Watershed Characterization Report

for the

The Black River Watershed Management Plan

This document was prepared for the New York State Department of State Division
of Coastal Resources with funds provided under Title 11 of the Environmental Protection Fund.

TABLE OF CONTENTS

Black River Watershed Management Plan
CHARACTERIZATION REPORT

1.1. INTRODUCTION 1

1.2. STUDY AREA DELINEATION 2

- 1.2.1. The Watershed 2
- 1.2.2. Subwatersheds 2

1.3. PLANNING CONSIDERATIONS 3

- 1.3.1. Development Trends 3
- 1.3.2. Regional Planning 7

1.4. PHYSICAL CHARACTERISTICS OF THE WATERSHED 8

- 1.4.1. Land Use and Land Cover 8
- 1.4.2. Topography 16
- 1.4.3. Hydrology 18
- 1.4.4. Natural Resources 29

1.5. IMPAIRMENTS AND THREATS 46

- 1.5.1. Introduction 46
- 1.5.2. Threats to the Black River Watershed 46

ENDNOTES 53

TABLE OF CONTENTS

Black River Watershed Management Plan
CHARACTERIZATION REPORT

List of Tables and Figure*

Table 1. Communities of the Black River Watershed	Page 2
Table 2. Subwatersheds of the Black River Watershed	Page 3
Table 3. Historic and Projected Population for Watershed Counties	Page 4
Table 4. Historic and Projected Population for Watershed and Subwatersheds	Page 5
Table 5. Projected Population and Urban Area Change, 2000 to 2020	Page 6
Table 6. Projected Land Cover Change, 2001 to 2020	Page 7
Table 7. Black River Watershed Land Use	Page 9
Table 8. Land Use Type Descriptions	Page 10
Table 9. NYSDEC Lands	Page 12
Table 10.Land Cover, Black River Watershed, 2001	Page 12
Table 11.Land Cover Type Descriptions	Page 13
Table 12.Land Cover Change, 1992 to 2001	Page 14
Table 13.Soil Hydrologic Group	Page 16
Table 14.Elevations	Page 17
Table 15.Climate Data, 1971 to 2000	Page 18
Table 16.Average Annual Precipitation by Subwatershed	Page 19
Table 17.Discharge and Recurrence Intervals	Page 20
Table 18.Discharges for Selected Recurrence Intervals	Page 21
Table 19.Annual Mean Flow	Page 22
Table 20.Steep Slopes	Page 23
Table 21.Wetland Habitats	Page 25
Table 22.Aquifers	Page 27
Table 23.Class A and AA Streams	Page 28
Figure 1. Change to Urban Land Areas, 1992 to 2001	Page 15

** Please note additional Tables and all Maps are included in a supplemental document, entitled "Black River Watershed Management Plan Characterization Report Appendices."*

1.1. INTRODUCTION

The Black River Watershed Characterization Report examines the existing conditions of the Black River watershed, incorporating summaries of the physical conditions of the natural and built environments. The character of the watershed has undergone a myriad of changes over the last century, some beneficial and some detrimental, with many implications to the physical environment. The Characterization Report looks at how shifts in key industry sectors, agricultural practices, changes to population centers, development patterns, and technology have, and will likely continue to, impact the natural resources and water quality within the watershed.

The Black River Watershed Characterization Report includes the following key components:

- Identification and discussion of watershed boundaries, at both the watershed and the subwatershed level;
- Physical characteristics of the watershed including land use and cover, topography, hydrology, and natural resources;
- Planning considerations which may have implications on the watershed including population trends, build-out potentials, and related regional planning efforts; and,
- Water quality characteristics, including impairments and threats.

1.2. STUDY AREA DELINEATION

1.2.1. The Watershed

The Black River drains approximately 1.2 million acres of the western slopes of the Adirondack Mountains and the eastern edge of the Tug Hill Plateau before emptying into Lake Ontario near Watertown (see Map 1). The Adirondack portion of the watershed is drained, for the most part, by two large watercourses – the Beaver River and the Moose River – and several smaller tributaries (e.g., Independence River, Otter Creek, Woodhull Creek). The Tug Hill region of the Black River watershed, however, is characterized predominantly by numerous small tributaries flowing over steep slopes.[i] As a whole, there are approximately 4,000 miles of rivers and streams within the watershed, as well as more than 500 lakes and ponds covering approximately 35,000 acres.

Traversed by this 1.2 million acre watershed are portions of five counties – Hamilton County, Herkimer County, Jefferson County, Lewis County, and Oneida County – and their associated cities, towns, and villages (see Map 2). In all, one city (Watertown), 37 towns, and 18 villages are wholly or partially located within the Black River watershed:

Table 1. Communities of the Black River Watershed

Hamilton County	Herkimer County	Jefferson County	Lewis County	Oneida County
Town of Arietta	Town of Ohio	City of Watertown	Town of Croghan	Town of Ava
Town of Inlet	Town of Russia	Town of Brownville	Town of Denmark	Town of Booneville
Town of Lake Pleasant	Town of Webb	Town of Champion	Town of Greig	Town of Forestport
Town of Long Lake		Town of Hounsfield	Town of Harrisburg	Town of Remsen
Town of Morehouse		Town of Le Ray	Town of Lewis	Town of Steuben
Village of Speculator		Town of Pamelia	Town of Leyden	Village of Booneville
		Town of Rutland	Town of Lowville	
		Town of Watertown	Town of Lyonsdale	
		Town of Wilna	Town of Martinsburg	
		Town of Worth	Town of Montague	
		Village of Black River	Town of New Bremen	
		Village of Brownville	Town of Pinckney	
		Village of Carthage	Town of Turin	
		Village of Deferiet	Town of Watson	
		Village of Dexter	Town of West Turin	
		Village of Glen Park	Village of Castorland	
		Village of Herrings	Village of Constableville	
		Village of West Carthage	Village of Copenhagen	
			Village of Croghan	
			Village of Lowville	
			Village of Lyons Falls	
			Village of Port Leyden	
			Village of Turin	

1.2.2. Subwatersheds

Subwatersheds are those areas from which groundwater and surface water drain and contribute to the flow of a larger watershed or drainage basin. Nineteen subwatersheds comprise the Black River watershed (see Map 3). Table 1 provides a list of the subwatersheds, as well as the size, relative percent cover, and HUC-11 (Hydrologic Unit Boundary) identification numbers for each. Developed by the U.S. Geological Survey (USGS), hydrologic unit boundaries provide a hierarchical method for delineating and identifying drainage basins to ensure a working, seamless dataset across community lines. Each watershed is assigned a unique hydrologic unit code according to its size and location, with the larger 8-digit sub-basins (e.g., the Black River watershed) subdivided into smaller 11-digit subwatersheds (e.g., the 19 subwatersheds within the Black River watershed).

Table 2. Subwatersheds of the Black River Watershed

SUBWATERSHED	HUC IDENTIFICATION NO.	ACRES	PERCENT OF TOTAL LAND
Beaver Creek	04150101150	98,761	8.1%
Crystal Creek	04150101130	17,085	1.4%
Cummings Creek	04150101030	14,212	1.2%
Deer River	04150101170	62,270	5.1%
Fish Creek	04150101080	14,966	1.2%
Independence River	04150101110	61,074	5.0%
Lower Black River	04150101190	39,532	3.2%
Lower Black Middle River	04150101180	51,985	4.3%
Middle Black River	04150101160	81,353	6.7%
Middle Branch Moose River	---	94,880	7.8%
Mill Creek	04150101120	22,512	1.8%
Moose River	04150101070	46,711	3.8%
Otter Creek	04150101090	42,181	3.5%
South Branch Moose River	04150101050	135,713	11.1%
Stillwater Reservoir	04150101140	109,992	9.0%
Sugar River	04150101040	44,732	3.7%
Upper Middle Black River	04150101100	102,016	8.4%
Upper Black River	04150101020	115,439	9.5%
Woodhull Creek	04150101010	62,661	5.1%
BLACK RIVER WATERSHED	04050101	1,218,075	100%

Source: 11- Digit Hydrologic Unit Boundary GIS Data Layer, NYSDEC

1.3. PLANNING CONSIDERATIONS

1.3.1. Development Trends

POPULATION CHARACTERISTICS

Planning for the future requires a clear understanding of both current conditions and recent trends. An understanding of trends allows community leaders to make informed decisions about future policies and land use decisions. An important trend to consider is population growth or decline.

Population growth is an important indicator of watershed health – too much growth can strain resources within the watershed and may result in an increase in both point and non-point source pollution. Additionally, associated increases in housing developments, roads, shopping areas, and commercial and industrial facilities increases the amount of impervious surface and often results in the removal of native vegetation, resulting in increased occurrences of flooding. Population growth, coupled with limited land use regulation, can also lead to rural sprawl, which reduces critical habitat areas, wetlands, and riparian corridors that in many instances act as filtration systems and provide protection for the waterbodies.

A review of population density maps for the watershed from 1990 to 2000 shows where population shifts have occurred (Maps 4 and 5). While the population density of Herkimer and Hamilton Counties has remained the same, with less than 10 people per square mile, Lewis County has seen an increase in population densities in a number of key areas. The population densities of the Independence River, Otter Creek, Fish Creek, and Moose River subwatersheds have experienced population density increases from under 10 people per square mile to between 10 and 50 people per square mile. Other increases to population density have also occurred in the areas immediately outside the Town of Lowville. In contrast, farther outlying areas of Lowville, including portions of the Deer River and Mill Creek subwatersheds, have seen their population densities decrease to under 10 people per square mile, suggesting a population shift closer to the County seat.

Today, a majority of the Black River watershed's population is concentrated within the Black River valley (see Map 5). In the earliest days of settlement within the region, development occurred along the river valley as this was the primary transportation corridor along the Black River Canal system, connecting the river and the communities along it with the Erie Canal to the south and Watertown to the north. In addition to commerce and transport, the Black River also provided opportunities for hydropower in certain locations and the fertile floodplain offered prime agricultural lands.

As previously noted, five counties are traversed by the Black River watershed – Hamilton, Herkimer, Jefferson, Lewis, and Oneida. To gain an understanding of the watershed's population trends, historic and projected population data was investigated. Data collected from the Cornell University Program on Applied Demographics (see Table 3), the total population of these five counties is projected to decrease by almost seven percent from 2000 to 2020 (Year 2020 is the full build-out date for this plan). Additionally, although Jefferson County is expected to gain in total population from 2000 to 2020, it is projected that the County will actually begin to depopulate beginning in 2015 and continuing into 2020. The sparsely populated Hamilton County, located entirely within the Adirondack Park, is expected to lose almost 15 percent of its population from 2000 to 2020.

Table 3. Historic and Projected Population for Watershed Counties

COUNTY	YEAR					PERCENT CHANGE (1990 to 2020)
	2000	2005	2010	2015	2020	
Hamilton	5,379	5,196	5,055	4,843	4,576	-14.9%
Herkimer	64,427	63,597	62,346	60,622	58,491	-9.2%
Jefferson	111,738	115,536	116,157	115,722	114,717	2.7%
Lewis	26,944	26,506	26,168	25,594	24,797	-8.0%
Oneida	235,469	233,969	226,880	219,490	211,544	-10.2%
TOTALS	445,957	446,809	438,616	428,286	416,145	-6.7%

Source: Cornell University Program of Applied Demographics

To determine the approximate year 2000 population for each subwatershed, data was collected from the U.S. Census Bureau at the block group level. Block group population data was then applied to the appropriate subwatershed using a weighted average based on the percent of a given block group within each subwatershed. Subsequent to calculation of subwatershed populations for year 2000, county-level rates of population change were determined and applied to each subwatershed to determine the projected population for year 2020. The results of this analysis are provided in Table 4.

Table 4. Historic and Projected Population for Black River Watershed and Subwatersheds

SUBWATERSHED	POPULATION		POPULATION CHANGE (2000 to 2020)	PERCENT CHANGE (2000 to 2020)
	2000	2020		
Beaver Creek	2,674	2,460	-214	-8.0%
Crystal Creek	1,013	932	-81	-8.0%
Cummings Creek	544	489	-55	-10.1%
Deer River	1,816	1,672	-144	-7.9%
Fish Creek	309	284	-25	-8.1%
Independence River	657	604	-53	-8.1%
Lower Black River	26,285	26,986	701	2.7%
Lower Black Middle River	11,156	11,396	240	2.2%
Middle Black River	7,284	6,704	-580	-8.0%
Middle Branch Moose River	1,155	1,036	-119	-10.3%
Mill Creek	1,066	981	-85	-8.0%
Moose River	892	820	-72	-8.1%
Otter Creek	550	506	-44	-8.0%
South Branch Moose River	426	371	-55	-12.9%
Stillwater Reservoir	307	271	-36	-11.7%
Sugar River	2,030	1,858	-172	-8.5%
Upper Middle Black River	5,499	5,033	-466	-8.5%
Upper Black River	3,278	2,948	-330	-10.1%
Woodhull Creek	766	689	-77	-10.1%
BLACK RIVER WATERSHED	67,707	66,040	-1,667	-2.5%

Source: U.S. Census Bureau; Cornell University Program of Applied Demographics

While the raw population numbers provide an indication of the current and projected population levels within the watershed, more important is population change as it is indicative of potential future impacts to each subwatershed. As is depicted in Table 3, several interesting population trends are occurring within the watershed study area. First, the population of the entire watershed is projected to decrease by approximately 1,667 people, or 2.5 percent. Most of this loss will occur in three subwatersheds, all of which are located in the heavily populated areas of the Black River valley (predominantly in Lewis County):

- The Middle Black River subwatershed;
- The Upper Middle Black River subwatershed; and
- The Upper Black River subwatershed.

Only two subwatersheds are projected to increase in population by 2020 – the Lower Black River and Lower Middle Black River subwatersheds. Both subwatersheds are located predominantly in Jefferson County, in the vicinity of the Village of Carthage, the City of Watertown, and Fort Drum.

BUILD-OUT ANALYSIS

Build-out analysis was used to evaluate potential future development intensities and patterns within the Black River watershed, as well as the 19 subwatersheds, at Year 2020. As previously noted, development intensities and patterns can play a significant role in water quality and overall watershed health. Thus, evaluating potential future development impacts is a crucial step in defining and developing the appropriate tools to improve and maintain ecosystem health.

For the purposes of this analysis, build-out refers to the amount of land cover classified as urban in 2020. A detailed discussion and explanation of land classifications can be found in Table 11. Note that urban lands are defined as all developed areas, from high intensity areas where people reside or work in high numbers, to open areas with a mixture of some constructed materials and vegetation in the form of lawn grasses and does not necessarily refer to urban city development.

The analysis was based on the projected populations for each of the subwatersheds and the relationship between population change and amount of land classified as urban. The first step in this analysis was to determine the change in lands classified as urban from 2001 to 2020 based on the projected change in population for those same years (see Table 5).

Table 5. Projected Population and Urban Area Change, 2000 to 2020

SUBWATERSHED	POPULATION CHANGE (2000-2020)	URBAN ACRES CHANGE (2000-2020)
Beaver Creek	-214	-151
Crystal Creek	-81	-23
Cummings Creek	-55	1
Deer River	-144	-84
Fish Creek	-25	30
Independence River	-53	3
Lower Black River	701	722
Lower Black Middle River	240	282
Middle Black River	-580	-500
Middle Branch Moose River	-119	-60
Mill Creek	-85	-27
Moose River	-72	-15
Otter Creek	-44	11
South Branch Moose River	-55	1
Stillwater Reservoir	-36	20
Sugar River	-172	-111
Upper Middle Black River	-466	-391
Upper Black River	-330	-261
Woodhull Creek	-77	-20
BLACK RIVER WATERSHED	-1,667	-573

Once the change in urban area was calculated for each subwatershed, this value was applied to the land cover values for 2001. As the total area for each subwatershed cannot change, any change to the amount of land classified as urban must result in changes to the remaining land cover types (e.g., forest, agriculture). To determine how the remaining land cover types changed as a result of changes in the amount of land classified as urban, rates of change were calculated for each cover type for each subwatershed for years 1992 to 2001. These rates were then used to determine the projected land cover values for year 2020 for the entire Black River watershed, as well as the 19 subwatersheds. Table 10 provides the projected land cover values for year 2020 for the Black River watershed.

Table 6. Projected Land Cover Change, 2001 to 2020

LAND COVER TYPE	TOTAL ACRES (2001)	TOTAL ACRES (2020)	ACRES CHANGE	PERCENT CHANGE
Open water	45,874	45,861	-13	0.0%
Agriculture	142,335	142,473	138	0.1%
Urban	20,806	20,233	-573	-2.8%
Barren Land	1,665	1,664	-1	0.0%
Forest	699,546	699,948	402	0.0%
Grassland / Shrub	95,528	95,528	0	0.0%
Wetlands	212,320	212,367	48	0.1%
Total	1,218,075	1,218,075	--	--

Source: 2001 National Land Cover Data, Multi-Resolution Land Characteristics (MRLC) Consortium

Although the watershed as a whole is projected to lose more than 570 acres of urban/developed area from 2001 to 2020, eight of the nineteen subwatersheds are projected to realize an increase in the amount of lands classified as urban within their drainage basins:

- Lower Black River subwatershed – 722 acre increase (9.9 percent increase)
- Lower Middle Black River subwatershed – 282 acre increase (7.7 percent increase)
- Fish Creek subwatershed – 30 acre increase (187.5 percent increase)
- Stillwater Reservoir subwatershed – 20 acre increase (32.3 percent increase)
- Otter Creek subwatershed – 11 acre increase (34.4 percent increase)
- Independence River subwatershed – 3 acre increase (20 percent increase)
- Cummings Creek subwatershed – 1 acre increase (2.5 percent increase)
- South Branch Moose River subwatershed – 1 acre increase (0.4 percent increase)

1.3.2. Regional Planning

REGIONAL PLANNING AGENCIES

In addition to the 61 units of government within the watershed, the study area also falls within the purview of three regional planning bodies:

- The Tug Hill Commission;
- The Adirondack Park Agency; and
- The Fort Drum Regional Liaison Organization.

Originally established in 1972 as a temporary body, the Tug Hill Commission (THC) was created to enable local governments, private organizations, and individuals to shape the future of the Tug Hill Region. The non-regulatory THC provides technical assistance to 62 local governments, economic development organizations, and other local groups in the areas of land use planning, community economic development, and natural resource management. The THC also provides training and information for local officials through workshops and issues papers on a variety of topics.

The Adirondack Park Agency (APA) was created in 1971 by the State Legislature to develop and administer long-range plans for both public and private lands within the Adirondack Park. The primary purpose of the APA is to insure conservation, protection, preservation, development and use of the unique scenic, aesthetic, wildlife, recreational, open space, historic, ecological and natural resources of the Park. Additionally, the APA is responsible for developing long-range park policy that takes into consideration the needs of the entire state. In contrast to the Tug Hill Commission, the APA is a regulatory body that strives to ensure that current and projected future pressures on the park's resources are provided for in a land use plan that recognizes matters of local concern, as well as those of the surrounding region and New York State.

The Fort Drum Regional Liaison Organization (FDRLO) fills a range of roles including the promotion and integration of Fort Drum activity with community and business development outside the base (since its creation, the FDRLO has sponsored numerous studies to define how Fort Drum can complement the region's economy, ranging from the Fort Drum economic impact update to military housing in the community, and even including joint-use airport options). Most recently, the FDRLO conducted a study to identify and explore ways to improve the quality of jobs in the North Country by leveraging opportunities associated with national changes in how the military procures contracts and services from private business.

REGIONAL PLANNING INITIATIVES

There is currently an unprecedented number of planning efforts underway within the Black River Watershed, ranging from local municipal projects to larger regional-based initiatives. The implementation of these initiatives could have implications on the watershed and should be considered and monitored to determine what potential impacts may be, and how they may be mitigated. In addition to over fifty locally-led municipal projects ranging from Main Street plans to infrastructure improvements to recreation planning, there are a series of regional planning initiatives occurring, at least in part, within the watershed study area:

- Black River Blueway Trail
- Fort Drum Growth Management Initiative
- Four Town Comprehensive Plan
- Lewis County Comprehensive Plan
- Maple Ridge Wind Farm
- Route 28 Corridor Revitalization Study
- Watertown to Black River Recreational Trail
- Old Forge to Maine Canoe Trail
- Black River Scenic Byway
- Olympic Scenic Byway
- Maple Traditions Scenic Byway
- Adirondack Scenic Byway
- TOBIE Trail Extension
- RACOG Land Use Review and Comprehensive Plan

Planning documents relevant to the watershed study area will be reviewed and considered more closely in latter phases of the Management Plan process.

1.4. PHYSICAL CHARACTERISTICS OF THE WATERSHED

1.4.1. Land Use and Land Cover

Land use refers to how the land is used, often has a political dimension, and is primarily defined at the parcel level (i.e., only one use is assigned to each parcel).[ii] Land use categories consist of general descriptions such as residential and commercial, as well as more detailed information including the type of residential or commercial use (e.g., single-family residential or highway commercial.)Land cover, however, describes both the vegetative and man-made features that characterize a particular area and reflects "the climate, topography, soils, geology, and other environmental features that have made various types of land use possible, and shaped settlement patterns and current economic activities".[iii] Land cover is determined based on the interpretation of aerial photography and is not constrained by parcel boundaries (i.e., one parcel could consist of multiple cover types). Examples of land cover types include forest, urban, or wetland, all of which can be further divided into more detailed subcategories (e.g., deciduous forest versus evergreen forest). Both land use and land cover are primary drivers affecting water quality, exerting considerable influence on the chemical, physical, and biological characteristics of waterbodies.[iv] Agricultural land uses, as well as the built environment, often produce non-point source pollution (e.g., sediments, nutrients) through runoff, which negatively impacts water quality and results in changes in aquatic community structure and degradation of stream biota. Additionally, the infiltration rate for rainwater and snowmelt (i.e., the rate at which the soil is able to absorb water) is determined according to land cover and the amount of impervious surface, with higher infiltration rates typically associated with natural land cover types (e.g., forest, grassland). Removing natural land cover types diminishes the soil's ability to absorb nutrients and trap sediments, resulting in increased amounts of pollution washing into surface waterbodies. Thus, understanding land use and land cover, particularly how these factors change over time, is critical to assessing regional ecosystem impacts and developing the tools necessary to protect watershed health.[v]

LAND USE

More than 53,000 parcels comprise the Black River watershed (see Map 6 and Table 7). The most predominant uses, in terms of total acreage, are those parcels classified as Wild, Conservation, Forest, & Parks, comprising almost 60 percent (722,347 acres) of the total watershed land area (see Table 8 for a description of each land use category). Additionally, of these more than 700,000 acres, approximately 82 percent (590,821 acres) are located within the Adirondack Park Blue Line. Also worth noting is the considerable amount of land classified as State Owned Forest Lands – approximately 55.7 percent (400,339 acres) of all Wild, Conservation, Forest, & Parks lands, or 32.7 percent of all land within the watershed. In terms of water quality, forested watersheds typically produce some of the highest quality water in the nation.[vi] Deep-rooted trees and their complex root systems stabilize the soil, thus decreasing erosion, particularly along riparian areas. Trees also reduce runoff through the interception of rainfall and enhancement of the evaporative process (i.e, direct evaporation or evapotranspiration).[vii]

Table 7. Black River Watershed Land Use

LAND USE CLASSIFICATION	NUMBER OF PARCELS	PERCENT OF TOTAL	TOTAL ACRES	PERCENT COVER
Agriculture	3,076	5.7%	172,066	14.1%
Residential	28,353	52.6%	185,490	15.2%
Vacant	11,607	21.5%	84,767	7.0%
Commercial	2,178	4.0%	5,247	0.4%
Recreation and Entertainment	198	0.4%	6,642	0.5%
Community Services	705	1.3%	6,426	0.5%
Industrial	188	0.3%	4,138	0.3%
Public Services	634	1.2%	11,595	1.0%
Wild, Conservation, Forest and Parks	4,820	8.9%	722,347	59.3%
No Data	2,186	4.1%	19,358	1.6%
TOTAL	53,945	100%	1,218,075	100%

Source: Property Parcel GIS Data provided by Hamilton, Herkimer, Jefferson, Lewis, and Oneida Counties

As previously noted, 19 subwatersheds comprise the larger Black River watershed. Of these 19 subwatersheds, five have less than 20 percent of their land classified as Wild, Conservation, Forest, & Parks:

- Lower Black River subwatershed – 1.4 percent (545 acres)
- Mill Creek subwatershed – 4.3 percent (976 acres)
- Lower Middle Black River subwatershed – 6.9 percent (3,574 acres)
- Sugar River subwatershed – 12.1 percent (5,402 acres)
- Middle Black River subwatershed – 13.4 percent (10,908 acres)

Additionally, five of the 19 subwatersheds have more than 80 percent of their land classified as Wild, Conservation, Forest, & Parks (note that these five subwatersheds are predominately located within the Adirondack Park and comprise approximately 50 percent of all lands classified as Wild, Conservation, Forest, & Parks):

- South Branch Moose River subwatershed – 97.2 percent (131,963 acres)
- Otter Creek subwatershed – 93.5 percent (39,436 acres)
- Moose River subwatershed – 90.0 percent (42,028 acres)
- Stillwater Reservoir subwatershed – 86.5 percent (95,091 acres)
- Woodhull Creek subwatershed – 80.1 percent (50,176 acres)

Table 8. Land Use Type Descriptions

Agriculture	Property used for the production of crops or livestock
Residential	Property used for human habitation. Living accommodations such as hotels, motels, and apartments are in the Commercial category
Vacant	Property that is not in use, is in temporary use, or lacks permanent improvement
Commercial	Property used for the sale of goods and/or services, including hotels, motels, and apartments
Recreation & Entertainment	Property used by groups for recreation, amusement, or entertainment
Community Services	Property used for the well being of the community
Industrial	Property used for the production and fabrication of durable and nondurable man-made goods
Public Services	Property used to provide services to the general public
Wild, Forested, Conservation Lands & Public Parks	Reforested lands, preserves, and private hunting and fishing clubs

Source: Property Classification Codes, NYS Office of Real Property Services (http://www.orps.state.ny.us/assessor/manuals/vol6/ref/prclas.htm)

Residential uses, comprising approximately 15 percent (185,490 acres) of the watershed, are primarily distributed along the periphery of the agricultural belt that follows the Black River, as well as adjacent to and within the watershed's numerous villages and hamlets. Some of the densest areas of residential development, however, are located in the northwest portion of the watershed in Carthage and Watertown. Residential land uses range from low-density single-family homes on large lots in rural areas to high-density multi-family apartment buildings in more urban areas, with an average residential parcel size of 6.4 acres.

Approximately 40 percent of all residential land use occurs in five subwatersheds, of which four are located within, or along the periphery of the Black River valley:

- Middle Branch Moose River subwatershed – 24,415 acres (25.7 percent of subwatershed land area)
- Lower Middle Black River subwatershed – 17,185 acres (33.1 percent of subwatershed land area)
- Independence River subwatershed – 16,016 acres (26.2 percent of subwatershed land area)
- Lower Black River subwatershed – 12,004 acres (30.4 percent of subwatershed land area)
- Crystal Creek subwatershed – 4,672 acres (27.3 percent of subwatershed land area)

This has important implications for watershed health as the use of septic tanks, sewage disposal systems, fertilizers and pesticides for lawn care, and runoff from driveways and parking lots in residential areas can all negatively affect water quality. [viii]

Agricultural lands make up the third largest category of uses, with more than 172,000 acres (14.1 percent) located within the Black River watershed. As depicted in Figure 5, agriculture uses are concentrated primarily within the Black River valley, from the Lewis-Oneida County line northwest to Lake Ontario. Of the approximately 172,000 acres of agricultural use, almost half (43.4 percent, or 74,761 acres) is within the Middle Black River and Upper Middle Black River subwatersheds. As previously noted, agricultural land uses produce nonpoint source pollution in the form of soil erosion and sedimentation, nutrients, and pesticides. Irrigation practices associated with agriculture can also negatively impact water quality.

Thus, in terms of water quality, three subwatersheds comprise a considerable portion of their land in agricultural uses:

- Mill Creek subwatershed – 75.4 percent (16,980 acres)
- Middle Black River subwatershed – 57.7 percent (46,938 acres)
- Sugar River subwatershed – 43.6 percent (19,524acres)

Almost one-half (79,973 acres) of all agriculture practiced within the watershed is directly related to livestock and its associated products This has important watershed management implications as the placement of livestock farming operations can severely impact water quality. Most livestock-related agriculture (53.5 percent or 42,778 acres) occurs in three of the nineteen subwatersheds:

- Middle Black River subwatershed – 21,864 acres (26.9 percent of subwatershed)
- Upper Middle Black River subwatershed –12,935 acres (12.7 percent of subwatershed)
- Mill Creek subwatershed – 7,979 acres (35.4 percent of subwatershed)

Worth additional note is the amount of land within the Black River watershed owned, or under the management of the New York State Department of Environmental Conservation (NYSDEC) (see Map 7 and Table 9). Almost 470,000 acres (38.5 percent) of the watershed comprises NYSDEC lands, most of which are located within the Adirondack Park. More specifically, Forest Preserve-Wild Forest and Forest Preserve-Wilderness make up the largest share of NYSDEC lands at 418,897 acres, or 89.6 percent of all NYSDEC lands. Wilderness lands are those areas of state land "having a primeval character, without significant improvement or protected and managed so as to preserve, enhance and restore, where necessary, its natural conditions".[ix] Wild Forests, however, allow for a higher degree of human use than do wilderness lands while retaining an essentially wild character. Appendix 2, Table 1 provides a detailed breakdown of land uses by subwatershed.

Table 9. NYSDEC Lands

DEC LAND CLASSIFICATION	ACRES
Administrative	1
Fishing Access	60
Forest Preserve	1,624
Forest Preserve – Intensive Use	1,085
Forest Preserve – Primitive	211
Forest Preserve – Wild Forest	260,111
Forest Preserve – Wilderness	159,786
State Forest	41,793
Waterway Access	34
Wildlife Management	3,733
TOTAL	468,437

Source: DEC Lands GIS Data Layer, NYSDEC

LAND COVER

Using data provided by the Multi-Resolution Land Characteristics (MRLC) Consortium (an association of nine federal agencies), land cover types from 2001 were mapped for the Black River watershed. As depicted in Map 8, seven general land cover types comprise the watershed – open water, agriculture, urban, barren land, forest, grassland/shrub, and wetlands. Much of the watershed's agricultural production is limited to the Black River valley, while urban development occurs in small nodes throughout the valley and in areas immediately adjacent to the Black River. Forested and wetland areas, however, occur primarily within the Adirondack Park Blue Line, as well as towards the higher elevations of the Tug Hill Plateau.

Table 10. Land Cover, Black River Watershed, 2001

LAND COVER TYPE	TOTAL ACRES	PERCENT COVER
Open Water	45,874	3.8%
Agriculture	142,335	11.7%
Urban	20,806	1.7%
Barren Land (rock, sand,clay)	1,665	0.1%
Forest	699,546	57.4%
Grassland / Shrub	95,528	7.8%
Wetlands	212,320	17.4%
Open Water	1,218,075	100%

Source: 2001 National Land Cover Data, Multi-Resolution Land Characteristics (MRLC) Consortium

Based on the data provided in Table 5, forest comprises almost 700,000 acres and is the single largest land cover type in the watershed (57.4 percent of total area). Wetland and agricultural areas are the next largest cover types, comprising approximately 212,320 acres (17.4 percent) and 142,335 acres (11.7 percent), respectively. Areas classified as urban account for only 1.7 percent, or 20,806 acres, of land in the Black River watershed.

At the subwatershed level, the Lower Black River subwatershed has both the highest rate of urban area (18.5 percent or 7,308 acres) and the lowest rate forest cover (16.5 percent or 6,507 acres), while the South Branch Moose River subwatershed contains more than 103,000 acres of forest cover, or 76.5 percent of its total land area.

Table 11. Land Cover Type Descriptions

Open Water	all areas of open water, generally with less than 25 percent cover or vegetation or soil comprise this cover type
Agriculture	this represents areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle, as well as areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Pasture/hay or area crop vegetation accounts for greater than 20 percent of total vegetation
Urban	this represents all developed areas, from high intensity areas where people reside or work in high numbers, to open areas with a mixture of some constructed materials and vegetation in the form of lawn grasses and impervious surfaces less than 20 percent of total cover
Barren Land	barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15 percent of total cover
Forest	all areas dominated by trees generally greater than 5 meters tall, and greater than 20 percent of total vegetation cover comprise this cover type
Grassland/Shrub	this includes areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20 percent of total vegetation, including true shrubs, young trees in an early successional stage or trees stunted from environmental conditions. This category also includes areas dominated by grammanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing
Wetlands	areas where forest or shrub land vegetation accounts for greater than 20 percent of vegetative cover, or where perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover, and the soil or substrate is periodically saturated with or covered with water

Source: 2001 National Land Cover Data, Multi-Resolution Land Characteristics (MRLC) Consortium

Appendix 2, Table 2 provides a detailed breakdown of land cover types by subwatershed.

Land Cover Change, 1992 to 2001

In addition to mapping Black River watershed land cover types for 2001, MRLC data was also used to determine changes to land cover from 1992 to 2001. As with population, examining how land cover changes over time can provide a better understanding of the potential future impacts facing the watershed. Note that each land cover category both lost and gained acreage from 1992 to 2001. For example, one farm that allows its lands to revert to a more natural vegetative state would result in the loss of agricultural land within the watershed, while one farm that converts forest to agriculture would result in the gain of agricultural land within the watershed. The resulting net acres of change is a combination of these losses and gains. Table 12 provides a summary of the acres lost, acres gained, and net change for each category.

Table 12. Land Cover Change, 1992 to 2001

LAND COVER TYPE	ACRES LOST	ACRES GAINED	NET ACRES (1992 TO 2001)	PRESENT CHANGE (1992 TO 2001)
Open Water	1,398	3,759	2,361	4.9%
Agriculture	711	3,874	3,162	2.2%
Urban	232	1,260	1,028	4.7%
Barren Land (rock, sand, clay)	4	168	164	9.0%
Forest	9,532	1,272	-8,260	-1.2%
Grassland / Shrub	0	3,524	3,524	3.6%
Wetlands	5,540	3,557	-1,983	-0.9%

Source: 1992-2001 Land Cover Change Data, Multi-Resolution Land Characteristics (MRLC) Consortium

In terms of net change, only two land cover types realized a net loss, with forested areas realizing the biggest decline from 1992 to 2001 with more than 8,200 acres lost. This loss, however, represents a loss of only 1.2 percent of total forest cover in the watershed. Further analysis indicated that forested areas lost the greatest proportion of land to agriculture (3,027 acres, or 32 percent of acres lost). The largest loss of forest cover occurred in the Middle Black River subwatershed (2,408 acres or 8.5 percent of subwatershed forest cover), of which more than 1,400 acres (58.1 percent) of this were lost to agriculture. The Cummings Creek subwatershed, however, lost only six acres (0.1 percent) of its total forest cover from 1992 to 2001. While the loss of forested areas can have considerable water quality implications (forested areas often produce the highest water quality), more important is the conversion of forested areas to agriculture, which often produce some of the lowest water quality.

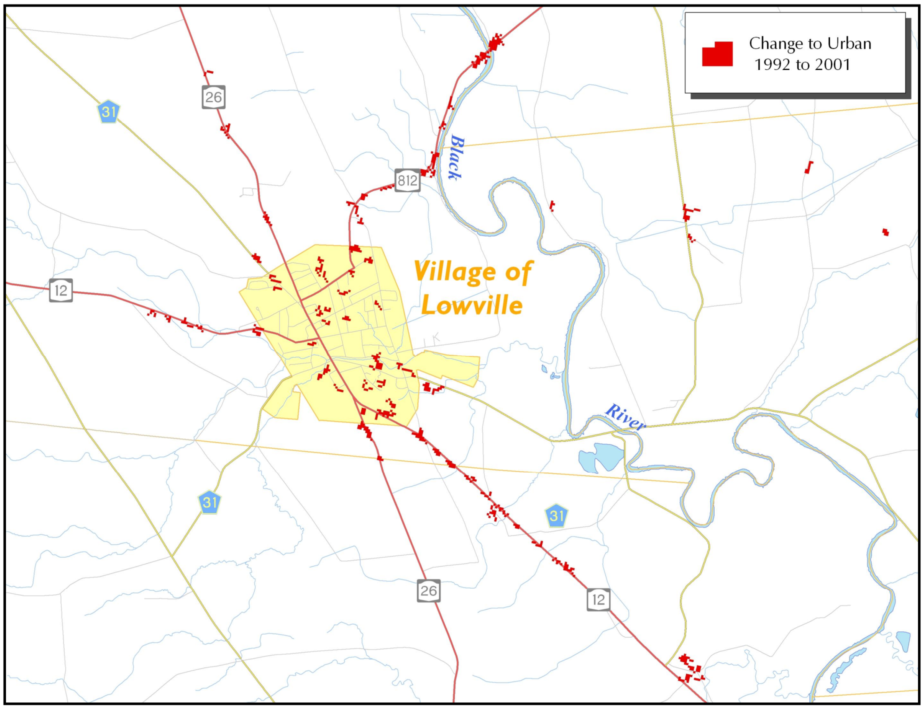
Forest areas also gained acreage from 1992 to 2001 – approximately 940 acres from wetlands and 240 acres from open water. Both of these gains likely resulted from the expansion of the tree canopy over existing wetland and open water areas.

Wetlands lost approximately 1,983 acres (net), or 0.9 percent of the total land area between 1992 and 2001. The largest loss of wetland area was to open water (1,955 acres, or 35.3 percent of acres lost), which likely resulted from the loss of wetland vegetation along streams, lakes, and other waterbodies. It should be noted that wetlands lost to urban areas accounted for only 345 acres, or 6.3 percent of total wetland acres lost. As wetlands provide valuable services in terms of flood storage and pollution filtration, any impacts to these areas can result in impacts to overall water quality and watershed health.

In relative terms, barren lands saw the largest increase in land area (10.9 percent), although in absolute terms this cover type only gained 164 acres. Open water areas also realized a considerable increase in acreage (2,361 net acres, or 5.4 percent) from 1992 to 2001. Further analysis of this change indicated that most of it occurred directly adjacent to existing waterbodies from areas classified as forest or wetland, suggesting that the loss of tree canopy cover and wetland vegetation is primarily responsible.

Finally, the amount of land classified as urban also increased from 1992 to 2001. While urban lands experienced only a minor increase of 5.2 percent (1,028 acres), the population living within the watershed decreased by 2.6 percent, which suggests lower density land development patterns. As an example, much of the increase in urban land area in and around the Village of Lowville occurred along existing transportation corridors, with direct frontage and access. This type of development is the product of simple land subdivision and can often lead to long term land and traffic management problems (see Figure 1).

Figure 1. Change to Urban Land Areas, 1992 to 2001



Source: 1992-2001 Land Cover Change Data, Multi-Resolution Land Characteristics (MRLC) Consortium

The largest increases in urban area occurred in three subwatersheds:

- Lower Black River subwatershed
- Lower Middle Black River subwatershed; and
- Upper Middle Black River subwatershed.

The Lower Black River subwatershed realized the largest gain (353 acres), of which 214 acres were converted from forest cover and 139 acres were converted from wetlands. The next largest gain occurred in the Lower Black River subwatershed (276 acres) – 142 acres from forest cover and 134 acres from wetlands. Finally, the Upper Middle Black River subwatershed gained 118 acres of urban area, of which 81 acres were converted from forest cover and 27 acres were converted from wetlands.

Appendix 2, Table 3 provides a detailed breakdown of land cover change by subwatershed.

1.4.2. Topography

SOILS

The Black River watershed encompasses 28 soil series, of which three comprise approximately 53 percent of the total watershed land area – the Adams series, the Becket series, and the Potsdam series. Soil series characterize groups of soil types aggregated together according to similar pedogenesis (i.e., the process of creating soil), soil chemistry, and physical properties. Each series thus represents broad areas that have a distinctive pattern of soils that perform similarly for land use purposes.

Soils in the Adams series, covering approximately 19.3 percent (234,943 acres) of the watershed, are located primarily along the Black River Valley west of the Black River. "The Adams series consists of very deep excessively drained or somewhat excessively drained soils on outwash plains, terraces, kames, eskers, and lake plains in the Adirondack region. The depth to bedrock is generally more than 6 feet."[x] Comprising approximately 23.7 percent (289,230 acres) of the watershed, the Becket Series consists of very deep, well drained soils on side slopes and hilltops on upland till plains in the Western Adirondack Foothills and Central Adirondacks.[xi] The Potsdam Series, located geographically between the Adams and Potsdam series, consists of very deep, well drained soils on glacial till plains.[xii] The series covers approximately 10.2 percent (124,268 acres) of the Black River Watershed.

Of direct importance to watershed management is the soils ability to absorb precipitation. Accordingly, the Natural Resource Conservation Service has classified soils into four Hydrologic Soil Groups based on the soil's runoff potential – A, B, C, and D. A brief discussion of each group, as well as its relation to the Black River watershed is provided in Table 13 and Map 9.

Table 13. Soil Hydrologic Group

SOIL HYDROLOGIC GROUP	DESCRIPTION	TOTAL ACRES	PERCENT COVER
A	sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.	258,315	21.2%
A/D	combination of A and D	24,144	2.0%
B	silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.	184,507	15.1%
C	sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.	644,709	52.9%
D	clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.	106,401	8.7%
TOTAL		1,218,075	

Source: Natural Resources Conservation Service (NRCS) Soils Website, USDA (http://soils.usda.gov/)

ELEVATIONS

The Black River watershed comprises a wide range of topographies, from generally flat and rolling hills to steep slopes and rocky outcroppings (see Map 10). Elevations within the watershed range from approximately 246 feet above mean sea level to 3,771 feet above mean sea level, with the mean elevation approximating 1,534 feet above mean sea level. Maximum, minimum, and mean elevations for each of the 19 subwatersheds are presented in Table 14.

Table 14. Elevations

SUBWATERSHED	ELEVATION (feet)		
	MINIMUM	MAXIMUM	MEAN
Beaver Creek	720	2,271	349
Crystal Creek	724	1,367	1,034
Cummings Creek	1,021	1,877	1,415
Deer River	720	1,986	1,592
Fish Creek	741	1,662	1,300
Independence River	728	2,351	1,594
Lower Black River	246	1,101	515
Lower Black Middle River	529	1,250	807
Middle Black River	718	1,701	921
Middle Branch Moose River	1,496	2,929	1,918
Mill Creek	727	1,982	1,414
Moose River	799	2,245	1,458
Otter Creek	731	2,355	1,531
South Branch Moose River	1,496	3,771	2,161
Stillwater Reservoir	1,656	2,829	1,894
Sugar River	910	2,032	1,482
Upper Middle Black River	730	2,113	1,310
Upper Black River	1,040	2,704	1,649
Woodhull Creek	1,127	2,404	1,689
BLACK RIVER WATERSHED	246	3,771	1,534

Source: Digital Elevation Models, U.S. Geological Survey

In terms of watershed protection, steep slopes can affect water quality as these areas have a greater tendency for erosion than more gently sloping areas. As is depicted on Map 11, most areas comprising steep slopes are located within the Adirondack Park Blue Line, in Hamilton and Herkimer Counties. A smaller area of steep slopes also occurs towards the upper reaches of the Black River, in the vicinity of Lyons Falls, as the river valley narrows towards the southern portion of Lewis County.

1.4.3. Hydrology

CLIMATE

The climate of the Black River watershed is characterized by long cold winters and short cool summers. As a whole, the climate of the watershed is slightly cooler and realizes more precipitation than the rest of the state, although variations in the local climates do exist (i.e., average temperature, rainfall and snowfall vary locally and are affected by differences in elevation and location relative to mountain ranges, prevailing wind, and local bodies of water).[xiii] Variations in local climate are demonstrated in Table 10. Based on data provided by the National Climatic Data Center, the average annual temperature for the watershed ranges from 40.5 °F to 45.4 °F. With one of the highest annual precipitation rates in New York State, the average annual precipitation for the Black River Watershed ranges from 34.75 inches in Watertown to 59.76 inches in Booneville (see Map 12 and Table 15 for a breakdown of precipitation by subwatershed). Although precipitation is distributed relatively uniformly throughout the year, the majority of annual precipitation occurs during the winter months as snowfall, with some areas receiving as much as 220 inches on average. Additional information on precipitation is provided in the Surface Hydrology section of this report.

Table 15. Climate Data, 1971 to 2000

CLIMATE MONITORING STATION	TEMPERATURE (FAHRENHEIT)			AVERAGE ANNUAL PRECIPITATION (INCHES)	AVERAGE ANNUAL SNOWFALL (INCHES)
	WINTER AVERAGE (JAN)	SUMMER AVAERAGE (JULY)	ANNUAL AVERAGE		
Watertown AP	18.8	68.6	44.7	34.75	92.4
Watertown	18.6	70.2	45.4	42.57	103.4
Old Forge	13.7	64.1	40.5	50.39	194.7
Lowville	17.5	67.8	43.8	41.34	119.2
Bonneville	16.3	66.0	42.4	59.76	220.5
Big Moose	NA	NA	NA	51.36	180.8

Source: National Climatic Data Center
NA = No data recorded

SURFACE HYDROLOGY

As shown in Map 1, the Black River watershed encompasses an area of approximately 1,903 square miles and is located within portions of Hamilton, Herkimer, Jefferson, Lewis, and Oneida Counties. The Black River flows from the Adirondack Mountains northwest into Lake Ontario; the two primary tributaries are the Moose River and the Beaver River. The overall length of the main stream channel is approximately 128.7 miles and flows along an average slope of approximately 0.164 percent. Overall the average watershed slope is moderate at approximately 0.00167 percent. The irregularly shaped drainage basin has a shape index of approximately 0.135, not atypical for major basins in the region. The average watershed width is approximately 952 miles.

In general the overall condition of the Black River can be classified as good. The major water uses include fishing, water contact recreation, aesthetics, municipal water supply, industrial water supply, irrigation, hydropower, and the support of riparian and aquatic habitat. On the Beaver River, the Hudson River – Black River Regulating District operates the Stillwater Reservoir, which has a 10.5-square-mile surface area and a 48-mile shoreline. The reservoir was originally flooded in 1876 to facilitate the logging industry by allowing logs to be floated down the Beaver River. Currently, the primary purpose of the reservoir is flood control for the Black River valley.

On the Moose River, the Regulating District operates the Fulton Chain of Lakes via dams at Old Forge and Sixth Lake. The combined storage capacity of these reservoirs is over forty billion gallons. Together, this network of dams and reservoirs has greatly reduced flooding and remains the source of water flow integral to the hydroelectric generating projects and industrial operations in Jefferson, Lewis, and Herkimer Counties. The Regulating District also owns and maintains a dam at Hawkinsville on the Black River in Oneida County. Other significant hydropower projects on the Black River include those operated by Brookfield Renewable Power at Beebee Island, Niagara Mohawk Power Corporation in Jefferson County, and Black River Limited Partnership in Lewis County.

Table 16. Average Annual Precipitation by Subwatershed

SUBWATERSHED	AVERAGE ANNUAL PRECIPITATION (inches)
Beaver Creek	43.5
Crystal Creek	42.0
Cummings Creek	53.3
Deer River	56.3
Fish Creek	45.0
Independence River	45.0
Lower Black River	38.0
Lower Black Middle River	42.4
Middle Black River	41.4
Middle Branch Moose River	48.2
Mill Creek	52.6
Moose River	45.1
Otter Creek	45.0
South Branch Moose River	53.4
Stillwater Reservoir	46.2
Sugar River	55.7
Upper Middle Black River	50.9
Upper Black River	55.0
Woodhull Creek	55.0
BLACK RIVER WATERSHED	48.7

Source: NYS Average Annual Precipitation GIS Data Layer, Spatial Climate Analysis Service, Oregon State University; USDA - NRCS National Water and Climate Center

As shown in Map 12 and Table 16, mean annual precipitation across the watershed ranges from a high of 65 inches to a low of 35 inches. The low of 35 inches is limited to a very small portion of the watershed downstream from Watertown. The high of 65 inches actually occurs at two different locations. One location is near the eastern-most watershed boundary in Hamilton County and the other location is near the watershed boundary southwest of Lowville in Lewis County. The aerial distribution of the precipitation is a function of the topographic relief and the general eastward-to-northeastward movement of storms. The watershed has a fairly uniform distribution of precipitation during the year, with no distinct rainy or dry season.

At the subwatershed level, the mean annual precipitation varies from a low of 38.0 inches in the Lower Black River to a high of 56.3 inches in Deer River. The mean annual precipitation exceeds 50 inches in a total of eight of the subwatersheds, including Cummings Creek, Deer River, Mill Creek, South Branch Moose River, Sugar River, Upper Middle Black River, Upper Black River, and Woodhull Creek. The eight subwatersheds encompass some 46 percent of the total watershed area.

The average annual snowfall over much of the watershed exceeds 100 inches. Each year, at least some of the snowpack remains unmelted in mid-March. At that time, as much as 10 inches of equivalent rainfall can lie stored in the snowpack. Thus, the greatest potential for flooding occurs during the spring, when substantial, relatively warm rains can cause rapid snow melting and produce significant runoff. As such, nearly half of the average annual runoff occurs from mid-February through mid-May. More local flooding generally occurs from summer thunderstorms in the smaller drainage catchments.

Table 17 summarizes the maximum known discharge and recurrence interval for six locations across the watershed according to data compiled and reported by the USGS. The drainage areas at the six locations range from 1.66 square miles to a maximum of 1,864 square miles. The maximum discharge ranges from 312 cubic feet per second up to 55,500 cubic feet per second. The recurrence intervals range from 50 years to more than 500 years.

Table 17. Discharge and Recurrence Intervals

LOCATION	COUNTY	DRAINAGE AREA	RECORD PERIOD	DATE	DISCHARGE	RECURRENCE INTERVAL
Black River near Boonville	Oneida	304	1911-2007	04-18-82	12,800	>50
Moose River at McKeever	Herkimer	363	1902-1970 1985-2007	06-03-47	18,700	>100
Independence River at Donnattsburg	Lewis	88.7	1928-2007	12-30-84	9,420	>100
Beaver River at Croghan	Lewis	291	1930-2007	05-21-69	5,100	50
Deer River at Deer River	Lewis	94.8	1930-1999	12-29-84	17,200	100
Black River at Watertown	Jefferson	1,864	1921-2007	01-10-98	55,500	>500

Throughout the twentieth century, the Black River watershed has experienced a number of significant flood events, most notably in 1969, 1982, 1984, and 1998. The flood of June 3, 1947 on the Moose River at McKeever was the result of a dam failure. From other rather limited historic information, a significant flood event also occurred on April 23, 1869. On that date, a maximum discharge of 39,700 cubic feet per second was reached on the Black River at Watertown. This discharge has a recurrence interval of approximately twenty-five years. It is interesting to note that significant floods have occurred within the watershed before detailed measurements were taken and systematic records were kept.

Table 18. Discharges for Selected Recurrence Intervals

LOCATION	2-YEAR	10-YEAR	25-YEAR	50-YEAR	100-YEAR	500-YEAR
Black River near Boonville	5,720	9,030	10,900	12,500	14,100	18,400
Moose River at McKeever	7,600	11,600	13,600	15,200	16,800	20,800
Independence River at Donnattsburg	2,090	3,780	4,880	5,820	6,880	9,890
Deer River at Deer River	5,420	9,850	12,600	14,800	17,200	23,700
Black River at Watertown	21,700	31,500	36,600	40,500	44,800	54,500

Table 18 presents the peak discharges in cubic feet per second at six locations for selected recurrence intervals. It should be noted that peak flood stage may be affected by ice cover, ice jams, debris, and other obstructions in the affected channel. For any given recurrence interval, the discharge per unit area is highly variable. For example, the unit discharge for the 2-year flood varies from approximately 10 cubic feet per second to more than 57 cubic feet per second per square mile. Likewise, the unit discharge for the 100-year flood varies from approximately 23 to more than 180 cubic feet per second per square mile. The smaller runoff rates apply to the lower, downstream portion of the watershed, while the highest rates generally apply to the uppermost portions of the watershed as they are subject to higher amounts of rainfall and snowfall.

Based on a preliminary analysis of data from water years 1920 through 2007, the annual mean flow of the Black River at Watertown is approximately 4,212 cubic feet per second. This is equivalent to approximately 30.7 inches of runoff annually. The highest annual mean of 6,392 cubic feet per second is from the 1976 water year, which is more than 51 percent greater than the long term annual mean. The smallest annual mean flow of 2,579 cubic feet per second is from the 1931 water year and is nearly 39 percent less than the long term annual mean. Thus, it is evident that considerable variability exists in the annual mean flow from year to year. The annual seven-day minimum flow is 637 cubic feet per second, recorded on August 15, 1923. Similar statistics are available for other selected locations in the watershed. Preliminary estimates of the annual mean flow at the mouth of each subwatershed is summarized in Table 19.

Table 19. Annual Mean Flow

SUBWATERSHED	SIZE (in acres)	ANNUAL MEAN FLOW (cubic feet per second)
Beaver River	98,761	350
Crystal Creek	17,085	60
Cummings Creek	14,212	50
Deer River	62,270	220
Fish Creek	14,966	53
Independence River	61,074	216
Lower Black River	39,532	140
Lower Middle Black River	51,985	184
Middle Black River	8,153	29
Middle Branch Moose River	94,880	335
Mill Creek	22,512	80
Moose River	46,711	165
Otter Creek	42,181	149
South Branch Moose River	135,713	479
Stillwater Reservoir	109,992	388
Sugar River	44,732	158
Upper Middle Black River	102,016	360
Upper Black River	115,439	408
Woodhull Creek	62,661	221

It should be noted that the New York State Canal Corporation exercises the right to withdraw all but 80 cubic feet per second from the Black River in Oneida County. The limit is intended to protect the downstream fishery. The water is withdrawn from the Alder Pond Reservoir and transported via the Forestport Feeder Canal into the Erie Canal during the navigation season from May 1 through November 1. Because less depth is required during the non-navigation season, the allowable withdrawal is all but 140 cubic feet per second. Thus, during that non-navigation season, the withdrawals are 60 cubic feet per second smaller that they are during the navigations season.

STEEP SLOPES

As a rule, steep slopes are more erosive than flatter slopes. In considering erosive potential, slopes greater than 8 percent are considered to be steep; slopes greater than 15 percent are considered to be very steep. Table 20 summarizes the relative presence of steep slopes within the subwatersheds (also see Map 11). Note that the areas of steep slopes presented in Table 20 do not include areas of exposed bedrock. Slightly less than one third of the entire Black River watershed has steep slopes. The subwatersheds having the most steep slopes include Middle Branch Moose River, South Branch Moose River, and Stillwater Reservoir, all situated along the easternmost portion of the watershed. Therefore it could be identified that these three subwatersheds have the most erosion potential. Conversely, the subwatersheds with the fewest steep slopes include Deer River, Lower Black River, Lower Middle Black River, Middle Black River, and Mill Creek. These five subwatersheds have the least erosion potential.

Table 20. Steep Slopes

SUBWATERSHED	SIZE (acres)	STEEP SLOPES			PERCENT OF SUBWATERSHED
		8 TO 15 PERCENT (acres)	> 15 PERCENT (acres)	STEEP SLOPE TOTALS (acres)	
Beaver River	98,761	20,271	14,486	34,757	35.2
Crystal Creek	17,085	3,569	1,720	5,289	31.0
Cummings Creek	14,212	2,520	1,462	3,982	28.0
Deer River	62,270	5,012	1,904	6,916	11.1
Fish Creek	14,966	2,098	1,190	3,288	22.0
Independence River	61,074	12,539	10,458	22,998	37.7
Lower Black River	39,532	2,821	1,903	4,725	12.0
Lower Middle Black River	51,985	4,256	2,363	6,619	12.7
Middle Black River	81,353	8,398	3,009	11,407	14.0
Middle Branch Moose River	94,880	18,017	24,407	42,424	44.7
Mill Creek	22,512	2,151	668	2,819	12.5
Moose River	46,711	7,799	5,015	12,814	27.4
Otter Creek	42,181	8,818	7,324	16,141	38.3
South Branch Moose River	135,713	27,526	37,234	64,760	47.7
Stillwater Reservoir	109,992	22,374	25,818	48,192	43.8
Sugar River	44,732	6,142	2,215	8,357	18.7
Upper Middle Black River	102,016	13,970	10,174	24,143	23.7
Upper Black River	115,439	21,790	16,489	38,279	33.2
Woodhull Creek	62,661	12,500	7,978	20,478	32.7
BLACK RIVER WATERSHED	1,218,075	202,571	175,817	378,388	31.1

Source: Digital Elevation Models, U.S. Geological Survey

WETLANDS

Wetlands, defined in terms of their physical geography, are those areas located at the interface between terrestrial and aquatic ecosystems and comprise a wide range of hydrologic and vegetative conditions. Generally, wetland hydrology varies from periodically to permanently inundated, or saturated to the soil surface for a certain time period during the growing season. Wetland vegetation is predominantly comprised of species that are tolerant of anaerobic soil conditions resulting from inundation (i.e., hydrophytes) and includes both woody and non-woody plants.

In addition to providing food and habitat for a wide range of plant and animal species, wetlands also contribute to water quality. By impeding drainage flow from developed land, wetlands can filter out pollutant- and sediment-laden run-off prior to it entering streams, thus improving water quality. [xiv] Riparian wetlands located along streams and rivers also provide valuable flood protection, acting as storage basins and reducing the amount of downstream flow. This temporary storage of water results in decreased runoff velocities, reduced flood peaks, and delayed distribution of stormflows, all which cause tributaries and main channels to peak at different times.[xv] In some instances it has been found that wetlands provide more cost-effective flood control than man-made measures such as reservoirs or dikes.[xvi]

To ensure consistency throughout this analysis, MLRC land cover (2001) data was used to determine the amount of wetlands present in the Black River watershed, as well as the 19 subwatersheds (see Map 13). This data set provides coverage information for two wetland classifications:

- Woody Wetlands – areas where forest or shrubland vegetation accounts for 25 to 100 percent of the cover and the soil or substrate is periodically saturated with or covered with water; and
- Emergent Herbaceous Wetlands – areas where perennial herbaceous vegetation (e.g., grasses, sedges) accounts for 75 to 100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

As is indicated in Table 21, approximately 17 percent (212,319 acres) of the Black River watershed comprises wetland habitats, of which the majority are forested (95.5 percent, or 202,869 acres). Within the Black River watershed, three subwatersheds comprise less than 10 percent of their total land area in wetlands:

- Mill Creek subwatershed – 4.5 percent (1,012 acres)
- Sugar River subwatershed – 7.1 percent (3,156 acres)
- Crystal Creek subwatershed – 7.8 percent (1,333 acres)

At the opposite extreme, the Deer River subwatershed contains approximately 17,090 acres of wetlands, or 27.4 percent of its total land area. Many of these wetland areas are located in the upper reaches of the watershed, away from the agricultural and urban development associated with the Black River valley. Four additional subwatersheds also comprise more than 20 percent of their total land area in wetlands (these four subwatersheds are located predominately within the Adirondack Park):

- Stillwater Reservoir subwatershed – 24.5 percent (26,918 acres)
- Middle Branch Moose River subwatershed – 24.0 percent (22,728 acres)
- Independence River subwatershed – 23.8 percent (14,517 acres)
- Woodhull Creek subwatershed – 21.7 percent (13,626 acres)

Table 21. Wetland Habitats

SUBWATERSHED	TOTAL ACRES	WETLAND ACRES			WETLAND PERCENT COVER
		FORESTED	EMERGENT	TOTAL	
Beaver Creek	98,761	14,309	365	14,674	14.9%
Crystal Creek	17,085	1,312	21	1,333	7.8%
Cummings Creek	14,212	2,481	10	2,491	17.5%
Deer River	62,270	16,544	546	17,090	27.4%
Fish Creek	14,966	2,119	10	2,129	14.2%
Independence River	61,074	14,012	505	14,517	23.8%
Lower Black River	39,532	4,346	391	4,737	12.0%
Lower Black Middle River	51,985	7,049	804	7,853	15.1%
Middle Black River	81,353	9,094	724	9,818	12.1%
Middle Branch Moose River	94,880	21,654	1,074	22,728	24.0%
Mill Creek	22,512	1,001	11	1,012	4.5%
Moose River	46,711	6,184	157	6,341	13.6%
Otter Creek	42,181	5,688	105	5,793	13.7%
South Branch Moose River	135,713	23,469	796	24,625	17.9%
Stillwater Reservoir	109,992	24,496	2,422	26,918	24.5%
Sugar River	44,732	3,101	55	3,156	7.1%
Upper Middle Black River	102,016	11,377	431	11,808	11.6%
Upper Black River	115,439	21,249	781	22,030	19.1%
Woodhull Creek	62,661	13,384	242	13,626	21.7%
BLACK RIVER WATERSHED	1,218,075	202,869	9,450	212,319	17.4%

Source: 2001 National Land Cover Data, Multi-Resolution Land Characteristics (MRLC) Consortium

FLOODPLAINS

Flooding, a natural and recurring event, results from heavy or continuous rainfall that exceeds the soil's absorptive capacity and the flow capacity of rivers and streams.[xvii] Once these capacities are exceeded (usually every 1 to 3 years), the waterway overflows its banks and spills into adjacent low-lying areas. Floodplains are these adjacent low-lying areas that are most subject to recurring inundation.

In terms of water quality and watershed management, floodplains provide a number of communal benefits and, as experience has shown, can be far more effective than many man-made structures (e.g., floodwalls, stream channelization) in reducing downstream flood peaks. First, floodplains provide flood and erosion control by storing and slowly releasing floodwaters, thus reducing the depth and velocity of flooding. Floodplain vegetation can also positively impact water quality, trapping sediments and capturing pollutants before they are carried off downstream. Floodplains also provide groundwater recharge by storing floodwaters and promoting aquifer infiltration.

Floods, and floodplains, are generally defined according to their statistical frequency of occurrence. For example, a "100-year floodplain" is an area that is subject to a one percent or greater chance of flooding in any given year. Depending on the degree of risk desired for a given analysis, any other statistical frequency of a flood event may be selected[xviii] For the purposes of this analysis, 100-year and 500-year floodplains were evaluated.

To determine the locations of floodplains within the Black River watershed, Flood Insurance Rate Maps (FIRMs) were acquired from the Federal Emergency Management Agency (FEMA) for the three of the five counties traversed by the watershed – Herkimer, Jefferson, and Lewis (see Map 14). At this time FEMA has not yet created FIRMs for the majority of Lewis or Hamilton Counties and the data that does exist is not in digital format; thus, floodplains were not mapped for these two counties.

GROUNDWATER

Groundwater is often a much misunderstood resource. It provides a source for drinking water to one-quarter of New Yorkers and half of all Americans. Groundwater may be found nearly everywhere on the planet at depths ranging from near or at the surface to very deep below the surface. When rain falls to the ground, some of it runs off down slope into streams, lakes, and other bodies of water. Some of the water is taken up by plants and some of it becomes caught in puddles and evaporates. The remaining water, however, seeps into the ground through the underlying soil material. As water continues its downward journey through the unsaturated zone (ie. the upper part of the soil layer that does not completely fill with water), the water moves through the interconnected spaces between the soil particles or through the fissures in rock until it reaches the saturated zone, located below the water table, where it becomes groundwater.

An aquifer is a geologic formation or stratum containing groundwater in its void spaces and pores that may be removed economically and used as a source of water supply. Generally, two types of aquifers exist –confined and unconfined aquifers. Confined aquifers are those groundwater storage areas sandwiched between two layers of impermeable materials (e.g., clay) that impede the flow of water into and out of the aquifer. These aquifers are also known as artesian aquifers. Unconfined aquifers, however, do not possess an upper confining layer and are instead bounded by the water table. As such, these types of aquifers, especially those located near the surface, are particularly vulnerable to contamination.[xix]

As shown in Map 15, aquifers are distributed across the watershed and occur to some degree in each subwatershed. Table 22 summarizes the extent of both confined and unconfined aquifers within each subwatershed. It is interesting to note that the single confined aquifer is roughly rectangular in shape. It is just over a mile wide and extends approximately 16 miles underneath the Black River channel and floodplain, predominantly in portions of the Middle Black River and Upper Middle Black River subwatersheds.

Table 22. Aquifers

SUBWATERSHED	CONFINED AQUIFERS (in acres)	UNCONFINED AQUIFERS (in acres)
Beaver River	144	55,132
Crystal Creek	217	14,040
Cummings Creek	-	11,192
Deer River	-	4,949
Fish Creek	-	10,415
Independence River	17	39,326
Lower Black River	-	8,119
Lower Middle Black River	-	17,572
Middle Black River	6,943	22,204
Middle Branch Moose River	-	32,812
Mill Creek	63	3,856
Moose River	-	28,712
Otter Creek	-	25,719
South Branch Moose River	-	47,758
Stillwater Reservoir	-	31,203
Sugar River	-	10,936
Upper Middle Black River	-	43,903
Upper Black River	-	35,121
Woodhull Creek	-	32,539
Total Black River	11,143	475,508

Source: Unconsolidated Aquifers GIS Data Layer, NYSDEC

Generally, the more productive aquifers consist of unconsolidated deposits of sands and gravels that occupy the larger river valleys or lake plains and terraces. Groundwater in these aquifers occurs under water-table (unconfined) or under artesian (confined) conditions. Municipalities, industries, farms, and individuals historically have built over these aquifers as they typically form relatively flat areas that are suitable for development and often offer an ample supply of groundwater. Such development, coupled with the relatively high permeability of the alluvial deposits (i.e., soil or sediments deposited by a river or other running water) and the shallow depth to the water table, makes these aquifers highly susceptible to contamination from point sources of pollution such as landfills and petroleum storage tanks, as well as nonpoint sources of pollution from both urban and agricultural land uses.

Bedrock formations may also provide a significant source of groundwater supply and are typically less susceptible to contamination. Bedrock aquifers generally are deeper than their confined/unconfined counterparts and, therefore, may require more energy to remove groundwater. Moreover, the more productive aquifers tend to be the more shallow alluvial deposits underlying streams, rivers, floodplains, and lake plains and terraces. These aquifers generally are capable of producing from 10 to 100 or more gallons of water per minute. As shown, the aquifers occupy approximately 486,651 acres or 40 percent of the total watershed area.

WATER SUPPLY

Traditionally, water supply has come from two primary sources – surface water and groundwater. In terms of surface water, the New York State Water Quality Standards Program, administered by the NYSDEC, is responsible for classifying surface waters for their best use, including water supply, swimming, boating, fishing, and shellfishing. Specific to water supply, both Class A and Class AA are potentially suitable for municipal water supply. Class A and AA waters are those waters that can provide a source of water supply for drinking, culinary or food processing purposes, primary and secondary contact recreation, and fishing. Map 16 depicts the NYSDEC use classifications for surface streams, while the lengths of streams designated as Class A and Class AA are summarized by subwatershed in Table 23.

It should be noted that not all of the subwatersheds contain streams classified as Class A or Class AA. The Middle Branch Moose River subwatershed, with 75.2 miles, by far has the most miles of stream designated as Class A and Class AA. The Upper Black River subwatershed has 14.1 miles, the next highest length of Class A or Class AA streams. These subwatersheds may be suitable for municipal water supply. The Middle Black River, Mill Creek, and Otter Creek subwatersheds have no Class A or Class AA streams. The Black River watershed as a whole contains 114.7 miles of Class A streams and 31.8 miles of Class AA streams.

Table 23. Class A and AA Streams

SUBWATERSHED	CLASS A STREAMS (miles)	CLASS AA STREAMS (miles)	TOTALS (miles)	PERCENT OF ALL STREAMS
Beaver River	-	2.2	2.2	0.7%
Crystal Creek	0.9	2.4	3.3	7.4%
Cummings Creek	3.9	-	3.9	7.4%
Deer River	5.7	-	5.7	2.3%
Fish Creek	3.7	-	3.7	7.1%
Independence River	1.3	1.1	2.4	1.2%
Lower Black River	4.0	-	4.0	3.9%
Lower Middle Black River	2.2	-	2.2	2.0%
Middle Black River	-	-	-	-
Middle Branch Moose River	65.5	9.7	75.2	21.7%
Mill Creek	-	-	-	-
Moose River	-	2.4	2.4	1.4%
Otter Creek	-	-	-	-
South Branch Moose River	7.3	-	7.3	1.3%
Stillwater Reservoir	4.8	0.01	4.8	1.2%
Sugar River	1.2	0.5	1.7	1.0%
Upper Middle Black River	-	10.8	10.8	3.2%
Upper Black River	11.6	2.5	14.1	3.8%
Woodhull Creek	2.5	-	2.5	1.1%
Total Black River	114.7	31.8	146.5	3.6%

Source: Water Quality Classifications GIS Data Layer, NYSDEC

Depending upon a number of factors, including both water quantity and water quality, other streams also may be suitable for municipal water supply. For example, streams that are not too polluted and have sufficient flows may be suitable for municipal water supply.

Map 18 depicts the assigned use classification for the other surface water bodies in the watershed. Class A designates suitability for municipal water supply. A total of 130.5 acres of water bodies in the watershed are designated Class A, of which 112.0 acres occur in the Independence River subwatershed and 18.5 acres occur in the Middle Branch Moose River subwatershed.

Groundwater is also a significant source of water supply in the watershed. Much of the withdrawals currently are in the unconsolidated alluvial aquifers situated along the river valleys which are capable of producing from 10 to 100 or more gallons per minute.

A potential, rather non-traditional source of future water supply is stormwater reuse. Known as the beneficial use of stormwater, reuse consists of storing stormwater runoff for future uses, such as landscape irrigation, firefighting, aesthetics, recreation, or other grey water uses (grey water is defined as non-industrial wastewater from domestic processes such as dish washing, laundry, and bathing). Grey water may be used for any non-potable use. Typically, stormwater is stored in lakes and ponds, tanks, cisterns, rain barrels, or some combination of facilities.

1.4.4. Natural Resources

ECOZONES AND VEGETATION

The Black River watershed is located in the rural and remote North Country region of New York State and is situated east of Lake Ontario between the Tug Hill Plateau and the Adirondack Mountains. Covering more than 10,000 square miles, this heavily forested region exhibits a variety of ecological conditions related to differences in climate, topography, dominant vegetation, land cover, soil, geology, and hydrology. These regional differences have been classified into distinct ecological zones (ecozones); the Black River watershed encompasses seven ecozones (there are 25 recognized zones in northern New York) – the Black River Valley, Central Adirondacks, Central Tug Hill, Eastern Ontario Plain, Tug Hill Transition, Western Adirondack Foothills, and the Western Adirondack Transition (see Map 18).[xx]

Black River Valley

This zone consists of low-elevation lands along the floodplain of the Black River and the lower portions of its tributaries. Much of the valley is underlain by limestone. Limestone terraces are well-developed along the western side of the valley.[xxi] A number of rare plant species occur in limestone fens in this vicinity. The igneous rocks which form the Adirondacks occur along the river channel and much of the eastern side of the valley. Parts of the valley have thick sand deposits formed as glacial outwash. The valley is characterized by its intensive agricultural use, in contrast to abandoned and second-growth agricultural areas of the Tug Hill Transition zone to the west and the Adirondack Transition zone to the east. [xxii] Much of the Lower Black River, Lower Middle Black River, Upper Middle Black River, and Sugar and Mill Creek subwatersheds are in this zone, as well as lower portions of the Deer River, Crystal Creek, Beaver River, and Moose River subwatersheds.

Central Adirondacks

This zone consists of portions of the Adirondack Mountains and the associated valley areas. The area consists of various coniferous communities at higher elevations and mixed forests at lower elevations. The area is also characterized by numerous lakes, ponds, and wetlands. The igneous bedrock of the zone leads to low soil fertility and contributes to the formation of acidic bog communities. The high proportion of public ownership in this area is one of its defining characteristics. [xxiii] In the Black River basin, most of the Stillwater, Middle Branch Moose River, South Branch Moose River and Upper Black River subwatersheds are in this zone, as well as upper portions of the Independence, Otter, and Woodhull Creek drainages. Several biotic communities are characteristic of higher-elevation areas in the Adirondacks (i.e., above approximately 3,000 feet). The Black River basin has little area of these higher elevations, with small areas on Little Moose Mountain within the South Branch Moose River subwatershed and Wakeley Mountain (elevation 3,760 feet) at the boundary between the Black River (South Branch Moose River) and Raquette River drainages.

Central Tug Hill
The Tug Hill Plateau, formed of sandstones over shale, ranges from approximately 1,500 to 1,900 feet in elevation. The plateau is characterized by high snowfall. The flat terrain and relatively impermeable soils lead to extensive wetland areas. The basic forest vegetation of the plateau is mixed hardwoods and conifers. The plateau also supports agriculture. Much of the plateau drains to the west and south of the Black River basin, but the upper Deer River also lies within the plateau. The headwaters of several creeks in the Middle Black River subwatershed (e.g., Whetstone Creek and Roaring Creek) and of Sugar Creek also reach the central plateau.

Eastern Ontario Plain (subtype of the Great Lakes plain)
In the Black River basin, virtually all areas in this zone are in the Lower Black River subwatershed. This zone consists of low elevations over limestone bedrock along the Lake Ontario shore. While hardwood forests historically covered much of this area, it now contains large amounts of agricultural land, largely as pastures for the dairy industry. Grasslands and shrublands support several rare species, such as Henslow's sparrow and loggerhead shrike. The Lower Black River subwatershed also includes the primary urban area in the basin – Watertown and its surrounding communities. The underlying limestone bedrock supports unusual communities, such as limestone pavement communities (alvars), a globally-rare group of communities formed on flat areas of exposed, cracked limestone bedrock. Alvar communities occur around Lake Ontario, with one site known within the basin containing calcareous limestone barrens and limestone woodlands. The limestone bedrock also contains caves that support several rare bat species. The mouth of the Black River, along with Black River Bay, is considered a significant waterfowl conservation area because of its importance as a wintering area.

Tug Hill Transition
This zone consists of areas along the edges of the Tug Hill Plateau. Many of its climatic and ecological characteristics are intermediate between those of the Central Tug Hill Plateau and adjacent zones (Lake Ontario Plains and Black River Valley). However, erosion of ravines (e.g., Whetsone Gulf, Deer River gorge) by creeks are characteristic of the transition zone. These gulfs support a variety of unusual communities, such as those associated with wet cliff-faces, talus slopes, and ravine bottoms.

Western Adirondack Foothills
This zone consists of lower, more rolling hills along the western edge of the Adirondacks. Although it does not contain the high elevation communities of the central Adirondacks, it supports many similar communities, as well as extensive areas of northern hardwood forests. In the Black River basin, most of the Woodhull, Otter, Independence, Moose, Fish, Cummings, and Beaver subwatersheds are in this zone, as well as substantial parts of the Upper Black River, South Branch Moose River, and Middle Branch Moose River subwatersheds.

Western Adirondack Transition
This zone forms a narrow band between the Western Adirondack Foothills and Black River Valley and is transitional between these zones. This zone is characterized by sandy, low-nutrient soils, ultimately derived from glacial outwash deposits. In the Black River valley, much of this area consists of abandoned agricultural areas (i.e., "sand farms"). Many of these areas were actively reforested with a mix of pine species after acquisition by the state. Extensive parts of the Upper Black River and Crystal

Creek subwatersheds are in this zone, as well as parts of all the lower east bank tributaries of the Black River (i.e., Beaver, Fish, Independence, Cummings, Moose, Otter and Woodhull subwatersheds).

The NYSDEC has also developed a classification system for biotic communities based on plant and animal occurrences, which are correlated with local environmental conditions. Communities are defined for terrestrial habitats, palustrine habitats (largely wetland and riparian areas), and lacustrine (lake) and riverine habitats. Some of these communities cover large areas, while others typically occur in small areas of appropriate conditions. For example, much of the basin was originally covered in northern hardwood forests (i.e., beech [*Fagus grandifolia*] and sugar maple [*Acer saccharum*] are typical dominants) and coniferous forests (spruce [*Picea* spp.] and balsam fir [*Abies balsamea*] are typical dominants), with a number of other communities in wetlands, floodplains, outwash plains, cliffs and other local habitats. Communities include a variety of natural successional stages, as well as human-maintained communities such as agricultural, suburban, and industrial areas. Some communities, such as the northern hardwood forest, occur in appropriate habitats throughout the basin, while others are typically small, uncommon, and limited to different parts of the basin. The New York Heritage Program maps certain of these ecological communities, many of which support unusual flora and fauna.

FISH AND WILDLIFE

Fish Occurrences

Much of the information regarding historical fish occurrence in the Black River drainage basin is the result of extensive sampling conducted in 1932.[xxiv] Subsequent sampling has been done by the NYSDEC, Cornell University, the American Museum of Natural History, and the Adirondack Lake Survey Corporation (ALSC). In particular, in 2007, NYSDEC completed a review of fishes of the drainage based on new sampling and a review of historic data.[xxv]

As the Black River drainage was glaciated as recently as 8,000 to 10,000 years ago[xxvi], fish occurrence is related to both opportunities for colonization and by local habitat and water quality characteristics. The early colonization of basin waterbodies resulted from two general routes. The first route was of mainly northern fishes that were able to move from glacial refugia to formerly glaciated areas by way of post-glacial lakes and drainage patterns that no longer exist. This group includes coldwater species like lake trout (*Salvelinus namaycush*), which has been restricted to cold lakes, as well as species like brook trout , which eventually occurred in appropriate habitats throughout the drainage. The second route of colonization is characterized by upriver movements from Lake Ontario. This route opened later and many species were blocked by upstream barriers. As a result, a number of species historically occurred mainly below Watertown or a little farther upstream. Several species that are found in Lake Ontario (including Black River Bay) have not been recorded in the river. Forty-two native species have been tabulated in the drainage upstream of the mouth, plus seven species found only at the mouth (Greeley). All of these were collected in recent sampling, although two species (American eel [*Anguilla rostrata*] and finescale dace [*Phoxinus neogaeus*]) were captured in such small numbers that they were considered essentially extirpated (Carlson). In addition to species found only near the mouth of the river, a number of other native species were captured at or otherwise known from only a few sites:

- Grass pickerel (*Esox americanus vermicultatus*);
- Brassy minnow (*Hybognathus hankinsoni*);
- Eastern silvery minnow (*H. regius*);
- Blacknose shiner (*Notropis heterolepis*);
- Mimic shiner (*Notropis volucellus*);
- Stonecat (*Noturus flavus*);
- Johnny darter (*Etheostoma nigrum*);
- Logperch (*Percina caprodes*);

- Round whitefish (*Prosopium cylindraceum*); and
- Summer sucker (*Catostomus utuwana*).

Two additional native species were discovered in the recent sampling.

The opening of the Black River Canal provided an additional path for immigration of fish from the Mohawk drainage into the Black River upstream of Watertown. At least one species, the satinfin shiner (*Cyprinella analostana*), probably entered the drainage via the canal. In addition, a number of species have been introduced into the drainage, many of which are native to New York. Some of these are found downstream in the Lake Ontario drainage, (e.g., lake whitefish [*Coregonus clupeiformis*], hornyhead chub [*Nocomis biguttatus*], green sunfish [*Lepomis cyanellus]*), while others are found in the Mohawk Drainage, as well as many mid-Atlantic drainages (e.g., margined madtom [*Noturus insignis]).* Others are exotic to the region, such as brown trout (*Salmo trutta*) and common carp (*Cyprinus carpio*), which are native to Europe, and the rainbow trout (*Oncorhynchus mykiss*), sockeye salmon (*O. nerka*) and chinook salmon (*O. tshawytscha)*, which are native to western North America. Additionally, many species have been introduced upstream of barriers into parts of the drainage where they were not native (e.g., the Atlantic salmon [*Salmo salar*], central mudminnow [*Umbra limi*], fallfish [*Semotilus corporalis*], northern hog sucker [*Hypentelium nigricans*], channel catfish [*ctalurus punctatus]*, banded killifish [*Fundulus diaphanous*], bluegill [*Lepomis macrochirus*], black crappie [*Pomoxis nigromaculatus*], and walleye [*Sander vitreum*]). The native range of some sport species in the drainage, such as chain pickerel *(Esox niger*), smallmouth bass (*Micropterus dolomieu*), and largemouth bass (*M. salmoides*), is poorly known. Many of these species were introduced as sport species, while others may have been introduced as bait bucket releases. Some species, such as fallfish (*Semotilus corporalis*) and walleye (*Sander vitreum*) are now relatively common in the main stem of the Black River.

Introductions of fish species have had major effects on lakes. Many lakes originally contained a fish fauna that included brook trout (*Salvelinus fontinalis*), suckers (*Catostomus* spp.), slimy sculpin (*Cottus cognatus*), and various species of minnow such as northern redbelly dace (*Chrosomus eos*) . Species such as yellow perch (*Perca flavescens*), pumpkinseed [check] (*Lepomis gibbosus*), golden shiner (*Notemigonus crysoleucas*) and smallmouth bass (*Micropterus dolomieu*) are now common in many lakes, with decreases in the abundance of the formerly-common species. Walleye, largemouth bass, rainbow smelt (*Osmerus mordax*), and northern pike have also been widely introduced into lakes in the drainage basin.

Appendix 2, Table 24 provides a breakdown of fish records by subwatershed. Many of these are coincident with the subwatersheds used in this plan, although subwatersheds within the Moose River (Middle Branch, South Branch, and Moose) subwatersheds were not broken out and different divisions of the main Black River drainage were used. These records depict 32 and 45 species in the two lower reaches of the Black River, 25 to 35 species in the larger, more-heavily sampled subwatersheds (Beaver, Moose, Mill, and Deer), and 11 to 18 species in smaller, less-heavily sampled subwatersheds. Few or no samples were taken in the Stillwater Reservoir, Fish Creek, and Cummings Creek subwatersheds.

The Lower Black River subwatershed is notable for occurrence of species not found upstream of Dexter or Watertown, such as sea lamprey (*Petromyzon marinus*), lake sturgeon (*Acipenser fulvescens*), longnose gar (*Lepisosteus osseus*), bowfin (*Amia calva*), gizzard shad (*Dorosoma cepedianum*), quillback (*Carpiodes carpio*), white perch (*Morone americana*), sockeye salmon, and chinook salmon. As noted above, many species once restricted to the lower part of the drainage are now more widely distributed. Philomel Creek, a tributary of the Black River located in the Lower Black River subwatershed, has characteristics similar to other Lake Ontario streams and contains, or did contain species several rare species such as brassy minnow and finescale dace.

The Black River from Lyons Falls to Carthage, located in the Lower Middle, Middle, and Upper Middle Black River subwatersheds, provides low gradient riverine habitat for a number of species. In addition, swamps, wetlands, and ditches within the floodplain of the river provide spawning and nursery areas for chain pickerel, northern pike, and probably burbot (*Lota lota*). Within the overall Black River basin, the common carp and spottail shiner *Notropis hudsonius*) are found primarily in the main stem. The burbot occurs in the Black River and associated tributary mouths; burbot have also been reported near the mouth of the Black River. Walleye and smallmouth bass are important recreational species. Chain pickerel and northern pike have fluctuated in relative abundance, with chain pickerel more common in recent surveys.[xxvii] The eastern silvery minnow has also been recorded only in the Black River (above Carthage and below Dexter), and the satinfin shiner occurs mainly in the Black River and lower parts of tributaries.

A few species were found only or mainly in streams draining the Tug Hill Plateau (e.g., in Deer River, Mill Creek, and Sugar Creek). These include blacknose shiner (found at one site in Deer Creek and known from other Tug Hill tributaries outside the Black River drainage), pearl dace (*Margariscus margarita*), and redside dace (*Clinostomus elongatus*).

Several species, such as fathead minnow (*Pimephales promelas*), bluntnose minnow (*P. notatus*), tesselated darter (*Etheostoma olmstedi*), brown bullhead (*Amieurus nebulosus*), and longnose dace *(Rhinichthys cataractae*) are found mainly in small streams at lower elevations, which would include tributaries of the various Black River subwatersheds, as well as the lower parts of most of the other subwatersheds. The tesselated darter and longnose may occur at moderate elevations (e.g., greater than 1,500 feet).

A variety of species are widespread in areas of the Adirondacks not impacted by acidification or flow regulation. These include brook trout (*Salvelinus fontinalis*), brown trout (which has replaced brook trout in many areas), cutlip minnow (*Exoglossum maxillingua*), common shiner (*Luxilus cornutus*), and creek chub (*Semotilus atromaculatus*). The longnose sucker (*Catostomus catostomus*) is a coldwater species that was widespread in the Adirondacks and other streams in the drainage. It is less common now, although it occurs in the Adirondacks and a few other streams. The lake chub (*Couesius plumbeus*) was also widespread in the Adirondacks, although recent records are mainly from the Upper Black River and Woodhull Creek subwatersheds. The lake chub is less sensitive to acidification than many other species.

Many shallow ponds and lake shallows contain species similar to their associated river and stream systems. These areas, however, have been heavily affected by the introduction of sport and other species and by acidification. The lake trout (*Salvelinus nemaycush*) typically occurs in deep, cold lakes in the region. It is still found in many lakes, though populations in some areas are sustained by hatchery supplementation. The round whitefish was known in more lakes in the Black River watershed than any other New York watershed. Currently, Little Moose Lake has a native population and round whitefish have been introduced into four other lakes. A heritage (i.e., native) strain of brook trout was identified in Horn Lake. Genetic analyses of brook trout in other areas may reveal other sites with heritage strains. The NYSDEC has developed an initiative to identify, protect, and manage brook trout stains in the state. Other local races of brook trout may have been extirpated or swamped by hybridization with stocked trout.

Reptiles and Amphibians

New York State conducted a herpetological atlas project that mapped reptile and amphibian presence on topographic maps coincident with USGS 7.5' topographic sheets. Occurrence of species within the Black River drainage can be determined from these maps, although the precise occurrence of species in or near the boundaries of the drainage cannot be distinguished.

A few species occur throughout the drainage – redback salamander (*Plethodon cinereus*), green frog (*Rana clamitans*), bullfrog (*Rana catesbiana*), spring peeper (*Hyla crucifer*), American toad (*Bufo americanus*), and common garter snake (*Thamnophis sirtalis*). Among the remaining fish species there exists a general elevational gradient of occurrence in the Black River drainage basin. A number of species, such as the chorus frog, northern water snake (*Nerodia sipedon*), brown snake (*Storeria dekayi*), smooth green snake (Opheodrys *vernalis*), and eastern milk snake (*Lampropeltus triangulum triangulum)* occur primarily in lower areas along the Black River. The northern dusky salamander (*Desmognathus fuscus*), mountain dusky salamander (*D. ochrophaeus*), and mink frog (*Rana septentrionalis)* occur mainly at higher elevations in the Adirondacks or on the Tug Hill Plateau. The mink frog is a northern species that is found in Canada, northern New England, the Adirondacks, and the Tug Hill Plateau. It occurs on the edge of the Black River drainage on the Tug Hill Plateau and there are records of the mink frog in several blocks in the eastern part of the drainage.

Several species of frog and salamander breed in shallow ponds. Survival is highest in ponds without fish and in vernal ponds, which are dry for much of the year and provide important habitats for these species. Recruitment from ponds with fish is much lower. Due to the greater area of ponds with fish, however, these ponds can contribute significantly to the maintenance of these species. Tadpoles of green frog and bull frog are apparently distasteful to fish and these species occur commonly in streams and lakes with fish.

Mammals

Local faunal information on mammals was obtained from *The Mammals of the Tug Hill Plateau, New York* and *Adirondack Mammals*.[xxviii, xxix] State harvest records also provide information on sport and fur species.[xxx] As with most of the faunal groups, mammal distributions reflect ecological conditions shaped by climate, geology and topography, and modified by existing land use and vegetational succession from former land uses. Many species of mammals were locally extirpated and current distribution reflects the dynamics of recolonization. The abundance and distribution of some species, such as moose (*Alces alces*) and fisher, continues to change.

Resulting from intensive fur trapping efforts, beaver (*Castor canadensis*) was extirpated through most of the northeastern United States. By 1640, beavers were extirpated from virtually all of New York State.[xxxi] In 1900, a few beaver occurred in the Adirondacks outside of the Black River drainage. Beavers were re-introduced to several locations from 1902 to 1910, including areas around the Fulton lakes, Big Moose Lake and the South Branch of the Moose River. In response to reintroduction efforts, beavers have expanded into the entire drainage basin. Beaver trapping was reinstated in 1924 and the harvest has generally increased since, with large fluctuations in catch. Beaver have major effects on vegetation and aquatic habitats; beaver dams increase shallow pond habitats and may affect sedimentation and channel erosion. As a result, the extirpation and re-introduction of beavers is likely to have had major effects on other organisms. Moose, for example, was extirpated from the state by the middle of the 19th Century. From 1935 to 1980, there were occasional records of moose in the Adirondacks, presumably of individuals wandering from populations in Canada and New England. With the increase in the beaver population, more moose habitat has been created within the basin, which has potentially resulted in an ever increasing moose population (moose have been recorded at a number of sites in Hamilton, Herkimer, and Lewis Counties).

White-tailed deer (*Odocoileus virginianus*) are found throughout the drainage and deer hunting is been economically important to the region. Deer populations increased along with early successional vegetation in the Adirondacks following logging of mature forests. This increase, combined with rarity or extirpation of deer outside the Adirondacks, made the area famous as a deer hunting destination. Up to about 1970, deer harvest rates (i.e., the number of deer taken per square mile) were higher inside the Adirondacks than out. Since then, maturation of forests has decreased deer populations within the Adirondacks, while populations outside have increased due to deer management, land use, and possibly climate change. Recent deer harvests (1986 to 2000), however, have been greater outside the park than within. Despite the increase in deer harvest in Jefferson and Lewis Counties, harvest rates are still lower than those in the southern part of the state.[xxxii]

Historically within the basin, carnivorous mammals were killed for fur and to reduce losses of livestock and game species. Mountain lion and gray wolf were last recorded in New York in 1894 and 1899, respectively. Fisher and marten were reduced to small areas in the central Adirondacks and the species were provided State protection in the 1930's. Since then, both species have increased in numbers. While the fisher prefers extensive areas of forest, it can use a variety of forest types and has expanded widely in southern Canada, New York, and New England. Coyotes have also expanded into the northeast, becoming established in northern New York by about 1950 and now widely established in the region.

As with most of the faunal groups, there are differences in distribution of mammals between the lower elevations (Black River valley) and higher elevations (Tug Hill Plateau and Adirondacks). For example, the opossum, gray fox, southern flying squirrel, gray squirrel, and Eastern cottontail occur primarily at lower elevations. The first two of these are relatively recent immigrants to the region. In addition to some of the mammals discussed above, bobcat, water shrew, northern flying squirrel, and rock vole occur primarily at higher elevations.

Birds

Breeding bird surveys were conducted from 1980 to 1985 and from 2000 to 2005, providing recent status and trend information.[xxxiii] The breeding bird surveys are conducted by volunteers in relatively small blocks. Occurrence in blocks is classified as confirmed, probable, or possible. Each block survey is not exhaustive, with more rare species potentially not being detected. The surveys supplement extensive general and regional studies of species present in the drainage. Additional information on wintering birds is available from Christmas Bird Counts. As with many groups, the distribution of breeding birds follows the general zonation of the region, ranging from the river mouth and Black River valley through to the Central Adirondacks and Tug Hill Plateau. These distributional patterns reflect both climatic and topographic variation, as well as current land uses. Agricultural areas, primarily located in the Black River valley, now support a variety of open country birds.

Several general distributional patterns of breeding bird populations can be identified within the Black River drainage basin. Approximately 20 species are found throughout the drainage, including common, resident woodland birds (e.g., Downy woodpecker, Black-capped chickadee, White-breasted nuthatch, Blue jay, summer residents of deciduous forests (e.g., Red-eyed vireo), Scarlet tanager, Rose-breasted grosbeak, least flycatcher, and several species of warblers), and common eastern birds such as the Eastern robin, Common yellowthroat, and Song sparrow. An additional 20 species may breed only or mainly near the mouth of the Black River, most of which are marsh-breeders (pied-billed grebe, several herons, Canada goose, ducks, coots, rail, and marsh wren). Blue-winged, golden-winged and prairie warblers prefer low, open woods and shrublands. Several predominately southern species, such as red-bellied woodpecker, Eastern mockingbird, and orchard oriole, occur along the edge of Lake Ontario; the range of these species has expanded northward and these species may have colonized the drainage relatively recently. Due to the narrowness of the Black River drainage at its mouth, it's possible that many of species may breed just outside the drainage (e.g., in marshes around Black River Bay).

Approximately 25 species of birds breed primarily along the Black River valley from its mouth upstream. Most of these species are typical of agricultural areas, grasslands, savannahs, and early successional habitats. This group includes hawks (e.g., Northern harrier, Red-tailed hawk), several swallows, several sparrows, killdeer, Eastern bluebird, horned lark, bobolink, Eastern meadowlark, and brown-headed cowbird. An additional 20 to 25 species occur frequently throughout much of the western part of the drainage (including much of the Black River valley and Tug Hill Plateau), but are uncommon to rare in the eastern part of the drainage. Some of these species may be absent from much of the Adirondacks, while others may be absent only from the eastern-most part of the drainage.

In contrast to these groups found mainly in the western or lower elevation portions of the drainage, many species are widespread in the Adirondacks and Tug Hill Plateau and much less frequent or absent in the Black River mouth and valley. Most of these species (e.g., winter wren , Swainsons thrush, brown creeper, red-breasted nuthatch, and several species of warblers) are typical of northern, coniferous woods. A few (e.g., parula warbler and broad-winged hawk) occur in wooded areas throughout the eastern US. Another group of northern species occur almost entirely in the Adirondacks, including some waterbirds (e.g., Ring-necked duck). This group also includes boreal species, which occur only in the higher mountains of New England and in the Adirondacks. Because of their limited range in the region, apparent declines in several species, and likely sensitivity to climate change, these species are of considerable conservation interest. Several of these are classified as Species of Special Concern in New York State (see below for a more detailed discussion of endangered, threatened, and rare species). This group includes the spruce grouse, gray jay, boreal chickadee, black-backed woodpecker, three-toed woodpecker, Bicknell's thrush, blackpoll warbler, and rusty blackbird. New York State has designated an Adirondack Sub-alpine Forest Bird Conservation Area (BCA), comprising Adirondack peaks over 2,800 feet in elevation with dense (stunted or early successional) balsam fir and/or red spruce vegetation, to sustain Adirondack populations of the Bicknell's thrush, as well as Swainson's thrush and Blackpoll warbler. Wakely Mountain, on the edge of the Black River drainage, is specifically included in this area. The status of other potentially qualifying sites in the drainage (e.g., Big Moose Mountain) that are not specifically listed is unclear. The main goal of the BCA is to sustain the wilderness quality of these areas, provide suitable habitat for the bird species of concern, and facilitate recreation where it is compatible with the aforementioned objectives. Some known areas for the boreal birds in the Black River basin are included in New York State forests, such as the Moose River Plains.

A few species share different distributional patterns than those previously discussed. Several species (e.g., white-throated sparrow, pine wabler, northern waterthrush, and mourning warbler) occur primarily on the Tug Hill Plateau and within the central Black River valley and parts of the Adirondacks Transition zone (the white-throated sparrow breeds in the Adirondacks, as well).This pattern may reflect preferences of these species for early successional thickets, woods, and pine forests. These habitats may be most common in abandoned agricultural areas and pine reforestation areas in the central part of the drainage basin.

Breeding records of Yellow-throated vireo and Goshawk occur mainly on the Tug Hill Plateau. Three species of ducks (Common merganser, American black duck, and wood duck) were recorded mainly near the mouth of the river and in the Adironacks, presumably reflecting occurrence of suitable riverine and pond habitats. A number of other species were recorded only a few times (often unconfirmed breeding records), so definitive statements about distribution cannot be made.

ENDANGERED, THREATENED, AND RARE SPECIES

To ensure the continued viability of certain species of fish, wildlife, and plants, federal and state laws have been enacted that identify and manage species threatened with extinction. In New York State, these species are classified as either endangered, threatened, or species of special concern:

- Endangered species include "any species of fish, shellfish, crustacea, wildlife or plant designated by NYSDEC that are native species in imminent danger of extirpation or extinction in New York; or are listed as endangered by the USFWS in 50 C.F.R. §§ 17.11-17.12”.[xxxiv]

- Threatened species include “any fish, shellfish, crustacea, wildlife or plant species that are native species likely to become an endangered species within the foreseeable future in NY; or are listed as threatened by the USFWS in 50 C.F.R. Part 17.11-17.12”.[xxxv]
- Species of Special Concern are those species that “warrant attention and consideration but current information, collected by the department, does not justify listing these species as either endangered or threatened”.[xxxvi]

Notes on some of the endangered, threatened, and species of special concern are included below.

Endangered Species

Round Whitefish (*Prosopium cylindraceum*). The round whitefish has endangered status in New York State. The round whitefish has been extirpated from many lakes in the watershed. A native population occurs in Little Moose Lake, and the species has been introduced into four other lakes.

Short-eared owl (*Asio flammeusi).* The short-eared owl is endangered in New York. The breeding bird atlas shows one site for short-eared owl, probably just outside the Black River drainage. The Heritage database shows one site in the Lower Black River subwatershed.

Golden eagle. The golden eagle has endangered status in New York State, although it is considered extirpated as a breeding bird in the State. The last known nesting area was in the Black River drainage.

*Black tern.*The black tern is endangered in New York State. Black terns breed in marshes around eastern Lake Ontario. Black River Bay is listed as a site for the species, but the Black River drainage is not considered habitat for the species.

Indiana Bat (Myotis sodalist). The Indiana bat is endangered in New York State. Although knowledge of its distribution is limited, data provided by the NYS Natural Heritage Program identifies four sites in the Lower Black River subwatershed.

Loggerhead shrike (*Lanius ludovicianus).* The loggerhead shrike is endangered in New York State. There are records of the loggerhead shrike in the Lower Black River and Upper Middle Black River subwatersheds of the drainage. The loggerhead shrike occurs in grasslands or fields with some shrubs or in open shrublands. The decrease of the shrike in the Northeastern United States has been attributed to the loss of grasslands and early successional habitats and more intensive farming practices which decrease shrubby cover near agricultural areas. No loggerhead shrikes were reported within the drainage in the latest breeding bird survey.

Threatened Species

Lake sturgeon (*Acipenser fulvescens*). The lake sturgeon is threatened in New York State. The lake sturgeon occurs in the mouth of the Black River up to the Dexter Dam. The Black River was a spawning site for lake sturgeon, and recent observations of sturgeon in rapids in the Black River indicate that the sturgeon probably still spawns in the river.

Blandings turtle (*Emys blandingi)*. This turtle has threatened status in New York State. The New York Natural Heritage Program lists a potential site of occurrence in the Lower Black River and/or the Lower Middle Black River subwatersheds. The herpetology atlas shows two records in or near the Lower Black River subwatershed; one of these is probably the same area as the Heritage program site.

Species of Special Concern

Brook trout (*Salvelinus fontinalis*). A heritage brook trout strain has been identified in Horn Lake. Other heritage strains may exist in the the drainage.

Summer sucker (*Catostomus utuwana*). The summer sucker was described as a distinct species from a tributary of Big Moose Lake. It was subsequently considered to be a form of white sucker. Recent studies indicate that it is a distinct species. The species is known from Squaw Lake and tributary streams. The species is endemic to the Adirondacks. As such, it is a major conservation priority for the Black River drainage. However, until its redescription is published, it cannot receive formal state or Federal designation as an endangered or threatened species.

Burbot (*Lota lota*). The burbot is present in the Black River between Carthage and Lyons Falls. The burbot also occurs in Lake Ontario. The burbot is not listed as a species of concern in New York State. However, the burbot's life history and requirement of relatively large, low gradient, cool water makes it vulnerable to climate warming. Riverine populations are at particular risk, and Pennsylvania has listed the inland populations of burbot. The burbot also has special status in Connecticut.

Bluespotted salamander (*Ambystoma jeffersonianum).* The bluespotted salamander is a species of special concern in New York State. There are a few records in the herpetology atlas near the mouth of the Black River.

Wood turtle (*Clemys insculpta).* The wood turtle is a species of special concern in New York State. The herpetology atlas shows about six records scattered throughout the Black River drainage.

Common loon (*Gavia immer*). Common loons occur on a number of lakes in the Adirondacks. Major concerns for the common loon are acidification (eliminating fish prey in lakes), bioaccumulation of mercury, lake level fluctuations, and ingestion of lead (on breeding and wintering grounds).

Bicknell's thrush (*Catharus bicknelli*). Bicknell's thrush breeds in shrubby spruce-fir forests mostly above 2,900 feet in elevation. It occurs in Maine, the White Mountains of New Hampshire, the Green Mountains of Vermont, and in the Adirondacks. There is one record of Bicknell's thrush on or just across the boundary of the South Branch Moose River subwatershed.

Golden-winged warbler (*Vermivora chrysoptera*). The golden-winged warbler inhabits shrubby habitats in the northeastern US. Its abundance has decreased with the decrease of early successional habitats. The blue-winged warbler has expanded its range into that of the golden-winged warbler during the last century. Genetic swamping of golden-winged warbler due to hybridization with the blue-winged warbler is considered a major cause of its decrease in areas which still contain suitable habitat.

INVASIVE PLANTS AND ANIMALS

Invasive plants and animals pose a threat to native species and ecosystems by predation, competition, disease transmission, and hybridization. Invasive species may be resistant to diseases that are highly virulent to native species and may actually be carriers of these diseases. For example, several important diseases of native trees have been introduced by cultivation of closely related non-native species. Hybridization between native and non-native taxa (i.e., varieties, other closely related species.) may have demographic and genetic effects on species.

Terminology

A variety of terms, such as invasive, exotic, and alien, are in common use for non-native species, often with overlapping or contradictory meanings. The following meanings are used in this report:

Non-native. A general term for a taxon that does not occur naturally in a region. A large number of non-native species have been established for a relatively long time. For example, many European plants arrived with early modern settlement of the area and are now common, familiar elements of many ecological communities. Nonindigenous is considered synonymous with non-native.

Exotic. A taxon introduced from outside North America.

Adventive. A taxon that is non-native, but which has immigrated into the region without direct introduction. However, introduction may be facilitated by human activities (e.g., dispersal along roads and railroad tracks) and establishment may be favored by human-caused changes in habitat.

Invasive. The New York State Invasive Species Task Force defines an invasive species as one that is "1) Non-native to the ecosystem under consideration; and 2) whose introduction causes or is likely to cause economic or environmental harm or harm to human health."[xxxvii] While many species are clearly invasive in terms of distribution, there is subjectivity in classification of less dominant non-native species.

Non-Native Species

Most discussions of invasives focus on species, but forms at lower levels (e.g., subspecies, varieties, races) may have impacts on native conspecifics and non-native forms may have different ecological effects. For example, the common reed (*Phragmites australis)* is a native species, naturally occurring along marsh edges. A European genotype of common reed, however, is considered invasive, forming dense, mono-specific stands in a variety of damp habitats.[xxxviii] The Canada goose (*Branta canadensis*) is native to New York, but didn't breed in the state until introduction of non-migratory forms in the 1930's and 1940's.[xxxix] Resident Canada geese may become nuisances, with significant effects on riparian vegetation and aquatic ecosystems.

Eradication of well-established, non-native species is often difficult or essentially impossible. Local control of these species may be done where they have the greatest ecological or economic effects. Prevention of introduction or early eradication of potentially-occurring species may be feasible. A number of aquatic plants and animals colonize new waterbodies by being held in residual water (e.g., bilge water, etc.) or attached to boats, trailers, or other equipment. Thorough cleaning and drying of equipment can prevent such transport and is critical in reducing spread of several species. A number of species, including fish, crayfish and earthworms, have been introduced via bait bucket release, and disease may be transmitted by bait fish.

Newly introduced exotic species are typically not included in standard regional floras and faunas, and the taxonomic status of newly-encountered forms is often uncertain. Ranges of many non-native species can change rapidly. As a result, websites of several agencies are important in providing information on identification, impacts and control techniques. These include:

- The National Invasive Species Council (USDA):
  http://www.invasivespeciesinfo.gov/

- New York Sea Grant, Aquatic Invasive Species:
  http://www.nysgextension.org/ans/anspages/NYSGAIS.htm

- USGS nonindigenous aquatic species: *http://nas.er.usgs.gov/*
- Adirondack Park Invasive Plant Program: *http://www.adkinvasives.com/*
- New York State Invasive Species Task Force: final report at *http://www.dec.ny.gov/docs/wildlife_pdf/istfreport1105.pdf*
- National Biological Information Infrastructure invasive species node: *http://invasivespecies.nbii.gov/index.html*

Exotic Species

A large number of exotic species occur in the Black River drainage basin. The range of taxa, from diseases to vertebrates, indicates the wide range of potential impacts from invasive species. The following are a few that are particularly significant to this watershed management plan:

Purple loosestrife (*Lythrum salicare*). Purple loosestrife has escaped from cultivation and become invasive over much of the northeastern United States. Purple loosestrife can be a dominant plant in many wetland communities. The ecological importance of wetlands and occurrence of many rare, native species in wetlands increases the potential damage of the species and also impedes the use of herbicide control. Biological control of purple loosestrife has been developed and successfully used in the northeast (e.g., Connecticut and Illinois). There have been a number of studies concerning the ecological impacts of purple loosestrife, demonstrating mixed effects.[xl, xli, xlii]

There is evidence that native generalist herbivorous insects feed on purple loosestrife, which may reduce its invasiveness.

Giant hogweed (*Heracleum mantegazzianum*). Giant hogweed was introduced as an ornamental plant and has become established in New York State, including the Black River drainage area. It is capable of forming dense cover in riparian areas where it may shade native species and increase bank erosion. Sap of giant hogweed causes photodermatitis in people. Cutting is usually ineffective at controlling giant hogweed and increases risk of skin contact with sap. Giant hogweed is on the US Federal noxious plant list. The NYS Department of Agriculture and Markets maintains a Giant Hogweed Hotline (1-800-554-4501, extension 72087) and posts information on giant hogweed at *http://www.agmkt.state.ny.us/nys_ghw_broch.pdf.*

Garlic mustard (*Allalaria petiolaris*). Garlic mustard is a biennial herb which can achieve high densities, particularly in disturbed situations. It has chemical (allelopathic) effects on other plant species. Garlic mustard is known along roads in several areas of the Black River drainage in the Adirondack Park.[xliii]

Japanese knotweed (*Polygonum cuspidatum*). Japanese knotweed is a perennial herb which has spread from cultivation throughout the northeastern US and Canada. It forms dense patches, which spread vegetatively, and it can also spread by seeds.[xliv] Japanese knotweed forms a large rhizome. These rhizomes can form numerous new shoots, and the rhizome can regrow from fragments. As a result, cutting or hand removal is usually ineffective, and herbicide control has been the most effective control technique. Japanese knotweed can dominate riparian zones and occurs in more upland habitats, as well as along road and railroad banks. Japanese knotweed was one of the more common exotics along roads in the Black River drainage area.[xlv]

Common reed (*Phragmites australis*). The exotic genotype of the common reed can form dense, monospecific stands in marsh areas and other damp areas. It is often considered to form poor cover for waterfowl and other organisms and to reduce density of native aquatic plants. Most studies of impacts of common reed have been done in freshwater and brackish tidal marshes (Fell, et al. 2003, Lathrop, et al. 2003, Weis and Weis 2003).[xlvi, xlvii, xlviii] These studies have found that marshes dominated by common reed still support aquatic biodiversity and ecological functions. However, the common reed may reduce the complexity of topography of the marsh surface, which could have significant effects on marsh ecology. Common reed is difficult to control, and herbicide may be the most effective technique. Common reed has been documented in settled areas in the Adirondacks.[xlix]

Common buckthorn (*Rhamnus cathartica*). Common buckthorn is a tree or shrub native to Eurasia. It is widely established in the northeast, including the Black River drainage. It often occurs on alkaline soils of a variety of moisture conditions.[l] It has also been noted that the Canadian Shield may be a barrier to its occurrence in the north.[li] Therefore, it may be an important invasive in the Black River valley, but is unlikely to become invasive in the Adirondacks as recent efforts identified buckthorns found buckthorns (*Rhamnus cathartica* and/or *R. frangula*) only in the northwest corner of the Park.[lii]

European water milfoil (*Myriophyllum spicatum*). This milfoil is an aquatic plant which has become widely established throughout the northeastern US, including New York State. It forms very dense patches which interfere with boat traffic and may affect native plants, such as the state-threatened Farwell's watermilfoil, and aquatic animals. It is tracked by the Adirondack Park Invasive Plant Program. It has been found in several lakes in the Fulton Chain, and the Fulton Chain of Lakes Organization has been co-ordinating survey and removal efforts. These efforts use divers and pumps to reduce fragmentation of plants, which is a primary means of colonization of the plant.

Honeysuckles. The fly honeysuckle (*Lonicera morrowii*) and Tartarian honeysuckle (*L. tatarica*) have escaped cultivation and become widely established. Recent efforts identified one or both species to be among the most widely distributed exotic species in the western Adirondacks.[liii]

Sport fishes. As discussed in the section on fishes of the Black River drainage, a number of species have been introduced for sport species. Species such as brown and rainbow trout have been introduced from outside the drainage, while many species occurred in parts of the drainage and have been spread within the drainage. Introductions of species such as smallmouth bass and yellow perch have had huge impacts on the fish faunas of lakes. Introduction of brook trout may have obliterated native races of the species.

A number of invasive species occur in the Great Lakes. Several of these occur in Lake Ontario and may occur in the lower part of the river. These species could potentially be transported into upper parts of the drainage.

Zebra mussel (*Dreissena polymorpha*). The zebra mussel was introduced to the Great Lakes via ballast water and has spread into a number of river and lake systems. Zebra mussels can clog water intakes and can overgrow native mussels. Zebra mussels are filter feeders and they have had huge effects on aquatic systems by removing phytoplankton and increasing benthic detrital material. The filtering has increased water clarity in places but has also affected aquatic food webs. Zebra mussels can be spread by boats, either as adults or juveniles attached to boats and trailers, or as larvae contained in bilge water or live well water.

Quagga mussel (*Dresseina bugensis* or *D. rostriformis bugensis*). The quagga mussel was also apparently introduced via ballast water into the Great Lakes. The quagga mussel was probably introduced after the zebra mussel and has not spread as extensively. However, it is expected to replace zebra mussels in many areas[liv]. Quagga mussels have similar impacts as zebra mussels. Quagga mussels occur in Lake Ontario.

Round goby (*Neogobius melanostomus* or *Apolonnia melanostomus*). Round goby was introduced into the Great Lakes by 1990. Impacts include predation on native fishes and other organisms, competition with native species for food, cover and nesting areas (especially sculpins *Cottus*) and predation on fish eggs, including those of smallmouth bass. It is preyed on by smallmouth bass, so interactions between bass and goby are complex. Round gobies are susceptible to viral hemorragic septicemia virus (VHSV) and could spread the disease to predatory smallmouth bass.[lv] Round gobies have been found in Black River Bay near the mouth of the Black River.[lvi]

Fishhook waterflea (Cercopagus pengoi) and spiny waterflea (Bythotrephes longimanus). Both of these species occur in Lake Ontario. These species are predatory zooplanktors that compete with fish for zooplankton and disrupt aquatic food webs. They can also be nuisance species, clogging fishing lines.

The European frog bit (*Hydrocharis morsus-ranae*) is an aquatic plant which is established along the shores of Lake Ontario.

The tubenose goby (*Proterorhinus marmoratus*) and ruffe *(Gymnocephalus cernuus)* are Eurasian fishes which are established in the Great Lakes and could potentially spread into Lake Ontario.

<u>Other Invasives</u>

A number of other invasive species have the potential to colonize the Black River drainage basin. The ranges of many of these species have been expanding and the Black River drainage would likely provide adequate conditions for their establishment.

Hemlock woolly adelgid (*Adelges tsugae*) is an insect that infects hemlocks, which is an important tree in the Black River drainage. The woolly adelgid has caused massive mortality of hemlocks in areas where it has occurred. Currently, control can only be done locally on a stand or few trees, so that protection of hemlock throughout the region is infeasible. An adelgid predator has been released in New York, but biological control is currently ineffective. The hemlock woolly adelgid is common in parts of southern New York and has been detected in Rochester.[lvii]

The Rusty crayfish (*Orconectes rusticus*) has been introduced into the Upper Susquehanna and the Hudson River drainages. In many areas, native crayfish have disappeared after invasion of rusty crayfish. Rusty crayfish grows to a size where it is invulnerable to most fish predators, so it can reach large densities and have significant effects on macrophytes and other organisms.

Didymo (*Didymosphenia geminata*) Didymo is a diatom that forms thick mats on river substrates. It has had major impacts on rivers (e.g., in New Zealand) and has been found in the Delaware River system in New York, including the East Branch, Batten Kill, West Branch and main stem. It is thought that didymo has been spread primarily by movement of boats and anglers' gear such as waders and boots. Didymo cannot stand complete drying, but can remain alive for long periods in moist gear. Thorough drying and/or cleaning of gear is considered the best way to prevent spread of Didymo. The Pennsylvania Fish and Boat Commission provides information on Didymo at *http://www.fish.state.pa.us/water/habitat/ans/didymo/faq_didymo.htm.*

Viral hemorragic septicemia virus (VHSV). VHSV is a viral disease now known to be endemic in marine and anadromous fish in both the Atlantic and Pacific Oceans. It caused large fish kills in Lake Ontario, other Great Lakes, the St. Lawrence River, and some inland lakes (e.g., Lake Oneida) from

2005 to 2007. It has been found in a variety of freshwater species in the Great Lakes. Muskellunge, freshwater drum, yellow perch, gizzard shad , emerald shiner, and round goby were most affected, with smaller numbers of deaths of Chinook salmon, walleye, white bass, redhorse, lake whitefish, smallmouth bass, bluegill, black crappie, burbot, and northern pike.[lviii, lix, lx] A total of 25 fish species have been identified with VHSV, with differences in symptoms, progression of the disease and mortality.[lxi] VHSV is not known to affect humans and handling or consumption of infected fish is not considered a health or wildlife risk. Management of movement of fish, including transport and sale of baitfish, has been instituted to control the spread of the disease. Population-level effects of the fish motalities are currently unknown. For example, large mortalities of freshwater drum in Lake Ontario were not matched with decreases in abundance of drum in subsequent years. Conversely, it is estimated that half of the mature muskellunge in the Thousand Islands section of the St. Lawrence Seaway died from the disease.[lxii]

The emerald ash borer (*Agrilus planipennis*) was first discovered in Ohio, Michigan and Ontario (Canada) in 2002 and could have huge effects on regional forests.[lxiii]

Sudden oak death (*Phytophthora ramorum*) is a disease that affects oaks and a variety of other broad-leaved trees and shrubs, such as *Rhododendron* and *Viburnum*. It may be spread through the horticultural trade.

Pale swallow-wort (*Vincetoxicum rossicum*). Pale swallow-wort is a perennial vine that can form large, dense infestations. It prefers limestone soils and therefore potentially occurs in the lower Black River valley. No occurrences in the Black River drainage have been located, but the pale swallow-wort occurs in Jefferson County, with known sites only a few miles from the drainage (e.g., at the Chaumont Barrens). The Cornell Cooperative Extension of Jefferson County is tracking this species and records may be reported at 315-788-8450.

Non-Native Species

A number of other non-native species have been recorded within the drainage. These species have impacted in other areas and could become invasive. These include the mute swan (*Cygnus olor*), which has bred near the mouth of the river. The Adirondack volunteer invasive survey recorded several non-native plants in relatively low frequency, such as Russian/Olive autumn (*Eleagnus* species) and black locust (*Robinia pseudoacacia*).[lxiv] Earthworms have recolonized slowly following glaciation, and native earthworms are rare or absent throughout many glaciated areas. Non-native earthworms have been widely introduced by anglers and possibly by horticulture. Some non-native earthworms consume humus and have had huge effects on soil conditions following introduction. Earthworms occur locally in the Black River drainage (e.g., around fishing camps and popular fishing areas). Controls on selling non-native earthworms may diminish movement, although many anglers may dig their own earthworms and bring them from outside the drainage.

There has been considerable investigation of factors affecting the establishment and invasiveness of non-native species to predict potential invasiveness of horticultural species, prioritize control of exotic species, and develop regional control strategies. Many species have spread widely following introduction and restriction of introduction (e.g., controls on flushing of ballast water) and dispersal (e.g., controls on use of live bait, and promotion of cleaning and drying of boating and fishing equipment) may be the most effective techniques for widely invasive species. Land disturbance may promote establishment of many weedy plant species. However, the local fauna and flora may be adapted to the local disturbance regime, so that fire, drought, flooding, etc., may have more significant effects on non-native than native species and serve to control the establishment of non-native species. Development of biological controls has been effective on some species, but the effort involved in producing safe, effective biological control restricts it to the most widespread and damaging non-native species. For many non-native species, control (e.g., through mechanical removal or pesticides) rather than eradication is the only practical approach. Finally, climate change is anticipated to have large effects on the spread of non-native species. For example, a large number of invasive species are important in areas south of the Black River drainage, and these species may continue to expand northward with climate change.

KEY HABITATS AND RESOURCES

The previous sections describe ecological characteristics of the Black River drainage. This section summarizes these sections with respect to important ecological resources, which will form the focus for management and restoration.

Adirondack Mountains and foothills

The Adirondacks represent one of the largest undeveloped areas in the northeastern United States. A significant portion of the Adirondacks is located within the Black River drainage, which allows for the maintenance of a mosaic of ecological communities, reflecting both inherent environmental variability (e.g., moisture, elevation, etc.) and different successional stages. A number of species of plants and animals depend on early successional stages of vegetation, while others prefer mature vegetation. The Adirondacks support a variety of ecological communities that are uncommon elsewhere in the United States, particularly several northern (boreal) upland and wetland communities. These communities support uncommon species of animals such as the suite of boreal birds. One species, the summer sucker, is endemic to the Adirondacks and the Black River drainage comprises a significant portion of its total range. The large extent of forest is important to a number of species, such as fisher and broad-winged hawk. The Adirondacks support an array of recreational activities, ranging from wilderness hiking and boating through summer and permanent residence on area lakes. The region provides opportunities for a variety of lake, stream, and river fishing, as well as hunting and trapping for a number of game and fur species. The Adirondacks are headwaters for a number of streams and are hydrologically important for regional water storage, supply, and hydropower. Rivers and lakes of the Adirondacks provide a variety of recreational boating experiences. The lower Moose River is a nationally-known whitewater river.

Tug Hill Plateau

The Tug Hill Plateau represents a second large area of largely undeveloped land. The Plateau provides many of the ecological and economic benefits of the Adirondacks. While this area supports some of the same northern fauna as the Adirondacks, differences in climate, geology, and hydrology lead to differences in the occurrence of species and communities. For example, the Plateau is less susceptible to acidification than the Adirondacks. Additionally, the gulfs formed by tributary creeks support a number of uncommon plant communities and provide unique recreational opportunities.

Mainstem Black River and Valley

The central portion of the Black River provides a large, undammed section of river. The continuous stretch of river is important to migratory fish species such as burbot and the river supports a variety of other game and nongame fish species. Floodplain swamps within the valley are an important habitat, providing food and cover for a variety of fish and other organisms. The Black River valley contains uncommon plant communities, such as calcareous wetlands, which support rare species of plants and other organisms. These areas also provide hunting and trapping opportunities.

Unforested upland Habitats

The Black River valley, including the lower valley, also contain grasslands and shrubland habitats. Many of these are culturally produced, (e.g., by dairy farming), while others, such as limestone pavement barrens, are controlled by soil, bedrock and moisture conditions. Many shrublands represent successional stages resulting from abandoned farms. Several rare plant species occur in these habitats. The importance of these habitats to a number of species of birds is well-established, and these habitats are important to a number of other taxa, as well. Many of these species have declined in the northeastern United States as a result of changing agricultural and land cover trends.

Lower Black River

The lower Black River is home to regionally important fisheries (e.g., walleye, steelhead and salmon runs). The mouth of the river serves as an important area for nongame fish, as well, including lake sturgeon spawning areas. The Black River gorge is a well-known whitewater run because of its level of difficulty, unique characteristics, and summer flows.

Wetland habitats

The Black River drainage contains a variety of wetlands, including calcareous fens, peatlands, and floodplain swamps. These habitats support a variety of rare plants and animals. Along with marshes along the Black River Bay, wetlands in the drainage provide important breeding and wintering habitat for a variety of species of waterbirds. Areas near the mouth of the river are important as both breeding and wintering areas, while ponds and wetlands in the rest of the drainage, including the Tug Hill Plateau, the Black River floodplain, and the Adirondacks, are important nesting areas for various species.

Caves

The limestone bedrock of the Black River valley contain caves, which provide habitat for several species, including the Federally-endangered Indiana Bat.

1.5. IMPAIRMENTS AND THREATS

1.5.1. Introduction

The Black River drainage area has been affected by a number of ecological impacts associated with settlement, agriculture, logging, and industrial development. Effects include erosion and stream sedimentation, nutrient inputs and eutrophication, hydrological change and stream channel modification, fires, river damming and dewatering, and contamination by pesticides and industrial wastes. While many of the historic impacts are still evident through the recycling of environmental contaminants between the atmosphere and watersheds, these environmental challenges were addressed by dedication of the Adirondack Park and land preservation, and a series of Federal and State regulations including the Clean Air Act and the Clean Water Act.

Under authority of the Clean Air Act and the U.S. Environmental Protection Agency, the NYSDEC monitors waterbodies of the state, determines impairments with respect to defined uses, identifies priority waterbodies for remediation, and develops plans for attainment of designated uses.

Priority waterbodies have been identified by the NYSDEC in 1996, 2006, and 2008, including water quality impacts and sites identified for development of total daily maximum load (TMDL) regulations under section 303d.[lxv, lxvi] The NYSDEC also samples water chemistry and macroinvertebrates as part of the Rotating Integrated Basin Studies, which alternate annually among regions, providing regular assessments of each basin – the Black River was most recently assessed during 2002 and 2003.[lxvii]

1.5.2. Threats to the Black River Watershed

The following sections highlight some of the significant current threats to the Black River drainage basin. These sections draw on the NYSDEC assessment documents, as well as extensive literature on the various issues.

ACIDIFICATION

The geology of the Adirondacks and their location with respect to acid deposition, acid rain, and dry deposition of sulfate and nitrate makes them highly susceptible to acidification. The bedrock and relatively thin soils, mainly derived from glacial tills, provides little buffering, leading to soft water with low acid neutralizing capacity (ANC). In the late 1980's, the Adirondack Lake Survey Corporation monitored water chemistry and ecological conditions of a number of lakes and ponds in the Adirondacks. Many of these were acid-impacted, and a number of small ponds, many in the Black River drainage, had high acidity (low pH). Fish species vary in their sensitivity to acidification. Species that commonly occur in areas of natural, organic acidity, such as chain pickerel, are relatively tolerant, as are some species typical of small, soft water lakes and streams (e.g, brook trout). Aluminum becomes more bioavailable in conditions of inorganic acidity, and aluminum toxicity is an important impact in acidified waters. For example, brook trout reproduction may fail due to aluminum toxicity of early life stages even where adults are able to survive. Fish community composition was strongly affected by acidification and a number of ponds had no fish. A number of lakes on the 2006 303(d) list in the Black River drainage are classified as impaired because of acid effects. Since most are small, however, the relative acreage affected by acidification is less than that of the fewer, but larger lakes impaired by fish consumption advisories. Individual acid-impaired lakes are no longer listed separately in the 2006 Priority Waterbody List (PWL), since impairment will be addressed on a regional, rather than a lake-by-lake basis. Several lakes, including Brook Trout Lake and Big Moose Lake, both in the Black River drainage, have been extensively studied with respect to acidification. In general, deposition of sulfates has decreased following control under the Clean Air Act, although deposition of nitrates has increased.[lxviii, lxix]The severity of acidification has decreased in many Adirondack lakes, with decreases in sulfate, nitrate, and monomeric aluminum, as well as increases in pH and ANC.[lxx] For example, conditions in Brook Trout Lake have changed and brook trout have been restocked (Farrell, et al. 2008). Studies in Brook Trout and other lakes have indicated a complex pattern of recovery, with some biological groups lagging behind apparent changes in water chemistry. While fish population recovery in Adirondack lakes has been monitored, the extent of recovery was difficult to assess due a greatly affected fish composition resulting from subsequent introductions of fishes.[lxxi] (Daniels et al. (2008)

While acidification of lakes and ponds has received a great deal of attention, streams have also been affected by acidification.[lxxii] From 2003 to 2005, the USGS, in cooperation with the NYSDEC, ALSC and the NYS Energy Research and Development Authority studied water chemistry and macroinvertebrate communities in a number of streams in the Black and Oswegatchie drainages in the Western Adirondacks.[lxxiii] Approximately 200 streams with little upstream pond and lake inputs were studied. In addition to measuring ANC, they measured base-cation surplus (BCS), since this was more clearly related to concentrations of inorganic aluminum. They found an average of 38 percent of streams had a BCS less than zero, corresponding to 31 percent of streams with aluminum concentrations of levels toxic to brook trout. A much higher percentage (56 percent) of streams had low BCS during high stream-flow events. They estimated that 446 miles of streams in the region would be vulnerable to acidification, excluding assessment of 1,916 miles of inaccessible streams which were not included in the study design. Seven rivers and streams are listed as acid-impaired in the 2006 303(d) list (North Branch Moose River, Bald Mountain Brook, Seventh Lake Inlet, Buck Creek, Wheeler Creek, Bradley Brook, and Cellar Brook), with suspected impacts on other streams (e.g., Independence River).

Acidification also affects terrestrial communities. High elevation coniferous forests, for example, are affected by acidification.[lxxiv] Additionally, studies specific to the region found low recent regeneration of sugar maple in western Adirondack forests and suggested depletion of soil calcium due to acidification as the most likely cause.[lxxv] Calcium depletion may also affect abundance of birds by reducing the abundance of terrestrial invertebrates that provide calcium necessary for egg-laying.[lxxvi]

Ultimately, recovery from acidification effects depends on decreasing acidic inputs and is expected to take a long time. Additionally, due to the nature of acidification, reduction of acidic inputs is a regulatory and technological issue best dealt with at the national level. As a result, NYSDEC's strategy for remediation involves participation in efforts to reduce acidic inputs, along with monitoring and assessment to determine continued effects and recovery.

CONTAMINANTS

Fish consumption advisories affect a number of lakes in the Black River drainage area. Sixteen lakes in the drainage are on the state 2006 303(d) list as a result of mercury consumption advisories. New York State has general fish advisories for all state waters due to the occurrence of contaminants throughout the state, including the Stillwater Reservoir and Big Moose Lake. Because of the larger average size of these contaminant-affected waterbodies, the proportion of acreage affected by contaminants is disproportionate to the number of sites. Additionally, the Western Adirondacks have been identified as a hotspot of mercury bioaccumulation in the Northeastern U.S. based on measured concentrations in yellow perch and common loon.[lxxvii]

Mercury, a toxic element that can threaten the health of both people and wildlife, enters ecosystems by a variety of point and nonpoint sources. In undeveloped areas, atmospheric deposition is the primary source of mercury. Deposition of mercury has increased from historical levels as a result of power plant emissions and other industrial sources (e.g., cement plants and landfills). Most deposition consists of inorganic mercury, which does not bioaccumulate readily. Bacterial methylation forms methylmercury, which is readily accumulated in food chains. Levels of mercury in fish reflect levels of mercury inputs, geochemical factors affecting methylation, and the trophic structure of waterbodies. Mercury methylation appears to be particularly active in deep lakes with fluctuating oxic-anoxic zones and in systems with extensive wetlands and dissolved organic carbon (DOC), conditions that are present in many Adirondack lakes. Because of the long-range transport of atmospheric mercury and the environmental factors affecting methylation, mercury bioaccumulation may be especially severe in otherwise relatively undisturbed ecosystems. Mercury bioaccumulation is not closely related to lipid (i.e., fat) content, but is higher in older, fish-eating fish. In addition to affecting mercury levels in fish within the basin, transport of mercury by the river is a significant source of mercury entering Lake Ontario. Neurological impairment during development is a primary human health issue for mercury, and different risk levels have been developed for both high risk groups (e.g., children, women of child-rearing age) and lower risk groups. Assessments of high risk groups indicate effects at relatively low amounts of mercury intake, which can be exceeded by frequent consumption of most species of freshwater fish. As a result, general advisories have been developed for all state fish.

As with acidic deposition, recovery ultimately depends on reduction of atmospheric inputs, which is a national regulatory and technological issue. As a result, the primary response to mercury contamination is monitoring concentrations in fish and promulgation of consumption advisories.

One lake, Fourth Lake, has fish consumption advisories based on DDT concentrations. The source of the DDT is unknown, but remediation efforts are underway (NYSDEC 2006a). Although DDT is no longer used in the US, DDT or its breakdown products DDE and DDD (the three together are referred to as DDX) persist in area ecosystems. DDX contamination in fish can result from sediment contamination from historical pesticide applications.

Approximately 43 miles of the lower Black River are classified as impaired due to priority organic contaminants (with other impairments as well). Kelsey Creek is listed as impaired due to PCB concentrations. Like DDT, PCBs are no longer used, but are present from historical uses. PCBs were used in transformers and PCB contamination may come from railroads, electrical facilities, or other industrial uses. In addition to point sources, PCBs can cycle through ecosystems by volatilization and subsequent wet or dry deposition.

Contaminant effects on groundwater resources have been identified as a significant issue in the Black River drainage (NYSDEC 2006a), resulting from historic industrial discharges, hazardous waste sites, and pesticide application.

SEWAGE INPUTS

The input of sewage into local waterbodies can pose both human and ecosystem health risks. Nutrient inputs from sewage can lead to eutrophication and oxygen depletion, with effects on algae, macrophytes, and aquatic fauna. Treatment of sewage from larger communities has reduced eutrophication issues associated with these sources, although failing septic systems still represent significant issues. Replacement of septic systems by municipal sewer systems is financially prohibitive in many areas.[lxxviii] Identification of failing septic systems (e.g., by dye studies) has been conducted by organizations such as the Fulton Chain of Lakes Association. Agricultural land uses represent another large source of nutrient inputs (see below). Combined sewer overflows (e.g., Watertown) are also listed as a source of impairment for the lower Black River.

Many natural and synthetic chemicals may be concentrated and introduced into waterbodies via sewage. Many chemicals are not removed by sewage treatment and may present problems even in areas with no regulatory sewage issues. Endocrine disruption of fish, for example, has been linked to the release of hormone mimics into local waterways from birth control or from plant compounds released below pulp and paper plants. Release of anti-microbial chemicals may affect microbial processing in receiving waters. These issues are generally poorly known and no information has been located on their occurrence in the Black River drainage.

AGRICULTURE

The Black River basin water quality report lists the following agricultural impacts as significant in the Black River drainage, many resulting from poor agricultural practices:

- Nutrient and silt/sediment inputs from agricultural runoff;
- Livestock access to streams, resulting in damage to riparian vegetation, bank erosion, and nutrient inputs;
- Improper manure application;
- Lack of silate leachate control;
- Inputs from manure or milkhouse wastewater treatment facilities;
- Intensive cropping near streams with inadequate riparian buffers;
- Fertilizer and pesticide application without approved pesticide/nutrient management plans. [lxxix]

Agricultural impacts are listed for over one-quarter of the Priority Waterbody List rivers in the drainage area, including tributaries of Mill Creek.[lxxx, lxxxi, lxxxii, lxxxiii] Unlike effects of acidic and mercury deposition, many of these effects can be controlled at the local level. For example, in 2005, the New York State Agricultural Non-point Source Abatement & Control Program awarded grants for several projects in the Black River watershed in Jefferson County to implement best management practices on combined animal feed operations (CAFO's).

Potential impacts from agricultural practices were highlighted by the major fish kill in the Black River near Lowville, resulting from a spill of liquid manure. On August 10, 2005, several million gallons of manure entered the river through a drainage ditch following rupture of a wall of the manure holding lagoon, resulting in depletion of dissolved oxygen and increases in ammonia. Mortality resulted from oxygen depletion, with progressive mortality as the manure traveled downstream, resulting in an estimated loss of 375,000 fish over 20 to 24 miles of river. Many species of fish were killed, including walleye, northern pike, smallmouth bass, rock bass, minnows and darters. Carp and bullhead appeared to be unaffected, as were fish in tributaries and floodplain waterways.

INVASIVE SPECIES

Invasive species can affect human health (e.g., West Nile virus) and wildlife health (e.g., West Nile virus, VHSV), displace native species through competition, predation, interbreeding, disease transmission or habitat destruction, modify food chains (e.g., zebra mussels), change nutrient biogeochemistry and contaminant pathways, and increase streambank erosion. Significant and potentially significant invasive species in the Black River drainage are discussed above.

The section on invasives discussed VHSV as a pathogen with potential effects on the fish fauna of the Black River drainage. A number of other diseases have recently become important locally or nationally. These include West Nile virus (affecting birds, humans, and other mammals), chronic wasting disease (which affects deer), largemouth bass virus, and Chytridiomycosis (a fungal disease that affects amphibians). Transmission of diseases and susceptibility of hosts depends on a variety of factors, including health and immune function of the host (which may be affected by contaminants, crowding, etc.), contact between hosts and native or exotic organisms carrying diseases, and increases in potential for long- and short- range dispersal of diseases.

CLIMATE CHANGE

Climate change is expected to change temperature and the pattern and timing of precipitation. Climate change will have extensive ecological effects, including decrease and possible extirpation of northern species and immigration and increase of southern species, including exotic, potentially-invasive species. The effects on any taxon will depend both on its temperature and moisture requirements and the sensitivity of its habitat to climate change. Sugar maple, for example, is projected to be much more heavily affected by climate change than eastern hemlock, which often occurs in shaded ravines. Changes in the extent and duration of ice cover on lakes and streams will have large effects on these systems by changing the amount of production and lake turnover patterns.

FLOW REGULATION

Flow regulation may be carried out for water storage, for flood control, and to deliver hydroelectric power at times of demand. Flow regulation may create lake conditions upstream of dams that support aquatic organisms, but changes in base flows, peak flows, and the timing of flow variation can have extreme impacts on the downstream biota. Hydroelectric power is generated by the Black, Moose and Beaver Rivers. In 1996, a settlement was made concerning operations of Beaver River Dams (excepting Stillwater). The settlement provided minimum flows for fish in river bypasses downstream of dams, as well as other provisions for increasing recreational use of the river.

NATURAL DISTURBANCES

Several notable short-term disturbances in the Black River drainage have affected ecological conditions over large areas in the basin.[lxxxiv] In November, 1950, a large cyclonic storm blew down large numbers of trees in the Adirondacks. Some of the largest areas of impact were in the Beaver and Moose River drainages. It affected a variety of tree species and was most damaging on north and east-facing hills.[lxxxv] Following the storm, salvage logging was done, with new roads built into wilderness areas to provide logging access. On July 15, 1995, an intense storm created bursts of strong winds, blowing down trees.[lxxxvi] Much of the damage was north and east of the Black River drainage, but parts of the drainage were affected.

EXTERNAL FACTORS

The effects of acidification, mercury, and invasive species, whose sources are primarily located outside the drainage, are discussed above. The drainage is affected by other influences that originate outside of the basin and are therefore largely outside local control. Migratory organisms are also strongly affected by conditions in other parts of their range. The American eel, for example, has been functionally extirpated in the Black River drainage, which was likely caused by dam blockage and various sources of mortality throughout its life stages. Many breeding birds of the drainage winter in the Southern US, the Caribbean, Central America, and/or South America. Decreases in winter habitat has been considered a major threat to many species wintering in the tropics and conditions on US wintering or migration areas could also threaten some species.

FLOODPLAINS

According to FEMA's Community Status Book, fifty-five of the communities located partially or entirely within the watershed are enrolled in the National Flood Insurance Program (NFIP). Only the Town of Montague is not. Eleven of the 55 communities, according to their effective Flood Insurance Studies, are entirely located within Zone C, meaning that there are no Special Flood Hazard Areas (SFHAs). Most all of the original Flood Insurance Rate Maps in these communities, prepared in the mid-1980s, are over 20 years old.

All communities enrolled in the NFIP have adopted zoning codes in the form of floodplain overlay districts, where NFIP regulations apply that are intended to assure compliance with NFIP requirements. Typically, a Floodplain Development Permit is issued by the local community to assure that projects constructed within SFHAs meet these requirements. Projects that are proposed to be located within SFHAs are subject to the NFIP regulations and the associated zoning provisions in the Zoning Code. All new construction and substantial improvements should:

- Be designed (or modified) and adequately anchored to prevent floatation, collapse, or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy; [44 CFR Part 60.3(a) (3) (i)]
- Be constructed with materials resistant to flood damage. This would include assuring that surfacing materials can resist the expected velocities; [44 CFR Part 60.3(a) (3) (ii)]
- Be constructed by methods and practices that minimize flood damages; [44 CFR Part 60.3(a) (3) (iii)];
- Be constructed with electrical, and other services facilities that are designed and/or located so as to prevent water from entering or accumulating within the components during conditions of flooding. [44 CFR Part 60.3(a) (3) (iv)]
- Prohibit any significant encroachments, including fill, new construction, substantial improvements, and other development within the adopted regulatory floodway. [44 CFR Part 60.3(d) (3)]; and
- Not increase the base (100-year) flood elevation by more than 1.0 feet. [44CFR Part 60.3 (c) (13)].

Projected urban land use development pressures will occur primarily along the valleys of the Lower Black River, Middle Black River, Fish Creek, Stillwater, Otter Creek, Independence River, Cummings Creek an the South Branch Moose River watersheds. Since development pressures will be most prevalent in floodplain areas, where development costs are lower, and since many of the FISs are over 20 years old, inclusion of Black River watershed counties (Hamilton, Herkimer, Lewis, Jefferson and Oneida) in FEMA's Map Modernization Program would be an important step towards assuring that floodplains are developed in a manner that minimizes future flood damages.

STORMWATER MANAGEMENT

Development projects generally change an area from natural vegetation to impervious areas, such as roofs, roads, and parking areas. This change can produce a change in runoff patterns downstream of the development. The increased runoff can also contain pollutants from roadway and parking area surfaces. Such an increase in runoff could cause accelerated erosion downstream of a development. The increase in pollutants could flow into wetland areas, streams, lakes and rivers downstream and decrease the quality of these water bodies.

The regulatory tool used in New York State for assuring that development projects neither significantly change stormwater runoff patterns nor significantly increase pollutant loadings is the NYSDEC SPDES General Permit for Stormwater Discharges from Construction Activity (Permit No GP-0-08-001). Actions that disturb more than one acre of land require coverage under this permit (or an individual permit from the US EPA). Requirements for this coverage include the development of an Erosion and Sediment Control Plan (E&SCP) and a Stormwater Pollution Prevention Plan (SWPPP). The SWPPP requires that additional runoff be controlled, and that the Water Quality Volume (WQ_V) be treated in accordance with New York State standards. The Stormwater Management Practices (SMP's) specified by New York typically used to treat the WQ_V are generally effective at removing 80 to 85 percent of pollutants.

In addition to construction activities, discharges from Municipal Separate Storm Sewer Systems (MS4s) in Urbanized or Additionally Designated Areas are also regulated, and must be authorized in accordance with a permit for stormwater discharges from MS4s. According to NYSDEC, there are no MS4s located within the Black River Watershed. Thus, there is presently no means to regulate separate storm sewer systems in the Black Creek Watershed.

ENDNOTES

---

[i] *The 2004 Black River Basin Waterbody Inventory and Priority Waterbodies List*, Bureau of Watershed Assessment and Research Division of Water, NYS Department of Environmental Conservation, May 2007 (http://www.dec.ny.gov/docs/water_pdf/pwlblck07.pdf)

[ii] *A Guide to Land-Use and Land-Cover Change (LUCC)*, Alex de Sherbinin, Columbia University Socioeconomic Data and Applications Center, September 2002 (http://sedac.ciesin.columbia.edu/tg/guide_frame.jsp?rd=LU&ds=1)

[iii] *The USGS Land Cover Institute Fact Sheet*, U.S. Geological Survey, January 2006 (http://landcover.usgs.gov/documents/LCI%20factsheet.pdf)

[iv] Stream Health Rankings Predicted by Satellite Derived Land Cover Metrics, Marcia N. Snyder, Scott J. Goetz, and Robb K. Wright, Journal of the American Water Resources Association (JAWRA), June 2005 (http://www.whrc.org/resources/published_literature/pdf/Snyderetal.JAWRA.05.pdf)

[v] *National Land Cover Database 2001 Factsheet*, The Multi-Resolution Land Characteristics (MLRC) Consortium (http://www.mrlc.gov/pdf/nlcd_fact_sheet_2001.pdf)

[vi] Water Quality on Forest Lands , U.S. Forest Service, April 2008 (http://www.fs.fed.us/rm/value/forest_water_quality.html)

[vii] *Forest Land Cover Effects on Water Quality*, Institute of Water Research, Michigan State University, January 1997 (http://www.iwr.msu.edu/edmodule/water/wtrfrm19.htm)

[viii] *Urban land Use Effects on Water Quality*, Institute of Water Research, Michigan State University, January 1997 (http://www.iwr.msu.edu/edmodule/water/wtrfrm20.htm)

[ix] *New York's Forest Preserve* , New York State Department of Environmental Conservation, 2008 (http://www.dec.ny.gov/lands/4960.html)

[x] *Soil Survey of Oneida County, New York*, U.S. Department of Agriculture Natural Resources Conservation Service, in partnership with Cornell University, 2008

[xi] Ibid

[xii] *Soil Survey of St. Lawrence County, New York*, U.S. Department of Agriculture Natural Resources Conservation Service, in partnership with Cornell University, 2005

[xiii] *Watershed Protection for Adirondack Wetlands: A Demonstration-Level GIS Characterization of Subcatchments of the Oswegatchie/Black River Watershed*, K.M.Roy, R.P.Curran, J.W.Barge, D.M.Spada (New York State Adirondack Park Agency), D.J.Bogucki, E.B.Allen (State University of New York at Plattsburgh), and W.A.Kretser (Adirondack Lakes Survey Corporation), February 1996 (http://www.apa.state.ny.us/Research/OB2/Reports/Ob1final.htm)

[xiv] *Wetlands and Wtaer Quality*, North Carolina Cooperative Extension Service, Publication Number: AG 473-7, June 1996 (http://www.bae.ncsu.edu/programs/extension/evans/ag473-7.html)

[xv] *Technical Aspects of Wetlands: Wetland Hydrology, Water Quality, and Associated Functions*, National Water Summary on Wetland Resources, U.S Geological Survey, March 1997 (http://water.usgs.gov/nwsum/WSP2425/hydrology.html)

[xvi] Ibid

[xvii] *Primer on Natural Hazard Management in Integrated Regional Development Planning: Chapter 8 – Floodplain Definition and Flood Hazard Assessment*, Organization of American States, Department of Sustainable Development, 1991 (http://www.oas.org/dsd/publications/Unit/oea66e/ch08.htm)

[xviii] Ibid

[xix] *Groundwater Primer*, Purdue University College of Engineering,, 1997 (http://cobweb.ecn.purdue.edu/~epados/ground/src/confined2.htm)

[xx] *The Ecological Zones of Northern New York*, G.B. Will, R.D. Stumvoll, R.F. Gotie, and E.S. Smith, New York Fish and Game JHournal, NYS Department of Environmental Conservation, Volume 29, No. 1, January 1982

[xxi] *A Biological Survey of the Oswegatchie and Black River Systems*, J.R. Greeley, 1932. New York Biological Survey No. 6. State of New York Conservation District, Supp. to 21st annual report, 1931. 344 pp

[xxii] *The Ecological Zones of Northern New York*, G.B. Will, R.D. Stumvoll, R.F. Gotie, and E.S. Smith, New York Fish and Game JHournal, NYS Department of Environmental Conservation, Volume 29, No. 1, January 1982

[xxiii] *Ibid*

[xxiv] *A Biological Survey of the Oswegatchie and Black River Systems*, J.R. Greeley, 1932. New York Biological Survey No. 6. State of New York Conservation District, Supp. to 21st annual report, 1931. 344 pp

[xxv] *Fishes of the Black River Watershed, Survey Update*, D.M. Carlson, February 2007.

[xxvi] *Comprehensive Wildlife Conservation Strategy (CWCS) Plan*, NYS Department of Environmental Conservation (http://www.dec.ny.gov/docs/wildlife_pdf/nathist.pdf)

[xxvii] *Fishes of the Black River Watershed, Survey Update*, D.M. Carlson, February 2007.

[xxviii] *The Mammals of the Tug Hill Plateau, New York*, P.F. Connor, 1966, Bull. 406 New York State Museum and Science Service. 82 pp.

[xxix] *Adirondack Mammals*. D.A. Saunders, no date, State University of New York, College of Environmental Science and Forestry. 216 pp.

[xxx] *The Adirondack Atlas: A Geographic Portrait of the Adirondack Park*, J.Jenkins and A. Keal, 2004, Wildlife Conservation Society. 274 pp.

[xxxi] *Adirondack Mammals*. D.A. Saunders, no date, State University of New York, College of Environmental Science and Forestry. 216 pp.

[xxxii] *The Adirondack Atlas: A Geographic Portrait of the Adirondack Park*, J.Jenkins and A. Keal, 2004, Wildlife Conservation Society. 274 pp.

[xxxiii] *New York State Breeding Bird Atlas 2000* [Internet]. 2000 - 2005. Release 1.0. Albany (New York): New York State Department of Environmental Conservation. [updated 2007 Jun 11; cited 2008 Aug 13]. http://www.dec.ny.gov/animals/7312.html.

[xxxiv] As defined by 6 NYCRR § 182.2(g) and 193.3(b)

[xxxv] As defined by 6 NYCRR § 182.2(h) and 193.3(c)

xxxvi As defined by 6 NYCRR § 182.2(i)

xxxvii *Final Report of the Invasive Species Task Force*, Invasive Species Task Force (ISTF), 2005. New York State Department of Environmental Convervation and the New York State Department of Agriculture and Markets. Albany, NY. 146 pp.

xxxviii *Cryptic Invasion by a Non-native Genotype of the Common Reed, Phragmites australis, into North America*, K.Saltonstall, 2002. Proc. Nat. Acad. Sci.: 99(4):2445-2449.

xxxix *The Atlas of breeding birds in New York State*, R.F. Andrle and J.R. Carroll, 1988, Cornell University Press, Ithaca. 551 pp.

xl *Is purple loosestrife (Lythrum salicaria) an invasive threat to freshwater wetlands? Conflicting evidence from several ecological metrics.* E.J. Farnsworth and D.R. Ellis, 2001, Wetlands 21(2):199-209.

xli *Wetland Vegetation Before and After Experimental Purple Loosestrife Removal*, J.A. Morrison, 2002, Wetlands. 22(1):159-169.

xlii *Avian use of purple loosestrife dominated habitat relative to other vegetation types in a Lake Huron wetland complex*, M.B. White, H.H. Prince, and R.R. Cox, Jr. 1999. Wilson Bull. 111(1):105-114.

xliii *Volunteer Monitoring of Nonindigenous Invasive Plant Species in the Adirondack Park, New York, USA*, W.T. Brown, M.E. Krasny, and N. Schoch, 2001, Natural Areas J. 21:189-196.

xliv *Seed germinability and its seasonal onset of Japanese knotweed (Polygonum cuspidatum)*, M.R. Bram and J. N. McNair, 2004, 52(5):759-767.

xlv *Volunteer Monitoring of Nonindigenous Invasive Plant Species in the Adirondack Park, New York, USA*, W.T. Brown, M.E. Krasny, and N. Schoch, 2001, Natural Areas J. 21:189-196.

xlvi *Comparison of fish and macroinvertebrate use of Typha angustifolia, Phragmites australis, and treated Phragmites marshes along the lower Connecticut River*, P.E. Fell, R.S. Warren, J.K. Light, R.L. Rawson, Jr., and S.M. Fairley, 2003, Estuaries 26(2B):534-551.

xlvii *Does Phragmites expansion alter the structure and function of marsh landscapes? Patterns and processes revealed*, R.G. Lathrop, L. Windham, and P. Montesano, 2003, Esturaries 26(2B):423-435.

xlviii *Is the invasion of the common reed, Phragmites australis, into tidal marshes of the eastern US an ecological disaster?* J.S.Weis and P. Weis, 2003, Mar. Poll. Bull. 46:816-820.

xlix *Volunteer Monitoring of Nonindigenous Invasive Plant Species in the Adirondack Park, New York, USA*, W.T. Brown, M.E. Krasny, and N. Schoch, 2001, Natural Areas J. 21:189-196.

l *Rhamnus cathartica: Native and naturalized distribution and habitat preferences*, J S Kurylo, K.S. Knight, J.R. Stewart, and A.G. Endress, 2007, Journal of the Torrey Botanical Society 134: 420-430.

li *Ibid*

lii *Volunteer Monitoring of Nonindigenous Invasive Plant Species in the Adirondack Park, New York, USA*, W.T. Brown, M.E. Krasny, and N. Schoch, 2001, Natural Areas J. 21:189-196.

liii *Ibid*

liv *Dreissena rostriformis bugensis* Fact Sheet, USGS Nonindigenous Aquatic Species Database, A.J. Benson, M.M. Richardosn, and E. Maynard, March 2008 (http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=95)

lv *Round goby mediated viral distribution and impacts to smallmouth bass in the St. Lawrence River*, G. Eckerlin, J. Farrell, P. Bowser, and G. Groocock, 2008, Annual Meeting of the American Fisheries Society, Ottawa, Canada, 17-21 August, 2008.

lvi *Fishes of the Black River Watershed, Survey Update*, D.M. Carlson, February 2007.

lvii *Final Report of the Invasive Species Task Force*, Invasive Species Task Force (ISTF), 2005. New York State Department of Environmental Convervation and the New York State Department of Agriculture and Markets. Albany, NY. 146 pp.

lviii *Viral Hemorrhagic Septicemia Virus (VHSV): Development of improved detection methodologies and viral stability at various environmental conditions*, K.Garver, L. Hawley, and S. Edes, 2008, Annual Meeting of the American Fisheries Society, Ottawa, Canada, 17-21 August, 2008.

lix *Emergence of Viral Hemorrhagic Septicemia Virus among populations of wild fish in the Great Lakes Region of the United States and Canada,* J. Winton, 2008. Annual Meeting of the American Fisheries Society, Ottawa, Canada, 17-21 August, 2008.

lx *Facts on Viral Hemorrhagic Septicemia (VHS)*, Wisconsin Department of Natural Resources, April 2008 (http://dnr.wi.gov/fish/vhs/vhsfacts.html)

lxi *Emergence of Viral Hemorrhagic Septicemia in the Great Lakes basin: lessons learned and effectiveness of surveillance strategies*, M. Faisal. and R. Kim, 2008, Annual Meeting of the American Fisheries Society, Ottawa, Canada, 17-21 August, 2008.

lxii *Die-off of muskellunge (Esox masquinongy) in the Upper St. Lawrence River caused by Viral Haemorrhagic Septicaemia, 2005-2007 impacts and consequences*, J. Casselman, T. Lusk, J. Farrell, and C. Lake, 2008, Annual Meeting of the American Fisheries Society, Ottawa, Canada, 17-21 August, 2008.

lxiii *Final Report of the Invasive Species Task Force*, Invasive Species Task Force (ISTF), 2005. New York State Department of Environmental Convervation and the New York State Department of Agriculture and Markets. Albany, NY. 146 pp.

lxiv *Volunteer Monitoring of Nonindigenous Invasive Plant Species in the Adirondack Park, New York, USA*, W.T. Brown, M.E. Krasny, and N. Schoch, 2001, Natural Areas J. 21:189-196.

lxv *New York State Water Quality 305b Report*, New York State Department of Environmental Conservation (NYSDEC), 2006 (http://www.dec.ny.gov/docs/water_pdf/305breport2006.pdf.)

lxvi *The New York State 2006 Section 303(d) List of Impaired Waters Requiring a TMDL/Other strategy,* New York State Department of Environmental Conservation (NYSDEC), 2006. (http://www.dec.ny.gov/docs/water_pdf/303dlist06.pdf)

lxvii *The Black River Drainage Basin, sampling years 2002-2003.* New York State Department of Environmental Conservation (NYSDEC), Rotating Integrated Basin Studies, Water Quality Assessment Program, New York Statewide Waters Monitoring Program, 2006, 90 pp.

lxviii *Response of surface water chemistry to reduced levels of acid precipitation: comparison of trends in two regions of New York, USA*, D.A. Burns, M.R. McHale, C.T. Driscoll, and K.M. Roy, 2005, Hydrological processes 20(7):1611-1627.

[lxix] *Changes in the chemistry of lakes in the Adirondack region of New York following declines in acidic deposition,* C.T. Driscoll, K.M.. Driscoll, K.M. Roy, and J. Dukett, 2007, Applied Geochemistry 22(6):1181-1188.

[lxx] *Ibid*

[lxxi] *Assessing Changes in Fish Assemblages in Adirondack Lakes,* R. Daniels, R. Bombard, J. Sutherland, and C. Boylen, 2008, Northeastern Natural History Conference, April 17-18, 2008, Albany, NY.

[lxxii] *Acid Rain in the Adirondacks: A Time of Change!*, K. Roy, W. Kretser, H. Simonin, and E. Bennett, 2000, Adirondack J. Env. Studies. Spring/summer 2000:26-32.

[lxxiii] *Effects of acid rain on the chemistry of Western Adirondack streams in 2003-2005. Wet and Dry deposition measurements : Do we have the total picture?,* G.B.Lawrence, K.M. Roy, B.P. Baldigo, H.A. Simonin, S.B. Capone, J.W. Sutherland, S.A. Nierzwicki-Bauer, and C.R. Boylen, 2007, Abstracts of the Meeting of the National Acid Deposition Program, Boulder, CO, 10-13 September, 2007. p 30.

[lxxiv] *Acid Rain in the Adirondacks: A Time of Change!*, K. Roy, W. Kretser, H. Simonin, and E. Bennett, 2000, Adirondack J. Env. Studies. Spring/summer 2000:26-32.

[lxxv] *Hardwood regeneration failure in the Adirondacks. Preliminary studies of Incidence and Severity*, J. Jenkins, 1997, Working Paper no. 9. Wildlife Conservation Society. 60 pp.

[lxxvi] *Adverse effects of acid rain on the distribution of the wood thrush Hylocichla mustelina in North America*, R.S. Haines, K.V. Rosenberg, J.D. Lowe, S.E. Barker, and A.A. Dhondt, 2002, Proc. Nat. Acad. Sci. 99(17):11235-11240.

[lxxvii] *Biological Mercury Hotspots in the Northeastern United States and Southeastern Canada*, D.C Evers, Y. Han, C.T. Driscoll, N.C. Kamman, M.W. Goodale, K.F. Lambert, T.M. Holsen, C.Y. Chen, T.A. Clair, and T. Butler, 2007, BioScience 57(1):29–43

[lxxviii] *New York State Water Quality 305b Report*, New York State Department of Environmental Conservation (NYSDEC), 2006 (http://www.dec.ny.gov/docs/water_pdf/305breport2006.pdf.)

[lxxix] *Ibid*

[lxxx] *Ibid*

[lxxxi] *The New York State 2006 Section 303(d) List of Impaired Waters Requiring a TMDL/Other strategy,* New York State Department of Environmental Conservation (NYSDEC), 2006. (http://www.dec.ny.gov/docs/water_pdf/303dlist06.pdf)

[lxxxii] *The 2004 Black River Basin Waterbody Inventory and Priority Waterbodies List*, Bureau of Watershed Assessment and Research Division of Water, NYS Department of Environmental Conservation, May 2007 (http://www.dec.ny.gov/docs/water_pdf/pwlblck07.pdf)

[lxxxiii] *The draft New York State 2008 Section 303(d) List of Impaired Waters Requiring a TMDL/Other strategy*, New York State Department of Environmental Conservation (NYSDEC), 2008 (http://www.dec.ny.gov/docs/water_pdf/303dlistdraft08.pdf)

[lxxxiv] *An Adirondack Chronology*, G Chilson, C. George, R. Tucker, and T. Wheeler, 2003, Association for the Protection of the Adirondacks. 157 pp.

[lxxxv] *The Adirondack Atlas; A Geographic Portrait of the Adirondack Park*, J. Jenkins and A. Teal, 2004, Wildlife Conservation Society, Syracuse University and The Adirondack Museum. 275 pp.

[lxxxvi] *Ibid*