures have been taken. The USACE is strategic and careful about their dredging practices to protect habitat and fish spawning. CSOs have already begun to be, with the installation of green infrastructure, real time control technology, and increased throughput at the Wastewater Treatment Plant, and will continue to be significantly abated under the BSA Long Term Control Plan. Toxic sediment has been removed and aquatic habitat has been restored. Recent studies and sampling have shown that even with limited recent progress, fish and wildlife are already rebounding and this positive trend should only continue.

Specific targets listed to restore habitat connectivity (criteria 1) have been met which aligns with delisting scenario A: "A delisting target has been met through remedial actions which confirms that the beneficial use has been restored." Remediation actions have been completed for criteria 2 but water quality concerns remain that are caused by sources outside of the AOC which aligns with delisting scenario D: "The impairment is caused by sources outside the AOC. The impairment is not restored but the impairment classification can be removed or changed to "impaired-not due to local sources." Responsibility for addressing "out of AOC" sources is given to another party." All remediation actions have been completed and BUI 14 is recommended for removal.

5.1 Future Management Recommendations

All actions needed to meet the BUI Removal Criteria have been completed for BUI 14 which has created a stable foundation for continued improvement of Buffalo River habitat, fish, and wildlife. Continued monitoring of the restored areas and the larger watershed is needed to ensure continued ecosystem recovery, that habitat restoration sites are maintained, and that implementation of the Green Code and BSA LTCP are leading to their intended benefits to the overall health of the River. Within the AOC corridor, the wildlife survey noted the loss of grassland habitat, the continued lack of wetland habitat, and that the riparian and floodplain habitat remains thin. Connectivity has been much improved because of the BUI 14 management actions, but reptile and amphibian diversity remain low and did not improve from 2012 to 2021. The wildlife survey indicated that the species diversity is trending in the right direction but there has not been a substantial increase.[75]

A long-term maintenance plan for each habitat restoration site with identified sustainable funding source(s) is needed. Concerned Buffalo River community members have also requested better pedestrian and paddling connectivity, and safety between restoration sites (pedestrian bridges, walking paths, bathrooms, and river ladders).[76] Investments in safety and recreation will will increase community value and thereby inspire long-term stewardship.

Continuing to support in-water habitat improvements outside, upstream, and downstream, of the AOC boundary to encourage fish and wildlife refugia is needed. As of 2008 upstream of the City of Buffalo, 60 to 70% of the 100-year floodplain remained undeveloped. Evidence shows that the upper Buffalo River and Lake Erie harbor support unique and important fish species.[77] It is critical to protect the undeveloped land that remains along the Buffalo River but also within the Buffalo River Watershed. As the Buffalo River continues to benefit from actions taken as part of the AOC program, it is important

[75] RAC Presentation, 2022
[76] BNW Water Safety Meeting Notes, 2018; Friends of Seneca Bluffs Meeting Notes, 2021; Erie County FAB Notes, 2021
[77] Wooster & Matthies, 2008; Ramboll & AnchorQEA, 2018

to maintain and improve the refugia system for wildlife populations that may recolonize the rebounding Buffalo River. Restoring remaining hardened and degraded shoreline within the Buffalo River Watershed will also support continued improvement of fish and wildlife habitat.

Invasive species including carp x goldfish hybrids, round goby, and rudd have moved into the Buffalo River since 1993 and compete with native fish.[78] In addition, invasive plants such as Japanese knotweed and tree of heaven persist and could easily takeover restoration sites if not actively managed.[79] A long-term monitoring of restoration sites to spot check and treat invasive plant species is needed. Invasive aquatic animals should be monitored to better understand their impact on the rebounding fish populations.

An examination of WNY's climate data (1965-2016) clearly indicates that the region is impacted by climate change.[80] A major component of the impact is seen as a significant rise in average regional air temperature. In addition to rising air temperatures, data shows that over the past 50 years, Lake Erie water temperatures, as measured at the Buffalo Water Treatment Plant at a depth of 30 feet, have increased. Annual maximum ice cover dates for Lake Erie show that although substantial ice cover is typical, the exceptions (with annual ice cover as low as 5%) appear more frequent since 1998. Lake Erie shows a trend of decreasing annual maximum ice coverage, and significantly earlier ice-out dates. Another trend is a significant rise of severe weather in WNY in the form of strong storms and increased seiche activity.[81] Storms and wet weather in WNY increase the likelihood of CSO events. These climate change related impacts could reduce DO levels in the Buffalo River, which will reduce the quantity and quality of habitat for wildlife. More intense storms will result in warmer water being conveyed in more intense deluges to the receiving streams with all the pollutants that they carry. This is true for both separate stormwater systems and CSSs, which would exceed carrying capacity and rather than overflowing to basements, will overflow to the waterways. Both the pollutants being carried, and the temperature of this water will result in reduced DO.

In addition to a changing climate that is already having impacts on Great Lakes habitats, there is a global freshwater biodiversity crisis that impacts waterways in the Great Lakes Basin, including the Buffalo River. This crisis should be taken into consideration when developing future adaptive management plans for the River. Albert et. al. provides a comprehensive overview of the current scientific community understanding of the global freshwater biodiversity crisis stating, "We recommend a set of urgent policy actions that promote clean water, conserve watershed services, and restore freshwater ecosystems and their vital services. Effective management of freshwater resources and ecosystems must be ranked amongst humanity's highest priorities".[82]

Through adaptive management of protected habitats, changes in policies that ensure water protection, and cultural change, the investments made in restoring Buffalo River habitat have the potential for great long-term gains for fish and wildlife. The River is under threat by the impacts of climate change, habitat degradation, and pollution. However, climate resiliency planning, continued

[78] Ramboll & AnchorQEA, 2018
[79] iMapInvasives, 2022
[80] Vermette, 2017
[81] Vermette, 2017
[82] Albert et. al., 2020

monitoring of habitat extent and quality, and continued restoration of the Buffalo River watershed could result in rebounding biodiversity.

The increased risk of storm events continues to emphasize the importance of infrastructure both for abating sewer overflows and to reduce flooding risks that could both damage restored habitat and significantly impact residence of the Buffalo River floodplain. Much of the residential area surrounding the Buffalo River AOC has been identified as potential environmental justice areas by NYSDEC.[83] The negative impacts of large storm events disproportionately harm people of color and low-income households.[84] Storm and sanitary sewer discharges from both the City of Buffalo but also from municipalities upstream continue to threaten the recovering populations of fish and wildlife.[85] In addition, Buffalo River headwaters are in agricultural areas and runoff from fields and septic leachate may be contributing to the slow recovery of fish populations. [86] Pollutants such as trash and plastic, oils, grease, bird and canine waste, as well as pesticides and fertilizers from lawns and golf courses can be conveyed directly into receiving streams in upstream communities with separate sewer systems. Municipalities upstream of the Buffalo River AOC should focus on increasing stormwater capture and treatment infrastructure, sanitary system rehabilitation, assess and fix septic systems to ensure they are functioning, protecting existing riparian and upland buffer habitat, and increasing natural spaces that can absorb the water from storm events. Promotion of the naturalization or ecologically mindful development of abandoned urban properties and installation of green infrastructure should also be continued in the land surrounding the Buffalo River AOC.

The Buffalo River is a tributary of the Niagara River Watershed, which has high ecological and cultural value. It is important to continue work related to restoration and connectivity of habitats within the Niagara River Watershed. The Haudenosaunee people of the region have lost the natural resources that are integral to their culture and wellbeing and hope to see the habitat central to their way of life returned. The continued acknowledgement of this loss that is noted in the Natural Resource Damage Assessment and Restoration Settlement is supported by the Buffalo River AOC RAC.[87]

6 Public Consultation

BNW, in partnership with Erie County Department of Environment and Planning, NYSDEC, USEPA, and the Buffalo River RAC, hosted a virtual public meeting on April 17, 2023 to present the case for removing the *Degradation of Benthos* BUI to local stakeholders. The meeting was held during the 30-day public review period from April 1- 20, 2023 during which public was invited to review and provide input on a draft version of this BUI removal report, which was hosted on the BNW website. Information about the meeting and the form to submit comments will be posted on www.bnwaterkeeper.org

BNW has prepared a summary of the public meeting comments. This summary is included as **Appendix X.**

[83] NYSDEC, 2022
[84] Howell and Elliot, 2018
[85] NYS Alert, 2021
[86] Regional Niagara River Lake Erie Watershed Management Plan, 2017
[87] U.S. FWS, 2019

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Appendices

A. Additional Tables and Figures

Table 3. Fish species collected in the Buffalo River AOC, 1973-1987

Sampling Period by Year	Jun-73 [1]	Jun-74 [1]	Apr 1981 – Jan 1982 [2]	Sep-84 [1]	May - Nov 1988 [3]
Common Name					
alewife					Ob
black crappie			Ob		Ob
bluegill		Ob	Ob	Ob	
bluntnose minnow			Ob	Ob	
brook silverside				Ob	
brown bullhead			Ob	Ob	Ob
brown trout					Ob
carp	Ob	Ob	Ob	Ob	Ob
central stoneroller				Ob	
chinook salmon			Ob		
coho salmon			Ob		Ob
common shiner	Ob		Ob	Ob	Ob
creek chub					Ob
emerald shiner			Ob	Ob	Ob
freshwater drum	Ob	Ob	Ob	Ob	Ob
gizzard shad	Ob	Ob	Ob	Ob	Ob
golden shiner			Ob	Ob	Ob
goldfish	Ob		Ob	Ob	Ob
lake trout			Ob		
largemouth bass		Ob	Ob	Ob	Ob
logperch				Ob	
longnose gar				Ob	
muskellunge			Ob		Ob

Sampling Period by Year	Jun-73 [1]	Jun-74 [1]	Apr 1981 – Jan 1982 [2]	Sep-84 [1]	May - Nov 1988 [3]
northern hog sucker		Ob	Ob		Ob
northern pike			Ob	Ob	Ob
pumpkinseed	Ob	Ob	Ob	Ob	Ob
quillback		Ob			Ob
rainbow smelt			Ob		
rainbow trout			Ob		Ob
redhorse species	Ob	Ob	Ob		Ob
rock bass		Ob	Ob	Ob	Ob
smallmouth bass	Ob	Ob	Ob	Ob	Ob
spottail shiner			Ob	Ob	Ob
stonecat			Ob		
trout-perch			Ob		
walleye	Ob		Ob		
warmouth			Ob		
white bass			Ob		Ob
white crappie				Ob	Ob
white perch			Ob	Ob	Ob
white sucker	Ob	Ob	Ob	Ob	Ob
yellow perch			Ob	Ob	Ob
Total number of species	10	12	33	24	29

1) Mikol et al., 1993; 2) Makarewicz et al. 1982; 3) Adrian, D. and C.N. Merckel. Unpublished. Update on the status of the biota of the Buffalo River, Buffalo, NY, Phase I: Fish. New York State University College at Buffalo, Aquatic Biology Program, Buffalo, NY (Poole et al. 1994)

Ob – Observed

Table 4: Buffalo River Remedial Action Plan Table 4.1

TABLE 4.1

COMPARISON OF CONTAMINANT CONCENTRATIONS IN BUFFALO RIVER BOTTOM SEDIMENTS WITH LAKE ERIE BOTTOM SEDIMENTS USACOE - BUFFALO DISTRICT SAMPLING - 1981 (ug/g)

PARAMETER	BUFFALO RIVER MEDIAN [1]	LAKE ERIE MEDIAN [2]
di-2-ethylhexyl phthalate	0.000	0.000
di-n-butyl phthalate	0.160	0.000
2,4-D isopropyl ester	0.000	0.000
hexachlorobenzene	0.000	0.000
beta-BHC	0.000	0.040
gamma-BHC	0.000	0.000
heptachlor	0.010	0.000
aldrin	0.000	0.000
heptachlor epoxide	0.000	0.000
dieldrin	0.000	0.000
4,4'-DDE	0.000	0.000
endrin	0.000	0.000
4,4'-DDD	0.000	0.000
4,4'-DDT	0.000	0.000
methoxychlor	0.000	0.000
PCB-1242	0.000	0.000
PCB-1248	0.000	0.000
PCB-1254	0.450	0.100
PCB-1260	0.000	0.000
gamma-chlordane	0.000	0.000
DCPA	0.080	0.070
2,4'-DDD	0.000	0.000
2,4'-DDE	0.000	0.000
2,4'-DDT	0.000	0.020
alpha-endosulfan	0.000	0.000
beta-endosulfan	0.000	0.000
isodrin	0.000	0.000
mirex	0.000	0.000
tetradifon	0.000	0.000
trifluralin	0.030	0.110
zytron	0.000	0.000
aluminum	8990.000	4300.000
arsenic	10.900	6.100
cadmium	1.150	0.000
chromium	30.350	19.500
copper	63.850	18.600
iron	27250.000	25700.000

TABLE 4.1 (continued)

PARAMETER	BUFFALO RIVER MEDIAN [1]	LAKE ERIE MEDIAN [2]
lead	121.000	21.900
manganese	483.500	651.500
mercury	0.540	0.110
nickel	36.750	18.700
zinc	390.700	267.100
cyanide	0.331	0.416
phenols (4AAP)	0.381	0.031

FOOTNOTES

[1] 12 Samples
[2] 3 Samples
Mean values and contaminant range values for the Buffalo River are presented in Table A.4, Appendix.

Table 5: Buffalo River Remedial Action Plan Table 5.7

TABLE 5.7
FREQUENCY OF OBSERVATIONS AND MEAN VALUES
IN BUFFALO RIVER
WATER OF METALS AND CYANIDES

Contaminant	Detection Limit (ug/l)	Frequency of Observations in Water Column	Mean Value (ug/l)
arsenic	30	0/27 1/	0.0
barium	NA 2/	NA	NA
copper	30	0/27	0.0
iron	NA	NA	NA
lead	30	2/27	9.1
manganese	NA	NA	NA
zinc	30	9/27	12.3
cyanides	NA	NA	NA

1/ Number of exceedances per number of samples

2/ Not analyzed

Figure 3: Spotted sucker caught on 6/21/21 in the lower Buffalo River; Photo by USGS

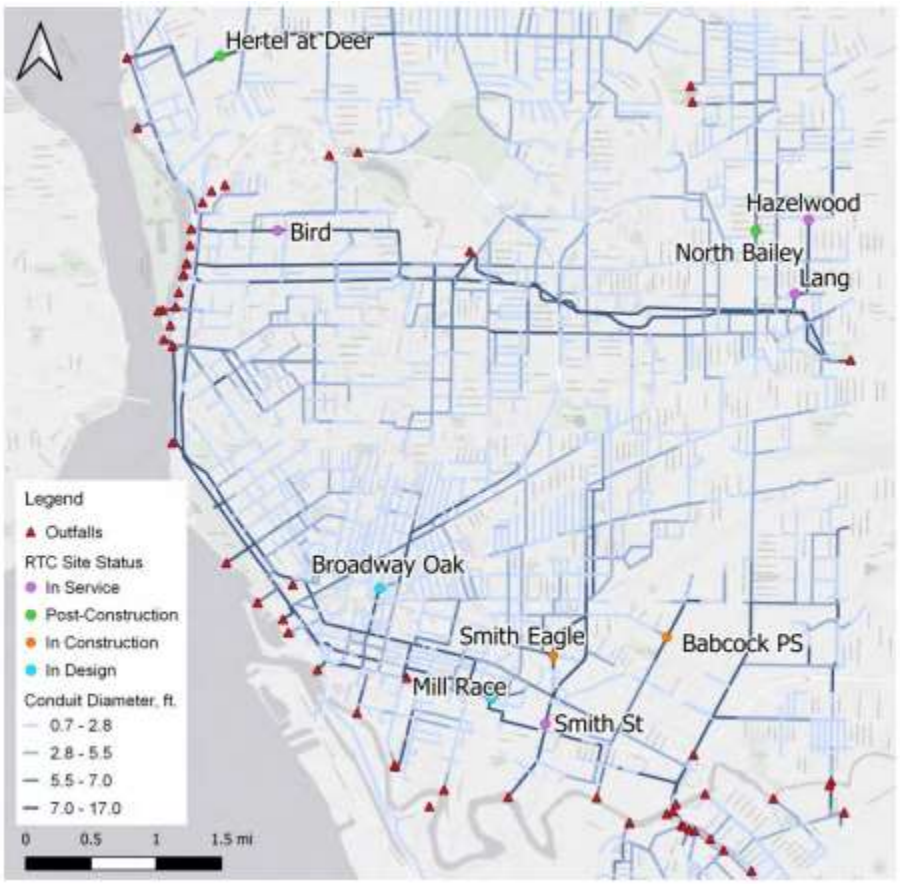
Figure 4: Red-tailed Hawk Chick at Old Bailey Woods on 6/2/2020. Photo by Claudia Rosen, BNW

Figure 5: A Monarch butterfly on milkweed planted at Thomas Higgins Habitat Park. Photo was taken August 30th, 2020.

Figure 6: Beaver seen along the shores of Red Jack Habitat Park in the month of September 2021; Photo by Friends of Red Jacket

Figure 7: Breeding eastern kingbird bird (left) and red headed woodpecker (right) within the AOC and at Seneca Bluffs respectively

Figure 8: A map made by BSA in the 2021 LTCP semi-annual report that shows you the location of key sewer infrastructure points.[88]



[88] Buffalo Sewer Authority, 2021

B. BR Habitat Restoration Site Summary: Action Plan and Great Lakes Legacy Act (GLLA)

This appendix includes information about 14 habitat restoration project sites completed as part of the RAP. Each restoration project was unique and careful consideration was taken when picking locations such as feasibility and benefits, designing plans for targeted wildlife, constructing safely and efficiently, and assessing the success of the sites. For each site profile the following information is listed:

Site Owner: The title holder to either the land or river bottom. Two site owners may be listed when title holder changed from start to finish of restoration.

Project Manager: The entity that supervised and lead the restoration from start to finish including managing funding, design selection, and implementation of project.

Funder: The agency or agencies that paid for the restoration project.

Design Consultant: The landscape architecture or engineering company that provided landscaping, construction, and or planting plans based on the needs of the site.

Construction Contractor: The company hired to implement the design plans.

Date of Completion/Success: The date at which the design was satisfactorily implemented is the completion date. The date at which the habitat restoration project was deemed a success by achieving project contract specifications and vegetative cover criteria is the success date.

Area Restored: The size of the restoration site.

Coordinates: A point within the restoration site.

Work Accomplished: Information about the management actions taken to improve habitat health and resiliency and success of the project.

Buffalo Motor and Generator Corporation	
Site Owner	Buffalo Motor and Generator Corp. / City of Buffalo
Project Manager	BNW
Funder	GLC-NOAA/GLRI
Design Consultant	Anchor QEA
Construction Contractor	Scott Lawn Yard
Date of Completion/Success	October 2018/2020
Area Restored	331 linear feet; 0.20 Acre
Coordinates	42.871461, -78.871867

Work Accomplished: This project site is one of the most visual of all the Buffalo River habitat projects due to its location in a heavily trafficked area of the City of Buffalo. This site, located in the lower section of the Buffalo River, is heavily utilized with development to the edge of the banks and a lack of Submerged Aquatic Vegetation (SAV), Emergent Vegetation (EV) and respite areas for fish and wildlife. This project aimed to remove invasive plant species from the shoreline and riparian area, plant native species, introduce SAV and EV to the nearshore area, and provide in-water fish and wildlife habitat with the alteration of an existing crib structure. Construction activities at the site began in early July 2016 with the clearing and removal of nearly 80 cubic yards of Japanese Knotweed and general debris from the riparian and shoreline areas. The upland portion of the site was then grubbed and leveled, and sediment erosion control measures and bat boxes were installed. Rootwads, boulders, and substrate were installed into the existing crib structure, - providing ideal habitat for fish and shoreline wildlife. A rootwad chain was installed in the water along the eastern portion of the project site to provide additional habitat and serve as a wave and debris deflector. In July 2018, the final work at the site began by obtaining bathymetric surveys to determine the amount the sediment settled over the course of the winter and identify the correct plant species to install. SAV and EV plants were established offsite before being installed in the project area. Over the course of the project, four rounds of invasive species treatments were conducted at the site to treat the Japanese Knotweed. As of 2020, this project has been deemed a success as the Japanese Knotweed population has been significantly reduced and replaced with thriving native plants. The SAV and EV have established in the near-shore area and the enhanced crib structure is providing habitat for fish and wildlife.

Ohio Street Boat Launch	
Site Owner	NYS Dept. of Environmental Conservation
Project Manager	BNW
Funder	GLC-NOAA/GLRI
Design Consultant	Gomez and Sullivan Engineers
Construction Contractor	Scott Lawn Yard
Date of Completion/Success	October 2018/2020
Area Restored	332 linear feet and 1.62 acres
Coordinates	42.865872, -78.868053

Work Accomplished: This project site is a fishing access site, kayak, and car-top boat launch in a highly utilized section of the Buffalo River. The project goal was to remove invasive species from the shoreline and replace the flat lawn areas with critically needed meadow habitat for local pollinators and wildlife. Construction at this site began on October 3, 2017. The site was prepped by installing a fence around the project area and treating the lawn with an herbicide to aid in removal at a later date. Numerous loads of high-quality topsoil were brought onto the site which was then planted with meadow mix and approximately 100 native trees and shrubs. Large boulders were imported to the site and arranged to create berm areas for planting beds as per the design. The shoreline was cleared of invasive and nuisance vegetation. Three large bat boxes were installed in the upland area to promote use of the site by pollinators. The meadow areas were then hydroseeded with meadow seed mix during the Spring of 2018. As of 2020, this project has been deemed a success as the meadows have fully established and are providing habitat for local pollinators and upland wildlife.

Toe of Katherine Street Peninsula	
Site Owner	City of Buffalo / Premier Towing
Project Manager	BNW
Funder	GLC-NOAA/GLRI
Primary Design Consultant	CHA
Primary Construction Contractor	Scott Lawn Yard
Date of Completion/Success	October 2018/2020
Area Restored	1693 linear feet; 7.3 Acres
Coordinates	42.857583, -78.855204

Work Accomplished: This project site is landlocked and privately owned. It is located in the less congested section of the Buffalo River. The site contained a near monoculture of Japanese knotweed and had severely eroding banks. The project goal was to remove invasive plant species, soften the shoreline, plant native species, and encourage wildlife to utilize the protected site. Contractors mobilized to the site and spent nearly three weeks clearing the site of Japanese knotweed, unwanted vegetation, and general debris. The site was then rough graded and coir logs and large stone were installed along the shoreline to prevent erosion. The turtle nesting beaches were then constructed through the installation of anchored logs, medium stone fill, rock slabs ("ramps") and special turtle nesting substrate. Final grading and the placement of coir logs occurred to provide site elevations and topography. The riparian area was planted with native trees and shrubs, live stakes were planted along the shoreline and the upland portion of the site was seeded and strawed. Over the course of the project, five rounds of invasive species treatments were conducted at the site to treat emerging Japanese knotweed. As of 2020, this project is deemed a success. The monoculture of Japanese knotweed has been nearly replaced by established native plants, the shorelines are no longer facing continuous erosion, and the turtle nesting beaches have seen signs of nesting activity.

Buffalo Color Peninsula	
Site Owner	South Buffalo Development
Project Manager	BNW
Funder	GLC-NOAA/GLRI
Primary Design Consultant	Gomez and Sullivan Engineers
Primary Construction Contractor	Applied Ecological Services
Date of Completion/Success	October 2018/2020
Area Restored	2,645 Linear feet; 1.5 Acres
Coordinates	42.859986, -78.847922

Work Accomplished

This site is a remediated NYS Superfund site that is capped and actively maintained by the current owner. The intent of the design for this project site was to eliminate invasive species, fill voids in the existing rip-rap shoreline, and allow for native plant establishment within a 25-foot riparian buffer.

The project began by removing invasive trees and other invasive plants from the shoreline. The shoreline work consisted of filling the large voids in the rip-rap with stone, installing coir blocks to build up planting benches, and installing coir matting and topsoil. The benches were then planted with native shrubs and seed mix. The shoreline enhancements were further bolstered by the contiguous installation of in-water plants, installed by the GLLA Project. As of 2020, this project is deemed a success. Native vegetation is filling in the voids in the rock-based shoreline and invasive plant species are limited.

Old Bailey Woods	
Site Owner	City of Buffalo
Project Manager	BNW
Funder	GLC-NOAA/GLRI
Design Consultant	Gomez and Sullivan
Construction Contractor	LDC Construction
Date of Completion/Success	October 2018/2020
Area Restored	807 Linear Feet; 3.25 Acres
Coordinates	42.860371, -78.829117

Work Accomplished. This project intended to protect and restore the last existing low-land floodplain forest in the Buffalo River AOC. The 3-acre site is owned by the City of Buffalo and was at risk due to a near monoculture of invasive plant species and significant bank erosion.

The upland portion of the site was cleared and grubbed to manually remove invasive Japanese knotweed and allow for the removal of debris. Over the course of the project, four rounds of invasive species treatments were conducted at the site to treat Japanese knotweed. Once the invasive plants were addressed, native trees and shrubs were planted to add understory vegetation. A lawn area was converted into meadow habitat with the application of meadow seed mix and planting of native, upland vegetation. The severely eroding banks were addressed by softening the shoreline slope and removing compromised vegetation. Four alternating rows of medium stone and live stakes were installed on the shoreline to stabilize the slope and provide habitat (circled below). Six large stone weir rocks were strategically placed at the bottom of the slope to deflect ice.

As of 2020, this project is deemed a success. The removal/treatment of invasive species and the restoration of the native understory has had significant impact on the riparian forest area and the site will now attract much needed wildlife to the area. A nesting Red Tailed Hawk and fledging were seen in 2020 (figure 4). The work that was performed in the erosion control area has already shown to be functioning as designed by preventing loss of shoreline to intense ice scour.

Blue Tower Turning Basin	
Site Owner	City of Buffalo
Project Manager	BNW
Funder/Source	GLC-NOAA/GLRI
Primary Design Consultant	Anchor QEA
Primary Construction Contractor	Scott Lawn Yard
Date of Completion/Success	October 2018/2020
Area Restored	1700 Linear feet; 0 upland acres
Coordinates	42.856870, -78.852694

Work Accomplished: The Blue Tower Turning Basin site is located approximately 3.1 miles upstream of the mouth of the Buffalo River and it is wholly in-water. Due to its shape and location on the River, the Turning Basin routinely fills up with woody debris that had floated from upstream sources, and ice scour and cover was significant. This debris, ice, and wave action had prevented the establishment of healthy SAV and EV populations. The goal of this project was to minimize debris accumulation and ice and wave action to allow for robust SAV and EV populations which would provide fish and wildlife habitat as well as improve water quality.

It took nearly two weeks for crane and barge equipment to remove the floating woody debris from the basin which was then brought onshore and chipped to be reused at another site. Twenty piles (made of locally sourced tulip trees) were driven into the southern portion of the basin and were connected by floating boom logs to deflect ice and waves, a novel approach that had not been implemented in the WNY area previously. A rootwad chain structure was installed in the northern part of the basin to provide a similar type of ice and wave protection. Planting substrate and SAV and EV were installed in the near-shore area behind the root wads and floating boom logs. Five duck boxes (with raccoon deterrents) were installed on the wooden piles to encourage usage by wood ducks.

As of 2020, this project is deemed a success. The project site has seen several winters of strong ice flows as well as several intense storm surges and the elements are functioning as designed. Woody debris is no longer a concern, and the SAV and EV now have the opportunity to establish in the area providing ideal habitat for fish and wildlife.

RiverBend Phase II	
Site Owner – at time of project start	Buffalo Urban Development Corporation (current owner: Tesla)
Project Manager	BNW
Funder/Source	NOAA/GLC-NOAA/GLRI
Design Consultant	Ecology and Environment / Nussbaumer and Clarke
Construction Contractor	Land Remediation
Date of Completion/Success	2015/2020
Area Restored	1,520 Linear feet; 3.5 acres
Coordinates	42.862217, -78.843086

Work Accomplished: The site of a former steel plant, the RiverBend Phase II project offered the potential to restore habitat to over 1,500 linear feet of shoreline and approximately 3.5 acres of upland habitat. Work began with excavation of the banks to allow the steep slopes to be transformed into a more natural, gradual shoreline. The bank materials consisted mainly of slag which was produced during the steel making process and disposed of on-site. Excavated materials were disposed of in an appropriate manner and clean topsoil was imported and spread to the correct grades. Live branches and soil burritos were installed along the shoreline to prevent erosion and provide habitat. Nearly 100 ball and burlap native trees were planted in addition to nearly 1,000 native container trees and shrubs, all of which were protected with wildlife exclusion fencing. The upland area was shaped into planting beds and planting soil mix was installed. Coir logs were installed along the entirety of the project to prevent sheet flow of water and erosion. Standing snags and white pine clusters were installed to encourage wildlife usage and prevent damage to new vegetation.
As of 2020, this project is deemed a success because it is capable of supporting a community of native vegetation and wildlife.

Riverbend Phase I	
Site Owner – at time of project start	Buffalo Urban Development (current Owner: Ciminelli)
Project Manager	BNW
Funder/Source	NOAA/GLC-NOAA/GLRI
Primary Design Consultant	Ecology and Environment
Primary Construction Contractor	Natural Restorations by Linda J. and Co.
Date of Completion/Success	2014/2020
Area Restored	1,200 Linear Feet; 3.5 Acres
Coordinates	42.863279, -78.840919

Work Accomplished: The Riverbend Phase I site is located approximately five miles upstream of the mouth of the river and was home to a steel and coke-making facility. This project aimed to enhance habitat at the shoreline, riparian, and upland areas at a brownfield site along one of the longest naturalized stretches of the Buffalo River. This multi-phased, multi-funder project improved and created habitat by softening the banks and providing erosion protection with the installation of coir logs and planted soil burritos. Invasive plant species were addressed along the shoreline and high-quality soil and planting substrate were spread on the site. Over 2,500 native plants and shrubs were installed to provide habitat for wildlife.

As of 2020, this project is deemed a success. Grass fields, steep shorelines, and invasive plant species have been replaced by natural shorelines and healthy native plant communities. This site provides one of the few grassland habitats along the river.

BEFORE

Post-Construction

Thomas F. Higgins Natural Habitat Park (Formerly Bailey Avenue Peninsula)	
Site Owner	Erie County
Project Manager	Erie County
Funder/Source	USEPA/GLRI
Primary Design Consultant	CHA
Primary Construction Contractor	Scott Lawn Yard
Date of Completion/Success	2019
Area Restored	1,050 linear feet; 4 acres
Coordinates	42.861274, -78.825995

Work Accomplished: Thomas F. Higgins Park is a natural habitat park located at the confluence of the Buffalo River and Cazenovia Creek. This park occupies approximately four acres of land on both sides of the Bailey Avenue bridge along with a parking area on the south side of Cazenovia Creek. The Bailey Bridge New York State Department of Transportation Road Reconstruction project replaced 80-year-old bridges with new single-span structures, maximizing the hydraulic openings to alleviate ice jamming and upstream flooding. Public parkland lost by relocating the bridge was replaced, invasive species were treated and replaced by native plants, and new seiche and pocket wetlands were created to enhance wildlife habitat and filter stormwater runoff. In-water restoration improved structural fish and wildlife habitat by repurposing over 50 trees from the site of the new Bailey Avenue bridge and anchoring the logs nearshore.

Red Jacket Riverfront Park	
Site Owner	Erie County
Project Manager	Erie County
Funder	USEPA/GLRI
Primary Design Consultant	Wendel
Primary Construction Contractor	LDC Construction
Date of Completion/Success	2019
Area Restored	745 linear feet; 7 acres
Coordinates	42.864341, -78.850585

Work Accomplished: This natural habitat park is located along the north bank of the Buffalo River at the foot of Smith Street. This 7-acre site is 3.7 miles upstream of the mouth of the river and contains approximately 745 linear feet of restored shoreline.

Restoration efforts involved re-constructing a backwater wetland similar to riparian and floodplain habitat features that were common in the lower Buffalo River watershed prior to development. Underwater log structures were placed along the shoreline to improve habitat for aquatic flora and fauna. Invasive species were treated, and native trees and shrubs were planted around the wetland and throughout the site. A riverine wetland was also constructed by placing a rock reef in the River channel to provide structural support.

Northeast Shoreline of Katherine Street Peninsula	
Site Owner	Linde, LLC (now Messer)
Project Manager	USEPA
Funder/Source	USEPA/GLRI
Design Consultant	CH2M (prime)/Ecology and Environment (sub)
Construction Contractor	Scott Lawn Yard
Date of Completion/Success	September 2019/Monitoring process ongoing
Area Restored	1775 linear feet; 3.7 acres
Coordinates	42.861723, -78.857409

Work Accomplished: The northeast shoreline of Katherine Street Peninsula site is located on private property between the Red Jacket Riverfront Park and Toe of Katherine Street habitat restoration projects. The objectives of the restoration are to improve nearshore, shoreline, and shallow-water habitat; control and manage invasive species; and naturalize, restore, and stabilize the riverbank. Tree of heaven, Japanese knotweed, mugwort, and bush honeysuckle are the predominant invasive species on site.

Restoration features include root wads and bendway weirs to dissipate shoreline wave energy and redirect stream velocity and debris away from the shoreline and encourage sedimentation and the establishment of EV/SAV; cabled logs to protect the shoreline and serve as downslope walls for planting troughs; reef balls and pilings to provide fish habitat; and rock sills to dissipate nearshore wave energy and/or create planting troughs, which will support plant growth along the shoreline. Invasive species treatment occurred in the upland areas using a combination of mechanical and chemical control. In addition, a barrier trench was dug six feet deep and lined with 60 mm HDPE liner to prevent re-establishment of invasive species through root growth. Lastly, native species of plants were installed across four planting zones (submerged/emergent, shoreline, riparian slope, and upland slope).

Construction activities took place between mid-July and the end of September 2019. Monitoring and maintenance activities, such as installing additional plants and conducting invasive species treatments, will be implemented during the restoration establishment period which runs through 2023.

Great Lakes Legacy Act (GLLA) Aquatic Habitat Restoration	
Site Owner	City of Buffalo (owner of river bottom)
Project Manager	Honeywell
Funder/Source	Honeywell
Primary Design Consultant	CH2M Hill (original) and Anchor QEA (revision)
Primary Construction Contractor	Sevenson (prime)/Cardno JFNew (sub)
Date of Completion/Success	2015/2020
Area Restored	9,095 linear feet
Coordinates	Multiple locations in the Buffalo River AOC

Work Accomplished: As part of the GLLA cost-shared project, in-water habitat restoration was conducted at five sites in the Buffalo River AOC: Riverbend, Buffalo Color Peninsula, Ohio Street Shoreline, Katherine Street Peninsula, and the City Ship Canal. The sites were restored by replacing and augmenting aquatic habitat impacted by dredging or capping as well as enhancing site aquatic zones. The habitat restoration efforts at the City Ship Canal and Katherine Street sites were specifically used to mitigate environmental impacts from the sediment dredging activities.

In 2014, primary activities for habitat restoration focused on fill placement, habitat structure installation, and base installation work. Approximately 26,500 tons of habitat subgrade material (gravel) were placed at the Katherine Street Peninsula habitat restoration area in order to construct an extended bench of suitable planting elevations for EV and SAV planting beds. A minimum six-inch habitat substrate layer was placed at all five habitat restoration areas to provide suitable, consolidated substrate material for EV and SAV plants. In addition, rock vanes were installed at three locations at Katherine Street Peninsula, three locations at Riverbend, and 12 locations at Buffalo Color Peninsula to dissipate wave energy and encourage sediment deposition. Bedding material and rip rap were placed at three locations at Riverbend and two locations at the City Ship Canal to provide outfall scour protection. 53 anchored rootwads and eight log poles were installed in the habitat restoration areas to provide fish habitat and sheltered planting areas for EV and SAV plants. Four gravel spawning beds and 12 porcupine cribs were installed for use as fish spawning habitat and shelter in the City Ship Canal.

The 2015 restoration activities focused on in-water planting of EV and SAV species. An empty building on site was used as a temporary nursery to provide shade and ventilation for the EV and SAV plant stock while waiting for installation. For all five habitat restoration areas combined, approximately 29,500 EV plants and approximately 47,500 SAV plants were installed. Monitoring and maintenance activities, such as supplemental planting and herbicide treatments, were implemented over a five-year timeframe and concluded in 2020.

Seneca Bluffs Natural Habitat Park (Reference Site Outside AOC)	
Site Owner	Erie County
Project Manager	USACE
Funder/Source	USEPA/GLRI
Design Consultant	USACE
Construction Contractor	Tidewater (prime)/Cardno (sub) / RES (formally AES (sub))
Date of Completion/Success	2020/Monitoring process ongoing
Area Restored	3000 Linear Feet; 4 acres
Coordinates	42.865582, -78.819531

Work Accomplished: The Seneca Bluffs Ecosystem Restoration Project addressed severe riverbank erosion along the Buffalo River and created riverine and riparian fish and wildlife habitat. Habitat restoration measures include bank stabilization with stone toe protection and bank cutbacks. Enhancement measures for in-channel and shallow water habitat include the installation of locked logs and single stone bendway weirs with root wads. Additionally, a backflow wetland approximately 0.2 acre in size was installed to create floodplain wetland habitat.

Invasive plant species were treated using mechanical removal and chemical application during the first three years, and spot chemical treatments in the fourth and fifth years of the project. Native dominated floodplain and riparian habitats were established through seeding and shrub/tree planting. The project stabilized eroding riverbanks, created in-channel aquatic habitat, reduced invasive species, and restored native riparian vegetation communities.

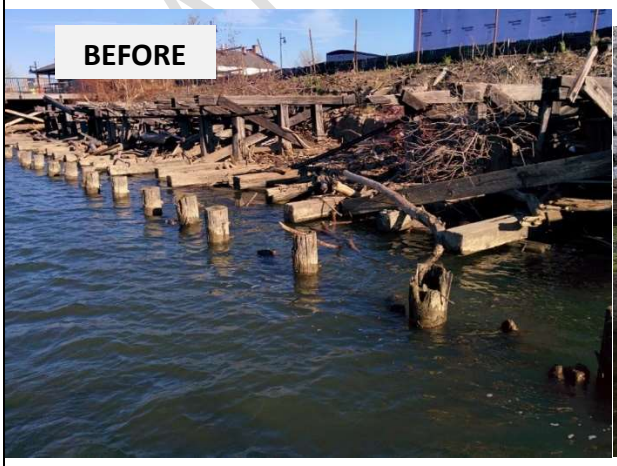
Project monitoring began in 2016 after completion of earthwork, initial invasive species removal, and initial planting and was carried out over a period of five years. Monitoring data documented the successful reduction of invasive species (< 5% of total cover) and establishment of native plant communities.

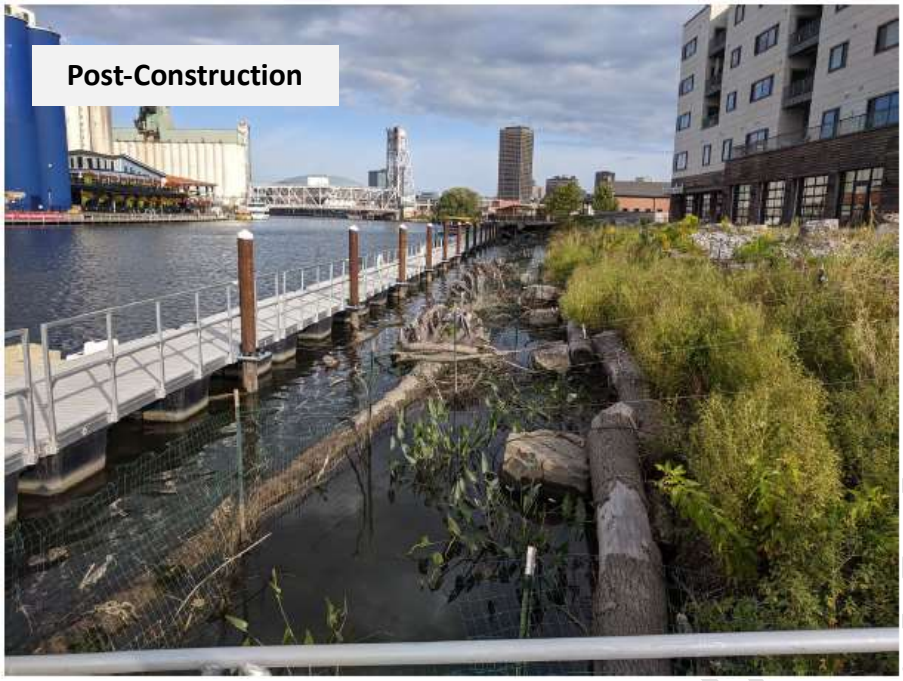
Buffalo River Aquatic Habitat Restoration - 1 South St., 70 Katherine St.; and 301 Ohio St.	
Site Owner	City of Buffalo (In water). Adjacent property owners Savarino Companies (1 South Street), Ellicott Development Co. (301 Ohio Street), Irish Propane (70 Katherine Street).
Project Manager	USACE
Funder/Source	USEPA/GLRI
Primary Design Consultant	USACE
Primary Construction Contractor	1 South Street: BIDCO Marine Group 70 Katherine Street: BIDCO Marine Group 301 Ohio Street: LDC (Prime), Sienna (QA/QC), AES (Sub)
Date of Completion/Success	1 South Street & 70 Katherine Street: 2019 301 Ohio Street: 2020 Monitoring process of success ongoing
Linear Feet Restored	1 South Street: 550' 70 Katherine Street: 820' 301 Ohio Street: 920' Total: 2,290'
Coordinates	Multiple locations within the Buffalo River AOC

Work Accomplished: The Buffalo River Aquatic Habitat Restoration project included restoration of aquatic habitat at three sites along the Buffalo River. The sites are in-water, adjacent to the following properties: 1 South Street (Savarino Companies), 70 Katherine Street (Irish Propane), and 301 Ohio Street (Ellicott Development).

The project consisted of construction of structural habitat in the form of submerged locked logs and rootwads, and the establishment of native aquatic SAV and EV vegetation communities. Additionally, work at the 301 Ohio Street site removed decrepit wooden infrastructure (wooden bulkheads) from the riverbank, installation of terraced planting areas using locked logs, and establishment of riparian vegetation and shrubs in front of an existing concrete retaining wall.

Monitoring since 2016 indicates a successful establishment of diverse SAV, EV, and riparian communities. Structural habitat reduces nearshore wave energy, and provides refuge habitat for fish, waterfowl, American mink, and migratory birds. Monitoring continued through2021.





C. UDO Zoning Code Map and Section 5.3.3.

Zoning Map

DECEMBER 2016

5.3.3 Specific Standards

A. **Waterfront Yards.** All development on waterfront lots within the C-W zone must provide a waterfront yard (either C-W-25 or C-W-100, depending upon the zone) along the shoreline of the property per Table 5A: Waterfront Yards. The standards for the C-W-25 and C-W-100 waterfront yard types are described below.

TABLE 5A: WATERFRONT YARDS

ZONE	WATERFRONT YARD TYPE
N-1D, N-1C, N-1S, N-2C, N-2E, N-2R, N-3C, N-3E, N-3R, N-4-30, N-4-50	C-W-25
D-R, D-M, D-E, D-S, D-C, D-IL, D-IH, D-OS, D-OG, D-ON, C-R	C-W-100

1. A required waterfront yard is the area of a waterfront lot measured from the mean high water line of the adjacent water body that must be maintained clear of all permanent structures and vehicular access and parking, except where necessary to facilitate water-dependent uses. The required waterfront yard substitutes for a required rear or interior side yard, wherever such yards coincide.

2. A water-dependent use is a use which can only be conducted in, on, over, or adjacent to a water body because such use requires direct access to that water body, and which involves, as an integral part of such activity, the use of the water. Water-dependent uses include, but are not limited to, marinas and yacht clubs, boat launch and service facilities, waterborne passenger terminals, fishing facilities, tour boat and charter boat facilities, research and educational facilities requiring access to water bodies, structures needed for navigational purposes, erosion and flood control structures, and facilities for loading and unloading bulk cargo by water. A shore public walkway, plus related accessory structures, is considered a water-dependent use.

3. Where a water-dependent use is proposed to be established or expanded within a required waterfront yard, the encroachment upon the required waterfront yard must, to the greatest extent practicable, avoid, minimize, and/or mitigate adverse impacts, including, but not limited to:

- **a.** Deterioration of water quality.
- **b.** Loss, fragmentation, and impairment of habitats and wetlands.
- **c.** Changes to the natural processes that would increase shoreline flooding and erosion.
- **d.** Impacts on physical and visual access to the water.
- **e.** Impacts upon historic, archaeological, cultural, or scenic resources.
- **f.** Interference with existing water-dependent uses.

4. **C-W-25 Standards.** The C-W-25 waterfront yard type is intended for intensely urbanized waterfronts, typically characterized by an existing bulkhead, breakwall, embankment, or wharf along the shore, enabling public engagement with the water's edge. The following standards apply to this type:

- **a.** A waterfront yard of a minimum depth of 25 feet is required along the shoreline.

5. **C-W-100 Standards.** The C-W-100 waterfront yard type is intended for less urbanized waterfronts, where a shoreline buffer of native vegetation protects and restores wildlife habitat and ecosystem services. The following standards apply to this type:

- **a.** A waterfront yard of a minimum depth of 100 feet is required along the shoreline. As part of major site plan review, per Section 11.3.7, the City Planning Board may adjust the depth of the required waterfront yard to include contiguous sensitive areas, such as steep slopes, erodible soils, wetlands, or floodplains,

where it finds that development in these areas will adversely affect the water quality of the water body.

b. A shoreline buffer, consisting of undisturbed native or naturalized vegetation, must be provided for a minimum depth of 50 feet from the mean high water line. Grading, filling, excavation, clear cutting, and removal of vegetative cover are prohibited within this shoreline buffer, except in the following instances:

i. To implement erosion and flood control measures.

ii. To facilitate a water-dependent use.

iii. To control noxious or invasive vegetation.

iv. To implement green infrastructure best management practices (BMPs).

v. To undertake activities related to environmental remediation.

vi. To undertake activities related to the protection or restoration of shoreline buffers, wetlands, or sensitive habitats.

B. Shore Public Walkways

1. The provision of a shore public walkway, which is a linear public access area running alongside the shore and accessible to the public, is encouraged wherever new development occurs.

2. A shore public walkway should be designed as a multi-use path, connected to adjacent shore public walkways and public rights-of-way, where possible, in accordance with the Manual on Uniform Traffic Control Devices (MUTCD), plus New York State Supplement, and the AASHTO Guide for the Development of Bicycle Facilities.

3. Public access easements may be dedicated to ensure public access to and along a shore public walkway.

C. Outer Harbor Review Area

1. The Outer Harbor boundaries are defined, as follows:

a. Beginning at the southern shoreline of the mouth of the Buffalo River where it meets Lake Erie and proceeding southerly along the City Ship Canal until reaching the southern extent of the City Ship Canal, then proceeding southerly to the southeastern corner of the former NFTA Terminal buildings property, then proceeding westerly until reaching the western extent of the former NFTA Terminal buildings property, then proceeding northerly along the Lake Erie shoreline until intersecting with the southern shoreline of mouth of the Buffalo River.

2. Attached house and detached house building types are prohibited within the Outer Harbor.

3. Except for Open Space, any proposed use (as permitted per Table 6A) within the Outer Harbor may be permitted only with a special use permit, subject to the following additional criteria:

a. The proposed use will incorporate opportunities for visual and physical access to the waterfront for site users and the public.

b. The proposed use will conserve environmentally sensitive and naturalized areas.

c. The proposed use will not cause a decrease in vitality or an increase in vacancy in established employment centers within the City of Buffalo.

d. The proposed use will provide for an efficient use of land that responds to the existing infrastructure, utilities, and service conditions in order to minimize, to the extent practicable, the demand for additional municipal services, utilities, and infrastructure.

D. **Supplemental Form Standards.** The following standards apply to waterside facades and building frontages along the waterfront yard, with the exception of single-unit or double-unit dwellings, which are exempt from these standards.

1. A waterside facade must comply with front facade transparency, pedestrian access, vertical and horizontal articulation, and materials requirements of the underlying zone, if any.

2. Where practicable, a waterside facade must be oriented to the shoreline and positioned parallel or radial to the mean high water line.

E. **Supplemental Use Standards**

1. The following uses are subject to additional standards if located within the C-W zone:

a. Car wash. Refer to Section 6.1.5.F.

b. Gas station. Refer to Section 6.1.5.M.

c. Off-premise signs. Refer to Section 9.3.1.B.

2. The following uses are prohibited within the C-W zone:

a. Adult establishment. Refer to Section 6.1.5.A.

b. Junk/salvage yard. Refer to Section 6.1.6.D.

c. Recycling facility. Refer to Section 6.1.6.F.

d. Waste transfer Station. Refer to Section 6.1.6.J.

e. Truck stop. Refer to Section 6.1.8.O.

f. Electronic Message Centers (9.1.5.B)

F. **Encroachments.** No structure may be erected, or any other encroachment established, within 40 feet of the mean high water line of any navigable waters of the City of Buffalo without written permission from the Commissioner of Public Works, Parks, and Streets, in accordance with § 495-16 of the City Code.

G. **Consistency Review.** All development within the C-W zone must also comply with the standards and procedures of the Local Waterfront Consistency Review Ordinance.

D. Letters of Support